z/OS

UNIX System Services User's Guide

Version 2 Release 2

SA23-2279-01

Note
Before using this information and the product it supports, read the information in "Notices" on page 337.

This edition applies to Version 2 Release 2 of z/OS (5650-ZOS) and to all subsequent releases and modifications until otherwise indicated in new editions.

Contents

Figures

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About this document

This document offers an introduction to the two shells available on z/OS UNIX System Services (z/OS UNIX) — the z/OS shell and the tcsh shell.

This document provides the information you need to use the z/OS Shells and Utilities on an IBM® z/OS® system. The Shells and Utilities and TSO/E (Time Sharing Option Extensions) provide commands for using z/OS UNIX.

This document helps you use the functions specified in the POSIX.2 standard (IEEE Std 1003.2-1992 and ISO/IEC 9945-1992 International Standard; Portable Operating System Interface [POSIX] Part 2: Shell and Utilities). For convenience, it also describes other z/OS UNIX support services.

Who should use z/OS UNIX System Services User's Guide?

This document is for application programmers, systems programmers, and users working on a z/OS system and using z/OS UNIX services or the z/OS shells.

This document assumes that readers are familiar with the z/OS system and with the information for z/OS and its accompanying products.

For information about the features and concepts of z/OS UNIX, and for answers to many questions you might have, see our website at

http://www.ibm.com/systems/z/os/zos/features/unix/

What is in z/OS UNIX System Services User's Guide?

This document describes how to use the shells, the file system, and communication services. Using the document, you can:

- Enter shell commands that request services from the system.
- Write shell scripts using the shell programming language; a shell script can be as powerful as a C-language program.
- Run shell scripts and C language programs interactively (in the foreground), in the background, or in batch.
- Switch easily between the shells and TSO/E.
- Move MVS™ data sets into the file system, or move files from the file system into MVS data sets.
- Enter shell commands or TSO/E commands from the shell command line.
- Create or edit a file in the file system.
- Manage your file system.

For a discussion of the z/OS UNIX shell commands, utilities, TSO/E commands, and file formats, see *z/OS UNIX System Services Command Reference*.

Tasks that can be performed in more than one environment

There are some tasks that can be performed in more than one environment: in the shells, in TSO/E, or perhaps in ISPF. If the same task can be performed in more than one environment, that is noted.

z/OS information

This information explains how z/OS references information in other documents and on the web.

When possible, this information uses cross document links that go directly to the topic in reference using shortened versions of the document title. For complete titles and order numbers of the documents for all products that are part of z/OS, see *z/OS Information Roadmap*.

To find the complete z/OS library, go to IBM Knowledge Center (http://www.ibm.com/support/knowledgecenter/SSLTBW/welcome).

IBM Systems Center publications

IBM Systems Centers produce IBM Redbooks® publications that can be helpful in setting up and using z/OS UNIX. See the IBM Redbooks site at IBM Redbooks (http://www.ibm.com/redbooks).

These documents have not been subjected to any formal review nor have they been checked for technical accuracy, but they represent current product understanding at the time of their publication and provide information on a wide range of topics. You must order them separately. A selected list of these documents is on the z/OS UNIX website at http://www.ibm.com/systems/z/os/zos/features/unix/library/.

Porting information for z/OS UNIX

A *Porting Guide* is available at z/OS UNIX System Services Porting Guide (http://www.ibm.com/systems/z/os/zos/features/unix/bpxa1por.html). It covers a range of useful topics, including sizing a port, setting up a porting environment, ASCII-EBCDIC issues, performance, and much more.

The porting page also features a variety of porting tips and lists porting resources that will help you in your port.

z/OS UNIX courses

For a current list of courses that you can take, go to IBM Education home page (http://www.ibm.com/services/learning/).

z/OS UNIX home page

Visit the z/OS UNIX home page at z/OS UNIX home page (http://www.ibm.com/systems/z/os/zos/features/unix/).

Some of the tools available from the website are ported tools, and some are unsupported tools designed for z/OS UNIX. The code works in our environment at the time we make it available, but is not officially supported. Each tool has a readme file that describes the tool and lists any restrictions.

The simplest way to reach these tools is through the z/OS UNIX home page. From the home page, click on **Tools and Toys**.

The code is also available from **ftp://ftp.software.ibm.com/s390/zos/unix/** through anonymous FTP.

Because the tools are not officially supported, APARs cannot be accepted.

Discussion list

Customers and IBM participants also discuss z/OS UNIX on the **mvs-oe discussion list**. This list is not operated or sponsored by IBM.

To subscribe to the mvs-oe discussion, send a note to:

listserv@vm.marist.edu

Include the following line in the body of the note, substituting your given name and family name as indicated:

`subscribe mvs-oe` *`given_name family_name`*

After you have been subscribed, you will receive further instructions on how to use the mailing list.

How to send your comments to IBM

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Use one of the following methods to send your comments:

1. Send an email to mhvrcfs@us.ibm.com.
2. Send an email from the "Contact us" web page for z/OS (http://www.ibm.com/systems/z/os/zos/webqs.html).

Include the following information:

- Your name and address.
- Your email address.
- Your telephone or fax number.
- The publication title and order number:
  z/OS V2R2 UNIX System Services User's Guide
  SA23-2279-01
- The topic and page number that is related to your comment.
- The text of your comment.

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If you have a technical problem

Do not use the feedback methods that are listed for sending comments. Instead, take one of the following actions:

- Contact your IBM service representative.
- Call IBM technical support.
- Visit the IBM Support Portal at z/OS Support Portal (http://www-947.ibm.com/systems/support/z/zos/).

Summary of changes

This information includes terminology, maintenance, and editorial changes. Technical changes or additions to the text and illustrations for the current edition are indicated by a vertical line to the left of the change.

Summary of changes for z/OS Version 2 Release 2 (V2R2)

The following changes are made in z/OS Version 2 Release 2 (V2R2).

New

- No content was added to this information.

Changed

- Additional information was added to "Naming files" on page 211.

Deleted

- No content was removed from this information.

Summary of changes for z/OS Version 2 Release 1

See the following publications for all enhancements to z/OS Version 2 Release 1 (V2R1):

- *z/OS Migration*
- *z/OS Planning for Installation*
- *z/OS Summary of Message and Interface Changes*
- *z/OS Introduction and Release Guide*

Part 1. The z/OS shells

These topics provide an overview of the information relating to the z/OS shells.

Chapter 1. An introduction to the z/OS shells

There are two shells available for use on z/OS UNIX System Services:

- The z/OS shell
- The tcsh shell

The z/OS shell is modeled after the UNIX System V shell with some of the features found in the Korn shell. As implemented for z/OS UNIX System Services, this shell conforms to POSIX standard 1003.2, which has been adopted as ISO/IEC International Standard 9945-2: 1992.

The tcsh shell is an enhanced but compatible version of csh, the Berkeley UNIX C shell. It is a command language interpreter usable as a login shell and as a shell script command processor.

Figure 1 shows how these shells fit into z/OS.

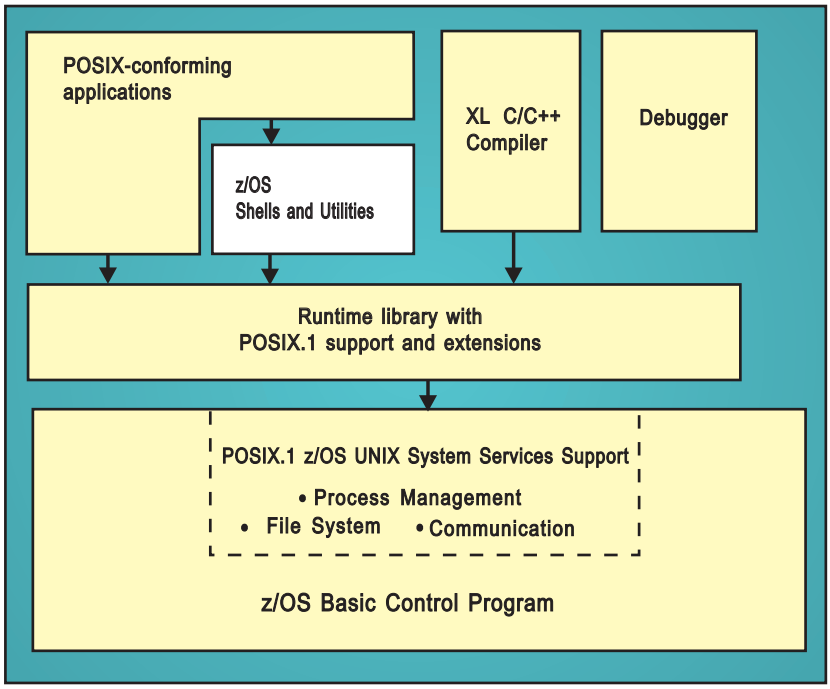

Figure 1. How the shells fit into z/OS

About shells

A shell is a command interpreter that you use to:

- Invoke shell commands or utilities that request services from the system.
- Write shell scripts using the shell programming language.
- Run shell scripts and C-language programs interactively (in the foreground), in the background, or in batch.

Shell commands and utilities

Both the z/OS shell and the tcsh shell provide commands and utilities that give the user an efficient way to request a range of services. In this topic, the term *command* is used to include both a *command* (a directive to a shell to perform a specific task) and a *utility* (the name of a program callable by name from a shell).

Shell commands often have *options* (also known as *flags*) that you can specify, and they usually take an *argument*—such as the name of a file or directory. The format for specifying the command begins with the command name, then the option or options, and finally the argument, if any. For example:

```
ls -a myfiles
```

ls is the command name, **-a** is the option, and *myfiles* is the argument.

This information describes various commands you can use to perform certain tasks; most of these are shell commands, and some are TSO/E commands. This discussion highlights only certain functions of the command. For complete information about each command and all its options, see *z/OS UNIX System Services Command Reference*

The locale in the shells

A *locale* specifies cultural and language characteristics of the z/OS UNIX environment for an application program. Locale affects collation, date and time conventions, numeric and monetary formats, program messages, yes and no prompts, and the hexadecimal encoding for the 13 variant characters whose encoding varies on different EBCDIC code pages.

The shells and utilities support a variety of locales. See “Changing the locale in the shell” on page 45 for information about changing the locale in the shells.

Daemon support

z/OS UNIX System Services provides daemons, such as **cron**, a batch scheduler, and **inetd**, which handles **rlogin** requests.

- For information about each daemon that z/OS UNIX System Services provides, see *z/OS UNIX System Services Command Reference*.

Running an X-Window application

If you are accessing the shell from a workstation or X-terminal running an X-Window server, you can run an X-Window application from the shell. An X-Window application needs the TCP/IP address and display identifier for your workstation.

The shell user

There are two categories of shell user: *superuser* and *user*. The superuser can do anything a user can, but has special authority to perform certain additional tasks, such as mounting and unmounting a file system. The superuser can access all z/OS UNIX services and all the files in the hierarchical file system.

Security

This information assumes that your system includes the RACF® security product. Instead of RACF, your system could have an equivalent security product.

The systems programmer defines a shell user by assigning the user an *OMVS user ID (UID)* and *group ID (GID)*. These are numeric values associated with a TSO/E user ID; they are set in the RACF user profile and group profile when a user is authorized to use z/OS UNIX services. The system uses the UID and GID to identify the files that a user owns and the processes that a user runs. The UID identifies a user of z/OS UNIX services. The GID is a unique number assigned to a group of related users.

As a user, you can control read, write, and execute access to your files by other users in your group or outside of your group, by setting the permission bits associated with the files.

Accessing the shells — the choices

User's settings are initially configured with the z/OS shell as the default login shell. To display these settings from TSO type:

```
LISTUSER USERNAME OMVS
```

The RACF settings for that user are displayed:

```
UID= 0000000012
 HOME= /shut/home/billyjc
 PROGRAM= /bin/sh
 CPUTIMEMAX= NONE
 ASSIZEMAX= NONE
 FILEPROCMAX= NONE
 PROCUSERMAX= NONE
 THREADSMAX= NONE
 MMAPAREAMAX= NONE
 READY
```

The PROGRAM line refers to the user's login shell. If it is **/bin/sh**, the login shell is set to the z/OS shell. If it is **/bin/tcsh**, the login shell is the tcsh shell. To change a user's default login shell from the z/OS shell to the tcsh shell, issue this command:

```
ALTUSER USERNAME OMVS(PROGRAM('/bin/tcsh'))
```

To change a user's default login shell from the tcsh shell to the z/OS shell, type:

```
ALTUSER USERNAME OMVS(PROGRAM('/bin/sh'))
```

Terminal emulators

z/OS provides several terminal emulators that you can use to access the shells:

- The TSO/E OMVS command, a 3270 terminal interface
- The **rlogin** command, an asynchronous terminal interface
- The **telnet** command, an asynchronous terminal interface

When selecting a terminal emulator, there are several key points to consider:

- **Code page conversion:** By default, z/OS UNIX System Services operates in the POSIX locale (also known as the C locale) using code page IBM-1047, but it can operate in other locales, including double-byte locales. Unless you change the locale in the shell so that the code page used by the shell matches the code page used by the workstation for the z/OS UNIX session, a terminal emulator must perform some code page conversion. Mechanisms are provided to specify the conversion required for your situation:

  - The OMVS command has the CONVERT parameter to specify the conversion between the code page used at your workstation and the code page used in the shell.
  - **rlogin** and **telnet** convert from ASCII ISO8859-1 to EBCDIC IBM-1047 by default. Once you are logged in to the shell, you can use the **chcp** to select other code pages to convert between for the session.
- **Number of sessions:** Some terminal emulators allow multiple interactive sessions for the same user. This can be accomplished by multiple logins or by using an emulator that allows multiple sessions with one login.
- **File editing:** With the OMVS emulator, you can use the ISPF editor. For the other terminal emulators, **vi** is the editor of choice.
- **Shell mode: rlogin** and **telnet** provide both line mode (also known as canonical mode) and raw mode, while OMVS operates in line mode only. Line mode is sufficient for most shell utilities. However, the full function of certain useful utilities, such as **vi** and the command line editing feature of the shell, are available only in raw mode.

  When you first login to the shell, you are in line mode. Depending on your means of access, you may then be able to use utilities that require raw mode or run an X-Window application.

  line mode
  Your input is processed after you press <Enter>.

  raw mode
  Each character is processed as you type it.

  graphical mode
  A graphical user interface for X-Window applications

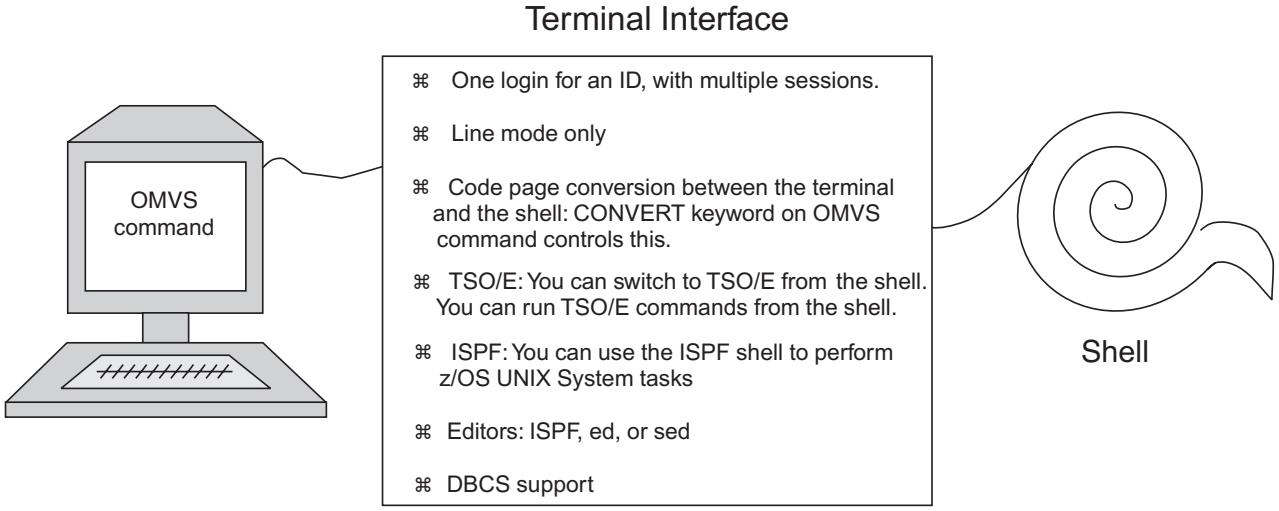

Figure 2. The OMVS interface to the shell

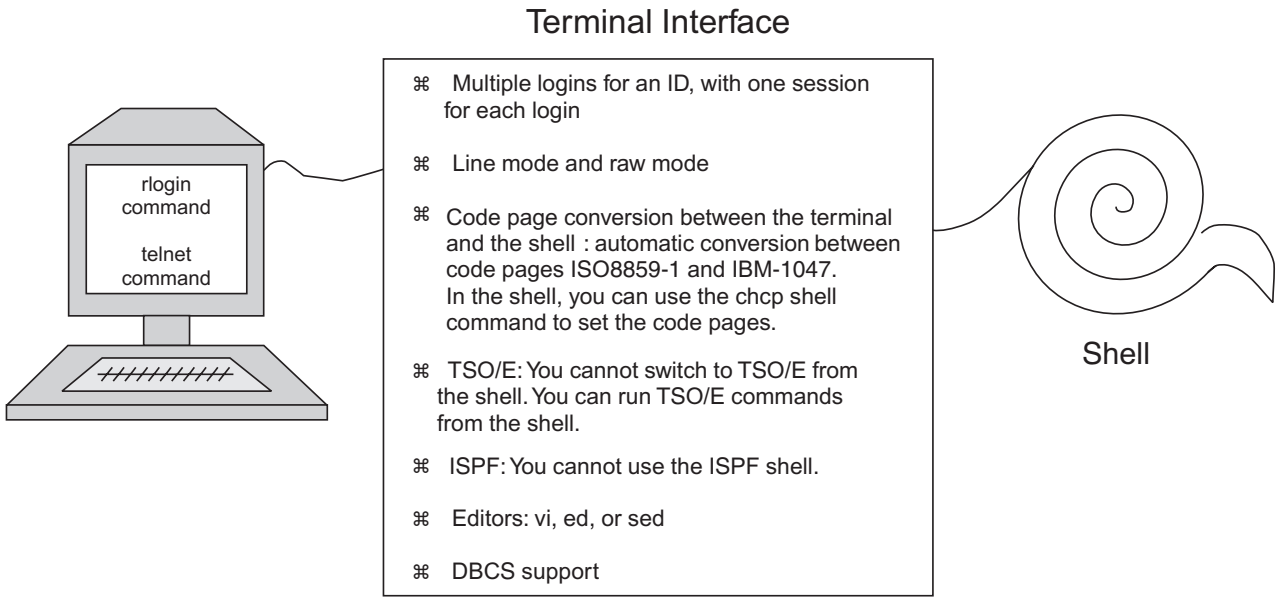

Figure 3. The asynchronous terminal interface to the shell

Interoperability between the shells and MVS

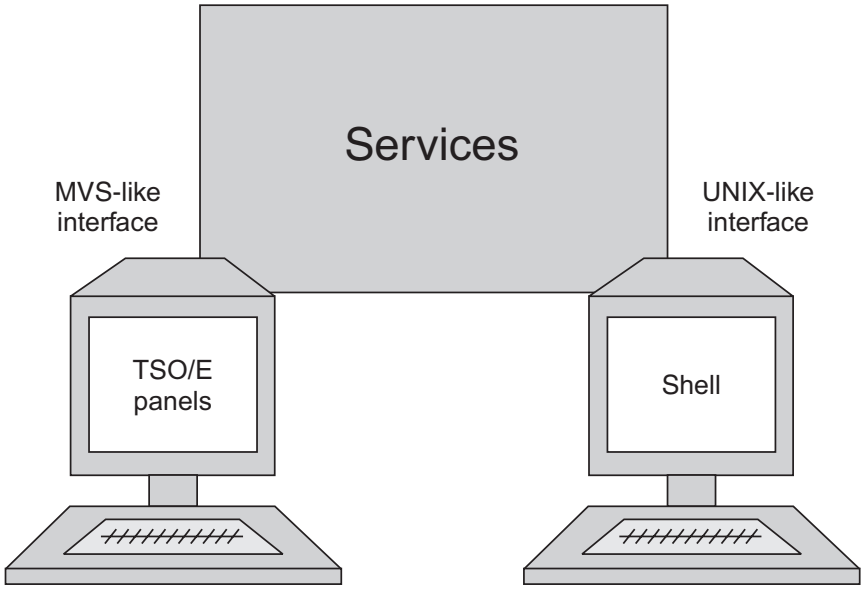

Figure 4. z/OS UNIX System Services provides the user interfaces of both MVS and UNIX

There is a high degree of interoperability between MVS and the z/OS shells:

- You can move data between MVS data sets and the z/OS UNIX file system. You can copy or move MVS data sets into z/OS UNIX files; likewise, you can copy or move z/OS UNIX files into MVS data sets.
- To work with z/OS UNIX files, you can use TSO/E commands or shell commands. If you have access to ISPF, you can use the panel interface of the

ISPF shell. For example, you can create a directory with the TSO/E MKDIR command, or the shell **mkdir** command, or the ISPF shell.

- You can issue TSO/E commands from the shell command line, from a shell script, or from a program. See "Using commands to work with directories and files" on page 197 for a list of TSO/E commands you can use to work with the file system.
- You can write job control language (JCL) that includes shell commands.
- To edit z/OS UNIX files, you can use the ISPF/PDF full-screen editor or one of the editors available in the shell.
- REXX programs can access kernel callable services by using z/OS UNIX extensions to the REstructured eXtended eXecutor (REXX) language. You can run REXX programs using these extensions from TSO/E, batch, the shell, or a C program.
- Use the OSHELL REXX exec to run a non-interactive shell command or shell script from the TSO/E `READY` prompt and display the output to your terminal. This exec is shipped with z/OS UNIX System Services.

Parallels between the MVS environment and the shell environment

Figure 5 on page 9 indicates how basic programming tasks are performed in the MVS environment and in the shell environment.

An interactive user who uses the OMVS command to access the shell can switch back and forth between the shell and TSO/E, the interactive interface to MVS.

- Programmers whose primary interactive computing environment is a UNIX or AIX® workstation find the shell programming environment familiar.
- Programmers whose primary interactive computing environment is TSO/E and ISPF can do much of their work in that environment.

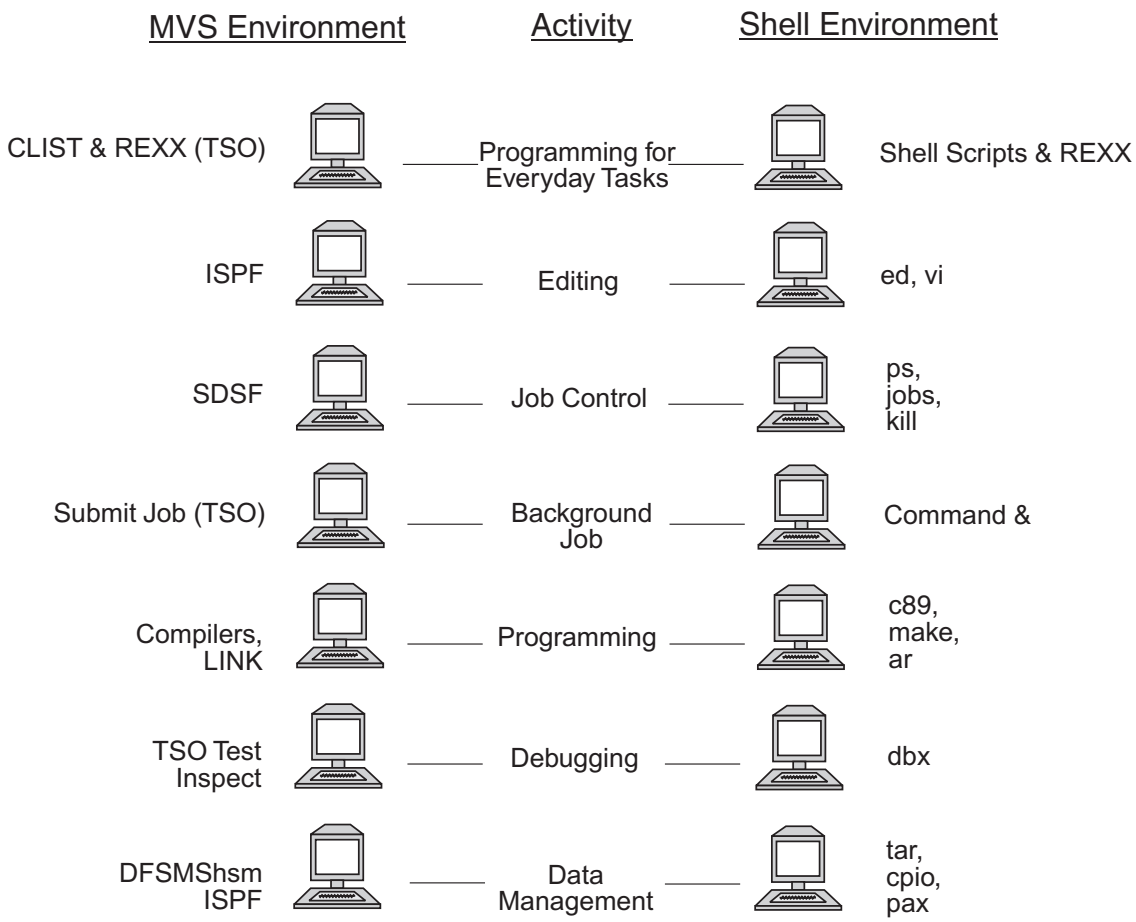

Figure 5. Working interactively in the MVS and shell environments

Programming for everyday tasks

The shell programming environment with its shell scripts provides function similar to the TSO/E environment with its command lists (CLISTs) and the *REstructured eXtended eXecutor (REXX)* execs.

The *CLIST* language is a high-level interpreter language that lets you work efficiently with TSO/E. A *CLIST* is a program, or command procedure, that performs a given task or group of tasks. CLISTs can handle any number of tasks, from running multiple TSO/E commands to running programs written in other languages. CLISTs can run only in a TSO/E environment. For a discussion of CLISTs, see *z/OS TSO/E CLISTs*.

The *REXX* language is a high-level interpreter language that enables you to write programs in a clear and structured way. You can use the REXX language to write programs called *REXX programs,* or *REXX execs,* that perform given tasks or groups of tasks. REXX programs can run in any MVS address space. You can run REXX programs that call z/OS UNIX services in TSO/E, batch, in the shell environment, or from a C program. For more information about writing REXX programs, see *z/OS TSO/E REXX User's Guide*, *z/OS TSO/E REXX Reference*, and *z/OS Using REXX and z/OS UNIX System Services*.

In the shells, command processing is similar to command processing for CLISTs. You can write executable *shell scripts* (a sequence of shell commands stored in a text file) to perform many programming tasks. They can run in any dubbed MVS address space. They can be run interactively, using **cron**, or using BPXBATCH. With its commands and utilities, the shell provides a rich programming environment.

Editing

In MVS, you can edit z/OS UNIX files by using the TSO/E OEDIT command to invoke ISPF File Edit or by selecting File Edit on the ISPF menu, if it is installed.

In a shell, you can use the **ed** and **sed** editors for editing z/OS UNIX files. You can use the **oedit** shell command to invoke ISPF File Edit. If you use **rlogin** or **telnet** to login to the shell, you can also use the **vi** editor.

Job control

In MVS, you can use the System Display and Search Facility (SDSF) to monitor and control a job. You can also use the TSO/E CANCEL, STATUS, and OUTPUT commands.

In the shell, you use the **ps** command or the **jobs** command to check the status of a job, and the **kill** command to end a job before it completes.

Additionally, in the shell you can stop, or suspend, a foreground job, and then enter the **bg** command to run it in the background or the **fg** command to start it back up in the foreground.

Background jobs

In MVS, you write a background job in job control language (JCL) and start it with the TSO/E SUBMIT command.

In the shell, you start a background job by typing an ampersand (**&**) at the end of the command line.

Programming

In MVS, you use the z/OS XL C/C++ compiler and the linkage editor to create a traditional z/OS XL C/C++ application program as a load module or to create a z/OS XL C/C++ application program as an executable file or a load module.

In the shell, you can use the **c89** or **cc** or **c++** command to compile and link-edit a z/OS UNIX program, creating an executable file. The **make** command is available for building applications, and **lex** and **yacc** are available for developing applications.

Debugging

Under TSO/E, for traditional z/OS XL C/C++ application programs, TSO/E Test and Inspect facilities are available for debugging. You can use TSO/E TEST for z/OS UNIX application programs that do not use **fork()** or **exec()**.

In the shell, **dbx** is the debugging facility for z/OS XL C/C++ programs. With **dbx**, you can debug multithreaded applications at the C-source level or at the machine level. Support for multithreaded applications gives you the ability to:

- Debug or display information about the following objects related to multithreaded applications: threads, mutexes, and condition variables.
- Control program execution by holding and releasing individual threads

The **dbx** debugger provides support for recognizing, displaying, and modifying program variables and constants that include double-byte character set (DBCS) characters.

The **dbx** debugger also provides core dump analysis when run in dump processing mode.

Data management

In MVS, the storage administrator uses Data Facility System-Managed Storage Hierarchical Storage Manager (DFSMShsm) to automatically back up and archive hierarchical file systems.

In the shell, you can use **tar**, **cpio**, and **pax** to read or write an archive file in the file system.

You can copy archive files to an MVS data set, and then to tape. You can retrieve archive files from a tape into an MVS data set and then copy them into the file system.

Chapter 2. OMVS, a 3270 terminal interface to the z/OS shell

The explanations and examples in this topic assume that the z/OS shell has been set up in your profile. The information presented here is primarily directed towards users of the z/OS shell.

The TSO/E **OMVS** command is one method of accessing the z/OS shell. It provides a 3270 terminal interface to the shell. To use the OMVS interface to the shell, you must be working at a 3270 terminal or a computer with 3270 emulation.

You issue the **OMVS** command from TSO/E:

- In an SNA network, remote users access TSO/E through VTAM®.
- In a TCP/IP network, remote users that have the Telnet 3270 client function access TSO/E by entering the TN3270 command. See the TCP/IP documentation for your system or the documentation for your computer's 3270 emulation.

For information about using an asynchronous terminal interface to the shell, see Chapter 3, “The asynchronous terminal interface to the shells,” on page 35.

Differences from a UNIX or AIX environment

If you come from a UNIX or AIX background, you will encounter some differences when you begin to use the OMVS interface to the shell. The 3270-type terminal interface may surprise you! For example:

OMVS interface	For more information
The 3270 interface operates in line mode (also known as canonical mode). You type data on a command line and no data is transmitted until you press the <Enter> key.	“Working in line mode” on page 16
The 3270 interface has function keys for various tasks such as scrolling through output, running TSO/E commands, and so on.	“Determining function key settings and the escape character” on page 17
The OMVS interface does not have a control key. Instead of using a <Ctrl> key to type control sequences (for example, <Ctrl-D>), you use the Control function key or a multicharacter escape-key sequence.	“Typing escape sequences in the shell” on page 22
With the OMVS interface, you can edit z/OS UNIX files using the ISPF editor or the **ed** editor. Because this interface runs in line mode, you cannot use the **vi** editor.	Chapter 19, “Editing files,” on page 241
Delayed display of output: If a command you are running does not produce output for more than a few seconds, you will need to repeatedly press the Refresh key to display the output as it is produced.	“Why isn't your output displayed on the screen?” on page 16

Invoking the shell

To invoke the z/OS shell, log on to TSO/E and enter the TSO/E **OMVS** command. Once you are working in a shell session, you can switch to TSO/E command mode or you can switch to subcommand mode.

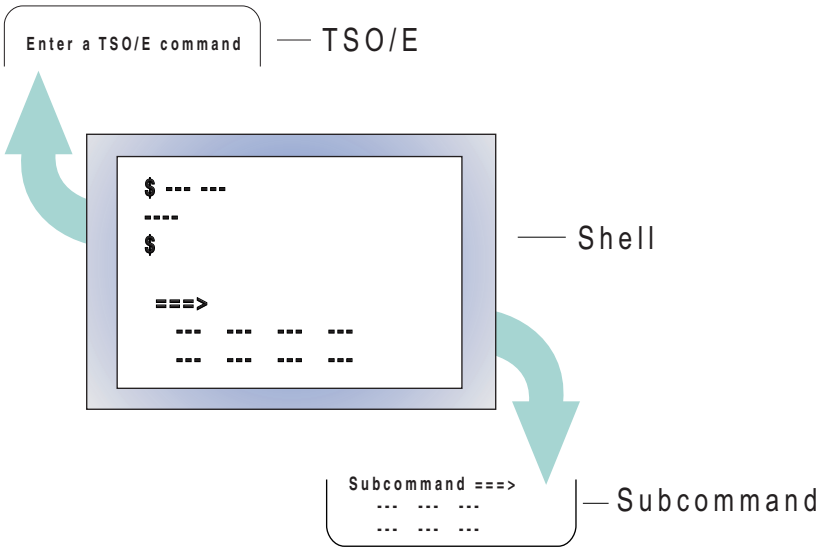

Figure 6. Switching temporarily to TSO/E command mode or subcommand mode

To invoke the shell:

1. Log on to TSO/E with your TSO/E user ID and password.
2. At the TSO/E `READY` prompt, enter the **OMVS** command. You do not need to supply a password when invoking the shell.

The systems programmer might have set up your TSO/E user's logon to invoke the shell automatically. In that case, you do not need to perform step 2.

You can start multiple shell sessions simultaneously when you log into the shell, and you can start an additional shell session at any time during a shell session by using the OPEN subcommand. You can switch from session to session, using a function key or a subcommand.

Changing options on the OMVS command

The OMVS command provides an interface to the shell; for example, the layout of the screen and the processing of the function keys.

You can create a customized version of the OMVS command for your own use, by writing a simple REXX program or CLIST that specifies certain keywords on the command. For information about how to do this, see “Customizing the OMVS interface” on page 26 and “An example of customizing the OMVS command” on page 26.

Understanding the shell screen

When you start the shell, you see the panel in Figure 7 on page 15.

```
 IBM
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 (C) Copyright Software Development Group, University of Waterloo, 1989.

 U.S. Government users - Restricted Rights
 Use, duplication, or disclosure restricted by
GSA-ADP schedule contract with IBM Corp.

 IBM is a registered trademark of the IBM Corp.


 $









===>
                                                                 RUNNING
ESC=¢  1=Help    2=SubCmd   3=HlpRetrn   4=Top      5=Bottom   6=TSO
       7=BackScr 8=Scroll   9=NextSess  10=Refresh 11=FwdRetr 12=Retrieve
```

Figure 7. The z/OS shell's display screen when the shell is first invoked. The bottom two lines show the default function key settings.

The $ prompt is an indication from the shell that it is ready to accept input, which you type at the command line (===>). For a superuser, the default prompt is a #.

You can define a different prompt in your `$HOME/.profile` file, if you want to. (See Chapter 4, "Customizing the z/OS shell," on page 39 for more information about your `$HOME/.profile` file.)

You see:

- The command line (===>), used for input.
- The current function key settings and the current escape character assignments. You can turn off the function key display by typing the `NOPF` subcommand and turn on the display by typing the `PF` subcommand; alternatively, you can customize a function key to control the display of the function key settings. See "Customizing the OMVS interface" on page 26 for details on customizing function keys.

  Note: The figures in this topic show the default function key settings.
- The status indicator in the right-hand corner, just above the function key lines. When you first enter the shell, the status indicator is `RUNNING`. This indicator lets you know the status of your session; for example, if an application is running or if the shell session is ready for input.
- The session number, in angle brackets, following the status indicator. The session number is displayed if there is more than one session active.

Figure 8 on page 16 shows how a screen would look after some input had been entered.

```
$ ls -l
total 7
drwxr-xr-x   2 SMITHA     0              0 Dec  3 04:25 bin
drwxr-xr-x   2 SMITHA     0              0 Nov 19 15:16 doc
-rw-rwxrwx   2 SMITHA     0            250 Nov 17 23:07 etc
-rw-r--r--   2 SMITHA     0             17 Nov 17 23:07 fora
-rw-r--r--   5 SMITHA     0           1605 Dec  3 16:38 port
-rw-r--r--   2 SMITHA     0            472 Nov 17 23:15 script
drwxr-xr-x   2 SMITHA     0              0 Nov 17 23:07 src
drwxr-xr-x  15 SMITHA     0              0 Dec  3 20:37 projecta
$




 ===>
                                                                  INPUT
ESC=¢  1=Help    2=SubCmd   3=HlpRetrn   4=Top      5=Bottom   6=TSO
       7=BackScr 8=Scroll   9=NextSess  10=Refresh 11=FwdRetr 12=Retrieve
```

Figure 8. The z/OS shell's display screen after input has been entered

At the top of the screen, $ is the prompt and `ls -l` is the command that was entered. Beneath that is the output from the command. When a command completes, a $ prompt is displayed, indicating that you can enter another command on the command line.

If you make an error entering a command or you are running a shell script or program that ends in error, the error message is displayed in the output area. Some error messages are displayed after the last output line. Others—for example, error messages issued in subcommand mode—appear at the very top of the panel followed by a separator line. To clear an error message displayed at the top of the panel above a separator line, press <Enter> without typing any input.

Working in line mode

Because you are working in 3270 mode, what you type on the command line is processed in *line mode* (also known as *canonical mode*). This means your input is not processed until you press <Enter>.

- To enter input, type it at the command line (===>) and press <Enter>.
- To see your echoed input data or any output written by an application, look at the screen. The first line of output is displayed, and then each subsequent line of output is displayed under it.

  After the screen fills up with output lines, the older output lines scroll upward, out of view, as new output lines are displayed . You can, however, use function keys to scroll the output backward and forward.

Why isn't your output displayed on the screen?

After you type a command and press <Enter>, the status of your session is displayed in the lower right-hand corner of your screen as `RUNNING`. After a short time, the status indicator automatically changes to `INPUT`; this means the shell session is ready for input and will not send any more output or messages to the display screen.

At times you may find that the status indicator changes to `INPUT` before you have received any or all of your output. Don't worry—the shell is producing output and

storing it in a buffer. Just press the Refresh function key and the shell will display more output on your screen. (If you don't have a Refresh function key, you can press a <Clear> key, <PA2>, or <PA3>.)

The reason for this behavior is that TSO/VTAM provides no way to wait for keyboard input and TTY output at the same time under TSO.

On the z/OS UNIX System Services Web site, there is some code (poll.c) that lets an OMVS user remain in RUNNING mode indefinitely. This improves usability, but it can have a significant performance impact if many people use it. You can download the code by going to the Tips section:

`http://www-03.ibm.com/systems/z/os/zos/features/unix/`

Determining function key settings and the escape character

The shell has function keys that you can use for certain tasks, instead of typing commands. To determine your function key settings and escape character assignments, look (Figure 9).

```
ESC=¢  1=Help    2=SubCmd   3=HlpRetrn   4=Top      5=Bottom   6=TSO
       7=BackScr 8=Scroll   9=NextSess  10=Refresh 11=FwdRetr 12=Retrieve
```

Figure 9. Default function key settings

The function key functions

Table 1 describes *all* the functions available for function keys, and shows which of those functions are assigned by default to keys. Function keys 13 to 24 are set to the same values as function keys 1 to 12. You can change the default function key settings. For example, you may want a Control function key for typing escape sequences.

You can perform the same actions with either a function key or a subcommand; the term you see under the column Function/Subcommand can be entered as a subcommand also. See “Running a subcommand” on page 25 for more information about subcommands.

In the first column, you see the default key assignment for a function. If a function is not assigned to a key by default, there is no entry in the first column. You can assign a function to a key by customizing your invocation of the **OMVS** command; see “Function key settings (PFn)” on page 29 for more information.

Table 1. Function key settings available in the z/OS shell

Default setting	Function/ Subcommand	Description
<F1> <F13>	HELP	Displays a help panel that explains the TSO/E OMVS command and the three modes you can work in: shell, subcommand, and TSO/E.

Table 1. Function key settings available in the z/OS shell (continued)

Default setting	Function/ Subcommand	Description
<F2> <F14>	SUBCMD	Processes an OMVS subcommand. A subcommand is a command that is passed to the OMVS command processor (instead of the shell). Most subcommands are used to control, or temporarily change, the OMVS interface. You can either enter a subcommand from the shell command line or switch to subcommand mode to do it. To run a subcommand from the shell command line, type the subcommand and press this function key. To leave the shell session and enter subcommand mode, press this function key when the shell command line is empty. You can type the OMVS subcommands at the command line in subcommand mode. To resume working in the shell, press the Return function key.
<F3> <F15>	HLPRETRN or RETURN	If you are viewing help information, pressing this key removes the help information from the screen. If you are in subcommand mode, pressing this key returns you to the shell session. (Refer to "Switching to subcommand mode" on page 25 for a discussion of subcommand mode.)
<F4> <F16>	TOP	Scrolls displayed data back to a screen of the oldest available output, or, in help, back to the first panel.
<F5> <F17>	BOTTOM	Scrolls displayed data to a screen of the most recent output, or, in help, to the final panel.
<F6> <F18>	TSO	You have the choice of switching to TSO/E command mode to enter a TSO/E command or running the TSO/E command from the shell command line. To switch to TSO/E command mode, press <F6>. To resume working in the shell, press <PA1>. To run a TSO/E command from the shell command line, select one of these options: • Type the command and press the TSO function key. • Use the **tso** shell command to run the TSO/E command **Note:** If you entered the OMVS command from ISPF, you cannot enter ISPF as a TSO/E command from the shell command line. You can, however, enter the ISHELL command. When the TSO/E command completes, typically *** is displayed on the screen. Press <Enter> or <Clear> to return to the shell.
<F7> <F19>	BACKSCR	Scrolls the displayed output backward, a screen at a time. The scrolling ends when you reach the oldest available saved line in a stack of saved output lines.
<F8> <F20>	SCROLL	Scrolls the output display a full screen forward.

Table 1. Function key settings available in the z/OS shell (continued)

Default setting	Function/ Subcommand	Description
<F9> <F21>	NEXTSESS	Displays the next session whose session number is higher than that of the session currently displayed. However, if the highest-numbered session is currently displayed, the lowest-numbered session will be displayed.
<F10> <F22>	REFRESH	Updates the screen with new data from the shell session. Use this function key if the display of output (for example, output from a command you issued) is incomplete , but the session is now displaying `INPUT` status.
<F11> <F23>	FWDRETR	Used with <F12> to retrieve commands from the stack of saved input lines. If you press <F12> one too many times and go past the line you want, you can press <F11> to display the line that was previously retrieved by <F12>.
<F12> <F24>	RETRIEVE	Retrieves the most recently entered input line from a stack of saved input lines. This key starts retrieving with the most recent in the stack of saved lines and works down to the oldest available.
	ALARM	Toggles the setting for the 3270 alarm to sound when the shell writes a <BEL> character. Some applications use an alarm to alert the user to particular events. The default setting is to sound the alarm. You can select a key to switch it off and on.
	AUTOSCR	Toggles the setting for autoscrolling of input and output written to the screen. The default setting is to autoscroll; you can select a key to switch it off and on.
	CLOSE	Ends the shell session currently displayed. Close provides the same function as the Quit function key.
	CONTROL	Treats a character on the command line as part of an escape sequence, and does not append a <newline> character to the sequence. For example, if you type `d` on the command line and press the Control function key, the system processes the `d` as the EBCDIC equivalent of the ASCII control sequence <Ctrl-D>.
	ECHO	Toggles the automatic hiding and display of input. If pressed while an application has control over the display of input, the application no longer controls it. If pressed while the application does not control the display of input, the application is given control. See the description of the Hide function key.
	HALFSCR	Scrolls forward half of the currently displayed output.
	HIDE	Toggles the hiding and display of input. If you are using OMVS in ECHO mode, pressing this key overrides the visibility asked for by an application, for the next input only. In NOECHO mode, if the input area is not hidden, pressing this key hides the input area for the next input only. If the input area is already hidden, pressing this key makes the input area visible.

Table 1. Function key settings available in the z/OS shell (continued)

Default setting	Function/ Subcommand	Description
	NO	Deactivates a function key so that it performs no function.
	NOALARM	Performs the same function as Alarm.
	NOAUTO	Performs the same function as Auto.
	NOECHO	Performs the same function as Echo.
	NOHIDE	Performs the same function as Hide.
	NOPFSHOW	Toggles the display of function key settings. The default setting is to display the settings; you can select a key to switch the display off and on.
	PFSHOW	Performs the same function as NoPFShow.
	OPEN	Starts another shell session and automatically switches to it. The session is assigned the next unused session number.
	PREVSESS	Displays the next-lower-numbered session. However, if the lowest-numbered session is currently displayed, the highest-numbered session will be displayed.
	QUIT	Ends the current session, and displays the next-lower-numbered session. However, if the lowest-numbered session is currently displayed, the next-higher-numbered session is displayed. If only one session is active, Quit causes the OMVS command to quit. The workstation returns to TSO/E, and the shell stops processing.
	QUITALL	Ends all active shell sessions. QuitAll causes the OMVS command to quit. The workstation returns to TSO/E. **Note:** If the OMVS interface is running in SHAREAS mode (shared address space) and you quit all sessions (QuitAll or Quit if there is just one session), the shell process ends immediately.

The escape character

ESC=¢

An escape sequence produces an EBCDIC version of the ASCII control sequence. (For example, the z/OS UNIX <EscChar-D> corresponds to the ASCII <Ctrl-D>.) If you do not use a Control function key to enter escape sequences, you will need to use an escape character. When you type an escape character followed by a second character and press Enter, the second character is converted into a different character before it is passed to the shell.

The default escape character depends on the character conversion table specified with the CONVERT keyword. For more information, see the **OMVS** command description in *z/OS UNIX System Services Command Reference*.

There can be up to eight escape characters defined and displayed on the screen; you can use any one of them as an escape character. For example, three are displayed here:

```
ESC=¢¯%
```

In this topic, the notation *EscChar* coupled with another letter (for example, <EscChar-D>) indicates an escape sequence.

For more information about escape sequences, see "Typing escape sequences in the shell" on page 22, which follows.

Entering a shell command

You type shell commands on the shell command line (===>) and press <Enter> to pass them to the shell.

Customizing the variant characters on your keyboard

If the shell is using a locale generated with code pages IBM-104 IBM-1027, or IBM-939, an application programmer needs to be concerned about variant characters in the POSIX portable character set whose encoding may vary from other EBCDIC code pages. For example, the encodings for the square brackets do not match on code pages IBM-037 and IBM-1047:

Left square bracket: [(X'AD' on IBM-1047)

Right square bracket:] (X'BD' on IBM-1047)

You may want to customize the encodings for those keys on your keyboard. See Appendix C, "Code page conversion when the shell and MVS have different locales," on page 323 for more information on this topic.

Entering a long shell command

If you are typing a long command that will not fit on the command line, you can use the \ (backslash) continuation character at the end of the first line. When you then press <Enter>, the command line is cleared so that you can continue typing. The line you typed prior to the backslash is displayed in the output area, and beneath it the shell prompt changes to > to indicate that you are continuing a command. For example:

```
$ cat /usr/macneil/uts/mydir/mydata\
>









===> /applprog/dbprog/dbget.c
                                                          RUNNING
```

While the shell is processing your command, it displays the RUNNING status indicator.

Where's the command output? If your output has not yet been displayed when the status changes to INPUT, press the Refresh function key to see the output.

Entering a shell command from TSO/E

You can use the OSHELL REXX exec to run a z/OS shell command from the TSO/E READY prompt and display the output to your terminal. The syntax is:

```
oshell shell_command
```

With this exec, do not use an & to run a shell command in the background. See "OSHELL: Running a shell command from the TSO/E READY prompt" on page 166 for more information.

Interrupting a shell command

If you want to interrupt a command and stop it from completing, type <EscChar-C> or type c and press the Control function key (if you have a function key customized to perform the Control function; see "Determining function key settings and the escape character" on page 17).

Typing escape sequences in the shell

An escape sequence produces an EBCDIC version of the ASCII control sequence. (For example, the z/OS UNIX <EscChar-D> corresponds to the ASCII <Ctrl-D>.) You can use escape sequences to type:

- Portable characters not included on your keyboard; see Appendix D, "Escape sequences for a 3270 keyboard," on page 327 for these sequences.
- Control characters that are normally available on ASCII workstations, but not EBCDIC ones; see Appendix D, "Escape sequences for a 3270 keyboard," on page 327 for these sequences.

In this topic, the notation *EscChar* coupled with another letter (for example, <EscChar-D>) indicates an escape sequence, corresponding to an ASCII control sequence. You can type an escape sequence in either of these ways:

- Type a letter on the command line and press the Control function key if you have one defined. The Control function key treats the character on the command line as if it were preceded by an escape character, and it does not append a <newline> character.

  For example, to exit the shell, you type d on the command line and press the Control function key.

  To use a Control function key, you must customize the **OMVS** command with a key setting for that function.
- Type an escape character sequence, beginning with one of the escape characters. After you type the two characters in sequence and press <Enter>, the system translates the two characters into a third character. For information on how to customize your keyboard for typing an escape sequence, see "Keyboard remapping" on page 23.

Suppressing the newline character

Whenever you press <Enter>, a <newline> character is automatically appended to the characters you typed. For certain UNIX applications, you may want to suppress the automatic <newline> character appended when you press <Enter>.

If you use the Control function key to input an escape sequence, no <newline> character is appended. However, if you use an escape character to input an escape sequence, a <newline> character is appended to the sequence. To suppress the <newline> character, add an escape character at the end of the input and press <Enter>.

For example, in the shell, the two-character EBCDIC sequence <EscChar-D> is the equivalent of the ASCII control sequence <Ctrl-D>. To enter only an <EscChar-D> with no final <newline>, type the string <EscChar-D-EscChar> on the command line, and press <Enter>; an example is shown in Figure 10.

```
===>  ¢d¢
                                                                  INPUT <3>
ESC=¢  1=Help    2=SubCmd   3=HlpRetrn   4=Top      5=Bottom   6=TSO
       7=BackScr 8=Scroll   9=NextSess  10=Refresh 11=FwdRetr 12=Retrieve
```

Figure 10. Typing an escape sequence

Keyboard remapping

With most terminal emulators, you can use the keyboard remapping function to define one key to generate a multikey sequence. For example, you could define the <D> key so that it generates <EscChar-D-EscChar-Enter> when the <Ctrl> key is pressed in sequence with it. Thus, the sequence <Ctrl-D> acts like the ASCII sequence <Ctrl-D>.

Determining your session status

To find out the status of your session, look in the lower right-hand corner of the screen. A status indicator and shell session number (if more than one session has been started) are displayed. The session number identifies the session displayed on your screen.

```
                  INPUT <1>
 5=Bottom    6=TSO
11=FwdRetr  12=Retrieve
```

The status indicators are:

INPUT
Indicates that the shell is ready for input and will not send any more output to the display screen. If your output has not yet been displayed when the status changes to INPUT, press the Refresh function key to see more output.

RUNNING
Indicates that the workstation and shell are being polled, or that an application program is running. After the polling completes, the indicator changes.

MORE...
Indicates that the screen is full of output and there is more output waiting to be displayed. To scroll the screen, do one of the following:

- Press the <Clear> key (or combination of keys, depending on your keyboard)

- Press the Scroll, HalfScr, or Bottom function key.

INPUT HIDDEN
Indicates that you have pressed a function key that will turn off the display of any input that you type. Typically, this function is used for typing in secure data. Once you press <Enter>, any further input is displayed.

HIDDEN is a short form of INPUT HIDDEN, used when it is combined with other status indicators, such as:
- HIDDEN/MORE
- HIDDEN/INPUT
- HIDDEN/NOT ACCEPTED
- HIDDEN/NOTACC/MORE
- HIDDEN/NOTACC/INPUT

NOT ACCEPTED
Indicates that the application or shell is hung and not accepting any input you enter. Try using a subcommand to interrupt the application.

NOTACC is a short form of NOT ACCEPTED, used when it is combined with other status indicators, such as:
- HIDDEN/NOTACC/MORE
- HIDDEN/NOTACC/INPUT

NOT ACCEPTED/MORE...
Indicates that the application is not accepting any input you enter and that there is more output waiting to be displayed. Scroll the screen to clear it before trying to reenter the input. To scroll the screen, do one of the following:
- Press the <Clear> key (or combination of keys, depending on your keyboard)
- Press the Scroll, HalfScr, or Bottom function key.

SUBCOMMAND
Indicates that you are working in subcommand mode.

Scrolling through output

You can scroll output forward and backward using:
- Function keys
- Cursor scrolling
- Scrolling subcommands

Using function keys or subcommands

There are five scrolling function keys that you can use during a shell session and in subcommand mode:
- BackScr
- Bottom
- HalfScr
- Scroll
- Top

These are discussed in Table 1 on page 17.

You can use the TOP, BOTTOM, SCROLL, BACKSCR, and HALFSCR subcommands to scroll output. They produce the same results as their corresponding function keys (see Table 1 on page 17).

Using cursor scrolling

Cursor scrolling gives you better control over the scrolling action. You place your cursor on a line in the output and then press one of these function keys or type the corresponding subcommand:

BackScr
Positions the output line containing the cursor at the bottom of the output displayed on the screen.

If the output partially fills the screen and the cursor is positioned below the last line of output, the empty line with the cursor is displayed .

HalfScr
Positions the output line containing the cursor near the center of the output displayed on the screen. This is similar to a partial scroll forward or backward.

If the output partially fills the screen and the cursor is positioned below the last line of output, the empty line with the cursor is displayed near the center of the screen.

Scroll Positions the output line containing the cursor at the top of the output displayed on the screen.

If the output partially fills the screen and the cursor is positioned below the last line of output, the last line of output is displayed at the top of the screen.

Running a subcommand

A subcommand is a command that is passed to the **OMVS** command processor (instead of to the shell). Most subcommands are used to control, or temporarily change, the OMVS interface. You can issue a subcommand in two ways:

- Type the subcommand on the shell command line and press the Subcommand function key, if you have one defined.
- Switch to subcommand mode and enter the subcommand.

The names of the subcommands match the names of the functions listed in Table 1 on page 17. Some subcommands have aliases; for information on the subcommands and their aliases, see the **OMVS** command description in *z/OS UNIX System Services Command Reference*.

You can enter the subcommands in uppercase, lowercase, or mixed-case letters.

Switching to subcommand mode

Instead of using the Subcommand function key to run a subcommand, you can switch to subcommand mode to enter it. To switch to subcommand mode, press the SubCmd function key when the shell command line is empty. In subcommand mode, the screen appears as it did in the shell, except that in the lower right-hand corner the status displayed is `SUBCOMMAND`. Existing output from the shell is displayed at the top of the screen, and any new output is displayed as it is available.

When you switch to subcommand mode, the command prompt changes to `OMVS Subcommand ==>`.

Using multiple sessions

You can run more than one shell session concurrently. When you have more than one session active, the sessions are numbered and the identifying number for a session is displayed next to the status indicator.

Starting sessions

To start additional sessions, you can:

- Use the SESSIONS keyword on the **OMVS** command to specify the number of sessions you want started automatically when you log into the shell. By writing a small REXX program or CLIST, you can customize your invocation of the **OMVS** command so that every time you log into the shell multiple sessions are started.
- Use the OPEN subcommand during a session. This starts another shell session and automatically switches to it. The session is automatically assigned the next unused session number.

Switching between sessions

You can use function keys or subcommands to switch between sessions:

- NextSess is the default setting for <F9>. If you wish, you can customize an additional key for the PrevSess setting. See Table 1 on page 17 for a discussion of these functions.
- The NEXTSESS and PREVSESS subcommands perform the same as the function keys.

Customizing the OMVS interface

You can select the keywords you want to use when you enter the TSO/E **OMVS** command:

```
ALARM | NOALARM
AUTOSCROLL | NOAUTOSCROLL
CONVERT()
DBCS | NODBCS
DEBUG()
ECHO | NOECHO
ENDPASSTHROUGH(ATTN | CLEAR | CLEARPARTITION | ENTER | NO | PA1 | PA3 | PF1
 ... PF24 | SEL)
ESCAPE()
HIDE | NOHIDE
LINES()
PF()
PFSHOW | NOPFSHOW
RUNOPTS()
SESSIONS()
SHAREAS | NOSHAREAS
WRAPDEBUG()
```

An example of customizing the OMVS command

To invoke the **OMVS** command to:

- Set function key 1 as the Control function key
- Start three sessions
- Not use a shared address space

Enter:

```
omvs pf1(control) sessions(3) noshareas
```

By writing a small REXX program or CLIST, you can customize your selection of keywords on the TSO/E **OMVS** command. If you intend to use these settings every time you enter the command, you could:

1. Write a REXX program that runs the **OMVS** command with the customized keywords. For example, here is a REXX program called MYOMVS:

   ```
   /* REXX */
   P = PROMPT("ON");                 /* Don't suppress prompting */
   "omvs pf1(control) sessions(3) NOSHAREAS";
   X = PROMPT(P);                    /* Restore original prompting state */
   Return;
   ```

   The use of the REXX function PROMPT() is required to prevent prompts from being suppressed. Otherwise, TSO/E commands cannot prompt you for additional information when the commands are issued during a shell session.
2. Install the exec in a data set that is part of either the SYSPROC or SYSEXEC concatenation.
3. When you log on to TSO/E, at the `READY` prompt you enter `MYOMVS` and the exec calls MYOMVS, your customized **OMVS** command. Your changes override the default settings.

For more discussion of the syntax of the **OMVS** command and its customizable keywords, see the **OMVS** command description in *z/OS UNIX System Services Command Reference*.

The alarm setting (ALARM | NOALARM)

Some applications sound an alarm to alert the user to particular events. To change the default alarm setting (which allows it to sound), use the NOALARM keyword.

Autoscrolling (AUTOSCROLL | NOAUTOSCROLL)

Automatic scrolling of input and output written to the screen is the default. Specify NOAUTOSCROLL to prevent the automatic scrolling.

If an application writes a <form-feed> character with no following data to a terminal and OMVS is in AUTOSCROLL mode, the screen is cleared.

The character conversion table (CONVERT)

There are both APL and non-APL character conversion tables. The IBM-supplied default is a null conversion table, but the systems programmer can select a different default for the **OMVS** command to use. If you do not want to use the default table, you can specify a table name with the CONVERT keyword. See the **OMVS** command description in *z/OS UNIX System Services Command Reference* for more details.

To access data in the z/OS UNIX file system, use a terminal that is operating in the same code page as the file system. In other words, if you have a 3270 terminal using a French code page, you cannot access z/OS UNIX file system data encoded in a German code page when you are using the OMVS-provided character conversion tables. However, you could provide your own OMVS conversion tables to convert between the French and German code pages.

Double-byte character set support (DBCS | NODBCS)

By default, the **OMVS** command supports the use of a double-byte character set (DBCS). If your terminal does not support DBCS, this default has no effect. To prevent DBCS processing on a DBCS terminal, specify the NODBCS keyword.

Use the NODBCS option if you have a DBCS terminal but do not want the overhead associated with using the **OMVS** command with DBCS support.

Debugging for the OMVS command (DEBUG)

Change this default setting from NO only if IBM asks you to do so. To control the collection and output of debugging information, change the DEBUG keyword as directed.

Giving an application control of the command line (ECHO | NOECHO)

You can use the ECHO option to allow an application to control the visibility of the input area. When ECHO is specified, OMVS hides or displays the input area based on the application's setting of the ECHO bit in the termios structure. If the bit is off, the command line is hidden, except in subcommand mode. If the bit is on, the command line is visible. The default is NOECHO, which does not allow the application to control the visibility of the input area.

Ending 3270 pass-through mode (ENDPASSTHROUGH)

Applications running from the shell can switch to TSO/3270 pass-through mode, which lets an application invoke TSO/E functions. For application development purposes, you can specify a key that ends TSO/3270 pass-through mode and forces OMVS to return to the shell session.

Because this key is used only during application development, the default is ENDPASSTHROUGH(NO).

For more information about TSO/3270 pass-through mode, see Appendix A. TSO/3270 pass-through Mode in *z/OS UNIX System Services Programming Tools*.

The escape character (ESCAPE)

If you do not use a Control function key to escape a character, you can type a two-character escape sequence instead. (For an explanation of escape characters, see “Typing escape sequences in the shell” on page 22.)

To change the default escape character, or have more than one escape character, type escape characters after the ESCAPE keyword. You can type up to eight characters, enclosed in single quotation marks with no space between them. For example:

```
OMVS ESCAPE('`¢')
```

When specifying escape characters:

- Select characters that are not in the POSIX portable character set. See “The POSIX portable character set” on page 324 to see the contents of the POSIX portable character set.
- Select single-byte characters, even if you are using a double-byte character set.

The escape characters specified with the **OMVS** command completely override those in the character conversion table being used. However, if no escape characters are specified with the **OMVS** command, the system uses those in the conversion table.

Controlling the size of the output scroll buffer (LINES)

You can override the default size of the output scroll buffer; the default is roughly four screens. With the LINES keyword, you can specify the size of the buffer; the range is 25 to 3000 lines.

Note: Using a large output scroll buffer increases the amount of storage that the **OMVS** command requires; it also causes additional overhead, impacting performance.

Function key settings (PFn)

To customize any of the default function key settings, type your selection in the parentheses after the function key name. For example:

```
OMVS PF1(CONTROL)
```

makes function key 1 the Control key, which you use to type an escape sequence such as <Ctrl-D> (first you type `d` on the command line, and then you press the function key).

Displaying the function key settings (PFSHOW | NOPFSHOW)

To turn off the display of function key settings, specify the NOPFSHOW keyword on the **OMVS** command.

Specifying Language Environment runtime options (RUNOPTS)

To run the TSO/E **OMVS** command with Language Environment® runtime options, specify the RUNOPTS keyword.

Example: To run the **OMVS** command and print out an options report, issue:

```
OMVS RUNOPTS('RPTOPTS(ON)')
```

See *z/OS Language Environment Programming Reference* for a list of runtime options.

Note: The use of inappropriate Language Environment runtime options, such as TRAP(OFF) or POSIX(OFF), may cause the **OMVS** command to fail.

Any valid runtime options specified by RUNOPTS normally get passed along to the shell.

Multiple sessions (SESSIONS)

If you want more than one session started when you invoke the **OMVS** command, use the SESSIONS keyword. The suggested maximum number of sessions is three or four. If you try to start too many sessions (the limit depends on the size of your TSO/E address space), your TSO/E user ID runs out of storage and various unpredictable errors might occur. You might have to log off your TSO/E user ID before you can continue.

The shared TSO/E address space (SHAREAS | NOSHAREAS)

Having the **OMVS** command and the shell run in the same (shared) TSO/E address space saves one address space per user and simplifies transaction accounting, as managed by the operating system. The shell shares the address space (SHAREAS) by default, unless the shell is a SETUID or SETGID program and the owning UID or GID is not the same as the current owner.

If you specify NOSHAREAS, the shell might keep running even after the QUIT subcommand was entered; in most cases, it will not.

For more information about shared address space, see Chapter 12, "Performance: Running executable files," on page 173.

Controlling data recorded in the debug data set (WRAPDEBUG)

Use the WRAPDEBUG keyword to specify how many lines of debug data that OMVS writes out before wrapping around to the top of the debug data set.

Performing TSO/E work or ISPF work after invoking the shell

After you invoke the shell, you can:
- Enter a TSO/E command from the command line
- Switch temporarily to TSO/E command mode
- Return to ISPF or the TSO/E `READY` prompt

Entering a TSO/E command from the z/OS shell

You can enter a TSO/E command from the shell in either of these ways:

- Type the **tso** shell command before the TSO/E command. For example:

  ```
  tso "oput source.c(hello) '/u/ehk/source/hello.c'"
  ```

  The **oput** command is quoted so that the shell does not process it. If you are copying a file, specify the *-t* option to copy a file to your current directory. For more information about the **tso** command and its options, see *z/OS UNIX System Services Command Reference*.
- Type the command on the shell command line and press the TSO function key.

  When the TSO/E command completes, typically *** is displayed on the screen. To return to the shell and resume working at the shell command line, press <Enter> or <Clear>.

Use the **man** command to view descriptions of TSO/E commands by prefixing the command with **tso**. For example, to view a description of the MOUNT command, you would enter:

```
man tsomount
```

For complete information about the **man** command, see the **man** command description in *z/OS UNIX System Services Command Reference*.

Command not found? If you type a TSO/E command from the shell and press <Enter> instead of the TSO function key, you may receive a message that the command is `not found`. Because you did not press the TSO function key, the shell attempted to process the command as a shell command. (You can use the Retrieve function key to redisplay the command.)

Switching to TSO/E command mode

There are two contexts for switching to TSO/E command mode:

- You are in the z/OS shell. You want to run TSO/E commands without shutting down any processes that might be running and without exiting the shell completely.
- You are in subcommand mode and want to run TSO/E commands.

You can switch to TSO/E command mode to run TSO/E commands (such as **OPUT** or **OGET**). When the command line is empty, press the TSO function key. Any shell scripts or processes that were running when you pressed the function key continue to run.

Once you are in TSO/E command mode, the screen is in line mode and no function keys are active or displayed. A special prompt (not the typical TSO/E `READY` prompt) is issued:

```
OMVS - Enter a TSO/E command, or press PA1 to return to the shell.
```

When you complete your work in TSO/E command mode, press <PA1> to return to wherever you were before you entered TSO/E. You can resume your work in the shell or return to subcommand mode.

ftp or telnet from TSO

There is an **ftp** command available in the shell, but no **telnet** command. However, when you use the **OMVS** command to login to the shell, you can switch to TSO and issue the **telnet** command from there, with the following restriction: When you **telnet** to a remote MVS host and then access a shell, you can work in line mode only (for example, you cannot use **vi**).

See *z/OS V2R2.0 Communications Server: IP User's Guide and Commands* for detailed information about using the **telnet** command from TSO.

Exiting the shell

There are four situations when you might want to exit the shell:

- **To leave the shell temporarily and switch to TSO/E command mode:** Press the TSO function key. You can do this any time during a session, regardless of whether you are currently running a command or script. See "Performing TSO/E work or ISPF work after invoking the shell" on page 30 for details.

  If you switch to TSO/E command mode, the shell and any shell commands continue running until they attempt to read from the terminal or until the terminal output buffer is full; if either of these situations occurs, the commands are suspended until you return to the shell.
- **To exit the shell when a foreground process has completed:** Type **exit** or <EscChar-D>. Scroll past all the output data (or use an autoscroll function key if you have customized a function key to do that), and exit.

  Note: The <EscChar-D> sequence does not work if you have entered `set -o ignoreeof` in the shell. See the **set** command description in *z/OS UNIX System Services Command Reference*.
  If you are using the shell option **set +m** or its equivalent **set +o monitor** to have background jobs run in the same process group as the shell, use the **nohup** command to run a script or program that will continue running after you log out.

If you were in ISPF when you entered the shell, you are returned to ISPF; if you were in TSO READY mode, you are returned to TSO/E `READY`.

- **To exit the shell when a background job is running:** Press the SubCmd function key and then enter the QUIT subcommand.

  Note: If your OMVS interface is running in SHAREAS mode (shared address space) and you quit all sessions (QUITALL subcommand or QUIT for the only session), the shell process ends immediately.

  If you were in ISPF when you entered the shell, you are returned to ISPF; if you were in TSO/E READY mode, you are returned to TSO `READY`.

  By default in the shell (the **set -m** option), a background job runs in a different process group from the shell, and the job keeps running after you exit the shell. To have background jobs run in the same process group as the shell, use the **set +m** command or its equivalent, **set +o monitor**.
- **If your application is in a loop:** Try using <EscChar-C> or <EscChar-V> to interrupt it. If this does not work, press the SubCmd function key to leave the shell. Then type `quit` and press <Enter>. This causes the **OMVS** command to quit abruptly. The workstation returns to TSO/E and the shell stops processing. For more information on using escape sequences such as <EscChar-C>, see "Typing escape sequences in the shell" on page 22.

Getting rid of a hung application

If your application hangs, try the following procedure to kill it:

1. On the command line, enter <EscChar-V> (or <EscChar-C>). When this is successful, the shell prompt is displayed.
2. If step 1 does not work, enter the OPEN or NEXTSESS subcommand to start or switch to a second shell session. In the second shell session, determine the process identifier (PID) of the hung application by entering `ps -ef`.

   Then enter `kill -s KILL` *nnnnnn*, where *nnnnnn* is the PID obtained from the **ps -ef** command. After the **kill** command completes, you can return to the first session using the NEXTSESS or PREVSESS subcommand.
3. If step 2 does not work, enter the QUIT subcommand, or QUITALL if more than one session is active. This should free your TSO/E terminal, and you can then enter the **OMVS** command to start another session. The application may still be hung; if so, you need to use the **kill** command.
4. If step 3 does not work, ask the operator to cancel your TSO/E user ID, using the CANCEL command. The operator may also need to use the FORCE command.
5. If step 4 does not work, try a VTAM logoff (using the <SYSREQ> key), and wait long enough for MVS to end your session before you try to log on again.

Using a double-byte character set (DBCS)

If you want to display or enter double-byte data, you must:

- Work at a terminal that is configured to generate data in code page IBM-939 and follow the procedures for the terminal emulator being used, if any.
- Specify special LOGMODEs to access TSO/E and VTAM support for DBCS. Typically the systems programmer sets them up and provides you with instructions.
- Run the TSO/E PROFILE PLANGUAGE(JPN) command, if required, to receive Japanese-language messages from the OMVS interface to the shell. Do not change your PROFILE PLANGUAGE when temporarily switched to TSO/E

from the shell. After you invoke the shell, OMVS will not change the language of the messages it issues until you exit the shell and return to TSO/E, change your PROFILE PLANGUAGE, and reinvoke OMVS.

- Use the null translate table (the default) for character conversion. You do not need to specify the CONVERT keyword on the **OCOPY**, **OGET**, **OGETX**, **OPUT**, and **OPUTX** commands.
- Access the shell using the **OMVS** command with the DBCS keyword, the default setting.
- Define a single-byte escape character for typing an escape sequence, if you do not use the default ¢.

The shell utilities (for example, **grep** and **ed**) work with DBCS data in the file system and can be used to create DBCS data in the file system.

Single-byte restrictions

When working with a double-byte character set, you must use single-byte characters in these situations:

- Single-byte characters for file names. DBCS characters in file names are treated as SBCS characters.
- Single-byte characters for command-line options
- Single-byte characters for command-line arguments
- Single-byte characters for delimiters, such as a slash, braces, parentheses, and so on
- For user-defined environment variables, only SBCS for the names, and SBCS or DBCS for the values
- For the shell environment variables, only **IFS**, **PS1**, and **PS2** support DBCS values
- For user IDs, passwords, and password phrases
- For device, group, and terminal names.

Chapter 3. The asynchronous terminal interface to the shells

For people who work with UNIX systems, the asynchronous terminal interface is familiar. You use the asynchronous terminal interface if you access the z/OS shells with one of these methods:

- **rlogin**
- **telnet**
- **rlogin** or **telnet** via the Communications Server
- Communications Server login from a serially attached terminal

ASCII-EBCDIC translation

When you use **rlogin**, **telnet**, or Communications Server to access the shell, the data you enter is translated from ASCII (ISO8859-1) to EBCDIC (IBM-1047) before the shell processes it. To change code pages for the current session, use the **chcp** command. To automatically change code pages after you login, see "Changing the locale in the shell" on page 45 for the z/OS shell, or "Changing the locale in the shell" on page 59 for the tcsh shell.

For a complete list of the single-byte and double-byte ASCII and EBCDIC code pages that you can specify, see *z/OS XL C/C++ Programming Guide*.

Using rlogin to access the shell

When the **inetd**daemon is set up and active, you can **rlogin** to a shell from a workstation that has **rlogin** client support and is connected via TCP/IP or Communications Server to the MVS system. To login, use the **rlogin** command syntax supported at your site.

To improve performance when you **rlogin** into a shell, you can use shared address space; for more information, see Chapter 12, "Performance: Running executable files," on page 173.

Note: If you are writing or porting an **rlogin** command to rlogin into a shell, the shell interface to **rlogin** consists of the FOMTLINP and FOMTLOUT modules, documented in *z/OS UNIX System Services Planning*.

Using telnet to access the shell

You can **telnet** to the shell from a workstation that is connected via TCP/IP or Communications Server to the MVS system. Use the **telnet** command syntax supported at your site.

Using Communications Server login to access the shell

If you are working at a terminal that is serially attached to the Communications Server, you can login directly to the shell.

1. Specify the host you want to login to. You receive a message confirming that you are connecting to the host.
2. At the prompts, enter your user ID and password or password phrase.

The shell session

Once your login completes, you see your normal shell prompt (for example, $ or >). This is a UNIX interface, not the 3270-type interface that is displayed by the OMVS command. By default, the terminal interface is in line mode (also known as canonical mode), which means that each time you type a command at the prompt, you need to press Enter to process the command. Some utilities switch the terminal interface to raw mode. When you use a raw mode utility (such as **vi** or **talk**), or when command line editing is enabled in the shell, each keystroke is transmitted; you do not need to press <Enter>.

When you are in a shell session, you can:
- Run all shell commands and utilities.
- Run any application from the z/OS UNIX file system.
- Use the **vi editor** and other full-screen applications such as **talk** and **more**.

In the z/OS UNIX environment, the asynchronous terminal interface session has some differences from an OMVS session:

1. You cannot switch to TSO/E. However, you can use the **tso** shell command to run a TSO/E command from your session.
2. You cannot use the ISPF editor. (This includes the **oedit** and TSO/E OEDIT commands, which invoke ISPF File Edit.)

Entering a shell command

You type shell commands and press <Enter> to pass them to the shell.

If you are typing a long command that will not fit on one line, you can use the \ (backslash) continuation character at the end of the first line. When you then press <Enter>, the line is cleared so that you can continue typing. The line you typed prior to the backslash is displayed in the output area, and beneath it the shell prompt changes to > (? in tcsh) to indicate that you are continuing a command.

Interrupting a shell command

If you want to interrupt a command and stop it from completing, type <Ctrl-C>. The command stops executing and the system displays the shell prompt. You can now enter another command.

Using multiple sessions

With **rlogin**, **telnet**, or Communications Server, you can login to a shell more than once, using the same user ID and password or password phrase. You can also be logged in to a shell using the OMVS 3270 interface and the asynchronous terminal interface at the same time, using the same user ID and password or password phrase.

Using a double-byte character set (DBCS)

If you want to display or enter double-byte data:
- You must work at a terminal that is configured to generate data in code page IBM-939 and follow the procedures for the terminal emulator being used, if any.
- Customize your locale and use the **chcp** command to specify the ASCII and EBCDIC code pages you are using.

– For information on how to customize your locale and configure your setup files, see “Changing the locale in the shell” on page 45 for the z/OS shell, or “Changing the locale in the shell” on page 59 for the tcsh shell.

When you are working with a double-byte character set, there are some restrictions. See “Single-byte restrictions” on page 33 for more information.

Standard shell escape characters

The following are some of the standard shell escape characters:

- <Ctrl-C> — Program interruption
- <Ctrl-D> — End of file
- <Ctrl-V> — Quit Program
- <Ctrl-Z> — Suspend Program

Chapter 4. Customizing the z/OS shell

If you are interested in working with the z/OS shell, read this information as well as:

- Chapter 6, "Working with z/OS shell commands," on page 67
- Chapter 8, "Writing z/OS shell scripts," on page 115

You can personalize your use of the z/OS shell. This topic covers this information:

- Creating or modifying your **.profile** file
- Understanding shell variables
- Customizing your shell environment with the **ENV** variable
- Customizing the search path for commands with the **PATH** variable
- Improving the performance of shell scripts
- Changing the locale
- Customizing the language of messages
- Setting the time zone
- Building a STEPLIB environment
- Setting options for a shell session

Customizing your .profile

When you start the z/OS shell, it uses information in three files to determine your particular needs or preferences as a user. The files are accessed in this order:

1. **/etc/profile**
2. **$HOME/.profile**
3. The file that the ENV variable specifies

Settings established in a file accessed earlier can be overwritten by the settings in a file accessed later.

The **/etc/profile** file provides a default system-wide user environment. The systems programmer can modify the variables in this file to reflect local needs (for example, the time zone or the language). If you do not have an individual user profile, the values in the **/etc/profile** are used during your shell session.

The **$HOME/.profile** file (where **$HOME** is a variable for the home directory for your individual user ID) is an individual user profile. Any values in the **.profile** file in your home directory that differ with those in the **/etc/profile** file override them during your shell session. z/OS provides a sample individual user profile. Your administrator may set up such a file for you, or you may create your own.

Typically, your **.profile** might contain the following:

```
export ENV=$HOME/.setup  #set and export ENV variable
export PATH=$PATH:$HOME:  #set and export PATH variable
export EDITOR=ed          #set and export EDITOR variable
export PS1='$LOGNAME':'$PWD':' >'
```

Figure 11. A sample .profile

If the value on the right-hand side of the **=** sign does not contain spaces, tab characters, or other special characters, you can leave out the single quotation marks.

Each of the lines begins with an **export** command. For the z/OS shell, this sets the variable and also specifies that whenever a subshell is created, these variables should be exported to it. You can also set a variable on one line and export it on another, as shown here:

```
ENV=$HOME/.setup
export ENV
```

If portability to a Bourne shell is a consideration, use the two-line syntax. See "Exporting variables" on page 118 for more information about exporting variables.

export ENV=$HOME/.setup
: Identifies the **.setup** file in your home directory as your login script (also known as a setup script or environment file) and specifies that whenever a shell is created, the **ENV** variable should be exported to it. See "Customizing your shell environment: The ENV variable" on page 42 for more information about a login script.

export PATH=$PATH:$HOME:
: Identifies the search path to be used when locating a file or directory, and specifies that whenever a subshell is created, the **PATH** variable should be exported to it. Here, the system first searches the path identified in the **PATH** variable in **/etc/profile**, the system profile; then the system searches your home directory; finally, the system searches your current working directory. A leading or trailing colon, or two colons in a row, represents the current working directory. To avoid confusion, this is often expressed as:

  ```
  export PATH=$PATH:$HOME:.
  ```

  This PATH setting and the one in the example are equivalent. See "Customizing the search path for commands: The PATH variable" on page 43 for more information.

export PS1='$LOGNAME:$PWD: >'
: Identifies the shell prompt that indicates when the shell is ready for input, and specifies that whenever a subshell is created, the **PS1** variable should be exported to it. Here the prompt (default is $) has been customized to show your login name and working directory. For example, for user ID TURBO working in the home directory, the prompt would display as:

  ```
  turbo:/u/turbo: >
  ```

  When TURBO changes directories, the prompt changes to indicate the working directory.

export EDITOR=ed
: Identifies **ed** as the default editor used by some of the utilities, such as **mailx**, and specifies that whenever a subshell is created, the **EDITOR** variable should be exported to it.

Tip: If you create a subshell with the command **sh –L**, the shell starts and reads and executes your profile file. Note that the letter **L** must be in uppercase. The shell looks for **.profile** in the **$HOME** directory. If it is not found, the shell looks in the working directory; therefore, make sure that you are working in the right directory when you enter this command.

Quoting variable values

When you have blanks in a variable value, you need to enclose it in quotation marks. The quotation marks tell the shell to treat blanks as literals and not delimiters. Single quotation marks are more serious about this than are double quotation marks:

- Single quotation marks preserve the meaning of (that is, treat literally) all characters.
- Double quotation marks still allow certain characters ($, ` (backquote), and \ (backslash)) to be expanded. This is important if you want variable expansion. For example, see how the $ is handled here:

  ```
  export HOMEMSG="Using $HOME as Home Directory"
  ```

  If your home directory were set to **/u/user**, the following:

  ```
  echo $HOMEMSG
  ```

  would display:

  ```
  Using /u/user as home directory
  ```

  If, instead, you enclosed the variable value in single quotation marks, like this:

  ```
  export HOMEMSG='Using $HOME as home directory'
  ```

  the following:

  ```
  echo $HOMEMSG
  ```

  would display:

  ```
  Using $HOME as home directory
  ```

  As you can see, the $ is not expanded.

Changing variable values dynamically

You can also change any of these values for the duration of your session (or until you change them again). You enter the name of the environment variable and equate it to a new value.

Example: To change the command prompt string to +>, issue:

```
PS1='+>'
```

Understanding shell variables

You can display the shell's variables and their values by entering this command:

```
set
```

You may see many variables that you don't recognize. These are *built-in*, or *predefined*, variables that are set up with default values when you start the shell.

You can customize the built-in variables by setting their value in your **.profile**. Only the variables **IFS**, **PS1**, and **PS2** support double-byte characters for the values.

Only the shell variables that are exported are available to shell scripts and commands invoked from the shell. Environment variables are a subset of shell variables that have been exported.

You can display the environment variables and their values by entering either of these commands:

```
env
printenv
```

You can display the value of a single variable with the **echo** command, the **print** command, or the **printenv** command. For example, any of these commands

```
echo $HOME

print $HOME

printenv $HOME
```

displays the current value of the **HOME** variable.

In general, **echo** displays the current values of all its arguments, after any shell processing has taken place. For example, consider:

```
echo *.doc
```

The shell first expands the wildcard character *. This produces the names of every file in the working directory that has the suffix **.doc**. So the output of **echo** is a list of all such files. And if there are no file names ending in **.doc**, the command output is just `*.doc`.

For more information about shell variables,

- Built-in variables are listed in a table in the **sh** command description in *z/OS UNIX System Services Command Reference*.
- There is an appendix that lists shell variables in *z/OS UNIX System Services Command Reference*.

Customizing your shell environment: The ENV variable

So far, we have discussed customization that is set up inside your **.profile** file. However, the shell reads your profile file only when you log into the shell or when you enter the **sh** command **–L** option.

To always have a customized shell session, you need to have a special shell script that sets up the environment started each time you start the shell; this is called a *login script* (also known as an environment file, or startup script). You specify the name of this script in the **ENV** variable in your **.profile** file.

When you start the shell, the shell looks for an environment variable named **ENV**. You can use the **ENV** variable to point to a login script that sets things up in the same way that the profile file does.

Example: For example, you might put all your alias definitions and other setup instructions into a file called **.setup** in your home directory. You want these instructions run when your shell starts after you login and whenever you explicitly create the shell during a session (for example, as a child shell to run a shell script). To make sure **ENV** is set up when you login or when you execute a shell, specify **export ENV** in your **.profile** file.

```
export ENV=$HOME/.setup
```

You might find it useful to put all your aliases in the login script that **ENV** points to, instead of in your **.profile** file. However, you should keep exported variable assignments in your profile, so that they are run only once.

Customizing the search path for commands: The PATH variable

Command interpreters usually have to search for a file that contains the command you want to run. When you are using the shell, you tell the shell where to search for a command. Essentially, the shell uses a list of directories in which commands may be found. This list is specified in your PATH variable in your **.profile** file. The list could be called your *search path,* because it tells the shell where you want to search.

You can set up a search path with a command of the form:

```
PATH='dir:dir:...'
```

For example, you might enter:

```
PATH='/bin:/usr/bin:/usr/etc:/usr/macneil/bin:/usr/games:/usr'
```

The shell then searches the directories in the following order, when looking for commands or shell scripts:

1. `/bin`
2. `/usr/bin`
3. `/usr/etc`
4. `/usr/macneil/bin`
5. `/usr/games`
6. `/usr`

As soon as the shell finds a file with an appropriate name, it runs that file.

Because the shell runs a command as soon as it finds a file with an appropriate name, pay close attention to the order in which you list directory names in your search path. For example, the previous search path specifies the `/bin` directory (where z/OS shell commands are stored) before the `/etc` directory.

If you set up your PATH incorrectly, you could get the wrong command. Always search the shell commands directory first: `/bin`. Some z/OS shell commands run other shell commands and utilities by name; they expect to get the z/OS UNIX version of that command and might not work correctly if a program that has the same name is found first in another directory.

Tip: To ensure that the z/OS shell properly identifies a shell built-in command, specify the shell commands directory `/bin` exactly as `/bin` (not as `/bin/` or any other variation) in addition to making the shell commands directory `/bin` part of your PATH. Some commands located in `/bin` are implemented as shell built-in commands in order to improve performance of shell scripts. The directories specified in PATH influence how the shell locates commands, including the built-in commands, which also influence how the shell handles tracked aliases. See “Using alias tracking” on page 73 for more information about tracked aliases.

Adding your working directory to the search path

You can have the shell search your working directory for commands (in addition to the standard directories that contain commands). As an example, suppose you have different directories containing the source code for different programs. In each directory, you create a shell script named **compile** that compiles all the source modules of the program in that directory. To compile a particular program, enter **cd** to change to the appropriate directory and then enter:

```
compile
```

The shell searches the working directory, finds the **compile** shell script, and runs it.

You can add your working directory to your search path by one of these methods:
- Putting in an entry without a name
- Using a period (**.**) for the working directory.

For example, both of these specify that the working directory should be searched after **/bin** but before **/usr/local**:

```
PATH='/bin::/usr/local'    #no name
PATH='/bin:.:/usr/local'   #using a period
```

Both of these say that your working directory should be searched before anything else:

```
PATH=':/bin:/usr/local'    #no name
PATH='.:/bin:/usr/local'   #using a period
```

Both of these say that your working directory should be searched after everything else:

```
PATH='/bin:/usr/local:'    #no name, ends in a colon
PATH='/bin:/usr/local:.'   #using a period
```

The best way to specify search paths is to put them into your **.profile** file. That way, they are set up every time you log into the shell.

Checking the search path used for a command

With aliases and search paths, it can be easy to lose track of what is executed when you enter a command. The **type** command can tell you which file is executed if you enter a command line that begins with a specific command. For example:

```
type date
```

tells you:

```
date is /bin/date
```

and the command:

```
type jobs
```

tells you:

```
jobs is a built-in command
```

You can figure out how the search path works and what effect aliases have.

Customizing the FPATH search path: The FPATH variable

The **FPATH** variable contains a list of directories that the z/OS shell searches to find executable functions. Directories in this list are separated by colons. **sh** searches each directory in the order specified in the list until it finds a matching function. **FPATH** should specify only directories where the only executable files are function definitions.

Customizing the DLL search path: The LIBPATH variable

If you use a utility that uses a dynamic link library (DLL) —for example, **dbx**— you can set up the search path for the DLL with the LIBPATH variable. If this variable is not set, your working directory is searched for the DLL. The default setting shipped in **/samples/profile** is:

```
LIBPATH=/lib:/usr/lib:.
```

Improving the performance of shell scripts

To improve the performance of shell scripts, set the **_BPX_SPAWN_SCRIPT** environment variable to a value of YES.

If **_BPX_SPAWN_SCRIPT=YES** is not already placed in **/etc/profile**, you can put it in your **$HOME/.profile**.

Here is what the variable does: if the spawn callable service determines that a file is not a z/OS UNIX executable or a REXX exec, this setting causes spawn to run the file as a shell script directly. In the default processing, however, if the spawn callable service determines that a file is not a z/OS UNIX executable or a REXX exec, the spawn fails with ENOEXEC, and the shell then forks another process to run the input shell script. Setting this variable to YES eliminates the additional overhead of the fork.

You may want to set the variable to NO when you are running a non-shell application. For example, if an application does not support shell script invocations, set the variable to NO. Likewise, if an application is in test mode and the returning of ENOEXEC would be a useful indication of an error in the format of the target executable file, set the variable to NO.

Changing the locale in the shell

The default locale for the shell and utilities is C. If you want to change the locale, read these topics:

For additional information about locale and **LC_SYNTAX**, see *z/OS Language Environment Programming Guide*.

Advantages of a locale compatible with the MVS code page

Running the shell and utilities in a locale whose code page matches the code page you are using in MVS (which may not be compatible with code page IBM-1047 with respect to the EBCDIC variant characters) has several advantages.

- Converting data from a country or region's native code page to IBM-1047 is no longer required. This may enhance interoperability with other non-z/OS UNIX components of MVS.
- Remapping your keyboard is unnecessary.

Customizing for a locale not based on code page IBM-1047

If you select a locale that is not based on code page IBM-1047 and you use the utilities **lex**, **mailx**, **make**, and **yacc**, there is a further customizing step. These utilities expect all their input files, both system files and user-created files, to be in the same code page. So, for example, if you select the German locale De_DE.IBM-273, these utilities expect the files they process to be in code page IBM-273. Because system files are in code page IBM-1047, you need to use **iconv** to convert the following system files to the code page used by your selected locale:

Utility File

lex **/etc/yylex.c**

mailx **/etc/mailx.rc**

make **/etc/startup.mk**

yacc **/etc/yyparse.c**

Advantages of a locale generated with code page IBM-1047

You might prefer using one of the locales that is compatible with IBM-1047, but not compatible with the MVS code page if:

- You already use one of the IBM-1047 locales and have made an investment in data conversion and keyboard remapping.
- You have a requirement to run, in your shell environment, strictly standards-compliant applications or other applications that do *not* use **LC_SYNTAX**. If you want to use a single compiled and link-edited instance of a program in multiple locales, such a program is guaranteed to work in multiple locales only if IBM-1047 locales are used.
- You have shell scripts that are used in multiple locales. Having different users operating in various locales that are not generated from code page IBM-1047 requires multiple copies of a shell script, one for each different locale's code page.

There are other important code page conversion considerations when the shell uses code page IBM-1047 and MVS does not; see Appendix C, “Code page conversion when the shell and MVS have different locales,” on page 323 for that information.

Changing the locale setting in your profile

To change the locale, you set the value for the **LC_ALL** variable and export it. This variable overrides any values for locale specified for the **LC_** variables such as **LC_COLLATE**, **LC_MESSAGES**, and **LC_SYNTAX**, but it does not override **LC_CTYPE**.

If you change **LC_ALL** to a new locale, and z/OS UNIX messages are provided in that language, change the **LANG** variable setting to match the **LC_ALL** setting. Currently, z/OS UNIX messages are shipped in English, Kanji, and Simplified Chinese. If you do not change **LANG**, the messages will be in English.

If z/OS UNIX messages are not provided in your language, changing **LANG** by itself will have no effect. However, although messages are not supplied in your language, the z/OS UNIX messages that are displayed in English will use your national language characters and should display correctly on your terminals.

When you change the locale, the shell and utilities run in the new locale, but the shell locale category **LC_CTYPE** stays in the POSIX locale. This can affect parsing and shell expansion, and cause unpredictable behavior. In order to avoid this problem, after you change locale you must overwrite the current shell by issuing the **exec sh -L** command. The new shell will correctly interpret the proper character set for the new locale.

If you place an `export LC_ALL=`*`localename`* statement in your login profile, or if one has been placed in **/etc/profile**, make sure it is followed with **exec sh -L** and protect that with **tty -s**, as shown in “Examples: Changing locale” on page 47. If you don't protect it with the **tty -s** test, BPXBATCH SH *command* will not run the command.

If you use **exec sh -L**, there are two situations that you must take into account:

1. Loop control; you only want the **exec sh -L** to be executed the first time.
2. If you plan to use BPXBATCH or OSHELL (which calls BPXBATCH) with national language support, you need to define the LANG and LC_ALL variables in a file for BPXBATCH to use. See "Passing environment variables to BPXBATCH" on page 158 for more information.

If your **/etc/profile** has been set up for the proper locale, you only need to change your **.profile** if you want a different locale than already set up as the default. For more information on setting up locale and messages, see the section on customizing for your national code page in the shell in *z/OS UNIX System Services Planning*.

Examples: Changing locale

If you are using OMVS, the 3270 terminal interface. If your **/etc/profile** is not set up for your locale and LANG, then in order to work in a locale such as Danish, then add this code to the **.profile** file:

```
if test -z "$LOCALE_SWITCH" && tty -s
then
  echo " - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - "
  echo " - Logon shell will now be invoked to reflect        - "
  echo " - code page IBM-277                                 - "
  echo " - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - "
  LOCALE_SWITCH=EXECUTED
  LANG=C
  LC_ALL=Da_DK.IBM-277
  export LANG LC_ALL LOCALE_SWITCH
  #Issue chcp if not using OMVS command
   if test "$_BPX_TERMPATH" ! "OMVS"
   then
   chcp -a ISO8859-1 -e IBM-277
   fi
exec sh -L
else
  echo " - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - "
  echo " -  Welcome to OS/390 UNIX System Services           - "
  echo " - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - "
fi
```

If you want your messages displayed in a different language than that specified in the system-wide **/etc/profile**, you must modify your **.profile** accordingly. For more information, see "Customizing the language of your messages" on page 49.

For a list of the z/OS UNIX locales (and their locale object names) and locale source files, see Appendix E, "Locale objects, source files, and charmaps," on page 331.

The LC_SYNTAX environment variable

There are 13 variant characters in the POSIX portable character set whose encoding might vary on different EBCDIC code pages:

Right brace (})
Left brace ({)
Backslash (\)
Right square bracket (])
Left square bracket ([)
Circumflex (^)
Tilde (~)
Exclamation point (!)

Pound sign (#)
Vertical bar (|)
Dollar sign ($)
Commercial at-sign (@)
Accent grave (`)

Before MVS SP Release 5.2.2, the z/OS shell and utilities required that all data in the z/OS UNIX file system be encoded in one of three code pages: IBM-1047, IBM-1027, or IBM-939. Any data moved into the z/OS UNIX file system from a workstation or from an MVS data set often had to be converted to one of code pages IBM-1047, IBM-1027, or IBM-939 before it could be processed by the shell. Similarly, to ensure that any variant characters keyed in at the terminal had the correct encoding, you had to either use the conversion option of the OMVS command or customize your keyboard.

Now, however, the shell can process data in additional EBCDIC code pages, not just the three code pages previously supported. When you specify a locale with the LC_ALL variable, the LC_SYNTAX environment variable is set. The shell uses the LC_SYNTAX environment variable to determine the code points to use for the 13 variant characters. This means that the shell can adapt dynamically to the code page of the current locale.

Applications that use LC_SYNTAX will work in multiple locales using multiple code pages. To be sensitive to the 13 variant characters, an application must be enabled to use LC_SYNTAX. For information about how to do this, see *z/OS XL C/C++ Programming Guide*.

LC_SYNTAX—an example

For example, consider the **echo** command and its use of the backslash (\) character. The backslash is one of the 13 variant characters. The following command:

```
echo 'this is\nreal handy'
```

produces the following output at the terminal:

```
this is
real handy
```

echo finds and converts the \n in the input to a <newline> character in the output. To do this, **echo** must know the encoding for the backslash character in the current user's environment—in this case, the character generated by the user's terminal when the backslash key is pressed.

A 3270 terminal operating in the USA locale En_US.IBM-037 (code page IBM-037) generates X'E0' for the backslash, while a 3270 terminal operating in the German locale De_DE.IBM-273 (code page IBM-273) generates X'EC'. The LC_SYNTAX locale category provides this locale-specific hexadecimal encoding information to **echo** and the other utilities.

When the USA user runs in locale En_US.IBM-037, **echo** determines from the LC_SYNTAX information in this locale that the expected encoding for backslash is X'E0'. Likewise, when the German user runs in locale De_DE.IBM-273, **echo** determines from the LC_SYNTAX information in this locale that the expected encoding for backslash is X'EC'.

Limitations

The LC_SYNTAX setting does not affect:

- REXX execs.
- The ISPF shell (ISHELL). ISHELL runs in the locale that MVS is using, and therefore this could be different from the shell locale.
- Shell scripts. The code page in which a shell script is encoded must match the code page of the locale in which it is run. For a shell script to be shared by multiple users, they must all be in a locale that uses the same code page as the code page in which the shell script is encoded.

  If you have different users operating in various locales, you need multiple copies of a shell script, one for each different locale code page. You can use the **iconv** command to convert a shell script from one code page to another.

  If shell scripts are tagged and automatic conversion is not enabled, then the code page in which a shell script is encoded must match the code page of the locale in which it is run.

  If shell scripts are tagged and automatic conversion is enabled, then the locale must indicate a SBCS code page and the scripts must be SBCS.

The LOCPATH environment variable

LOCPATH is an environment variable that tells the **setlocale()** function the name of the directory from which to load locale object files. If LOCPATH is not defined, the default directory **/usr/lib/nls/locale** is searched. LOCPATH is similar to the PATH environment variable; it contains a list of z/OS UNIX directories separated by colons. For detailed information on how **setlocale()** searches for locale object files, see the description of **setlocale()** in *z/OS XL C/C++ Runtime Library Reference*.

Customizing the language of your messages

If you want your messages displayed in a different language than that specified in the system-wide **/etc/profile**, add this line to your **.profile**:

```
export LANG=your_language
```

your_language is the first part of the locale name listed in Appendix E, "Locale objects, source files, and charmaps," on page 331—for example, Ja_JP in the locale name JA_JP.IBM-939. Currently, z/OS UNIX ships messages in English, Kanji, and Simplified Chinese.

Setting your local time zone

The shell and utilities assume that the times stored in the file system and returned by the operating system are stored using the Greenwich mean time (GMT) or Universal Time Coordinated (UTC) as a universal reference. In the system-wide **/etc/profile**, the **TZ** environment variable maps that reference time to the local time specified with the variable. You can use a different time zone by setting the **TZ** variable in your **.profile**.

The three primary fields in the time zone specification are:

1. The local standard time, abbreviated—for example, EST or MSEZ.
2. The time offset west from the universal reference time, typically specified in hours (minutes and seconds are optional). A minus sign (-) indicates an offset east of the universal reference time.

3. The daylight saving time zone, abbreviated—for example, EDT. If this and the first field are identical or this value is missing, daylight saving time conversion is disabled. Optionally, you can specify an additional rule that indicates when daylight saving time starts and ends.

Example: If you want to set your time zone to Eastern Standard Time (EST) and export it, specify:

```
export TZ="EST5EDT"
```

- EST is Eastern Standard Time, the local time zone.
- The standard time zone is 5 hours west of the universal reference time.
- EDT is Eastern Daylight Saving time zone.

For complete information about how to specify the local time zone, see Appendix I. Setting the Local Time Zone with the TZ Environment Variable in *z/OS UNIX System Services Command Reference*.

Building a STEPLIB environment: The STEPLIB environment variable

Traditionally, some MVS users have preferred to alter the search order for MVS executable files when they are running a new or test version of an application program, such as a runtime library. To do this, they code a STEPLIB DD statement on the JCL used to run the application. Accessed ahead of LINKLIB or LPALIB, a STEPLIB is a set of private libraries where the new or test version of the application is stored.

The STEPLIB environment variable provides the ability to use a STEPLIB when running a z/OS UNIX executable file. This variable is used to determine how to set up the STEPLIB environment for an executable file. The STEPLIB environment variable should always be exported.

You can set the variable in one of three ways:

Table 2. Three ways to set the STEPLIB environment variable (z/OS shell)

Statement	Action
STEPLIB=CURRENT	Passes on any currently active TASKLIB, STEPLIB, or JOBLIB allocations from the invoker's MVS program search order environment to the environment created for the executable file to run in. Any STEPLIB environment in the invoker's process image is recreated in the new process image for the executable file when the file is invoked. This is the default value that is set if no STEPLIB variable is specified. If an application uses **fork()**, **spawn()**, or **exec()**, the STEPLIB data sets must be cataloged.
STEPLIB=NONE	Specifies that no STEPLIB environment should be set up for executable files.

Table 2. Three ways to set the STEPLIB environment variable (z/OS shell) (continued)

Statement	Action
STEPLIB=DSN1:DSN2:DSN3	Sets up a library search order for the STEPLIB, in the order that the data sets are specified. You can specify up to 255 fully qualified data set names, separated by colons. For example: `export STEPLIB=SMITH.C.LOADLIB:SMITH.PL1.LOADLIB` The specified data sets must be cataloged MVS load libraries that you have security access to. The data sets specified here are built into a STEPLIB environment for the executable file.

Restrictions on STEPLIB data sets

For executable files that have the set-user-ID or set-group-ID bit set, there are restrictions on the data sets that can be built into the STEPLIB environment for the file to run in. The systems programmer maintains a STEPLIB sanction list of data sets that can be included in the STEPLIB environment for such executable files. Only data sets on that list are built into the STEPLIB environment for such files. If you need a data set added to the list, contact your systems programmer.

Setting options for a shell session

The **set** command lets you set options, or flags, for your shell session. These flags control the way the shell handles certain situations.

1. To display the shell flags that are currently set, enter:

   `set –o`

2. To turn on an option, enter:

   `set –o` *name*

   where *name* is the name of the option you want to turn on. If you want an option turned on for every shell session, put the **set** command in your login script (the script specified on the **ENV** variable).

3. To turn off an option, enter:

   `set +o` *name*

   Contrary to what you might expect, **-** means *on*, and **+** means *off*.

The following discussion highlights some of the options you may find useful. For all the options, see the **set** command description in *z/OS UNIX System Services Command Reference*.

Exporting variables

The command:

```
set -o allexport
```

indicates that you want to *export*—that is, pass to a child process or subsequent command—every variable that is assigned a value. This command exports all variables that currently have values, plus all variables assigned a value in the future.

Controlling redirection

The command:

```
set -o noclobber
```

indicates that you do not want the > redirection operator to overwrite existing files. When this option is on and you specify the construct >*file*, the redirection works only if *file* does not exist. If you have this option on and you really do want to redirect output into an existing file, you must use >|*file* (with an "or" bar after the >) to indicate output redirection. See "“Using a wildcard character to specify file names” on page 80" for more information.

Preventing wildcard character expansion

The command:

```
set -o noglob
```

tells the shell not to expand wildcard characters in file names. This command is occasionally useful if you are entering command lines that contain a number of characters that would normally be expanded. See “Using a wildcard character to specify file names” on page 80 for a discussion of wildcard characters.

Displaying input from a file

The command:

```
set -o verbose
```

tells the shell to display its input on the screen as the input is read. This command lets you keep track of material that comes from a file.

Running a command in the current environment

The command:

```
set -o pipecurrent
```

causes the shell to run the last command of a pipeline in the current environment.

Displaying current option settings

The command:

```
set -o
```

displays all current option settings. The display of each option is preceded by one of these:

`-o` to indicate that the option is enabled
`+o` to indicate that the option is disabled

Chapter 5. Customizing the tcsh shell

If you are interested in using the tcsh shell, read this information as well as:

- Chapter 7, "Working with tcsh shell commands," on page 91
- Chapter 9, "Writing tcsh shell scripts," on page 133

You can personalize your use of the tcsh shell. This topic covers these tasks:

- Understanding and modifying your startup files
- Understanding shell variables
- Customizing the search path for commands with the **PATH** variable
- Improving the performance of shell scripts
- Changing the locale
- Customizing the language of messages
- Setting the time zone
- Building a STEPLIB environment
- Setting options for a shell session

Understanding the startup files

When you start the tcsh shell, it uses information in several files to determine your particular needs or preferences as a user. The files are accessed in the following order:

1. **/etc/csh.cshrc**
2. **/etc/csh.login**
3. **$HOME/.tcshrc**
4. **$HOME/.cshrc**
5. **$HOME/.history**
6. **$HOME/.login**
7. **$HOME/.cshdirs**

Settings established in a file accessed earlier can be overwritten by the settings in a file accessed later.

The **/etc/csh.cshrc** file contains system-wide settings that are common to all shell users. It is used for setting shell variables and defining command aliases. Usually, it will set environment variables such as PATH.

The **/etc/csh.login** file is a system-wide file that is only executed by tcsh login shells, and is used for setting environment variables such as TERM. Opening messages are typically placed here.

The **/$HOME/.tcshrc** file contains settings that may be customized for an individual shell user. It is used for setting shell variables and defining command aliases. Here, users can set variables that are different from the system defaults set in the system-wide profiles.

The **/$HOME/.cshrc** file is included for compatibility with C-Shell users, and is read only if **/$HOME/.tcshrc** does not exist. It contains the same types of settings as **/$HOME/.tcshrc**.

The /$HOME/.history file is read by login shells to initialize the history list. It is created by the shell, based on the setting of certain shell variables.

The **/$HOME/.login** file is only executed by tcsh login shells, and is used for setting environment variables that have been customized for an individual user. It usually contains commands that affect a user's terminal settings.

Typically, your **.login** file might contain the following:

```
# set TERM environment variable
setenv TERM vt220

# set DISPLAY environment variable
setenv DISPLAY mymachine.mydomain.com:0
```

Figure 12. A sample .login

The **$HOME/.cshdirs** file is read by login shells to initialize the directory stack. It is created by the shell, based on the setting of certain shell variables.

The system-wide startup files (located in **/etc**) are modified by system administrators to contain settings that should pertain to all users. The startup files in a user's home directory (**$HOME/. . .**) can be altered to suit specific user preferences, with the exception of **$HOME/.history** and **$HOME/.cshdirs**, which are created by the shell. A user can "unset" or "unalias" anything that was defined in a system-wide startup file.

Quoting variable values

When you have blanks in a variable value, you need to enclose it in quotation marks. The quotation marks tell the shell to treat blanks as literals and not delimiters. Single quotation marks are more serious about this than are double quotation marks:

- Single quotation marks preserve the meaning of (that is, treat literally) all characters.
- Double quotation marks still allow certain characters ($, ` (backquote), and \ (backslash)) to be expanded. This is important if you want variable expansion. For example, see how the $ is handled here:

  ```
  setenv HOMEMSG "Using $HOME as Home Directory"
  ```

  If your home directory were set to **/u/user**, the following:

  ```
  echo $HOMEMSG
  ```

  would display:

  ```
  Using /u/user as home directory
  ```

  If, instead, you enclosed the variable value in single quotation marks, like this:

  ```
  setenv HOMEMSG 'Using $HOME as home directory'
  ```

  the following:

  ```
  echo $HOMEMSG
  ```

  would display:

  ```
  Using $HOME as home directory
  ```

  As you can see, the $ is not expanded.

Changing variable values dynamically

You can also change any of these values for the duration of your session (or until you change them again). You enter the name of the environment or shell variable and equate it to a new value.

Example: To change the command prompt string to +>, issue:

```
set prompt='+>'
```

Understanding shell variables

You can display the shell's variables and their values by entering this command:

```
set
```

or

```
set -r
```

set -r displays readonly shell variables.

You may see many variables that you don't recognize. These are *built-in*, or *predefined*, variables that are set up with default values when you start the shell.

You can customize the built-in variables by setting their value in your **.tcshrc** file.

Only the shell variables that are defined in the **.tcshrc** file are available to shell scripts and commands invoked from the shell. Environment variables are inherited by subshells, and can be displayed by entering either of these commands:

```
setenv
printenv
```

You can display the value of a single variable with the **echo** command or the **printenv** command. For example, either of these commands

```
echo $HOME
```

```
printenv $HOME
```

displays the current value of the **HOME** variable.

In general, **echo** displays the current values of all its arguments, after any shell processing has taken place. The shell first expands the wildcard character *.

Example: Consider:

```
echo *.doc
```

Result: This produces the names of every file in the working directory that has the suffix **.doc**. So the output of **echo** is a list of all such files. And if there are no file names ending in **.doc**, the command output is just `*.doc`.

For more information about shell variables,

- Built-in variables are listed in a table in the **tcsh** command description in *z/OS UNIX System Services Command Reference*.
- There is an appendix that lists shell variables in *z/OS UNIX System Services Command Reference*.

Customizing your shell environment: The .tcshrc file

So far, we have discussed customization that is set up inside your **.login** file. However, the shell reads this file only when you log into the shell or when you enter the **tcsh** command with the **–l** option. Note that the option is a lowercase "L".

To always have a customized shell session, you need to have a special shell script that customizes your shell variables each time you start the shell; this is the purpose of the **.tcshrc** file (also known as a startup script).

For example, you might put all your alias definitions and other setup instructions into this file. You want these instructions run when your shell starts after you login and whenever you explicitly create the shell during a session (for example, as a child shell to run a shell script).

Figure 13 on page 57 is a sample **.tcshrc** file:

```
# ================================================================
#                       path shell variable
#                       -------------------
# Lists directories in which to look for executable commands.
# ================================================================
#set path = ( /bin /usr/local/bin /usr/bin )

# test if we are an interactive shell
if ($?prompt) then
# ================================================================
#                       prompt shell variable
#                       ---------------------
# The string which is printed before reading each command from the
# terminal.  Currently set to display hostname, and current working
# directory.
# ================================================================
set prompt = "%m:%~> "

# ================================================================
#                       rmstar shell variable
#                       ---------------------
# If set, the user is prompted before 'rm *' is executed.
# ================================================================
set rmstar

# ================================================================
#                       noclobber shell variable
#                       ------------------------
# If set, output redirection will not overwrite existing files.
# ================================================================
#set noclobber

# ================================================================
# source complete.tcsh
# ================================================================
if (`filetest -e /etc/complete.tcsh`) then
        source /etc/complete.tcsh
endif
endif  # interactive shell

# ================================================================
# set up useful aliases
# ================================================================
alias m more
```

Figure 13. A sample .tcshrc

Customizing the search path for commands: The PATH variable

Command interpreters usually have to *search* for a file that contains the command you want to run. When you are using the shell, you tell the shell where to search for a command. Essentially, the shell uses a list of directories in which commands may be found. This list is specified in your **PATH** variable in your **etc/csh.cshrc** file. The list could be called your search path, because it tells the shell where you want to search.

You can set up a search path with a command of the form:

```
setenv path 'dir:dir:...'
```

or,

```
set path=(dir1 dir2)
```

For example, you might enter:

```
setenv path '/bin:/usr/bin:/usr/macneil/bin:/usr/games:/usr'
```

The shell then searches the directories in the following order, when looking for commands or shell scripts:

1. **/bin**
2. **/usr/bin**
3. **/usr/macneil/bin**
4. **/usr/games**
5. **/usr**

As soon as the shell finds a file with an appropriate name, it runs that file.

Because the shell runs a command as soon as it finds a file with an appropriate name, pay close attention to the order in which you list directory names in your search path. For example, the previous search path specifies the **/bin** directory (where shell commands are stored) before the **/usr/bin** directory.

If you set up your **PATH** incorrectly, you could get the wrong command. You should generally search the shell commands directory first: **/bin**.

Adding your working directory to the search path

You can have the shell search your working directory for commands (in addition to the standard directories that contain commands). As an example, suppose you have different directories containing the source code for different programs. In each directory, you create a shell script named **compile** that compiles all the source modules of the program in that directory. To compile a particular program, enter **cd** to change to the appropriate directory and then enter:

```
compile
```

The shell searches the working directory, finds the **compile** shell script, and runs it.

You can add your working directory to your search path by one of these methods:

- Putting in an entry without a name
- Using a period (**.**) for the working directory.

For example, both of these specify that the working directory should be searched after **/bin** but before **/usr/local**:

```
setenv path '/bin::/usr/local'    #no name
setenv path '/bin:.:/usr/local'   #using a period
```

Both of these say that your working directory should be searched before anything else:

```
setenv path ':/bin:/usr/local'    #no name
setenv path '.:/bin:/usr/local'   #using a period
```

Both of these say that your working directory should be searched after everything else:

```
setenv path '/bin:/usr/local:'    #no name, ends in a colon
setenv path '/bin:/usr/local:.'   #using a period
```

The best way to specify search paths is to put them into your **.tcshrc** file. That way, they are set up every time you log into the shell.

Checking the search path used for a command

With aliases and search paths, it can be easy to lose track of what is executed when you enter a command. The **which** command can tell you which file is executed if you enter a command line that begins with a specific command. The **where** command can tell you where versions of the command are located. For example:

```
which kill
```

tells you:

```
kill: shell built-in command.
```

and the command:

```
where kill
```

tells you:

```
kill is a shell built-in
/bin/kill
```

Customizing the DLL search path: The LIBPATH variable

If you use a utility that uses a dynamic link library (DLL) —for example, **dbx**— you can set up the search path for the DLL with the LIBPATH variable. If this variable is not set, your working directory is searched for the DLL. The default setting shipped in **/samples/login** is:

```
setenv LIBPATH "/lib:/usr/lib:."
```

Changing the locale in the shell

The default locale for the shell and utilities is C. If you want to change the locale, read the information presented here.

For additional information on locale and **LC_SYNTAX**, see *z/OS Language Environment Programming Guide*.

Advantages of a locale compatible with the MVS code page

Running the shell and utilities in a locale whose code page matches the code page you are using in MVS (which may not be compatible with code page IBM-1047 with respect to the EBCDIC variant characters) has several advantages:

- Converting data from a given country or region's native code page to IBM-1047 is no longer required. This may enhance interoperability with other non-z/OS UNIX components of MVS.
- Remapping your keyboard is unnecessary.

Customizing for a locale not based on code page IBM-1047

If you select a locale that is not based on code page IBM-1047 and you use the utilities **lex**, **mailx**, **make**, and **yacc**, there is a further customizing step. These utilities expect all their input files, both system files and user-created files, to be in the same code page. So, for example, if you select the German locale De_DE.IBM-273, these utilities expect the files they process to be in code page IBM-273. Because system files are in code page IBM-1047, you need to use **iconv** to convert the following system files to the code page used by your selected locale:

Utility	File
lex	**/etc/yylex.c**

mailx **/etc/mailx.rc**

make **/etc/startup.mk**

yacc **/etc/yyparse.c**

Advantages of a locale generated with code page IBM-1047

On the other hand, you may prefer using one of the locales that is compatible with IBM-1047, but not compatible with the MVS code page if:

- You already use one of the IBM-1047 locales and have made an investment in data conversion and keyboard remapping.
- You have a requirement to run, in your shell environment, strictly standards-compliant applications or other applications that do *not* use **LC_SYNTAX**. If you want to use a single compiled and link-edited instance of a program in multiple locales, such a program is guaranteed to work in multiple locales only if IBM-1047 locales are used.
- You have shell scripts that are used in multiple locales. Having different users operating in various locales that are not generated from code page IBM-1047 requires multiple copies of a shell script, one for each different locale's code page.

There are other important code page conversion considerations when the shell uses code page IBM-1047 and MVS does not; see Appendix C, “Code page conversion when the shell and MVS have different locales,” on page 323 for that information.

Changing the locale setting in your profile

To change the locale, you set the value for the **LC_ALL** variable. This variable overrides any values for locale specified for the **LC_** variables such as **LC_COLLATE**, **LC_MESSAGES**, and **LC_SYNTAX**, but it does not override **LC_CTYPE**.

If you change **LC_ALL** to a new locale, and z/OS UNIX messages are provided in that language, change the **LANG** variable setting to match the **LC_ALL** setting. Currently, z/OS UNIX messages are shipped in English, Kanji, and Simplified Chinese. If you do not change **LANG**, the messages will be in English.

If z/OS UNIX messages are not provided in your language, changing **LANG** by itself has no effect. However, although messages are not supplied in your language, the z/OS UNIX messages that are displayed in English will use your national language characters and should display correctly on your terminals.

When you change the locale, the shell and utilities run in the new locale, but the shell locale category **LC_CTYPE** stays in the POSIX locale. This can affect parsing and shell expansion, and cause unpredictable behavior. In order to avoid this problem, after you change locale you must overwrite the current shell by issuing the **exec tcsh -l** command. The new shell will correctly interpret the proper character set for the new locale.

If you place a `setenv LC_ALL` *`localename`* statement in your login profile, or if one has been placed in **/etc/csh.login**, make sure it is followed with **exec tcsh -l** and protect that with **tty -s**, as shown in “Examples: Changing locale” on page 61. If you don't protect it with the **tty -s** test, BPXBATCH SH *command* will not run the command.

If you use **exec tcsh -l**, there are two situations that you must take into account:

1. Loop control; you only want the **exec tcsh -l** to be executed the first time.
2. If you plan to use BPXBATCH or OSHELL (which calls BPXBATCH) with national language support, you need to define the LANG and LC_ALL variables in a file for BPXBATCH to use. See "Passing environment variables to BPXBATCH" on page 158 for more information.

If your **/etc/csh.login** was set up for the proper locale, you only need to change your **.login** if you want a different locale than already set up as the default. For more information on setting up locale and messages, see the section on customizing for your national code page in the shell in *z/OS UNIX System Services Planning*.

Examples: Changing locale

For example, say that you are using OMVS, the 3270 terminal interface. If your **/etc/csh.login** is not set up for your locale and LANG, then in order to work in a locale such as Danish, you should add this to your **.login** file:

```
tty -s
set tty_rc=$status
if (($?LOCALE_SWITCH == 0 ) && ($tty_rc == 0)) then
        echo "-------------------------------------------------"
        echo "- Logon shell will now be invoked to reflect   -"
        echo "- code page IBM-277                            -"
        echo "-------------------------------------------------"
        setenv LOCALE_SWITCH EXECUTED
        setenv LANG C
        setenv LC_ALL Da_DK.IBM-277
        # Issue chcp if not using OMVS command
        if ($?_BPX_TERMPATH != "OMVS"  ) then
          chcp -a ISO8859-1 -e IBM-277
        endif
        exec tcsh -l
endif
unset tty_rc
```

If you want your messages displayed in a different language than that specified in the system-wide **/etc/csh.login**, you have to modify your **.login** accordingly.

For a list of the z/OS UNIX locales (and their locale object names) and locale source files, see Appendix E, "Locale objects, source files, and charmaps," on page 331.

The LC_SYNTAX environment variable

There are 13 variant characters in the POSIX portable character set whose encoding may vary on different EBCDIC code pages:

Right brace (})
Left brace ({)
Backslash (\)
Right square bracket (])
Left square bracket ([)
Circumflex (^)
Tilde (~)
Exclamation point (!)
Pound sign (#)
Vertical bar (|)
Dollar sign ($)
Commercial at-sign (@)
Accent grave (`)

When you specify a locale with the **LC_ALL** variable, the **LC_SYNTAX** environment variable is set. The shell uses the **LC_SYNTAX** environment variable to determine the code points to use for the 13 variant characters. This means that the shell can dynamically adapt to the code page of the current locale.

Applications that use **LC_SYNTAX** will work in multiple locales using multiple code pages. To be sensitive to the 13 variant characters, an application must be enabled to use **LC_SYNTAX**. For information on how to do this, see *z/OS XL C/C++ Programming Guide*.

LC_SYNTAX—an example

For example, consider the **echo** command and its use of the backslash (\) character. The backslash is one of the 13 variant characters. When the echo style is **all** or **sysv**, the following command:

```
echo 'this is\nreal handy'
```

produces the following output at the terminal:

```
this is
real handy
```

echo finds and converts the \n in the input to a <newline> character in the output. To do this, **echo** must know the encoding for the backslash character in the current user's environment—in this case, the character generated by the user's terminal when the backslash key is pressed.

A 3270 terminal operating in the USA locale En_US.IBM-037 (code page IBM-037) generates X'E0' for the backslash, while a 3270 terminal operating in the German locale De_DE.IBM-273 (code page IBM-273) generates X'EC'. The **LC_SYNTAX** locale category provides this locale-specific hexadecimal encoding information to **echo** and the other utilities.

When the USA user runs in locale En_US.IBM-037, **echo** determines from the LC_SYNTAX information in this locale that the expected encoding for backslash is X'E0'. Likewise, when the German user runs in locale De_DE.IBM-273, **echo** determines from the LC_SYNTAX information in this locale that the expected encoding for backslash is X'EC'.

Limitations

The LC_SYNTAX setting does not affect:

- REXX execs.
- The ISPF shell (ISHELL). ISHELL runs in the locale that MVS is using, and therefore this could be different from the shell locale.
- Shell scripts. The code page in which a shell script is encoded must match the code page of the locale in which it is run. For a shell script to be shared by multiple users, they must all be in a locale that uses the same code page as the code page in which the shell script is encoded.

  If you have different users operating in various locales, you need multiple copies of a shell script, one for each different locale code page. You can use the **iconv** command to convert a shell script from one code page to another.

  If shell scripts are tagged and automatic conversion is not enabled, then the code page in which a shell script is encoded must match the code page of the locale in which it is run.

If shell scripts are tagged and automatic conversion is enabled, then the locale must indicate a SBCS code page.

The LOCPATH environment variable

LOCPATH is an environment variable that tells the **setlocale()** function the name of the directory from which to load locale object files. If LOCPATH is not defined, the default directory **/usr/lib/nls/locale** is searched. LOCPATH is similar to the PATH environment variable; it contains a list of z/OS UNIX directories separated by colons. For detailed information on how **setlocale()** searches for locale object files, see the description of **setlocale()** in *z/OS XL C/C++ Runtime Library Reference*.

Customizing the language of your messages

If you want your messages displayed in a different language than that specified in the system-wide **/etc/.login**, add this line to your **.login**:

```
setenv LANG your_language
```

your_language is the first part of the locale name listed in Appendix E, "Locale objects, source files, and charmaps," on page 331—for example, Ja_JP in the locale name JA_JP.IBM-939. Currently, z/OS UNIX ships messages in English, Kanji and Simplified Chinese.

Setting your local time zone

The shell and utilities assume that the times stored in the file system and returned by the operating system are stored using the Greenwich Mean Time (GMT) or Universal Time Coordinated (UTC) as a universal reference. In the system-wide **/etc/csh.login**, the **TZ** environment variable maps that reference time to the local time specified with the variable. You can use a different time zone by setting the **TZ** variable in your **.login**.

The three primary fields in the time zone specification are:

1. The local standard time, abbreviated—for example, EST or MSEZ.
2. The time offset west from the universal reference time, typically specified in hours (minutes and seconds are optional). A minus sign (-) indicates an offset east of the universal reference time.
3. The daylight saving time zone, abbreviated—for example, EDT. If this and the first field are identical or this value is missing, daylight saving time conversion is disabled. Optionally, you can specify an additional rule that indicates when daylight saving time starts and ends.

Example: If you want to set your time zone to Eastern Standard Time (EST) and export it, specify:

```
setenv TZ "EST5EDT"
```

- EST is Eastern Standard Time, the local time zone.
- The standard time zone is 5 hours west of the universal reference time.
- EDT is Eastern Daylight Saving time zone.

For complete information about how to specify the local time zone, see Appendix I. Setting the Local Time Zone with the TZ Environment Variable in *z/OS UNIX System Services Command Reference*.

Building a STEPLIB environment: The STEPLIB environment variable

Traditionally, some MVS users have preferred to alter the search order for MVS executable files when they are running a new or test version of an application program, such as a runtime library. To do this, they code a STEPLIB DD statement on the JCL used to run the application. Accessed ahead of LINKLIB or LPALIB, a STEPLIB is a set of private libraries where the new or test version of the application is stored.

The STEPLIB environment variable provides the ability to use a STEPLIB when running a z/OS UNIX executable file. This variable is used to determine how to set up the STEPLIB environment for an executable file.

You can set the variable in one of three ways:

Table 3. Three ways to set the STEPLIB environment variable (tcsh shell)

Statement	Action
setenv STEPLIB CURRENT	Passes on any currently active TASKLIB, STEPLIB, or JOBLIB allocations from the invoker's MVS program search order environment to the environment created for the executable file to run in. Any STEPLIB environment in the invoker's process image is re-created in the new process image for the executable file when the file is invoked. This is the default value that is set if no STEPLIB variable is specified. If an application uses **fork()**, **spawn()**, or **exec()**, the STEPLIB data sets must be cataloged.
setenv STEPLIB NONE	Specifies that no STEPLIB environment should be set up for executable files.
setenv STEPLIB DSN1:DSN2:DSN3	Sets up a library search order for the STEPLIB, in the order that the data sets are specified. You can specify up to 255 fully qualified data set names, separated by colons. For example: `setenv STEPLIB SMITH.C.LOADLIB:SMITH.PL1.LOADLIB` The specified data sets must be cataloged MVS load libraries that you have security access to. The data sets specified here are built into a STEPLIB environment for the executable file.

Restrictions on STEPLIB data sets

For executable files that have the set-user-ID or set-group-ID bit set, there are restrictions on the data sets that can be built into the STEPLIB environment for the file to run in. The systems programmer maintains a STEPLIB sanction list of data sets that can be included in the STEPLIB environment for such executable files. Only data sets on that list are built into the STEPLIB environment for such files. If you need a data set added to the list, contact your systems programmer.

Setting variables for a shell session

The **set** and **unset** commands let you set and unset variables for your shell session. These variables control the way the shell handles certain situations. To display the shell variables that are currently set, type `set` . To turn on an option, enter:

`set` *name*

where *name* is the name of the option you want to turn on. If you want an option turned on for every shell session, put the **set** command in your **.tschrc** file.

To turn off an option, enter:

```
unset name
```

The following discussion highlights some of the options you may find useful. For all the options, see *set in the tcsh shell* under the **set** command description in *z/OS UNIX System Services Command Reference*.

Displaying current option settings

The command:

```
set
```

displays all current option settings.

Controlling redirection

The command:

```
set noclobber
```

indicates that you do not want the > redirection operator to overwrite existing files. When this option is on and you specify the construct >*file*, the redirection works only if *file* does not exist. If you have this option on and you really do want to redirect output into an existing file, you must use >|*file* (with an "or" bar after the >) to indicate output redirection.

Preventing wildcard character expansion

The command:

```
set noglob
```

tells the shell not to expand wildcard characters in file names. This command is occasionally useful if you are entering command lines that contain a number of characters that would normally be expanded.

Displaying input from a file

The command:

```
set xtrace
```

tells the shell to display its input on the screen as the input is read. This command lets you keep track of material that comes from a file.

Displaying deletion verification

The command:

```
set rmstar
```

prompts you for deletion verification when you enter the **rm** command in conjunction with the * character.

Files accessed at termination

When you terminate the tcsh shell, the following files are read at logout in this order:

1. **/etc/csh.logout**
2. **$HOME/.logout**

Chapter 6. Working with z/OS shell commands

The shell is, above all, a *programmer's* interface. As a result, the shell commands are strongly slanted towards the needs of a programmer. The z/OS shell has many *general* tools that can help any programmer. In addition, there are a number of commands designed especially for the C programmer.

Specifying shell command options

Most of the commands discussed in this topic accept options. Shell command options are usually specified by a minus sign (–) followed by a single character. For example, the **ls** command simply lists a directory's contents in multiple columns on your screen. However:

```
ls –F
```

distinguishes between various file types when listing the contents of a directory. (See "Listing directory contents" on page 207 for an example.)

```
ls –1
```

lists directory names in a single column.

Options consisting of a minus sign followed by a character are called *simple options*. You specify simple options after the name of the command and before any other arguments for the command (that is, arguments that are not options). For example, you would enter:

```
ls –1 dir1
```

to list the contents of **dir1** in a single column.

Command options and arguments must be typed as single-byte characters. Additionally, delimiters such as a slash, braces, and parentheses must be typed as single-byte characters.

The order of options and arguments is important. If you enter:

```
ls dir1 –F
```

ls lists the contents of **dir1** and then tries to list the contents of the directory, or attributes of the file, called **–F**.

As a special notation, most z/OS shell commands let you specify a double minus sign (--) to separate the options from the nonoption arguments; **--** means that there are no more options. Thus, if you really have a directory named **–F**, you could enter:

```
ls -- –F
```

to list the contents of that directory or the file attributes.

The z/OS shell gives you a shorthand way to specify more than one simple option to a command. For example, **–t** and **–v** are both simple options that you can specify with the **cat** command. (To find out what these options do, read the **cat** command description in *z/OS UNIX System Services Command Reference*.) You could enter:

```
cat –t –v file
```

or you could combine the two options into:

```
cat –tv file
```

The order of the options is not important:

```
cat –vt file
```

is equivalent to the previous version of the command.

Specifying options with accompanying arguments

In addition to simple options, some commands accept options that have accompanying arguments. Such options look like simple options followed by additional information. The argument may be a number, a string, the name of a file, or something else.

For example, if you read the **ps** command description in *z/OS UNIX System Services Command Reference*, you will see that **ps** accepts an argument of the form:

–u *userlist*

When *z/OS UNIX System Services Command Reference* shows part of a command line in *italics*, the italicized material is just a placeholder; when you actually use the command, you should fill in something else in its place. In this case, the *userlist* should be a string of one or more UID numbers or login names separated by commas and enclosed in single quotation marks. In the command:

```
ps –u 'macneil,wellie1'
```

the *userlist* string is *macneil,wellie1*. (If the string does not contain spaces, tabs, or other special characters, you can actually omit the enclosing single quotation marks, but the command is often easier to read if you use quotes anyway.) When executed, **ps** displays information for the specified users.

Help for shell command usage

If you incorrectly specify a command, a usage note for the command is displayed. The usage note displays the proper format for the command. Often you can display a usage note deliberately if you specify the command with a *-?* option.

For online help information about a command, see “Using the man command to get online help” on page 89.

Understanding standard input, standard output, and standard error

Once a command begins running, it has access to three files:

1. It reads from its *standard input* file. By default, standard input is the keyboard.
2. It writes to its *standard output* file.
   - If you invoke a shell command from the shell, a C program, or a REXX program invoked from TSO READY, standard output is directed to your terminal screen by default.
   - If you invoke a shell command, REXX program, or C program from the ISPF shell, standard output cannot be directed to your terminal screen. You can specify a z/OS UNIX file or use the default, a temporary file.
3. It writes error messages to its *standard error* file.

- If you invoke a shell command from the shell or from a C program or from a REXX program invoked from TSO READY, standard error is directed to your terminal screen by default.
- If you invoke a shell command, REXX program, or C program from the ISPF shell, standard error cannot be directed to your terminal screen. You can specify a z/OS UNIX file or use the default, a temporary file.

  If the standard output or standard error file contains any data when the command completes, the file is displayed for you to browse.

Using the shell: In the shell, the names for these files are:
- **stdin** for the *standard input* file.
- **stdout** for the *standard output* file.
- **stderr** for the *standard error* file.

The shell sometimes refers to these files by their *file descriptors,* or identifiers:
- `0` for **stdin**
- `1` for **stdout**
- `2` for **stderr**

For more information about the file descriptors that the shell supports, see the **sh** command description in *z/OS UNIX System Services Command Reference*.

Using TSO/E: When you are invoking the BPXBATCH utility, you can specify these standard files in MVS DD statements, TSO/E ALLOCATE commands, or DYNALLOC macros using the ddnames:
- STDIN for standard input
- STDOUT for standard output
- STDERR for standard error

For more information about BPXBATCH, see "The BPXBATCH utility" on page 156.

Using ISPF: When you run shell commands, REXX programs, and C programs from the ISPF shell, **stdout**, and **stderr** cannot be directed to your terminal. You can specify a z/OS UNIX file, or use the default—a temporary file. If it has any contents, the file is displayed for you to browse when the command or program completes.

Redirecting command output to a file

Commands entered at the command line typically use the three standard files described previously, but you can redirect the output for a command to a file you name. If you redirect output to a file that does not already exist, the system creates the file automatically.

Most z/OS shell commands display information on your workstation screen, *standard output*. If you redirect the output, you can save the output from a command in a file instead. The output is sent to the file rather than to the screen. At the end of any command, enter:

```
>filename
```

For example:

```
cat file1 file2 file3 >outfile
```

writes the contents of the three files into another file called **outfile**. All the information in the original three files is concatenated into a single file, **outfile**.

When you redirect output with **>***filename* and it is an existing file, the output writes over any information that the file already contains. To *append* command output at the end of the file, use:

```
>>file name
```

instead. For example:

```
sort -u file1 >output 2>>outerr
```

redirects the result of the sort to the file named **output** (instead of standard output) and appends any error messages to the file **outerr**, which is a record of errors encountered during various sorts.

Suppose you entered:

```
sort -u filea 2>&1 >output
```

In this command, you see two redirections:

- Error output from the sort is redirected to standard output (`&1`), the display screen.
- The result of the sort is redirected to the file named **output**.

Here is another example with two redirections, sending both standard error and standard output to a file. This command produces the program **hello** and a listing with error messages in a file called **hello.list**:

```
c89 -o hello -V hello.c >hello.list 2>&1;
```

Redirecting input from a file

You can redirect input in much the same way that you redirect output. A command that normally takes input from standard input can be redirected to take input from a file instead.

Example: To send the file **power** to another user, issue:

```
mailx DEEJ <power
```

Result: The file **power** becomes input to **mailx**, rather than your input from the keyboard.

Redirecting error output to a file

You can redirect error output from the workstation screen to a file, using **2>**. (As you remember, `2` is the file descriptor for **stderr**.) For example:

```
sort -u filea 2>errfile
```

sorts **filea**, checking for unique output records. Any messages regarding duplicate records are redirected to a file named **errfile**.

If you want to append error output to an existing file, use **2>>**.

If you do not care about seeing the error output, you can redirect it to **/dev/null** (also known as the bit bucket). This is equivalent to discarding the error messages.

```
sort -u filea 2>/dev/null
```

Closing a file

The operating system has a limit on the number of streams to a file that a process can open. The shell closes a stream for you when a shell script ends. However, to conserve on the number of active file streams, you can close regular files when you are finished working with them in a shell script. To close a regular file, use either of the following:

```
exec n<&-
exec n>&-
```

where *n* can be file descriptors 3 through 9.

Similarly, you can close standard output, standard input, and standard error when you do not need them. For example, for an application that does not display anything, you may want to close standard output. Here is the command syntax for those files:

- `exec 0<&-` (close standard input)
- `exec 1>&-` (close standard output)
- `exec 2>&-` (close standard error)

Dumping nontext files to standard output

The **od** command can dump the contents of a file to *standard output*, your workstation screen, in several different formats.

```
od file
```

dumps a file in octal.

```
od -h file
```

dumps the file in hexadecimal. Either of these may be useful if you want to check the actual contents of a nontext file. Other dump formats are available.

Setting up an alias for a command

After you have used the shell for a while, you will probably find that there are some commands that you use frequently. Rather than typing them over and over, you can set up an *alias* for these commands. An alias is a personalized name that stands for all or part of a command. You can create an alias by entering:

```
alias name="string"
```

in response to the shell's usual prompt for input. This is not a normal command; it is an instruction to the shell itself.

For example, suppose you have a hard time remembering that the **mv** command actually renames files. To make life easier for yourself, you could set up a simple alias by entering this on your command line:

```
alias renam="mv"
```

From this point onward in your session, whenever the shell sees the command **renam**, the **renam** is replaced with **mv**. The alias facility lets you create more usable commands.

Clearly, you could use an alias to save yourself some typing too. You could define **c** as an alias for **cat**. Then you would enter:

```
c file
```

to get the effect of:

```
cat file
```

Tip: If you issue an **exec sh**, alias names are not exported. For information about how to put alias definitions in your login script pointed to by the **ENV** variable, see "Customizing your shell environment: The ENV variable" on page 42.

DBCS recommendation: We recommend that you use single-byte characters when specifying an alias name, because the POSIX standard states that alias names must contain only characters in the POSIX portable character set.

Defining an alias

If you will be using an alias frequently, put the **alias** command in your profile file (**$HOME/.profile**). When you issue the OMVS command or start a shell with **sh –L**, the shell reads the aliases from the file and sets them up immediately. That way, you do not have to type them in every time you start using the shell. See "Customizing your .profile" on page 39 for more information about customizing your profile file.

To display all the currently defined aliases, you just enter:

```
alias
```

and the shell displays them. You will see a number of aliases that you did not set up. These are *predefined aliases* that the shell always creates.

When the shell replaces an alias, it checks to see if the result is another alias. The shell continues to check for and replace aliases until no aliases remain or the replacement would result in an infinite loop of alias expansion. For example, the shell defines the alias **functions** as follows:

```
alias functions="typeset -f"
```

Now, you might say to yourself, "Why do I need to type **functions** when I could just set up the alias **f**?" You could therefore enter:

```
alias f=functions
```

Then you enter:

```
f abc
```

the shell replaces **f** with **functions**, which the shell in turn replaces with:

```
"typeset -f"
```

Redefining an alias for a session

You can redefine an alias during a session, even if it is defined in your profile file. If you enter the command:

```
alias name="string"
```

during a session and *name* is already an alias, the shell forgets the old meaning and uses the new meaning from then on.

Setting up an alias for a particular version of a command

If you tend to use a command with the same options every time, you may want to set up an alias for the command with those particular options. Let's take an example. The **grep** command searches through files and prints out lines that contain a requested string. For example:

```
grep hello file
```

displays all the lines of *file* that contain the string `hello`. Normally, **grep** distinguishes between uppercase and lowercase letters; this means, for example, that the search in the previous example does not display lines that contain `HELLO`, `Hello`, and so forth. If you want **grep** to ignore the case of letters as it searches, you must specify the **–i** option, as in:

```
grep -i hello file
```

This finds `hello`, `HELLO`, `Hello`, and so on.

If you think you prefer to use the **–i** version of **grep** most of the time, you can define the alias:

```
alias grep="grep -i"
```

From this point on, if you use the command:

```
grep string file
```

it is automatically converted to:

```
grep -i string file
```

and you get the case-insensitive version of the command **grep**.

As another example, the **rm** command to delete (remove) a file has an **–i** option that prompts you to confirm the deletion. The file name and a question mark are displayed. For example, if you entered `rm -i file1` and **file1** is in your working directory, you would see the prompt:

```
file1: ?
```

before the system actually removes the file. You then enter `y` (yes) or `n` (no) in response. If you like this extra bit of safety, you might define:

```
alias rm="rm -i"
```

After this, when you call **rm**, it automatically checks with you before deleting a file, just to make sure that you really want to delete it.

It may seem odd to define an alias that has the same name as a command that is used in the alias, but this is so common that the z/OS shell checks specifically for an alias of the same name, and does the correct thing.

If you find yourself using the same option every time you call a command, you might consider creating an appropriate alias so that the shell automatically adds the option. Of course, the best place to define this alias is in your **.profile** file; then the alias is set up every time you invoke the shell.

Using alias tracking

Alias tracking can reduce the time the shell spends searching your search path (specified with the **PATH** variable) for a command; it helps shell scripts run faster. A *tracked alias* is a shell-created alias that is the full pathname for a command. The

shell automatically tracks everything it finds in the default path for executables (**/bin**). For example, if you enter the **ps** command, the shell creates the alias:

```
ps="/bin/ps"
```

To use alias tracking for commands in other locations, enter the command:

```
set -o trackall
```

The first time you enter a command, the shell creates an alias that is the full pathname of the command. For example, if the user **marcw** entered the **hello** command and the shell tracked the command, it would create the alias:

```
hello="/u/marcw/bin"
```

Each time you enter a command, the shell uses its tracked alias, instead of searching the **PATH** for the command.

To list your tracked aliases, enter the command:

```
alias -t
```

To turn off alias tracking of all commands, enter the command:

```
set +o trackall
```

Then commands found in directories other than **/bin** are not tracked. When the **PATH** search finds a command in **/bin**, the pathname will always be tracked.

To remove tracked aliases, use:

```
alias -r
```

Turning off an alias

If you have set up an alias like the one previously described for **rm**, you may find that you *do not* want the alias to apply in some situations. For example, when you delete a huge number of files, you probably do not want **rm** to ask if it is okay to delete each one. In this situation, you have several options:

- Get rid of the alias entirely. The command:

  ```
  unalias rm
  ```

  gets rid of the **rm** alias for the session. After this, when you enter **rm**, you get the real **rm** command.
- Escape the alias. If you put a backslash in front of an alias, the shell uses the real command rather than the alias. For example:

  \rm *file*
- Specify the full pathname. For example:

  /bin/rm *file*

  tells the shell to run the program in **/bin/rm**. The shell does not perform alias substitution when you specify a command as a pathname.

These alternatives should help you get around options that you have automatically associated with a command.

Combining commands

There are several simple ways you can combine several commands on a single command line:

- You can run a series of commands, one after the other:
  - Using a semicolon (**;**)
  - Using **&&** and **||**
- You can run more than one command concurrently:
  Using a pipe (**|**) or a filter with a pipe

  The output from the first command is piped to the next command as the first command is running.

Using a semicolon (;)

The shell lets you enter several commands on the same command line. To do this, just use the semicolon character to separate the commands; for example:

```
cd mydir ; ls
```

Also, if you have defined the alias:

```
alias l="ls –l"
```

you can enter:

```
cd mydir ; l
```

because you can use aliases such as **l** after a semicolon.

Using && and ||

When stringing together more than two commands, you may want to control the running of the second command based on the outcome of the first command. You can use:

&& If the command that precedes && completes successfully, the command following && is run. Leave a space on either side of the && operator: `command && command`.

|| If the command that precedes || fails, the command following || is run. Leave a space on either side of the || operator: `command || command`.

Using a pipe

The output from one command can be *piped in* as input to the next command. Two or more commands linked by a pipe (**|**) are called a *pipeline*. A pipeline is written as:

command | *command* | ...

You enter the commands on the same line and separate them by the "or-bar" character **|**.

Many z/OS shell commands are well suited to being used in a pipeline. For example, the **grep** command searches for a particular string in input from a file or standard input (the keyboard). A command such as:

```
history | grep "cp"
```

displays all the **cp** commands recorded among the 16 most recently recorded commands in your history file. The command:

```
ls –l | grep "Jan"
```

uses **ls** to obtain information about the contents of the working directory and uses **grep** to search through this information and display only the lines that contain the string Jan. The pipeline displays the files that were last changed in January.

A *filter* is a command that can read from standard input and write to standard output. A filter is often used within a pipeline. In the following example, **grep** is the filter:

```
ps -e | grep cc | wc -l
```

lists all of your processes that are currently active in the system and pipes the output to **grep**, which searches for every instance of the string *cc*. The output from **grep** is then piped to **wc**, which counts every line in which the string *cc* occurs and sends the number of lines to standard output.

Using substitution in commands

Another shell feature that is useful for programmers is *command substitution*. When it encounters a construct of the form:

```
$(command)
```

or:

```
 `command `
```

in an input command line, the shell runs the given *command*. It then puts the output of the command, after converting newlines into spaces, back into the command line, replacing *command*, and runs the new command line. This is called *command substitution*.

You may find the $( ) syntax easier to use for long command lines. However, the ` ` (backward apostrophes) syntax is more traditional and accepted on older UNIX shells.

As an example of how a programmer could use command substitution, consider a file called **srclist**, containing the following list of source code file names: **alpha.c**, **beta.c**, and **gamma.c**. If you enter the command:

```
grep printf $(cat srclist)
```

the shell runs **cat** against the contents of **srclist**, and rewrites the original command line, so that this line appears as:

```
grep printf alpha.c beta.c gamma.c
```

This line is then run, with **grep** searching through the given files, displaying lines that contain the string printf. This type of construct quickly locates all references to a particular variable or function in the source code for a program.

Using the find command in command substitution constructs

The **find** command is useful in command substitution constructs. **find** displays the names of files that have specified characteristics. For example:

```
find dir1 –name "*.c"
```

finds all files in the directory **dir1** whose names match the wildcard pattern *.c. In other words, it finds all files in that directory with names having the **.c** suffix.

The command:

```
ls -l $(find dir1 –name "*.c")
```

finds all the **.c** files and then uses **ls** to display information about these files.

Complicating things further, you could enter

```
ls -l $(find dir1 –name "*.c") | grep -F "Nov"
```

This sets up a pipeline that displays **ls** information only for files that were last changed in November. (To be perfectly accurate, it also displays information about files that have the string `Nov` in their names, too.)

Another useful **find** option has the form:

```
find path –ctime number
```

This says that you want to find files that have changed in the last *number* of days. For example:

```
ls -l $(find dir –ctime 1)
```

displays **ls** information about all files that changed either yesterday or today.

On many UNIX and AIX systems, the **find** command prints out the file names only if you specify the **–print** option. Thus, you would have to enter:

```
find dir –name "*.c" –print
```

to get the results just described. The z/OS UNIX **find** command automatically prints its results without **–print**. However, if you have an existing shell script or compatibility with UNIX systems is important to you, you can use **–print**.

For more information about the **find** command, see the **find** command description in *z/OS UNIX System Services Command Reference*.

Characters that have special meaning to the shell

Certain characters have special meaning to the shell; these are often called *metacharacters*. If you enter a command that contains any of these characters, the shell often assumes that you are using the character in its special sense.

Characters used with commands

Character	Usage
`|`	Pipes the output from one command to a second command; separates commands in a *pipeline*.
`||`	Separates two commands. If the command preceding `||` fails, it runs the following command (Boolean OR operator).
&	Runs a command in the background, if placed at the end of a command line. Used in redirection, &0 represents standard input, &1 represents standard output, and &2 represents standard error.
&&	Separates two commands. If the command preceding && succeeds, it runs the following command (Boolean AND operator).

; Separates sequential commands; allows you to enter more than one command on the same line.

( ) Around a sequence of commands, groups those commands that are to run as a separate process in a subshell environment. The commands run in a separate execution environment: changes to variables, the working directory, open files, and so on, will not remain in effect after the last command finishes.

( ) is also used to group mathematical operations.

{ } Around a sequence of commands, groups those commands that are run in the current shell environment. Changes to variables, etc., will affect the current shell.

Both { and } are reserved words to the shell. To make it possible for the shell to recognize these symbols, you must enter a blank or <newline> after the {, and a semicolon or <newline> before the }.

Following a command in a shell script, indicates the beginning of a comment.

$ At the beginning of a string, indicates that it is a variable name.

**** The backslash character turns off the special meaning of the character that follows it. For more information, see "Using a special character without its special meaning" on page 79.

' ' A pair of single quotation marks turns off the special meaning of all characters within the quotes. For more information, see "Using a special character without its special meaning" on page 79.

" " A pair of double quotation marks turns off the special meaning of the characters within the quotes, except for $, `, ", and \. See "Using a special character without its special meaning" on page 79 for more information.

Characters used in file names

Character
Usage

/ Separates the components of a file's pathname.

~ (Tilde) symbolizes your home directory when used by itself. When used together with a user ID, ~ symbolizes that user's home directory. For example:

```
~susanb/.profile
```

refers to user SUSANB's **.profile** file.

You can also use the ~ to refer to your previous working directory; for example, the command

```
cd ~-
```

returns you to the directory you were previously working in.

. When used as a component of a pathname, indicates the working directory.

.. When used as a component of a pathname, indicates the parent directory.

? Used as a wildcard character that can match any one character, except a leading dot (.).

* Used as a wildcard character that can match a sequence of zero or more characters, except a leading dot (.).

Redirecting input and output

Character	Usage	Example
<	Redirects input to a specified file.	"Redirecting input from a file" on page 70.
>	Redirects output to a specified file.	"Redirecting command output to a file" on page 69.
>>	Redirects output to be appended to the end of the specified file.	"Redirecting command output to a file" on page 69.
2>	Redirects error output to a specified file.	"Redirecting error output to a file" on page 70.

<<text	Reads standard input until it encounters *text*.	This is used in what is called a "here-document." Input is usually typed on the screen or in a shell script. For example, this script creates a file called **hello.c**, compiles it into **hello**, and then executes it:
		`echo "Creating program source..."`
		`if cat > hello.c <<End_Of_File`
		`main() {`
		`  puts("Hello, world!");`
		`}`
		`End_Of_File`
		`then`
		`  echo "Compiling program..."`
		`  if make hello`
		`  then`
		`  echo "Executing program..."`
		`  exec ./hello`
		`  else`
		`  exit $? # make failed`
		`  fi`
		`else`
		`  exit $? # cat failed`
		`  fi`
		
		When you run the shell script, it runs the **cat > hello.c** command using the input between the two End_of_File strings.

Using a special character without its special meaning

If you do not want to use the special sense of the metacharacters, instruct the shell to ignore them by escaping them or quoting them. To do this, you use:

```
\
' '
" "
```

The backslash

The backslash character (\) turns off the special meaning of the character that follows it. For example:

```
echo it\'s me
```

prints:

```
it's me
```

If you just try:

```
echo it's me
```

without the backslash, the shell prints a > prompt after you press <Enter>instead of the usual $. The > prompt is a *continuation prompt*. An apostrophe ' without a backslash is taken to be the start of a string and the shell assumes that the string keeps going until you type another apostrophe, even if that goes on for several lines. The shell does not process the string until you type the closing apostrophe.

So remember to put a backslash in front of any special character, unless you know its special meaning and you want that meaning. Because a backslash itself is a special character, you must type two of them whenever you want a single backslash.

A pair of single quotation marks (' ')

A pair of single quotation marks (' ') turns off the special meaning of *all characters* within the quotes.

A pair of double quotation marks (" ")

A pair of double quotation marks (" ") turns off the special meaning of the characters within the quotes, except for $, `, ", and \.

Using a wildcard character to specify file names

If you have used other operating systems, you are probably familiar with the concept of *wildcard characters*. (In an MVS context, the wildcard character is referred to as a *global character,* or *pattern-matching character*.) A wildcard character is a special character that may be used to save typing in file names in shell commands. The z/OS shell recognizes several different wildcard characters:

*
?
[ ]

The * character

The asterisk (*) stands for any sequence of zero or more characters, except a leading dot. You can use the asterisk in file names. For example:

```
ls aa*
```

lists all files in the working directory with names that begin with `aa`.

The command:

```
mv *.c dir1/dir2
```

moves every file with the **.c** suffix from your working directory to the directory **dir1/dir2**.

You can use the * wildcard character in directory names as well as in file names. For example:

```
cat */*.c
```

displays the contents of all files that have the **.c** suffix, in directories under your working directory.

The ? character

In a pathname, the question mark **?** can stand for any single character, except a leading dot. For example:

```
file.?
```

refers to any and all files with names that consist of **file.** followed by any single character. This can mean **file.a**, **file.b**, **file.c**, and so on ... whichever of the files currently exist.

You can combine * and **?**.

```
ls *.?
```

displays the names of all files under the working directory that have one-character file name suffixes.

Again, you can use the **?** in directory names as well as file names. For example:

```
ls ???/*
```

shows all files in every directory under your working directory that have a three-character name.

The square brackets

Square brackets containing one or more characters stand for any one of the contained characters. For example:

```
[bch]at
```

matches `bat`, `cat`, or `hat`.

```
ls [abc]*
```

lists all files in the working directory the names of which start with `a`, `b`, or `c`, followed by any other sequence of zero or more characters. In other words, it lists all files whose names start with `a`, `b`, or `c`.

You can specify ranges of characters inside the square brackets by specifying the first character in the sequence, a hyphen (**-**), and the last character. For example:

```
[a–m]
```

This matches any character from `a` through `m`.

Suppose, for example, that you want to copy the contents of the working directory into two separate directories. You might enter:

```
cp [a–m]* dira
```

to copy all files with names beginning with the letters `a` through `m` to the directory `dira`, and then issue the second command:

```
cp [n–z]* dirb
```

to copy the rest of the files to the directory `dirb`. A command such as:

```
rm *.[a-z]
```

removes every file with a suffix consisting of a single lowercase letter.

If the first character inside a bracket construct is an exclamation mark **!**, the construct matches any character that *is not* inside the brackets. For example:

```
ls [!a–m]*
```

lists any file that does not begin with one of the letters in the range `a` through `m`.

In the same way:

```
rm [!0-9]*
```

removes any file with a name that does not start with a digit.

Retrieving previously entered commands

In the shell, you can retrieve previously issued commands using:

- The **history** command, combined with the **r** command
- The two retrieve function keys that are part of the TSO/E OMVS command interface to the shell
- Command-line editing, when you are using an asynchronous terminal interface

Retrieving commands from the history file

The shell records each command that you enter in a file under your *home directory*. This file is called the *history file*; its name is **.sh_history**.If you enter the command:

```
history
```

the shell displays the current contents of your history file. Each command is numbered.

You can rerun any of the commands in your history file by typing **r**, followed by a space, followed by the number of the command you want to use. Think of **r** as the redo command.

For example, suppose that you are a programmer and you enter a complicated command to compile part of a program. The program contains a syntax error, so you call a text editor to edit the source code and correct the problem. Now you want to run the same compile command on the corrected program. You may save yourself a good deal of typing by using:

```
history
```

to find out the number of the previous compile command; you can then run the command with **r**.

Another time-saver is to specify your shell prompt as:

```
PS1='(!)$'
```

in your **.profile**. The shell prompt is then preceded by the number assigned to the command in the command history file.

This is how you use the command numbers to enter a command. To repeat command number 14, enter:

```
r 14
```

The shell displays the original command 14 in the output area of the screen and then runs it. If you get another error, you can correct it, and then compile again with another `r 14`. You can perform the operation many times, but you have to type the original only once.

If you type **r** followed by a space, followed by a string of characters (not beginning with a digit), the shell checks backward through the history file and runs the most recent command that begins with the given string. For example, let's look at the compilation example. Suppose you are using the **c++** command to compile your program. Then:

```
r c++
```

looks back through the history and runs the most recent **c++** command. You do not even have to check on the number of the command you want to enter. The shell displays the selected command in the output area of the screen and then runs it.

This *backward-search* feature of **r** can search for aliases as well as normal commands. **r** searches for the beginning of the command line as you typed it, not the way that the line looked after the alias was replaced.

If you enter **r** without a number after it, the shell repeats the most recent command.

Editing commands from the history file

Suppose that you have a sequence of source files named **file1.c**, **file2.c**, **file3.c**, and so on that you want to compile with similar **c89** commands. This situation is a little different from the one discussed in the previous topic. You do not want to rerun the *same* command for each file; the command has the same form each time, but you have to specify in a new file name each time.

You can still do this using the history file. The command:

```
r old_string=new_string command
```

runs a previous *command* but replaces the first occurrence of the *old* string with the *new* string. For example, suppose you compile **file1.c** with:

```
c89 options file1.c
```

Then the command:

```
r file1=file2 c89
```

tells the shell to search back for the most recent **c89** command and change **file1** to **file2**. The shell makes this change, and then displays and runs the modified command.

```
r file2=file3 c89
```

performs the same kind of operation, changing **file2** in the previous command to **file3** and then going ahead with the compilation. This saves you the trouble of retyping all the options for the command.

Entering `alias` displays all the currently defined aliases. You will see a number of aliases that you didn't set up; for example:

```
history="fc –l"
```

The **history** command is actually a *predefined* alias for the **fc** command with the **–l** option. The **fc** command is used to display and edit commands in the history file. Generally, it is easier to remember to type **history**, so the shell predefines this alias.

If you have displayed the predefined aliases, you probably noticed that **r** is also a predefined alias. It also stands for a version of the **fc** command. As with **history**, the **r** alias was created because it's easier to use and read than the straight **fc** command. For full details about **fc**, see the **fc** command description in *z/OS UNIX System Services Command Reference*.

Using the retrieve function keys

When you are using the OMVS interface, there are two function key settings for retrieving commands:

Retrieve
This key performs a "backward retrieve" function. It retrieves a saved command from a stack of saved input lines, starting with the most recent and moving down to the oldest available line.

FwdRetr
This key is used with the Retrieve key to retrieve commands from the stack of saved input lines. If you press the Retrieve key one too many times and go past the line you want, you can press the FwdRetr key to display the line that was previously retrieved by the Retrieve key.

Press the Retrieve key repeatedly until the command you want to use is displayed on the command line. Once the command is displayed, you can modify the command or use it as it is displayed. Press <Enter> to run the command.

Command-line editing

When you use **rlogin** or **telnet** to login to the shell, you can use command-line editing. Command-line editing lets you access commands from your history file, edit them, and run the result. You have already seen this process before, when reading about some of the features of the **r** command.

Command editing is useful at those times when you are running the same sequence of commands, or slight variations on the same sequence of commands. The point of command editing is to save yourself the trouble of typing the same thing over and over again—look especially for long commands that normally require a lot of typing. Command editing is also useful when you have made a mistake in typing a command line and wish to correct it.

Using the vi command editor

If you run the command:

```
set -o vi
```

or

```
export EDITOR=vi
```

it tells the shell that you want the ability to edit commands the way that you normally edit text with **vi**; you are set up for **vi** command editing. Whenever the shell prompts you for input, it is as if the shell puts you into **vi** insert mode on a new line at the end of the history file. You can type in a new command just as you normally would.

You can also press <Esc> to enter a **vi**-like command mode. When you enter command mode, you can use the usual cursor movement commands to move around on the command line, or to move up and down in the history file. For example:

- Press the **k** key to move back to the previous line in the history file (the last command line you entered). Press the **k** key again, and you move to the line before that.
- Press **j** and you move forward in the history file.

In this way it is simple to retrieve recent commands from the history file. You can then edit them using standard **vi** commands. For example, you can use **$** to move to the end of the line, and **A** to begin appending text to the end of the line. When you have edited the line to produce the command that you want to run, simply press <Enter> to run that line.

As you might expect, you can use these search commands:

```
/string
?string
```

to search backwards and forwards through the history file. You can edit the command line with these **vi** commands:

w Move to next word
b Move to previous word
d delete
c change
a append
i insert
u undo

and many of the other **vi** commands. For a complete list of available commands, see the **shedit** command description in *z/OS UNIX System Services Command Reference*.

Using the emacs command editor

To set up for **emacs** command editing, enter:

```
set -o emacs
```

This lets you use commands identical to **emacs** commands to edit your shell command line. For more information, see the description of **shedit** in *z/OS UNIX System Services Command Reference*.

Using record-keeping commands

Record-keeping commands can be very helpful for programmers. For example, suppose you have a program that is split into several source files. For the sake of simplicity, assume that the source files all have the extension **.c** and are all stored in a subdirectory called **src**. (To read about extensions, see “Naming files” on page 211.)

It is often the case that you want to find out which source files in the subdirectory refer to a particular variable or function. You can do this very simply with the command:

```
grep 'name' src/*.c
```

The command checks all the appropriate files in the subdirectory **src** and displays the lines that contain the given *name*. Each line is labeled with the name of the file that contains the line. You can quickly find the use of a function or data object in source files.

As another example of using record-keeping commands, suppose that you are working on a large program and every few days you back up the source code for the program by copying it to a directory in a different file system (as a precaution). You would like to compare the current version of your source files with one of the saved versions, to find out what changes have been made between the two. The command:

```
diff oldfile newfile
```

prints out all the differences between two versions of a file, making comparisons possible.

The **cksum** command gives a checksum for each file. If applied to two versions of what was at one time the same file, **cksum** gives a convenient way to tell if the files are still the same. It does not, however, indicate what the differences are.

The **find** command also has applications to programming. For example, suppose you are looking for a particular C source program but cannot remember where it is stored.

```
find / –name '*.c'
```

searches all the files and file systems, starting at the root, and displays the names of all files with the **.c** extension.

Finding elements in a file and presenting them in a specific format

awk is a powerful command that can perform many different operations on files. The general purpose of **awk** is to read the contents of one or more files, obtain selected pieces of information from the files, and present the information in a specified format.

One simple way to use **awk** is with a command line with the form:

```
awk '/regexp/ {action}' file
```

This asks **awk** to obtain information from the specified file. **awk** obtains the information by performing the specified *action* on every line in the file that contains a string matching the given regular expression, *regexp*. (For further information, see Appendix C. Regular Expressions (regexp) in *z/OS UNIX System Services Command Reference*.) For example:

```
awk '/abc/ {print}' file
```

displays every record in the file that contains the string `abc`.

For more discussion on using **awk**, see Appendix B, “Using awk,” on page 299.

Timing programs

The **time** command lets you time programs to find out how much processor time they actually require. You might use this to compare two versions of a program to see if one runs faster than the other. You can run a program with:

```
time command-line
```

where *command-line* is a command line that invokes the program you want to time. **time** runs the program and displays:

- The total time the program took to execute, labeled `real`
- The total time spent in the user program, labeled `user`
- The central processor time spent performing system services for the user, labeled `sys`

For more information, see the **time** command description in *z/OS UNIX System Services Command Reference*.

Using the passwd command

You can change a user's password or password phrase by using the **passwd** command:

passwd [**-u** *userid*]

The **passwd** command changes the login password or password phrase for the user ID specified. If *userid* is omitted, the login name associated with the current terminal is used. You are prompted for the new password or password phrase.

For example:

```
passwd
```

changes the password or password phrase for the invoker. The invoker is prompted for the old password or password phrase and then for the new value.

Non-superusers can change the password or password phrase for another user if they know the user ID and the current password or password phrase. This example changes the password or password phrase for user ID **steve**:

```
passwd -u steve
```

For more information about the **passwd** command, see the **passwd** command description in *z/OS UNIX System Services Command Reference* For information on setting up RACF to enable password phrase support, see *z/OS Security Server RACF Security Administrator's Guide*.

Switching to superuser or another ID

With the **su** command, you can switch to any user ID, including the superuser. A user can switch to superuser authority (with an effective UID of `0`), if the user is permitted to the BPX.SUPERUSER resource in the FACILITY class within the Resource Access Control Facility (RACF). Either the ISPF shell or the **su** shell command can be used for switching to superuser authority.

If you do not specify a user ID, the **su** command changes your authorization to that of the superuser. If you specify a user ID, **su** changes your authorization to that of the specified user ID.

When you switch to superuser (UID `0`) without specifying a user ID, you keep your MVS identity (TSO/E ID). You keep your access authority to MVS data sets, while gaining authority to access any files.

When you change user ID by specifying a user ID and password or password phrase, you assume the MVS identity of the new user ID even if the user ID has UID `0`.

If you use the **–s** option on the **su** command you will not be prompted for a password. Use this option if you have access to the BPX.SRV.*userid* SURROGAT class profile. The *userid* is the MVS user ID associated with the target UID.

To return to your own user ID, type:

```
exit
```

This returns you to the shell in which you entered the **su** command.

For more information, see the **su** command description in *z/OS UNIX System Services Command Reference*.

Using the whoami command

The **whoami** command displays a username associated with the effective user ID, unlike the **who am i** command which displays the login name.

For example, if you login as 'user1' but then you use the **su** command to change to 'user2':

```
command                 returned
who am I                user1
whoami                  user2
```

For more information about the **whoami** command, see the **whoami** command description in *z/OS UNIX System Services Command Reference*.

Running a TSO/E command

To run a TSO/E command from the shell or in a shell script, simply preface the TSO/E command with either the **tso** or **tsocmd** shell command.

Using the tso command

To run a TSO/E command from the shell or in a shell script, you can preface the TSO/E command with the **tso** shell command; for example:

```
tso -t tso_command
```

There are two options you can use:

- Specify the *-t* option to run a command through the TSO/E service routine. The command output is written to stdout. If you specify a relative path name, the command looks for the file in your current directory.

  Restriction: TSO/E has some restrictions on the type of commands that can be run using the TSO/E service routine (mini-TSO environment). In summary, you cannot run the following commands in this environment:
  - Commands that run authorized
  - FIB (foreground initiated background) commands
  - Other commands that require the TSO/E task structure; for example, interactive commands such as **oedit**, where interactive means that the user can interact with the command processing while issuing additional terminal input (subcommands, function keys). For example, once the **oedit** command is entered, the user can enter more subcommands to add more lines and then quit or exit the command.

  For a full description of the restrictions, see the information on IKJTSOEV in *z/OS TSO/E Programming Guide*.

- Specify the *-o* option to run a TSO command as if it had been entered on the OMVS command line and run using the TSO subcommand or function key. If you use a relative path name, the command looks for the file in the working directory of your TSO/E session, which is typically your home directory.

If no option is specified, the following rules are applied in this order:

1. If stdout is not a tty, the TSO service routine is used since it is possible that the command output is redirected to a file or piped to another command. Otherwise,
2. If the controlling tty supports 3270 pass-through mode, OMVS is used. Otherwise,
3. The TSO service routine is used.

See "Understanding standard input, standard output, and standard error" on page 68 for more information about stdin, stdout, and stderr.

The **tso** command supports several environment variables. For more information about the **tso** command and the environment variables that are associated with it, see *z/OS UNIX System Services Command Reference*.

Using the tsocmd command

You may also use the **tsocmd** shell command to run a TSO/E command from the shell or in a shell script.

Unlike the **tso** shell command, the **tsocmd** shell command can be used to issue authorized TSO commands. For more information about the **tsocmd** shell command and the environment variables associated with it, see *z/OS UNIX System Services Command Reference*..

Using the man command to get online help

Use the **man** command to get help information about a shell command. The man page is displayed in your shell session, and you can work in the shell while viewing the command. The **man** syntax is:

```
man command_name
```

- To scroll the information in a man page, press <Enter>.
- To end the display of a man page, type **q** and press <Enter>.

To search for a particular string in a system that has a list of one-line command descriptions, use the *-k* option:

```
man -k string
```

For example, to produce a list of all the shell commands for editing, you could type:

```
man -k edit
```

You can use the **man** command to view descriptions of TSO/E commands. To do this, you must prefix all commands with **tso**.

To view a description of the MOUNT command, enter:

```
man tsomount
```

You can also use the **man** command to view descriptions of **dbx** subcommands. To do this, you must prefix all subcommands with **dbx**. For example, to view a description of the **dbx alias** subcommand, enter:

```
man dbxalias
```

For complete information about the **man** command, see the **man** command description in *z/OS UNIX System Services Command Reference*.

Shell messages

Messages issued by the z/OS shell and utilities are prefixed with the letters FSUM. The shell messages are documented in *z/OS UNIX System Services Messages and Codes*.

Chapter 7. Working with tcsh shell commands

The shell is, above all, a *programmer's* interface. As a result, the shell commands are strongly slanted towards the needs of a programmer. The tcsh shell has many *general* tools that can help any programmer, and is specifically designed to have syntax similar to the C programming language. In addition, there are a number of commands designed especially for the C programmer.

Specifying shell command options

Most of the commands discussed in this topic accept options. Shell command options are usually specified by a minus sign (–) followed by a single character. For example, the **ls** command simply lists a directory's contents in multiple columns on your screen. However:

```
ls –F
```

distinguishes between various file types when listing the contents of a directory. (See "Listing directory contents" on page 207 for an example.)

```
ls –1
```

lists directory names in a single column.

Options consisting of a minus sign followed by a character are called *simple options*. You specify simple options after the name of the command and before any other arguments for the command (that is, arguments that are not options). For example, you would enter:

```
ls –1 dir1
```

to list the contents of **dir1** in a single column.

Command options and arguments must be typed as single-byte characters. Additionally, delimiters such as a slash, braces, and parentheses must be typed as single-byte characters.

The order of options and arguments is important. If you enter:

```
ls dir1 –F
```

ls lists the contents of **dir1** and then tries to list the contents of the directory, or attributes of the file, called **–F**.

As a special notation, most tcsh shell commands let you specify a double minus sign (--) to separate the options from the nonoption arguments; **--** means that there are no more options. Thus, if you really have a directory named **–F**, you could enter:

```
ls -- –F
```

to list the contents of that directory or the file attributes.

The tcsh shell gives you a shorthand way to specify more than one simple option to a command. For example, **–t** and **–v** are both simple options that you can

specify with the **cat** command. (To find out what these options do, read the **cat** command description in *z/OS UNIX System Services Command Reference*.) You could enter:

```
cat –t –v file
```

or you could combine the two options into:

```
cat –tv file
```

The order of the options is not important:

```
cat –vt file
```

is equivalent to the previous version of the command.

Specifying options with accompanying arguments

In addition to simple options, some commands accept options that have accompanying arguments. Such options look like simple options followed by additional information. The argument may be a number, a string, the name of a file, or something else.

For example, if you read the **ps** command description in *z/OS UNIX System Services Command Reference*, you will see that **ps** accepts an argument of the form:

```
–u userlist
```

When *z/OS UNIX System Services Command Reference* shows part of a command line in *italics*, the italicized material is just a placeholder; when you actually use the command, you should fill in something else in its place. In this case, the *userlist* should be a string of one or more UID numbers or login names separated by commas and enclosed in single quotation marks. In the command:

```
ps –u 'macneil,wellie1'
```

the *userlist* string is macneil,wellie1. (If the string does not contain spaces, tabs, or other special characters, you can actually omit the enclosing single quotation marks, but the command is often easier to read if you use quotes anyway.) When executed, **ps** displays information for the specified users.

Help for shell command usage

If you incorrectly specify a command, a usage note for the command is displayed. The usage note displays the proper format for the command. Often you can display a usage note deliberately if you specify the command with a *-?* option.

For online help information about a command, see “Using the man command to get online help” on page 89.

Understanding standard input, standard output, and standard error

Once a command begins running, it has access to three files:

1. It reads from its *standard input* file. By default, standard input is the keyboard.
2. It writes to its *standard output* file.
   - If you invoke a shell command from the shell, a C program, or a REXX program invoked from TSO READY, standard output is directed to your terminal screen by default.

- If you invoke a shell command, REXX program, or C program from the ISPF shell, standard output cannot be directed to your terminal screen. You can specify a z/OS UNIX file or use the default, a temporary file.

3. It writes error messages to its *standard error* file.
   - If you invoke a shell command from the shell or from a C program or from a REXX program invoked from TSO READY, standard error is directed to your terminal screen by default.
   - If you invoke a shell command, REXX program, or C program from the ISPF shell, standard error cannot be directed to your terminal screen. You can specify a z/OS UNIX file or use the default, a temporary file.

     If the standard output or standard error file contains any data when the command completes, the file is displayed for you to browse.

Using the shell: In the shell, the names for these files are:
- **stdin** for the *standard input* file.
- **stdout** for the *standard output* file.
- **stderr** for the *standard error* file.

Using TSO/E: When you are invoking the BPXBATCH utility, you can specify these standard files in MVS DD statements, TSO/E ALLOCATE commands, or DYNALLOC macros using the ddnames:
- STDIN for standard input
- STDOUT for standard output
- STDERR for standard error

For more information about BPXBATCH, see "The BPXBATCH utility" on page 156.

Using ISPF: When you run shell commands, REXX programs, and C programs from the ISPF shell, **stdout**, and **stderr** cannot be directed to your terminal. You can specify a z/OS UNIX file, or use the default—a temporary file. If it has any contents, the file is displayed for you to browse when the command or program completes.

Redirecting command output to a file

Commands entered at the command line typically use the three standard files described previously, but you can redirect the output for a command to a file you name. If you redirect output to a file that does not already exist, the system creates the file automatically.

Most shell commands display information about your workstation screen, *standard output*. If you redirect the output, you can save the output from a command in a file instead. The output is sent to the file rather than to the screen. At the end of any command, enter:

```
>filename
```

For example:

```
cat file1 file2 file3 >outfile
```

writes the contents of the three files into another file called **outfile**. All the information in the original three files is concatenated into a single file, **outfile**.

When you redirect output with >*filename* and it is an existing file, the output writes over any information that the file already contains. To *append* command output at the end of the file, use:

```
>>filename
```

instead.

Another example:

```
(sort -u file1 >output) >&outerr
```

redirects the result of the sort to the file named **output** (instead of standard output) and redirects any error messages to the file **outerr**, which is a record of errors encountered during various sorts.

Suppose you entered:

```
sort -u filea >output
```

In this command, you see two redirections:

- Error output from the sort is redirected to standard output, the display screen.
- The result of the sort is redirected to the file named **output**.

Here is another example of redirection, sending both standard error and standard output to a file. This command produces the program **hello** and a listing with error messages in a file called **hello.list**:

```
c89 -o hello -V hello.c >&hello.list
```

Redirecting input from a file

You can redirect input in much the same way that you redirect output. A command that normally takes input from standard input can be redirected to take input from a file instead. For example, with this **mailx** command, you can send the file **lessons** to another user.

```
mailx JAYD <lessons
```

The file **lessons** becomes input to **mailx**, rather than your input from the keyboard.

Redirecting error output to a file

You can redirect error output from the workstation screen to a file. For example:

```
(sort -u filea >dev/tty) >& outerr
```

sorts **filea**, checking for unique output records. Any messages regarding duplicate records are redirected to a file named **outerr**.

And if you do not care about seeing the error output, you can just redirect it to **/dev/null**, also known as the bit bucket. This is equivalent to discarding the error messages.

```
(sort -u filea >/dev/tty) >& /dev/null
```

Dumping nontext files to standard output

The **od** command can dump the contents of a file to *standard output*, your workstation screen, in several different formats.

```
od file
```

dumps a file in octal.

```
od -h file
```

dumps the file in hexadecimal. Either of these may be useful if you want to check the actual contents of a nontext file. Other dump formats are available.

Setting up an alias for a command

After you have used the shell for a while, you will probably find that there are some commands that you use frequently. Rather than typing them over and over, you can set up an *alias* for these commands. An alias is a personalized name that stands for all or part of a command. You can create an alias by entering:

```
alias name "string"
```

in response to the shell's usual prompt for input. This is not a normal command; it is an instruction to the shell itself.

For example, suppose you have a hard time remembering that the **mv** command actually renames files. To make life easier for yourself, you could set up a simple alias by entering this on your command line:

```
alias renam "mv"
```

From this point onward in your session, whenever the shell sees the command **renam**, the **renam** is replaced with **mv**. The alias facility lets you create more usable commands.

Clearly, you could use an alias to save yourself some typing too. You could define **c** as an alias for **cat**. Then you would enter:

```
c file
```

to get the effect of:

```
cat file
```

Defining an alias

If you will be using an alias frequently, put the **alias** command in your profile file (**$HOME/.tcshrc**). That way, you do not have to type them in every time you start using the shell. See “Understanding the startup files” on page 53 for more information about customizing your startup files.

To display all the currently defined aliases, you just enter:

```
alias
```

and the shell displays them.

Arguments in aliases

Any arguments that follow an alias are treated just as if they had been following the command that the alias stands for. For example, if you define the alias **f** as follows:

```
alias f "ls"
```

the shell replaces **f** with **ls**, which is the command to list files in a directory.

You can refer to arguments in an alias by simply adding them at the end of the alias as you would with a command. For example:

```
f -la
```

would perform the **ls** command with the arguments **la**, which will list all the files in the directory in a long directory listing format. And,

```
f /bin
```

will list the contents of the **/bin** directory.

Redefining an alias for a session

You can redefine an alias during a session, even if it is defined in your profile file. If you enter the command:

```
alias name "string"
```

during a session and *name* is already an alias, the shell forgets the old meaning and uses the new meaning from then on.

Setting up an alias for a particular version of a command

If you tend to use a command with the same options every time, you may want to set up an alias for the command with those particular options. Let's take an example. The **grep** command searches through files and prints out lines that contain a requested string. For example:

```
grep hello file
```

displays all the lines of *file* that contain the string `hello`. Normally, **grep** distinguishes between uppercase and lowercase letters; this means, for example, that the search in the previous example does *not* display lines that contained `HELLO`, `Hello`, and so forth. If you want **grep** to ignore the case of letters as it searches, you must specify the **–i** option, as in:

```
grep -i hello file
```

This finds `hello`, `HELLO`, `Hello`, and so on.

If you think you prefer to use the **–i** version of **grep** most of the time, you can define the alias:

```
alias grep "grep -i"
```

From this point on, if you use the command:

```
grep string file
```

it is automatically converted to:

```
grep -i string file
```

and you get the case-insensitive version of the command **grep**.

As another example, the **rm** command to delete (remove) a file has an **–i** option that prompts you to confirm the deletion. The file name and a question mark are displayed. For example, if you entered `rm -i file1` and **file1** is in your working directory, you would see the prompt:

```
file1: ?
```

before the system actually removes the file. You then enter `y` (yes) or `n` (no) in response. If you like this extra bit of safety, you might define:

```
alias rm "rm -i"
```

After this, when you call **rm**, it automatically checks with you before deleting a file, just to make sure that you really want to delete it.

It may seem odd to define an alias that has the same name as a command that is used in the alias, but this is so common that the shell checks specially for an alias of the same name, and does the correct thing.

If you find yourself using the same option every time you call a command, you might consider creating an appropriate alias so that the shell automatically adds the option. Of course, the best place to define this alias is in your **.tcshrc** file; then the alias is set up every time you invoke the shell.

Turning off an alias

If you have set up an alias like the one previously described for **rm**, you may find that you *do not* want the alias to apply in some situations. For example, when you delete a huge number of files, you probably do not want **rm** to ask if it is okay to delete each one. In this situation, you have several options:

- Get rid of the alias entirely. The command:

  ```
  unalias rm
  ```

  gets rid of the **rm** alias for the session. After this, when you enter **rm**, you get the real **rm** command.
- Escape the alias. If you put a backslash in front of an alias, the shell uses the real command rather than the alias. For example:

  `\rm` *`file`*
- Specify the full pathname. For example:

  `/bin/rm` *`file`*

  tells the shell to run the program in **/bin/rm**. The shell does not perform alias substitution when you specify a command as a pathname.

These alternatives should help you get around options that you have automatically associated with a command.

Combining commands

There are several simple ways you can combine several commands on a single command line:

- You can run a series of commands, one after the other:
  Using a semicolon (**;**)
  Using **&&** and **||**
- You can run more than one command concurrently:
  Using a pipe (**|**) or a filter with a pipe

  The output from the first command is piped to the next command as the first command is running.

Using a semicolon (;)

The shell lets you enter several commands on the same command line. To do this, just use the semicolon character to separate the commands; for example:

```
cd mydir ; ls
```

Also, if you have defined the alias:

```
alias l "ls –l"
```

you can enter:

```
cd mydir ; l
```

because you can use aliases such as **l** after a semicolon.

Using && and ||

When stringing together more than two commands, you may want to control the running of the second command based on the outcome of the first command. You can use:

&& If the command that precedes && completes successfully, the command following && is run. Leave a space on either side of the && operator: `command && command`.

|| If the command that precedes || fails, the command following || is run. Leave a space on either side of the || operator: `command || command`.

Using a pipe

The output from one command can be *piped in* as input to the next command. Two or more commands linked by a pipe (|) are called a *pipeline*. A pipeline is written as:

command | *command* | ...

You enter the commands on the same line and separate them by the "or-bar" character |.

Many commands are well suited to being used in a pipeline. For example, the **grep** command searches for a particular string in input from a file or standard input (the keyboard). A command such as:

```
history | grep "cp"
```

displays all the **cp** commands recorded among the 16 most recently recorded commands in your history file. The command:

```
ls –l | grep "Jan"
```

uses **ls** to obtain information about the contents of the working directory and uses **grep** to search through this information and display only the lines that contain the string Jan. The pipeline displays the files that were last changed in January.

A *filter* is a command that can read from standard input and write to standard output. A filter is often used within a pipeline. In the following example, **grep** is the filter:

```
ps -e | grep cc | wc -l
```

lists all your processes that are currently active in the system and pipes the output to **grep**, which searches for every instance of the string *cc*. The output from **grep** is then piped to **wc**, which counts every line in which the string *cc* occurs and sends the number of lines to standard output.

Using substitution in commands

Another shell feature that is useful for programmers is *command substitution*. When encountering a construct of the form:

```
`command `
```

in an input command line, the shell runs the given *command*. It then puts the output of the command, after converting newlines into spaces, back into the command line, replacing *command*, and runs the new command line. This is called *command substitution*.

As an example of how a programmer could use command substitution, consider a file called **srclist**, containing the following list of source code file names: **alpha.c**, **beta.c**, and **gamma.c**. If you enter the command:

```
grep printf `cat srclist`
```

the shell runs **cat** against the contents of **srclist**, and rewrites the original command line, so that this line appears as:

```
grep printf alpha.c beta.c gamma.c
```

This line is then run, with **grep** searching through the given files, displaying lines that contain the string `printf`. This type of construct quickly locates all references to a particular variable or function in the source code for a program.

Using the find command in command substitution constructs

The **find** command is useful in command substitution constructs. **find** displays the names of files that have specified characteristics. For example:

```
find dir1 –name "*.c"
```

finds all files in the directory **dir1** whose names match the wildcard pattern `*.c`. In other words, it finds all files in that directory with names having the **.c** suffix.

The command:

```
ls -l `find dir1 –name "*.c"`
```

finds all the **.c** files and then uses **ls** to display information about these files.

Complicating things further, you could enter

```
ls -l `find dir1 –name "*.c"` | grep -F "Nov"
```

This sets up a pipeline that displays **ls** information only for files that were last changed in November. (To be perfectly accurate, it also displays information about files that have the string `Nov` in their names, too.)

Another useful **find** option has the form:

```
find path –ctime number
```

This says that you want to find files that have changed in the last *number* of days. For example:

```
ls -l `find dir –ctime 1`
```

displays **ls** information about all files that changed either yesterday or today.

On many UNIX and AIX systems, the **find** command prints out the file names only if you specify the **–print** option. Thus, you would have to enter:

```
find dir –name "*.c" –print
```

to get the results just described. The z/OS UNIX **find** command automatically prints its results without **–print**. However, if you have an existing shell script or compatibility with UNIX systems is important to you, you can use **–print**.

For more information about the **find** command, see the **find** command description in *z/OS UNIX System Services Command Reference*.

Characters that have special meaning to the shell

Certain characters have special meaning to the shell; these are often called *metacharacters*. If you enter a command that contains any of these characters, the shell often assumes that you are using the character in its special sense.

Characters used with commands

Character	Usage
|	Pipes the output from one command to a second command; separates commands in a *pipeline*.
||	Separates two commands. If the command preceding || fails, it runs the following command (Boolean OR operator).
>	Redirects stdout.
<	Redirects stdin.
&	Runs a command in the background, if placed at the end of a command line.
>&	Used for redirecting stdout and stderr.
&&	Separates two commands. If the command preceding && succeeds, it runs the following command (Boolean AND operator).
;	Separates sequential commands; allows you to enter more than one command on the same line.
( )	Around a sequence of commands, groups those commands that are to run as a separate process in a subshell environment. The commands run in a separate execution environment: changes to variables, the working directory, open files, and so on, will not remain in effect after the last command finishes. ( ) is also used to group mathematical operations.
{ }	Around a sequence of commands, groups those commands that are run in the current shell environment. Changes to variables will affect the current shell.

Both { and } are reserved words to the shell. To make it possible for the shell to recognize these symbols, you must enter a blank or <newline> after the {, and a semicolon or <newline> before the }.

Following a command in a shell script, indicates the beginning of a comment.

$ At the beginning of a string, indicates that it is a variable name.

**** In general, the backslash character turns off the special meaning of the character that follows it. For more information, see "Using a special character without its special meaning" on page 102.

' ' A pair of single quotation marks turns off the special meaning of all characters within the quotation marks. For more information, see "Using a special character without its special meaning" on page 102.

" " A pair of double quotation marks turns off the special meaning of the characters within the quotation marks, except that `!event`, `$var`, and `` `cmd` `` will show history, variable, and command substitution. See "Using a special character without its special meaning" on page 102 for more information.

Characters used in file names

Character
Usage

/ Separates the components of a file's pathname.

~ (Tilde) symbolizes your home directory when used by itself. When used together with a user ID, ~ symbolizes that user's home directory. For example:

```
~valerie/.tcshrc
```

refers to user VALERIE's **.tcshrc** file.

. When used as a component of a pathname, indicates the working directory.

.. When used as a component of a pathname, indicates the parent directory.

? Used as a wildcard character that can match any one character, except a leading dot (**.**).

***** Used as a wildcard character that can match a sequence of zero or more characters, except a leading dot (**.**).

Redirecting input and output

Character	Usage	Example
<	Redirects input to a specified file.	"Redirecting input from a file" on page 94.
>	Redirects output to a specified file.	"Redirecting command output to a file" on page 93.
>>	Redirects output to be appended to the end of the specified file.	"Redirecting command output to a file" on page 93.
>&	Redirects stdout and stderr.	"Redirecting error output to a file" on page 94.

Character	Usage	Example

<<text	Reads standard input until it encounters *text*.	This is used in what is called a "here-document." Input is usually typed on the screen or in a shell script. For example, this script creates a file called **hello.c**, compiles it into **hello**, and then executes it:
		`# create program`
		`cat > hello.c << EOF`
		`main() {`
		`  puts("Hello, World!\n");`
		`}`
		`EOF`
		`# compile program`
		`c89 -o hello hello.c`
		`#execute program`
		`hello`
		
		When you run the shell script, it runs the **cat > hello.c** command using the input between the two End_of_File strings.

Using a special character without its special meaning

If you do not want to use the special sense of the metacharacters, instruct the shell to ignore them by escaping them or quoting them. To do this, you use:

```
\
' '
" "
```

The backslash

The backslash character (\) turns off the special meaning of the character that follows it. For example:

```
echo it\'s me
```

prints:

```
it's me
```

If you just try:

```
echo it's me
```

without the backslash, the shell prints a > prompt after you press <Enter>instead of the usual $. The > prompt is a *continuation prompt*. An apostrophe ' without a backslash is taken to be the start of a string and the shell assumes that the string keeps going until you type another apostrophe, even if that goes on for several lines. The shell does not process the string until you type the closing apostrophe.

So remember to put a backslash in front of any special character, unless you know its special meaning and you want that meaning. Because a backslash itself is a special character, you must type two of them whenever you want a single backslash.

A pair of single quotation marks (' ')

A pair of single quotation marks (' ') turns off the special meaning of *all characters* within the quotation marks.

A pair of double quotation marks (" ")

A pair of double quotation marks turns off the special meaning of the characters within the quotation marks, except that `!event`, `$var`, and `` `cmd` `` will show history, variable, and command substitution.

Using a wildcard character to specify file names

If you have used other operating systems, you are probably familiar with the concept of *wildcard characters*. (In an MVS context, the wildcard character is referred to as a *global character*, or *pattern-matching character*.) A wildcard character is a special character that may be used to save typing in file names in shell commands. The tcsh shell recognizes several different wildcard characters:

*
?
[ ]

The * character

The asterisk (*) stands for any sequence of zero or more characters, except a leading dot. You can use the asterisk in file names. For example:

```
ls aa*
```

lists all files in the working directory with names that begin with `aa`.

The command:

```
mv *.c dir1/dir2
```

moves every file with the **.c** suffix from your working directory to the directory **dir1/dir2**.

You can use the * wildcard character in directory names as well as in file names. For example:

```
cat */*.c
```

displays the contents of all files that have the **.c** suffix, in directories under your working directory.

The ? character

In a pathname, the question mark **?** can stand for any single character, except a leading dot. For example:

```
file.?
```

refers to any and all files with names that consist of **file.** followed by any single character. This can mean **file.a**, **file.b**, **file.c**, and so on ... whichever of the files currently exist.

You can combine * and **?**.

```
ls *.?
```

displays the names of all files under the working directory that have one-character file name suffixes.

Again, you can use the **?** in directory names as well as file names. For example:

```
ls ???/*
```

shows all files in every directory under your working directory that have a three-character name.

The square brackets

Square brackets containing one or more characters stand for any one of the contained characters. For example:

```
[bch]at
```

matches `bat`, `cat`, or `hat`.

```
ls [abc]*
```

lists all files in the working directory the names of which start with `a`, `b`, or `c`, followed by any other sequence of zero or more characters. In other words, it lists all files whose names start with `a`, `b`, or `c`.

You can specify ranges of characters inside the square brackets by specifying the first character in the sequence, a hyphen (**-**), and the last character. For example:

```
[a–m]
```

This matches any character from `a` through `m`.

Suppose, for example, that you want to copy the contents of the working directory into two separate directories. You might enter:

```
cp [a–m]* dira
```

to copy all files with names beginning with the letters `a` through `m` to the directory `dira`, and then issue the second command:

```
cp [n–z]* dirb
```

to copy the rest of the files to the directory `dirb`. A command such as:

```
rm *.[a-z]
```

removes every file with a suffix consisting of a single lowercase letter.

If the first character inside a bracket construct is an exclamation mark **!**, the construct matches any character that is not inside the brackets. For example:

```
ls [!a–m]*
```

lists any file that does not begin with one of the letters in the range `a` through `m`.

In the same way:

```
rm [!0-9]*
```

removes any file with a name that does not start with a digit.

Retrieving previously entered commands

In the tcsh shell, you can retrieve previously issued commands using:

- The **history** command, combined with the **!** command
- The two retrieve function keys that are part of the TSO/E OMVS command interface to the shell
- Command-line editing, when you are using an asynchronous terminal interface

Retrieving commands from the history file

The shell records each command that you enter in a file under your *home directory*. This file is called the *history file*; its name is **.history**. If you enter the command:

```
history
```

the shell displays the current contents of your history file. Each command is numbered.

You can rerun any of the commands in your history file by typing **!**, followed by a space, followed by the number of the command you want to use.

For example, suppose that you are a programmer and you enter a complicated command to compile part of a program. The program contains a syntax error, so you call a text editor to edit the source code and correct the problem. Now you want to run the same compile command on the corrected program. You may save yourself a good deal of typing by using:

```
history
```

to find out the number of the previous compile command and then running the command with **!**. For example, if the history file shows you that the command you want to run is number 44, you would type:

```
! 44
```

to run the previous compile command.

Another time-saver is to specify your shell prompt as:

```
set prompt="\!>
```

in your **.tcshrc** file. The shell prompt is then preceded by the number assigned to the command in the command history file.

If you type **!** followed by a space, followed by a string of characters (not beginning with a digit), the shell checks backward through the history file and runs the most recent command that begins with the given string. For instance, look at the compilation example. Suppose you are using the **c++** command to compile your program. Then:

```
! c++
```

looks back through the history and runs the most recent **c++** command. You do not even have to check on the number of the command you want to enter. The shell displays the selected command in the output area of the screen and then runs it.

This *backward-search* feature of **!** can search for aliases as well as normal commands. **!** searches for the beginning of the command line as you typed it, not the way that the line looked after the alias was replaced.

If you enter **!!** without a number after it, the shell repeats the most recent command.

Editing commands from the history file

Suppose that you have a sequence of source files named **file1.c**, **file2.c**, **file3.c**, and so on that you want to compile with similar **c89** commands. This situation is a little different from the one discussed in the previous topic. You do not want to

rerun the *same* command for each file; the command has the same form each time, but you have to specify in a new file name each time.

You can still do this using the history file. The command:

```
^old_string^new_string
```

runs a previous *command* but replaces the first occurrence of the *old* string with the *new* string. For example, suppose you compile **file1.c** with:

```
c89 options file1.c
```

Then the command:

```
^file1^file2
```

tells the shell to look at the previous command and change **file1** to **file2**. The shell makes this change, and then displays and runs the modified command.

```
^file2^file3
```

performs the same kind of operation, changing **file2** in the previous command to **file3** and then going ahead with the compilation. This saves you the trouble of retyping all the options for the command.

Using the retrieve function keys

If you are using the OMVS interface, there are two function key settings for retrieving commands:

Retrieve
: This key performs a "backward retrieve" function. It retrieves a saved command from a stack of saved input lines, starting with the most recent and moving down to the oldest available line.

FwdRetr
: This key is used with the Retrieve key to retrieve commands from the stack of saved input lines. If you press the Retrieve key one too many times and go past the line you want, you can press the FwdRetr key to display the line that was previously retrieved by the Retrieve key.

Press the Retrieve key repeatedly until the command you want to use is displayed on the command line. Once the command is displayed, you can modify the command or use it as it is displayed. Press <Enter> to run the command.

Command-line editing

When you use **rlogin** or **telnet** to login to the shell, you can use command-line editing. Command-line editing lets you access commands from your history file, edit them, and run the result. You have already seen this process before, when reading about some of the features of the **!** command.

Command editing is useful at those times when you are running the same sequence of commands, or slight variations on the same sequence of commands. The point of command editing is to save yourself the trouble of typing the same thing over and over again—look especially for long commands that normally require a lot of typing. Command editing is also useful when you have made a mistake in typing a command line and wish to correct it.

Using the vi command editor

If you run the command:

```
bindkey -v
```

it tells the shell that you want the ability to edit commands the way that you normally edit text with **vi**; you are set up for **vi** command editing. Whenever the shell prompts you for input, it is as if the shell puts you into **vi** insert mode on a new line at the end of the history file. You can type in a new command just as you normally would.

You can also press <Esc> to enter a **vi**-like command mode. When you enter command mode, you can use the usual cursor movement commands to move around on the command line, or to move up and down in the history file. For example:

- Press the **k** key to move back to the previous line in the history file (the last command line you entered). Press the **k** key again, and you move to the line before that.
- Press **j** and you move forward in the history file.

In this way it is simple to retrieve recent commands from the history file. You can then edit them using standard **vi** commands. For example, you can use **$** to move to the end of the line, and **A** to begin appending text to the end of the line. When you have edited the line to produce the command that you want to run, simply press <Enter> to run that line.

As you might expect, you can use these search commands:

```
/string
?string
```

to search backwards and forwards through the history file. You can edit the command line with these **vi** commands:

w Move to next word
b Move to previous word
d delete
c change
a append
i insert
u undo

and many of the other **vi** commands. For a complete list of available commands, see the **tcsh** command description in *z/OS UNIX System Services Command Reference*.

Using the emacs command editor

To set up for **emacs** command editing, enter:

```
bindkey -e
```

This lets you use commands identical to **emacs** commands to edit your shell command line. For more information, see the **tcsh** command description in *z/OS UNIX System Services Command Reference*.

Using file name completion

Tip: File name completion requires the use of the TAB key. This key must be mapped correctly for the feature to work. Most connections through **telnet** and **rlogin** will transmit the TAB information correctly. If you are connected in any other manner, this feature may not work correctly.

The tcsh shell provides a time saving feature for completing file names. Rather than having to type out the entire string to access a file or execute a program, you can type just the first letter or letters and let the shell help you with the rest.

For example, if you have a file called *phonebook*, and you want to list the contents of this file on the screen with the **more** command, you can do so by typing the command, the first letter or letters of the file, and then pressing the TAB key. For example, if you type:

```
more ph
```

and then press the TAB key, the shell will provide you with:

```
more phonebook
```

you can then press ENTER and execute the command.

If you have more than one file name that matches the letter or letters you have typed, the shell will alert you with a beep. For example, if you have three files, called *list1*, *list2*, and *list3*, and you type:

```
more li
```

and press TAB, the beep will sound, and the shell will complete the file name as far as it can:

```
more list
```

you must then type *1*, *2*, or *3* and press ENTER.

If you are unsure of how many files there are, or which one you want, you can type <CRTL-D> when the shell beeps, and you will be provided with matching names. For example:

```
> more list
list1   list2  list3
> more list
```

Underneath the matching names the command prompt is displayed again. Now you can enter the number that you wish and then press ENTER.

If there are no matches for the letter or letters you have typed, the shell will beep, but when you press <CRTL-D>, nothing will be displayed.

You can also use file name completion to aid in changing between directories with long paths. If you keep files in the directory *stuff/data/graphics*, it is easier to use file name completion to access the directory than to type the entire path by hand. For example, if you are in your home directory, and *stuff* is a subdirectory containing *data/graphics*, and you want to change into that directory, you can do the following:

```
cd s     [TAB]
cd stuff/.
cd stuff/d   [TAB]
cd stuff/data
cd stuff/data/g   [TAB]
cd stuff/data/graphics
```

then press ENTER, and the directory change command will execute.

You can find more information about file name completion in *z/OS UNIX System Services Command Reference*.

Using record-keeping commands

Record-keeping commands can be very helpful for programmers. For example, suppose you have a program that is split into several source files. For the sake of simplicity, assume that the source files all have the extension **.c** and are all stored in a subdirectory called **src**. (To read about extensions, see "Naming files" on page 211.)

It is often the case that you want to find out which source files in the subdirectory refer to a particular variable or function. You can do this very simply with the command:

```
grep 'name' src/*.c
```

The command checks all the appropriate files in the subdirectory **src** and displays the lines that contain the given *name*. Each line is labeled with the name of the file that contains the line. You can quickly find the use of a function or data object in source files.

As another example of using record-keeping commands, suppose that you are working on a large program and every few days you back up the source code for the program by copying it to a directory in a different file system (as a precaution). You would like to compare the current versions of your source files with one of the saved versions, to find out what changes have been made between the two. The command:

```
diff oldfile newfile
```

prints out all the differences between two versions of a file, making comparisons possible.

The **cksum** command gives a checksum for each file. If applied to two versions of what was at one time the same file, **cksum** gives a convenient way to tell if the files are still the same. It does not, however, indicate what the differences are.

The **find** command also has applications to programming. For example, suppose you are looking for a particular C source program but cannot remember where it is stored.

```
find / –name '*.c'
```

searches all the files and file systems, starting at the root, and displays the names of all files with the **.c** extension.

Finding elements in a file and presenting them in a specific format

awk is a powerful command that can perform many different operations on files. The general purpose of **awk** is to read the contents of one or more files, obtain selected pieces of information from the files, and present the information in a specified format.

One simple way to use **awk** is with a command line with the form:

```
awk '/regexp/ {action}' file
```

This asks **awk** to obtain information from the specified file. **awk** obtains the information by performing the specified *action* on every line in the file that contains a string matching the given regular expression, *regexp*. (For further information, see Appendix C. Regular Expressions (regexp) in *z/OS UNIX System Services Command Reference*.) For example:

```
awk '/abc/ {print}' file
```

displays every record in the file that contains the string `abc`.

For more discussion on using **awk**, see Appendix B, "Using awk," on page 299.

Timing programs

The **time** command lets you time programs to find out how much processor time they actually require. You might use this to compare two versions of a program to see if one runs faster than the other. You can run a program with:

```
time command-line
```

where *command-line* is a command line that invokes the program you want to time. **time** runs the program and displays:

- The total time the program took to execute, labeled `real`
- The total time spent in the user program, labeled `user`
- The central processor time spent performing system services for the user, labeled `sys`

For more information, see the **time** command description in *z/OS UNIX System Services Command Reference*.

Using the passwd command

You can change a user's password or password phrase with the **passwd** command:

```
passwd [-u userid]
```

The **passwd** command changes the login password or password phrase for the user ID specified. If *userid* is omitted, the login name associated with the current terminal is used. You are prompted for the new password or password phrase.

For example:

```
passwd
```

changes the password or password phrase for the invoker. The invoker is prompted for the old password or password phrase and then for the new value.

Non-superusers can change the password or password phrase for another user if they know the user ID and the current password or password phrase. This example changes the password or password phrase for user ID **bonnie**:

```
passwd -u bonnie
```

For more information about the **passwd** command, see the **password** command description in *z/OS UNIX System Services Command Reference* For information on setting up RACF to enable password phrase support, see *z/OS Security Server RACF Security Administrator's Guide*.

Switching to superuser or another ID

With the **su** command, you can switch to any user ID, including the superuser. A user can switch to superuser authority (with an effective UID of `0`), if the user is permitted to the BPX.SUPERUSER resource in the FACILITY class within the Resource Access Control Facility (RACF). Either the ISPF shell or the **su** shell command can be used for switching to superuser authority.

If you do not specify a user ID, the **su** command changes your authorization to that of the superuser. If you specify a user ID, **su** changes your authorization to that of the specified user ID.

When you switch to superuser (UID `0`) without specifying a user ID, you keep your MVS identity (TSO/E ID). You keep your access authority to MVS data sets, while gaining authority to access any z/OS UNIX files.

When you change user ID by specifying a user ID and password, you assume the MVS identity of the new user ID, even if the user ID has UID `0`.

If you use the **–s** option on the **su** command, you will not be prompted for a password. Use this option if you have access to the BPX.SRV.*userid* SURROGAT class profile. The *userid* is the MVS user ID associated with the target UID.

To return to your own user ID, type:

```
exit
```

This returns you to the shell in which you entered the **su** command.

For more information, see the **su** command description in *z/OS UNIX System Services Command Reference*.

Using the whoami command

The **whoami** command displays a username associated with the effective user ID, unlike the **who am i** command, which displays the login name.

For example, if you login as *user1* and then use the **su** command to change to 'user2':

```
command          returned
who am I         user1
whoami           user2
```

For more information about the **whoami** command, see the **whoami** command description in *z/OS UNIX System Services Command Reference*.

Running a TSO/E command

To run a TSO/E command from the shell or in a shell script, simply preface the TSO/E command with either the **tso** or **tsocmd** shell command.

Using the tso command

To run a TSO/E command from the shell or in a shell script, you may preface the TSO/E command with the **tso** shell command; for example:

```
tso -t tso_command
```

There are two options you can use:

- Specify the *-t* option to run a command through the TSO/E service routine. The command output is written to **stdout**. If you specify a relative pathname, the command looks for the file in your current directory.

  Restrictions: TSO/E has some restrictions on the type of commands that can be run using the TSO/E service routine (mini-TSO environment). In summary, you cannot run the following commands in this environment:
  - Commands that run authorized
  - FIB (foreground initiated background) commands
  - Other commands that require the TSO/E task structure, i.e., interactive commands such as **oedit**, where interactive means that the user can interact with the command processing while issuing additional terminal input (subcommands, function keys). For example, once the **oedit** command is entered, the user can enter additional subcommands to add more lines and then quit or exit the command.

  For a full description of the restrictions, see the information on IKJTSOEV in *z/OS TSO/E Programming Guide*.
- Specify the *-o* option to run a TSO command as if it had been entered on the OMVS command line and run using the TSO subcommand or function key. If you use a relative pathname, the command looks for the file in the working directory of your TSO/E session, which is typically your home directory.

If no option is specified, the following rules are applied in this order:

1. If **stdout** is not a tty, the TSO service routine is used since it is possible that the command output is redirected to a file or piped to another command. Otherwise,
2. If the controlling tty supports 3270 passthrough mode, OMVS is used. Otherwise,
3. The TSO service routine is used.

See “Understanding standard input, standard output, and standard error” on page 68 for more information about stdin, stdout, and stderr.

The **tso** command supports several environment variables. For more information about the **tso** command and the environment variables associated with it, see *z/OS UNIX System Services Command Reference*.

Using the tsocmd command

You can also use the **tsocmd** shell command to run a TSO/E command from the shell or in a shell script.

Unlike the **tso** shell command, the **tsocmd** shell command can be used to issue authorized TSO commands. For more information about the **tsocmd** shell command and the environment variables associated with it, see *z/OS UNIX System Services Command Reference*.

Online help

Two help facilities are available with the shell:

- The **man** command, which displays help information about a shell command. The man page is displayed in your shell session, and you can work in the shell while viewing the help information.

Using the man command

You can use the **man** command to get help information about a shell command. The **man** syntax is:

man *command_name*

- To scroll the information in a man page, press <Enter>.
- To end the display of a man page, type **q** and press <Enter>.

To search for a particular string in a system that has a list of one-line command descriptions, use the **-k** option:

```
man -k string
```

For example, to produce a list of all the shell commands for editing, you could type:

```
man -k edit
```

You can use the **man** command to view descriptions of TSO/E commands. To do this, you must prefix all commands with **tso**. For example, to view a description of the MOUNT command, you would enter:

```
man tsomount
```

You can also use the **man** command to view descriptions of **dbx** subcommands. To do this, you must prefix all subcommands with **dbx**. For example, to view a description of the **dbx alias** subcommand, you would enter:

```
man dbxalias
```

For complete information about the **man** command, see the **man** command description in *z/OS UNIX System Services Command Reference*.

Shell messages

Messages issued by the tcsh shell and utilities are prefixed with the letters FSUC. See *z/OS UNIX System Services Messages and Codes*.

Chapter 8. Writing z/OS shell scripts

Programming interface information

Most people find themselves using some sequences of commands over and over again.

- A programmer might always use the same commands to compile source code, and link the resulting object code.
- A bookkeeper can have to go through the same sequence of shell commands each week to update the books and produce a report.

To simplify such jobs, the shell lets you run a sequence of commands that have been stored in a text file. For example, the programmer could store all the appropriate compiling and linking commands in a file. A file containing commands in this way is called a *shell script*. After such a file is completed and it is made executable, the programmer can run all the commands in the file by entering the file name on the command line.

Putting commands in a shell script has several advantages over typing the commands individually. Using a shell script:

- Reduces the amount of typing you have to do. You have to type in the shell script only once. Then you can run all the commands in the script by entering the name of the file as a single shell command. A shell script can save you a lot of time and effort if you are working with many files, or if some command lines have several options.
- Reduces the number of errors. If you are typing in ten commands, you have ten chances to make a mistake. With a shell script, however, you can take your time, edit the file carefully and be sure that it is correct before you try to run it.
- Makes it easy for other people to do what you do. For example, consider the bookkeeper example. When the bookkeeper goes on vacation, someone else has to fill in. It is much easier for the substitute bookkeeper to type a single command that does everything correctly than to try to type in the full sequence of commands.

For all these reasons, you will probably find that the use of shell scripts makes your work easier and more productive. This topic provides only a brief overview, but it should give you an idea of how to write and use shell scripts.

Running a shell script

You can run a shell script by typing the name of the file that contains the script. For example, suppose you have a script named **totals.scp** that has three shell commands in it. If you enter:

```
totals.scp
```

the shell runs the three commands.

Before you can run a shell script, you must have read and execute permission to the file. Use the **chmod** and **umask** commands to set the permissions. See the discussion of permissions in Chapter 18, "Handling security for your files," on page 231.

For another example, suppose you want to compile a collection of files written in the C programming language. You could use the **c89**, **cc**, or **c++** command. The **c89** command, for example, compiles any file **file.c**, link-edits the object module, and produces an executable file. The shell script:

```
c89 -c file1.c file2.c                      # compile only
c89 -o outfile file1.o file2.o file3.c      # outfile for executable
```

compiles and link-edits the files and produces an executable file, **outfile**. Notice that in a shell script you precede a comment with a #.

If you store this script in an executable file named **compile**, it could be run with the single command **compile**. A new process is created for the script to run in.

To run a shell script in your current environment, without creating a new process, use the **.** (dot) command. You could run the **compile** shell script this way:

```
. compile
```

If you want to use a shell script that updates a variable in the current environment, run it with the **.** command.

Tip: You can improve shell script performance by setting the _BPX_SPAWN_SCRIPT environment variable to a value of YES. See "Improving the performance of shell scripts" on page 45 for more information.

Using the magic number

When a script file starts with #!, the kernel's spawn and exec services recognize the file name after the #! as the program to be run. For example, the z/OS UNIX file **/u/userid/util1** contains the following in the start of the file:

```
#!  /u/userid/othershell
```

The kernel recognizes the magic number (#!) and runs **/u/userid/othershell**.

Using TSO/E commands in shell scripts

A shell script can include TSO/E commands as well as shell commands, and it can process TSO/E command output. You use the **tso** shell command to run the TSO/E command. For a discussion of the **tso** command, see "Using the tso command" on page 88.

Using variables

You can think of shell scripts as *programs* made up of shell commands. To allow more versatile shell scripts, the shell supports many of the features of normal programming languages.

In a conventional programming language, a *variable* is a name that has an associated value. When you want to use the value, you can use the name instead.

Note: A shell script does not inherit any variables from your current shell session. To pass on a variable, you must export it.

Creating a variable

The shell also lets you create variables. A shell variable name can consist of uppercase or lowercase letters, plus digits and the underscore character _. The

name can have any length, but the first character cannot be a digit. Uppercase letters are distinguished from lowercase ones, so **NAME**, **name**, and **Name** are all *different* names.

To create a shell variable, just enter:

```
name='string'
```

as a command to the shell. No spaces are allowed around the **=**. For example:

```
HOME='/usr/macneil'
```

sets up a variable with the name **HOME** and the value **/usr/macneil**.

After you set a variable, you refer to it by prefixing its name with a dollar sign ($). Any command can use the value of a variable by referring to it this way. For example, if **HOME** is set to **/usr/macneil**:

```
cd $HOME
```

is equivalent to:

```
cd /usr/macneil
```

Similarly:

```
cp $HOME/* /newdir
```

is equivalent to:

```
cp /usr/macneil/* /newdir
```

To change the value of an existing variable, you use a command with the same form as the existing variable. For example:

```
HOME='/usr/benjk'
```

changes the value of **HOME** from **/usr/macneil** to **/usr/benjk**.

If the value on the right-hand side of the **=** sign does not contain spaces, tab characters, or other special characters, you can leave out the single quotation marks. For example, you can enter:

```
HOME=/usr/benjk
```

Calculating with variables

Suppose you run the following commands either in a shell script or by typing in one command after another:

```
i=1
j=$i+1
echo $j
```

The output of **echo** is 1+1, because a normal variable assignment assigns a *string* to a variable. Thus `j` gets the string 1+1.

To *evaluate* an arithmetic expression, you can enter:

```
let "variable=expression"
```

This command line assigns the value of an expression to the given variable. For example:

```
i=1
let "j=$i+1"
echo $j
```

Here `j` is assigned the value of the expression and the **echo** command displays the value 2.

You can also use **let** to change the value of a variable. If you enter:

```
i=1
let "i=$i+1"
echo $i
```

the **let** command *changes* the value of `i`. The new value of `i` is the old value plus 1.

A **let** command can have any of the standard arithmetic expressions:

-A Negative `A`

A*B `A` times `B`

A/B `A` divided by `B`

A%B Remainder of `A` divided by `B`

A+B `A` plus `B`

A-B `A` minus `B`

The standard mathematical order of operations is used, as shown in the way that operations are grouped:

- All unary minus operations are carried out;
- Then any `*`, `/`, or `%` operations (from left to right in the order they appear);
- Then any additions or subtractions (from left to right in the order they appear).

Many operators use special shell characters, so you usually need to put double quotation marks around the expression. Thus:

```
let "i=5+2*3"
```

assigns 11 to `i`, because the multiplication is done first. You can use parentheses in the usual way to change the order of operations. For example:

```
let "i=(5+2)*3"
```

assigns 21 to `i`.

Note: let does not work with numbers that have fractional parts. It works only with integers.

Exporting variables

Up to this point, we have talked about defining shell variables and then using them in later command lines. You can also define a shell variable and then call a shell script that makes use of that variable. But you have to do a certain amount of preparation first.

A shell script is run like a separate shell session. By default, it does not share any variables with your current shell session. If you define a variable **VAR** in the current session, it is *local* to the current session; any shell script that you call will not know about **VAR**.

To deal with this situation, you can export the command; enter:

```
export VAR
```

The **export** command says that you want the variable **VAR** passed on to all the commands and shell scripts that you execute in this session. After you do this, **VAR** becomes *global* and the variable is known to all the commands and shell scripts that you use.

As an example, suppose you enter the commands:

```
MYNAME="Robin Hood"
export MYNAME
```

Now all your commands can use the **MYNAME** variable to obtain the associated name. You may, for example, have shell scripts that write form letters that contain your name, `Robin Hood`, obtained from the **MYNAME** variable.

Note: You could use single or double quotation marks to enclose the variable value. See "Quoting variable values" on page 41 for more information.

When a script begins running, it automatically inherits all the variables currently being exported. However, if the script changes the value of one of those variables, that change is not reflected to the calling shell—unless you run the script with the dot (**.**) utility.

By default, any variables created within a shell script are *local* to that script. This means that when another program is run, those variables do not apply in its environment. However, the script can use the **export** command to turn local variables into global ones. Inside a shell script:

```
export name
```

indicates that the variable with the given *name* should be exported. When other programs are run from that script, they inherit the value of all exported variables. However, when the script ends, all its exported variables are lost to the calling shell.

Some variables are automatically marked for export by the software that creates them. For example, if you invoke the shell, the initialization procedure automatically marks the **HOME** variables for export so that other commands and shell scripts can use it. In Chapter 4, "Customizing the z/OS shell," on page 39, you saw that in a typical **.profile** file for an individual user, the **PATH** variable is exported. Exporting **PATH** ensures that search rules and changes to search rules are automatically shared by all shell sessions and scripts.

You must export other variables explicitly, using the **export** command.

Associating attributes with variables

The **typeset** command lets you associate attributes with shell variables. This process is analogous to declaring the type of a variable in a conventional programming language. For example:

```
typeset –i8 y
```

says that `y` is an octal integer. In this way, you can make sure that arithmetic with `y` is always performed in base 8 rather than the usual base 10.

Other attributes may specify how the variable's value is displayed when the variable is expanded. Attributes of this kind are:

–L*n* The value should always be displayed with *n* characters, left-justified within that space.

–R*n* The value should always be displayed with *n* characters, right-justified within that space.

–RZ*n* The value should always be displayed with *n* characters, right-justified and with enough leading zeros to fill out the rest of the space.

–Z*n* The same as **-RZ***n*.

–LZ*n* The value should always be displayed with *n* characters, left-justified and with leading zeros stripped off.

All of these options may lead to truncation of a value that is longer than the specified length.

You can use the **–u** attribute of **typeset** for variables with string values. Then whenever such a variable is assigned a new value, all lowercase letters in the value are automatically converted to uppercase. Similarly, the **–l** attribute specifies that whenever a variable is assigned a new value, all uppercase letters in the value are automatically converted to lowercase.

The read-only attribute **–r** is useful when a variable is marked for export. The command:

```
typeset –r name
```

says that the variable *name* cannot be changed from its present value. Then subsequent commands cannot change this value. You can also use the format:

```
typeset –r name=value
```

which sets the variable to the given value and marks it read-only so that the value cannot be changed.

Displaying currently defined variables

The command **typeset** without any arguments displays the currently defined variables and their attributes. The variation:

```
typeset -x
```

displays all the variables currently defined for export.

Using positional parameters — the $N construct

The sample shell script discussed previously in this topic compiled and link-edited a program stored in a collection of source modules. This information discusses a shell script that can compile and link-edit a C program stored in any file.

To create such a script, you need to be familiar with the idea of *positional parameters*. When the shell encounters a `$N` construct formed by a `$` followed by a single digit, it replaces the construct with a value taken from the command line that started the shell script.

- `$1` refers to the first string after the name of the script file on the command line
- `$2` refers to the second string, and so on.

As a simple example, consider a shell script named **echoit** consisting only of the command:

```
echo $1
```

Suppose we run the command:

```
echoit hello
```

The shell reads the shell script from **echoit** and tries to run the command it contains. When the shell sees the `$1` construct in the **echo** command, it goes back to the command line and obtains the first string following the name of the shell script on the command line. The shell replaces the `$1` with this string, so the **echo** command becomes:

```
echo hello
```

The shell then runs this command.

A construct like `$1` is called a *positional parameter*. Parameters in a shell script are replaced with strings from the command line when the script is run. The strings on the command line are called *positional parameter values* or *command-line arguments*.

If you enter:

```
echoit Hello there
```

the string `Hello` is considered parameter value `$1` and the string `there` is `$2`. Of course, the shell script is only:

```
echo $1
```

so the **echo** command displays only the `Hello`.

Positional parameters that include a blank can be enclosed in quotation marks (single or double). For example:

```
echoit "Hello there"
```

echoes the two words instead of just one, because the two words are handled as one parameter.

Returning to a compile and link example, a programmer could write a more general shell script as:

```
c89 -c $1.c
c89 -o $1 $1.o
```

If this shell script were named **clink**, the command:

```
clink prog
```

would compile and link **prog.c**, producing an executable file named **prog** in the working directory. In the same way, the command:

```
clink dir/prog2
```

would compile and link **dir/prog2.c**. The shell script compiles and links a C program stored in a single file.

As another example of a shell script containing a positional parameter, suppose that the file **lookup** contains:

```
grep $1 address
```

(where **address** is a file containing names, addresses, and other useful information). The command:

```
lookup Smith
```

displays address information about anyone in the file named Smith.

Using quotation marks to enclose a construct in a shell script

A $N construct in a shell script can be enclosed in double or single quotation marks.

- When double quotation marks are used, the parameter is replaced by the appropriate value from the command line. For example, suppose that the file search contains:

  ```
  grep "$1" *
  ```

  If you enter the command:

  ```
  search 'two words'
  ```

  the parameter value `'two words'` replaces the construct $1 in the **grep** command:

  ```
  grep "two words" *
  ```

  If the **grep** command does not contain the double quotation marks, the parameter replacement would result in:

  ```
  grep two words *
  ```

  which has an entirely different meaning.
- When you use single quotation marks to enclose a $N construct in a shell script, the $N is *not* replaced by the corresponding parameter value. For example, if the file **search** contains:

  ```
  grep '$1' *
  ```

  grep searches for the string $1. The $1 is not replaced by a value from the command line. In general, single quotation marks are “stronger” than double quotation marks.

Using parameter and variable expansion

A $ followed by a number stands for a positional parameter passed to the script or function. A positional parameter is represented with either a single digit (except 0) or two or more digits in braces; for example, 7 and {15} are both valid representations of positional parameters. For example, if the command:

```
echo $1
```

appeared in a shell script, it would **echo** the first positional parameter.

Similarly, a $ followed by the name of a shell variable (such as **$HOME**) stands for the value of the variable.

These constructs are called *parameter expansions*. In this sense, the term *parameter* can mean either a positional parameter or a shell variable.

The z/OS shell also supports more complicated forms of parameter expansions, letting you obtain only part of a parameter value or a modified form of the value.

Parameter expansion	Usage

${parameter:-value}	You can use ${*parameter*:-*value*} in any input to the shell. If *parameter* currently has a value and the value is not null (for example, a string without characters), the foregoing construct stands for the parameter's value. If the value of the parameter is null, the construct is replaced with the *value* shown in the brace brackets. For example, a shell script might contain:
	`SHELL=${SHELL:-/bin/sh}`
	
	If the **SHELL** variable currently has a value, this simply assigns **SHELL** its own current value. However, if the value of **SHELL** is null, the given assignment will have the value of **/bin/sh**. The value after **:–** can be thought of as a *backup* value in case the parameter itself does not have a value. As another example, consider:
	`cp $1 ${2:-$HOME}`
	
	(This might occur in a shell script.) If both positional parameters are present and have a nonnull value, the copy command is just:
	`cp $1 $2`
	
	However, if you call the shell script without specifying a second positional parameter, it uses the backup value of **$HOME**. The result is equivalent to:
	`cp $1 $HOME`

${parameter:=value}	The expansion form ${*parameter*:=*value*} is similar to the previous form; the difference is that if the given *parameter* does not currently have a value, the given *value* is assigned to *parameter*, and then the new value of parameter is used. Thus the **:=** form actually assigns a value if the *parameter* does not already have one. In this case, *parameter* must be a variable; it cannot be a positional parameter.

${parameter:?message}	The expansion ${*parameter*:?*message*} is related to the previous two forms. If the value of the given *parameter* is null, the given *message* is displayed. If the construct is being used inside a shell script, the script ends with an error status. For example, you might have:
	`cp $1 ${2:?"Must specify a directory name"}`
	
	In this case, the message following the **?** is displayed if there is no second positional parameter. If you omit the *message*, the shell prints a standard message. For example, you could just enter:
	`cp $1 ${2:?}`
	
	to get the standard error message.

Parameter expansion	Usage

${parameter:+replacement}	The construct ${*parameter*:+*replacement*} might be thought of as the opposite of the preceding expansions. If *parameter* has not been assigned a value, or has a null value, this construct is just the null string. If *parameter does* have a value, the value is ignored and the *replacement* value is used in its place. Thus, if a shell script contains:
	`echo ${1:+"There was a parameter"}`
	
	the **echo** command displays:
	`There was a parameter`
	
	if the script was invoked with a parameter. If no parameter was specified, the **echo** command has nothing to echo.

${parameter#pattern}	The construct ${*parameter#pattern*} is evaluated by expanding the value of *parameter* and then deleting the *smallest leftmost* part of the expansion that matches the given *pattern* of pathname wildcard characters. For example, suppose that the variable *NAME* stands for a file name. You might use:
	`${NAME#*/}`
	
	to remove the highest-level directory from the pathname. If:
	`NAME="user/dir/subdir/file.c"`
	
	then:
	`${NAME#*/}`
	
	expands to:
	`dir/subdir/file.c`

${parameter##pattern}	The construct ${*parameter##pattern*} removes the *largest leftmost* part that matches the pattern. For example, if:
	`NAME="user/dir/subdir/file.c"`
	
	then:
	`${NAME##*/}`
	
	yields:
	`file.c`
	
	The wildcard character * stands for any sequence of characters. In this situation, it stands for everything up to the final slash.

${parameter%pattern}	The construct ${*parameter%pattern*} removes the *smallest rightmost* part of the parameter expansion that matches *pattern.* Thus if:
	`NAME="user/dir/subdir/file.c"`
	
	then:
	`${NAME%.?}`
	
	stands for:
	`user/dir/subdir/file`

Parameter expansion	Usage

${parameter%%pattern}	Similarly, ${*parameter%%pattern*} stands for the expansion of *parameter* without the *longest rightmost* string that matches *pattern*. Using the previous example of *NAME*,
	`${NAME%%/*}`
	
	stands for:
	`user`

Using special parameters in commands and shell scripts

The z/OS shell has a variety of special parameters that may be used in command lines and shell scripts.

Parameter	Expands to

$@	The complete list of positional parameters, each separated by a single space. If **$@** is quoted, the separate arguments are each quoted; for example:
	`echo "$@"`
	
	is equivalent to:
	`"$1" "$2" "$3"`
	
	If the positional parameters are all file names:
	`cp $@ dir`
	
	copies all the files to the given directory **dir**.

$*	The complete list of positional parameters. If **$*** is quoted, the result is concatenated into a single argument, with parameters separated by the first character of the value of the shell variable **IFS**. For example, if the first character of **IFS** is a comma, then:
	`echo "$*"`
	
	displays the parameters with separating commas:
	`"$1,$2,$3"`

$#	The number of positional parameters passed to this shell script. This number can be changed by several shell commands (for example, **set** or **shift**); see *z/OS UNIX System Services Command Reference*.
$?	The exit status value returned by the most recently run command. The command **echo $?** prints out the status from the most recently run operation or command.
$–	The set of options that have been specified for this shell session. This includes options that were specified on the command line that started the shell, plus other options that have been set with the **set** command.

Using control structures

The shell provides facilities similar to those found in programming languages. It offers these *control structures,* which are related to programming control structures:

- The **if** conditional
- The **while** loop
- The **for** loop

Using test to test conditions

Before discussing the various control structures, it is useful to talk about ways to test for various conditions.

The **test** command tests to see if something is true. Here are some ways it can be used:

Table 4. Uses for the **test** *command*

Examine the nature of a file	
test -d *pathname*	Is *pathname* a directory?
test -f *pathname*	Is *pathname* a file?
test -r *pathname*	Is *pathname* readable?
test -w *pathname*	Is *pathname* writable?
Compare the age of two files	
test *file1* **-ot** *file2*	Is *file1* older than *file2*?
test *file1* **-nt** *file2*	Is *file1* newer than *file2*?
Compare the values of numbers *A* **and** *B*	
test *A* **-eq** *B*	Is *A* equal to *B*?
test *A* **-ne** *B*	Is *A* not equal to *B*?
test *A* **-gt** *B*	Is *A* greater than *B*?
test *A* **-lt** *B*	Is *A* less than *B*?
test *A* **-ge** *B*	Is *A* greater than or equal to *B*?
test *A* **-le** *B*	Is *A* less than or equal to *B*?
Compare two strings *str1* **and** *str2*	
test *str1* **=** *str2*	Is *str1* equal to *str2*?
test *str1* **!=** *str2*	Is *str1* not equal to *str2*?
Test whether strings are empty	
test -z *string*	Is *string* empty?
test -n *string*	Is *string* not empty?

Any of these tests will also work if you put square brackets ([ ]) around the condition instead of using the **test** command. For example, `test 1 -eq 1` is the equivalent of `[ 1 -eq 1 ]`.

The double square bracket `[[test_expr]]` syntax is also supported. The double square bracket ([[ ]]) also supports additional tests over the **test** command, and there are some subtle differences between the tests (for example, string equal vs. pattern matching).

The result of **test** is either true or false. **test** returns a status of `0` if the test turns out to be true and a status of `1` if the test turns out to be false.

You can use **–n** to check if a variable has been defined. For example:

```
test -n "$HOME"
```

is true if **HOME** exists, and false if you have not created a **HOME** variable.

You can use **!** to indicate logical negation;

```
test ! expression
```

returns false if *expression* is true, and returns true if *expression* is false. For example:

```
test ! -d pathname
```

is true if *pathname* is not a directory, and false otherwise.

The if conditional

An **if** conditional runs a sequence of commands if a particular condition is met. It has the form:

```
if condition
then commands
fi
```

The end of the commands is indicated by **fi** (which is "if" backward). For example, you could have:

```
if test -d $1
then ls $1
fi
```

This tests to see if the string associated with the first positional parameter, $1, is the name of a directory. If so, it runs an **ls** command to display the contents of the directory.

Any number of commands may come between the **then** and the **fi** that ends the control structure. For example, you might have written:

```
if
    test -d $1
then
    echo "$1 is a directory"
    ls $1
fi
```

This example also shows that the commands do not have to begin on the same line as **then**, and the condition being tested does not have to begin on the same line as **if**. The condition and the commands are indented to make them stand out more clearly. This is a good way to make your shell scripts easier to read.

Another form of the **if** conditional is:

```
if condition
then commands
else commands
fi
```

If the condition is true, the commands after the **then** are run; otherwise, the commands after the **else** are run. For example, suppose you know that the string associated with the variable *pathname* is the name of either a directory or a file. Then you could write:

```
if
    test -d $pathname
then
    echo "$pathname is a directory"
    ls $pathname
else
    echo "$pathname is a file"
    cat  $pathname
fi
```

If the value of *pathname* is the name of a file, this shell script uses **echo** to display an appropriate message, and then uses **cat** to display the contents of the file.

The final form of the **if** control structure is:

```
if condition1
then commands1
elif condition2
then commands2
elif condition3
then commands3
      ...
else commands
fi
```

elif is short for "else if" In this example, if *condition1* is true, *commands1* are run; otherwise, the shell goes on to check *condition2*. If that is true, *commands2* are run; otherwise, the shell goes on to check *condition3* and so on. If none of the test conditions are true, the *commands* after the **else** are run. Here is an example of how this can be used:

```
if test ! "$1"
then
    echo "no positional parameters"
elif test -d $1
then
    echo "$1 is a directory"
    ls $1
elif test -f $1
then
    echo "$1 is a file"
    cat $1
else
    echo "$1 is just a string"
fi
```

The test after the **if** determines if the value of the first positional parameter, $1, is an empty string. If so, there are no positional parameters, and the shell script uses **echo** to display an appropriate message; otherwise, the script checks to see if the parameter is a directory name; if so, the contents of the directory are listed with **ls** (after an appropriate message). If that does not work, the script checks to see if the parameter is a file name; if so, the contents of the file are listed with **cat** (after an appropriate message). Finally, if none of the previous tests work, the parameter is assumed to be an arbitrary string, and the script displays a message to this effect.

You could put that script into a file named **listit** and run commands of the form:

```
listit name
```

to list the contents of *name* in a useful form.

The while loop

The **while** loop repeats one or more commands while a particular condition is true. The loop has the form:

```
while condition
do commands
done
```

The shell first tests to see if *condition* is true. If it is, the shell runs the *commands*. The shell then goes back to check the *condition*. If it is still true, the shell runs the *commands* again, and so on, until the *condition* is found to be false.

As an example of how this can be used, suppose you want to run a program named **prog** 100 times to get an idea of the program's average running speed. The following shell script does the job:

```
i=100
date
while test $i -gt 0
do
    prog
    let i=$i-1
done
date
```

The script begins by setting a variable *i* to 100. It then uses the **date** command to get the current date and time.

Next the script runs a **while** loop. The **test** condition says that the loop should keep on going as long as the value of *i* is greater than zero. The commands of the loop run **prog** and then subtract 1 from the *i* variable. In this way, *i* goes down by 1 each time through the loop, until it is no longer greater than 0. At this point, the loop stops and the final instruction of the script prints out the date and time at the end of the loop. The difference between the starting time and the ending time should give some idea of how long it took to run the program 100 times.

(Of course, the shell itself takes some time to perform the **test** and to do the calculations with *i*. If **prog** takes a long time to run, the time spent by the shell is relatively unimportant; if **prog** is a quick program, the extra time that the shell takes may be large enough to make the timing incorrect.)

You can rewrite this shell script to make it a little more efficient:

```
i=100
date
while let "(i=$i-1) >= 0"
do
    prog
done
date
```

In this example, the **let** command is the condition of the **while** loop. It gives *i* a new value and then compares this value to zero. The advantage of this way of writing the program is that it does not have to call **test** to make the comparison; this speeds up the loop and makes the time more accurate.

The for loop

The final control structure to be examined is the **for** loop. It has the form:

```
for name in list
do commands
done
```

The parameter *name* should be a variable name; if this variable doesn't exist, it is created. The parameter *list* is a list of strings separated by spaces. The shell begins by assigning the first string in *list* to the variable *name*. It then runs the *commands* once. Then the shell assigns the next string in *list* to *name*, and repeats the *commands*. The shell runs the *commands* once for each string in *list*.

As a simple example of a shell script that uses **for**, consider:

```
for file in *.c
do
    c89 $file
done
```

When the shell looks at the **for** line, it expands the expression `*.c` to produce a *list* containing the names of all files (in the working directory) that have the suffix **.c**. The variable *file* is assigned each of the names in this list, in turn. The result of the **for** loop is to use the **c89** command to compile all **.c** files in the working directory. You could also write:

```
for file in *.c
do
    echo $file
    c89 $file
done
```

so that the shell script displayed each file name before compiling it. This would let you keep track of what the script was doing.

As you can see, the **for** loop is a powerful control structure. The *list* can also be created with command substitution, as in:

```
for file in $(find . -name "*.c" -print)
do
    echo $file
    c89 $file
done
```

Here the **find** command finds all **.c** files in the working directory, and then compiles these files. This is similar to the previous shell script, but it also looks at subdirectories of the working directory.

Combining control structures

You can combine control structures by nesting (that is, putting one inside another). For example:

```
for file in $(find . -name "*.c" -print)
do
    if test $file -ot $1
    then
        echo $file
        c89 -c $file
    fi
done
```

This shell script takes one positional parameter, giving the name of a file. The script looks in the working directory and finds the names of all **.c** files. The **if** control structure inside the **for** loop tests each file to see if it is older than the file named on the command line. If the **.c** file is older, **echo** displays the name, and the file is compiled. You can think of this as making a set of files up to date with the file name specified on the command line.

For more information about the**test** command, see *z/OS UNIX System Services Command Reference*. The section that discusses reserved words in *z/OS UNIX System Services Command Reference* contains information about the [[...]] form.

Using functions

A *shell function* is similar to a function in C: It is a sequence of commands that do a single job. Typically, a function is used for an operation that you tend to do frequently in a shell script. Before you can call a function in a shell script, you must define it in the script. After the function is defined, you can call it as many times as you want in the script.

As an example, consider the following piece of a shell script, showing the function definition and how the function is called in the shell script:

```
function td
{
    if  test -d "$1"               # test if first argument is directory
    then
        curdir=$(pwd)              # set curdir to working directory
        cd $1                      # change to specified directory
        $2                         # run specified command
        cd $curdir                 # change back to working directory
        return 0                   # return 0 if successful
    else
        echo $1 "is not a directory"
        return 1                   # return 1 if not successful
    fi
}
td /u/turbo/src.c ls               # invoking the function
```

The purpose of **td** is to go to a specified directory, run a single command, and then return to the directory from which the function was called.

To run a function, specify the function's name followed by whatever arguments it expects. To run the function **td**, specify the function name followed by a directory name and a command name, as shown in the last line of the foregoing example.

As you see in the **td** example, a function can also return a value. If the statement:

```
return expression
```

appears inside a function, the function ends and the value of *expression* is returned as the status, or *result*, of the function. In general, the returned value:

- `0` means that the function has succeeded in its task.
- `1` means that the function has failed.

Anytime you need to repeatedly perform the same sequence of commands in a shell script, consider defining a function to do the sequence of commands. This lets you organize a large script into smaller blocks of subroutines.

In order to make a shell function available as a shell command, the function definition must be processed by the shell that will execute the command. Typically, the user sets up a shell script (such as **$HOME/.setup**) that contains all of the function definitions, and sets the ENV variable to the pathname of that shell script. As the number of functions in this script grows, the time to process the function definitions causes shell initialization time to increase.

Autoloading functions

Autoloading improves the performance of shell initialization by delaying function definition processing until the first use. Functions that are not used by a particular

user are never read by the shell, thus avoiding the processing of unused functions. The **FPATH** variable allows flexibility in accessing directories with systemwide, group, or personal function definitions.

FPATH is defined with the same format as the **PATH** variable. **FPATH** is a list of directories separated by colons. These directories contain only function definitions and should not contain the current working directory.

To use autoloading, place frequently used and shared functions in a directory pointed to by the **FPATH** variable and specify the function name on an **autoload** or **typeset –f** command in the user's ENV setup script.

The **autoload** command identifies functions that are not yet defined. The first time that an **autoload** function is called within the shell, the shell searches **FPATH** directories for a file with the same name as the function definition. If a matching file with the same name as the function is found, it is processed and stored in the shell's memory for subsequent execution. The matching file contains the function definition for the **autoload** function. Other function definitions may be found in this matching file, and if so, they will be defined to the shell when the file is processed. For information about how to set up the **FPATH** search path, see "Customizing the FPATH search path: The FPATH variable" on page 44.

End of Programming interface information

Chapter 9. Writing tcsh shell scripts

Programming interface information

Most people find themselves using some sequences of commands over and over again.

- A programmer may always use the same commands to compile source code, and link the resulting object code.
- A bookkeeper may have to go through the same sequence of shell commands each week to update the books and produce a report.

To simplify such jobs, the shell lets you run a sequence of commands that have been stored in a text file. For example, the programmer could store all the appropriate compiling and linking commands in a file. A file containing commands in this way is called a *shell script*. After such a file is completed and it is made "executable," the programmer can run all the commands in the file by entering the file name on the command line.

Putting commands in a shell script has several advantages over typing the commands individually. Using a shell script:

- Reduces the amount of typing you have to do. You have to type in the shell script only once. Then you can run all the commands in the script by entering the name of the file as a single shell command. A shell script can save you a lot of time and effort if you are working with many files, or if some command lines have several options.
- Reduces the number of errors. If you are typing in ten commands, you have ten chances to make a mistake. With a shell script, however, you can take your time, edit the file carefully, and get it right before you try to run it.
- Makes it easy for other people to do what you do. For example, consider the bookkeeper example. When the bookkeeper goes on vacation, someone else has to fill in. It is much easier for the substitute bookkeeper to type a single command that does everything correctly than to try to type in the full sequence of commands.

For all these reasons, you will probably find that the use of shell scripts makes your work easier and more productive. This topic provides only a brief overview, but it should give you an idea of how to write and use shell scripts.

Running a shell script

You can run a shell script by typing the name of the file that contains the script. For example, suppose you have a script named **totals.scp** that has three shell commands in it. If you enter:

```
totals.scp
```

the shell runs the three commands.

Before you can run a shell script, you must have read and execute permission to the file. Use the **chmod** and **umask** commands to set the permissions. See the discussion of permissions in Chapter 18, "Handling security for your files," on page 231. See the descriptions of **chmod** and **umask** in *z/OS UNIX System Services Command Reference*.

For another example, suppose you want to compile a collection of files written in the C programming language. You could use the **c89**, **cc**, or **c++** command. The **c89** command, for example, compiles any file **file.c**, link-edits the object module, and produces an executable file. The shell script:

```
c89 -c file1.c file2.c                        # compile only
c89 -o outfile file1.o file2.o file3.c        # outfile for executable
```

compiles and link-edits the files and produces an executable file, **outfile**. Notice that in a shell script you precede a comment with a #.

If you store this script in an executable file named **compile**, it could be run with the single command **compile**. A new process is created for the script to run in.

To run a shell script in your current environment, without creating a new process, use the **source** command. You could run the **calculate** shell script this way:

```
source calculate
```

Should you want to use a shell script that updates a variable in the current environment, run it with the **source** command.

Tip: To improve shell script performance, set the **_BPX_SPAWN_SCRIPT** environment variable to NO when using the tcsh shell. This variable is intended only for use with the z/OS shell. If this variable is inherited from a z/OS shell session, put

```
#!/bin/tcsh
```

as the first line in your tcsh shell scripts to avoid any errors. If tcsh is your login shell, you should unset **_BPX_SPAWN_SCRIPT**, because it is only used for increasing performance of z/OS shell scripts.

Using the magic number

All tcsh scripts must have # as the first character of the script. When a script file starts with #!, the kernel's spawn and exec services recognize the file name after the #! as the program to be run. It is recommended that the first line of all tcsh scripts look like:

```
#!/bin/tcsh
```

with **/bin/tcsh** being the location of tcsh on the z/OS system. The kernel recognizes the magic value (#!) and runs **/bin/tcsh**.

Using TSO/E commands in shell scripts

A shell script can include TSO/E commands as well as shell commands, and it can process TSO/E command output. You use the **tso** shell command to run the TSO/E command. For a discussion of the **tso** command, see “Using the tso command” on page 88.

Using variables

You can think of shell scripts as *programs* made up of shell commands. To allow more versatile shell scripts, the shell supports many of the features of normal programming languages.

In a conventional programming language, a *variable* is a name that has an associated value. When you want to use the value, you can use the name instead.

Creating a shell variable

The shell also lets you create variables. A shell variable name can consist of uppercase or lowercase letters, plus digits and the underscore character _. The name can have any length, but the first character cannot be a digit. Uppercase letters are distinguished from lowercase ones, so **NAME**, **name**, and **Name** are all *different* names.

To create a shell variable, just enter:

```
set name='string'
```

as a command to the shell. For example:

```
set home='/usr/adams'
```

sets up a variable with the name **home** and the value **/usr/adams**.

After you set a variable, you refer to it by prefixing its name with a dollar sign ($). Any command can use the value of a variable by referring to it this way. For example, if **home** is set to **/usr/adams**:

```
cd $home
```

is equivalent to:

```
cd /usr/adams
```

Similarly:

```
cp $home/* /newdir
```

is equivalent to:

```
cp /usr/adams/* /newdir
```

To change the value of an existing variable, you use a command with the same form as the existing variable. For example:

```
set home='/usr/benjk'
```

changes the value of **home** from **/usr/adams** to **/usr/benjk**.

If the value on the right-hand side of the **=** sign does not contain spaces, tab characters, or other special characters, you can leave out the single quotation marks. For example, you can enter:

```
home=/usr/benjk
```

Calculating with variables

Suppose you run the following commands either in a shell script or by typing in one command after another:

```
set i=1
set j=$i+1
echo $j
```

The output of **echo** is 1+1, because a normal variable assignment assigns a *string* to a variable. Thus `j` gets the string 1+1.

To *evaluate* an arithmetic expression, you can enter:

```
@ variable=expression
```

This command line assigns the value of an expression to the given variable. For example:

```
i=1
@ j=$i + 1
echo $j
```

Here `j` is assigned the value of the expression and the **echo** command displays the value 2.

You can also use @ to change the value of a variable. If you enter:

```
i=1
@ i=$i + 1
echo $i
```

the @ command *changes* the value of `i`. The new value of `i` is the old value plus 1.

An @ command can have any of the standard arithmetic expressions:

-A Negative `A`

A * B `A` times `B`

A / B `A` divided by `B`

A % B Remainder of `A` divided by `B`

A + B `A` plus `B`

A - B `A` minus `B`

The standard mathematical order of operations is used, as shown in the way that operations are grouped:

- All unary minus operations are carried out;
- Then any `*`, `/`, or `%` operations (from left to right in the order they appear);
- Then any additions or subtractions (from left to right in the order they appear).

Many operators use special shell characters, so you usually need to put double quotation marks around the expression. Thus:

```
@ i =  5 + 2 * 3
```

assigns 11 to `i`, because the multiplication is done first. You can use parentheses in the usual way to change the order of operations. For example:

```
@ i = ((5 + 2) * 3 )
```

assigns 21 to `i`.

Note: @ does not work with numbers that have fractional parts. It works only with integers.

Setting environment variables

Up to this point, we have talked about defining shell variables and then using them in later command lines. You can also define a shell variable and then call a shell script that makes use of that variable. But you have to do a certain amount of preparation first.

A shell script is run as a child process to the parent shell. By default, the child process does not share any variables with the parent. If you define a variable **var** in the parent shell, it is *local* to the current session; any shell script, or child process, that you call will not inherit **var**.

To deal with this situation, you can enter the following:

```
setenv var [value]
```

The **setenv** command says that you want the variable **var** passed on to all the child processes that you execute in this session. After you do this, **var** becomes inherited and the variable is known to all the commands and shell scripts that you use.

As an example, suppose you enter the commands:

```
setenv myname "Friar Tuck"
```

Now all your child processes can use the **myname** variable to obtain the associated name. You may, for example, have shell scripts that write form letters that contain your name, `Friar Tuck`, obtained from the **myname** variable.

Note: You could use single or double quotation marks to enclose the variable value. See "Quoting variable values" on page 54 for more information.

When a script or child process begins running, it automatically inherits all the environment variables passed on to it. However, if the script changes the value of one of those variables, that change is *not* passed back to the parent process —unless you run the script with the **source** utility.

By default, any variables created within a shell script are *local* to that script. This means that when another program is run, those variables do not apply in its environment. However, the script can use the **setenv** command to turn shell variables into global environment ones. Inside a shell script:

```
setenv name [value]
```

indicates that the variable with the given *name* should be defined as an environment variable. When other programs are run from that script, they inherit the value of all environment variables. However, when the script ends, all its environment variables are lost to the calling shell.

Some variables are automatically inherited by the software that creates them. For example, if you invoke the shell, the initialization procedure automatically marks the **HOME** variables for environment variables so that other commands and shell scripts can use it. In Chapter 5, "Customizing the tcsh shell," on page 53, you saw that in a typical **.tcshrc** file for an individual user, the **PATH** variable is an environmental variable. Making the **PATH** variable an environmental variable ensures that search rules and changes to search rules are automatically shared by all shell sessions and scripts.

Using positional parameters — the $N construct

The sample shell script discussed previously compiled and link-edited a program stored in a collection of source modules. This topic discusses a shell script that can compile and link-edit a C program stored in any file.

To create such a script, you need to be familiar with the idea of *positional parameters*. When the shell encounters a `$N` construct formed by a `$` followed by a single digit, it replaces the construct with a value taken from the command line that started the shell script.

- `$1` refers to the first string after the name of the script file on the command line
- `$2` refers to the second string, and so on.

As a simple example, consider a shell script named **echoit** consisting only of these commands:

```
#!/bin/tcsh #
echo $1
```

Suppose we run the command:

```
echoit hello
```

The shell reads the shell script from **echoit** and tries to run the command it contains. When the shell sees the $1 construct in the **echo** command, it goes back to the command line and obtains the first string following the name of the shell script on the command line. The shell replaces the $1 with this string, so the **echo** command becomes:

```
echo hello
```

The shell then runs this command.

A construct like $1 is called a *positional parameter*. Parameters in a shell script are replaced with strings from the command line when the script is run. The strings on the command line are called *positional parameter values* or *command-line arguments*.

If you enter:

```
echoit Hello there
```

the string `Hello` is considered parameter value $1 and the string `there` is $2. Of course, the shell script is only:

```
echo $1
```

so the **echo** command displays only the `Hello`.

Positional parameters that include a blank can be enclosed in quotes (single or double). For example:

```
echoit "Hello there"
```

echoes the two words instead of just one, because the two words are handled as one parameter.

Returning to a compile and link example, a programmer could write a more general shell script as:

```
c89 -c $1.c
c89 -o $1 $1.o
```

If this shell script were named **clink**, the command:

```
clink prog
```

would compile and link **prog.c**, producing an executable file named **prog** in the working directory. In the same way, the command:

```
clink dir/prog2
```

would compile and link **dir/prog2.c**. The shell script compiles and links a C program stored in a single file.

As another example of a shell script containing a positional parameter, suppose that the file **lookup** contains:

```
grep $1 address
```

where **address** is a file containing names, addresses, and other useful information. The command:

```
lookup Smith
```

displays address information on anyone in the file named Smith.

Using quotes to enclose a construct in a shell script

A $N construct in a shell script can be enclosed in double or single quotation marks.

- When double quotation marks are used, the parameter is replaced by the appropriate value from the command line. For example, suppose the file **search** contains:

  ```
  grep "$1" *
  ```

  If you enter the command:

  ```
  search 'two words'
  ```

  the parameter value 'two words' replaces the construct $1 in the **grep** command:

  ```
  grep "two words" *
  ```

  If the **grep** command does not contain the double quotation marks, the parameter replacement results in:

  ```
  grep two words *
  ```

  which has an entirely different meaning.
- When you use single quotation marks to enclose a $N construct in a shell script, the $N is *not* replaced by the corresponding parameter value. For example, if the file **search** contains:

  ```
  grep '$1' *
  ```

  grep searches for the string $1. The $1 is not replaced by a value from the command line. In general, single quotation marks are “stronger” than double quotation marks. Less is more!

Using parameter and variable expansion

A $ followed by a number stands for a positional parameter passed to the script or function. A positional parameter is represented with either a single digit (except 0) or two or more digits in braces; for example, 7 and {15} are both valid representations of positional parameters. For example, if the command:

```
echo $1
```

appeared in a shell script, it would **echo** the first positional parameter.

Similarly, a $ followed by the name of a shell variable (such as **$HOME**) stands for the value of the variable.

These constructs are called *parameter expansions*. In this sense, the term *parameter* can mean either a positional parameter or a shell variable.

The tcsh shell also supports more complicated forms of parameter expansions, letting you obtain only part of a parameter value or a modified form of the value.

Modifier	Description
r	Root of value
e	Extension of value
h	Head of value
t	Tail of value

For example, to extract only part of a file name, you can add one of these modifiers as follows:

File name	r	e	h	t
/usr/bin/vi.txt	/usr/bin/vi	txt	/usr/bin	vi.txt
/u/bobby/mail	/u/bobby/mail	empty	/u/bobby	mail
storybook.pdf	storybook	pdf	empty	storybook.pdf
INSTALL	INSTALL	empty	empty	INSTALL

Using special parameters in commands and shell scripts

The tcsh shell has a variety of special parameters that can be used in command lines and shell scripts. These parameters are listed in the Variable Substitution topic of the **tcsh** command description in *z/OS UNIX System Services Command Reference*.

Using control structures

The shell provides facilities similar to those found in programming languages. It offers these *control structures*, which are related to programming control structures:

- The **if** conditional
- The **while** loop
- The **for** loop

The if conditional

An **if** conditional runs a sequence of commands if a particular condition is met. It has the form:

```
if (expr) command
```

The end of the commands is indicated by **endif**. For example, you could have:

```
if ( -d $1 ) then
 ls $1
endif
```

This tests to see if the string associated with the first positional parameter, $1, is the name of a directory. If so, it runs an **ls** command to display the contents of the directory.

Any number of commands can come between the **then** and the **endif** that ends the control structure. For example, you might have written:

```
if ( -d $1 ) then
     echo "$1 is a directory"
     ls $1
 endif
```

This example also shows that the commands do not have to begin on the same line as **then**, and the condition being tested does not have to begin on the same line as **if**. The condition and the commands are indented to make them stand out more clearly. This is a good way to make your shell scripts easier to read.

Another form of the **if** conditional is:

```
if (expr) then
commands
else
commands
endif
```

If the condition is true, the commands after the **then** are run; otherwise, the commands after the **else** are run. For example, suppose you know that the string associated with the variable *pathname* is the name of either a directory or a file. Then you could write:

```
if (  -d $pathname ) then
     echo "$pathname is a directory"
     ls $pathname
 else
     echo "$pathname is a file"
     cat  $pathname
 endif
```

If the value of *pathname* is the name of a file, this shell script uses **echo** to display an appropriate message, and then uses **cat** to display the contents of the file.

The final form of the **if** control structure is:

```
if (expr1) then
commands1
else if (expr2) then
commands2
else if (expr3) then
commands3
else
commands
endif
```

In this example, if *expr1* is true, *commands1* are run; otherwise, the shell goes on to check *expr2*. If that is true, *commands2* are run; otherwise, the shell goes on to check *expr3* and so on. If none of the test conditions are true, the *commands* after the **else** are run. Here is an example of how this can be used:

```
if ( !  $?argv ) then
     echo "no positional parameters"
 else if ( -d $1 ) then
     echo "$1 is a directory"
     ls $1
 else if ( -f $1 ) then
     echo "$1 is a file"
```

```
    cat  $1
else
    echo "$1 is just a string"
endif
```

The test after the **if** determines if the value of the first positional parameter, $1, is an empty string. If so, there are no positional parameters, and the shell script uses **echo** to display an appropriate message; otherwise, the script checks to see if the parameter is a directory name; if so, the contents of the directory are listed with **ls** (after an appropriate message). If that does not work, the script checks to see if the parameter is a file name; if so, the contents of the file are listed with **cat** (after an appropriate message). Finally, if none of the previous tests work, the parameter is assumed to be an arbitrary string, and the script displays a message to this effect.

You could put that script into a file named **listit** and run commands of the form:

```
listit name
```

to list the contents of *name* in a useful form.

The while loop

The **while** loop repeats one or more commands while a particular condition is true. The loop has the form:

```
while (expr)
commands
end
```

The shell first tests to see if *condition* (expr) is true. If it is, the shell runs the *commands*. The shell then goes back to check the *condition*. If it is still true, the shell runs the *commands* again, and so on, until the *condition* is found to be false.

As an example of how this can be used, suppose you want to run a program named **prog** 100 times to get an idea of the program's average running speed. The following shell script does the job:

```
@ i=100
date
while ( $i > 0)
    prog
    @ i--
end
date
```

The script begins by setting a variable *i* to 100. It then uses the **date** command to get the current date and time.

Next the script runs a **while** loop. The condition says that the loop should keep on going as long as the value of *i* is greater than zero. The commands of the loop run **prog** and then subtract 1 from the *i* variable, similar to C programming language syntax. In this way, *i* goes down by 1 each time through the loop, until it is no longer greater than 0. At this point, the loop stops and the final instruction of the script prints out the date and time at the end of the loop. The difference between the starting time and the ending time should give some idea of how long it took to run the program 100 times.

(Of course, the shell itself takes some time to perform the condition and to do the calculations with *i*. If **prog** takes a long time to run, the time spent by the shell is relatively unimportant; if **prog** is a quick program, the extra time that the shell takes may be large enough to make the timing incorrect.)

The foreach loop

The final control structure to be examined is the **foreach** loop. It has the form:

```
foreach name (wordlist)
commands
end
```

The parameter *name* must be a variable name; if this variable does not exist, it is created. The parameter *list* is a list of strings separated by spaces. The shell begins by assigning the first string in *list* to the variable *name*. It then runs the *commands* once. Then the shell assigns the next string in *list* to *name*, and repeats the *commands*. The shell runs the *commands* once for each string in *list*.

As a simple example of a shell script that uses **foreach**, consider:

```
foreach file ( *.c )
  c89 $file
end
```

When the shell looks at the **foreach** line, it expands the expression `*.c` to produce a *list* containing the names of all files (in the working directory) that have the suffix **.c**. The variable *file* is assigned each of the names in this list, in turn. The result of the **foreach** loop is to use the **c89** command to compile all **.c** files in the working directory. You could also write:

```
foreach file ( *.c )
  echo $file
  c89 $file
end
```

so that the shell script displayed each file name before compiling it. This would let you keep track of what the script was doing.

As you can see, the **foreach** loop is a powerful control structure. The *list* can also be created with command substitution, as in:

```
foreach file ( `find . -name "*.c" -print` )
     echo $file
     c89 $file
end
```

Here the **find** command finds all **.c** files in the working directory, and then compiles these files. This is similar to the previous shell script, but it also looks at subdirectories of the working directory.

Combining control structures

You can combine control structures by nesting (that is, putting one inside another). For example:

```
foreach file ( `find . -name "*.c" -print` )
        if ( -M $file > -M $1 ) then
                echo $file
                c89 -c $file
        endif
end
```

This shell script takes one positional parameter, giving the name of a file. The script looks in the working directory and finds the names of all **.c** files. The **if** control structure inside the **foreach** loop tests each file to see if it is older than the file named on the command line. If the **.c** file is older, **echo** displays the name, and the file is compiled. You can think of this as making a set of files up to date with

the file name specified on the command line.

End of Programming interface information

Chapter 10. Using job control in the shells

When you enter a shell command, you start a process, the execution of a function. When you enter that command, the shell runs it in its own process group. As such, it is considered a separate *job* and the shell assigns it a job identifier, which is a small number known only to the shell. (A shell job identifier identifies a shell job, not an MVS job.) When the process completes, the system displays the shell prompt.

The system also assigns a process group identifier (PGID) and a process identifier (PID). When only one command is entered, the PGID is the same as the PID. The PGID can be thought of as a systemwide identifier. If you enter more than one command at a time using a pipe, several processes, each with its own PID, are started. However, these processes all have the same PGID and shell job identifier. The PGID is the same as the PID of the first process in the pipe.

To sum it up, there are several types of process identifiers associated with a process:

PID A process ID (PID) is a unique identifier assigned to a process while it runs. When the process ends, its PID is returned to the system. Each time you run a process, it has a different PID (it takes a long time for a PID to be reused by the system). You can use the PID to track the status of a process with the **ps** command or the **jobs** command, or to end a process with the **kill** command.

PGID Each process in a process group shares a process group ID (PGID), which is the same as the PID of the first process in the process group. This ID is used for signaling related processes.

If a command starts just one process, its PID and PGID are the same.

PPID A process that creates a new process is called a *parent process*; the new process is called a *child process*. The parent process ID (PPID) becomes associated with the new child process when it is created. The PPID is not used for job control.

Several job control commands can either take as input or return the job identifier, process identifier, or process group identifier: **bg**, **fg**, **jobs**, **kill**, and **wait**.

The **nice** and **renice** commands can be used to change the priority of processes. Their use is dependent on the way performance groups have been prioritized at your installation; check with your system administrator for information about using **nice** and **renice** to change job priority.

Running several jobs at once (foreground and background)

The shell can run more than one job at a time. While one is running in the foreground, one or more can be running in the background.

After you enter a command, you see the output from the command displayed on your screen. You cannot enter any other commands until the shell prompt ($ or >) appears. This command has run as a *foreground job*. Commands that take a few seconds to complete are convenient to run in the foreground.

You may prefer to run as *background jobs* those shell commands that take longer to run, because they prevent you from running any other commands while they are running in the foreground. The shell does *not* wait for the completion of a background command before returning a prompt to you. Instead, while the command runs in the background, you can continue entering other commands on the command line.

In TSO/E, a *background job* is one that is typically entered at a workstation by a SUBMIT command. Like a TSO/E background job or a batch job, a z/OS UNIX *background job* runs without user interaction.

You can use any of these methods to run a shell background job:

- Start the job in the background when you first enter it.
- Move a job from the foreground to the background.
- Use JCL with BPXBATCH. This utility is discussed in "The BPXBATCH utility" on page 156.

Starting a job in the background with an ampersand (&)

To start a command as a background job, end the command line with an ampersand (&). For example:

```
sort myfile >myout &
```

When the background job starts to run, the system:

1. Assigns it a job identifier, a process group ID (PGID), and a process ID (PID).
2. Displays the job identifier (in brackets) and one or more PIDs (more than one if there is a pipe).
3. Issues the shell prompt so that you can enter another command.

The first (or only) PID is also the PGID. This is an example of the output when you enter a background command:

```
$sort myfile >myout &
[3] 717046
$
```

3 is the job identifier and 717046 is the PID and PGID.

Tip: Note the PID numbers and the job number when you create a background job; you can use them to check the status of the job or to end it.

Unlike a batch job, a shell job running in the background directs its output to standard output, your workstation screen. If you do not want to have this output interfering with your work in the foreground, remember to redirect the output to a file when you start a background command. After the output is redirected, you can look at it whenever it is convenient.

A background job can be suspended. A background job that attempts to read from **stdin** is suspended until it is made the foreground process. Therefore, if a program reads from **stdin**, you may want to redirect **stdin** from a file. Also, if the `tostop` setting of the terminal is enabled (you can set or query this by using the **stty** command), output from a background job causes the job to be suspended.

Moving a job to the background

Suppose you want to move the foreground job to the background, where it can run while you enter other commands in the foreground. To put the job in the background:

1. Stop the job by entering <EscChar-Z>. A message displays the job identifier.
2. Enter the **bg** command. You may need to specify the job identifier with **bg** if there is more than one stopped job. If you do not specify a job identifier, **bg** uses the most recently stopped job.

A message displays the job identifier and the command that is running in the background.

Moving a job to the foreground

When you want to move a job from the background to the foreground, use the **fg** command. If there are multiple background jobs, you need to supply the job identifier preceded by a % sign. For example:

```
fg %7
```

Setting up job tracing

The **bpxtrace** command provides details on job activity. It enables you to start a job with tracing activated, or enables you to dynamically activate tracing for a job that is already running. For example, to activate job tracing for the **echo** command, enter:

```
bpxtrace -c -f format "echo hello"
```

This command produces tracing output (to stdout) and formats the output in one line per trace record format. For more information about the **bpxtrace** command, see *z/OS UNIX System Services Command Reference*.

Checking the status of jobs

You can use the **jobs** command or the **ps** command to check on the status of jobs.

Using the jobs command

The **jobs** command reports the status of background processes that are currently running, based on the job identifier; it also reports on the status of stopped processes and completed processes. If you use the **-l** option, you can display both the job identifier and the PID for the process.

Say you entered a command that involves more than one process, for example:

```
myprog | grep write
```

If you want to check the status of that command, use the **jobs -l** command. The status message displays the job identifier, the PID number for each process in the job, the status of the command, and the command that is being run. In this case the status message shown in the z/OS shell is:

```
[1] 720902 + Stopped (SIGTSTP)  myprog|grep write
  720902        alive           -sh
  458759        alive           -sh
```

In this case:

- The job identifier is 1 (from [1]).

- The PIDs of the processes are 720902 and 458759.
- The PGID is 720902 (the PID of the first process in the process group).

The status message for the tcsh shell is similar to that in the previous example.

Using the ps command

You can use the **ps** command to display a list of your processes that are currently running and obtain additional information about those processes. (Only a superuser or a user with appropriate permissions can obtain information about all processes.)

For example, here the **ps** command displays the status of started processes:

```
    PID TTY       TIME COMMAND
 262148 ttyp0000  2:46 /bin/sh
 196614 ttyp0000  0:22 ./myprog
  65543 ttyp0000  0:13 /bin/grep
 196616 ttyp0000  2:07 /bin/ps
```

PID This is a PID displayed as a decimal value.

TTY The name of the controlling terminal, if any. The *controlling terminal* is the workstation that started the process. On a system with more than one workstation, the names of the workstations that have started processes are listed here.

TIME The amount of central processor time the process has used since it began running.

COMMAND
The name of the command or program that started the process. The display indicates which directory the command or program is found in. For example, the **ps** command is in **/bin**.

Usually, just issuing **ps** will tell you all you need to know about your current processes. However, there are a number of options you can use to tailor the displayed information. For example, you can use the **–a** option to display only processes associated with a terminal, not the system processes. Read the **ps** command description in *z/OS UNIX System Services Command Reference*.

Canceling a job

Often you will start a job and then decide to interrupt it before it completes. You can do this regardless of whether the job is running in the foreground or background.

Canceling a foreground job

To cancel a foreground job, enter <EscChar-C>. The command stops and the shell displays the shell prompt.

Canceling a background job

To cancel a background job, use the **kill** command. To be able to kill a process, you must own it. (The superuser, however, can kill any process except **init**.)

Before you can cancel a background job, you need to know either a PID, job identifier, or PGID. You can use the **jobs** command to determine any of these.

The format of the **kill** command in the z/OS shell is:

```
kill [-s signal name] [pid] [job-identifier]
```

The format of the **kill** command in the tcsh shell is:

```
kill [-signal name] [pid] [job-identifier]
```

To kill one process, use its PID.

Example: To kill a process with the PID 717, issue:

```
kill 717
```

Any other processes in the job—from a pipe—would not be killed.

To kill a particular process group, you can use a job identifier or a negative PGID.

- You can use the job identifier for one process in the group preceded with a % to kill every process in the group. In the z/OS shell, use:

  ```
  kill -s KILL %7
  ```

  In the tcsh shell, use:

  ```
  kill -KILL %7
  ```

- You can use a negative PGID to kill every process in a process group. (The PGID is the PID for the first process in the process group.) For example, in the z/OS shell:

  ```
  kill -s KILL -- -123456
  ```

  will kill every process in the process group with PGID 123456.

  In the tcsh shell:

  ```
  kill -KILL -123456
  ```

  will kill every process in the process group with PGID 123456.

Stopping and resuming a job

Occasionally, you may want to stop a job that is running in the foreground or background, perform a different task, and then later resume the stopped job.

Stopping a foreground job

To stop a foreground job, enter <EscChar-Z>. A message displays the job identifier, the status `Stopped`, and the command that is stopped.

Stopping a background job

To stop a background job, use the **kill** command with the STOP signal and the job identifier preceded with a `%`.

Examples::

1. In the z/OS shell, to stop a background job with the job identifier 3, issue:

   ```
   kill -s -STOP %3
   ```

2. In the tcsh shell, to stop a background job with the job identifier 3, issue:

   ```
   kill -STOP %3
   ```

Resuming a stopped job

When you are ready to resume a stopped job, you can resume it in the foreground using the job identifier. Enter:

```
fg %n
```

where *n* is the job identifier for the stopped job.

To resume a stopped job in the background, enter:

```
bg %n
```

where *n* is the job identifier for the stopped job. The `%n` is unnecessary if there is only one job.

Delaying a command

If you want to delay a command from running until a previous background job has completed, you can use the **wait** command. You need to know the job identifier of the job you want to wait for; you can use the **jobs** command to get that.

Example: To have `Time for tea` display on your screen when the command whose job identifier is 7 finishes running, issue:

```
wait %7; print "Time for tea"
```

Exiting the shell with background jobs running

When you exit the shell, any stopped background jobs are terminated. But if you have a background job in the running state, you can exit the shell without terminating it.

In the z/OS shell, the default setting **set -m** runs background jobs in a separate process group. Jobs in a separate process group are not sent a **SIGHUP** signal when you exit the shell. With the default **-m** setting, background jobs continue to run after you exit the shell.

In the tcsh shell, use **NOHUP** to exit the shell with background jobs running.

For the **OMVS interface:**

To exit with a background job running, use the **quit** subcommand. (Type **quit** and press the Subcommand function key or switch to subcommand mode and enter the **quit** command.) A background job that is running will continue running.

If you are using the OMVS interface and you use the **exit** command to exit the shell while you have a shell background job running, OMVS may send this message:

```
The shell process ended, but the session did not end automatically.
You may need to run the QUIT subcommand to end the session.
```

For the **Asynchronous terminal interface:**

To exit when a background job is running, type <Ctrl-D> or use the **exit** command. A background job that is running will continue running. You do not get any indication that a background job is running.

Changing the default in the z/OS shell

If you change the setting to **+m**, background jobs end when you exit the shell. If you have changed the setting to **+m** and you want to start a long-running command and have it continue running after you exit the shell, use the **nohup** command and an ampersand (**&**):

```
nohup 'command-line' &
```

For example:

```
nohup sort -u file1 >output 2>>outerr &
```

Ending the **nohup** command with an **&** makes the command run in the background, even after you exit the shell.

Comparison of shell background jobs and MVS batch jobs

Table 5 compares two methods for submitting a background job:

- Typing an **&** (ampersand) after the shell command
- Using JCL with BPXBATCH. This utility is discussed in "The BPXBATCH utility" on page 156.

Table 5. Comparison of running a background job from the shell and from MVS

Topic	Shell (command &)	JCL with BPXBATCH
Starting the job	Background jobs start running immediately.	Background jobs are put in a queue; there may be a wait until the job starts running.
Interactive access	You can see output from the job displayed on the terminal. You can move the job to the foreground if you need to give it input, and then move it to the background again.	Background jobs run separately; you cannot interact with them. However, if you redirect output to a file in the file system, from your interactive shell session you could periodically browse the output file to see what is in it. You could do this with any of these commands: **cat**, **pg**, **more**, **obrowse**, or the TSO/E OBROWSE command.
System limits	Due to system limits on the number of processes per user, multiple background jobs run by the same user could fail at some point.	Due to system limits on the number of processes per user, multiple background jobs run by the same user could fail at some point.
Managing the job	You can use **ps**, **kill**, **bg**, **fg** and **jobs** on the background job.	You can use **ps** and **kill** on the background job.
Impact on system	Creates an immediate demand on the system to support another address space. This could degrade performance for all users.	The system determines when it is a reasonable time to run batch jobs. Batch work can be suspended during periods of heavy interactive workload.

Chapter 11. Using z/OS UNIX from batch, TSO/E, and ISPF

Note: This information is directed towards users of the z/OS shell. Most examples pertain to the z/OS shell and not the tcsh shell.

You can access z/OS UNIX services from batch, TSO/E, or ISPF, using:

- MVS job control language (JCL) to run shell scripts or z/OS UNIX application programs as batch (background) jobs. This information describes the JCL that supports the z/OS UNIX file system. For more general information about JCL, see *z/OS MVS JCL User's Guide*. and *z/OS MVS JCL Reference*.
- Executable files in batch. An *executable file* is any file that can be run as a program. An executable file can be a load module (which is a member of a PDS), a program object (which is either a member of a PDSE or a file in the z/OS UNIX file system), or an interpreted file (such as a REXX EXEC). For a file to be treated as an executable file, it must have execute permission allowed for the invoker.
- BPXBATCH, a utility that can do the following:
  - Run executable files in batch.
  - Run shell commands and executable files from the TSO/E `READY` prompt.
- TSO/E commands designed to work with MVS data sets. See the section on using commands to work with directories and files and also the section on copying data between the z/OS UNIX file system and MVS data sets for more information. For the complete command descriptions, see the section on TSO/E commands in *z/OS UNIX System Services Command Reference*.
- REXX programs written using z/OS UNIX extensions called *syscall commands*.
- The ISPF shell.

JCL support for z/OS UNIX

JCL data definition (DD) statements use a *data definition name (ddname)* to specify the data to be used by the program that you are submitting as a batch job. The ddname is used in two places:

1. In your application program. Here the ddname refers to nonspecific data, rather than a specific data set name or path name.
2. In the JCL used to submit the application program as a background job. Here it binds the nonspecific reference in the program to a specific data set name or path name.

You can specify a z/OS UNIX file in the JCL for user-written applications or for IBM-supplied services, such as:

- DFSMS, Program Management Binder, a prelinker, or a linkage editor
- BPXBATCH
- The TSO/E OCOPY command

Note: In this discussion, references to JCL also apply to the equivalent dynamic allocation functions.

The PATH keyword

You can use the PATH keyword on a JCL DD statement to specify the path name for a z/OS UNIX file. When you use the PATH keyword, you can also use these keywords:

- **PATHOPTS** to indicate the access for the file (for example, read or read-write) and to set the status for the file (for example, append, create, or truncate). This is analogous to the option arguments on the C **open()** function.

  Note: If you specify either OCREAT or OCREAT together with OEXCL on the PATHOPTS parameter and the file does not exist, z/OS UNIX performs an **open()** function. The options from PATHOPTS, the path name from the PATH parameter, and the options on PATHMODE (if specified) are specified in the **open()**. z/OS UNIX uses the **close()** function to close the file before the application program receives control.
- **PATHMODE** to indicate the permissions, or file access attributes, to be set when a file is being created. This is analogous to the mode arguments of the **open()** function.
- **PATHDISP** to indicate how MVS should handle the file when the job step ends normally or abnormally. This performs the same function as the DISP parameter for a data set.

If PATHOPTS and PATHMODE are absent from the DD statement, an application needs to supply defaults for the options and mode, or issue an error message and fail.

The DSNTYPE keyword

There are two related subparameters on the DSNTYPE keyword of the DD statement:

- HFS (hierarchical file system)
- PIPE (named pipe)

For more information about the JCL keywords, see *z/OS MVS JCL Reference*.

Using the ddname in an application

Instead of using data set names or path names in an application, you can use a ddname; then in the JCL, you associate a specific data set or file with that ddname.

Note: The parent process's allocations, for both data sets and files, are not propagated by **fork()** and are lost on **exec()**, except for STEPLIB.

You have a choice of two methods for accessing data sets and files in an application:

- The ANSI C function **fopen()**
- The OPEN macro

The fopen() function

The **fopen()** function recognizes and handles the difference between a ddname associated with a data set (DSN keyword) or with a path name (PATH keyword).

Example: Issue:

```
fopen("dd:FRED", "r+")
```

Result: The **fopen()** function takes the ddname FRED, determines if FRED refers to a ddname for a file or a data set, and opens it. Once a file is opened, **fread()** and **fwrite()** can access the data

The OPEN macro

The OPEN macro can open a z/OS UNIX file specified with the PATH keyword or an MVS data set specified with the DSN keyword. The macro supports DD statements that specify the PATH parameter only for data control blocks that specify DSORG=PS (EXCP is not allowed). DFSMSdfp supports BSAM and QSAM interfaces to these types of files:

- Regular files
- Character special files (null files only)
- FIFO special files
- Symbolic links

You cannot open directories or external links.

For more information about BSAM and QSAM interface support for access to z/OS UNIX files, see *z/OS DFSMS Macro Instructions for Data Sets*.

Specifying a ddname in the JCL

In the JCL for a job, you use a DD statement to associate a ddname with the name of a specific MVS data set or z/OS UNIX file.

To specify a file, use the PATH keyword.

Example: To associate the path name for the file **/u/fred/list/wilma** with the ddname FRED, specify:

```
//FRED     DD  PATH='/u/fred/list/wilma'
```

At another time, you might specify a different file to be associated with the ddname FRED.

To specify a data set, use the DSN keyword.

Example: To associate the data set FRED.LIST.WILMA with the ddname FRED, specify:

```
//FRED     DD  DSN=FRED.LIST.WILMA,DISP=SHR
```

At another time, you might specify a different data set to be associated with the ddname FRED.

Using the submit command

The **submit** command submits JCL from the shell. By using this command you do not need to open a TSO session to submit JCL. This command accepts the following as input:

- One or more pathnames
- One or more sequential data set or partitioned data set member names
- Standard input.

For example, to submit a job that resides in the z/OS UNIX file `buildjcl.jcl`, enter the following:

```
submit buildjcl.jcl
```

For more information about the **submit** command, see *z/OS UNIX System Services Command Reference*.

The BPXBATCH utility

BPXBATCH is a utility that you can use to run shell commands or executable files through the batch facility. You can invoke BPXBATCH from a batch job or from the TSO/E environment (as a command, through a CALL command, or from a CLIST or REXX EXEC).

Note: This document provides some examples of how you can use BPXBATCH. For more detailed information about BPXBATCH, see the description of the BPXBATCH utility and the detailed discussion on using BPXBATCH to run executable files under MVS environments in *z/OS UNIX System Services Command Reference*.

BPXBATCH has logic in it to detect when it is running from a batch job. By default, BPXBATCH sets up the stdin, stdout, and stderr standard streams (files) and then calls the exec callable service to run the requested program. The exec service ends the current job step and creates a new job step to run the target program. Therefore, the target program does not run in the same job step as the BPXBATCH program; it runs in the new job step created by the exec service. In order for BPXBATCH to use the exec service to run the target program, all of the following must be true:

- BPXBATCH is the only program running on the job step task level.
- The _BPX_BATCH_SPAWN=YES environment variable is not specified.
- The STDOUT and STDERR ddnames are not allocated as MVS data sets.

If any of the these conditions is not true, then the target program runs either in the same job step as the BPXBATCH program or in a WLM initiator in the OMVS subsys category. The determination of where to run the target program depends on the environment variable settings specified in the STDENV file and on the attributes of the target program.

Restriction: File and data set allocation considerations vary when a BPXBATCH or BPXBATSL request is processed in the same address space via local spawn or forked to another address space. Allocations for any files and data sets other than **stdin**, **stdout**, **stderr**, or **stdenv** and STEPLIB are not available to a program when BPXBATCH uses fork() or exec (STEPLIB EXCLUDED) to run a program in another address space. Data sets that are allocated in JCL, TSO, or an application may conflict with data sets used by BPXBATCH.

Aliases for BPXBATCH

BPXBATSL, BPXBATA2, and BPXBATA8 are provided as aliases for BPXBATCH that use a local spawn to run in the same address space.

BPXBATSL

BPXBATSL performs a local spawn, but does not require resetting of environment variables. BPXBATSL behaves exactly like BPXBATCH and allows local spawning whether the current environment is set up or not. For more information, see the BPXBATCH command in *z/OS UNIX System Services Command Reference*.

BPXBATA2 and BPXBATA8

BPXBATA2 and BPXBATA8 are provided as APF-authorized alternatives to BPXBATSL. BPXBATA2 and BPXBATA8 provide the capability for a target APF-authorized z/OS UNIX program to run in the same address space as the originating job, allowing it to share the same resources, such as allocations and the

job log. See the BPXBATCH utility in *z/OS UNIX System Services Command Reference* for details and restrictions on using these interfaces.

Defining standard input, output, and error streams for BPXBATCH

z/OS XL C/C++ programs require that the standard streams, stdin, **stdout**, and stderr, be defined as either a file or a terminal. Many C functions use stdin, stdout, and stderr. For example:

- **getchar()** obtains a character from stdin.
- **printf()** writes output to stdout.
- **perror()** writes output to stderr.

(For more information about stdin, stdout, and stderr, see "Understanding standard input, standard output, and standard error" on page 68.)

Guidelines for defining stdin, stdout, and stderr

For BPXBATCH, the default for stdin and stdout is **/dev/null**.

The default for stderr is the same as what is defined for stdout. For instance, if you define stdout to be **/tmp/output1** and you do not define stderr, then both **printf()** and **perror()** direct their output to **/tmp/output1**.

Rule: If you define stdin, it must be a z/OS UNIX file.

If you define stdout or stderr, it can be a z/OS UNIX file or an MVS data set.

If you use an MVS data set for stdout or stderr:

- It can be a sequential data set, a partitioned data set (PDS) member, a partitioned data set extended (PDSE) member, or SYSOUT.
- It must have a nonzero logical record length (LRECL) and a defined record format (RECFM). Otherwise, BPXBATCH will redirect the DD to**/dev/null** and issue message BPXM081I, indicating the redirection of the effected ddname.

Ways to define stdin, stdout, and stderr

You can define stdin, stdout, and stderr in the following ways:

- With the The TSO/E ALLOCATE command, using the ddnames STDIN, STDOUT, and STDERR. For example, the following command allocates the z/OS UNIX file /u/turbo/myinput to the STDIN ddname:

  ```
  ALLOCATE DDNAME(STDIN) PATH('/u/turbo/myinput') PATHOPTS(ORDONLY)
  ```

- The following command allocates the MVS sequential data set TURBO.MYOUTPUT to the STDOUT ddname:

  ```
  ALLOCATE DDNAME(STDOUT) DSNAME('TURBO.MYOUTPUT') VOLUME(volser) DSORG(PS)
     SPACE(10) TRACKS RECFM(F,B) LRECL(512) NEW KEEP
  ```

- A JCL DD statement, using the ddnames STDIN, STDOUT, and STDERR

  The following JCL allocates the z/OS UNIX file /u/turbo/myinput to the STDIN ddname:

  ```
  //STDIN    DD PATH='/u/turbo/myinput',PATHOPTS=(ORDONLY)
  ```

  The following JCL allocates member M1 of a new PDSE TURBO.MYOUTPUT.LIBRARY to the STDOUT ddname and directs STDERR output to SYSOUT:

```
//STDOUT   DD DSNAME=TURBO.MYOUTPUT.LIBRARY(M1),DISP=(NEW,KEEP),DSNTYPE=LIBRARY,
//    SPACE=(TRK,(5,1,1)),UNIT=3390,VOL=SER=volser,RECFM=FB,LRECL=80
//STDERR   DD SYSOUT=*
```

- Redirection, using <, >, and >>

  Even if stdout currently defaults to **/dev/null**, entering the following command from the TSO/E command prompt redirects the output of the **ps -el** command to be appended to the file **/tmp/ps.out**:

  ```
  BPXBATCH SH ps -el >>/tmp/ps.out
  ```

For more information about defining the standard streams for BPXBATCH, see the detailed discussion on using BPXBATCH in the appendix of *z/OS UNIX System Services Command Reference*.

Passing environment variables to BPXBATCH

When you are using BPXBATCH to run a program, you typically pass the program a file that sets the environment variables. If you do not pass an environment variable file when running a program with BPXBATCH, or if the **HOME** and **LOGNAME** variables are not set in the environment variable file, those two variables are set from your logon RACF profile. **LOGNAME** is set to the user name, and **HOME** is set to the initial working directory from the RACF profile.

Note: When using BPXBATCH with the SH option (SH is the default), environment variables specified in the STDENV DD are overridden by those specified in **/etc/profile** and **.profile** (which overrides **/etc/profile**). This is because SH causes BPXBATCH to execute a login shell that runs the **/etc/profile** script and runs the user's **.profile**.

To pass environment variables to BPXBATCH, you define a file containing the variable definitions and allocate it to the STDENV ddname. The file can be one of the following:

- A z/OS UNIX file identified with the ddname STDENV
- An MVS data set identified with the ddname STDENV

Guidelines for defining STDENV

The default for STDENV is **/dev/null**.

The following guidelines apply when you specify a z/OS UNIX file for STDENV:

- It must be a text file defined with read-only access.
- Specify one variable per line, in the format `variable=value`. Environment variable names must begin in column 1.
- The file cannot have sequence numbers in it.

  Tip: If you use the ISPF editor to create the file, set the sequence numbers off by typing `NUMBER OFF` on the command line before you begin typing the data. If sequence numbers already exist, type `UNNUM` to remove them and then type `NUMBER OFF`.

The following guidelines apply when you specify an MVS data set for STDENV:

- It must be a sequential data set, a PDS member, a PDSE member, or an JCL in-stream data set.
- The record format can be fixed or variable (unspanned).
- Specify one environment variable per record, in the format `variable=value`. Environment variable names must begin in column 1. Do not use terminating nulls.

- The data set cannot have sequence numbers in it.

  Tip: If you use the ISPF editor to create the file, set the sequence numbers off by typing `NUMBER OFF` on the command line before you begin typing the data. If sequence numbers already exist, type `UNNUM` to remove them and then type `NUMBER OFF`.
- Trailing blanks are truncated for in-stream data sets, but not for other data sets.

Ways to define STDENV

You can define the STDENV environment variable file in the following ways:

- The TSO/E ALLOCATE command

  Example: The environment variable definitions reside in the MVS sequential data set TURBO.ENV.FILE.

  ```
  ALLOCATE DDN(STDENV) DSN('TURBO.ENV.FILE') SHR
  ```

- A JCL DD statement. To identify a z/OS UNIX file, use the PATH operand and specify PATHOPTS=ORDONLY.

  Example: The environment variable definitions reside in the z/OS UNIX file u/turbo/env.file.

  ```
  //STDENV DD PATH='u/turbo/env.file',PATHOPTS=ORDONLY
  ```

- An JCL in-stream data set

  Example: The environment variable definitions immediately follow the STDENV DD statement.

  ```
  //STDENV   DD *
  variable1=aaaaaaa
  variable2=bbbbbbbb
  ⋮
  variable5=ffffffff
  /*
  ```

  Trailing blanks are truncated for in-stream data sets, but not for other data sets.
- SVC 99 dynamic allocation, if you are running BPXBATCH from a program

For more information about defining STDENV, see the detailed discussion about using BPXBATCH in*z/OS UNIX System Services Command Reference*.

Example: Setting up code page support in a STDENV file

To enable national language support for BPXBATCH, set the locale environment variables to your desired locale in the STDENV file. For example, to use the Danish locale, you could put these lines in the file:

```
LANG=Da_DK.IBM-277
LC_ALL=Da_DK.IBM-277
```

After you allocate this file to STDENV, you can test it by typing:

```
OSHELL echo $HOME
```

The path name of your home directory should be displayed, instead of just **$HOME**.

_BPX_BATCH_SPAWN and _BPX_BATCH_UMASK environment variables

BPXBATCH uses two environment variables for execution that are specified by STDENV:

- **_BPX_BATCH_UMASK=0755**
- **_BPX_BATCH_SPAWN=YES|NO**

_BPX_BATCH_UMASK allows the user the flexibility of modifying the permission bits on newly created files instead of using the default mask (when PGM is specified).

Valid characters for the mask value are the octal digits 0 to 7, inclusive. If an invalid character is found, that character and all subsequent characters to the right are ignored. For example, `0348` is interpreted as `0034` and `0586` is interpreted as `0005`.

Note: This variable will be overridden by **umask** (usually set from within **/etc/profile**) if BPXBATCH is invoked with the SH option (SH is the default). SH causes BPXBATCH to execute a login shell which runs the **/etc/profile** script (and runs the user's **.profile**) and which may set the umask before execution of the intended program.

_BPX_BATCH_SPAWN causes BPXBATCH to use spawn instead of fork/exec and allows data definitions to be carried over into the spawned process. When **_BPX_BATCH_SPAWN** is set to YES, spawn will be used. If it is set to NO, which is equivalent to the default behavior, fork/exec will be used to execute the program.

If **_BPX_BATCH_SPAWN** is set to YES, you must consider two other environment variables that affect spawn (BPX1SPN):

- **_BPX_SHAREAS=YES|NO|REUSE**

  When _BPX_SHAREAS is YES or REUSE, the child process created by spawn will run in the same address space as the parent's under these conditions:
  - The child process is not setuid or setgid to a value different from the parent
  - The spawned file name is not an external link or a sticky bit file
  - The parent has enough resources to allow the child process to reside in the same address space
  - The NOSHAREAS extended attribute is not set

  When _BPX_SHAREAS is NO, the child and parent run in separate address spaces.
- **_BPX_SPAWN_SCRIPT=YES**

  When _BPX_SPAWN_SCRIPT is YES, the spawn will treat the specified file as a shell script and will invoke the shell to run the shell script.

Setting **_BPX_SPAWN_SCRIPT=YES** improves shell script performance. See "Improving the performance of shell scripts" on page 45 for more information. For more information about spawn, see spawn (BPX1SPN, BPX4SPN) — Spawn a process in *z/OS UNIX System Services Programming: Assembler Callable Services Reference*.

Passing parameter data to BPXBATCH

Normally, you pass parameters to BPXBATCH using the parameter string—either in a batch job by using the `PARM=` parameter on the JCL EXEC statement (see "Invoking BPXBATCH in a batch job" on page 162) or in TSO by typing them on the command line (see "Invoking BPXBATCH from the TSO/E environment" on page 166). The format of the BPXBATCH parameter string is:

`SH|PGM` *`shell_command|shell_script|program_name`* `[`*`arg1...argN`*`]`

In a batch job, BPXBATCH only allows up to 100 bytes for the parameter string due to JCL limitations. In a TSO command environment, the maximum length of a parameter string is 32,754 bytes. However, BPXBATCH supports the use of a parameter file to pass much longer parameter data—up to 65,536 (64K) bytes.

To pass parameters to BPXBATCH using a parameter file, you define a file containing the parameter data and allocate it to the ddname STDPARM. The parameter file can be one of the following:
- A z/OS UNIX text file
- An MVS data set

The default is to use the parameter string specified on the TSO command line or in the `PARM=` parameter of the JCL EXEC statement. If the STDPARM ddname is defined, BPXBATCH uses the data found in the specified file rather than what is found in the parameter string or in the STDIN ddname.

Guidelines for defining STDPARM

The contents of the STDPARM file must follow the same format as the BPXBATCH parameter string.

The following guidelines apply when you specify a z/OS UNIX or an MVS data set for STDPARM:

- A z/OS UNIX file must be a text file that the user has read access to. An MVS data set must be a sequential data set, a PDS member, a PDSE member, or a JCL in-stream data set.
- The record format can be fixed or variable (unspanned).
- For in-stream data sets: with the `SH` option, trailing blanks are not truncated. Records in in-stream data sets are concatenated with blanks as separator characters, and the string remaining after the SH token is passed as a single argument to a `/bin/sh -c` command. For the `PGM` option, the string is divided not only at line boundaries but also at blanks within a line.
- The file or data set should not have sequence numbers in it.

  Tip: If you use the ISPF editor to create the file, set the sequence numbers off by typing `NUMBER OFF` on the command line before you begin typing the data. If sequence numbers already exist, type `UNNUM` to remove them and then type `NUMBER OFF`.

Ways to define STDPARM

You can define the STDPARM parameter file by using one of the following:

- The TSO/E ALLOCATE command

  Example: The parameter data to be passed to BPXBATCH resides in the MVS sequential data set TURBO.ABC.PARMS.

  ```
  ALLOCATE DDNAME(STDPARM) DSN('TURBO.ABC.PARMS') SHR
  ```

- A JCL DD statement. To identify a z/OS UNIX file, use the PATH operand and specify PATHOPTS=ORDONLY.

  Example: The parameter data resides in the z/OS UNIX file /u/turbo/abc.parms.

  ```
  //STDPARM DD PATH='/u/turbo/abc.parms',PATHOPTS=ORDONLY
  ```

  Example: The BPXBATCH parameter data resides in member P1 of the MVS PDSE TURBO.PARM.LIBRARY.

  ```
  //STDPARM DD DSN=TURBO.PARM.LIBRARY(P1),DISP=SHR
  ```

- An JCL in-stream data set

  The BPXBATCH parameter data immediately follows the STDPARM DD statement. Trailing blanks are truncated for in-stream data sets, but not for other data sets.

  Example: The following invokes the **echo** shell command.

  ```
  //STDPARM  DD *
  SH echo "Hello, world!"
  /*
  ```

  Example: Consider the following shell script called myscript.sh. This shell script writes to stdout the first three arguments that are passed to it.

  ```
  #!/bin/sh
  #Write arguments 1 through 3 to stdout
  echo $1
  echo $2
  echo $3
  ```

  The following is one way to define STDPARM to run the script:

  ```
  //STDPARM  DD *
  SH /myscript.sh AAAA BBBB CCCC
  /*
  ```

  Here is another way, placing the arguments on separate lines:

  ```
  //STDPARM  DD *
  SH /myscript.sh AAAA
  BBBB
  CCCC
  /*
  ```

  Result: Both of these STDPARM definitions produce the following output:

  ```
  AAAA
  BBBB
  CCCC
  ```

- SVC 99 dynamic allocation, if you are running BPXBATCH from a program

For more information about defining STDPARM for BPXBATCH, see the detailed discussion about using BPXBATCH *z/OS UNIX System Services Command Reference*.

Invoking BPXBATCH in a batch job

You can create a batch job that invokes BPXBATCH to run a z/OS UNIX shell command or executable file.

The JCL to invoke BPXBATCH looks like this:

```
//jobname  JOB ...
//stepname EXEC PGM=BPXBATCH,PARM='SH|PGM program_name [arg1...argN]'
```

where:

- When `SH` is specified, *program_name* is the name of a shell command or a file containing a shell script. `SH` is the default; therefore, you can omit the `PARM=` and use STDIN to define the name of the shell script to be invoked. BPXBATCH invokes the login program to run the shell as a login shell. BPXBATCH always runs the shell found in the user's RACF OMVS Segment.
- When `PGM` is specified, *program_name* is the name of an executable file that is stored in a z/OS UNIX file. Inadvertent use of a shell script with `PGM` may result in a process that will not end as expected, and will require use of the **kill -9** pid command to force termination.

- You can supply optional arguments, *arg1...argN*, to *program_name*. For SH, the entire string after the SH is passed to the login shell without further parsing. For PGM, the arguments are broken at blanks and passed separately. You cannot use quotes in the parameter to pass arguments that contain blanks.
- You can omit the `PARM=` and, instead, place the parameter data in a file or data set defined by STDPARM.

In the job, you can supply DD statements to define any of the resources discussed previously using the following ddnames:

DDname
Description

STDIN
Standard input (see "Defining standard input, output, and error streams for BPXBATCH" on page 157)

STDOUT
Standard output (see "Defining standard input, output, and error streams for BPXBATCH" on page 157)

STDERR
Standard error (see "Defining standard input, output, and error streams for BPXBATCH" on page 157)

STDENV
Environment variable definitions (see "Passing environment variables to BPXBATCH" on page 158)

STDPARM
BPXBATCH parameter data (see "Passing parameter data to BPXBATCH" on page 160)

Note:

1. If you specify data sets in a STEPLIB DD statement, all the data sets should be cataloged.
2. `UNIT=` and `VOL=SER=` parameters are not propagated to the process that is being executed by BPXBATCH unless the process is run locally by BPXBATCH via the setting of the _BPX_SHAREAS and _BPX_BATCH_SPAWN environment variables: _BPX_SHAREAS=YES and _BPX_BATCH_SPAWN=YES.
3. If the job needs to run with a group other than your default group, you need to code `GROUP=grpname` on the job card to specify the group your job needs to run under. For BPXBATCH, the group needs to have an OMVS segment and a GID defined for it.
4. If your job requires a REGION size greater than the default on your system, you may receive this abend code:

   ```
   ABEND 4093 reason code 0000001c
   ```

   To fix this, use a larger REGION size.

   Example: The following invokes BPXBATCH with a region size of 8M:

   ```
   //SHELLCMD EXEC PGM=BPXBATCH,REGION=8M,PARM='SH shell_command'
   ```

Example: Running a shell script in batch

You can use BPXBATCH to run a shell script through batch and redirect the output and error messages to z/OS UNIX files or MVS data sets. Because the default is `PARM='SH'`, the `PARM=` is not specified in the following example. The shell script associated with the STDIN ddname is invoked. You can allocate STDIN, STDOUT,

and STDERR as z/OS UNIX files, using the PATH operand on the DD statements. You can also allocate STDOUT and STDERR as MVS data sets.

Example: User TURBO runs a shell script in batch, as follows:
- The STDIN ddname defines a shell script to be invoked, /u/turbo/bin/myscript.sh.
- STDOUT defines a file to which to write the standard output, /u/turbo/bin/mystd.out.
- STDERR defines a file to which to write standard error messages, /u/turbo/bin/mystd.err.

```
//jobname  JOB  ...
//stepname EXEC PGM=BPXBATCH,REGION=8M
//STDIN    DD   PATH='/u/turbo/bin/myscript.sh',PATHOPTS=(ORDONLY)
//STDOUT   DD   PATH='/u/turbo/bin/mystd.out',PATHOPTS=(OWRONLY,OCREAT),
//              PATHMODE=SIRWXU
//STDERR   DD   PATH='/u/turbo/bin/mystd.err',PATHOPTS=(OWRONLY,OCREAT),
//              PATHMODE=SIRWXU
```

Example: The following JCL is similar to the previous example and produces equivalent results but uses the PARM= string to specify the shell script to be run:

```
//jobname  JOB  ...
//stepname EXEC PGM=BPXBATCH,REGION=8M,
//              PARM='SH /u/turbo/bin/myscript.sh'
//STDOUT   DD   PATH='/u/turbo/bin/mystd.out',PATHOPTS=(OWRONLY,OCREAT),
//              PATHMODE=SIRWXU
//STDERR   DD   PATH='/u/turbo/bin/mystd.err',PATHOPTS=(OWRONLY,OCREAT),
//              PATHMODE=SIRWXU
```

Example: Running a shell command in batch

In the following example, BPXBATCH runs the shell command **compress** to compress the file /usr/lib/junk. To start the next JCL job step before the **compress** command completes, the parameter string is specified as:

```
SH nohup compress /usr/lib/junk & sleep 1
```

If, instead, the parameter string is specified as:

```
SH compress /usr/lib/junk
```

the job step waits for the **compress** shell command to end. For short-running commands, this is fine.

For long-running commands, however, where you want to use BPXBATCH to start a shell command in the background and not wait for completion, you must specify the parameter string like this:

```
SH nohup command args & sleep 1
```

SH starts a login shell to parse and run the command. The login shell parses the &, signifying that the command is to run asynchronously (in the background), and forks a child process to run the **nohup** command. In the child process, the **nohup** shell command (which takes another command as an argument) prevents the process from being terminated when the login shell returns to BPXBATCH.

In parallel with the **nohup** processing, the login shell runs the **sleep** command. Running the **sleep** command delays the login shell from returning to BPXBATCH until the child process has had enough time (1 second) to protect itself from being terminated. The login shell returns to BPXBATCH, while the child process continues to run the **compress** command.

Example: User TURBO runs the **compress** shell command in batch, as follows:
- STDPARM defines an in-stream data set containing the parameter string.
- STDERR defines a file to which to write error messages, /u/turbo/bin/mystd.err.
- The STDIN and STDOUT files default to /dev/null.
- The STEPLIB is propagated for the execution of the shell and for any processes created by the shell.

```
//jobname  JOB  ...
//stepname EXEC PGM=BPXBATCH,REGION=8M
//STEPLIB  DD   DSN=CEE.SCEERUN,DISP=SHR
//STDERR   DD   PATH='/u/turbo/bin/mystd.err',
//              PATHOPTS=(OWRONLY,OCREAT,OTRUNC),PATHMODE=SIRWXU
//STDPARM  DD   *
SH nohup compress /usr/lib/junk & sleep 1
/*
```

Example: The following JCL is similar to the previous example and produces equivalent results but uses PARM= to specify the parameter string:

```
//jobname  JOB  ...
//stepname EXEC PGM=BPXBATCH,REGION=8M,
//              PARM='SH nohup compress /usr/lib/junk & sleep 1'
//STEPLIB  DD   DSN=CEE.SCEERUN,DISP=SHR
//STDERR   DD   PATH='/u/turbo/bin/mystd.err',
//              PATHOPTS=(OWRONLY,OCREAT,OTRUNC),PATHMODE=SIRWXU
```

Example: Running a z/OS UNIX executable file or REXX exec in batch

You can also use BPXBATCH to run a z/OS UNIX executable file or REXX exec through MVS batch and redirect the output and error messages to z/OS UNIX files or MVS data sets.

Example: User JAYMC runs an executable file in batch, as follows:
- The program name to be run is /u/jaymc/bin/xparse1.
- STDOUT is to be written to the file /u/jaymc/bin/mystd.out.
- STDERR is to be written to the file /u/jaymc/bin/mystd.err.
- STDIN defaults to /dev/null.

```
//jobname  JOB  ...
//stepname EXEC PGM=BPXBATCH,REGION=100M,
//              PARM='PGM /u/jaymc/bin/xparse1'
//STEPLIB  DD   DSN=ISFSHR.JAYMC.ISFLOAD,DISP=SHR
//STDOUT   DD   PATH='/u/jaymc/bin/mystd.out',PATHOPTS=(OWRONLY,OCREAT),
//              PATHMODE=SIRWXU
//STDERR   DD   PATH='/u/jaymc/bin/mystd.err',PATHOPTS=(OWRONLY,OCREAT),
//              PATHMODE=SIRWXU
```

Example: This example is very similar to the previous one, except that STDOUT and STDERR are directed to members of an existing PDSE. If you wish to use two members of the same partitioned data set for STDOUT and STDERR output, then you must use a PDSE (not a PDS).
- The program name to be run is /u/jaymc/bin/xparse1.
- STDOUT is to be written to the PDSE member JAYMC.MYSTDLIB(XP1OUT).
- STDERR is to be written to the PDSE member JAYMC.MYSTDLIB(XP1ERR).
- STDIN defaults to /dev/null.

```
//jobname  JOB  ...
//stepname EXEC PGM=BPXBATCH,REGION=100M,
//              PARM='PGM /u/jaymc/bin/xparse1'
//STEPLIB  DD   DSN=ISFSHR.JAYMC.ISFLOAD,DISP=SHR
//STDOUT   DD   DSN=JAYMC.MYSTDLIB(XP1OUT),DISP=MOD
//STDERR   DD   DSN=JAYMC.MYSTDLIB(XP1ERR),DISP=MOD
```

Invoking BPXBATCH from the TSO/E environment

You can use BPXBATCH to run a z/OS UNIX shell command, shell script, or executable file from the TSO/E environment. (For shell commands, however, it may be even easier to use the OSHELL exec, which invokes BPXBATCH. See "OSHELL: Running a shell command from the TSO/E READY prompt.")

You can invoke BPXBATCH under TSO/E like this:

```
BPXBATCH SH|PGM program_name [arg1...argN]
```

where:

- When `SH` is specified, *program_name* is the name of a shell command or a file containing a shell script. SH starts a login shell which processes your **.profile** before running a shell command or shell script. `SH` is the default; therefore, you can allocate a file containing a shell script to the STDIN ddname, invoke BPXBATCH without any parameters, and the shell script will be invoked.
- When `PGM` is specified, *program_name* is the name of an executable file that is stored in a z/OS UNIX file. Inadvertent use of a shell script with `PGM` may result in a process that will not end as expected, and will require use of the **kill -9** pid command to force termination.
- You can supply optional arguments, *arg1...argN*, to *program_name*.
- You can invoke BPXBATCH without any parameters on the command line and, instead, place the parameter data in a file or data set defined by STDPARM.

Prior to invoking BPXBATCH, you can allocate any of the resources discussed previously, using the TSO/E ALLOCATE command with the following ddnames:

DDname
Description

STDIN
Standard input (see "Defining standard input, output, and error streams for BPXBATCH" on page 157)

STDOUT
Standard output (see "Defining standard input, output, and error streams for BPXBATCH" on page 157)

STDERR
Standard error (see "Defining standard input, output, and error streams for BPXBATCH" on page 157)

STDENV
Environment variable definitions (see "Passing environment variables to BPXBATCH" on page 158)

STDPARM
BPXBATCH parameter data (see "Passing parameter data to BPXBATCH" on page 160)

OSHELL: Running a shell command from the TSO/E READY prompt

The OSHELL REXX exec, shipped in SYS1.SBPXEXEC, invokes BPXBATCH to run non-interactive shell commands from the TSO/E `READY` prompt. The output is displayed in your TSO/E session.

OSHELL usage notes: Note that:

1. With OSHELL, you cannot use a shell command with an & (ampersand) to run it in the background.
2. OSHELL cannot be used to invoke an interactive shell command.
3. OSHELL creates a temporary file in the **/tmp** directory. The name of the temporary file includes the time, to avoid naming conflicts (for example, **/tmp/userid1.12:33:32.461279.IBM**). The file is deleted when OSHELL completes.

OSHELL examples: For example:

To delete the file **dbtest.c**, user TURBO would enter at the TSO/E `READY` prompt:

```
oshell rm -r /u/turbo/testdir/dbtest.c
```

To display the amount of free space in your file system, you could enter:

```
oshell df -P
```

To display information on all accessible processes, you could enter:

```
oshell ps -ej
```

Figure 14 on page 168 shows how OSHELL is coded.

```
/* REXX */
parse arg shellcmd
username =,
TRANSLATE(userid(),'abcdefghijklmnopqrstuvwxyz','ABCDEFGHIJKLMNOPQRSTUVWXYZ')
/*********************************************************************/
/* Free STDERR just in case it was left allocated                    */
/*********************************************************************/
/*                                                                   */
msgs = msg('OFF')
"FREE DDNAME(STDERR)"
/*********************************************************************/
"ALLOCATE FILE(STDOUT) PATH('/tmp/"username"."time('L')".IBM') ",
"PATHOPTS(OWRONLY,OCREAT,OEXCL,OTRUNC) PATHMODE(SIRWXU)",
"PATHDISP(DELETE,DELETE)"
IF RC ¬= 0 Then
  DO
    "FREE DDNAME(STDOUT)"
    "ALLOCATE FILE(STDOUT) PATH('/tmp/"username"."time('L')".IBM') ",
    "PATHOPTS(OWRONLY,OCREAT,OEXCL,OTRUNC) PATHMODE(SIRWXU)",
    "PATHDISP(DELETE,DELETE)"
    IF RC ¬= 0 Then
      DO
        msgs = msg(msgs)
        /* Allocate must have failed */
        Say ' This REXX exec failed to allocate STDOUT.'
        Say ' This REXX exec did not run shell command ' shellcmd
        RETURN
      END
  END
msgs = msg(msgs)

"BPXBATCH SH "shellcmd

IF RC ¬= 0 Then
   DO
     Say ' RC = ' RC
     Say ' '
   END
IF RC > 255 Then
   DO
     Say ' Exit Status = ' RC/256
     Say ' '
   END
IF (RC ¬= 254) & (RC ¬= 255) THEN
   DO
     "ALLOCATE FILE(out1) DA(*) LRECL(255) RECFM(F) REUSE"
     "OCOPY indd(STDOUT) outdd(out1) TEXT PATHOPTS(OVERRIDE)"
     "FREE DDNAME(out1)"
   END
"FREE DDNAME(STDOUT)"
```

Figure 14. The OSHELL REXX exec

Using TSO/E REXX for z/OS UNIX processing

You can use a set of z/OS UNIX extensions to TSO/E REXX—host commands and functions—to access kernel callable services. The z/OS UNIX extensions, called *syscall commands*, have names that correspond to the names of the callable services that they invoke—for example, **access**, **chmod**, and **chown**.

You can run a REXX program with z/OS UNIX extensions from MVS, TSO/E, the shell, or a C program. The exec is not portable to an operating system that does not have z/OS UNIX installed.

For more information about the REXX extensions that call z/OS UNIX services, see *z/OS Using REXX and z/OS UNIX System Services*.

Using the ISPF shell

With the ISPF shell (ISHELL), a user or systems programmer can use ISPF dialogs instead of shell commands to perform many tasks, especially those related to file systems and files. An ordinary user can use the ISPF shell to work with:

- Directories
- Regular files
- FIFO special files
- Symbolic links, including external links

You can also run shell commands, REXX programs, and C programs from the ISPF shell. The ISPF shell can only direct **stdout** and **stderr** to a file in your file system, not to your terminal. If it has any contents, the file is displayed when the command or program completes.

Invoking the ISPF shell

You can invoke the ISPF shell in one of the following ways:

- Type the TSO/E command: `ISHELL [-d] [pathname]`

  See "Entering a TSO/E command" on page 198 for information about entering TSO/E commands in TSO/E, the shell, and ISPF.
- Select the ISPF shell from the ISPF menu, if a menu option is installed.

The optional *pathname* parameter specifies the initial path name that you want to appear on the ISHELL main panel.

Example: The following command invokes the ISPF shell and supplies the path name `/tmp/` on the ISHELL main panel:

```
ishell /tmp/
```

Guidelines: When invoking the ISPF shell, follow these guidelines:

1. ISHELL can be invoked with the option **–d**, which prevents ISHELL from suppressing ISPF severe dialog errors. This will cause ISHELL to terminate on errors. This option should only be used at the direction of an IBM technical support representative.
2. The environment variable BPXWISHTZ can be set to a time zone value to have ISHELL use a local time zone that is different than your TZ setting. BPXWISHTZ must be specified in /etc/profile or in .profile. For example, if the TZ setting does not specify GMT, to allow ISHELL users to return to GMT add the following line to etc/profile or .profile:

   ```
   export BPXWISHTZ=GMT
   ```

   For more information about using the SMFPRM*xx* parmlib member to specify timeouts, see *z/OS UNIX System Services Planning*.
3. Since ISHELL contains code to run the TSO commands OGET and OPUT, these commands should not be included in the PLATCMD area of any IKTSOxx member in effect. Doing so will result in a delay in exiting ISHELL, especially if a copy operation has been performed in the ISHELL session. In general, none of the z/OS UNIX TSO commands should be listed as PLATCMD entries. For more information, see *z/OS UNIX System Services Planning*.

Working in the ISPF shell

Figure 15 is the main panel, which you see when you invoke the ISPF shell. At the top of the panel is the action bar, with the following choices:

- File
- Directory
- Special file
- Tools
- File systems
- Options
- Setup
- Help

When you select one of these choices, a pulldown panel displays a list of actions.

```
  File  Directory  Special_file  Tools  File_systems  Options  Setup  Help
-------------------------------------------------------------------------
                     UNIX System Services ISPF Shell

Enter a pathname and do one of these:

    - Press Enter.
    - Select an action bar choice.
    - Specify an action code or command on the command line.

Return to this panel to work with a different pathname.
                                                                  More:    +
   /_____________________________________________________________________
   _____________________________________________________________________
   _____________________________________________________________________
   _____________________________________________________________________
EUID=nnnn




Command ===> _____________________________________________________________
 F1=Help      F3=Exit      F5=Retrieve  F6=Keyshelp  F7=Backward  F8=Forward
F10=Actions  F11=Command  F12=Cancel
```

Figure 15. ISPF shell: The main panel

In the center of the panel, you see four lines. Here you can type the path name of a file (a directory is a type of file) that you want to work with. It can be the name of an existing file or a new file that you are creating.

In the lower part of the panel, you see a command line. Here you can type an *action code*, a one-character code that specifies an action that you want to perform on the path name you are working with. For example, `D` is the action code for "delete" (To familiarize yourself with the action codes, press <F1> on the main panel. On the help panel that is displayed, position your cursor under the highlighted words *action code* and press <F1>.)

Work in the ISPF shell is a two-step sequence:

1. Select an *object*—the path name of a new or existing file.
2. Select an action for that object.

For more about ISPF

The discussion in this topic is an introduction to ISPF. For detailed information, see *z/OS V2R2 ISPF User's Guide Vol I*.

Using the online help facility

In the ISPF shell, you can get help information for:

- Panels
- Fields on panels
- Highlighted words on panels

Position your cursor on one of those locations and press <F1>.

For more information on the online help facility when you begin working in the ISPF shell, select the `Help` choice on the action bar and read the information there.

Chapter 12. Performance: Running executable files

Note: This information is directed toward users of the z/OS shell. Most examples pertain to the z/OS shell and not to the tcsh shell.

A process is a collection of threads that execute within an address space, along with the required system resources. A user's login shell is one example of a process.

- The OMVS command creates two processes per login: a process to control the terminal and a process for the login shell.
- **rlogin** and **telnet** logins each create two processes: one to control the socket connection to the user, another for the login shell.
- Communications Server logins require only one process per login. Consequently, there is no method for requesting a shared address space for the Communications Server login shell.

Most utilities invoked from the shell command line run in new processes that the shell creates.

There is a system-wide limit on:

- The number of z/OS UNIX processes across the system
- The number of z/OS UNIX processes per user

For a discussion of these limits, see the section on defining system limits in *z/OS UNIX System Services Planning*.

The shell, and other z/OS UNIX commands and daemons, can assign multiple processes to the same MVS address space; this is called a *shared address space*. Using a shared address space offers these advantages:

- A new process in the same address space can be started more quickly than a new process in another address space.
- A new process in the same address space requires fewer system resources (storage, for example) than a new process in another address space.

For **rlogin**, the system administrator must update **/usr/sbin/inetd.conf** by adding **-m** to the rlogind entry to enabled shared address space. When **-m** is added, the socket connection process and the login shell process share the same address space.

For the OMVS command, use the SHAREAS keyword to enable shared address space. When the SHAREAS keyword is used, the login shell process is nested in the user's TSO address space. Any other login shells started with the OMVS OPEN subcommand are also nested in the user's TSO address space. (With NOSHAREAS, other login shells started with the OMVS OPEN subcommand will each consume another address space.)

To enable shared address space for the shell, issue the command

```
export _BPX_SHAREAS=YES
```

interactively, or place it in your **$HOME/.profile**. All simple commands (commands that are run in the foreground and not in a pipeline) will then run in processes nested in the shell's address space. If the _BPX_SHAREAS variable is not set, or if it is not set to the value YES, the shell creates all processes in separate address spaces. No matter how the shell is started (with or without shared address

space enabled), you must set _BPX_SHAREAS=YES if processes started by the shell itself are to run in processes nested in the shell's address space.

User applications can also use shared address spaces. See spawn (BPX1SPN, BPX4SPN) — Spawn a process and attach_exec (BPX1ATX, BPX4ATX) — Attach a z/OS UNIX program in *z/OS UNIX System Services Programming: Assembler Callable Services Reference* for details.

Some processes cannot execute correctly in a shared address space. For example, if a process needs to reserve MVS system resources that are common to all processes in an MVS address space, it must run by itself. If two processes using the same MVS resource attempt to execute concurrently in the same address space, they will compete for these resources, causing at least one of them to fail. When a potential storage shortage is detected, the new processes are created in their own address spaces, even if _BPX_SHAREAS=YES is present in the invoker's environment. For more details about these restrictions, see the descriptions of the spawn() function and the BPX1SPN callable service.

Improving shell script performance

You may be able to improve shell script performance by setting the **_BPX_SPAWN_SCRIPT** environment variable to a value of YES. However, when **_BPX_SPAWN_SCRIPT=YES**, the behavior will not conform completely to the XPG4 Commands & Utilities specification.

See “Improving the performance of shell scripts” on page 45 for more information.

Chapter 13. Communicating with other users

You can communicate only with users in the same environment you are working in. For example, if you are working in the TSO/E environment, you cannot use MVS facilities to send a message to a user working in the shell.

Shell users who want to exchange messages with other shell users at the same system can use shell commands. Other users may prefer to use TSO/E facilities, in order to be able to exchange messages with all TSO/E users, not just those using the shell.

Within the shell, you can send and receive messages using these shell commands:
- **mailx**
- **mail**
- **write**
- **talk**
- **wall**

Alternatively, you can switch into your TSO/E session and send messages to any TSO/E user by using TSO/E facilities, through the OFFICE option of the Information Center Facility (ICF), if it is installed on your system, or through TSO/E commands. You can also receive messages using TSO/E.

If your system has Transmission Control Protocol/Internet Protocol (TCP/IP) or other network management facilities installed, you can log in to the TCP/IP network and send messages to users at other systems.

If your system has UUCP (UNIX-to-UNIX Copy Program) installed and set up, you can use this facility to send files to, or run commands or custom applications at, other sites in the UUCP network.

Using mailx to send and receive mail

You can use the **mailx** command to send a message to a system-specified mail file. When the shell user receiving the message is ready to read messages, he or she can use **mailx** to see what messages have arrived and read them.

Administrators and users can customize the behavior of **mailx** in a number of ways, by selecting variables and setting them in files named **/etc/mailx.rc** and **$HOME/mail.rc**. Some variables apply for the duration of any session; others can be set or reset within a session.

The systems programmer can set up a list of variables (using the **set** command) in the **/etc/mailx.rc** file. You can use these values as a default, or you can set up a **$HOME/mail.rc** file that sets these variables for your personal use. These variables are described in the **mailx** command description in *z/OS UNIX System Services Command Reference*.

You can reset certain variables during a session, or, when entering **mailx**, specify that the variables in the **/etc/mailx.rc** file are not to be used.

Steps for sending mail to another user

Before you begin: You need to know that you can send a message to one or more users at a time. The following example is a message sent to several users. The word in italics is output by **mailx** itself.

```
     mailx macneil
Subject: Reminder
     Our work group meets today at 10:30.
     Let's get together in the library.
      ~c smitha emilig fabish
      ~.
```

On the first line, the message is addressed just to macneil. The `~c` line adds people who will receive copies of the message.

The `~.` line identifies the end of the message and indicates to **mailx** that you are ready to send it. After you type that line and press <Enter>, the message is sent.

Perform the following steps to send mail to another user

1. Type `mailx name`, where *name* is a login name.

   _____

2. The system prompts you for a `Subject`. You can type a word or phrase and press <Enter>.

   _____

3. Start typing the message. At the end of each line, press <Enter>. In the example used above, you would press <Enter> after `Reminder`, `10:30.`, `library.`, and `fabish`.

   _____

4. To copy other people on the note, type `~c` before their login names.

   _____

5. To end the message and transmit it, type `~.` and press <Enter>.

   _____

You know you are done when the system displays an `EOT` message.

Sending mail to a distribution list

You can send the same message to multiple users at the same time by using a distribution list.

If you use **mailx** to send a message, you can specify the *address* of each z/OS UNIX user you want to receive the message. The simplest address is the TSO/E user ID.

Example: To send a message to pfeif, lowell, eliza, and fabish, issue:

```
mailx pfeif lowell eliza fabish
```

To send a message to a list of people, you can specify an *address alias* that contains a list of login names.

Example: To set up an alias for the test team, issue:

```
alias test pfunt lulu detsch naga
```

Result: When you send a message to the address alias `test`, it will go to all the login names you specified on the **alias** command.

Aliases that are entered interactively remain in effect only for the current session. If you want to make the address alias permanent, put the **alias** command in your **.mailrc** startup file.

Sending a message to an MVS operator

You can use the **logger** shell command to send a message to an MVS operator.

Example: To send a message to an MVS operator:

```
logger -d1 Is the tape I requested here yet?
```

Result: A message is sent to a console with the route code 1.

Receiving mail from other users

The simplest way to read incoming messages is to enter the command **mailx**. This starts an interactive session that lets you read your mail and perform other actions, such as display new messages and delete old ones. If you do not have any mail, you will get a message telling you so.

When you have mail, the mail program shows you a list of messages similar to this one:

```
mailx xxxxxxx Type ? for Help.
"/usr/mail/SMITHA/...": 3 messages 3 new
>N  1 CLIFLWR           Thu Jul 15 14:28  6/93  testing
>N  2 HOMEBRW           Thu Jul 15 15:03  5/81  lunch plans
>N  3 ELVIS             Thu Jul 15 16:17  6/95  softball
?
```

The first line is the **mailx** program banner; xxxxxxx is information about the version of **mailx**. As indicated, you can type ? to see a help panel. The second line displays the name of the mailbox being used, /usr/mail/SMITHA/, followed by the number of messages in the mailbox, and their status. Then you see a list of three messages:

- Number 1 was sent by CLIFLWR and has the subject "testing". It was sent on July 15 at 2:28 p.m., and contains 6 lines and 93 characters.
- Number 2 was sent by HOMEBRW and has the subject "lunch plans". It was sent on July 15 at 3:03 p.m., and contains 5 lines and 81 characters.
- Number 3 was sent by ELVIS and has the subject "softball". It was sent on July 15 at 4:17 p.m., and contains 6 lines and 95 characters.

The user names are all displayed in uppercase.

The question mark (?) is the mail program prompt; it indicates that you can enter **mailx** subcommands now. Try the subcommand **n** (next message) to read the messages in sequence:

```
? n
Message  1:
From CLIFLWR Thu Jul  15 14:28
To: SMITHA
Subject:  testing

I'm setting up a meeting to test the toolkit
on Monday the 19th at 10AM.
Let me know if you can make it.
?
```

The question mark (?) prompt appears after the displayed message. You can also enter the **n** subcommand with a number to specify a particular message; for example, **n 3** displays the message about softball. Now you can choose what to do with the message: reply to it, save it, or delete it.

Replying to mail

At the question mark (?) prompt, you can use the **R** (reply to sender) subcommand to reply to a particular message. This is an uppercase **R**: it differs from the **r** subcommand, which sends the reply to everyone who sent and received the message. When you give the **R** subcommand, follow it with the message number. For example:

```
? R 1
To:  cliflwr
Subject:  Re:  testing

Yes, I can make the meeting.  where ?
 ~.
EOT
```

The EOT indicates that your reply has been sent.

Saving and deleting mail

If you exit mail without specifically deleting or saving your messages, the system saves those messages.

To save a message, use the **s** subcommand and give the name of the file you want to save the message in.

Example: To save the file named *climail*:

```
s climail
```

Result: If this is an existing file, the message is appended to it. If the file does not exist, it is created.

To delete a message, use the **d** subcommand and give the number of the message you want to delete:

```
? d 1
?
```

The mail program deletes message number 1 and returns another ? prompt.

Ending the mailx program

To exit from **mailx**, use the **q** (quit) subcommand:

```
? q
$
```

The shell prompt indicates that you have left mail and can enter shell commands again.

For more information on **mailx**, see the **mailx** command description in *z/OS UNIX System Services Command Reference*.

Using write to send a message or a file

The **write** command lets you send a message directly to someone else who is logged on to the system. To determine who is logged on, use the **who** command. The **who** command displays information about who is logged on in this form:

```
BUBBA    ttyp0002                Feb 8 09:49
```

where BUBBA is a login name, ttyp0002 is the terminal, and Feb 8 09:49 is the login time.

The typical format of the **write** command is:

```
write user_name
```

However, if a user is logged in more than once, you can specify *terminal* (in the ttyp form that **who** returns) rather than *user_name*.

Sending a message: An example

Here is an example of how to send a message, using **max** as the sender and **bubba** as the recipient:

```
write bubba
```

When **max** sends a message to **bubba**, **bubba** receives a message like this:

```
Message from max (ttyp002) [Feb  8 15:04 ] ...
```

After the system establishes the connection to **bubba**, it sends two alert characters (usually a beeping sound) to **max**'s terminal to indicate that it is ready to send a message. **max** can then type a message, which appears on **bubba**'s terminal. If a message is more than one line, each time you press <Enter> a line is sent to **bubba**'s terminal.

Ending a message

To end a message, enter <EscChar-D> for end-of-file or <EscChar-C> for an interrupt. When **write** receives an end-of-message indicator, it displays an EOF message on the other user's screen and breaks the connection.

When your message is completed, the other user can reply to your message with

```
write your_user_name
```

However, if both of you are trying to write on each other's terminal at the same time, the messages may get interleaved on your screens, making them difficult to read. For two-way conversations, use **talk** instead of **write**. For more information about **talk**, see "Using talk for an online conversation" on page 180.

Sending a file

You can add the output of a command to a message that you are writing. To do this, start a line with an exclamation mark (!) and put a standard shell command on the rest of that line. **write** calls your shell to execute the command, and sends the standard output (**stdout**) from the command to the other user. The other user does not see the command itself or any input to the command. For example, you might write:

```
Here is what my file contains:
!cat file1
```

The contents of **file1** are displayed on the other user's screen.

Using talk for an online conversation

talk lets you start up a two-way conversation with someone else logged in to the system. However, **talk** is available only if you access the shell with **rlogin** or **telnet** or the Communications Server, because it requires raw mode.

The typical format of the **talk** command is:

```
talk user_name
```

However, if a user is logged in more than once, you can specify *terminal* (in the form `ttyp` that **who** returns) rather than *user_name*.

Beginning a conversation: An example

Here is an example of how to begin a conversation with **talk**, using **max** as the person starting a conversation with **bubba**. Here **max** begins by typing:

```
talk bubba
```

bubba receives a message like this:

```
Message from max.
talk: connection requested by max
talk: respond with: talk max
```

To set up the two-way connection, **bubba** must enter:

```
talk max
```

After this connection has been established, the two can type simultaneously.

Viewing the conversation

talk displays incoming messages from the other person in one part of the screen and your outgoing messages in another part of the screen.

Some terminals may not be able to split the screen into parts in this way. Depending on the terminal type, **talk** may try to simulate this effect. However, it may not be possible for both users to enter messages simultaneously.

Using wall to broadcast messages

A superuser can use the **wall** command to send a message to all logged in shell users:

```
wall [message]
```

If the message is omitted from the command line, the user will receive two beeps as a prompt to enter the message. You input the message, pressing enter after each line, and when done inputting the entire message, enter end-of-file or an interrupt (typically, `<EscChar-D>` for end-of-file or `<EscChar-C>` for an interrupt).

The user of **wall** should be a superuser. This ensures that the user is permitted to write to all the users that are logged on. If a user who is not a superuser attempts to use **wall** to broadcast a message, some writes will fail and those users will not receive the message.

Users who are sent a broadcast message will receive a beep announcing the message, and a message in the form:

```
Broadcast Message from SWER@AQFT (ttyp0006) at 10:43:54 (EDT5EST) ...

This is the text of the message line1
This is line2
```

For more information on the **wall** command, see the **wall** command description in *z/OS UNIX System Services Command Reference*.

Controlling messages and online conversations

You can use the **mesg** command to control whether other users can send messages to your terminal with **talk**, **write**, or similar commands.

To let other people send you messages, issue:

```
mesg y
```

To tell the system not to let other people send you messages, issue:

```
mesg n
```

To display the current setting without changing it, issue:

```
mesg
```

Using the UUCP network

If your system administrator has UUCP (UNIX-to-UNIX Copy Program) set up to communicate with remote sites, you can use this facility to send or retrieve files, or to run commands or custom applications at other sites in the UUCP network. To send or retrieve files from remote sites, use the **uucp** command; this causes a file transfer request to be queued. Depending on how your system is set up, a file transfer request may be processed immediately or later at a scheduled time.

UUCP provides the **uucp** command, which schedules files to be exchanged with other UUCP systems, and the **uux** command, which schedules commands to be executed by other UUCP systems. However, the **uucp** and **uux** commands do not cause any files to be exchanged or commands to be executed. For this, UUCP provides two daemons called **uucico** and **uuxqt**, which establish communication sessions, transfer data, and execute commands according to the requests scheduled by **uucp** and **uux**.

The commands that you use with UUCP are:

uucp Copy files between remote systems

uuname
: Display a list of UUCP systems

uupick
: Manage files sent to you via **uuto**

uustat Display the status of pending UUCP transfers

uuto Copy files to users on remote systems

uux Request command execution on remote systems

Tip: uucp, **uuto**, and **uupick** do not convert file data to or from EBCDIC. The sending and/or receiving user must convert file data if two systems have different codesets. You can use the **iconv** command to do this.

Transferring a file to a remote site

To transfer a file to a remote site, use the **uucp** command or the **uuto** command.

Using uucp to transfer files

uucp automatically handles text and binary files. When a file is transferred by **uucp** to another site, it is put in the public UUCP directory—by default, this is **/usr/spool/uucppublic**.

1. You need to know the name of the remote site. To list the remote sites that have been configured, type:

   ```
   uuname
   ```

   The sites are listed, one per line.
2. Copy the file to the other site.

   To make file transfers easier, you can use a special character in pathnames for the public UUCP directory. When tilde (~) is written as the first directory in a destination path name, the **~/** stands for the public UUCP directory. You can specify the public UUCP directory with the pathname **~/**.

   For example, to copy the file `memo1.pay` in your current directory to the public directory on the site named `north`, type:

   ```
   uucp memo1.pay north!~/memo1.pay
   ```

   File transfers may not get processed immediately. If there is any chance that the file that is to be sent will not be available later, use the **-C** option on the **uucp** command to immediately copy the file to the **uucp** spool directory. This ensures that the file is available later when the file transfer occurs.

Using uuto to transfer files

uuto is a simplified method of invoking **uucp**, and it also handles text and binary files automatically. When a file is transferred by **uuto** to another site, it is put in the **receive/usr** subdirectory of the public UUCP directory. Within the **receive** subdirectory, each user on the local system has a subdirectory. For example, a file for user stiert would be transferred to **/usr/spool/uucppublic/receive/stiert**.

1. You need to know the name of the remote site. To list the remote sites that have been configured, type:

   ```
   uuname
   ```

   The sites are listed, one per line.
2. Copy the file to the other site. For example, to copy the file `memo1.pay` in your current directory to the public directory on the site named `north`, type:

   ```
   uuto memo1.pay north!nuucp
   ```

   The recipient is notified by mail when the file arrives. To get the file, the recipient should use the **uupick** command. See “Working with your files in the public directory” on page 184 for information on how to use the **uupick** command.

Transferring multiple files to a remote site

You can use **uucp** to transfer more than one file, specifying the files by name or by using wildcards. To send more than one file, you must specify a directory as the destination, not a file name. To do this, end the destination pathname with a slash (/).

For example, to send the files **jan.wks**, **feb.wks**, **mar.wks**, and **memo1.txt**, to the directory **receive** at the `north` site, type:

```
uucp *.wks memo1.txt north!~/receive/
```

The trailing slash (/) shows that **receive** is a directory.

You can send an entire directory, by specifying the contents of the directory with a wildcard.

Transferring a file to the local public directory

You may want to put a file in your local public directory so that others can access it there. To specify the public directory in a local pathname, put single quotation marks around the pathname so that the shell does not treat the tilde as your home directory. (For more information on how the shell interprets a tilde in file names, see "Characters used in file names" on page 78.)

Example: To copy that file to your own UUCP public directory, issue:

```
uucp memo1.pay '~/memo1.pay'
```

Notification of transfer

If you want to be certain that a file has been transferred, or if you want someone at the remote site to know that the file has arrived, you can use the **-m** and **-n** options on the **uucp** command, or the **-m** option on the **uuto** command.

- With **uucp -m** or **uuto -m**, as soon as the file is successfully transferred, you receive a mail message. You can use **mailx** to read the message. The first line describes the file transfer request, and the second line describes the result. For example, it might look like this:

  ```
  REQUEST: home!/usr/spool/uucppublic/memo1.txt north!/usr/spool/uucppublic/memo1.txt
  (SYSTEM north) copy successful
  ```

- With **uucp -n** *name*, if you are transferring a file to a remote site, you can specify the login name of the person at the remote site to be notified when the file is transferred. That person can read the notification message using **mailx**.

Permissions

Each site in a UUCP network has a **Permissions** file that is used to control the access that remote systems have to data and programs on the local system. This file is used to specify, among other options, the areas in the file system that a remote system can read or write from, the commands that the remote system can run on the local system, and a different public directory than the default. Those options are specified as:

READ Indicates which directories can be read. By default, this is the home directory of user uucp (**/usr/spool/uucppublic**).

WRITE
Indicates which directories **uucico** can write to. By default, this is **/usr/spool/uucppublic**, the home directory of user uucp.

NOREAD
Indicates that files in the specified directories cannot be read. If a directory is specified by both `READ` and `NOREAD`, files in that directory cannot be read. The public directory can always be read (even if specified on `NOREAD`).

NOWRITE
Indicates that files in the specified directories cannot be written to. If a

directory is specified by both WRITE and NOWRITE, files in that directory cannot be written to. The public directory can always be written to (even if specified on NOWRITE).

PUBDIR
Indicates the public directory. By default, this is the home directory of user uucp (**/usr/spool/uucppublic**).

COMMANDS
Indicates the commands that the remote system can execute on your system. If more than one command is specified, the command names are separated with a colon (:). For example, COMMANDS=uucp:ls. If all commands are prohibited, the COMMANDS option is not used.

For a full description of all the **Permissions** file options, see The Permissions File in *z/OS UNIX System Services Planning*.

Transferring a file from a remote site

To copy a file from a remote site, your site must have read permissions on the file. Normally your site would have read permissions only on the public UUCP directory and its subdirectories.

For example, say you want to copy the program **pages** from **programs**, a subdirectory of the remote site's public UUCP directory, to your public UUCP directory.

To retrieve the file, you would enter this command:

```
uucp south!~/programs/pages '~/pages'
```

where south is the remote site.

For more information about the **uucp** command, see *z/OS UNIX System Services Command Reference*.

Checking a file's transfer status

To check the status of pending transfer requests, use the **uustat** command. You can specify options to display the status of transfers for a particular job ID or user ID.

To display completed file transfer attempts, use the **uulog** command. To see the record of completed file transfer attempts and connections by site, type:

```
uulog -s site
```

where *site* is the name of the remote site.

Working with your files in the public directory

All users have read access to the UUCP public directory. When you have a file in the public directory, you can use the **cp** command to copy the file or the **mv** command to move the file. If the sender uses the **-n** option on **uucp**, you are notified when the file is placed in the public directory.

Files sent to you with the **uuto** command are automatically placed in the **receive** subdirectory. You can use **uupick** to manage files in the **receive** subdirectory of the UUCP public directory. If **receive** is specified as the target directory on the **uucp** command, you can use **uupick** to manage the files.

Within the **receive** subdirectory, each user on the local system has a subdirectory.

To check your public UUCP directory for files sent to you by the **uuto** command, type **uupick**. For each file or directory found, **uupick** prompts you with a message and then you specify how that entry should be handled. For example, for a file, it might display:

```
from south:  file memo2.txt ?
```

In response, you could type **d** to delete the file, or **m** to move the file into your current working directory, or **m /mydir/tmp** to put it in the directory **/mydir/tmp**.

For more information about the **uupick** command, see *z/OS UNIX System Services Command Reference*.

Running a command on a remote site

You can use the **uux** command to run commands on remote sites, but they cannot be interactive commands such as **vi**. You must have a working UUCP connection and permission to execute commands on the remote site.

Using a remote file as an argument

To ask `south` to print the file **south!/schedule/january** using the **lp** command, you would type:

```
uux 'south!lp' '/schedule/january'
```

where **/schedule/january** is the name of the file on `south` to be printed. In general, if no site is specified on the arguments for the remote command, **uux** assumes the command is on the site running the command. You must specify full pathnames for files in **uux** commands. As a general rule, enclose all arguments to **uux** in single quotation marks to prevent the shell from interpreting them.

Using a local file as an argument

To ask `south` to print the local file **/schedule/january** using the **lp** command, you would type:

```
uux south!lp !/schedule/january
```

uux sends a copy of the file for printing; after the remote command has run, the copy is removed.

Using TSO/E to send or receive mail

You can use the TSO/E panel facilities or TRANSMIT and RECEIVE commands to communicate with any TSO/E user (including z/OS UNIX users). If you use TSO/E to send a message, your correspondent must use TSO/E to receive it.

Sending a message

You can use the TSO/E Information Center Facility (ICF), if installed, or TSO/E commands to send a message. For example, to send a short message (with no more than 115 characters), you can switch to TSO/E command mode and enter:

```
SEND 'Have to go home to take my cat to the vet' USER(alice)
```

You use SEND for messages to people on the same system as you.

For a longer message, or a message to someone on a different system, you could use:

```
TRANSMIT dallas.alice
```

where `dallas.alice` identifies the person to receive the message: `dallas` is the ID of the MVS system (known as a *node* in the network) where the person works, and `alice` is the person's user ID. The system then prompts you to enter the message.

Sending a message to a distribution list

You can use the TSO/E ICF, if installed, or the TSO/E TRANSMIT command to send a message to a distribution list. You set up a distribution list by specifying a nickname entry in the NAMES data set that contains a list of names or nicknames you want the message sent to.

Example: If you have set up the nickname `test` for a distribution list, issue:

```
transmit test
```

Result: The system displays a screen for input. Type your message and press <F3> to send it.

Sending a message to an MVS operator

To send a message to a specific MVS operator, you must know the operator's route code and specify it in the OPERATOR operand.

Example: Issue:

```
SEND 'Are the tapes I wanted from the library here yet?' OPERATOR(7)
```

You can also send a message to a specific operator console by using the CN operand. A console name or ID is defined at your enterprise.

Example: To send a message to the operator console named TAPELIB, issue:

```
send 'please send the tapes to the floor.' CN(TAPELIB)
```

Receiving mail from other users

How and whether you are notified when TSO/E messages are received by the system depends on how your TSO/E system is set up:

- You may be notified when you log on or as messages arrive.
- You may have to enter a RECEIVE command periodically to see if a message has arrived.

Unless the messages are automatically displayed when you log on, you enter a RECEIVE command to see your currently unread messages. For more information on TSO/E mail and messaging, see *z/OS TSO/E User's Guide*.

Receiving messages from other systems

TSO/E users can receive messages from other systems through the TSO/E message interface. Receiving a message from a user on another system is the same as receiving one from a user on the same system.

Part 2. The z/OS UNIX file system

These topics discuss tasks involved with the z/OS UNIX file system.

Chapter 14. An introduction to the z/OS UNIX file system

z/OS UNIX files are organized in a hierarchy, as in a UNIX system. All files are members of a *directory*, and each directory is in turn a member of another directory at a higher level in the hierarchy. The highest level of the hierarchy is the *root directory*.

The root file system and mountable file systems

Taken as a whole, the *file system* is the entire set of directories and files, consisting of all files shipped with the product and all those created by the systems programmer and users. The systems programmer (superuser) defines the *root file system*; subsequently, a user with mount authority can mount other mountable file systems on directories within the file hierarchy. (See the section on mount authority in *z/OS UNIX System Services Planning*.) Altogether, the root file system and mountable file systems comprise the file hierarchy used by shell users and applications.

After installation of z/OS, the end user's logical view of the file system is as shown in Figure 16.

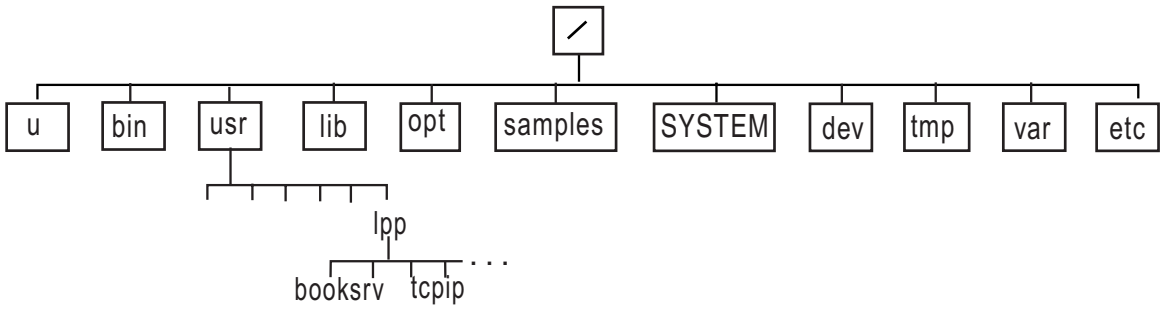


Figure 16. End user's logical view of the file system

System programmers need to know that the illustration of directories in Figure 16 is not a true representation of file systems. The file system, as installed through ServerPac or CBPDO, consists of `/dev`, `/tmp`, `/var`, and `/etc` symbolic links that point to the `/dev`, `/tmp`, `/var`, and `/etc` directories, as demonstrated in Figure 17 on page 190.

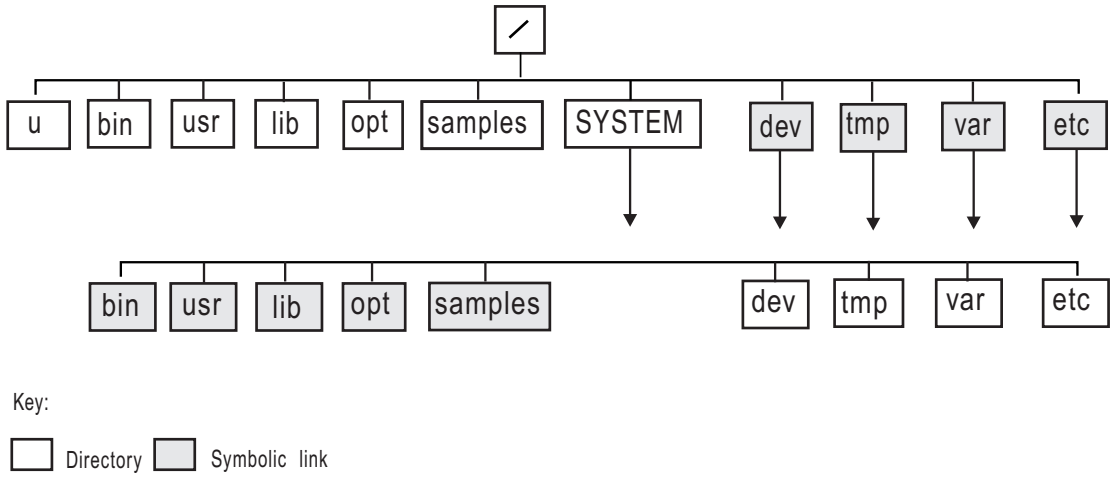


Figure 17. Organization of the file system

Here SYSTEM is a data set that contains directories which are used as mount points, specifically for the `/etc`, `/var`, `/tmp`, and `/dev` file systems. IBM requires that you mount `/etc`, `/var`, `/dev`, and `/tmp` in separate data sets.

The z/OS shells and utilities typically impose a *line orientation* on the byte-oriented files. A *line* is a stream of bytes terminated with a <newline> character. A line terminated by a <newline> character is sometimes referred to as a record. So, there is a single <newline> character between every pair of adjacent records. Text files use the <newline> character to delimit lines; binary files do not.

Several types of file systems can be mounted within the file hierarchy:

- z/OS File System (zFS): zFS is the strategic file system for z/OS UNIX and continues to be enhanced to provide superior performance, reliability, and data integrity. zFS file systems can be mounted into the z/OS UNIX hierarchy along with other local (or remote) file system types (for example, HFS, TFS, AUTOMNT and NFS). Also, zFS can support access control lists (ACLs). For more information, see *z/OS Distributed File Service zFS Administration*and *z/OS Migration*.
- Hierarchical File System (HFS): In HFS, the entire file hierarchy is a collection of hierarchical file system data sets (HFS data sets). Each HFS data set is a mountable file system. DFSMS facilities are used to manage an HFS data set, and DFSMS Hierarchical Storage Manager (DFSMShsm) is used to back up and restore an HFS data set.
- Network File System (NFS): Using NFS client on z/OS UNIX System Services, you can mount a file system, directory, or file from any system with an NFS server within your user directory. You can edit or browse the files. For more information, see "Using the Network File System feature" on page 199 and *z/OS Network File System Guide and Reference*.
- Distributed File System (DFS): DFS joins the local file systems of several file server machines, making the files equally available to all DFS client machines. DFS allows users to access and share files stored on a file server anywhere in the network, without having to consider the physical location of the file. For more information, see *z/OS DFSMS Using Data Sets*.
- Temporary File System (TFS): The TFS is an in-memory physical file system that delivers high-speed I/O. To take advantage of that, the systems programmer (superuser) can mount a TFS over the `/tmp` directory so it can be used as a

high-speed file system for temporary files. (Normally, the TFS is the file system that is mounted instead of the HFS if the kernel is started in minimum setup mode.)

Directories

Files are grouped in a *directory*, which is a special kind of file consisting of the names of a set of files and other information about them. Usually, the files in a directory are related to each other in some way. The files listed can be thought of as being contained in that directory (although their actual locations in physical storage are managed by the operating system).

A directory can include a file that is itself a directory (sometimes referred to as a *subdirectory*) and so on, through a number of levels in a hierarchical arrangement. For example, in Figure 16 on page 189, the slash (/) symbol at the top represents the *root directory*, which all other directories are descended from. There are ten directories branching from the root. Each of these directories, in turn, has its own system of subdirectories and files. For example, **localedef** is a subdirectory in the directory **/usr/lib/nls**.

When you first enter the z/OS shell, you are automatically placed in your *home directory*, which is defined when your user ID is defined.

Files

In addition to directories, there are four other types of files that can exist in the file system:

- A **regular file** is an identifiable (named) unit of text or binary data information. A file can be C source code, a list of names or places, a printer-formatted document, a string of numbers organized in a certain way, an employee record containing smaller information units in fields, a memo, and many other possible things. A user or an application program must understand how to access and use the individual increments of information (such as employee record fields) within a file.
- A **character special file** defines one of the following:
  - A terminal (**/dev/ptyp***nnnn* and **/dev/ttyp***nnnn*).
  - The default controlling terminal for a process (**/dev/tty**).
  - A null file (**/dev/null**). Data written to this file is discarded; hence, it is known as the bit bucket. This file is always empty for reading.
  - A zero file (**/dev/zero**). Data written to this file is discarded and binary zeros are supplied for any amount read from it.
  - The random number files (**/dev/random** and **/dev/urandom**). These files provide random numbers for cryptographic purposes.
  - A file descriptor file (**/dev/fd***n* or **/dev/fd/***n*).
  - A system console file (**/dev/console**). Data written to this file is sent to the console using a write-to-operator (WTO) that displays the data on the system console.
  - A UNIX domain socket name file. This is a path name that specifies the socket address for a UNIX domain socket. The path name is assigned by the application programmer; there is no convention for the name. The operating system creates the file.

- A Communications Server remote tty file (for example, **rtynnnn**) that corresponds to the requesting terminal on the originating Communications Server node. The name is assigned by the Communications Server administrator.
- The Communications Server character special file (**/dev/ocsadmin**) that supports **ioctl** functions for Communications Server administrative functions.

Character special files are dynamically created by the operating system when they are first referenced. However, they can also be explicitly created by a superuser (for instance, in order to assign different permissions).

- A **FIFO special file** is a file that is typically used to send data from one process to another so that the receiving process reads the data first-in-first-out (FIFO). A FIFO special file is also known as a *named pipe*.
- A **symbolic link** is a file that contains the path name for another file, in essence a reference to the original file. Only the original path name is the real name of the original file. You can create a symbolic link to a file or a directory. In OS/390® V2R9 and later, **/etc, /tmp, /dev,** and **/var** are symbolic links.

  An *external link* is a type of symbolic link, a link to an object outside of the HFS. Typically, it contains the name of an MVS data set.

Users and programs create regular files, FIFO special files, symbolic links, and external links.

Files not in the file system

There are two types of unnamed files that you might be aware of, but that do not exist in the file system:

- **unnamed pipe**

  A program creates a pipe with the **pipe()** function. A pipe typically sends data from one process to another; the two ends of a pipe can be used in a single program task. A pipe does not have a name in the file system, and it vanishes when the last process that is using it closes it.

- **socket**

  A program creates a socket with the **socket()** function. A socket is a method of communication between two processes that allows communication in two directions, in contrast to a pipe, which allows communication in only one direction. The processes using a socket can be on the same system or on different systems in the same network.

Comparison between MVS data sets and the z/OS UNIX file system

In Figure 18 on page 193, you see that:

- The MVS master catalog is analogous to the root directory in a z/OS UNIX file system.
- The user prefix assigned to MVS data sets is an organizer analogous to a user directory (`/u/smitha`) in the file system. Typically, one user owns all the data sets whose names begin with his user prefix. For example, the data sets belonging to the TSO/E user ID SMITHA all begin with the prefix SMITHA. There could be data sets named SMITHA.TEST1.C, SMITHA.TEST2.C, SMITHA.TEST1.LIST, and SMITHA.TEST2.LIST.

  In the file system, SMITHA would have a user directory named `/u/smitha`; under that directory there could be subdirectories named `/u/smitha/test1` and `/u/smitha/test2`.

- Of the various types of MVS data sets, a partitioned data set (PDS) is most akin to a user directory in the file system. In a partitioned data set such as SMITHA.TEST1.C, you could have members PGMA, PGMB, and so on—for example, SMITHA.TEST1.C(PGMA) and SMITHA.TEST1.C(PGMB). Likewise, a subdirectory such as `/u/smitha/test1` can hold many files, such as **pgma.c**, **pgmb.c**, and so on.

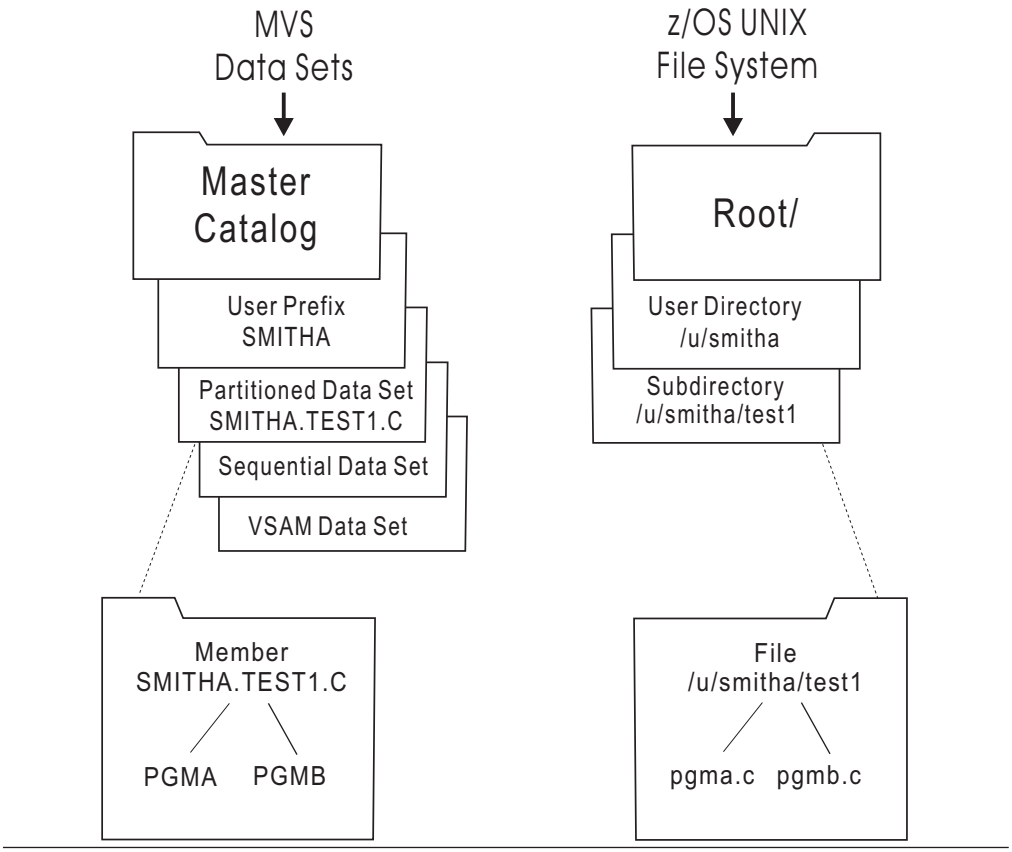


Figure 18. Comparison of MVS data sets and the z/OS UNIX file system

Sharing files between LPARs

z/OS UNIX files cannot reside on a DASD that is shared in read/write mode between LPARs. However, you can share z/OS UNIX files (both zFS files and HFS files) between LPARs when you use the shared file system capability provided by z/OS UNIX. To share only zFS files, you can use the sysplex support found in zFS.

Executable modules in the file system

You can have an executable module in the z/OS UNIX file system. To run a shell script or executable, a user must have read and execute permissions to the file. Use **chmod** to set the permissions.

- For frequently used programs in the file system, you can use the **chmod** command to set the *sticky bit*. This reduces I/O and improves performance. When the bit is set on, z/OS UNIX searches for the program in the user's STEPLIB, the link pack area, or the link list concatenation. For further information, see "Using a symbolic mode to specify permissions" on page 233.

- The **extattr** command is used to set, reset and display extended attributes for files to allow executable files to be marked so they run APF authorized, as a program controlled executable, or not in a shared address space.

  The **ls** shell command has an option that displays these attributes:

  -E Displays extended attributes for regular files:

  - **a** Program runs APF authorized if linked AC=1
  - **p** Program is considered program controlled
  - **s** Program runs in a shared address space
  - **-** Attribute not set

  When the **extattr** attribute **l** is set (**+l**) on an executable program file, it will be loaded from the shared library region.
- You can copy executable modules between z/OS UNIX and the file system. For more information about how to do this, see "Copying executable modules between MVS data sets and the z/OS UNIX file system" on page 280.
- For information about how to set up a STEPLIB environment for an executable file, see "Building a STEPLIB environment: The STEPLIB environment variable" on page 50.

For more information about the **ls** and **extattr** shell commands, see *z/OS UNIX System Services Command Reference*.

Path and path name

The set of names required to specify a particular file in a hierarchy of directories is called the *path* to the file, which you specify as a *pathname*. Path names are used as arguments for commands.

An *absolute path name* is a sequence that begins with a slash for the root, followed by one or more directory names separated with slashes, and ends with a directory name or a file name. The search for the file begins at the root and continues through the elements in the path name until it gets to the final name. For example:

```
/u/smitha/projectb/plans/1dft
```

is the absolute path name for **1dft**, the first draft of the plans for a particular project that a user named Alice Smith (**smitha**) is working on.

Instead of using the absolute path name with shell commands, you can specify a path name as relative to the working directory; this is called the *relative path name*. In most cases, a user can specify a particular file without having to use its absolute path name. A relative path name does not have a / at the beginning, and the search for the file begins in the working directory. For example, if Alice Smith is working in the directory **projectb**, she can specify the relative path name for the file **/u/smitha/projectb/plans/1dft** as:

```
plans/1dft
```

A path name can be up to 1023 characters long, including all directory names, file names, and separating slashes. For path names and file names, use characters from the POSIX portable character set. Using DBCS data in these names is not recommended; it may cause unpredictable results.

The system performs *path name resolution* to resolve a path name to a particular file in a file hierarchy. The system searches from element to element in a path name in order to find the file.

Requirement for an absolute path name

In some situations, an absolute path name is required. Table 6 shows that job control language (JCL) and some TSO/E commands require an absolute path name and that they require an MVS data set name to be specified in a certain way. In these situations, the maximum length of the absolute path name is 255 characters.

Table 6. Absolute path name requirements

	Path name	**Dataset name**
JCL	Absolute, in single quotation marks	Fully qualified (no quotation marks needed).
ALLOCATE command	Absolute, in single quotation marks	Fully qualified in single quotation marks. If specified without quotation marks, the TSO/E prefix is added to the data set name. Normally the TSO/E prefix is the TSO/E user ID (this can be changed with the PROFILE PREFIX( ) command).
OEDIT and OBROWSE commands	Absolute, unless you are working in your current directory	Not applicable
OPUT, OGET commands	Absolute (unless you are working in your home directory), in single quotation marks	Fully qualified in single quotation marks. If specified without quotation marks, the TSO/E prefix is added to the data set name. Normally the TSO/E prefix is the TSO/E user ID (this can be changed with the PROFILE PREFIX( ) command).
OPUTX, OGETX commands	Absolute (unless you are working in your home directory)	Fully qualified in single quotation marks. If specified without quotation marks, the TSO/E prefix is added to the data set name. Normally the TSO/E prefix is the TSO/E user ID (this can be changed with the PROFILE PREFIX( ) command).

Resolving a symbolic link in a path name

A symbolic link is a file that contains the path name for another file; that path name can be relative or absolute. If a symbolic link contains a relative path name, the path name is relative to the directory containing the symbolic link.

If you use a symbolic link as a component of a path name, during path name resolution the original path name is changed. How it changes depends on whether the symbolic link contains a relative or absolute path name. For example, consider the path name **/u/turbo/dlg/lev1**:

- If **dlg** is a symbolic link containing the relative path name **dbopt/pgma/src**, **dlg** is replaced by the relative path name. This is how it resolves:

  ```
  /u/turbo/dlg/lev1   →   /u/turbo/dbopt/pgma/src/lev1
  ```

- If **dlg** is a symbolic link containing the absolute path name **/usr/bin/dbopt/pgma/src**, then the components in the original path name that preceded **dlg** are replaced by the absolute path name in the symbolic link. This is how it resolves:

  ```
  /u/turbo/dlg/lev1   →   /usr/bin/dbopt/pgma/src/lev1
  ```

Up to eight symbolic links can be resolved in a path name.

Note: An external link is a type of symbolic link that refers to an object outside of the hierarchical file system. As used by the Network File System feature, an external link refers to an MVS data set name.

Symbolic and external links with a sticky bit

The following behavior applies to DLLs and all forms of **spawn()** and **exec()**. What applies for **exec()** also applies for all forms of module loading.

- External links

  exec() does a **stat()** on the passed file name. **stat()** does the search, not **exec()**. If the file name is an external link, then **stat()** fails with a unique reason code which causes **exec()** to read the external link. If the external link name is a valid PDS member name (that is, 1 - 8 alphanumeric or special characters), then **exec()** attempts to locate the module in the MVS search order. If it cannot find the module, **exec()** fails.

  The external link is normally used when you want to set the sticky bit on for a file name which is longer than eight characters or contains characters that are unacceptable for a PDS member name.

- Symbolic links

  If the file name you specify is a symbolic link and **exec()** sees the sticky bit on, then it truncates any dot qualifiers. As long as the base file name is an acceptable PDS member name, the need to set up links in order to get **exec()** to go to the MVS search order should not be an issue.

  For example, if you have a file named `java.jll`, when you set the sticky bit on, **exec()** attempts to load a member named JAVA. If **exec()** cannot find JAVA, it reverts to using the `java.jll` file in the file system.

  The important thing to understand is that **exec()** never sees the name that the symbolic link resolves to, even though it can see the **stat()** data for the final file.

Example: If you define `/u/user1/name1` as a symbolic link to `/u/user1/name2` and then invoke *name1*, the following occurs:

1. The shell will spawn *name1*.
2. **spawn()** will access the file for *name1*, unaware that there is a symbolic link already established. It will access the *name2* file by its underlying vnode, not by the *name2* handle.
3. If the sticky bit is on for the *name2* file, **spawn()** will do the MVS search for *name1* (the only name it has to work with).

Command differences with symbolic links

Certain directories like **/etc, /dev, /tmp,** and **/var** are converted to symbolic links. Some shell commands have minor technical differences when they refer to symbolic links instead of regular files or directories. For example, **ls** does not follow symbolic links by default.

In order to follow symbolic links, you must specify `ls -L` or provide a trailing slash. For example, `ls -L /etc` and `ls /etc/` both display the files in the directory that the **/etc** symbolic link points to.

Other shell commands that have differences due to symbolic links are **du, find, pax, rm** and **tar**.

While these behavioral changes should be minor, users can tailor command defaults by creating aliases for the shell command. For example, if you want **ls** to follow symbolic links, you could issue the command `alias ls="ls -L"`. Aliases are typically defined in the users' **ENV** file.

Note: After this alias has been established, **ls** will follow all symbolic links.

An administrator can put **alias** commands in **/etc/profile** that could affect all users' login shells. IBM does not recommend this, because changing the default behavior in **/etc/profile** may produce unexpected results in shell scripts or by shell users.

Using commands to work with directories and files

There are numerous shell commands you can use to create and work with directories and files. See the z/OS shell summary section in *z/OS UNIX System Services Command Reference* for a list of them.

To get online help for using the shell commands, you can use the **man** command.

You can also use TSO/E commands to do certain tasks with the file system. Some of these are tasks that UNIX users traditionally perform while in the shell.

Command
Task

ISHELL
Invoke the ISPF shell. This is a panel interface for performing many user and administrator tasks. For more information, see "Using the ISPF shell" on page 169.

MKDIR
Create a directory. Unlike the **mkdir** shell command, this command does not create intermediate directories in a path name if they do not exist.

MKNOD
Make a character special file. To use this command, you must be a superuser.

MOUNT
Add a mountable file system to the file hierarchy. To use this command, you must have mount authority. (See the section on mount authority in *z/OS UNIX System Services Planning*.)

OBROWSE
Browse (read but not update) a z/OS UNIX file using the ISPF full-screen browse facility.

OCOPY
Copy data between sequential data sets, or PDS and PDSE members, and z/OS UNIX files.

OEDIT
Create or edit text using the ISPF editor.

OGET Copy a z/OS UNIX file to an MVS sequential data set or partitioned data set member. You can specify text or binary data, and select code page conversion.

OGETX
Copy one or many files from a directory to a partitioned data set, a PDS/E, or a sequential data set. You can specify text or binary data, select

code page conversion, allow a copy from lowercase file names, and delete one or all suffixes from the file names when they become PDS member names.

OPUT Copy an MVS sequential data set or partitioned data set member to a z/OS UNIX file. You can specify text or binary data, and select code page conversion.

OPUTX
Copy one or many members from a partitioned data set, PDS/E, or a sequential data set to a directory. You can specify text or binary data, select code page conversion, specify a copy to lowercase file names, and append a suffix to the member names when they become file names.

OSTEPLIB
Build a list of files that are sanctioned as valid step libraries for programs that have the set-user-ID or set-group-ID bit set. To use this command, you must be a superuser.

UNMOUNT (or UMOUNT)
Remove a file system from the file hierarchy. To use this command, you must have mount authority. (See the section on mount authority in *z/OS UNIX System Services Planning*.)

For information about existing TSO/E commands that you might commonly use, see *z/OS TSO/E Command Reference*.

To get online help for TSO/E commands, you can use either the TSO/E HELP command. See "Entering a TSO/E command" for information about entering TSO/E commands in TSO/E, the shell, and ISPF.

Entering a TSO/E command

How you can enter a TSO/E command depends on whether you are using the OMVS terminal interface or the asynchronous terminal interface you get with **rlogin**, **telnet**, or the Communications Server.

OMVS terminal interface: You can enter a TSO/E command:

- At the TSO/E `READY` prompt.
- In the shell, using the **tso** shell command. For more information on this command, see *z/OS UNIX System Services Command Reference*.
- In the shell, by typing a TSO/E command at the shell prompt and pressing the TSO function key to run it.
- On an ISPF panel.

CAUTION:
You need to be aware of two things about entering TSO/E commands in ISPF:

1. **On most ISPF panels, you must type TSO before the name of the TSO/E command; for example,**

   ```
   TSO OBROWSE 3 fopen
   ```

   However, on the TSO Command Processor panel (ISPF option 6), you can just enter the name of the TSO/E command, unless the command exists in both ISPF and TSO (for example, HELP or PRINT).
2. **On most ISPF panels, ISPF folds what you type to uppercase. ISPF folds lowercase or mixed-case file names to uppercase, even if they are enclosed in single quotation marks. However, the TSO Command Processor panel (ISPF option 6) processes what you enter exactly as it is typed—mixed case, uppercase, or lowercase.**

Asynchronous terminal interface: You can enter TSO/E commands in the shell, using the **tso** shell command. For more information on this command, see the **tso** command in *z/OS UNIX System Services Command Reference*.

Using a relative path name on TSO/E commands

If you run a TSO/E command by using the OMVS TSO subcommand or function key or the **tso -o** command, the TSO/E command runs in your TSO/E address space. The working directory of your TSO/E address space is typically your home directory. Therefore, if you specify a relative path name on a TSO/E command, the system searches for it in your home directory—even if you are working in a different directory.

If you run a TSO/E command by using the **tso -t** command, it runs in its own process. If you run the command using a relative path name, the system searches for it in your working directory.

Finding the data set that contains a file

To determine which data set (file system) contains a file, use the **df** shell command. You can use **df** to find the data set (file system) that contains your current working directory, or **df** *file name* to find the data set of another file.

Using the ISPF shell to work with directories and files

If you are a user with an MVS background, you may prefer to use the ISPF shell panel interface instead of shell commands or TSO/E commands to work with the file system. The ISPF shell also provides the administrator with a panel interface for setting up users for z/OS UNIX access, for setting up the root file system, and for mounting and unmounting a file system. For more information about the ISPF shell, see “Using the ISPF shell” on page 169.

Using the Network File System feature

Using the Network File System feature, you can mount z/OS UNIX files on an empty directory at your workstation.

To access the z/OS UNIX files, you first enter the **mvslogin** command, which gives you permission to use NFS.

Then you enter the **mount** command to make a connection between a mount point on your local file system and a directory or file in the z/OS UNIX file system. After a directory is mounted, you can create, delete, read, or write to a file in or below that directory in the file hierarchy; generally, you can treat a file in or below that directory as a member of your own workstation file system.

- For text files, the Network File System feature handles conversion between the EBCDIC code page used in the z/OS shell and the ASCII code page used at your workstation.
- RACF checks the authority of a workstation user to access z/OS UNIX files on the host. This is based on the authority of the MVS user ID specified on the **mvslogin** command.

For more information, consult the appropriate Network File System documentation.

External links

An external link is a type of symbolic link that you can use to associate an MVS data set or PDS member with a z/OS UNIX path name. The external link lets the NFS client user transparently access an MVS data set using a path name. A program using the **exec()** family of functions or the BPX1EXC (exec), BPX1LOD (loadhfs), or BPX1SPN (spawn) callable services can also access an MVS data set using an external link.

The data set appears in a mounted z/OS UNIX directory with z/OS UNIX files. If you are working with both MVS data sets and z/OS UNIX files on the workstation, with an external link you can have one directory for both the data sets and the files—for example, **/host**, instead of **/host/ds** for the data sets and **/host/hfs** for the files.

For information about how to create an external link when working at the host, see "Creating an external link" on page 216.

Security for the file system

The security facility is assumed to be the Resource Access Control Facility (RACF). You could use an equivalent security product.

Power® failures and the file system

Should there be a power failure, you might lose recent data that is still buffered, but the file system structures, directories, inodes and such, will not be damaged. A shadow writing technique is used to ensure that structural changes are always committed automatically. The z/OS UNIX file system does its own repair, as needed, on each mount of a file system. This is based on records it keeps of changes in progress.

There is no **fsck** command and the z/OS UNIX file system was designed so that this is not needed. The **fsck** utility generally ensures structural integrity, not data integrity.

Of course, there is always a possibility that user data, critical file system data, or the media can be damaged, so prudent backup procedures are always warranted.

Chapter 15. Converting files between code pages

Enhanced ASCII and Unicode Services make porting applications to z/OS UNIX easier by providing conversion from ASCII to EBCDIC.

Enhanced ASCII

Enhanced ASCII enables users to deal with files that are in both ASCII and EBCDIC format. z/OS is an EBCDIC platform. The z/OS UNIX shells and utilities are configured as EBCDIC programs. That is, characters are coded in the EBCDIC code set. Before z/OS Version 1 Release 2, applications that ran on z/OS UNIX had to exist in EBCDIC form, and expected text data to be stored in EBCDIC form. If you wanted to convert files from EBCDIC to ASCII or ASCII to EBCDIC, you needed to use **iconv**. With Enhanced ASCII, you can deal with applications and their data in your choice of ASCII or EBCDIC code sets. z/OS UNIX still operates as an EBCDIC system, but it can automatically convert the data from ASCII to EBCDIC and back as necessary to complete commands and tasks.

File tagging in Enhanced ASCII

Enhanced ASCII provides support for file tagging. File tags are used to identify the code set of text data within files. When Enhanced ASCII functionality is enabled, z/OS UNIX needs to know whether files are encoded as ASCII or EBCDIC. The file tag provides this data. If no file tag exists on a particular file, that file is treated as an EBCDIC file. Setting a file tag does not force automatic code set conversion but allows it to take place when automatic code set conversion is enabled. For additional information on automatic code set conversion, see "Automatic code set conversion" on page 202.

Note: An entire file system can be mounted such that untagged files and new files created within the file system are treated as tagged while the mount option is in effect.

z/OS utilities provide options to manage tags on UNIX files. The **chtag** command allows you to set, modify, remove, or display information in a file tag. In this example:

```
chtag -t -c ISO8859-1 christmas.songs
```

the file **christmas.songs** is tagged as an ASCII file. ISO8859–1 is the code set for ASCII. In this example:

```
chtag -t -c IBM-1047 christmas.recipes
```

the file **christmas.recipes** is tagged as an EBCDIC file. IBM-1047 is the code set for EBCDIC.

The **ls** command with option **-T** and the command **chtag -p** display information about the file text and codeset tags. For more information about the **chtag** and **ls** commands, see *z/OS UNIX System Services Command Reference*.

Unicode Services

z/OS UNIX exploitation of Unicode Services is functionally similar to that provided for Enhanced ASCII. The basic EBCDIC nature of the z/OS platform remains. Likewise, programs cannot alter their EBCDIC nature as compiled units, except for C programs, which can be compiled as ASCII. Locale restrictions that apply to Enhanced ASCII functions apply to Unicode Services functions as well.

For more information about Unicode Services, see *z/OS Unicode Services User's Guide and Reference*.

File tagging in Unicode Services

Files that are tagged can be converted between any CCSID of the program or user and the CCSID of the file, if Unicode Services supports that conversion. Unlike Enhanced ASCII, which affects conversion of regular file, pipes, and character special files, an environment enabled for Unicode Services environment affects regular files and pipes only. No character special support beyond that provided for Enhanced ASCII is included.

Automatic code set conversion

Automatic conversion of files from one code set to another is controlled globally by the **AUTOCVT(ON|OFF)** parameter in the BPXPRMxx parmlib member. **AUTOCVT** can be overridden by individual programs at a thread level, and therefore is a controlling switch only for programs that do not explicitly establish their own conversion options. The default setting for **AUTOCVT** is **OFF**.

Although the value of **AUTOCVT** can be changed using the **SETOMVS** command, changing the conversion mode does not affect conversion of opened files for which I/O has already started.

Guideline: When **AUTOCVT(ON)** is set, every read or write operation for a file is checked to see if conversion is necessary. A performance penalty is therefore involved, even if no conversion occurs. It is recommended that **AUTOCVT** be left off and each program be enabled for conversion.

For information on commands that allow or disallow automatic code set conversion by default, see Appendix L. Automatic Codeset Conversion: Default Status for Specific Commands in *z/OS UNIX System Services Command Reference*.

Porting considerations

If your system administrator enabled Enhanced ASCII or Unicode Services, you can able to tell z/OS UNIX which files are ASCII (code set ISO8859-1) files and which files are EBCDIC (code set IBM-1047) files. This enhanced functionality is useful when working with portable XPG 4.2 applications that are written in ASCII. You can port an application to z/OS UNIX, compile it in ASCII, and also tag text files as ASCII. z/OS UNIX performs conversion when an ASCII program reads or writes an EBCDIC tagged file or when an EBCDIC program reads or writes an ASCII tagged file.

For more information about enabling Enhanced ASCII or Unicode Services at the system level, see Using Enhanced ASCII and Using Unicode Services in *z/OS UNIX System Services Planning*. For information about porting applications to z/OS UNIX, see *z/OS UNIX System Services Porting Guide*.

Chapter 16. Working with directories

This information covers these topics:
- The working directory
- Displaying the name of your working directory
- Changing directories
- Creating a directory
- Removing a directory
- Listing directory contents
- Comparing directory contents
- Finding a directory or file

The working directory

The shell always identifies a particular directory within which you are assumed to be working. This directory is known as the *working directory* (also known as the *current working directory*). To work with a file within your working directory, you need specify only the file name with a command. If you want to work with a file in another directory, you can change your working directory, using the **cd** shell command and naming the new directory.

Tip: Instead of changing directories, you could use relative notation to access a file in a different directory; see "Using notations for relative path names" on page 204 for more information.

When you type the OMVS command and begin working in the shell environment, you are placed in your *home directory* as your working directory.

Displaying the name of your working directory

To check on the name of the directory you are currently working in, just enter the **pwd** command (print working directory).

If Alice Smith is working in her home directory, for example, the system displays the name of her working directory in this form:

```
/u/smitha
```

/u/smitha is the *pathname* of her working directory.

If Alice Smith enters the command `cd projecta`, the **projecta** subdirectory of her home directory becomes her working directory. If she issues the **pwd** command, it displays:

```
/u/smitha/projecta
```

Note: A directory name can be specified in two ways, with or without a trailing slash; for example:

/u/smitha/projecta
/u/smitha/projecta/

In this topic, a trailing slash is not used.

Changing directories

Use the **cd** command to change from one working directory to another. If you have permission to access the directory, you can move to any directory in the file system by using **cd** and the path name for the directory:

```
cd pathname
```

See Chapter 18, "Handling security for your files," on page 231 for more information on directory permissions.

When you want to go to your home directory, just enter the **cd** command with no arguments:

```
cd
```

To change to a directory other than your home directory, you must supply the path name. For example, if Alice Smith is working in her home directory (**smitha**) and she wants to switch to her **projectb** directory, she types the relative path name:

```
cd projectb
```

To check that she has changed directories, Alice types **pwd** and the system displays:

```
/u/smitha/projectb
```

Using notations for relative path names

To change directories quickly or to work with a file name in another directory, use these relative path name notations:

dot notation (**.** and **..**)
tilde notation (**~**)

Dot notation

If you use the **ls -a** command to list the contents of a directory, you see that every directory contains the entries **.** (dot) and **..** (dot dot):

. (dot) This refers to the working directory.

.. (dot dot)
This refers to the parent directory of your working directory, immediately above your working directory in the file system structure.

If one of these is used as the first element in a relative path name, it refers to your working directory. If **..** is used alone, it refers to the parent of your working directory.

For example, if you are working in **/bin/util/src**, you can go to **/bin/util** by entering:

```
cd ..
```

Tilde notation

A ~ (tilde) can be used from the z/OS shell in several forms:

Notation	Meaning

~	Your home directory (that is, the directory given by your **HOME** environment variable). The command:
	`cp ~/file1 file2`
	
	copies **file1** in your home directory into **file2** in your working directory. This works regardless of what your working directory is.
	`cp file1 ~/dir`
	
	copies **file1** from the working directory into **dir** in your home directory.

~ +	The variable **$PWD** (which contains the name of your working directory).
~ –	The variable **$OLDPWD** (which gives the name of the working directory you were in immediately before the last **cd** command).
~*login name*	That user's home directory. **Example:** To display the profile file of **allane**, from that user's home directory, issue: `cat ~allane/.profile` This is useful if there are a group of you working on a project and you have read-write access to some of each other's files. **Note:** In the z/OS shell, your *login name* is your TSO/E user ID.

Example

Suppose that your home directory is **/u/turbo** and you are working in **/u/turbo/prog/src**, and you want to display the file **limits** in the directory **/u/turbo/appl/hdr**. You could refer to the file in several different ways:

```
cat ../../appl/hdr/limits
cat ~/appl/hdr/limits
cat /u/turbo/appl/hdr/limits
```

Creating a directory

Using the shell: To create a new directory, enter:

`mkdir pathname`

For example, if Alice Smith is working in her home directory, **smitha**, and she wants to create a new directory, **projecta**, under her working directory, she would enter:

```
mkdir projecta
```

The default mode (read-write-execute permissions) for a directory created with **mkdir** is:

owner=rwx
group=rwx
other=rwx

For directories, execute permission means permission to search the directory. The octal representation of these permissions is 777 (7 for the owner permission bits, the group permission bits, and the other permission bits).

The new directory, **projecta**, is one level below her working directory. Figure 19 shows this relationship. If you do not specify an absolute path name for the directory to be created, the shell creates the new directory as a subdirectory of whatever your working directory is at the time you enter the command.

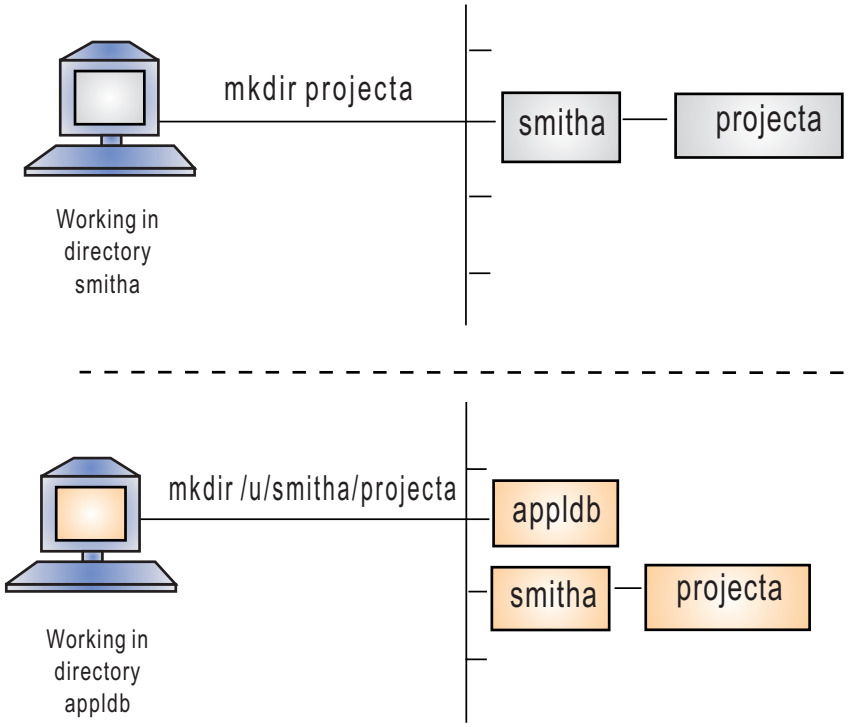


Figure 19. Creating a new directory

If you want to create a new directory that is *not* under your working directory, specify an absolute path name. Both directory names and file names can be up to 255 characters long. You may want to adopt some naming convention that allows you to distinguish between directory names and file names.

Your business may have adopted naming conventions for directories. For example, a typical convention is for each user to be assigned a directory based uniquely on the TSO/E user ID to make the name unique. Only that user would have write access to the directory. For information on how to change access permissions for a directory or file so that other users can read or write to it, see Chapter 18, "Handling security for your files," on page 231.

Using TSO/E: To create a new directory, enter:

```
MKDIR 'directory_name' MODE(directory_permission_bits)
```

where *directory_name* specifies the path name of the directory to be created. The path name can be a full path name or a relative path name. Specify the name, which can be up to 1023 characters long, in single quotation marks. Specify MODE, the directory permission bits, in 3 octal characters; they can be separated by commas or blanks. The default mode (read-write-execute permission) is:

owner = rwx
group = r-x
other = r-x

The octal representation of these permissions is 755. (When MKDIR is used to create a directory, the default permission bits are different from when **mkdir** is used.) Here execute permission means permission to search the directory.

Example: To specify a directory with a full path name and mode 700, enter:

```
MKDIR '/u/smitha/umods' MODE(7,0,0)
```

It is best to use a full path name with the MKDIR command. When a relative path name is specified, MKDIR defines the directory in the user's home directory, regardless of the working directory. If user Alice Smith is in her home directory **smitha** and wants to create a directory with a relative path name and the default mode, she can enter:

```
MKDIR 'umods'
```

The directory **umods** is one level below her home directory, **smitha**. Its full path name is /u/smitha/umods.

Removing a directory

You can remove an empty directory (one with no files or subdirectories) from the file system with the **rmdir** command. The format of the command is:

```
rmdir directory
```

To remove your working directory, you must first move into another working directory.

To delete the files in a directory and the directory itself in one step, use the **rm** command with the **-r** option. The format of the command is:

```
rm -r file
```

where **file** is the name of the directory. Be careful! You may want to use the **-i** option so that you will be prompted to confirm the deletions:

```
rm -ri file
```

Listing directory contents

The **ls** command lists the contents of a directory. To see the contents of your working directory, enter:

```
ls
```

To list the contents of a different directory, add the relative or absolute name of the directory you want to look at, as in:

```
ls dira/dirb
ls abc/def/ghi
```

ls displays directory contents in alphabetic order. Typical **ls** output looks like:

```
bin         csrb.cpy    fifotest    makefl         temp.t
cc          etc         helplist    phones.com     totals
```

ls does not normally distinguish between directories, regular files, and special files. If you want a list of directory contents that distinguishes between file types, use the **-F** option. Entering:

```
ls –F
```

gives you output in the form:

```
bin/        csrb.cpy    fifotest|   makefl/        temp.t
cc/         etc/        helplist    phones.com*     totals/
```

The symbols following the file names indicate the type of file:

/ Directory
* Executable file
| FIFO special file
@ Symbolic link
&; External link

If there is no character following the file name, the file is none of these types.

ls can list the contents of more than one directory at a time. For example:

```
ls dir1 dir2
```

lists the contents of the two given directories, one after the other. Try this command on a pair of directories to see what format **ls** uses.

The **ls** command with the **-E** option displays a character indicating whether or not the program is loaded from the shared library region. If the program is from the shared library region, an 'l' will appear as the fourth character in the second column. If the program is not from the shared library region, a '-' will appear. For example:

```
total 11
-rwxr-xr-x  -ps-    1 FRED  SYS1  101 Oct 02 16:30 james
-rwxrwxrwx  a-s-    1 FRED  SYS1  654 Oct 02 16:30 backup
-rwxr-xr-x  a---    1 FRED  SYS1   40 Oct 02 16:30 temp
-rwxr--r--  ap-l    1 FRED  SYS1  562 Oct 02 16:34 diag
-rwxr--r--  --sl    1 FRED  SYS1  106 Oct 02 16:53 bird
```

In this example, the files *james*, *backup*, and *temp* are not loaded from the shared library region, but the files *diag* and *bird* are.

Comparing directory contents

You can use the command:

```
diff -r dir1 dir2
```

to check whole directories for changes. With the **-r** option, **diff** compares the files in **dir1** with the files in **dir2** that have the same names.

This command can be useful if you have two directories that hold different versions of the same files and subdirectories.

You can use the **-r** option with other commands. For example:

```
cp -r dir1 dir2
```

copies all the files and subdirectories from **dir1** to **dir2**.

```
rm -r dir
```

removes all the files and subdirectories under **dir** and then removes **dir** itself.

Finding a directory or file

The **find** command lists the names of all the files under a directory with a given characteristic or set of characteristics. The simplest version of the command is:

```
find dirname
```

It displays the names of all files under the given directory, including files in subdirectories under the directory.

To display the names of all files whose names have the form specified in *pattern*, issue:

```
find dirname –name pattern
```

Example: To list the names of all files under the directory **abc** with the file name extension **.lst**,issue: (

```
find abc –name '*.lst'
```

The asterisk (*) is a wildcard character that stands for any sequence of zero or more characters.l Using **find**, you can locate files quickly, even when you have a complicated file system structure, with many directories and subdirectories. See the **find** command description in *z/OS UNIX System Services Command Reference*.

Chapter 17. Working with files

This information covers these topics:
- Using an editor to create a file
- Naming files
- Deleting a file
- Deleting files over a certain age
- Identifying a file by its inode number
- Creating links
- Deleting links
- Renaming or moving a file or directory
- Comparing files
- Sorting file contents
- Counting lines, words, and bytes in a file
- Searching files by using pattern matching
- Browsing files
- Simultaneous access to a file
- Backing up and restoring files
- Listing process IDs of processes with open files

Using an editor to create a file

When you are logged into the shell, you have a choice of editors to use to create and change files, depending on which terminal interface you are using, OMVS or the asynchronous terminal interface. For details about the editors, see Chapter 19, "Editing files," on page 241.

If you are using NFS from your workstation, you can edit z/OS UNIX files directly with your editor of choice.

When you create directories and files, you can control access to them. Whenever you want, you can change the *access permissions* that are set when you first create a directory or file. See Chapter 18, "Handling security for your files," on page 231 for more information about access permissions.

Naming files

A file name can be up to 255 characters long. To be portable, the file name should use only the characters in the POSIX portable file name character set:
- Uppercase or lowercase A to Z
- Numbers `0` to 9
- Period (`.`)
- Underscore (_)
- Hyphen (-)

Do not include any nulls or slash characters in a file name.

The POSIX portable file name character set (see "The POSIX portable file name character set" on page 324) is a subset of the POSIX portable character set, which is listed in "The POSIX portable character set" on page 324.

The POSIX portable character set (see "The POSIX portable character set" on page 324) is a complete list of all valid characters for a file name.

Restriction: Double-byte characters are not supported in a file name and are treated as single-byte data. Using double-byte characters in a file name might cause problems. For instance, if you use a double-byte character in which one of the bytes is a `.` (dot) or `/` (slash), the file system treats this as a special delimiter in the path name.

The shells are case-sensitive, and distinguish characters as either uppercase or lowercase. Therefore, FILE1 is not the same as `file1`.

A file name can include a suffix, or *extension*, that indicates its file type. An extension consists of a period (`.`) and several characters. For example, files that are C code could have the extension `.c`, as in the file name `dbmod3.c`. Having groups of files with identical suffixes makes it easier to run commands against many files at once.

Processing in uppercase and lowercase

Case-sensitive processing means that an environment distinguishes and handles characters as either uppercase or lowercase: **FILE1** is not the same file as **file1**. The availability of case-sensitive processing depends on the environment:

Shell Case-sensitive. In the file system, you can use mixed-case path names.

ISPF To issue a TSO/E command with a z/OS UNIX path name and get case-sensitive processing of the path name, enter the command on a command line that supports mixed-case processing, for example the Command Processor panel (usually ISPF option 6). Some ISPF option panels convert the command and file name to uppercase before they are processed.

The default ISPF edit profile usually folds to uppercase the data you enter in a file. To prevent this, type `caps off` on the command line before you begin working in the file. After you enter `caps off`, it remains in your profile.

If you are working on a file and realize that you have been typing in uppercase when you really wanted lowercase, you can change the contents of the file to all lowercase. Type this on the command line:

```
c all p'>' p'<'
```

TSO/E Case-sensitive. Follow the syntax rules of the command you are using. For instance, make sure to enclose a path name in single quotation marks when using commands such as ALLOCATE, OPUT, and so on.

JCL Case-sensitive. You can specify z/OS UNIX files in DD statements by giving the absolute path name (no relative path names) and enclosing the names in single quotation marks. Be careful to keep JCL keywords such as DD, PATH, and so on, in uppercase.

Note: Traditional MVS utilities may define their own requirements for allowing mixed-case file names to be specified as input (as compared with the rules for specifying mixed-case file names on DD statements in JCL). For example, you need to use the binder's CASE=MIXED option if you want to bind a load module into the file system and give the load module a lowercase name.

Deleting a file

The command **rm** can delete, or remove, several files at once. For example:

```
rm file1 file2 file3
```

removes all the specified files.

Suppose Alice Smith's directory **projectb** had several old meeting notices in it that she wanted to delete: **0607.mtg**, **0615.mtg**, **0623.mtg**, and **0628.mtg**. She could remove all four with just a single command:

```
rm 06*.mtg
```

Tip: Be careful when using the wildcard asterisk (*) for removing files; you may want to use the **-i** option, which prompts you to verify the deletion.

For the tcsh shell, see "Displaying deletion verification" on page 65 for more information on how to control the wildcard asterisk.

Deleting files over a certain age

The **skulker** shell script provides a way to delete files in a directory based on comparing the file's access time to a specified age. This can be useful for removing temporary files created by utilities, or files that were intended to be temporary but were forgotten about.

The **skulker** script is a z/OS shell script, and can be easily modified to fit any particular system or user need. The script is located in **/samples**, but the system administrator should have relocated it somewhere else. Check with the system administrator for the location of the script. You should copy the script into your home directory or subdirectory, where you can modify it if you desire different removal criteria.

It is also possible to invoke the **skulker** script with the **cron** daemon so that it may be run on a regular basis.

The format for running the **skulker** script is as follows:

```
skulker [-iw] [-r|-R] [-l logfile] directory days_old
```

The **-i** option displays the files that are candidates for deletion, and then prompts the user to terminate the script or continue with the deletion.

The **-w** option does not delete the files, but sends a warning to the owner of each file (via **mailx**) that the file is a candidate for deletion.

The **-r** option moves recursively through subdirectories, finding non-directory files that are equal to or older than the specified number of days. The **-r** option is mutually exclusive with the **-R** option.

The **-R** option moves recursively through subdirectories, finding both non-directory files and subdirectories that are equal to or older than the specified number of days. Any subdirectories that are found as candidates for deletion are only deleted if they are empty after all their contents (files, subdirectories and files in subdirectories) that are candidates for deletion have been deleted. The **-R** option is mutually exclusive with the **-r** option.

The **-l** *logfile* specifies a *logfile* to store a list of files that have been deleted, are candidates for deletion, or for which warnings have been mailed; and any errors that might have occurred.

directory specifies the directory in which to look for files that are candidates for deletion.

days_old specifies the age of files you want to remove, based on when the file was last accessed.

For more information about the **skulker** script, including restrictions, see **skulker** in *z/OS UNIX System Services Command Reference*.

Identifying a file by its inode number

In addition to its file name, each file in a file system has an identification number, called an *inode number*, that is unique in its file system. The inode number refers to the physical file, the data stored in a particular location. A file also has a device number, and the combination of its inode number and device number is unique throughout all the file systems in the hierarchical file system.

A directory entry joins a file name with the inode number that represents the physical file.

To display the inode numbers of the files in your working directory, enter:

```
ls -i
```

If Alice Smith issues that command for her **proja** directory, she sees the following display:

```
1077 inspproc   1077 isoproc    1492 kgnproc   1500 mcrproc
```

Because the files **inspproc** and **isoproc** are hard-linked, they have the same inode number.

Creating links

A *link* is a new path name, or directory entry, for an existing file. The new directory entry can be in the same directory that holds the file or in a different directory. You can access the file under the old path name or the new one. After you have a link to a file, any changes you make to the file are evident when it is accessed under any other name.

You might want to create a link:

- If a file is moved and you want users to be able to access the file under the old name.
- As an alias: You can create a link with a short path name for a file that has a long path name.

You can use the **ln** command to create a hard link or a symbolic link. A file can have an unlimited number of links to it.

Creating a hard link

A *hard link* is a new name for an existing file. You cannot create a hard link to a directory, and you cannot create a hard link to a file on a different mounted file system.

All the hard link names for a file are of equal importance with its original name. They are all real names for the one original file. To create a hard link to a file, use this command format:

```
ln old new
```

Thus, *new* is the new path name for the existing file *old*. In Figure 20, `/u/benson/proja` is the new path name for the existing file `/u/smitha/proja`.

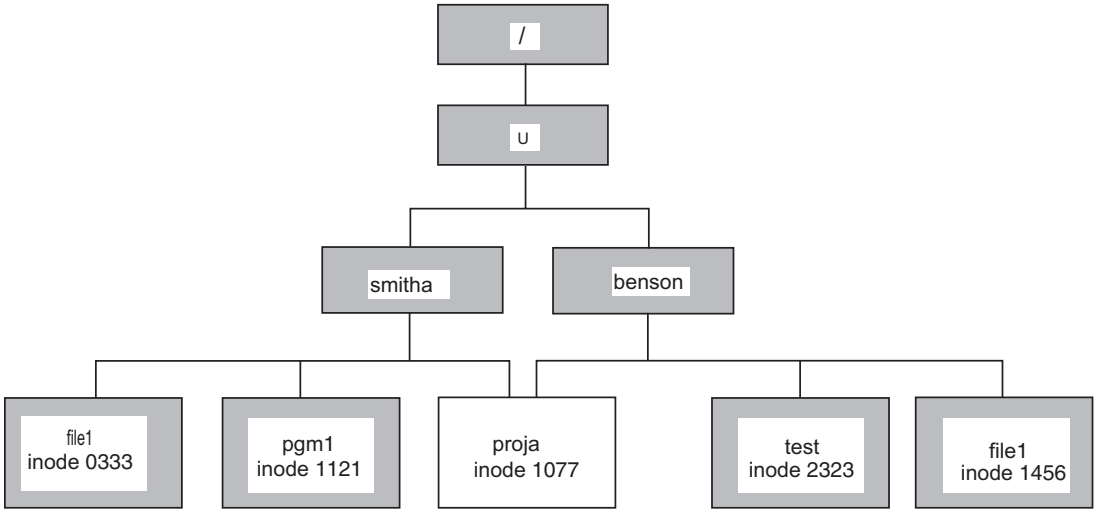


Figure 20. Hard link: a new name for an existing file. The hard link has an identical inode number.

When you create a hard link to a file, the new file name shares the inode number of the original physical file, as shown in Figure 20. Because an inode number represents a physical file in a specific file system, you cannot make hard links to other mounted file systems.

Creating a symbolic link

You can create a symbolic link to a file or a directory. Additionally, you can create a symbolic link across mounted file systems, which you cannot do with a hard link. A *symbolic link* is another file that contains the path name for the original file—in essence, a reference to the file. A symbolic link can refer to a path name for a file that does not exist.

To create a symbolic link to a file, use this command format:

```
ln -s old new
```

Thus, *new* is the name of the new file containing the reference to the file named *old*. In Figure 21 on page 216, `/u/benson/proja` is the name of the new file that contains the reference to `/u/smitha/proja`.

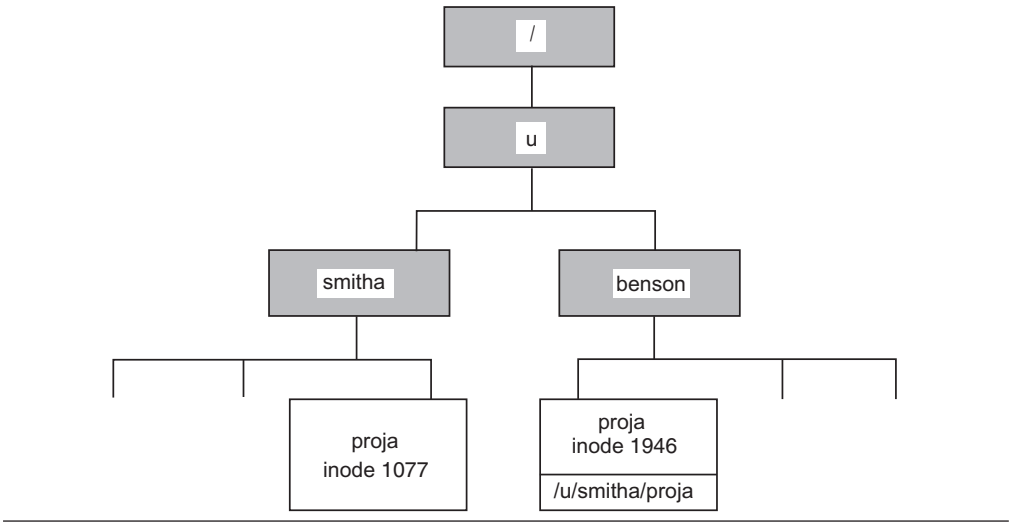


Figure 21. Symbolic link: a new file. A symbolic link has its own inode number.

When you create a symbolic link, you create a new physical file with its own inode number, as shown in Figure 21. Because a symbolic link refers to a file by its path name rather than by its inode number, a symbolic link can refer to files in other mounted file systems.

To understand how a symbolic link that is a component of a path name is handled during path name resolution, see "Resolving a symbolic link in a path name" on page 195.

Creating an external link

An *external link* is a special type of symbolic link, a file that contains the name of an object outside of the z/OS UNIX file system. Using an external link, you associate that object with a path name. For example, **setlocale()** searches for locale object files in the z/OS UNIX file system, but if you want to keep your locale object files in a partitioned data set, you can create an external link in the file system that points to the PDS. This will improve performance by shortening the search made by **setlocale()**.

A file can be an external link to a sequential data set, a PDS, or a PDS member. When a file is an external link to an MVS data set, an NFS client user can use the path name to access the data set. To use the path name to edit, browse, or display the attributes of the data set that is the target of an external link, you must be using the Network File System feature. Working in a shell, you can create (**ln**) an external link, display information (**ls**) about the link (not the target of the link), or delete (**rm**) the link.

These services support external links:

- NFS client: You can create external links as files within the z/OS UNIX file system and then access these files as an NFS client user to access the MVS data sets that they point to.
- A program using the **exec()** family of functions, the BPX1EXC (exec) callable service, the BPX1LOD (loadhfs) callable service, or the BPX1SPN (spawn)

callable service can access an MVS data set using an external link. This capability includes external link programs that are invoked as commands in the shell.

- Dynamic link libraries: The external link name used on a DLL load is a member name. For example, you would code a link as:

```
ln -e IMWYWWS /usr/lpp/internet/bin/wwwss.so
```

  where IMWYWWS is the member name that is linked to the file `wwwss.so`.

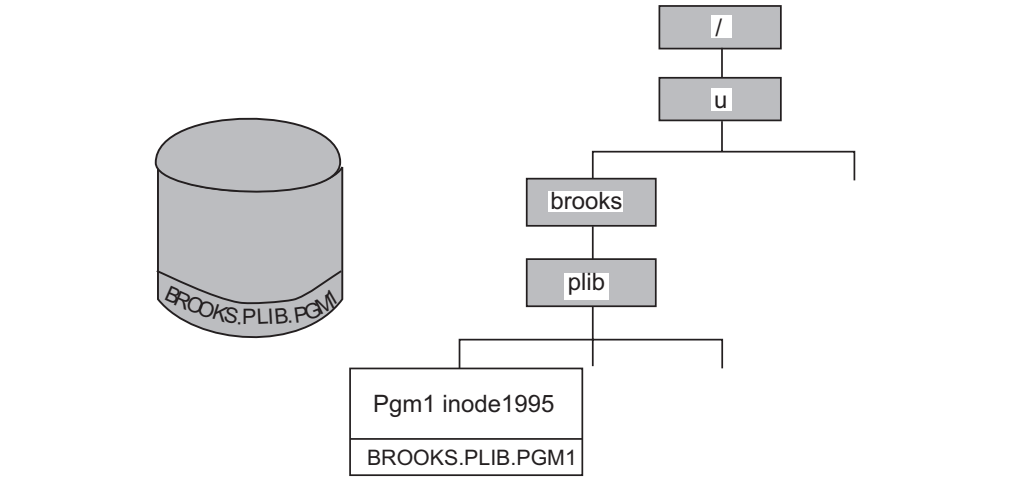


Figure 22. External link: A new file. An external link has an inode number. The MVS data set does not.

To create an external link to a data set, use this command format:

```
ln -e old new
```

In Figure 22, `/u/brooks/plib/pgm1` is the name of the new file that contains the reference to the partitioned data set BROOKS.PLIB.PGM1.

Limitations of an external link: z/OS UNIX C programs running cannot **fopen()** or **fread()** an external link. For more information, see the **ln** command description in *z/OS UNIX System Services Command Reference*.

Due to NFS protocol limitations, **-e** does not create an external link on NFS. For more information on creating an external link on NFS, see Creating an external link in *z/OS Network File System Guide and Reference*.

Deleting links

To delete a file that has hard links, you must enter **rm** against all the link names, including the original file name. If you try to delete a file that is hard-linked, its contents do not disappear until you remove every link to it.

To delete a file that is a symbolic link, you enter **rm** against the symbolic link name. This removes the link, not the file it refers to. When you delete a file that is symbolically linked, any remaining symbolic links refer to a file that no longer exists. If you know the names of the symbolic link files, you may want to delete them.

To delete a file that is an external link, run **rm** against the external link name. If you delete a data set that is externally linked, the remaining external link refers to a data set that no longer exists.

Renaming or moving a file or directory

You can use the **mv** command to *move* or rename files. For example:

```
mv file1 file2
```

moves the contents of *file1* to *file2* and deletes *file1*. This is similar to:

```
cp file1 file2
rm file1
```

except that, when the files are in the same mountable file system, **mv** renames the file rather than copying it. *file1* and *file2* do not have to be in the same directory.

The **mv** command can move several files from one place to another.

For example:

```
mv file1 file2 file3 directoryb
```

moves all three files to *directoryb*.

Using the **-R** or **-r** option, you can move a directory and all its contents (files, subdirectories, and files in subdirectories) into another directory. For example:

```
mv -R directorya directoryb
```

Comparing files

Consider the following situation: A warehouse has an *active file* that keeps track of current inventory. As goods are brought in, appropriate records are added to the file. As orders are shipped out, the records are deleted. At the end of the day, the warehouse makes a copy of the active file to keep as a permanent journal.

It would be useful for such a business to be able to compare one day's journal to another day's to see what has changed. This can be done with the **diff** command:

```
diff oldfile newfile
```

compares the two files. The output of **diff** shows lines that are in one file but not in the other. The lines in *oldfile* but not in *newfile* are displayed with a < in front of them. Lines in *newfile* but not in *oldfile* are displayed with > in front.

For example, say you have a file **wmnhist.text** with one line in it:

```
Susan B. Anthony awoke one morning
```

Then you created a copy of the file with the command:

```
cp wmnhist.txt newhist.txt
```

You use an editor—either the ISPF editor or the **ed** text editor—to change the first line in **newhist.text** to:

```
Sojourner Truth awoke one morning
```

You save the file. Now you enter the command:

```
diff wmnhist.txt newhist.txt
```

diff displays:

```
1c1
< Susan B. Anthony awoke one morning
--->
 Sojourner Truth awoke one morning
```

The `1c1` at the beginning of the **diff** output indicates that line 1 in the old file has changed (`c`) when compared with line 1 in the new file. **diff** shows what must be changed in the first file to make it look like the second file. Remember this sequence when you look at the output of **diff**. Here the first file, **wmnhist.txt**, contained the line `Susan B. Anthony awoke one morning` where the second file, **newhist.txt**, has `Sojourner Truth awoke one morning`.

New lines are indicated with an `a` (add lines), and lines that should be deleted are indicated with a `d` (delete). See the **diff** command description in *z/OS UNIX System Services Command Reference* for more details.

diff helps you determine what has changed in the time that elapsed between saving the two files. The same sort of operation is useful in many record-keeping situations, any time you have two different versions of the same file and you want to check the differences.

Sorting file contents

When you create a file of records, you usually do not type the information in any particular order. However, you may want to keep lists in some useful order after you have entered the information. To sort the records in a file, use the **sort** command. **sort** assumes two things:

- Your file contains one record per line. To put it another way, there is a single <newline> character between a record and the next record.
- The fields in a record are separated by recognizable characters. In the sample file **comics.lst** in **/samples** (shown in Figure 23), we use colons.

```
Detective Comics:572:Mar:1987:$1.75
Demon:2:Feb:1987:$1.00
Ex-Mutants:1:Sep:1986:$2.60
Justice League of America:259:Feb:1987:$1.00
Boris the Bear:1:Sep:1986:$1.50
Flaming Carrot:14:Oct:1986:$2.75
Demon:4:Apr:1987:$1.00
The Question:1:Jan:1987:$2.10
Elektra:7:Feb:1987:$2.00
Howard the Duck:29:Jan:1979:$0.35
Wonder Woman:3:Apr:1987:$1.00
Justice League of America:261:Apr:1987:$1.00
```

Figure 23. A sample file: comics.lst

To sort a file such as our comic book file, enter:

```
sort /samples/comics.lst
```

This command sorts the list and displays it. To save the sorted list in a file, enter:

```
sort /samples/comics.lst >filename
```

where *filename* is the name of the file where you want to store the sorted list. For example:

```
sort /samples/comics.lst >sorted.lst
```

sorts the file and stores the result in **sorted.lst** without changing the input file.

When you use `>filename` to redirect sorted output into a file, you may want to make the output file name different from the (unsorted) input file name. If you want to overwrite a file with its sorted contents, see the description of the **–o** flag in the **sort** command description in *z/OS UNIX System Services Command Reference*.

Using sorting keys — an example

By default, **sort** sorts according to all the information in the record, in the order given in the record. Since the name of the comic book is the first thing on the line, the output is sorted according to comic book name. But suppose that you want to sort according to some different piece of information. For example, suppose you want to sort by date of publication. You can do this by specifying sorting keys.

A *sorting key* tells **sort** to look at specific fields in a record, instead of looking at each record as a whole. A sorting key also tells what kind of information is stored in a particular field (for example, an ordinary word, a number, or a month) and how that information should be sorted (in ascending or descending order).

A sorting key can refer to one or more fields. Fields are specified by number. The first field in a record is field number 1, the field after the first separator character is field number 2, and so on. In the comic book list, the month is field number 3, and the year is field number 4.

A single **sort** command can have several sorting keys. The most important sorting key is given first; less important sorting keys follow. Let us look at an example that sorts by year and then by month within a year. Therefore, the first sorting key refers to the year field, and the second to the month field. To specify a sorting key, use the **-k** option. This option has the following format:

```
-k start_field[.char1] [opts] [,end_field[.char2] [opts]]
```

where *start_field*, *end_field*, *char1*, and *char2* are all integers.

- *start_field* indicates which field in the input record contains the start of the sorting key.
- *char1* indicates which character in that field is the first character of the key. Omitting *char1* means the key begins with the first character of the starting field.

In our example, the first sorting key (referring to the year) has a *start_field* value of `4` (since the year is field 4). We do not need to specify *char1*, since we want to start the key with the first character of the year field.

The options, *opts*, are specified with letters; they identify the type of data in the specified field and tell how to sort it. Some of the possible options and their meanings are:

d Indicates that the field contains uppercase, lowercase, or mixed-case letters, letters and digits, or digits. **sort** sorts the field in *dictionary* order, ignoring all other characters.

M Indicates that the field contains the name of a month. **sort** looks only at the first three characters of the name, so `January`, `JAN`, and `jan` are all equal.

n Indicates that the field contains an integer (positive or negative).

Putting an `r` after any of these letters tells **sort** to sort in reverse order (from highest to lowest rather than lowest to highest). For example, `Mr` means to sort in the order `December`, `November`, `October`, and so on.

In our example the sorting key based on the year uses `n`. Thus, the sorting key for the year field (4) in the file **comics.lst** is:

```
-k 4n
```

The second sorting key in the example refers to the month field (3). This key has the form:

```
-k 3M
```

A **sort** command that uses sorting keys needs to know which character separates the record fields. You can specify this with the option **-t** followed by the separator character. The example uses **-t:**. Therefore, the full **sort** command is:

```
sort -t: -k4n -k3M  comics.lst >sorted.lst
```

The file to be sorted comes after the various options. This is the order that you must use. The redirection construct can come anywhere on the line, but is usually put at the end.

Counting lines, words, and bytes in a file

The **wc** command tells you how big a text document is.

```
wc file file ...
```

tells you the number of lines, words, and bytes in each file.

If you want to find out how many files are in a directory, enter:

```
ls | wc
```

This pipes the output of **ls** through **wc**. Because **ls** prints one name per line when its output is being piped or redirected, the number of lines is the number of files and directories under your working directory.

Searching files by using pattern matching

One of the most common record-keeping operations is obtaining a sublist of a list. For example, you might want to list all the *Watchmen* comics that appear in the main comics list. The command to do this is **grep**.

The simplest form of the **grep** command is:

```
grep word file
```

where *word* is a particular sequence of characters that you want to find, and *file* is your list of records. **grep** lists every line in the file that contains the given word. For example:

```
grep Watchmen comics.lst
```

lists every line in **comics.lst** that contains the word `Watchmen`. As another example:

```
grep 1986 comics.lst
```

lists every line in **comics.lst** that contains the sequence of characters `1986`. Presumably, this lists all the comics that were published in 1986.

```
grep Jul:1986 comics.lst
```

lists all the comics published in July 1986.

If the string of characters you want to search for contains a blank, put single quotation marks (apostrophes) around the string; for example:

```
grep 'Dark Knight' comics.lst
```

You can save a sublist created by **grep** in a file using redirection:

```
grep Elektra comics.lst >el.lst
```

Patterns

The examples of **grep**, so far, have displayed the records in a file that contain the desired string anywhere in the line. If you want to be more specific—say to find records that *begin* with a certain string of characters (instead of having that string anywhere in the line)—use **grep** with *patterns* instead of strings.

To understand patterns, it helps to think about the special wildcard characters discussed in "Using a wildcard character to specify file names" on page 80. Remember that you can use patterns in commands; for example:

```
rm *.txt
```

removes all files in the working directory that have the **.txt** extension. Instead of specifying a single file name, this example uses the special character * to represent any file name of the appropriate form.

In the same way, a **grep** pattern uses special characters so that one pattern can represent many different strings.

Note: The special characters for **grep** patterns are not the same as the characters used on command lines, and the mechanisms involved are also different: however, patterns and *wildcard characters* are conceptually similar.

Special characters used in a pattern are called *pattern characters*, or *metacharacters*. Some pattern characters are:

^ (caret)
: Stands for the beginning of a line. For example, **^abc** is a pattern that represents *abc* at the beginning of a line.

$ (dollar sign)
: Stands for the end of a line. For example, **xyz$** is a pattern that represents *xyz* at the end of a line.

. (dot or period)
: Stands for any (single) character. For example, **a.c** is a pattern that represents *a*, followed by any character, followed by *c*.

*** (asterisk)**
: Indicates zero or more repetitions of part of a pattern. For example, **.*** indicates zero or more repetitions of **.** (period). Since the **.** stands for any character, **.*** stands for any number of characters. For example, **^a.*z$** is a pattern that represents *a* at the beginning of a line, *z* at the end, and any number of characters in between.

A typical **grep** command has the form:

```
grep 'pattern' file
```

This displays all the records in the file that match the given pattern. For example:

```
grep '^Superman' comics.lst
```

displays all the records that begin with the word *Superman*.

```
grep '00$' comics.lst
```

displays all the records that end in *00*.

If you want to use the *literal* meaning of a pattern character instead of its special meaning, put a backslash (\) in front of the character.

Example: To find all the lines that end in *$1.00*, issue:

```
grep '\$1\.00$' comics.lst
```

Without a backslash in front of the **$** and **.** (period), these characters would have their special pattern meanings.

Regular expressions

More complex patterns than the ones discussed here are accepted. The formal name for a pattern is a *regular expression*. For further information, see Appendix C. Regular Expressions (regexp) in *z/OS UNIX System Services Command Reference*.

Browsing files

When you display, or browse, a file, you cannot make any changes to the file while you are viewing it. You can browse a z/OS UNIX file using ISPF or using shell commands. With shell commands, you have the choice of browsing the file in an unformatted or formatted display.

Browsing files without formatting

Using the shell: The z/OS shell has a quick way to find out what is in a given file: the **head** command and the **tail** command.

head *filename*
: Displays the first 10 lines of the given file or files.

tail *filename*
: Displays the last 10 lines of the given file or files.

Suppose you have a file that contains records sorted according to date. **tail** tells you the date of the last records in the file, giving you an idea of how current the file's contents are. In a sorted comic book list, for example, **tail** could show the most recent comics that had been recorded in the file.

To display the contents of an entire file, you can use any of these commands: **cat**, **pg**, **more**, or **obrowse**.

Using ISPF: To use ISPF to browse a z/OS UNIX file, you can take one of the following actions:

- Enter the TSO/E OBROWSE command followed by the path name for the file. This command displays the file, which you can begin browsing.
- Select an option for browse on the ISPF menu, if such an option is available.

After the file is displayed, you can use function keys to scroll forward and backward in the file.

For complete information about browsing, see *z/OS V2R2 ISPF User's Guide Vol II*.

Browsing files with formatting

Using the shell: The term *formatting* refers to controlling the appearance of the file contents when you browse or print them. You can use the **pr** command to browse (or print to standard output) a formatted file:

```
pr file
```

You can specify more than one file name, each separated from the other by a space.

If you do not specify any options, **pr** formats the file into single-column, 66-line pages, each with a 5-line header. The first 2 lines are blank. On the 3rd line appear the file's path name, the date of its last modification, and the current page number. The next 2 lines are blank, and the text of the file begins on the 6th line. At the end of each page, there are 5 blank lines. There are numerous options for the **pr** command; for example, you can specify the page number where the display is to begin, specify output in columns, or change the width of the displayed page.

Simultaneous access to a file

It is possible that two or more utilities or programs could be accessing the same file at the same time, making changes. For example, two people could be using **ed** to edit the same file at the same time. When a file has been accessed by more than one user simultaneously, the last changes saved overwrite any previous changes.

In a program, you can use byte-range locking to avoid this problem. For more information about byte-range locking in a program, see *z/OS XL C/C++ Programming Guide*.

You can use the Network File System feature to coordinate locking of remote files and directories. See "Using the Network File System feature" on page 199 for an overview of this feature. For more detailed information, consult the appropriate Network File System documentation.

Backing up and restoring files: options

There are several options for backing up and restoring files:

- Data Facility System-Managed Storage Hierarchical Storage Manager (DFSMShsm) provides automatic backup facilities for data sets. The systems programmer uses DFSMShsm facilities to back up mountable file systems by backing up the data sets that contain them on a regular basis; the data sets can be restored when necessary. DFSMShsm is also used for migrating (archiving) and restoring unmounted file systems.
- Tivoli® Storage Manager (TSM), formerly known as ADSTAR Distributed Storage Manager (ADSM), provides a backup function for z/OS UNIX clients. There are two types of backup: *incremental*, in which all new or changed files are backed up; and *selective*, in which the user backs up specific files.

  Backup can be performed automatically or when the user requests it. The user can initiate a specific type of backup or start the scheduler, which will run whatever action the administrator has scheduled for the user's machine.
- From the shells, you can manually back up data by using the TSO/E OGET command to copy files into an MVS sequential data set, partitioned data set, or partitioned data set extended (PDSE) that you know is backed up. To simplify

archiving multiple files, the **pax** or **tar** utilities can be used to consolidate individual component files into a single archive file that can then be copied to an MVS data set. **pax** and **tar** can write the archive directly to an MVS data set, eliminating the need to copy the archive manually with OGET. For more information about using **pax** or **tar** and OGET to backup and restore file from the shell, see "Backing up and restoring files from the shell."

You can use the **cron** utility to automatically start running **pax** or **tar** commands at a specified time.

After the files are in an MVS data set, you can load the data set to a tape. Conversely, you can load files from a tape into an MVS data set and then copy them into the file system. For more information, refer to "Transporting an archive file on tape or diskette" on page 287.

Backing up and restoring files from the shell

This information describes how to use the **pax** or **tar** utilities to back up and restore files. The purpose of both utilities is to store the data and attributes of one or more *component files* into a single file, referred to as the *archive file*. **pax** is considered to be the standard utility for managing archive files, replacing **tar**; therefore, **pax** is used as the default utility in the examples that follow. However, **tar** is still widely used, and in the z/OS environment provides practically equivalent function. Therefore, the corresponding **tar** commands are also shown.

Both **pax** and **tar** support multiple archive formats and options that allow a greater or lesser degree of file characteristics to be preserved. The USTAR format allows the most information to be saved, therefore it is used as the default format in the examples that follow. For more information about the USTAR and other archive formats, refer to *z/OS UNIX System Services Command Reference*. Because both **pax** and **tar** can read and write archives in USTAR format, either utility can be used to restore an archive that was created by the other. The significant difference between the two utilities is that only **pax** can perform code page conversion on files during creation of, or extraction from, an archive. Users of **tar** can use the **iconv** utility to perform the same conversion on files as a separate step.

Both **pax** and **tar** support inline compression and decompression of files. Because compressed archives occupy an average of 50-60% percent of the uncompressed archive, many of the examples shown here use compression. Note that compressed archives are not guaranteed to be portable to other UNIX systems.

Archives can be copied to an MVS data set using the TSO/E OGET command and later copied back to the file system using the TSO/E OPUT command. For OS/390 Release 8 and later, **pax** and **tar** can read and write archives that reside in an MVS data set, making it unnecessary to first manually move files between the file system and MVS using OGET or OPUT.

pax and **tar** support file names and link names that exceed 100 characters in length. The utilities remain compatible with other UNIX systems and with previous versions of OS/390.

The remainder of this topic describes the following specific steps for backing up and restoring files to and from an MVS data set and performing other related archive management tasks.

- Backing up a complete directory into an MVS data set
- Restoring a complete directory from an MVS data set

- Viewing the contents of an archive
- Converting between code pages
- Appending to an existing archive
- Storing selected files into an archive
- Restoring selected files from an archive
- Appending to an existing archive
- Backing up selected files by date

These examples demonstrate the most common tasks related to backing up and restoring files, and do not attempt to describe all of the options of the **pax** and **tar** utilities. See *z/OS UNIX System Services Command Reference* for a complete description of **pax** and **tar**.

Backing up a complete directory into an MVS data set

To back up the complete directory **/u/project**, including the subdirectories and their contents, into a compressed archive stored in the MVS data set `'PROJECT.ARCHIVE'`, enter the following commands:

```
cd /u/project
pax -wzvf /tmp/project.pax.Z  ./
tso "oget '/tmp/project.pax.Z'  'PROJECT.ARCHIVE' binary"
```

Note:

1. The **pax** command can write directly to the MVS data set; you can skip the OGET command by specifying the MVS data set on the **pax** command:

   ```
   pax -wzvf "//'PROJECT.ARCHIVE'" ./
   ```

2. The equivalent **tar** commands are:

   ```
   tar -cUzvf /tmp/project.pax.Z  ./
   ```

   To write directly to MVS (OS/390 Release 8 or later):

   ```
   tar -cUzvf "//'PROJECT.ARCHIVE'" ./
   ```

3. You change to the current directory first in order to simplify the **pax/tar** command, and so that the files are stored in the archive using a path name that is relative to the current directory. This simplifies the task of restoring the archive later to a different directory. The "`./`" is used rather than an asterisk to collect any component files that begin with "." in the current directory.
4. The archive is written to a directory that is not in the source path that is being archived, in order to prevent **pax/tar** from trying to store the archive within itself. Doing so can cause **pax/tar** to loop infinitely during creation, and can result in corrupted files during restore.
5. Naming archives with a suffix of "`pax.Z`" (or "`tar.Z`") is not required by **pax/tar**, but is done as a convention to identify them as **pax** or **tar** archive files. The "`.Z`" is used to identify a compressed file.
6. The **-z** option is used to turn on compression, and is not required.
7. The **-v** option is used to display the names of files as they are being stored, and is not required.

Restoring a complete directory from an MVS data set

To restore the directory backed up in the previous example to **/u/project_old**, enter the following commands:

```
tso "oput 'PROJECT.ARCHIVE' '/tmp/project.pax.Z  binary"
cd /u/project_old
pax -pe -rvf /tmp/project.pax.Z
```

Note:

1. The **pax** command can read an archive directly from an MVS data set; you can skip the OPUT command by specifying the MVS data set on the **pax** command:
   ```
   pax -pe -rvf  "//'PROJECT.ARCHIVE'"
   ```
2. The equivalent **tar** command is:
   ```
   tar -p -xvf /tmp/project.pax.Z
   ```

   To read directly from MVS (OS/390 Release 8 or later):
   ```
   tar -p -xvf "//'PROJECT.ARCHIVE'"
   ```
3. The **-pe** option for **pax** and the **-p** option for **tar** are used to restore the original owner, group, modes, and extended attributes. If you do not have the appropriate privileges to restore these, warning messages are generated. These options are not required to restore the component files and can be omitted. For **tar**, the **-o** option is also used to disable restoring the owner and group.
4. **pax** and **tar** automatically detect the archive format and whether the archive is compressed, so the **-z** option for **pax** and, for **tar**, the **-U** option is not required. If these options are used, **pax/tar** fails if the archive is not compressed or not in USTAR format.
5. The **-v** (verbose) option is used to display the names of files as they are being restored, and is not required.
6. Component files can be renamed during extraction by **pax** using the **-i** or **-s** option.

Viewing the contents of an archive

To view the contents of the **/tmp/project.pax.Z** archive created in the previous step, enter one of the following commands:

To list only the names of component files:

```
pax -f /tmp/project.pax.Z
```

To list the contents in a verbose format similar to `"ls -l"`:

```
 pax -vf /tmp/project.pax.Z
```

For OS/390 Release 7 and later, to list the extended attributes in a verbose format similar to `"ls -E"`:

```
pax -Ef /tmp/project.pax
```

Note: The equivalent **tar** commands are:

- To list only component files: `tar -tf /tmp/project.pax.Z`
- For a verbose list: `tar -tvf /tmp/project.pax.Z`
- For extended attributes (OS/390 Release 7 or later):
  ```
  tar -tEf /tmp/project.pax.Z
  ```

Converting between code pages

Archives are often used to move files between UNIX systems. When an archive contains text files, it is frequently the case that the file must be converted from the source system's default code page to the target system's code page. You can do this by using the **iconv** utility on each file before storing it in an archive or after restoring it from an archive. The **pax** utility, however, provides an inline code page translation option, **-o** that can simplify this task. For example:

- To convert component files from EBCDIC (IBM-1047) to ASCII (ISO8859-1) when storing them in an archive:

  ```
  pax -o to=iso8859-1 -wzvf /tmp/project.pax.Z  ./
  ```

- To convert component files from ASCII (ISO8859-1) to EBCDIC (IBM-1047) when extracting them from an archive:

  ```
  pax -o from=iso8859-1 -pe -rzvf /tmp/project.pax.Z
  ```

Note:

1. The **-o** option allows both a "from" and a "to" code page to be specified on the same command. If a "from" or "to" codepage is not specified, **pax** assumes it to be EBCDIC (IBM-1047).
2. For more information about the code sets supported for this command, see the Coded Character Set Conversion Table in *z/OS C/C++ Programming Guide*.

Converting archives that contain text and non-text component files. Archives often contain both text and non-text files. Examples of non-text files are image files, such as JPGs and GIFs, and other **pax/tar** archives. When the **-o** option is specified, **pax** converts all files, regardless of type. This corrupts non-text files. The general approach for overcoming this limitation is to run **pax** two or more times against the same archive, extracting component files in groups of text and non-text types. Whether it is easier to identify (by file name) text files or non-text files will determine how you approach this.

For example, suppose you wish to restore the archive **mywebsite.pax**, which consists of HTML files (text files) and JPG files (JPEGS, non-text image files) and was created on a system whose default code page is ASCII (ISO8859-1), into the directory **/u/website**. Assume that the majority of the files are HTML files and that the archived files represent several levels of subdirectories.

First, restore the entire archive using the **-o** option:

```
pax -rvf mywebsite.pax  -o to=IBM-1047
```

This extracts and converts all component files. The extracted non-text JPEG files would be corrupted because they were also converted. The next step would be to re-extract the JPG files without the **-o** option. The **pax** option allows you to specify a "pattern" that will be used to extract only those files that match the pattern. However, because of the multiple subdirectories, there is no way to create a pattern that would match every JPG in each subdirectory. Instead, a list of file names to be extracted must first be created and then used as the pattern for the **pax** command to extract the files. Issuing the following command in the z/OS shell would accomplish this:

```
pax -rvf mywebsite  $( pax -f mywebsite.pax | grep -i JPG$ )
```

This command consists of two parts:

```
pax -rvf mywebsite  $(    )
```

and

```
pax -f mywebsite.pax | grep -i JPG$
```

The first part is simply the regular **pax** command for extracting files from an archive. The `$(  )` expression says to first run the command between the parentheses and substitute the results in place. The second part is the command that generates a list of file names in the archive that end in "JPG" (or any mixed-case variation).

The previous example shows one approach. In general, for any archive, the breakdown of text to non-text files and the uniqueness of the names that identify each type dictate the manner and order in which the files are extracted. For example, we could have reversed the process by first extracting all files without using the **-o** option, and then re-extracting the HTML files on the second command using the **-o** option to convert the files

Appending to an existing archive

To add additional files and directories to a previously created *uncompressed* archive, use the **-a** (append) option.

Example: To add the file **oops.forgot** to the existing archive **allfiles.pax**, issue: :

```
pax -awvf allfiles.pax  oops.forgot
```

Result: The file **oops.forgot** is added to the end of the archive. If a file with the same name already exists in the archive, it will not be overwritten or replaced.

Note:

1. You can append directly to archives in sequential MVS data sets only. **pax** and **tar** do not support appending to archives that reside in partitioned MVS data sets.
2. The equivalent **tar** command is:

   ```
   tar -rvf allfiles.pax  oops.forgot
   ```

Backing up selected files by date

The following examples pertain to the z/OS shell only, and demonstrate how to back up selected files that may have been modified within a specified number of days. To do this you create a "find" command that returns the list of files that meet the specified criteria, and then use the output from this command as the list of files input to **pax**.

Example: To back up all files in the directory **/u/source** that have been modified in the last week, issue:

```
pax -wzvf backup.pax.Z    $( find /u/source -type f -mtime -8 )
```

Example: To back up all files in the directory **/u/usrtools/** that have not been accessed in the last 100 days, issue:

```
pax -wzvf backup.pax.Z    $( find /u/usrtools -type f -atime +100 )
```

Note: The **tar** equivalent for the **pax** portion of the previous commands is:

```
tar -czUvf backup.pax.Z
```

Listing process IDs of processes with open files

It is often helpful to know which processes have open files. This information can be provided with the **fuser** utility.

The **fuser** utility lists the process IDs of all processes on the local system that have one or more named files open.

The syntax of the command is as follows:

```
fuser [-cfku] file
```

file is the path name of the file for which information is to be returned, or, if the**-c** option is used, the path name of a file on the file system for which information is to be reported.

Option Description

-c Reports on all open files within the file system of which the specified file is a member.

-f Reports on only the named files. This is the default for this command.

-k Sends the SIGKILL signal to each local process. Note that only a superuser can terminate a process that belongs to another user.

-u The user name associated with each process ID is written to standard error.

Chapter 18. Handling security for your files

Each user has user ID (UID) and group ID (GID) numbers that are set when the user is defined to the system. A user always belongs to at least one group—for example, a department—and each group that uses the system is assigned a GID. The system uses the UID and GID to identify the files and processes that a user may use. When you create a directory or a file, it is automatically associated with your UID, and its GID is set to the owning GID for the *parent directory* (the directory it is in).

There are three classes of users whose access you can control with the permission bits (ACLs allow access control for any user or group):
- Owner (the owner of the file or directory whose UID matches the UID for the file)
- Group (a member of the group whose GID matches the GID for the file)
- Other (anyone else)

You control access to a file and directory *that you own* through its permission bits. (Taken together, the permission bits are often called the *mode*.)

In this topic, we discuss:
- Default permissions set by the system
- Changing permissions for files and directories
- Using the sticky bit on a directory to control file access
- Auditing file access
- Displaying file and directory permissions
- Setting the file mode creation mask for programs
- Changing the owner ID or group ID associated with a file
- Temporarily changing the user ID or group ID during execution
- Displaying extended attributes
- Using access control lists (ACLs) to control access to files and directories

Default permissions set by the system

When you first create a file or directory, the system sets default *read*, *write*, and *execute* (`rwx`) permissions. The meanings of the three permissions differ somewhat for a file and a directory:

Permission	Notation	Meaning
read	**r**	**Directory:** Permission to read, but not search, contents. **File:** Permission to read or print contents. To run a shell script, you need both read and execute permission.
write	**w**	**Directory:** Permission to change the directory, adding or deleting members. **File:** Permission to change the file, adding or deleting data

Permission	Notation	Meaning
execute	**x**	**Directory:** Permission to search a directory. Usually **r** and **x** are used together. **File:** Permission to run a file—that is, enter it as a command. Typically this permission is used for shell scripts and for files containing executable programs. (To run a shell script, you need read and execute permission.)

The following table shows the default permissions set by the system:

Using	To create a	Default permissions
mkdir shell command	Directory	owner=rwx group=rwx other=rwx In octal form: 777
MKDIR TSO command	Directory	owner=rwx group=r-x other=r-x In octal form: 755
JCL with no PATHMODE specified	Directory or file	owner=--- group=--- other=--- In octal form: 000
ISPF editor, OEDIT command, oedit command	File	owner=rwx group=--- other=--- In octal form: 700
vi editor	File	owner=rw- group=rw- other=rw- In octal form: 666
ed editor	File	owner=rw- group=rw- other=rw- In octal form: 666
Redirection (>)	File	owner=rw- group=rw- other=rw- In octal form: 666
cp command	File	Sets the output file permissions to the input file permissions.

Using	To create a	Default permissions
OCOPY command	File	Permission bits for a new file are specified with the ALLOCATE command, using the PATHMODE keyword, prior to entering the OCOPY command. If the PATHMODE keyword is omitted, the default is: owner=--- group=--- other=--- In octal form: 000
OPUT or OPUTX command	File	For a text file: owner=rw- group=--- other=--- In octal form: 600 For a binary file: owner=rwx group=--- other=--- In octal form: 700

For more information on octal numbers, see "Using octal numbers to specify permissions" on page 234.

Changing permissions for files and directories

You can use the **chmod** command to set or change permissions for your files and directories. To change permissions, you must be the owner or a superuser. (If you are uncertain about ownership, use the **ls -l** command and look for your TSO/E user ID.)

You can specify the **chmod** command like this:

```
chmod mode pathname
```

You can specify the mode in symbolic form or as an octal value. For more information on the **chmod** command, see the **chmod** command description in *z/OS UNIX System Services Command Reference*.

Using a symbolic mode to specify permissions

A symbolic mode has the form:

```
[who] op permission [op permission ...]
```

The *who* value is optional; it can be any combination of the following:

u Sets owner (user) permissions.
g Sets group permissions.
o Sets other permissions.
a Sets all permissions; this is the default.

The *op* part of a symbolic mode is an operator that tells **chmod** to turn the permissions on or off. The possible values are:

+ Turns on a permission.
– Turns off a permission.
= Turns on the specified permissions and turns off all others.

To set the *permission* part of a symbolic mode, you can specify any combination of the following permissions in any order:

r Read permission.

s This stands for *set-user-ID-on-execution* or *set-group-ID-on-execution* permission. See "Temporarily changing the user ID or group ID during execution" on page 238 for more information.

t This sets the *sticky bit* on, for a file or directory.

Directory: The sticky bit is set on for a directory so that a user cannot remove or rename a file in the directory unless one or more of these conditions is true:

- The user owns the file.
- The user owns the directory.
- The user has superuser authority.

File: The sticky bit is set for frequently used programs in the file system, to reduce I/O and improve performance. When the bit is set on, z/OS UNIX searches for the program in the user's STEPLIB, the link pack area, or the link list concatenation. For information on copying a load module from the file system into a data set, see "Copying an executable module from the file system" on page 281. See Verifying that the sticky bit is on in *z/OS UNIX System Services Planning* for information on using the sticky bit with daemons.

w Write permission. If this is off, you cannot write to the file.

x Execute permission. If this is off, you cannot execute the file.

X Search permission for a directory; or execute permission for a file only when the current mode has at least one of the execute bits set.

For example, to turn on read, write, and execute permissions, and turn off the set-user-ID and sticky bit attributes for a file, enter the command:

```
chmod a=rwx file
```

You can specify multiple symbolic modes if you separate them with commas.

Using octal numbers to specify permissions

Typically, octal permissions are specified with three or four numbers, in these positions:

```
1234
```

Each position indicates a different type of access:

- In position 1 are the bits that set permission for set-user-ID on access, set-group-ID on access, or the *sticky bit*. Specifying this position is optional.
- In position 2 are the bits that set permissions for the owner of the file. Specifying this position is required.
- In position 3 are the bits that set permissions for the group that the owner belongs to. Specifying this position is required.
- In position 4 are the bits that set permissions for others. Specifying this position is required.

Position 1

Specifying the bits in position 1 is optional. For position 1, you can specify these octal numbers:

0 Off

1 Sticky bit on

2 Set-group-ID-on execution

3 Set-group-ID-on execution and set the sticky bit on
4 Set-user-ID on execution
5 Set-user-ID on execution and set the sticky bit on
6 Set-user-ID and set-group-ID on execution
7 Set-user-ID and set-group-ID on execution and set the sticky bit on

Positions 2, 3, and 4

Specifying these bits is required. For each type of access—owner, group, and other—there is a corresponding octal number:

0 No access (`---`)
1 Execute-only access (`--x`)
2 Write-only access (`-w-`)
3 Write and execute access (`-wx`)
4 Read-only access (`r--`)
5 Read and execute access (`r-x`)
6 Read and write access (`rw-`)
7 Read, write, and execute access (`rwx`)

To specify permissions for a file or directory, you use at least a *three-digit* octal number, omitting the digit in the first position. When you specify three digits instead of four, the first digit describes owner permissions, the second digit describes group permissions, and the third digit describes permissions for all others.

If you are not setting the first octal digit, you can just specify 3 digits instead of 4. When the first digit is not set, some typical 3-digit permissions are specified in octal this way:

Table 7. Three-digit permissions specified in octal

Octal number		Meaning
666	6 6 6 / | \\ rw- rw- rw-	owner (rw-) group (rw-) other (rw-)
700	7 0 0 / | \\ rwx --- ---	owner (rwx) group (---) other (---)
755	7 5 5 / | \\ rwx r-x r-x	owner (rwx) group (r-x) other (r-x)
777	7 7 7 / | \\ rwx rwx rwx	owner (rwx) group (rwx) other (rwx)

Using the sticky bit on a directory to control file access

Using the **mkdir**, MKDIR, or **chmod** command, you can set the sticky bit on a directory to control permission to remove or rename files or subdirectories in the directory. When the bit is set, a user can remove or rename a file or remove a subdirectory only if one of these is true:

- The user owns the file or subdirectory.
- The user owns the directory.
- The user has superuser authority.

If you use the **rmdir**, **rename**, **rm**, or **mv** utility to work with a file, and you receive a message that you are attempting an operation not permitted, check to see if the sticky bit is set for the directory the file resides in.

Auditing file access

Using the **chaudit** command, you can specify which types of file access are audited by RACF. RACF writes the audit information to system management facilities (SMF) record 80.

Only a file owner or a security auditor can specify if auditing is turned on or off, and when audit records should be written for a directory or a file: for successful accesses, failed accesses, or for all accesses.

You can specify audits for read, write, and search or execute attempts. For each of these, you can specify audits for successful access, failed access, or both. You can also set the audit flags off, so that audits are not performed.

The default audit bits are set at file creation:

- The user-requested-audit flags are set to audit failed attempts to read, write, or execute. Only the file owner or a superuser can specify user audit options.
- The auditor-requested-audit flags are set off (no auditing). To specify auditor audit options, you must have security auditor authority.

See the **chaudit** command description in *z/OS UNIX System Services Command Reference* for a description of the **chaudit** command. See the topic about specifying file audit options in *z/OS UNIX System Services Planning* for a description of how a superuser or security auditor would use the **chaudit** command.

Displaying file and directory permissions

To display the permissions for the files and directories in your working directory, use **ls -W**. (The **ls -l** command displays all the access permissions but does not display the audit permissions.) The display format is:

```
drwxr-x---  fff---    2  ELVIS  64MB   96 Jun 15 10:34 statrp
-rwx------  fff---    1  ELVIS  64MB  107 Jul 10 07:45 jun93
-rwx------  fff---    1  ELVIS  64MB   80 Aug 09 13:15 jul93
-rwx------  fff---    1  ELVIS  64MB  150 Sep 15 10:45 aug93
drwxr-xr-x  fff---    2  ELVIS  64MB   96 Jun 17 09:05 dbappl
-rwxr-x---  fff---    1  ELVIS  64MB  150 Jun 17 10:15 txn1
```

- **First field:** A string of 10 characters. The first character indicates the file type. The next 9 characters are the permissions. For example:

  ```
  -rwxr-xr-x
  ```

  View them this way:

  ```
  - rwx r-x r-x
  ```

  – The first character indicates whether this is a file or directory.
  - for a regular file (binary or text)
  c for a character special file
  d for a directory
  e for an external link
  l for a symbolic link
  p for a named pipe (FIFO special file)

  In the example, **-** indicates a regular file.

  - The first set of 3 characters show the owner's permissions. In this example, the owner has read, write, and execute permission (`rwx`).
  - The second set of 3 characters show the group permissions. In this example, the group to which the user belongs has read and execute permission (`r-x`).
  - The third set of 3 characters show the other permissions. In this example, any other user can read the file and execute it (`r-x`). If the sticky bit is on, you see a `T` or `t` in the final field (`--T` or `--t`).
- **Second field:** The audit settings. These 6 characters are actually two groups of 3 characters. The first group of 3 describes the audit settings requested by a user; the second group describes audit settings requested by a security auditor. The characters can be:

  s to audit successful access attempts
  f to audit failed access attempts
  a to audit all accesses
  - for no audit

  In the example, `fff---`,

  fff means *failed* read, write, and execute or search attempts to access the file are audited by the user.

  --- means read, write, and execute or search attempts to access the file are not audited by the security auditor.
- **Third field:** The number of links to the file or directory.
- **Fourth field:** The owner's login name (TSO/E user ID).

  Note: When files owned by user ID 0 (UID=0) are transferred from any UNIX-type system across an NFS connection to another UNIX-type system, the user ID changes to -2 (UID=-2). On a z/OS UNIX system, -2 is not a valid user ID; therefore, **ls** displays UID 4294967294 (the unsigned equivalent of -2).
- **Fifth field:** The name of the group associated with the file or directory.
- **Sixth field:** The size of the file, expressed in bytes.
- **Seventh field:** A date and time. For a file, this is the time the file was last changed; for a directory, it is the last time a file was created or deleted in the directory.
- **Eighth field:** The name of the file or directory. If the file is a symbolic link, that also is indicated. See the additional information for the filename **lnk** in this example:

```
l---------   1 ELVIS    SYS1           8 May 21 15:30 lnk -> /tmp/ehk
$
```

Setting the file mode creation mask

When a file is created, it is assigned initial access permissions. If you want to control the permissions that a program can set when it creates a file or directory, you can set a *file mode creation mask* using the **umask** command.

You can set this file mode creation mask for one shell session by entering the **umask** command interactively, or you can make the umask command part of your login. When you set the mask, you are setting limits on allowable permissions: You are implicitly specifying which permissions are *not* to be set, even though the calling program may allow those permissions. When a file or directory is created, the permissions set by the program are adjusted by the **umask** value: The final permissions set are the program's permissions minus what the umask values restrict.

To use the **umask** command for a single session, enter:

umask *mode*

and specify the mode in either of the formats used by **chmod**: symbolic (`rwx`) or octal values. The symbolic form expresses what can be set, what is *allowed*, while octal values express what cannot be set, what is *disallowed*. For example, both of these commands set the same umask:

```
umask a=rx
umask 222
```

To display the mask,

- If you just enter **umask**, you see the mode displayed in octal values, indicating what *cannot* be set.
- If you enter **umask -S**, you see the mode displayed in symbolic form, indicating what *can* be set.

The shell's initial setting of the mask is 000, which means that read, write, and execute permission can be set on for everyone. But the system-wide profiles provided with the product set the mask to 022.

Changing the owner ID or group ID associated with a file

The user might need to change the UID or GID for a file. To protect the data in a file from unauthorized users, the system controls who can change the file access:

- To change the owner (UID) of a file, the superuser can enter a **chown** command.
- To change the group (GID) of a file, the superuser or the file owner can enter a **chgrp** command, specifying either a RACF group name or a GID. The file owner must have the new group as his group or one of his supplementary groups.

Superuser tasks are discussed in Using the BPX.SUPERUSER resource in the FACILITY class in *z/OS UNIX System Services Planning*.

Temporarily changing the user ID or group ID during execution

An executable file can have an additional attribute, which is displayed in the execute position (**x**) when you issue **ls -l**. This permission setting is used to allow a program temporary access to files that are not normally accessible to other users. An **s** or **S** can appear in the execute permission position; this permission bit sets the effective user ID or group ID of the user process that is executing a program to that of the file whenever the file is run. The setuid and setgid bits are only honored for executable files that contain load modules.

s In the owner permissions section, **s** indicates that the set-user-ID (S_ISUID) bit is set and execute (search) permission is set.

In the group permissions section, **s** indicates that the set-group-ID (S_ISGID) bit is set and execute (search) permission is set.

S In the owner permissions section, **S** indicates that the set-user-ID (S_ISUID) bit is set, but the execute (search) bit is not.

In the group permissions section, **S** indicates that the set-group-ID (S_ISGID) bit is set, but the execute (search) bit is not.

A good example of this behavior is the **mailx** utility. A user who is sending mail to another user on the same system is actually appending the mail to the recipient's mail file, even though the sender does not have the appropriate permissions to do this action. The mail program does.

Displaying extended attributes

The **-E** option on the **ls** shell command displays extended attributes. For more information about this option, refer to "Executable modules in the file system" on page 193.

Using access control lists (ACLs) to control access to files and directories

Using access control lists (ACLs), you can control access to UNIX files and directories by individual users (UIDs) and groups (GIDs). ACLs are used in conjunction with permission bits.

There are three kinds of ACLs:

- *Access ACLs* are ACLs that are used to provide protection for a file system object.
- *File default ACLs* are model ACLs that are inherited by files created within the parent directory. The file inherits the model ACL as its access ACL. Directories also inherit the file default ACL as their file default ACL.
- *Directory default ACLs* are model ACLs that are inherited by subdirectories created within the parent directory. The directory inherits the model ACL as its directory default ACL and as its access ACL.

There are two kinds of ACL entries:

- *Base ACL entries* are permission bits (owner, group, other). You can change the permissions using **chmod** or **setfacl**.
- *Extended ACL entries* are ACL entries for individual users or groups. Like the permission bits, they are stored with the file, not in RACF profiles.

Additional access control mechanisms are allowed to further restrict the access permissions that are defined by the file permission bits. Because ACLs can grant and restrict access, the use of ACLs is not UNIX 95-compliant.

ACLs are supported by HFS, zFS, and TFS. It is possible that other physical file systems will eventually support z/OS ACLs. Consult your file system documentation to see if ACLs are supported.

Setting up ACL support

Using access control lists (ACLs) in *z/OS UNIX System Services Planning*provides detailed information on setting up and managing ACLs. It also explains the considerations involved when you are using ACLs in a sysplex and how ACLs are used in file access checks. To add, delete, or update an ACL, or update the permission bits, use the **setfacl** shell command. The **getfacl** shell command displays the contents of an ACL. The **ls** with **–l** output will also indicate if extended ACL entries exist.

See ACL tasks and their associated commands in *z/OS UNIX System Services Planning* for a chart that shows how various shell commands are used when working with ACLs. For complete information on the commands involved, see *z/OS UNIX System Services Command Reference*.

Chapter 19. Editing files

When you are logged into the shell, you have a choice of editors to use to create and change files, depending on which interface you are using:

- **OMVS terminal interface:**
  - The full-screen ISPF editor, which you can invoke using the OEDIT or **oedit** command.
  - The **ed** editor, a line editor
  - The **sed** stream editor, a noninteractive editor. It is intended for *systematic* editing; you invoke the editor with a file of editing commands and a target data file and it produces an edited target file, with no user interaction.
- **Asynchronous terminal interface:**
  - The **vi** editor, an interactive editor

If you are using NFS from your workstation, you can directly edit z/OS UNIX files with your workstation editor of choice.

Using ISPF to edit a z/OS UNIX file

ISPF Edit provides a full-screen editor you can use to create and edit z/OS UNIX files. You can access ISPF Edit in several ways:

- Using the **oedit** shell command
- Using the TSO/E OEDIT command at the TSO/E `READY` prompt or from the shell command line
- From the ISPF menu (if a menu option is installed)
- From the ISPF shell (accessed using the TSO/E ISHELL command)

Tip: If you know you will be using OEDIT or OBROWSE during a shell session, make your initial invocation of the shell from ISPF. If you enter the OMVS command from ISPF, you can subsequently access OEDIT and OBROWSE more quickly than if you had entered the OMVS command from TSO/E.

Using ISPF Edit, you can edit only regular files (not special files). You need read and write permission for the file and search permission for any intermediate directories.

When you are working in MVS (TSO/E or ISPF), your home directory is the default working directory.

When you create a new file, you must have the appropriate permissions to add a new file to the parent directory. When a file is created using ISPF Edit, its default permissions are:

```
owner = rwx
group = ---
other = ---
```

The octal number is 700.

ISPF Edit allows only one edit session at a time per file. It reads the entire file when the edit session begins. At the end of the session, it replaces the original file with the edited file.

During an ISPF Edit session, you can use these types of commands:

Type of commands	Usage notes
Scrolling commands	You can use commands to scroll the data up, down, left, or right.
Line commands	You perform line editing by entering a *line command* directly on the line number of the affected line. For example, to delete a line, you enter `D` on the line number; to repeat a line, you enter `R` on the line number. You can enter line commands for several lines at the same time.

Primary commands	To perform general editing tasks, you enter *primary commands* at the command line on the panel. For example, you can use the FIND command to scan data for a specific character string. If you entered:
	`FIND printf(`
	on the command line, your cursor moves to the next occurrence of **printf(**. Likewise, you can enter the CHANGE command to make global changes within a file.
	Example: To change all instances of `CRTL` to `C-RTL`, issue:
	`CHANGE CRTL C-RTL ALL`

External data commands	While you are editing one file, you can use external data commands to work with another file, a sequential data set, or a member of a partitioned data set or PDSE—moving data to or from the file you are editing. ISPF Edit provides five external data commands: COPY, MOVE, REPLACE, CREATE, and EDIT.

To end an edit session:
- Saving all changes, enter the END command or press <F3>.
- Without saving any changes, enter the CANCEL command.

When you end the edit session, you go back to where you were when you began it: on the entry panel, on an ISPF command line, at the TSO/E `READY` prompt, or at the shell prompt.

All you ever wanted to know about ISPF Edit

The discussion in this topic is an introduction to ISPF Edit. For detailed information about ISPF Edit, use the online help facility or refer to *z/OS V2R2 ISPF Edit and Edit Macros*.

Using the vi screen editor

The **vi** editor is available if you login to the shell using **rlogin** or **telnet**. It is not available if you login using the OMVS command. The **vi** editor is a full-featured text editor with the following major features:
- Full-screen editing and scrolling capability
- Separate text entry and edit modes
- Global substitution and complex editing commands using the underlying **ex** commands.

This overview just introduces some fundamentals to help you get started. For more information, see Appendix A, "Advanced vi topics," on page 293 and the **vi** command description in *z/OS UNIX System Services Command Reference*.

Basic principles

To begin using **vi**, you type the command:

```
vi filename
```

where *filename* is the name of a file you want to edit. This can be an existing file, or it can be a new file that you want to create.

The **vi** command begins a **vi** session. In a **vi** session, you enter input that creates or changes the contents of the file specified on the command line. **vi** reads and uses the input you type until you quit your **vi** session.

In a **vi** session, you are always in one of two modes:

- **Insert Mode**, in which everything you type is taken as text input. **vi** displays text on the screen as you enter it. Eventually, **vi** stores this text in a file.
- **Command Mode**, in which **vi** interprets everything you type as a command to change the text in some way. Usually, commands do not appear on the screen—you just see the effects of the command. For example, if you enter the command to delete a line of text, you see the line disappear, but you never see the delete line instruction that you actually typed.

To switch from Insert Mode to Command Mode, simply press the key marked <Esc>. If you are not sure which mode you are in, press <Esc> several times. This always brings you back to Command Mode.

To delete a character, you must be in Insert Mode. Pressing <Backspace> deletes the last character you typed; pressing <Backspace> twice deletes the last two characters, and so on. **vi** usually does not immediately delete these characters on the screen—it just backs up the cursor so that anything you enter is typed over the characters that were there. When you leave Insert Mode, **vi** adjusts the screen to remove any characters that were deleted by <Backspace> and not over-typed.

To quit a **vi** session, do one of these:

- **:wq** to save your changes and quit **vi**
- **:q!** to quit without saving your work

A simple vi session

This information shows you how to edit a simple text file. Try it to get the feel of using **vi**. You can edit the text file:

```
vi1.txt
```

which is supplied as part of the z/OS shell. It is in the directory **/samples**. To do this, copy this file to current working directory:

```
cp /samples/vi1.txt vitest
```

Now, begin your **vi** session by typing:

```
vi vitest
```

vi clears the screen, then displays the contents of the file. , **vi** also displays:

```
"vitest" 30 lines, 668 characters
```

This tells the name of the file being edited and how big it is.

The cursor is positioned at the beginning of the file. These keys let you position the cursor anywhere on any line in the file:

Table 8. **vi** *editor: Positioning the cursor*

To move the cursor:	**Press**
Down a line	**j** or ↓ (the Down arrow key)
Up a line	**k** or ↑ (the Up arrow key)
Left along a line	**h** or ← (the Left arrow key)
Right along a line	**l** or → (the Right arrow key)

Note: The arrow keys do not work on all terminals.

To experiment a bit more, move the cursor to the beginning of the first line in the file, then press 5 followed by →. You do not see the 5 displayed anywhere—but when you press →, you see the cursor move five characters to the right. As a general rule, when you type a number followed by an action, **vi** repeats the action that number of times.

By the way, ask yourself if you are in Insert Mode or Command Mode. You must be in Command Mode because the characters you type (for example, the 5) do not appear on the screen. When you start a **vi** session, you always begin in Command Mode.

Adding text

The simplest action you can perform is adding text to what is already on the screen. Move the cursor to the blank line following:

```
And frightened Miss Muffet away.
```

The cursor should be at the first position in the blank line. Now type **a**. Because you are in Command Mode, this is taken to be a command, not text. The **a** command tells **vi** to begin adding to the text that is already on the screen. If you now type:

```
Little Boy Blue
```

you can see the characters appear on the line. The **a** command switches from Command Mode to Insert Mode. You can now see what you are typing.

Press <Enter> at the end of the line. The bottom part of the screen moves down to make a new blank line after the line you were typing. Keep typing more lines:

```
Come blow your horn
The sheep's in the meadow,
The cow's in the corn.
```

You see that the bottom part of the screen keeps moving down to make more room for what you are typing. After the **a** command, the text that you type is added into the middle of existing text.

When you have typed the last line, press <Enter> to make a new blank line, then press <Esc>. <Esc>switches from Insert Mode back to Command Mode. Now, **vi** interprets what you type as commands again. If you type 4 followed by ↑, the

cursor moves up four lines to the beginning of the text you just typed in. The 4 does not appear on the screen when you type it, because command input is not usually displayed.

Move the cursor to the B at the beginning of the word Blue in the text you have just typed. Press **a** to add more text, then type the letter l. The l is added after the B and the rest of the text on the line moves over to make room for the new character. This shows that **a** adds text after the current cursor position.

Press <Backspace>. The cursor backs up one space. Press <Esc>to return to Command Mode. The l disappears when you leave Insert Mode, and **vi** adjusts the screen to get rid of characters deleted by backspacing.

The Little Boy Blue rhyme that you have just added to the file follows the previous nursery rhyme immediately. The file would look better with a blank line separating the two rhymes. Figure out how to put in this blank line, and do it.

Moving the cursor up and down the screen

You already know how to move the cursor up and down; however, this can be a slow process if you have a large file that you want to move through quickly. To speed this process up, **vi** offers several commands that can jump the cursor up or down many lines at a time.

In Command Mode, use the following commands:

Command
Moves the cursor:

H To the upper left hand corner of the screen. **H** stands for High and it moves the cursor as high on the screen as it can go.

L To the bottom of the screen. **L** (uppercase) stands for Low.

M To the middle of the screen. **M** stands for Middle. Experiment with these commands to see how they move the cursor.

Moving up and down through a file

While you are editing a file, you can move through it one line at a time, several lines at a time, or screens at a time. You can use these commands to move up and down through a file:

Command
Moves the cursor:

<Ctrl-D>
Down (or forward) half a screen. The cursor stays where it is -- the text moves underneath it.

<Ctrl-F>
Down (or forward) almost a full screen. This lets you move forward through the file very rapidly.

<Ctrl-U>
Up (or backwards) half a screen.

<Ctrl-B>
Up (or backwards) almost a full screen.

If you move forward far enough through **vitest**, you will see a number of lines that are blank except for a tilde (~) as the first character. These lines are actually beyond the end of the file -- the file ends with the line:

```
And the mome raths outgrabe.
```

vi could just show an empty screen after this last line, but then you would not know if the screen was empty because you had reached the end of the file or if the file just contained a lot of blank lines; therefore, **vi** uses ~ to mark lines that are past the end of the file.

Moving the cursor on the line

You can also move the cursor by whole word boundaries, using word-motion commands. Make sure that you are in Command Mode (press <Esc>). **0** and **$** let you move back and forth on a line quickly.

Command	**Moves the cursor:**
^ or 0	To the beginning of the current line (to the first nonblank space). The command **0** is short for **0|**, which moves the cursor to column number 0.
$	To the end of the current line

$ stands for the end of the line in a number of **vi** commands.

Go to the beginning of a line, and press **w**. The cursor jumps forward to the beginning of the next word on the line. **w** stands for word and it moves the cursor forward one word. If you keep pressing **w**, the cursor keeps jumping forward. When you jump forward from the last word in the line, you go to the first word in the next line. If you precede **w** with a number (as in **5w**), the cursor jumps forward that many words.

Typing **b** is like typing **w**, except that you go back a word instead of forward. If you go back from the first word on a line, you get to the last word on the previous line. If you precede **b** with a number (as in **3b**), the cursor jumps backward that many words.

If the cursor is in the middle of a word, typing **e** moves the cursor to the end of the word. For example, if the cursor is in the middle of the word `slithy`, typing **e** moves the cursor to the last letter in the word. If the cursor is already on the last letter of a word, typing **e** moves the cursor to the end of the next word.

To move the cursor between words *including punctuation* (that is, punctuation is considered to be a word), use the following commands:

Command	**Moves the cursor:**
e	To the end of the current word
w	To the beginning of the next word
b	To the beginning of the previous word

To move the cursor between words *ignoring punctuation* (that is, punctuation is skipped), use the following commands:

Command	**Moves the cursor:**

E	To the end of the current word
W	To the beginning of the next word
B	To the beginning of the previous word

Moving to sentences and paragraphs

To move between sentences and paragraphs, use the following commands:

Command	**Moves the cursor:**
)	To the beginning of the next sentence
(	To the beginning of the preceding sentence
}	To the beginning of the next paragraph
{	To the beginning of the preceding paragraph

These commands can also be preceded by a number to change the effect of the command. For example, **3)** moves the cursor forward 3 sentences.

Deleting text

There are several commands that delete text from the screen. All of these begin with the letter **d**. After the **d** comes a letter indicating what you want to delete. Usually this letter is based on one of the cursor movement commands. For example:

Command	**Action**
d$	Deletes text from the cursor's current position to the end of the line.
dd	Deletes the entire line containing the cursor.
dL	Deletes text from the cursor's current position to the bottom of the screen.
dw	Deletes text from the cursor's current position to the beginning of the next word.
de	Deletes text from the cursor's current position to the end of a word. If the cursor is in the middle of a word, **de** deletes to the end of the same word; if the cursor is at the end of a word, **de** deletes to the end of the next word.

In the same way, **d** followed by → or ← (**l** or **h**) can delete a single character. Try both instructions and see which character gets deleted.

If you delete something by accident, you can undo the deletion by typing **u** (lowercase). Try this now. Type **dH**. What happens? Now type **u** and see the deleted text return.

A number followed by a delete command repeats the command that number of times. For example:
- **5dw** deletes five words
- **10dd** deletes ten lines

Changing text

To change existing text, use the **c** command the same way you use **d**. **c** is a combination of **d** and **a**—it deletes text, then begins to append text to replace what was deleted.

Command
Action

c$ Lets you change everything from the cursor's current position to the end of the line.

cL Lets you change everything to the end of the page.

cc Lets you change all of the current line, regardless of the cursor position.

Go to the beginning of the first line of **vitest** and type **c$**. **vi** puts a $ at the end of the line. The $ marks the end of the block of text that **vi** intends to change. If you now begin typing something like `The rain in Spain`, you type over the text that was previously on the line. If you keep typing, you eventually type over the $. The $ was never there -- it was just a marker to show the block of text to be replaced.

After a **c** command, the text you type shows up on the screen. This means that **c** puts you in Insert Mode. When you finish typing replacement text, you must press <Esc> to return to Command Mode.

You can enter any amount of text to replace existing text. For example, **c$** only gets rid of part of a line, but you can enter many lines of replacement text.

Undoing a command

If you make a change and then realize it was in error, you may still be able to correct it.

Command
Action

u Undoes the last command entered

U Undoes all changes made to the current line

Saving a file

When you finish editing text, you must save your work in a file. Until you save your work, your text is on the screen but it is not recorded in any usable way. When you quit **vi**, your work disappears unless it is saved.

If you started your **vi** session with `vi filename`, it is easy to write the edited text back into the same file. In Command Mode, just type:

```
:w
```

and press <Enter>. When you type the colon, it appears at the very bottom of the screen. The **w** also appears . When you press <Enter>, there is a short pause and then **vi** displays some statistics about the saved text: the name of the file, and the number of lines and characters saved.

If you want to save your changes and quit **vi**, enter:

```
:wq
```

If you want to save your text in a different file, type:

```
:w newfilename
```

and press <Enter>. Again, this appears . After you save your work, you can quit **vi** by typing:

```
:q
```

Normally, **vi** does not let you quit before saving; if you do, you lose everything you have done since the last time you saved. If you really want to quit **vi** without saving your work, type:

```
:q!
```

If the file system that you are attempting to save your file to is full, you will see the following message:

```
FSUM7971 Write error (out of space?)
```

At this point, you should issue a command to save your file to a new file system where space is available. This can be done by typing:

```
:w newfilesystem/newfilename
```

where *newfilesystem* is the name of another file system that has space available, and *newfilename* is the name you wish to call the file.

Once the original file system has space available, you can safely copy the file back to that location.

Searching for strings

In a large document, searching for a particular text string can be very time consuming. The **/** command prompts for a string to search for in the file. When you press <Enter>, **vi** searches the file for the next occurrence of the string you entered.

To try searching for a string, first move to the top of **vitest**. Then type:

```
/Blu
```

and press <Enter>.

As soon as you enter **/**, it is displayed on the bottom of the screen. As you type the string **Blu**, it is echoed . You can use <Backspace> to fix mistakes as you type the search string. After you press <Enter>, the cursor moves to the first occurrence of the string.

The **n** command searches for the next occurrence of the last string you searched for. Try it now by entering:

```
n
```

The cursor should move to the next occurrence of the string, which is the **th** in the word **with**. You can also use **N** like **n** to search the other direction through the file.

If you just type a slash without anything after it, **vi** looks for the most recent word or phrase you searched for.

Searching backwards through a file

To specify a search string for a backward search through the file, use the **?** command in the same way as **/**. If you just type a **?** without anything after it, **vi** searches backwards for the most recent word or phrase you searched for. When

you search backwards, the **n** command moves the cursor backward to the next occurrence of the string, and the **N** command moves the cursor forward.

Case-sensitive searching

When you type in characters after a slash or question mark, make sure you enter them in the correct case. For example, ask **vi** to search for `IN`, and type the word in uppercase. You will see that **vi** prints the message `Pattern not found` . As it turns out, this file does not contain the word `IN` in uppercase, although it has the word several times in lowercase.

Notice that the message used the word `Pattern`. In a **vi** command, anything after a slash or question mark is called a *pattern*.

Special search characters

In order to make searching more useful, **vi** gives special meanings to several characters when they are used in patterns. For example, the circumflex or caret character (^) stands for the beginning of a line. Move the cursor to the next line and type:

```
/^All
```

vi will look for the word `All` occurring at the beginning of a line.

The end of a line is represented by the dollar sign ($). Move the cursor to the next line and type:

```
/plum$
```

You will see that **vi** searches forward for a line that ends in the word `plum`.

Inside patterns, the dot (.) stands for any character. For example, move the cursor to the top of the file and type:

```
/t.e
```

You will see that the cursor moves to the word `the`. Type `/` over and over, and you will see the cursor keep jumping forward to any sequence of three letters that starts with `t` and ends in `e`. Were you surprised that the cursor jumped into the middle of the word `slithey`? **vi** finds character strings, even when they are in the middle of larger words.

Inside patterns, a dot followed by an asterisk (`.*`) stands for any sequence of zero or more characters. For example, type:

```
/^A.*g$
```

You will find the next line that begins with the letter `A`, ends with the letter `g` and has any number of characters in between.

Character	**Stands for:**
^	Beginning of the line
$	End of the line
.	Any character
.*	Any sequence of zero or more characters

vi gives special meanings to several other characters inside patterns. For complete details, see Appendix C. Regular Expressions (regexp) in *z/OS UNIX System*

Services Command Reference. A regular expression is the POSIX name for a pattern; here we use the word *pattern* because it is more descriptive.

What happens if you want to search for a character that has a special meaning in patterns? For example, suppose you want to search for the string `2.3*25` somewhere in a file. If you just type:

```
/2.3*25
```

vi will think the `3*` stands for zero or more occurrences of the digit `3`, not the `*` character. In such cases, put a backslash (`\`) in front of any characters with special meanings, as in the example:

```
/2\.3\*25
```

Notice that we had to put a backslash in front of the dot as well as the asterisk; both have a special meaning in patterns.

By default, all searches in **vi** wrap around from the bottom of the file to the top. Similarly, if you use question marks to search backward through a file, the search will wrap around from the top of the file to the bottom, if necessary.

Moving text

The first step in moving a block of text is to select text for moving. In fact, you already know how to do this. The **d** command not only deletes a block of text, but also copies it to a paste buffer. Once in the paste buffer, the text can be moved by repositioning the cursor and then using the **p** command to place the text after the current cursor position.

To delete the first line of the file, move there and type:

```
dd
```

The line is deleted and copied into the paste buffer, and the cursor is moved to the next line in the file. To paste the line following the current line, type:

```
p
```

To paste text before the cursor rather than after it, use the **P** (uppercase) command.

If you delete a letter or word size block, it will be pasted into the new position within the current line. For example, to move the word **came** after the word **spider**, you could use the following command sequence:

```
/came <Enter>
dw
/spider <Enter>
p
```

Copying text

You copy text in the same manner as you move it, except that instead of using the delete text command **d**, you use the yank text command, **y**. The **y** command copies the specified text into the paste buffer without deleting it from the text. It follows the same syntax as the **d** command. You can also use the shortcut **yy** to copy an entire text line into the paste buffer, in the same way as **dd**.

For example, you can copy the first two lines of the file to a position immediately underneath them. To do so, enter the following command sequence from the first line of the file:

```
2yy
j
p
```

Note that you must move down one line using **j**, or the two lines will be pasted after the first line rather than after the second.

Other vi features

Here are a few more helpful **vi** subcommands:

J Joins the following line to the current line

. Repeats the last command

s Substitutes the current character with the following entered text

x Deletes the current character

Message: vi/ex edited file recovered

Have you received mail with this subject: "vi/ex edited file recovered" ? This is what the mail messages look like:

```
From OMVS Mon Apr 29 13:58:50 1996
To: 1234567
Status: R
Subject: vi/ex edited file recovered.

Mon Apr 22 13:47:45 1996, the file

        NoFilename

that you were editing has been recovered.
You can retrieve most of your changes to this file
using the "-r" option or the ":recover" command of the
vi or ex editors. An easy way to do this is with the command

          vi -r NoFilename
```

This message is being sent to you because the **exrecover** command recovered text files from working files created by **ex** or **vi**. When **ex** or **vi** is invoked, it first creates these working files in a temporary directory so that it can recover the file being edited if any system errors occur or if the editor is otherwise terminated abnormally.

When **vi** is invoked, it first creates files in **/tmp** so that it can recover the file being edited if any system errors occur. When **vi** is invoked from OMVS, it creates its recovery files in **/tmp** but cannot continue.

The current default directory for temporary **vi** files (usually **/tmp**) may be implemented as a TFS. In this case, all **vi**'s temporary files that the **exrecover** daemon uses for recovery would be gone after a system crash. The environment variable **TMP_VI** can contain a directory path name that can be specified by an administrator as an alternative location for these temporary files. See “Using the TMP_VI environment variable” on page 253 for more information.

The **exrecover** command automatically recovers these files. By default, this command is started from the **/etc/rc** file. In **/etc/rc** you will see these lines:

```
# Invoke vi recovery
mkdir -m 777 /etc/recover
/usr/lib/exrecover
```

Every IPL, the **/etc/rc** script is run and the **exrecover** command is also run. **exrecover** goes through all the recovery files that were left by the **ex** or **vi** editors. These files have names that begin with **VI**; three of them are created for each **vi** command. **exrecover** creates directories in **/etc/recover** for each userid, puts the recovered files there, and sends the user mail telling what it did.

Using the TMP_VI environment variable

An administrator can set the **TMP_VI** environment variable to the path name of an alternate location where **vi** is to create its recovery files.

Guideline: This environment variable should be set by a system administrator rather than a user. If a user sets the **TMP_VI** directory to something other than the name that **exrecover** recognizes as **TMP_VI**, the user must manually run the **exrecover** daemon to allow the directory files to be converted to the recoverable files that are used by **vi** (located in **/etc/recover/$LOGNAME**).

Restriction: A system administrator should *not* set **TMP_VI** to **/etc/recover/$LOGNAME** or to any directory where a path name component is an environment variable with a user's value that is different from the value of the init process—for example, **$HOME**.

The temporary **vi** files are converted into a form that is recoverable by **vi** when **exrecover** is run during IPL. Because **exrecover** is issued during IPL, it is owned by the init process and, therefore, contains different values for certain environment variables if those environment variables have been set. Throughout the file system, there may be some temporary files that can only be converted by **exrecover**. This conversion can be done manually by a system administrator to recover files owned by all users or by individual users to recover their own files.

Stopping the mail messages

If no one at your installation intends to use **vi**, a superuser can get rid of the **exrecover** mail messages as follows:

1. Edit **/etc/rc**
2. Comment out the line that says `/usr/lib/exrecover`. This stops the **exrecover** command from running, so no new mail messages will be sent.
3. `cd /tmp`
4. `rm VI*`

If your installation has some users who will be editing with **vi**, then it's a little trickier. In this case, your **vi** users will want the recovery capabilities of **vi**, so you do not want to remove the **exrecover** command from **/etc/rc**.

Anyone can remove those **/tmp/VI*** files that were generated when users on dumb terminals tried **vi**. To stop **exrecover** from sending new mail messages about those files:

1. Broadcast a message to make sure no one is using **vi** at the moment
2. `cd /tmp`
3. `rm VI*`

Deleting the old mail messages

If you want to delete only the mail messages sent by **exrecover**:

1. Enter
   ```
   mailx
   ```

2. Use the **mailx** commands to read each message: Enter the number of the message
3. Enter

   ```
   d
   ```

   to delete that message.

To delete all your mail messages, issue:

1. `rm /usr/mail/$LOGNAME`

   But be careful because this will delete all your mail messages.

Using the ed editor

Using the shell: The **ed** editor is a line editing program available in the shell for editing text files. When you edit a file with **ed**, the file is copied into the *edit buffer,* a temporary storage area. You use various subcommands to edit the text in the buffer. When you end your edit session, the contents of the buffer are written to the file system, overwriting the previous contents of the file.

With **ed**, you work with one line in the buffer at a time. In this discussion, that position in the buffer is called the *current working line*.

For more details about **ed**, see *z/OS UNIX System Services Command Reference*.

Creating and saving a text file

1. To begin editing a new file, enter:

   ```
   ed filename
   ```

   where *filename* is the name of a new file.
2. After you see the `?filename` message, enter:

   ```
   a
   ```

   This indicates that you want to *append* lines.
3. Type your text. At the end of each line, press <Enter>. You can then enter more text.
4. When you have finished entering text, enter:

   ```
   .
   ```

   (a period) at the start of a new line.
5. To write the contents of the edit buffer to the file *filename*, enter:

   ```
   w
   ```

   After writing to the file, the shell displays the number of characters that were copied—for example, 746. This number includes blanks and newline characters appended to each line of text, which you cannot see on the screen.

   If you want to write to a file different from the original *filename*, specify a different *filename* when you enter the **w** subcommand; for example:

   ```
   w diffname
   ```

   Entering the **w** subcommand does not change the contents of the buffer.
6. To exit the **ed** program, enter:

   ```
   q
   ```

This deletes the contents of the buffer.

Editing an existing file

To begin editing an existing file, enter:

```
ed filename
```

Your current working line is the last line in the file. If you want to change your position in the file before you begin editing, see "Identifying line numbers and changing your position in the buffer."

If you are already using **ed**, have finished editing one file and saved it with the **w** subcommand, and you now want to edit another file, enter:

```
e filename
```

This erases the previous contents of the buffer and loads in the new file.

Identifying line numbers and changing your position in the buffer

To find out how many lines there are in a file, enter:

```
$=
```

To identify the line number of your current working line, enter:

```
.=
```

You can make a different line in the file your current working line and then identify its number.

To move the current working line forward a line at a time, press <Enter>. The text of the line is displayed.

To move the current working line backward a line at a time, enter:

```
–
```

(hyphen). The text of the line is displayed.

Changing position using numbers

To change the current working line to a different line in the file, enter:

```
n
```

where *n* is the number of the line you want to work with. The text of the line is displayed.

To move the current working line *n* lines forward, enter:

```
.+n
```

To move the current working line *n* lines backward, enter:

```
.–n
```

Changing position using a search string (regular expression)

If you don't know the number or position of the line you want to make your current working line, you can locate a string (or *regular expression*) in the line. To search forward for one or more words or a string of characters, enter:

```
/regexp/
```

where *regexp* is one or more words or a string of characters. The line containing the search string is displayed and it is now your current working line.

To search backward for one or more words or a string of characters, enter:

```
?regexp?
```

where *regexp* is one or more words or a string of characters. The line containing the search string is displayed and it is now your current working line.

Appending one file to another

If you want to append a file at the end of the file you are working on in the buffer, enter:

```
r filename
```

Or, if you want to read a file in after a specific line in the buffer, enter:

```
nr filename
```

where *n* is the number of the line in the file.

To display the contents of a file in the edit buffer, enter:

```
,p,
```

On your screen, each line of the file is displayed, for example:

```
,p,
Oh, you better watch out
You better not shout
You better not cry
I'm telling you why
```

Once you know the line numbers, you could insert the file **scrooge** after the line `You better not cry`. Thus, you would enter:

```
3r scrooge
```

Displaying the current line in the edit buffer

When you enter subcommands, you identify the current working line with the symbol **.** (dot).

To display the current working line, enter:

```
p
```

To display the line number of the current working line, enter:

```
.=
```

Changing a character string

For changing text or correcting spelling errors, use the **s** (substitute) subcommand. When you enter the subcommand, the line you are changing becomes your current working line. To display the line after you make the change, enter the **p** (print) subcommand.

- To substitute text for the first matching string on the current working line, enter:

  ```
  s/oldtext/newtext/
  ```

- To substitute text for the first matching string on a specified line, enter:

  ```
  ns/oldtext/newtext/
  ```

where *n* is the number of the line.

- To substitute text for the first matching string on more than one line, enter:
  ```
  a1,a2s/oldtext/newtext/
  ```

  where *a1* is the number (or address) of the first line to be changed and *a2* is the number of the last line to be changed.
- To change every occurrence of a string on more than one line, enter:
  ```
  a1,a2s/oldtext/newtext/g
  ```

  where *a1* is the number of the first line to be changed and *a2* is the number of the last line to be changed. **g** is the global operator.

  To change every occurrence of a string on one line, enter:
  ```
  ns/oldtext/newtext/g
  ```

  g is the global operator.
- To delete a word or string, enter:
  ```
  s/oldtext//
  ```

Inserting text at the beginning or end of a line

Use the **s** (substitute) subcommand and these two special substitution characters to insert text at the beginning or end of a line:

^ (circumflex)
Inserts text at the beginning of a line

$ (dollar sign)
Inserts text at the end of a line

- To insert text at the beginning of the current working line, enter:
  ```
  s/^/newtext
  ```
- To insert text at the beginning of a specified line, enter:
  ```
  ns/^/newtext
  ```

  where *n* is the number of the line. This line becomes the current working line.
- To insert text at the end of the current working line, enter:
  ```
  s/$/newtext
  ```
- To insert text at the end of a specified line, enter:
  ```
  ns/$/newtext
  ```

  where *n* is the number of the line. This line becomes the current working line.

Deleting lines of text

Use the **d** (delete) subcommand to delete one or more lines of text. After you delete a line, the first line following the deleted line (or lines) becomes the current working line. After a line is deleted, the remaining lines in the buffer are renumbered.

- To delete the current working line, enter:
  ```
  d
  ```
- To delete a specific line number, enter:
  ```
  nd
  ```

  where *n* is the line number.
- To delete more than one line, enter:

```
a1,a2d
```

where *a1* is the number of the first line and *a2* is the number of the last line.

Changing lines of text

To replace one or more lines with one or more new lines, use the **c** (change) subcommand. This actually deletes the lines you want to replace and inserts the new lines.

1. Enter:

   ```
   a1,a2c
   ```

   where:
   a1 is the number of the first line to be deleted.
   a2 is the number of the last line to be deleted.
2. Type the new lines, pressing <Enter> at the end of each line.
3. End the insert by typing a **.** (period) on a line by itself.

Inserting lines of text

To insert one or more lines of new text into the edit buffer, use the **i** subcommand.

1. You can specify the subcommand in one of two ways, depending on how you want to identify the line that the new lines are to be inserted *before*:
   - If you know the number of the line that you want to insert the new lines before, enter:

     ```
     ni
     ```

     where *n* is the number of that line.
   - To identify the line that the new lines are to be inserted before by words or a string of characters in the line (known as a *regular expression*), enter:

     ```
     /regexp/i
     ```

   where *regexp* is one or more words or a string of characters.
2. Enter the new lines.
3. End the insert by typing a **.** (period) on a line by itself.

Copying lines of text

Use the **t** (transfer) subcommand to copy one or more lines within the edit buffer.

To copy one line, enter:

```
a1tn
```

where:
a1 is the number of the line to be copied.
n is the number of the line that the line is to be copied after.

To copy a block of lines, enter:

```
a1,a2tn
```

where:
a1 is the number of the first line in the block of lines to be copied.
a2 is the number of the last line in the block of lines to be copied.
n is the number of the line that the lines are to be copied after.

To copy lines to the top of the edit buffer, use `0` as the line number for the lines to be copied after.

To copy lines to the bottom of the edit buffer, use `$` as the line number for the lines to be copied after.

Moving lines of text

Use the **m** (move) subcommand to move a block of lines to a different position in the edit buffer. After the text is moved, the last line in the block of lines becomes the current working line. Enter:

a1,*a2*m*n*

where *a1* is the number of the first line in the block, *a2* is the number of the last line in the block, and *n* is the number of the line that the block of lines are to be moved *after*.

To move text to the top of the buffer, use `0` as the line number for the lines to be moved after.

To move text to the end of the buffer, use `$` as the line number for the lines to be moved after.

Undoing a change

To undo a change, use the **u** subcommand. This subcommand undoes the changes made by the last subcommand that changed the buffer. For the purposes of **u**, subcommands that change the buffer are: **a**, **c**, **d**, **g**, **G**, **i**, **j**, **m**, **r**, **s**, **t**, **v**, **V**, and **n**.

Entering a shell command while using ed

To temporarily switch out of the **ed** program and run a shell command, enter:

!*command name*

Ending an ed edit session

When you have finished working with a file, you save the changes by entering:

```
w
```

To end the edit session, enter:

```
q
```

If you enter **q** without entering **w** to first save the buffer, the changes you have made are not saved.

Default permissions

When you create a file using the **ed** editor, its default permissions are:

owner=rw-
group=rw-
other=rw-

The octal number is 666.

Using sed to edit a z/OS UNIX file

Using the shell: Because **sed** is a *noninteractive* editor, you do not use it in an interactive session. Instead, enter the **sed** command specifying a file that contains editing commands and a data file, and it produces an edited target file with no user interaction. **sed** is intended for *systematic* editing, as opposed to the usual *editing-on-the-fly* performed by interactive users.

sed subcommands are similar to those used with **ed**, except that **sed** commands view the input text as a stream rather than as a directly addressable file. Each line of the file that contains editing commands has up to two addresses, a single-letter command, possible command modifiers, and an ending newline character.

For more details on **sed**, see the **sed** command description in *z/OS UNIX System Services Command Reference*.

Chapter 20. Printing files

If you are a workstation user, you are probably accustomed to having a printer close by, if not on, your desk. In contrast, the MVS system intentionally screens the user from printer knowledge and uses a printer resource pool. One facility provided to manage this pool is the System Display and Search Facility (SDSF).

You can, of course, download z/OS UNIX files and print them at your workstation. However, it may be more convenient to have print jobs sent to accessible Job Entry Subsystem (JES) printers directly by the shell. In addition, you may want to use the large-volume printing facilities offered by MVS.

Formatting files for online browsing or printing

Using the shell: You can use shell commands to format a file for browsing or printing, and then later use the **lp** command to send the formatted file to a printer.

If you want to format and print a file immediately, you can request this printing as a single piped command.

To format a z/OS UNIX file, use the **pr** command; for example:

```
pr -2 report1
```

This command requests the shell to format for printing in two columns a file named **report1**, and send the output to standard output (your workstation screen). The file appears on your screen in the format you selected. There are many format options for the **pr** command; see the **pr** command description in *z/OS UNIX System Services Command Reference*.

If, instead, you redirect standard output to a file named **report2**, you can later print the file by entering:

```
lp report2
```

This requests the printing of the formatted file in **report2**; because the *dest* option is not specified, the file is sent to the default printer destination.

If you want to format a file and print it right away, you can join the requests using a pipe. (See "Using a pipe" on page 75 for more information on using a pipe.) For example:

```
pr -2 report1 | lp
```

formats and prints the file **report1**.

To save the formatted output as well as print it, try:

```
pr  -2 report1 | tee report2 | lp
```

This command formats **report1** and pipes the formatted output to **tee**. **tee** writes the formatted output to **report2** and at the same time pipes **report2** to the next command, **lp**, which sends the input to the printer queue. The formatted output is saved in **report2**.

Printing requests in shell scripts

Including print requests in a shell script may limit the portability of the shell script, because printer configuration options in other operating systems may differ. To minimize the work involved in porting the shell script to another system, be sure to identify environment assumptions and aliases that may have been used.

Printing with the lp command

Using the shell: You can use the **lp** command to send a previously formatted file to a JES printer:

```
lp filename
```

You can specify more than one file name with the command. The **lp** command uses existing JES printer facilities. Because a default printer destination is assigned to you, you do not need to specify a destination (with the **-d** *dest* option) when entering the **lp** command. However, you can specify a destination other than the default by using the **-d** *dest* option. For **-d** *dest*, you can specify LOCAL for any printer or any of the symbolic destination names your systems programmer defined for JES printers. These symbolic names are defined locally.

Class is a frequently used option, and at your site there might be several different classes defined. For instance, `C` may be designated the class for confidential information. Suppose that you want to print the file **temp.prt** using the default printer destination and specifying class `C`; you would enter it in either of these ways:

```
lp -d ,c temp.prt
```

```
lp -d,c temp.prt
```

The parameters on the **-d** option are positional, so if you omit a destination, you must still include the comma.

To specify the number of copies you want printed, use the **-n** option. For example,

```
lp -n 2 report2
```

requests the printing of two copies of the formatted file in **report2** to the default printer destination.

If you have z/OS Print Server installed on your system, you will use the Print Server version of the **lp** command.

Printing with TSO/E commands

Using TSO/E: Some printer services, such as printing a single file to multiple destinations, are not available through the **lp** command. To print in TSO/E, you need to know:

- The TSO/E commands you can use to submit print jobs
- The printing options (class) you want to specify

Here are the steps:

1. If you are working in the shell, switch to TSO/E command mode by pressing the TSO function key.
2. If you want to print an MVS data set, skip to the next step. If you want to print a z/OS UNIX file, you must first copy it into an MVS data set using the TSO/E

OGET or OCOPY command. (See "Copying a z/OS UNIX file into a sequential data set or PDS member" on page 272 for more information on copying.)

Tip: Someone at your installation may have written an MVS command list (CLIST) or a REXX program that you can enter as a TSO/E command for printing. The command list could include the OGET or OCOPY command, and would let you specify such things as multiple destinations, special character sets, and notification for a set of people.

3. You can format an MVS data set for printing using TSO/E commands. Possibly you will be using ISPF panels.
4. Print the data set:
   - To enter the request to print the formatted data set, for example, you might enter:

     ```
     printds da(project1.list) class(c)
     ```
   - To submit a print request to the MVS job queue, for example, you might enter:

     ```
     submit  jcl.cntl(print1)
     ```

For a print batch job request, the system returns a message confirming that the job request has been received.

Checking the status of print jobs

If you submit a print job with a shell command, there is no way to check on the status of the job. (The **lpstat** and **cancel** commands are not supported.) All output looks the same on the queue in terms of job number. Print jobs could have different setups such as destination or class, but normally the only difference is the number of lines, bytes, or pages and the time of day the output was available to print.

Note: The Print Server is included with z/OS. The Print Server, if enabled, replaces the **lp** command and provides other commands, including **lpstat** and **cancel**.

If your operating system includes SDSF, you can use the SDSF panels to monitor and control a TSO/E or batch print job, look at its output as it is running, check its completion, and release it to print.

For a batch job, the STATUS command can provide status if you specify the job name as your user ID followed by one character (for example, MACNEILA). You cannot use the STATUS command for print jobs that you ran using **lp** or PRINTDS. STATUS takes either no operands or one or more job names as operands. If you use no operands, the system looks for jobs with names that start with your user ID followed by one character. If you list a job name, it looks for that job name.

Requirement: If you use SDSF to view the output from a job where the job name was assigned using the _BPX_JOBNAME environment variable, you must set the SDSF group function APPC to ON. If APPC is set OFF, the assigned job name will not be displayed, and the jobs will differ only by job number. For more information, see *z/OS SDSF Operation and Customization*.

Chapter 21. Copying data between the z/OS UNIX file system and MVS data sets

As shown in Figure 24, you can copy data between the z/OS UNIX file system and MVS data sets using z/OS UNIX shell commands **cp** and **mv** or the TSO/E commands OPUT, OPUTX, OGET, OGETX, and OCOPY.

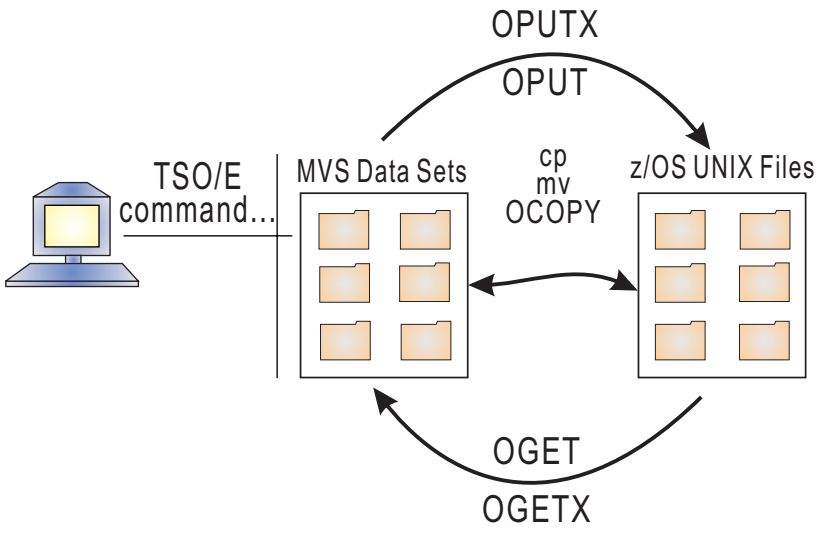


Figure 24. Copying data between z/OS UNIX and MVS

Copying data using z/OS shell commands

You can use the z/OS shell commands **cp** (copy) and **mv** (move) to copy or move files:

- Between the z/OS UNIX file system and MVS data sets
- Within the z/OS UNIX file system.

With the **cp** and **mv** commands you can specify whether the file or data set is to be copied or moved as text, binary, or as an executable. You can also append or truncate suffixes. For examples of using these commands, see:

- "Using cp to copy a sequential data or PDS member into a z/OS UNIX file" on page 267
- "Using cp to copy a PDS to a z/OS UNIX directory" on page 271
- "Using cp to copy a z/OS UNIX file into a sequential data set or PDS member" on page 272
- "Using cp to copy z/OS UNIX files into a PDS or PDSE" on page 276
- "Copying files within the z/OS UNIX file system" on page 277
- "Using cp to copy executables between MVS and z/OS UNIX" on page 280

For more information about the **cp** and **mv** shell commands, see *z/OS UNIX System Services Command Reference*.

Copying data using TSO/E commands

You use TSO/E commands to copy data:

- Between the z/OS UNIX file system and MVS data sets
- Within MVS data sets.

The TSO/E commands that enable you to do this are:

OPUT Puts (copies) an MVS sequential data set or partitioned data set (PDS or PDSE) member into the file system. You can specify text or binary data, and select code page conversion for single-byte data.

OPUTX
Puts (copies) a sequential data set, a data set member, an MVS partitioned data set, or a PDSE into a z/OS UNIX directory. You can specify text or binary data, select code page conversion for single-byte data, specify a copy to lowercase file names, and append a suffix to the member names when they become file names.

OGET Gets a z/OS UNIX file and copies it into an MVS sequential data set or partitioned data set member. You can specify text or binary data, and select code page conversion for single-byte data.

OGETX
Gets a z/OS UNIX file or directory and copies it into an MVS partitioned data set, PDSE, or sequential data set. You can specify text or binary data, select code page conversion for single-byte data, allow a copy from lowercase file names, and delete one or all suffixes from the file names when they become PDS member names.

OCOPY
Copies data in either direction between an MVS data set and a z/OS UNIX file, using ddnames. OCOPY can also copy within MVS (one data set to another data set) or within the shell (one file to another file). OCOPY has a CONVERT operand for converting single-byte data from one code page to another.

For examples of using these commands, see:

- "Using OPUT and OCOPY to copy a PDS member, a PDSE member, or a sequential data set" on page 267
- "Using OPUTX to copy a sequential data set or members of a PDS or PDSE" on page 271
- "Copying an MVS VSAM data set to a z/OS UNIX file" on page 272
- "Using OGET and OCOPY to copy a file into a sequential data set or a PDS member" on page 273
- "Copying z/OS UNIX files into a PDS or PDSE" on page 276
- "Copying an MVS data set into another MVS data set" on page 278
- "Using TSO/E commands and JCL to copy executables" on page 280

You can also invoke BPXCOPY as a TSO/E command as described in the BPXCOPY command description in *z/OS UNIX System Services Command Reference*, but the OPUT interface is generally more appropriate.

For information about the TSO/E OPUT, OPUTX, OGET, OGETX, and OCOPY commands, see *z/OS UNIX System Services Command Reference*.

For information about the TSO/E ALLOCATE and FREE commands, see *z/OS TSO/E Command Reference*. These commands have z/OS UNIX keyword parameters. It is a good idea to use the TSO/E FREE command to free the allocated data set when you have finished copying to or from a data set.

Copying a sequential data set or PDS member into a z/OS UNIX file

You might want to copy an MVS sequential data set or a member of a partitioned data set or PDSE to a z/OS UNIX file, so that:

- The data can be used by a program running under the shell.
- If it is a C program source file developed at your workstation, you can compile, link-edit, and debug it in the shell using the **c89/cc/c++** and **dbx** commands.

The data set can be text or binary.

Using cp to copy a sequential data or PDS member into a z/OS UNIX file

The following examples use the **cp** command to copy a sequential data set or PDS member into a z/OS UNIX file. You use the same syntax for the **mv** command.

To copy an MVS sequential dataset to a z/OS UNIX file (in the current working directory):

```
cp   "//'posix.mylogfile'"  mylogfile
```

To copy an MVS PDS member to a z/OS UNIX file (in the current working directory):

```
cp   "//'posix.cpmvtest(myfile)'"  myunixfile
```

If there is an existing z/OS UNIX file with the path name that you specify on the command, it is automatically replaced and the mode of the file is not changed. The directories specified in the path name must already exist. This command creates a new file, but it does not create a new directory.

Using OPUT and OCOPY to copy a PDS member, a PDSE member, or a sequential data set

You can use the TSO/E OPUT command or OCOPY commands to do the copy. You can enter either command:

- In TSO/E, in the shell, or in ISPF. See "Entering a TSO/E command" on page 198 for information about entering TSO/E commands in TSO/E, the shell, and ISPF.
- In batch, using a Terminal Monitor Program (TMP) job.

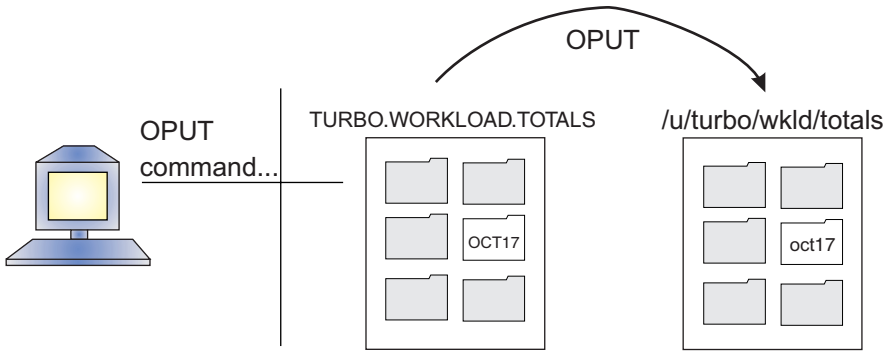
Using OPUT

To specify data set names and file names, use the OPUT command. To specify ddnames, use the ALLOCATE command and the OCOPY command together. Because you can specify permissions on the ALLOCATE command first, the OCOPY command lets you set the permission bits for a newly created file.

If you are moving the data set permanently to the file system, use the TSO/E DELETE command to delete the data set after copying it.

You can use the CONVERT option for single-byte data, but not for double-byte data. See “Double-byte data” on page 283 for information about code page conversion for double-byte data.

Example: Using OPUT with a PDSE member



If the user ID TURBO wants to copy a member of a PDSE into a file, TURBO enters the following TSO/E OPUT command:

```
OPUT WORKLOAD.TOTALS(OCT17) '/u/turbo/wkld/totals/oct17' TEXT CONVERT(YES)
```

This command:

- Copies the MVS partitioned data set member OCT17 from the data set TURBO.WORKLOAD.TOTALS to a text file with the pathname **/u/turbo/wkld/totals/oct17**.
- Converts the data using the default conversion table (from MVS code page IBM-037 to code page IBM-1047), because YES was specified. To use a different conversion table, specify its name—for example, BPXFX311—for conversion to and from the ASCII conversion table. If you do not want conversion, omit the CONVERT operand or specify CONVERT(NO).

  For more information, see “Copying data: Code page conversion” on page 282.
- Sets a default mode (read-write-execute permission) if **oct17** is a *new* file. For a new text (non-U-format data set) file, the default is octal 600:

  owner=rw-
  group=---
  other=---

  The default mode for a binary load module (U-format data set) is octal 700:

  owner=rwx
  group=---
  other=---

  After the file is created, you can change the permissions with the **chmod** command.

If there is an existing z/OS UNIX file with the path name that you specify on the command, it is automatically replaced and the mode of the file is not changed.

The directories specified in the path name must already exist. This command creates a new file, but it does not create a new directory.

Example: Using OPUT with a sequential data set

If the user ID TURBO wants to copy a sequential data set into a file, TURBO enters the following TSO/E OPUT command:

```
OPUT WORKLOAD.PROJA.NOV '/u/turbo/wkld/proja/nov' TEXT CONVERT(YES)
```

This command:

- Copies the MVS sequential data set TURBO.WORKLOAD.PROJA.NOV to a text file with the path name **/u/turbo/wkld/proja/nov**.
- Converts the data from the MVS code page IBM-037 to code page IBM-1047, using the default conversion table because YES was specified.
- Because **nov** is a *new* text file, this command sets a default mode (read-write-execute permission) of octal 600, representing:
  - owner=rw-
  - group=---
  - other=---

Using OCOPY

To copy a data set into a file and use data definition names (ddnames) instead of a data set name and path name, use the OCOPY command.

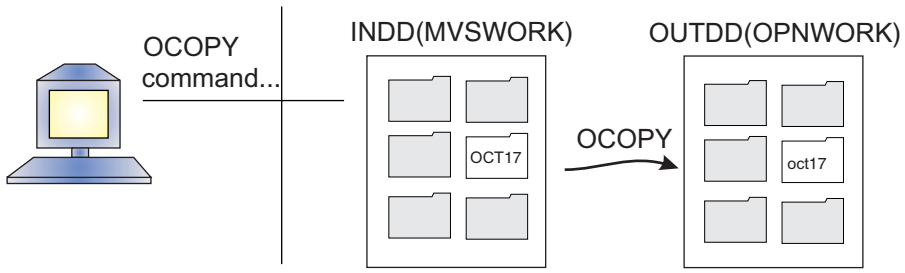
1. If the data set and file are not yet allocated, allocate them and specify ddnames, using either the ALLOCATE command or the DD statement in JCL.

   The ALLOCATE command has these operands for allocating a z/OS UNIX file:

   ```
   PATH
   PATHDISP
   PATHMODE
   PATHOPTS
   ```

   They are explained in *z/OS TSO/E Command Reference*.
2. Enter the OCOPY command, making sure that the ddnames used match the ddnames that were specified when the data set and file were allocated.
3. You can use the CONVERT option for single-byte data, but not for double-byte data. See "Double-byte data" on page 283 for information about code page conversion for double-byte data.
4. If you are moving the data set or partitioned data set member permanently to the file system: After the copy is completed, delete the original using the TSO/E DELETE command.

Example: Using ALLOCATE and OCOPY



1. Using the ALLOCATE command to associate the PDSE member with the ddname specified in the DDNAME keyword, user TURBO could enter:

   ```
   ALLOCATE DDNAME(MVSWORK) DSNAME('TURBO.WORKLOAD.TOTALS(OCT17)')
   ```

   Tip: For an ALLOCATE that begins with your TSO/E prefix as the high-level qualifier, you can enter the data set name more simply as `DSNAME(WORKLOAD.TOTALS(OCT17))`— without the user ID. (The TSO/E prefix defaults to your user ID, but it can be set with the PREFIX command.) If you do not enclose the data set name in quotes, TSO/E automatically prefixes the name with your TSO/E prefix. For JCL, you need the user ID.

2. Using the ALLOCATE command to create a new z/OS UNIX file and associate it with the ddname specified in the DDNAME keyword, TURBO could enter:

```
ALLOCATE DDNAME(OPNWORK) PATH('/u/turbo/wkld/totals/oct17')
         PATHDISP(KEEP,DELETE) PATHOPTS(ORDWR,OCREAT)
         PATHMODE(SIRUSR,SIWUSR)
```

   In this example:
   - PATHDISP(KEEP,DELETE) indicates that the file should be saved if the session ends normally, but that it should be deleted if the session ends abnormally.
   - The PATHOPTS operand is required only when you are creating a new file. PATHOPTS(ORDWR,OCREAT) indicates that the owner has read/write access and this is a new file being created.
   - Specifying PATHMODE is required only when you are creating a new file (OCREAT). PATHMODE(SIRUSR,SIWUSR) indicates that the owner has read and write permission. If you do not specify a PATHMODE, the default permissions set when the file is allocated are:
     owner=---
     group=---
     other=---

3. After the data set and file have been allocated, TURBO would enter the OCOPY command, using the ddnames, to copy the MVS partitioned data set member to a z/OS UNIX file using the default conversion table:

```
OCOPY INDD(MVSWORK) OUTDD(OPNWORK) TEXT CONVERT(YES) PATHOPTS(USE)
```

   PATHOPTS(USE) indicates that TURBO wants to use the PATHOPTS specified on the ALLOCATE command.

Example: Using JCL and OCOPY

Alternatively, TURBO could specify the ddnames in the DD statements and perform the OCOPY in the JCL for a batch job. A DD statement allocates a data set or file and sets up a ddname. In the following example, the //INMVS statement refers to the input data set, and the //OUTHFS statement refers to the output file:

```
//TEST JOB MSGLEVEL=(1,1)
//COPYSTEP EXEC PGM=IKJEFT01
//INMVS    DD DSN=TURBO.WORKLOAD.TOTALS(OCT17),DISP=SHR
//OUTHFS   DD PATH='/u/turbo/wkld/totals/oct17',
//            PATHDISP=(KEEP,DELETE),
//            PATHOPTS=(OWRONLY,OCREAT,OEXCL),PATHMODE=(SIRUSR,SIWUSR)
//SYSTSPRT DD SYSOUT=*
//SYSTSIN  DD *
OCOPY INDD(INMVS) OUTDD(OUTHFS) TEXT CONVERT(YES) PATHOPTS(USE)
/*
```

In this example:

- IKJEFT01 is the name of the Terminal Monitor Program (TMP), which needs to be started to process the TSO/E OCOPY command.
- For CONVERT(YES), the default is TO1047 when you are copying from an MVS data set to a file.
- PATHOPTS(USE) indicates that TURBO wants to use the PATHOPTS specified on the ALLOCATE command.

For more information about:

- The OPUT and OCOPY commands, see *z/OS UNIX System Services Command Reference*.
- The ALLOCATE command, see *z/OS TSO/E Command Reference*.

- The FREE command, see *z/OS TSO/E Command Reference*.
- The JCL, see *z/OS MVS JCL Reference*.

Copying a PDS or PDSE to a z/OS UNIX directory

This topic tells you how to copy a PDS or PDSE into a z/OS UNIX directory.

Using cp to copy a PDS to a z/OS UNIX directory

The following example uses the **cp** command to copy a sequential data set or PDS member into a z/OS UNIX file. You use the same syntax for the **mv** command.

To copy all members from the fully-qualified PDS `'turbo.gammalib'` to the existing z/OS UNIX directory `dir1`, enter the following:

```
cp "//'turbo.gammalib'" dir1
```

Note that `dir1` is in the current working directory.

Using OPUTX to copy a sequential data set or members of a PDS or PDSE

The OPUTX command is actually an exec that calls OPUT. You can use the OPUTX command to copy either of these:

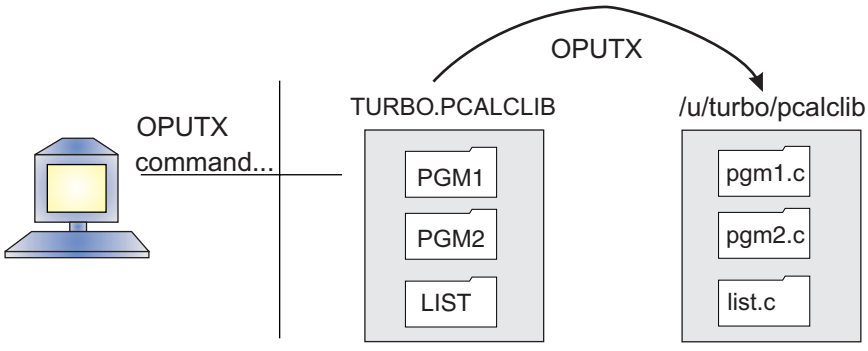
- Members of an MVS partitioned data set or PDSE to a z/OS UNIX directory
- A sequential data set or a single member of a partitioned data set to a file

For the copy, you can specify whether this is text or binary data, or select code page conversion. When copying a partitioned data set or PDSE, you can specify a copy to lowercase file names and append a suffix to the member names when they become file names.

You can use the CONVERT option for single-byte data, but not for double-byte data. See "Double-byte data" on page 283 for information on code page conversion for double-byte data.

The single quotation marks around the directory name and file name are optional. Avoid using OPUTX with pathnames that contain quotes and spaces. For details on the OPUTX command, see *z/OS UNIX System Services Command Reference*.

Example: Using OPUTX with a PDSE



User TURBO wants to copy the members from the data set TURBO.PCALCLIB into the directory `/u/turbo/pcalclib`. He issues the command:

```
OPUTX PCALCLIB /u/turbo/pcalclib LC CONVERT(YES) SUFFIX(c)
```

This command:

- Copies the partitioned data set to a directory. Because the data set name is not enclosed in single quotation marks, the system automatically uses the data set whose high-level qualifier is the user's user ID.
- Converts data set member names to lowercase file names.
- Converts the file to code page IBM-1047.
- Appends the suffix **.c** to each file name.

The members of the partitioned data set become files in the directory:

Member name	File name
TURBO.PCALCLIB(PGM1)	`/u/turbo/pcalclib/pgm1.c`
TURBO.PCALCLIB(PGM2)	`/u/turbo/pcalclib/pgm2.c`
TURBO.PCALCLIB(LIST)	`/u/turbo/pcalclib/list.c`

Copying an MVS VSAM data set to a z/OS UNIX file

To copy a VSAM data set:

1. Use the access method services (AMS) utility to move the VSAM data set to a sequential data set.
2. Copy the MVS sequential data set to a z/OS UNIX file. See "Copying a sequential data set or PDS member into a z/OS UNIX file" on page 267 for instructions.

To move the VSAM data set to a z/OS UNIX file permanently, delete the data set from MVS with the TSO/E DELETE command.

Copying a z/OS UNIX file into a sequential data set or PDS member

You might want to copy a z/OS UNIX file to a sequential data set or to a member of a partitioned data set or PDSE. After it is moved, the file:

- Can be data for an existing MVS application program.
- Can be sent to another system, including a workstation.

You can copy text files or binary files. See "Copying an executable module from the file system" on page 281 for more information about copying an executable.

Using cp to copy a z/OS UNIX file into a sequential data set or PDS member

The following examples use the **cp** command to copy a z/OS UNIX file into a sequential data set or PDS member. You use the same syntax for the **mv** command.

To copy the z/OS UNIX file `myunixfile` (from the current working directory) to the MVS PDS member `myfile` within the PDS called `'posix.cpmvtest'`:

```
cp  myunixfile  "//'posix.cpmvtest(myfile)'"
```

To copy the z/OS UNIX file `file1` to a new, fully-qualified sequential data set `'turbo.gammalib'` to be created with specific attributes:

```
cp -P "RECFM=U,space=(500,100)" file1 "//'turbo.gammalib'"
```

To copy the z/OS UNIX file `f1` to a fully-qualified sequential data set `'turbo.gammalib'` and treat it as binary:

```
cp -F bin f1 "//'turbo.gammalib'"
```

Using OGET and OCOPY to copy a file into a sequential data set or a PDS member

You can use the TSO/E OGET command or the TSO/E OCOPY command to copy a z/OS UNIX file into a sequential data set or PDS member. You can enter either of these commands:

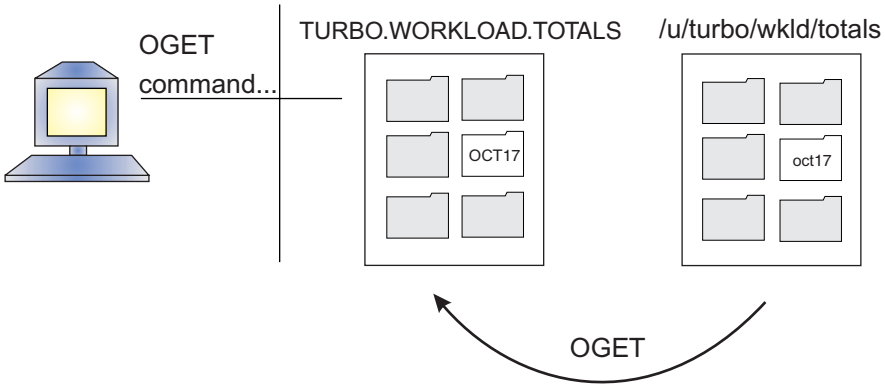
- In TSO/E, in the shell, or in ISPF. See "Entering a TSO/E command" on page 198 for information about entering TSO/E commands in TSO/E, the shell, and ISPF.
- In batch, using a Terminal Monitor Program (TMP) job.

To work with data set names and file names, use the OGET command. To work with ddnames, use the OCOPY command.

OGET

You can use the CONVERT option for single-byte data, but not for double-byte data. See "Double-byte data" on page 283 for information about code page conversion for double-byte data.

Example: Using OGET with a PDSE member



If a person with the user ID TURBO enters the following command:

```
OGET '/u/turbo/wkld/totals/oct17' WORKLOAD.TOTALS(OCT17) CONVERT(YES)
```

the system:

- Copies the text file `/u/turbo/wkld/totals/oct17` into the member OCT17 of the PDSE TURBO.WORKLOAD.TOTALS. (The default file type is a text file.)
- Converts the data from code page IBM-1047 to the MVS code page IBM-037, using the default conversion table. You can specify a table name if you do not want to use the default table. If you do not want conversion, omit the CONVERT operand.

  For more information, see "Copying data: Code page conversion" on page 282.

If a member by this name already exists in the data set, it is replaced. If the member does not exist, a new member is created. However, if a partitioned data set or PDSE does not exist, it is not allocated.

If you are moving the z/OS UNIX file permanently to an MVS data set, remove it from the file system with the **rm** shell command.

Example: Using OGET with a sequential data set

If a person with the user ID TURBO enters the following command:

```
OGET '/u/turbo/wkld/proja/nov' WORKLOAD.PROJA.NOV CONVERT(YES)
```

the system:

- Copies the text file **/u/turbo/wkld/proja/nov** into the sequential data set TURBO.WORKLOAD.PROJA.NOV. (The default file type is a text file.)
- Converts the data from code page IBM-1047 to the MVS code page IBM-037, using the default conversion table. You can specify a table name if you do not want to use the default table. If you do not want conversion, omit the CONVERT operand.

  For more information, see "Copying data: Code page conversion" on page 282.

If a data set with this name already exists, it is replaced. If the sequential data set does not exist, it is automatically allocated. For details on the format and size of the data set that is allocated, see the OGET command description in *z/OS UNIX System Services Command Reference*.

If you are moving the z/OS UNIX file permanently to an MVS data set, remove it from the file system with the **rm** shell command.

OCOPY

To copy a z/OS UNIX file into an MVS data set using data definition names (ddname) instead of a data set name or path name, use the OCOPY command.

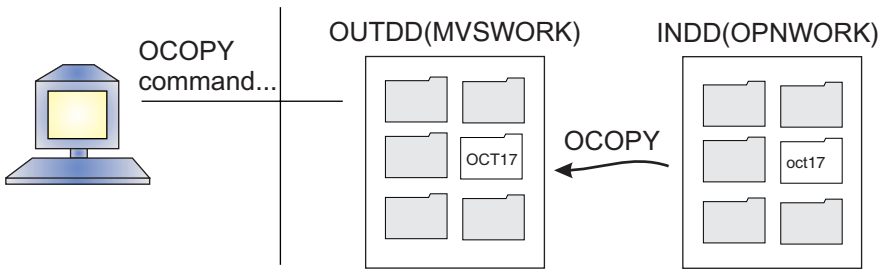
1. If the file and data set are not yet allocated, allocate them and specify ddnames, using either the TSO/E ALLOCATE command or the DD statement for JCL.

   The ALLOCATE command has these keywords for allocating a z/OS UNIX file:

   ```
   PATH
   PATHDISP
   PATHMODE
   PATHOPTS
   ```

   They are explained in *z/OS TSO/E Command Reference*.
2. Enter the OCOPY command, making sure that the ddnames used match the ddnames that were specified when the data set and file were allocated.
3. You can use the CONVERT option for single-byte data, but not for double-byte data. See "Double-byte data" on page 283 for information on code page conversion for double-byte data.
4. After the copy is completed, you can delete the file using the **rm** shell command.

Example: Using ALLOCATE and OCOPY



1. Using the ALLOCATE command to associate an existing z/OS UNIX file with the ddname specified in the DDNAME keyword, user TURBO could enter:

   ```
   ALLOCATE DDNAME(OPNWORK) PATH('/u/turbo/wkld/totals/oct17')
            PATHOPTS(ORDWR,OAPPEND) PATHDISP(KEEP,KEEP)
   ```

   In this example:

   - The file already exists, and PATHOPTS(ORDWR,OAPPEND) indicates that the file owner has read/write access to the file and the owner's data should be written at the end of the file.
   - PATHDISP(KEEP,KEEP) indicates that the file will be saved in case of normal or abnormal termination.
2. Using the ALLOCATE command to associate the output data set with the ddname specified in the DDNAME keyword, user TURBO could enter:

   ```
   ALLOCATE DDNAME(MVSWORK) DSNAME('TURBO.WORKLOAD.TOTALS(OCT17)') OLD
   ```

   where the DDNAME keyword specifies the ddname. OLD indicates that this is an existing data set and others cannot access the data set while the system is writing to it.

   Tip: For an ALLOCATE, you can enter the data set name more simply as `DSNAME(WORKLOAD.TOTALS(OCT17))`—without the user ID. (TSO/E automatically prefixes the data set name with your user ID if you do not enclose the name in quotes.) For JCL, you need the user ID.
3. TURBO then enters the OCOPY command, using ddnames, to copy the z/OS UNIX file to an MVS data set:

   ```
   OCOPY INDD(OPNWORK) OUTDD(MVSWORK) TEXT CONVERT(YES) PATHOPTS(USE)
   ```

   PATHOPTS(USE) indicates that TURBO wants to use the PATHOPTS specified on the ALLOCATE command.

Example: Using JCL and OCOPY

Alternatively, TURBO could specify the ddnames in the //IN DD and //OUT DD statements in the JCL for a batch job. A DD statement allocates a data set or file and sets up a ddname. For example:

```
//TEST JOB MSGLEVEL=(1,1)
//COPYSTEP EXEC PGM=IKJEFT01
//INHFS    DD PATH='/u/turbo/wkld/totals/oct17',PATHOPTS=(ORDONLY)
//OUTMVS   DD DSN=TURBO.WORKLOAD.TOTALS(OCT17),DISP=OLD
//SYSTSPRT DD SYSOUT=*
//SYSTSIN  DD *
OCOPY INDD(INHFS) OUTDD(OUTMVS) TEXT CONVERT(YES) PATHOPTS(USE)
/*
```

In this example:

- IKJEFT01 is the name of the Terminal Monitor Program (TMP), which needs to be started to process the TSO/E OCOPY command.
- PATHOPTS(USE) indicates that TURBO wants to use the PATHOPTS specified on the ALLOCATE command.

For further information about:

- The OGET and OCOPY commands, see *z/OS UNIX System Services Command Reference*.
- The ALLOCATE command, see *z/OS TSO/E Command Reference*.
- The JCL, see *z/OS MVS JCL Reference*.

Copying z/OS UNIX files into a PDS or PDSE

You might want to copy z/OS UNIX files int a partitioned data set or a PDSE. After they are moved, the files:

- Can be data for an existing MVS application program.
- Can be sent to another system, including a workstation.

Using cp to copy z/OS UNIX files into a PDS or PDSE

The following example uses the **cp** command to copy z/OS UNIX files (in the current working directory) into a PDS or a PDSE. You use the same syntax for the **mv** command. This example assumes the z/OS UNIX directory does not contain subdirectories.

To drop `.c` suffixes before copying the files `file1.c`, `file2.c`, and `file3.c` in the directory `dir1` into the existing PDS `'turbo.gammalib'`, enter the following:

```
cp -S d=.c  file1.c file2.c file3.c  "//'turbo.gammalib'"
```

Using OGETX to copy files into a PDS or PDSE

The OGETX command is actually an exec that calls OGET. You can use the OGETX command to copy either of these:

- Files from a z/OS UNIX directory to an MVS partitioned data set or PDSE
- An individual file to a sequential data set or member of a partitioned data set

For the copy, you can specify text or binary data and select code page conversion. When copying a directory, you can specify a copy from lowercase file names and delete one or all suffixes from the file names when they become PDS member names. For a file to be copied, its name must conform to partitioned data set member name conventions after any suffix and LC processing is done. Member names can be 1–8-character uppercase alphanumeric or national characters (A–Z, 0–9, $, #, @). They cannot start with a numeric.

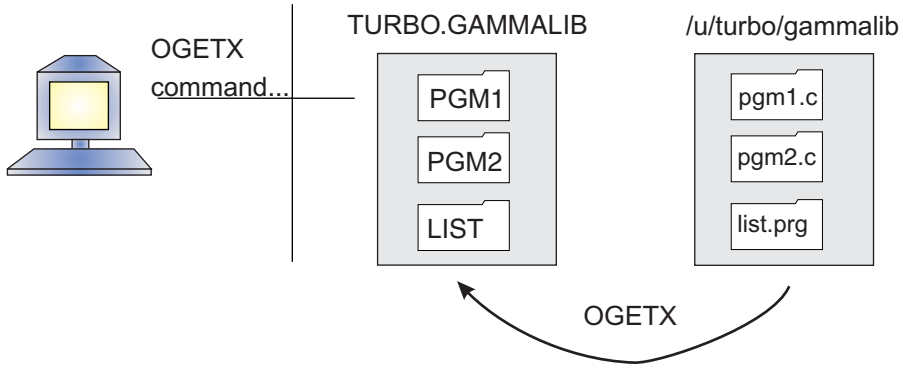
If you specify a particular suffix, only files with that suffix are copied—with the suffix deleted. If you use the SUFFIX operand without specifying a particular suffix, any file names with suffixes have the suffix deleted, and all files are copied. (After the suffix is deleted, if more than one file has the same name, each subsequent file that is copied overlays a file with the same name that was copied previously.)

The single quotation marks around the directory name and file name are optional. Avoid using OGETX with pathnames that contain quotes and spaces.

You can use the CONVERT option for single-byte data, but not for double-byte data. See “Double-byte data” on page 283 for information on code page conversion for double-byte data.

If the OGETX command creates a new data set, it has the same format and size as a data set created by the OGET command. For details on the OGETX command, see *z/OS UNIX System Services Command Reference*.

Example: Using OGETX with a PDSE



User TURBO wants to copy the directory `/u/turbo/gammalib` into the partitioned data set TURBO.GAMMALIB. He issues the command:

```
OGETX /u/turbo/gammalib GAMMALIB LC SUFFIX
```

This command:

- Copies into the partitioned data set all the files in the directory that meet MVS member name requirements. Because the data set name is not enclosed in single quotation marks, the system automatically supplies the user's user ID (TURBO) as a high-level qualifier.
- Copies from files with lowercase, uppercase, or mixed-case names.
- Removes any suffixes to the file names. (After the suffix is deleted, if more than one file has the same name, each subsequent file that is copied overlays a file with the same name that was copied previously.)

The files in the directory become partitioned data set members:

File name	Member name
`/u/turbo/gammalib/pgm1.c`	TURBO.GAMMALIB(PGM1)
`/u/turbo/gammalib/pgm2.c`	TURBO.GAMMALIB(PGM2)
`/u/turbo/gammalib/list.prg`	TURBO.GAMMALIB(LIST)

Copying files within the z/OS UNIX file system

You can use the shell commands **cp** or **pax** or the TSO/E command OCOPY to copy files within the z/OS UNIX file system.

Using the shell: Use the **cp** shell command to copy:

- One file to another file in the working directory, or to a new file in another directory.
- A file, a set of files, or a set of directories to another location in your file system.

To copy one file to another file in the working directory, enter:

```
cp file1 file2
```

This command copies the contents of *file1* into *file2*.

To copy a list of files into another directory, enter:

```
cp file1 file2 file3 dir1
```

This command copies the files *file1*, *file2*, *file3* into the directory *dir1*.

For further information about the **cp** command, see *z/OS UNIX System Services Command Reference*.

You can use the **pax** shell command in copy mode to copy a set of directories and files to another place in your file system.

To use **pax** in copy mode, specify the **-r** and **-w** (or **-rw**) options, as follows:

```
pax -rw pathname directory
```

pax reads the specified path name and copies it to the target directory. The target directory must already exist and you must have write access to it. If a path name is a directory, **pax** copies all the files and subdirectories in that directory, as well as the directory itself, to the target directory.

Using **pax** in copy mode with additional options such as **-C** and **-M** can be useful for migrating data from one file system type to another (for instance, from HFS to zFS). For further information about the **pax** command, see the **pax** command description in *z/OS UNIX System Services Command Reference*.

Using TSO/E: You can use the TSO/E OCOPY command to copy a z/OS UNIX file to another z/OS UNIX file and, in the process, convert the data from one code page to another.

Example: To copy a z/OS UNIX file to another z/OS UNIX file in a different directory, converting the data:

```
ALLOCATE DDNAME(KPAYR) PATH('/u/kinn/bin/payroll')
ALLOCATE DDNAME(MPAYR) PATH('/u/mills/bin/payroll')
OCOPY INDD(KPAYR) OUTDD(mpayr) TEXT CONVERT((BPXFX311)) TO1047
```

The combination of CONVERT((BPXFX311)) and TO1047 indicates that you want to use the ASCII conversion table to convert from ASCII to code page IBM-1047. TO1047 or FROM1047 is required if CONVERT is specified.

With the CONVERT parameter, you can specify a data set name, a member name, or both. In this example, the use of (( )) with no data set name indicates that you are specifying a member that is a module in the standard search order for MVS.

If the files that are being allocated are new files, the PATHOPTS and PATHMODE operands are required.

Copying an MVS data set into another MVS data set

You can use the TSO/E OCOPY command to copy an MVS data set into another data set. It has a CONVERT option that lets you convert between these code pages:

- IBM-037 and IBM-1047
- IBM-037 and ISO8859-1
- Code pages in a user-defined conversion table

With the TSO/E OCOPY command, you can copy:

- A sequential data set to a sequential data set
- A sequential data set to a partitioned data set or PDSE member

- A partitioned data set or PDSE member to a partitioned data set or PDSE member
- A partitioned data set or PDSE member to a sequential data set

You can enter the command:

- In TSO/E, in the shell, or in ISPF. See "Entering a TSO/E command" on page 198 for information about entering TSO/E commands in TSO/E, the shell, and ISPF.
- In batch, using a Terminal Monitor Program (TMP) job.

The OCOPY command uses ddnames instead of data set names:

```
OCOPY INDD(ddname1) OUTDD(ddname2)
      {TEXT | BINARY}
      {CONVERT(convert_table_name | YES | NO)}
      {TO1047 | FROM1047}
```

You do not need the PATHOPTS operand when copying from one data set to another.

There are two ways to specify ddnames, using either the ALLOCATE command or JCL for a batch job.

Example: Using ALLOCATE and OCOPY

Using the ALLOCATE command to associate each data set with a ddname, user TURBO could enter:

```
ALLOCATE DDNAME(TMP1) DSNAME(TEMP1) SHR
ALLOCATE DDNAME(TMP1OC) DSNAME(TEMP1OC) OLD
```

where the DDNAME keyword specifies the ddname. SHR indicates that this is an existing data set and others can access it while the system is reading from it. OLD indicates that this is an existing data set and others cannot access the data set while the system is writing to it.

TURBO could then enter the OCOPY command, using the ddnames from the ALLOCATE command, to convert the data in TEMP1 from the MVS country-extended code page to code page IBM-1047, and copy it to the data set TEMP1OC:

```
OCOPY INDD(TMP1) OUTDD(TMP1OC) TEXT CONVERT(YES) TO1047
```

If CONVERT is specified, you must also specify TO1047 or FROM1047.

Example: Using JCL and OCOPY

Alternatively, TURBO could specify the ddnames in the //IN DD and //OUT DD statements in the JCL for a batch job. A DD statement allocates a data set or file and sets up a ddname. For example:

```
//TEST JOB MSGLEVEL=(1,1)
//COPYSTEP EXEC PGM=IKJEFT01
//IN       DD DSN=TURBO.TEMP1,DISP=SHR
//OUT      DD DSN=TURBO.TEMP1OC,DISP=OLD
//SYSTSPRT DD SYSOUT=*
//SYSTSIN  DD *
OCOPY INDD(IN) OUTDD(OUT) TEXT CONVERT(YES) TO1047
/*
```

In this example,

- IKJEFT01 is the name of the Terminal Monitor Program (TMP), which needs to be started to process the TSO/E OCOPY command.
- TO1047 is required, because you are copying from one data set to another data set.

Copying executable modules between MVS data sets and the z/OS UNIX file system

Using cp to copy executables between MVS and z/OS UNIX

The following example uses the **cp** command to copy an MVS executable module to a z/OS UNIX executable file in the current working directory. You use the same syntax for the **mv** command.

```
cp  -X "//'posix.my.loadlib(myexec)'" myexec
```

The following example uses the **cp** command to copy a z/OS UNIX executable file in the current working directory to an MVS executable module. You use the same syntax for the **mv** command.

```
cp  -X  myexec "//'posix.my.loadlib(myexec)'"
```

Using TSO/E commands and JCL to copy executables

Copying an executable module from a PDSE

If the load module is in a PDSE, you can copy it to the file system using one of these commands:

- The OPUT or OPUTX command. For a new text (non-U-format data set) file, the default permission is octal 600; you can use the **chmod** command or the MODE keyword on the OPUTX command to make it executable. If you replace an existing file, the existing permissions are unchanged.
- The OCOPY command. Specify PATHMODE(SIRWXU) to make the file executable for the owner.

Copying an executable module from a PDS

If the load module is in a partitioned data set (PDS), you can do one of these:

- Use OPUTX. If the source data set is a PDS with an undefined record format, OPUTX treats the members as load modules. In order for the program to be able to run from the file hierarchy, the entry point must be at the beginning of the load module.

  In order for OPUTX to treat the file as a load module, do not specify BINARY or TEXT. Once the module is in the file system, use **chmod** to make it executable. If you replace an existing file, the permissions are unchanged.
- Use JCL that invokes the binder before you copy the module into the file system. See the following example for sample JCL.

Example: Using JCL to copy from a PDS to the file system: To copy a load module out of a partitioned data set and into the file system, you have to use the binder to flatten the load module. Here is an example of JCL our friend TURBO wrote for copying a z/OS XL C/C++ load module into the file system:

```
//TURBO     JOB (XX,YY,ZZ),MSGCLASS=H,CLASS=A,
//          MSGLEVEL=(1,1)
//*
//LKED      EXEC PGM=IEWBLINK,REGION=500K,
//          PARM='LIST,REUS,RENT,NCAL,LET,MAP,CASE=MIXED'
//SYSPRINT DD  SYSOUT=*
```

```
//INLIB    DD  DSN=TURBO.POSIX.LOADLIB,DISP=SHR
//*
//SYSLMOD  DD  PATH='/u/turbo/llib/payrll'
//*
//SYSLIN   DD  *
        INCLUDE INLIB(PAYRLL)
        ENTRY CEESTART
/*
```

This job relinks, or rebinds, the load module PAYRLL from TURBO.POSIX.LOADLIB(PAYRLL), and puts the output into the file system as `/u/turbo/llib/payrll`. Be sure you specify the correct entry point—in this case, CEESTART—for a z/OS XL C/C++ program. If you do not specify the entry point, the entry point is assumed to be at the beginning of the load module.

If the file does not exist you must specify the PATHOPTS and PATHMODE parameters on the DD statement in order to create the file with the appropriate permissions. If the file already exists but you do not have the appropriate file permissions, either the permissions or your access privileges will have to be changed.

Copying an executable module from the file system: There are two methods for copying an executable module from the file system into a data set. These methods are not exactly copy operations; instead, they bind the executables over to the data set. As a result, certain attributes are not preserved, but rather, re-established:

- Use OGETX without the TEXT or BINARY option. If you are copying into a target data set that is a PDS or PDSE with an undefined record format, OGETX treats the files as executables. Because the entry point is re-established, this option only works if the original entry point is at the beginning of the executable.

  Along with the entry point, other attributes are re-established, such as the authorization (AC) value, which is reset to AC=1 (the AUTH option allows it to be set to AC=1).

  Be aware that most executables will not copy successfully into a PDS. When you attempt to execute this kind of operation, you'll receive the following type of error:

  ```
  IEW2606S 4B39 MODULE INCORPORATES PROGRAM MANAGEMENT 3
  FEATURES AND CANNOT BE SAVED IN LOAD MODULE FORMAT.
  ```

  Instead of copying into a PDS, executables created with OS/390 V2R4 or later can be copied into a PDSE.

  Another exception is DLL-enabled executables created with OS/390 V2R4 or later. These executables will not copy successfully into both PDSs and PDSEs. This occurs because the information that is provided by the IMPORT control statements is not preserved, and must be specified again during the rebind.
- Use JCL that invokes the binder before you copy the executable into the data set. See the following example for sample JCL.

Example: Using JCL to copy from the file system to a PDS: To copy an executable out of the file system and into a data set, you need to use the binder to reprocess the executable. Here is an example of JCL our friend TURBO wrote for copying a z/OS XL C/C++ load module into a data set:

```
//TURBO    JOB (XX,YY,ZZ),MSGCLASS=H,CLASS=A,
//          MSGLEVEL=(1,1)
//*
//LKED     EXEC PGM=IEWBLINK,REGION=500K,
//          PARM='LIST,REUS,RENT,NCAL,LET,MAP'
```

```
//SYSPRINT DD  SYSOUT=*
//SYSLMOD  DD  DSN=TURBO.POSIX.LOADLIB,DISP=SHR
//*
//INLIB    DD  PATH='/u/turbo/llib/payrll',
//             PATHOPTS=(ORDONLY)
//*
//SYSLIN   DD  *
        INCLUDE INLIB
        ENTRY CEESTART
        NAME PAYRLL(R)
/*
```

This job relinks, or rebinds, the XL C/C++ executable `/u/turbo/llib/payrll`, and puts the output into TURBO.POSIX.LOADLIB(PAYRLL). Be sure you specify the correct entry point—in this case, CEESTART—for a XL C/C++ program. If you do not specify the entry point, the entry point is assumed to be at the beginning of the executable. Also, if required, you must specify AC=1.

If this is a DLL created using V2R4 or later and without the use of the prelinker, any definition side-decks of IMPORT control statements will need to be re-specified as input to the binder. In general, any control statements and options that were used when the original `/u/turbo/llib/payrll` was created will need to be specified again.

Copying data: Code page conversion

The method you use to convert data from one code page to another depends on whether it is single-byte or double-byte data.

Single-byte data

If you are copying single-byte data into or out of the z/OS UNIX file system, you can use one of these:

- Working in MVS, you can use the z/OS XL C/C++ **iconv** utility to convert MVS data from one code page to another. For information about the z/OS XL C/C++ **iconv** utility, see the **iconv** command description in *z/OS XL C/C++ Programming Guide*.
- Working in the shell, you can use the **iconv** shell command to convert z/OS UNIX data from one code page to another. For information about the **iconv** shell command, see the **iconv** command description in *z/OS UNIX System Services Command Reference*.
- The CONVERT operand on the OCOPY, OGET, OGETX, OPUT, and OPUTX commands provides these code page conversion choices for the data as you are copying:

  CONVERT((BPXFX111))
  Specifies a conversion table to convert between code pages IBM-037 and IBM-1047.

  CONVERT((BPXFX311))
  Specifies an ASCII-EBCDIC conversion table to convert between code pages ISO8859-1 and IBM-1047.

  CONVERT(YES)
  Specifies the default conversion table BPXFX000, which is an alias that points to BPXFX111, to convert the data.

  CONVERT(user-defined table)
  Specifies the name of a user-defined conversion table.

In this list, the use of (( )) with no data set name indicates that you are specifying a member that is a module in the standard search order for MVS.

Double-byte data

If you are moving double-byte data into or out of the z/OS UNIX file system, you can convert the data to or from the shell-supported DBCS code page IBM-939 using one of two utilities:

- Working in MVS, you can use the z/OS XL C/C++ **iconv** utility. For information about the z/OS XL C/C++ **iconv** utility, see *z/OS XL C/C++ Programming Guide*.
- Working in the shell, you can use the **iconv** shell utility. For information about the **iconv** shell utility, see the **iconv** command description in *z/OS UNIX System Services Command Reference*.

Example: Using the iconv shell utility with MBCS data

In this example, the PDSE member MBCSDATA is moved into the file system and then converted to code page IBM-939 from code page IBM-932 (a multibyte ASCII code page):

1. Run the OPUT command from the shell, using the double quotation marks to prevent the shell from processing it:

   ```
   tso oput "'usr3.data(mbcsdata)' '/tmp/usr3/mbcsdata' bin"
   ```

2. Change to the directory that the file **mbcsdata** is in:

   ```
   cd /tmp/usr3
   ```

3. Use **iconv** to convert the data and put it into the output file **dbcsdata**:

   ```
   iconv -f IBM-932 -t IBM-939 mbcsdata > dbcsdata
   ```

Chapter 22. Transferring files between systems

You can create applications and files at your workstation and then move the resulting files to the z/OS UNIX file system for further application development, such as compiling and debugging, or to share the files. There may also be times when you want to send z/OS UNIX files to your workstation. This information discusses several methods for moving files directly between your workstation and z/OS UNIX. Note that most of the examples show z/OS UNIX files being transferred to or from the workstation.

File transfer directly to or from z/OS UNIX

To move a file or file system between your workstation and z/OS UNIX, you can use one of the following methods.

Transferring files using File Transfer Protocol (FTP)

If both the workstation and z/OS UNIX have TCP/IP installed, you can use the File Transfer Protocol (FTP) facility of TCP/IP.

With the z/OS Communications Server installed on a remote z/OS system, you can **ftp** files into or from that system's file system.

An FTP client is not available for the shell and utilities. However, we have ported **ncftp**, an FTP client, and it is available for downloading at z/OS UNIX System Services Tools and Toys Web page (http://www.ibm.com/systems/z/os/zos/features/unix/bpxa1toy.html). You can use it to **ftp** files into or from a local z/OS UNIX file system.

Transferring files using the Network File System feature

Using the Network File System feature, you can edit or browse a z/OS UNIX file directly from your workstation. For example, if you want to copy a file to a workstation file, you do not need to move it to an MVS data set first. Here is an example showing the steps involved:

1. Log on to the host using **mvslogin**.
2. Mount the directory **/u/usr1/a/b** at the workstation with the command:
   ```
   mount mvshost:"/u/usr1/a/b" /x/y
   ```
3. Copy the file **/u/usr1/a/b/c** to the workstation file **/mycopy/c** with the command:
   ```
   cp /x/y/c /mycopy/c
   ```

Using the Network File System feature from your workstation, you can copy a workstation file to z/OS UNIXfile without having to move it to an MVS data set first. This example assumes that you have run your **mvslogin** and mounted the directory **/u/usr1/pgma/b** at the workstation under the pathname **/mypgma/b**. You copy the workstation file **/proj2/modc** to the file **/u/usr1/pgma/b/modc** with the command:

```
cp /proj2/modc /mypgma/b/modc
```

Suppose you have an executable that you compiled and linked ont a workstation, and you want to store it in an MVS data set but run it from the workstation. You copy the executable to the mounted z/OS UNIX file in binary format. Later, when

you want to run the program from the workstation, you use NFS to mount the directory in binary format, and then run the program from the mounted z/OS UNIX file system.

For more information about working with NFS files on your workstation, see *DFSMS: Network File System User's Guide*.

Transferring files using the SEND and RECEIVE programs

You can transfer files using the SEND and RECEIVE programs that are available with PC 3270 emulation programs and with OS/2 Extended Edition Version 1.2 or later.

Requirement: Before you use the SEND and RECEIVE programs, you must be working in TSO/E. If you are using the OMVS interface to work in the shell, use the TSO function key to switch to TSO/E command mode *before* using the programs.

Transferring files using the File Transfer, Access, and Management Function

You can also transfer files between your workstation and the z/OS UNIX file system using the File Transfer, Access, and Management (FTAM) function of OSI/File Services.

File transfer using MVS data sets

Transferring files between systems can also take place without the Network File System feature.

Transferring files into the z/OS UNIX file system

If the z/OS Communications Server is installed on a remote system, you can **ftp** files directly into that file system.

Tip: If you are **ftp**-ing to a remote z/OS UNIX file system, be aware that the z/OS UNIX server often listens to a port other than the well-known port. Make sure you know the address and port to use.

If you are not using the Network File System feature and the z/OS Communications Server is not installed, perform these steps:

1. Transfer the data to the host, using your preferred method (for example, FTP).
2. While logged on to TSO/E, copy the data from an MVS data set into the file system, using the TSO/E OPUT command.

   Single-byte data: If you need to convert to a shell-supported code page, use the CONVERT option on the OPUT command. See "Using OPUT" on page 267.

   Double-byte data or multibyte ASCII-based data: If you need to convert to a shell-supported code page, use the z/OS C/C++**iconv** utility (while working in MVS) or the **iconv** shell utility (while working in the shell). For more information, see "Copying data: Code page conversion" on page 282.
3. If you want, you can delete the MVS data set after the copy with the TSO/E DELETE command.

Transferring files to the workstation

If you are working without the Network File System feature, perform these steps while logged on to TSO/E:

1. Copy the file to an MVS data set (sequential or partitioned) using the TSO/E OGET command. See "OGET" on page 273.

   Single-byte data: If you need to convert to a different code page, you can use the CONVERT option on the OGET command.

   Double-byte data: If you need to convert the data, you can use the **iconv** shell utility while working in the shell. For more information, see "Copying data: Code page conversion" on page 282.
2. If you want, you can delete the file after the copy with the **rm** shell command.
3. Send the data set to the workstation, using your preferred method (for example, FTP).

Transporting an archive file on tape or diskette

A directory or file system that is going to be transported on tape or diskette is put into an archive file, as discussed in "Backing up and restoring files: options" on page 224. This information discusses the steps involved in

- Installing an archive file from tape or diskette into a z/OS UNIX file system
- Putting an archive file on tape or diskette to send to another site

Putting an archive file into the file system

You may receive an archive file on tape or diskette. There are two main steps involved in installing the archive file into a z/OS UNIX file system:

1. Transferring the archive file to an MVS data set, from either a workstation or a tape drive at your MVS system.:
2. Copying the archive file from the data set into the file system

Step 1. Transferring the archive file to a data set

From a workstation: If you have TCP/IP on your workstation, you can use the **ftp** command to transfer an archive file to MVS or to the z/OS shell (if you have the z/OS Communications Server installed).

a. Copy the archive file into a file.

b. Enter the **FTP** command.

Tip: If you are **ftp**-ing to a remote z/OS UNIX file system, be aware that the z/OS UNIX server often listens to a port other than the well-known port. Make sure you know the address and port to use.

c. Enter the **binary** subcommand.

d. Enter the **put** subcommand, specifying a z/OS UNIX directory or a sequential or partitioned data set as the destination.

If you are specifying a data set, you may prefer to use one partitioned data set for all your archive files, with each archive file a member in the partitioned data set. Here is an example of the partitioned data set attributes you might want:

```
DATA SET NAME: TURBO.CMPL.ARCHIVE

GENERAL DATA:                              CURRENT ALLOCATION:
   Volume serial:         TRBLK1             Allocated Cylinders: 26
   Device type:           3380               Allocated extents:    5
   Organization:          PO
   Record format:         VB
   Record length:         255
   Block size:            23476           CURRENT UTILIZATION:
   1st extent Cylinders:  12                 Used Cylinders:       0
   Secondary Cylinders:   0                  Used extents:         0

   Creation date:         1994/12/18
   Expiration date:       ***NONE***
```

e. Go to "Step 2. Copying the file from a data set into a file system."

From a tape drive at your MVS system: If you have an archive file on tape and the necessary tape drive at your MVS system, you can copy the file directly from the tape into a data set.

a. Copy the archive file from the tape into a data set. Here is some sample JCL for copying an archive file (TURBO.TARTAPE) from a tape into a data set (TURBO.TAR):

```
//TAPE2DS   JOB ,',MSGLEVEL=(1,1)
//*
//STEP1    EXEC PGM=IEBGENER
//SYSIN    DD  DUMMY
//SYSPRINT DD  SYSOUT=*
//SYSUT1   DD  DSNAME=TURBO.TARTAPE,UNIT=TAPE,LABEL=(1,NL),DISP=OLD,
//             VOL=SER=123456,DCB=(RECFM=U,BLKSIZE=5120)
//SYSUT2   DD  DSNAME=TURBO.TAR,DISP=(NEW,CATLG),UNIT=SYSDA,
//             SPACE=(5120,(100,100),RLSE)
```

Note: For LABEL=, NL indicates that there is no label. Use NL when transferring a tape between an MVS and a UNIX system; use SL when transferring a tape between two MVS systems.

b. Go to "Step 2. Copying the file from a data set into a file system," which follows.

Step 2. Copying the file from a data set into a file system

Working in MVS: Use the **pax** or the **tar** shell command to restore the directory or file system from the archive file; all the component files are restored from the archive file. If you need to convert the source to the code page IBM-1047 used in the z/OS shell, use the **pax** command with the **-o** option. See "Backing up and restoring files: options" on page 224 for more information.

Sending an archive file to others

The following are the steps for sending an archive file that contains multiple files on tape or diskette. In the example, the **pax** command creates an archive file for a directory or file system. The TSO/E OGET command, with the BINARY option, then copies the archive file into a partitioned data set or a sequential data set. Step 2 is not necessary with OS/390 Release 8 and later.

Step 1. Create an archive file for multiple files

You can use either the **pax** or the **tar** shell command to create the archive file. All the component files are stored in one archive file. For more information, see

"Backing up and restoring files from the shell" on page 225, and also see *z/OS UNIX System Services Command Reference* for a complete description of the **pax** and **tar** commands.

If you need to convert to a different code page than the one used in the shell, use the **pax** command with the **-o** option. See "Backing up and restoring files: options" on page 224 for more information.

Step 2. Copy the file from the file system to a data set

Use the TSO/E OGET command with the BINARY option to copy the archive file into a sequential data set. See "OGET" on page 273 for more information.

```
tso "OGET '/tmp/testpgm.pax' 'POSIX.TESTPGM.PAX' BINARY"
```

The OGET command copies the archive file into the specified MVS data set:

- **'/tmp/posix/testpgm.pax'** is the absolute pathname for the archive file.
- **'POSIX.TESTPGM.PAX'** is the fully qualified data set name for the data set.
- BINARY indicates that the data is binary.

The final step is to use **ftp** (or some other method) to send the file to the intended destination.

Step 3. Transfer the archive file to a tape or diskette

To a tape or diskette at the workstation: While working in MVS:

a. For information about how to copy an archive file from the file system into a data set, see "Step 2. Copy the file from the file system to a data set."

b. Enter the **FTP** command.

c. Enter the **binary** subcommand.

d. Enter the **put** subcommand, specifying a pathname at your workstation as a destination.

e. At the workstation, copy the archive file into a file.

To a tape at the host: While working in MVS:

a. For information about how to copy an archive file from the file system into a data set, see "Step 2. Copy the file from the file system to a data set."

b. Copy the archive file from the data set to tape. Here is some sample JCL for copying a data set containing an archive file (TURBO.TAR) to a tape (TURBO.TARTAPE):

```
//DS2TAPE  JOB ',',MSGLEVEL=(1,1)
//*
//STEP1    EXEC PGM=IEBGENER
//SYSIN    DD  DUMMY
//SYSPRINT DD  SYSOUT=*
//SYSUT1   DD  DSNAME=TURBO.TAR,DISP=OLD
//SYSUT2   DD  DSNAME=TURBO.TARTAPE,UNIT=TAPE,LABEL=(1,NL),
//             DISP=(NEW,KEEP)
```

Guideline: For LABEL=, NL indicates that there is no label. Use NL when transferring a tape between an MVS and a UNIX system; use SL when transferring a tape between two MVS systems.

Part 3. Appendixes

Appendix A. Advanced vi topics

After you have mastered basic usage of **vi**, as described in "Using the vi screen editor" on page 242, you may want to explore some of the editor's other capabilities.

Editing options

vi has many options that change the way the editor behaves during an editing session. We will discuss a few that may be immediately useful. For a complete list of these options, see the **vi** command description in *z/OS UNIX System Services Command Reference*.

You must be in Command Mode to set options. To set an option, begin by typing a colon (:). You will see the cursor move to the bottom of the screen. Then type the word `set`, a space, and the name of the option you want to set—we will talk about option names in a moment. You can correct typing mistakes by backspacing. When you have typed everything correctly, press <Enter>.

One commonly used option is "ignorecase". If you type:

```
:set ignorecase
```

vi does not pay attention to the case of letters when searching. Many people prefer caseless searches over case-sensitive ones. If you want to go back to case-sensitive searches, type

```
:set noignorecase
```

Setting tab stops

By default, **vi** sets tab stops every 8 spaces. For example, if you begin a paragraph by typing a tab, the tab moves the cursor over 8 spaces. Many people feel 8 spaces are too many for a tab stop. You can set tab stops of 5 spaces with:

```
:set tabstop=5
```

Similar commands can set tab stops to any number of spaces.

Using abbreviations

You can define an abbreviation for commonly used words or phrases. For example, if you type:

```
:ab www World Wide Web
```

and then press <Enter>, this sets the abbreviation. As soon as you type the abbreviation in text and move the cursor to the next space after `www`, the abbreviation is expanded into the associated phrase. The abbreviation function is case-sensitive. An abbreviation lasts for the duration of a **vi** session. For information about how to set up a file with frequently used editing options, see "Setting up an editing options command file" on page 294.

If you want to get rid of an abbreviation that has been set, use the **:una** (unabbreviate) command. For example, type:

```
:una www
```

to get rid of the abbreviation.

Other editing options

For a complete list of the editing options, see the **vi** command description in *z/OS UNIX System Services Command Reference*.

Setting up an editing options command file

A command file contains a number of commands that can be executed as if they were typed in a **vi** session. For example, you might use **vi** to create a file with the contents:

```
set wrapmargin=8
set tabstop=5
set shiftwidth=5
ab www World Wide Web
```

This sets all the options you want to use and all the abbreviations you need. The file can only contain instructions that normally start with a colon (:) in **vi**, but you omit the colons in the command file. During a **vi** session, you can execute all the instructions in the command file with the instruction:

```
:so cmdfile
```

where *cmdfile* is the name of your command file. **so** stands for source, and it tells **vi** that the given file should be taken as the source of a number of commands.

You can execute the commands in a command file when you first start **vi**. Start **vi** with the command:

```
vi -c 'so cmdfile' filename
```

where *cmdfile* is the name of your command file and *filename* is the name of the file you want to edit. You might want to set up an alias for `vi -c 'so cmdfile'`; for example:

```
alias vic="vi -c 'so cmdfile'"
```

You can also set up a **$HOME/.exrc** file that contains all the commands you may want to run whenever you enter **vi**.

Editing several files

In a typical **vi** session, you may want to edit several files. When you have finished editing one file, you must first save your text in that file. Once you have saved your changes, you can start editing a different file by typing:

```
:edit newfilename
```

and then press <Enter>. This will clear out the text you have been editing and set things up so you can edit the new file. If the file already exists, its current contents will be read in.

Here's a trick to remember when you want to edit a number of files. If you start **vi** with a command line of the form

```
vi file1 file2 file3 ...
```

you can edit several files one after the other. After you have finished editing a file and saved it, you can move among files using the following commands:

Command
Action

:n Edits the next file in the list of files.

:n! Edits the next file in the list of files and discards the changes made to the current file.

:n *filenames*
Specifies a new list of files to be edited.

It may be particularly useful to use wildcard characters on the **vi** command line, as in

```
vi *.c
```

This is expanded to a list of all the files under the current catalog that have the **.c** extension.

Combining files

Occasionally, you may want to combine a number of files into a single document. For example, you may have a table of data stored in one file and want to add the table to another file. You can read in the contents of a file after the line that holds the cursor. The **r** stands for Read; it reads the contents of a file to be added to the current file after the line indicated by the cursor.

The same sort of command can be used to combine the chapters of a document into a single file. For example,

```
:r chapter1
G
:r chapter2
G
:r chapter3
```

will read in chapters that are stored in separate files. Notice that we had to use **G** commands to go to the end of the file after each read operation, so that the next input file would be added to the end of the text.

Editing program source code

Because **vi** originated on a UNIX system, the editor has a number of features aimed primarily at programming in the C language. However, these same features are applicable to many other languages.

Controlling indention

The source code for a program differs from ordinary text in a number of ways. One of the most important of these is the way in which source code uses indention. Indention shows the logical structure of the program: the way in which statements are grouped into blocks.

Issue the command:

```
:set autoindent
```

(Don't forget to press<Enter>after you have typed this.) This command turns on an option supplied primarily to control indention when entering source code. Each line is automatically indented the same distance as the previous one. As a

programmer, you will find this saves you quite a bit of work getting the indention right, especially when you have several levels of indention.

When you are entering code with autoindent enabled, typing <EscChar-T> gives you another level of indention, and typing <EscChar-D>takes one away. While you are in Insert Mode (not Command Mode):

- Type <EscChar-T> at the start of a line to indent it in one level.
- Type <EscChar-D> at the start of a line to indent it out one level.

The amount of indention provided by <EscChar-T> is one tab character; the space depends on the setting of **tabstop**.

Try using the **autoindent** option when you are entering source code. It simplifies the job of getting indention correct. It can even sometimes help you avoid bugs; for example, in C source code, you usually need one closing } for every level of indention you go backwards.

The **<<** and **>>** commands are also helpful when indenting source code:

>> Shifts a line right 8 spaces (that is, adds 8 spaces of indention)

<< Shifts a line left 8 spaces (that is, removes 8 spaces of indention)

You can shift a number of lines by typing the number followed by **>>** or **<<**. For example, typing **5>>** will indent five lines, including the line the cursor is on.

The default shift is 8 spaces (right or left). You can change this default with this command:

```
:set shiftwidth=4
```

Tip: It is convenient to have a shiftwidth that is the same size as the width between tab stops.

Searching for opening and closing brackets

The characters **(**, **[**, **{**, and **<** can all be called opening brackets. When the cursor is resting on one of these characters, pressing the **%** key moves the cursor from the opening bracket to the corresponding closing bracket character **)**, **]**, **}**, and **>**, keeping in mind the usual rules for nesting brackets. For example, if you move the cursor to the first **(** in:

```
if ( cos(a i ) > sin(b i +c i ) )
               {
                   printf("cos and sin equal!");
               }
```

and press **%**, you will see the cursor jump to the parenthesis at the end of the line. This is the closing parenthesis that matches the opening one.

Similarly, if the cursor is on one of the closing bracket characters, pressing **%** will move the cursor backwards to the corresponding opening bracket character.

Not only does this search character help you move forward and backward through a program in long jumps, but it also lets you check the nesting of parentheses in source code. For example, if you put the cursor on the first **{** at the beginning of a C function, pressing **%** should move you to the **}** that (you think) ends the function. If it doesn't, something has gone wrong somewhere.

Making substitutions

If the name of a data object or function has to be changed in a program (for whatever reason), it becomes necessary to change every occurrence of that name. This would be a tedious process using the **vi** features we have discussed up to this point, because you would have to search through each source file for the name and then type in the new name wherever the old one was found. To avoid much of this work, **vi** offers the substitute command.

The usual form of the substitute command is

```
:s/pattern/replacement/
```

where *pattern* is any of the patterns used in searches, and *replacement* is any string.

As soon as you type the colon (:), you see the cursor move to the bottom of the screen. Then type the rest of the command and press <Enter>. The command puts the given *replacement* string in the place of the first string that matches the given *pattern*.

What happens if a line has more than one string that matches the pattern? The **s** command replaces only the first occurrence of a given string on a line. The position of the cursor in the line does not matter.

If you want to change every occurrence of a string on a line, type a **g** (for global) after the last slash.

Specifying a range of lines to change

You can also apply **s** to a range of lines. For example, let's examine the command:

```
:1,200s/^/!/
```

What happens? The **1,200** in front of the **s** indicates that the command should be applied to the lines from 1 through 200 (everything up to the 200th line in the file). The **s** command itself says to replace the beginning of the line (^) with an exclamation point. So an exclamation point would be put at the beginning of every line up to number 200. To get rid of the exclamation points, you would type:

```
:1,200s/^!//
```

which says change every ! at the beginning of a line to nothing.

Determining line numbers

In these instructions, we made use of line numbers to refer to lines. How do you know what number a line has? If you just want to know the number of one line, move the cursor to that line and type

```
:.=
```

For another approach, type:

```
:set number
```

and press <Enter>. As you can see, this displays the number of every line in the file. If you want to turn off the display of line numbers, type:

```
:set nonumber
```

A number of special symbols can be used when specifying a range of lines. The . (period) stands for the line where the cursor is currently positioned. For example, move the cursor to this line and type:

```
:1,.s/$/???/
```

This adds `???` to the end of every line from the start of the file to the line containing the cursor.

When you issue a substitute command with a range, it is all right if some of the lines in the range do not contain the pattern you are replacing. When specifying a range of lines, **$** stands for the last line in the file. For example, the command:

```
:1,$s/the/THE/g
```

changes every `the` in the file to uppercase (including words like `there`, where `the` is part of another word).

Checking as you substitute

What would you do now if you want to change the variable *i* into a *k*? You can't just use an instruction like

```
:254,267s/i/k/g
```

because that will change the letter *i* into *k* even in other words like **int** and **list**.

The solution to this is to add a **c** (for check) after the **s** command. For example,

```
:s/pattern/replacement/gc
```

When you do this, **vi** checks with you before making every substitution. Before each possible change, **vi** prints the line at the bottom of your screen and puts a **^** under the string that might be changed. If you want the change to happen, press the <Y> key followed by <Enter>. If you do not want the change to happen, press the <N> key followed by <Enter>.

Appendix B. Using awk

awk is a programming language that lets you work with information stored in files. With **awk** programs, you can:

- Display all the information in a file, or selected pieces of information
- Perform calculations with numeric information from a file
- Prepare reports based on information from a file
- Analyze text for spelling, frequency of words or letters, and so on

You can combine these operations to perform quite complicated tasks.

awk allows most of the logical constructs of modern computing languages: **if-else** statements, **while** and **for** loops, function calls, and so on.

This appendix introduces some of the principles and concepts of **awk**. The z/OS version of **awk** is based on the POSIX definition of **awk**, and also supports the functionality of **nawk**, the new **awk**. Experienced programmers may prefer to turn directly to the **awk** command description in *z/OS UNIX System Services Command Reference*. For an excellent reference for **awk**, see *The AWK Programming Language* by Alfred V. Aho, Peter J. Weinberger, and Brian W. Kernighan (Addison-Wesley, 1988). Aho, Weinberger, and Kernighan are the people who created **awk** at AT&T Laboratories, and the name *awk* comes from their last names.

Data files

awk programs work with *data*. Programs can obtain data typed in from the workstation or from the output of other commands (for example, through *pipes*), but usually data is obtained from *data files*.

awk's data files are always text files (not binary files). The files contain readable text—for example, words, numbers, and punctuation characters.

As an example, consider a data file named **hobbies**, which contains information on the hobbies of a group of people. Each line in this file gives a person's name, one of that person's hobbies, how many hours a week he or she spends on the hobby, and how much money the hobby costs per year. One hobby per person appears on each separate line. The file might look like this:

```
Jim     reading          15     100.00
Jim     bridge            4      10.00
Jim     role playing      5      70.00
Linda   bridge           12      30.00
Linda   cartooning        5      75.00
Katie   jogging          14     120.00
Katie   reading          10      60.00
John    role playing      8     100.00
John    jogging           8      30.00
Andrew  wind surfing     20    1000.00
Lori    jogging           5      30.00
Lori    weight lifting   12     200.00
Lori    bridge            2       0.00
```

Figure 25. The hobbies file

This file is included with the z/OS UNIX shell as **/samples/hobbies**.

Records

An **awk** data file is a collection of *records*. A record contains a number of pieces of information about a single item; these pieces are called *fields*.

Records are separated by a *record separator character*, which, for **awk**, is usually the *newline* character. The newline character shows where one line of text ends and another begins. By using the newline as a record separator, each line of the file becomes a separate record. This is convenient and easy to understand; newline is used as a record separator in all of the examples.

In the **hobbies** file, each line is a separate record, giving a set of information about one person's hobby.

Fields

A record consists of a number of *fields*. A field is a single piece of information. For example, the hobby record:

```
Jim     reading          15     100.00
```

contains four fields:

```
Jim
reading
15
100.00
```

Fields should be provided in the same order in each record. That way **awk** and other programs can easily access a particular piece of information in any record.

The fields of a record are separated by one or more *field separator characters*. The **hobbies** file uses strings of blank characters (spaces) to separate fields. By default, **awk** uses blanks or horizontal tab characters to separate fields. You can change the default.

The shape of a program

An **awk** program looks like this:

```
pattern {actions}
pattern {actions}
pattern {actions}
  ...
```

Each line is a separate instruction. **awk** looks through the data files record by record and executes the instructions, in the given order, on each record.

Simple patterns

An instruction of the form:

```
pattern {actions}
```

indicates that **awk** is to perform the given set of actions on every record that meets a certain set of conditions. The conditions are given by the *pattern* part of the instruction.

The *pattern* of an instruction often looks for records that have a particular value in some field. The notation `$1` stands for the first field of a record, `$2` stands for the second field, and so on. For example, here's a simple **awk** instruction:

```
$2 == "jogging" { print }
```

The notation == stands for "is equal to". Therefore, the instruction means: *If the second field in a record is jogging, print the entire record.*

This instruction is a complete **awk** program. If you ran this program on the **hobbies** file, **awk** would look through the file record by record (line by line). Whenever a line had `jogging` as its second field, **awk** would print the complete record. The printout from the program would be:

```
Katie   jogging          14     120.00
John    jogging           8      30.00
Lori    jogging           5      30.00
```

Let's take another example. Ask yourself what the following **awk** program does.

```
$1 == "John" { print }
```

As you probably guessed, it prints every record that has `John` as its first field. The printout from the program would be:

```
John    role playing      8     100.00
John    jogging           8      30.00
```

You could perform the same sort of search on any text database. The only difference is that databases tend to contain a great deal more data than this example.

If an **awk** instruction does not contain an action, **print** is assumed. The preceding examples use the **print** action; however, this action does not need to be written explicitly. You could write the programs as:

```
$2 == "jogging"
```

and:

```
$1 == "John"
```

and they would have exactly the same effect.

On the other hand, you can specify an action and leave out the pattern part of an instruction. In this case, **awk** applies the action part of the instruction to every record in the file. For example:

```
{ print }
```

is a complete **awk** program that displays every record in the data file.

Using blanks and horizontal tabs

You can put any number of extra blanks or horizontal tabs into **awk** patterns and actions. For example, you can enter:

```
{ print $1 , $2 , $3 }
```

Applying more than one instruction

When an **awk** program contains several instructions, **awk** applies every appropriate instruction to the first record, then every appropriate instruction to the second record, and so on. Instructions are applied in order. For example, consider the following **awk** program, which has two instructions:

```
$1 == "Linda"
$2 == "bridge" { print $1 }
```

The output of this program is:

```
Jim
Linda   bridge           12      30.00
Linda
Linda   cartooning        5      75.00
Lori
```

awk looks through the file record by record. The first record to satisfy one of the patterns is:

```
Jim     bridge            4      10.00
```

so **awk** prints the first field of the record (as dictated by the second instruction). The next record of interest is:

```
Linda   bridge           12      30.00
```

This satisfies the first instruction's pattern, so the whole record is printed. It also satisfies the second instruction's pattern, so the first field is printed. **awk** continues through the file, record by record, executing the appropriate actions when a record satisfies the pattern.

Assigning values to variables

Suppose you want to find out how many people have jogging as a hobby. To do this, you have to look through the **hobbies** file, record by record, and keep a count of the number of records that have `jogging` in their second field. This means that you have to *remember* the count from one record to the next.

awk programs *remember* information by using *variables*. A variable is a storage place for information. Every variable has a name and a value. An **awk** action of the form:

```
name = value
```

assigns the specified *value* to the variable that has the given *name*. For example:

```
count = 0
```

assigns the value `0` to the variable *count*.

You can use variables in expressions. For example, the value of the expression:

```
count + 1
```

is the current value of *count*, plus 1.

String values

A *string value* is just a sequence of characters, like `"abc"`. A string value is always enclosed in quotes. All types of characters are allowed (even digits, as in `"abc123"`). Strings can contain any number of characters. A string with zero characters is called the *null string*, and is written `""`.

When **awk** compares strings, it makes comparisons in accordance with the collating order set by the locale that is defined on the system. This is a little like alphabetic order; for example, the program:

```
$1 >= "Katie"
```

prints the `Katie`, `Linda`, and `Lori` lines, which is what you would expect from alphabetic order. However, collating orders differ. ASCII collating order, for example, differs from alphabetic order in a number of respects; for example, lowercase letters are greater than uppercase ones, so that *a* is greater than *Z*.

Numeric values

A *numeric value* consists of digits with an optional sign and decimal point. A numeric value is not enclosed in quotes. For example:

```
10    0.34    -78    +2.56    -.92
```

are all valid in **awk**. **awk** does not let you put commas inside numbers. For example, you must write 1000 instead of 1,000.

Note: **awk** lets you use exponential or scientific notation. Exponents are given as `e` or `E`, followed by an optionally signed exponent. Thus:

```
1E3    1.0e3    10E2    1000
```

are all equivalent.

When **awk** compares numbers (with such operators as > or <), it makes comparisons in accordance with the usual rules of arithmetic.

Using the print action for output

So far, **print** has been the only action discussed. As you have seen, **print** can display an entire record. It can also display selected fields of the record, as in:

```
$2 == "bridge" { print $1 }
```

This displays the first field of every record with a second field that is `bridge`. The output is:

```
Jim
Linda
Lori
```

print can display more than a single field. If you give **print** a list of fields separated by commas, as in:

```
$1 == "Jim" { print $2,$3,$4 }
```

print displays the given fields separated by single blanks, as in:

```
reading 15 100.00
bridge 4 10.00
role playing 5 70.00
```

The **print** action can display strings and numbers along with fields. For example:

```
$1 == "John" { print "$",$4 }
```

prints:

```
$ 100.00
$ 30.00
```

In this instruction, the **print** action prints a string containing a $, followed by a blank, followed by the value of the fourth field in each selected record.

As an exercise, predict the output of the following:

```
(a)  $1 == "Lori" { print $1,"spends $", $4,"on",$2 }
(b)  $2 == "jogging" { print $1,"jogs",$3,"hours a week" }
(c)  $4 > 100.00 { print $1, "has an expensive hobby" }
```

You can check your predictions by running these programs against the **hobbies** file.

Running awk programs

There are two ways to run **awk** programs: from a command line and from a program file.

The awk command line

The simplest **awk** command line is:

```
awk 'program' datafile
```

The **awk** program is enclosed in single-quote or apostrophe (') characters. The *datafile* argument gives the name of the data file. For example:

```
awk '$1 == "Linda"' hobbies
```

executes the program:

```
$1 == "Linda"
```

on the data file **hobbies**.

If you are using the z/OS shell, you can type in a multiline program within single quotation marks, as in:

```
awk '
   $1 == "Linda"
   $2 == "bridge" { print $1 }
   ' hobbies
```

awk assumes that blanks or horizontal tabs separate fields in a record. If the data file uses different field separator characters, you must indicate this on the command line. You can do this with an option of the form:

```
–Fstring
```

where *string* lists the characters used to separate fields. For example:

```
awk –F":" '{ print $3 }' file.dat
```

indicates that the given data file uses colon (**:**) characters to separate record fields. The **–F** option must come before the quoted program instructions.

awk also allows you to define the value of variables on the command line by using the **–v** option. See *z/OS UNIX System Services Command Reference* for details.

Program files

A program file is a text file that contains an **awk** program. You can create program files with any text editor (such as **ed**). For example, you might create a file named **lbprog.awk** that contains the lines:

```
$1 == "Linda"
$2 == "bridge" { print $1 }
```

To execute a program on a particular data file, use the command:

```
awk –f progfile
datafile
```

where *progfile* is the name of the file that contains the **awk** program, and *datafile* is the name of the data file. For example:

```
awk –f lbprog.awk hobbies
```

runs the program in **lbprog.awk** on the data in **hobbies**.

If the data file does not use the default separator characters, you must specify a **–F** option after the *progfile* name, as in:

```
awk –f prog.awk –F":" file.dat
```

To gain some experience using **awk**, you can test the examples on the **hobbies** file. Run some from the command line and some from program files.

Sources of data

If you do not specify a data file on the command line, **awk** begins to read data from standard input. For example, if you enter the command:

```
awk '{ print $1 }'
```

awk prints the first word of every line you type. When you type in data from the workstation, press <Enter> at the end of each line. To stop passing data to **awk**, type <EscChar-D> and press <Enter>.

A command line may also specify several data files, as in:

```
awk -f progfile data1 data2 data3 ...
```

When **awk** has finished reading through the first data file **data1**, it goes on to **data2**, and so on.

Operators

awk recognizes these types of operators:

- Comparison operators
- Arithmetic operators
- Compound assignments
- Increment and decrement operators
- Matching operators
- Multiple-condition operators

Comparison operators

The == notation is an example of a *comparison*. **awk** recognizes several types of comparisons:

Operator	Meaning
==	Equal to
!=	Not equal to
>	Greater than
<	Less than
>=	Greater than or equal to
<=	Less than or equal to

Arithmetic operators

The following **awk** program uses simple arithmetic:

```
$3 > 10 { print $1, $2, $3–10 }
```

In the **print** statement:

```
$3–10
```

has the value of the third field in the record, minus 10. This is the value that **print** prints. If you apply this program to the **hobbies** file, the output is:

```
Jim reading 5
Linda bridge 2
Katie jogging 4
Andrew wind surfing 10
Lori weight lifting 2
```

You could describe how the program works like this: If someone spends more than 10 hours on a hobby, the program prints the person's name, the name of the hobby, and how many *extra* hours the person spends on the hobby (that is, the number of hours more than 10).

An expression such as:

```
$3–10
```

is called an *arithmetic expression*. It performs an arithmetic operation and comes up with a result, which is called the *value* of the expression.

awk recognizes the following arithmetic operations:

Operation	Operator	Example
Addition	*A* + *B*	2+3 is 5
Subtraction	*A* – *B*	7–3 is 4
Multiplication	*A* * *B*	2*4 is 8
Division	A / B	6/3 is 2
Negation	– *A*	– 9 is –9
Remainder	*A* % *B*	7%3 is 1
Exponentiation	*A* ^ *B*	3^2 is 9

The remainder operation is also known as the *modulus,* or *integer remainder* operation. The value of this expression is the integer remainder you get when you divide *A* by *B*. For example:

```
7 % 3
```

has a value of 1, because dividing 7 by 3 gives you 2 with a remainder of 1.

The value for the *exponentiation* operation:

```
A ^ B
```

is the value of *A* raised to the exponent *B*. For example:

```
3 ^ 2
```

has the value 9 (that is, 3^2).

Operation ordering

Expressions can contain several operations, as in:

```
A+B*C
```

As is customary in mathematics, all multiplications and divisions and remainder operations are performed *before* additions and subtractions. When handling the foregoing expression, **awk** performs `B*C` first and then adds `A`. The value of:

```
2+3*4
```

is therefore 14 (3*4 first, then add 2). If you want a particular operation done first, enclose it in parentheses, as in:

```
(A+B)*C
```

When evaluating this expression, **awk** performs the addition before the multiplication. Therefore:

```
(2+3)*4
```

is 20 (2+3 first, then multiply by 4). As an example of this, consider the program:

```
{ print $4/($3*52) }
```

`$4` is the amount of money a person spent on a hobby in the last year. `$3` is the average number of hours a week the person spent on that hobby, so `$3*52` is the number of hours in 52 weeks (that is, 1 year). `$4/($3*52)` is therefore the amount of money that the person spent on the hobby *per hour*.

An order-of-operations table for **awk** can be found in the **awk** command description in *z/OS UNIX System Services Command Reference*.

Compound assignments

The following are the compound assignment operations of **awk** and their equivalents:

Compound operation	Equivalent
A += B	A = A + B
A –= B	A = A – B
A *= B	A = A * B
A /= B	A = A / B
A %= B	A = A % B
A ^= B	A = A ^ B

Increment and decrement operators

You can advance the value held in a variable, with:

```
count = count + 1
```

This is such a common operation that **awk** has a special operator for incrementing variables by 1.

++ The ++ operator increments the current value of the variable by 1. For example:

```
count++
```

adds 1 to the current value of *count*.

– – The – – decrements (subtracts 1 from) the current value of a variable. For example, to subtract 1 from *count*, write:

```
count--
```

Matching operators

If the pattern in an instruction is just a regular expression, **awk** looks for a matching string anywhere in a record. Sometimes, however, you want to look for a matching string only in a particular field of a record. In this case, you can use a *matching* expression.

There are two types of matching expressions:

string **~** */regular-expression/*
: Is true if *string* matches the given regular expression. (The ~ character is called a tilde.)

string **!~** */regular-expression/*
: Is true if *string* does not match the given regular expression.

Multiple-condition operators

Operator
: **Meaning**

&&
: The double ampersand operator means **AND**. For example:

```
$3 > 10 && $4 > 100.00 { print $1, $2 }
```

prints the first and second fields of any record where `$3` is greater than 10 *and* `$4` is greater than 100.00.

||
: The double "or-bar" operator means **OR**. For example:

```
$1 == "Linda" || $1 == "Lori"
```

prints any record with a first field that is *either* `Linda` *or* `Lori`.

Regular expressions

A regular expression is a way of telling **awk** to select records that contain certain strings of characters. For example, the instruction:

```
/ri/ { print }
```

tells **awk** to print all records that contain the string `ri`. Regular expressions are always enclosed in *slashes*, as shown in the instruction just discussed. For a discussion of regular expressions beyond their usage in **awk**, see Appendix C. Regular Expressions (regexp) in *z/OS UNIX System Services Command Reference*.

The following characters have special meanings when you use them in regular expressions:

Character
: **Meaning**

^
: Stands for the beginning of a field. For example:

```
$2 ~ /^b/ { print }
```

Prints any record whose second field begins with `b`.

$
: Stands for the end of a field. For example:

```
$2 ~ /g$/ { print }
```

prints any record with a second field that ends with `g`.

.
: Matches any single character (except the newline). For example:

```
$2 ~ /i.g/ { print }
```

selects the records with fields containing `ing`, and also selects the records containing `bridge` (`idg`).

|
: Means *or*. For example:

```
/Linda|Lori/
```

is a regular expression that matches either of the strings `Linda` or `Lori`.

***** Indicates zero or more repetitions of a character. For example:

```
/ab*c/
```

matches `abc`, `abbc`, `abbbc`, and so on. It also matches `ac` (zero repetitions of `b`). Since **.** matches any character except the newline, **.*** matches an arbitrary string of zero or more characters. For example:

```
$2 ~ /^r.*g$/ { print }
```

prints any record with a second field that begins with `r`, ends in `g`, and has any set of characters between (for example, `reading` and `role playing`).

+ Is similar to `*`, but stands for *one* or more repetitions of a character. For example:

```
/ab+c/
```

matches `abc`, `abbc`, and so on, but does not match `ac`.

\{*m,n***\}**
Indicates *m* to *n* repetitions of a character (where *m* and *n* are both integers). For example:

```
/ab\{2,4\}c/
```

would match `abbc`, `abbbc`, and `abbbbc`, and nothing else.

? Is similar to `*`, but stands for zero or one repetitions of a string. For example:

```
/ab?c/
```

matches `ac` and `abc`, but not `abbc`, and so on.

[X] Matches any one of the set of characters *X* given inside the square brackets. For example:

```
$1 ~ /^[LJ]/ { print }
```

prints any record whose first field begins with either `L` or `J`. As a special case: `[:lower:]` inside the square brackets stands for any lowercase letter, `[:upper:]` inside the square brackets stands for any uppercase letter, `[:alpha:]` inside the square brackets stands for any letter, and `[:digit:]` inside the square brackets stands for any digit.

Thus:

```
/[[:digit:][:alpha:]]/
```

matches a digit or letter.

[^X] Matches any one character that is not in the set *X*. For example:

```
$1 ~ /^[^LJ]/ { print }
```

prints any record with a first field that does not begin with `L` or `J`.

```
$1 ~ /^[^[:digit:]]/ { print }
```

prints any record with a first field that does not begin with a digit.

(X) Matches anything that the regular expression *X* does. You can use

parentheses to control how other special characters behave. For example, * normally applies to the single character immediately preceding it. This means that:

```
/abc*d/
```

matches abd, abcd, abccd, and so on. However:

```
/a(bc)*d/
```

matches ad, abcd, abcbcd, abcbcbcd, and so on.

The characters with special meanings are:

```
^  $  .  *  +  ?  [  ]  (  )  |
```

These are known as *metacharacters*.

When a metacharacter appears in a regular expression, it usually has its special meaning. If you want to use one of these characters literally (without its special meaning), put a backslash in front of the character. For example:

```
/\$1/ { print }
```

prints all records that contain a dollar sign $ followed by a 1. If you simply entered:

```
/$1/ { print }
```

awk would search for records where the end of the record was followed by a 1, which is impossible.

Because the backslash has this special meaning, \ is also considered a metacharacter. If you want to create a regular expression that matches a backslash, you must therefore use two backslashes \\.

Pattern ranges

An instruction of the form:

```
pattern1, pattern2 { action }
```

performs the given *action* on every line, starting at an occurrence of *pattern1* and ending at the next occurrence of *pattern2* (inclusive). For example, the instruction

```
/Jim/, /Linda/ { print $2 }
```

prints the second field of all lines between an occurrence of Jim and an occurrence of Linda. Using the **hobbies** file as our data file, the output is:

```
reading
bridge
role playing
bridge
```

When **awk** finds a record matching *pattern2,* it begins to look for a line matching *pattern1* again. Thus, with this instruction:

```
/reading/, /role/
```

the output is

```
Jim     reading          15     100.00
Jim     bridge            4      10.00
Jim     role playing      5      70.00
Katie   reading          10      60.00
John    role playing      8     100.00
```

awk prints the first range of records from `reading` to `role` and then starts looking for `reading` again.

awk starts performing the instruction's action as soon as there is a record that matches *pattern1*. **awk** does not check to make sure that there is a line matching *pattern2* in the rest of the file. This means that:

```
/Lori/, /Jim/ { print $2 }
```

begins printing at the first record that contains `Lori`, and keeps going until it reaches the end of the file. No `Jim` is found.

Using special patterns

`BEGIN` and `END` are two special patterns.

BEGIN When an instruction has `BEGIN` as its pattern, **awk** performs the associated action *before* looking at any of the records in the data file.

END When an instruction has `END` as its pattern, **awk** performs the associated action *after* looking at all records in the data files specified on the command line.

Consider the action:

```
count = count + 1
```

awk first finds the value of:

```
count + 1
```

and then assigns this value to *count*. Thus this action increases the value of *count* by 1. In a program, you can use this sort of action to count how many people have jogging as a hobby:

```
BEGIN { count = 0 }
$2 == "jogging" { count = count + 1 }
END { printf "%d people like jogging.\n", count }
```

Let's look at this program line by line.

```
BEGIN { count = 0 }
```

In this example, **awk** begins by assigning the value `0` to *count*:

```
$2 == "jogging" { count = count + 1 }
```

adds 1 to *count* every time **awk** finds a record with `jogging` in the second field.

```
END { printf "%d people like jogging.\n", count }
```

When **awk** has looked at all the records, the **printf** action prints the count of people who jog. The output from the program is:

```
3 people like jogging.
```

Notice how the value of *count* was printed in place of the **%d** placeholder. For more information about using a placeholder, see “Placeholders” on page 319.

Built-in variables

awk has a number of *built-in variables* that you can use in your programs. You do not have to assign values to these variables; **awk** automatically assigns the values for you.

Built-in numeric variables

The following list describes some of the important numeric built-in variables:

NR Contains the number of records that have been read so far. When **awk** is looking at the first record, `NR` has the value 1; when **awk** is looking at the second record, `NR` has the value 2; and so on. In a `BEGIN` instruction, `NR` has the value `0`. In an `END` instruction, `NR` contains the total number of records that were read. This instruction:

```
END  { print NR }
```

prints the total number of data records read by the **awk** program.

FNR Is like `NR`, but it counts the number of records that have been read so far *from the current file*. When you give several data files on the **awk** command line, **awk** sets `FNR` back to 1 when it begins reading each new file. Thus, a command such as:

```
{ printf "%d:%s\n",FNR,$0 }
```

prints the line number in the current file, followed by a colon, followed by the contents of the current line.

NF Gives the number of fields in the current record. For the **hobbies** file, `NF` is 4 for each line, because there are four fields in each record. In an arbitrary text file, `NF` gives the number of words on the current line in the file; by default, **awk** assumes that blanks separate the fields of a record, so it considers each word on a line to be a separate field. Therefore, the program:

```
{ count = count + NF }
END  { print count }
```

prints the total number of words in the file.

Using these built-in variables, you can create more ambitious **awk** commands.

```
awk 'NF == 1 {print}' file
```

prints those records with precisely one field in them. There is no **–F** option specified for this command, so **awk** assumes that blanks or tab characters separate the fields. The foregoing command therefore prints all lines that contain only one word (that is, one field).

```
awk '{print FNR ": " $0}' file
```

`$0` stands for the entire record. The foregoing command displays the contents of **file**, putting a line number and a colon before each line.

```
awk '/abc/ {print FILENAME ": " $0}' *.bas
```

examines all files that have the **.bas** extension in the working directory. It prints every line that contains the string `abc` and also displays the filename, so you know which file contains which lines.

Built-in string variables

awk also provides a number of built-in string variables:

FILENAME
Contains the name of the current input file. For example, when running programs against the **hobbies** file, the value of `FILENAME` would be **hobbies** (if that is the file you are using). If the input is coming from the **awk** standard input, the value is `-`.

FS Is the *field separator* string, giving the character that is used to separate fields in the current file. The default value for `FS is ""` (a single blank), which as a special case matches both blank and tab. However, if the command line contains an **–F** option specifying a different field separator, `FS` is a string containing the given separator character. A program may also assign values to `FS` to indicate new field separator characters. For example, you could create a data file with a first line that provides the character used to separate fields in the records in the rest of the file. An **awk** program could then contain the instruction:

```
FNR == 1 { FS = $0 }
```

This says that the field separator string `FS` should be assigned the contents of the first record in the current data file. The character in this line is then taken to be the field separator for the rest of the file (unless `FS` changes value again). Any `FS` value of more than one character is used as a regular expression. For details, see the Input topic of the **awk** command description in *z/OS UNIX System Services Command Reference*.

RS Is the *input record separator*. Just as `FS` indicates the character that separates fields within records, `RS` indicates the character that separates one record from another. By default, `RS` contains a newline character, which means that input records are separated by newlines. However, you can assign a different character to `RS`; for example, with:

```
RS = ";"
```

input records are separated by semicolons. This lets you have several records on a single line, or a single record that extends over several lines. Records are separated by a semicolon, not a <newline> character. As an important special case:

```
RS = ""
```

separates records by empty lines.

OFS Gives the *output field separator string*. When you use the **print** action to print several values, as in:

```
{ print A, B, C }
```

awk prints the output field separator string between each of the values. By default, `OFS` contains a single blank character, which is why output values are separated by a single blank. However, if you make the assignment:

```
OFS = " : "
```

the output values are separated by the given string. You can also use `OFS` to reconstruct the `$0` field during field assignment.

ORS Gives the *output record separator*. When you use the **print** action to print records, **awk** prints the output record separator at the end of each record. By default, `ORS` is the newline character, which is why **print** prints a new

output line each time it is called. However, you can use a different separator string by assigning the string to ORS.

OFMT
Is the *default output format* for numbers when they are displayed by **print**. This is a format string like the one used by **printf**. By default, it is %.6g, indicating that numbers are to be displayed with a maximum of six digits after the decimal point. By changing OFMT, you can obtain more or less displayed precision.

CONVFMT
Is the *default format* which **awk** uses when converting numbers into strings internally. This differs from the **OFMT** variable, which is used only when displaying numbers. The internal conversion of a number to a string occurs when you perform concatenation, indexing, and some comparison operations. **awk** converts floating-point numbers (numbers that are not integers) to strings as if you had specified the operation:

```
sprintf(CONVFMT, number ...)
```

By default, the value of **CONVFMT** is %.6g.

Note: **CONVFMT** is a POSIX extension not found in traditional implementations of **awk**.

Statements and loops

awk supports the following types of statements and loops:
- **if** statement
- **while** loop
- **for** loop
- **next** statement
- **exit** statement

The if statement

An **if** statement is an action of the form:

```
if (expression) statement1 else
statement2
```

Typically, the *expression* in the **if** statement has a true-or-false value. If the value is true, *statement1* is performed; otherwise, *statement2* is performed. The **else** *statement2* part is optional.

The while loop

A **while** loop repeats one or more other instructions as long as a given condition holds true. The format of the loop is:

```
while (expression) statement
```

where the statement can be a single statement or a compound statement.

The for loop

The statement:

```
for
(expression1;expression2;expression3)
statement
```

is equivalent to the following instruction sequence:

```
expression1
while (expression2) {
    statement
    expression3
}
```

The next statement

The **next** instruction skips immediately to the next record in the data file.

The exit statement

The **exit** statement makes an **awk** program behave as if it had just reached the end of data input. No further input is read. If there is an `END` action, **awk** executes it before the program ends. As with **next**, **exit** is often used when input data is found to be incorrect.

If **exit** appears inside the `END` action, the program ends immediately.

Functions

awk supports:

- Arithmetic functions
- String manipulation functions
- User-defined functions
- Passing an array to a function
- The **getline** function

Arithmetic functions

awk recognizes the most common mathematical functions, as shown in the following table.

Function	Result
sqrt(*x*)	Square root of *x*
sin(*x*)	Sine of *x*, where *x* is in radians
cos(*x*)	Cosine of *x*, where *x* is in radians
atan2(*y,x*)	Arctangent of *y/x* in range -π to π
log(*x*)	Natural logarithm of *x*
exp(*x*)	The constant *e* to the power *x*
int(*x*)	Integer part of *x*
rand()	Random number between 0 and 1
srand(*x*)	Sets *x* as seed for **rand()**

Several of these functions may require more explanation.

The **int** function takes a floating-point number as an argument and returns an integer. The integer is just the floating-point number, without its fractional part.

Every call to **rand** returns a new random number between 0 and 1. In this way, you can get a sequence of random numbers. You can use **srand** to set the starting point, or seed, for a random number sequence. If you set the seed to a particular value, you always get the same sequence of numbers from **rand**. This is useful if you want a program to use **rand** but obtain uniform results every time the program runs.

String manipulation functions

awk has a number of functions that perform string operations:

length Returns an integer that is the length of the current record (that is, the number of characters in the record, without the newline on the end). For example, the following program calculates the total number of characters in a file (except for newline characters):

```
    { sum = sum + length }
END { print sum }
```

length(*s***)**

Returns an integer that is the length of the string *s*. For example, the following program prints the length of the first field in each record of the file:

```
{ print length($1) }
```

The function call **length**($0) is equivalent to just **length**.

gsub(*regexp*,*replacement***)**

Puts the replacement string *replacement* in place of every string matching the regular expression *regexp* in the current record. For example, the program:

```
{
    gsub(/John/,"Jonathan")
    print
}
```

checks every record in the data file for the regular expression `John`, replaces matching strings with `Jonathan`, and prints the resulting record. As a result, the program's output is exactly like its input, except that every occurrence of `John` is changed to `Jonathan`. This form of the **gsub** function returns an integer telling how many substitutions were made in the current record. This is 0 if the record has no strings that match *regexp*.

sub(*regexp*,*replacement***)**

Is similar to **gsub**, except that it replaces only the *first* occurrence of a string matching *regexp* in the current record.

gsub(*regexp*,*replacement*,*string_var***)**

Puts the replacement string *replacement* in place of every string matching the regular expression *regexp* in the string *string_var*. For example, the program:

```
{
    gsub(/John/,"Jonathan",$1)
    print
}
```

is similar to the previous program, but the replacement is made only in the first field of each record. This form of the **gsub** function returns an integer telling how many substitutions were made in *string_var*.

sub(*regexp*,*replacement*,*string_var***)**

Is similar to the previous version of `gsub`, except that it only replaces the *first* occurrence of a string matching *regexp* in the string *string_var*.

Note: You must use four backslashes to embed one literal backslash in a **gsub()** or **sub()** substitution string. For example,

```
gsub(/backslash/,"\\\\")
```

replaces all occurrences of the word `backslash` with the single character `\`.

index(*string,substring***)**
Searches the given *string* for the appearance of the given *substring*. If it cannot find *substring*, **index** returns 0; otherwise, **index** returns the number (origin 1) of the character in *string* where *substring* begins. For example:

```
index("abcd","cd")
```

returns the integer 3 because `cd` is found beginning at the third character of `abcd`.

match(*string,regexp***)**
Determines if *string* contains a substring that matches the regular expression (pattern) *regexp*. If so, the function returns an index giving the position of the matching substring within *string*; if not, **match** returns 0. **match** also sets a variable named **RSTART** to the index where the matching string starts, and a variable named **RLENGTH** to the length of the matching string.

substr(*string,pos***)**
Returns the last part of *string*, beginning at a particular character position. The argument *pos* is an integer, giving the number of a character. Numbering begins at 1. For example, the value of:

```
substr("abcd",3)
```

is the string `cd`.

substr(*string,pos,length***)**
Returns the part of *string* that begins at the character position given by *pos* and has the length given by *length*. For example, the value of:

```
substr("abcdefg",3,2)
```

is `cd` (a string of length 2 beginning at position 3).

sprintf(*format,value1,value2,...***)**
Is based on the **printf** action. The value of **sprintf** is the string that would be printed out by the action

```
printf(format,value1,value2,...)
```

For example:

```
str = sprintf("%d %d!!!\n",2,3)
```

assigns the string `"2 3!!!\n"` to the string variable `str`.

tolower(*string***)**
Returns the value of *string*, but with all the letters in lowercase. (This function is an extension to standard **awk**.)

toupper(*string***)**
Returns the value of *string*, but with all the letters in uppercase. (This function is an extension to standard **awk**.)

ord(*string***)**
Converts the first character of *string* into a number. This number gives the decimal value of the character in the character set used on the system. (This function is an extension to standard **awk**.)

User-defined functions

In an **awk** program, a function definition looks like this:

```
function name(argument-list) {
    statements
}
```

The *argument-list* is a list of one or more names (separated by commas) that represent argument values passed to the function. When an argument name is used in the *statements* of a function, it is replaced by a copy of the corresponding argument value.

For example, the following is a simple function that takes a single numeric argument *N* and returns a random integer between 1 and *N* (inclusive):

```
function random(N) {
    return (int(N * rand() + 1))
}
```

Passing an array to a function

When an array is passed as an argument to a function, it is passed *by reference*. This means that the function works with the actual array, not with a copy. Anything that the function does to the array has an effect on the original array. **split** is a built-in function that takes an array as an argument.

split(*string*,*array***)**

split breaks up *string* into fields, and assigns each of the fields to an element of *array*. The first field is assigned to *array*`[1]`, the next to *array*`[2]`, and so on. Fields are assumed to be separated with the field separator string `FS`. If you want to use a different field separator string, you can use:

`split(`*string*`,`*array*`,`*fsstring*`)`

where *fsstring* is the field separator string you want to use instead of `FS`. The result of **split** is the number of fields that *string* contained.

Note: split actually changes the elements of `array`. When an array is passed to a function, the function may change the array elements.

The Getline function

The **getline** function reads input from the current data file or from a different file.

Running system commands

You can run commands with the **system** function:

```
system("command line")
```

runs the given command line: For example:

```
system("cd XYZ")
```

runs a **cd** command to change the working directory.

Controlling awk output

By default, **awk** output is written to your workstation screen. You can save the output of an **awk** program in a file by using *output redirection*. To do this, put:

```
>filename
```

on the end of any **awk** command line. For example:

```
awk –f progfile datafile >outfile
```

writes all the output from the **awk** program to a file named **outfile**. In this case, the output does not appear on the workstation screen.

Formatting the output

The output of the program:

```
$1 == "Jim" { print "$", $4/52 }
```

is:

```
$ 1.92308
$ 0.192308
$ 1.34615
```

This output shows the amount of money per week that Jim spent on his hobbies. However, money amounts usually have only two digits after the decimal point. How can you change the program to make the money amounts appear more normal? The answer is to use the **printf** action instead of **print**. This lets you specify the *format* in which **awk** prints the output.

A **printf** action looks like this:

```
{ printf format-string, value, value, ... }
```

The *format-string* indicates the output format. The *values* are the data to be printed.

A format string contains two kinds of items:

- *Normal characters,* which are just printed out as is
- *Placeholders,* which **awk** replaces with values given later in the **printf** action

As an example, try running the following program on the **hobbies** file:

```
$2 == "bridge" { printf "%5s plays bridge\n", $1 }
```

awk prints:

```
  Jim plays bridge
Linda plays bridge
 Lori plays bridge
```

The format string:

```
"%5s plays bridge\n"
```

has one placeholder: `%5s`. When **printf** prints its output, replacing the placeholder with the value `$1`, which is the first field of the record being examined. The rest of the format string is just printed out as is.

Note: The format string ends in `\n`; for more information, see "Escape sequences" on page 321.

Placeholders

The form of the placeholder `%5s` tells **awk** how to print the associated value. All placeholders begin with `%` and end in a letter. The following are some of the most common letters used in placeholders:

c If the associated value is an integer, **printf** prints the character in the native character set that has that integer value; if the associated value is a string, **printf** prints the first character of the string.

d An integer in decimal form (base 10).

e A floating-point number in scientific notation, as in `-d.ddd dddE+dd`.

f A floating-point number in conventional form, as in `-ddd.ddd ddd`.

g A floating-point number in either `e` or `f` form, whichever is shorter; also, nonsignificant zeros are not printed.

o An unsigned integer in octal form (base 8).

s A string.

x An unsigned integer in hexadecimal form (base 16).

For example, the format string:

```
"%s %d\n"
```

contains two placeholders: `%s` represents a string, and `%d` represents a decimal integer.

Between the `%` and the letter at the end of the placeholder, you can put additional information. If you put an integer, as in `%5s`, the number is used as a *width*. **awk** prints the corresponding value using (at least) the given number of characters. Therefore in:

```
$2 == "bridge" { printf "%5s plays bridge\n", $1 }
```

the value of the string `$1` replaces the placeholder `%5s` and is always printed using five characters. The output is therefore:

```
  Jim plays bridge
Linda plays bridge
 Lori plays bridge
```

as shown before. If you just write:

```
$2 == "bridge" { printf "%s plays bridge\n", $1 }
```

without the 5, the output is:

```
Jim plays bridge
Linda plays bridge
Lori plays bridge
```

If no *width* is given, **awk** prints values using the smallest number of characters possible.

awk also lets you put a minus sign (–) in front of the number in the width position. The amount of output space is the same, but the information is left-justified. For example:

```
$2 == "bridge" { printf "%–5s plays bridge\n", $1 }
```

prints:

```
Jim   plays bridge
Linda plays bridge
Lori  plays bridge
```

A placeholder for a floating-point number can also contain a *precision*. You can write this as a dot (decimal point) followed by an integer. Specifying a precision tells **printf** how many digits to print after the decimal point in a floating-point number. For example, in:

```
$1 == "John" { printf "$%.2f on %s\n", $4 * 1.05, $2 }
```

the placeholder `%.2f` indicates that **printf** is to print all floating-point numbers with two digits after the decimal point. The output of this program is:

```
$105.00 on role playing
$31.50 on jogging
```

For good-looking output, you might specify both a width and a precision. For example, the program:

```
$1 == "John" { printf "$%6.2f on %s\n", $4 * 1.05, $2 }
```

prints the following:

```
$105.00 on role playing
$ 31.50 on jogging
```

`%6.2f` indicates that the corresponding floating-point value should be printed with a width of six characters, with two characters after the decimal point.

Here are a few more **awk** programs that work on the **hobbies** file. Predict what each prints and run them to see if your prediction is right:

```
(a)  { printf "%6s %s\n", $1, $2 }
(b)  { printf "%20s: %2d hours/week\n", $2, $3 }
(c)  $1=="Katie" { printf "%20s: $%6.2f\n",$2,$4 }
```

Escape sequences

All the format strings shown so far have ended in `\n`. This kind of construct is called an *escape sequence*. All escape sequences are made from a backslash character (\) followed by one to three other characters.

Escape sequences are used inside strings, not just those for **printf**, to represent special characters. In particular, the `\n` escape sequence represents the newline character. A `\n` in a **printf** format string tells **awk** to start printing output at the beginning of a newline.

The following list shows escape sequences that can be used in **awk** strings:

Escape	**ASCII character**
`\a`	Audible bell
`\b`	Backspace
`\f`	Formfeed
`\n`	Newline
`\r`	Carriage return
`\t`	Horizontal tab
`\v`	Vertical tab
`\`*ooo*	ASCII character, octal *ooo*
`\x`*dd*	Hexadecimal value *dd*
`\"`	Quote
`\`*c*	Any other character *c*

Appendix C. Code page conversion when the shell and MVS have different locales

A *code page* for a specific character set determines the graphic character produced for each hexadecimal encoding. The code page used is determined by the programs and national languages being used.

If the shell is using a locale generated with code pages IBM-1047, IBM-1027, or IBM-939, an application programmer needs to be concerned about variant characters in the POSIX portable character set whose encoding may vary from other EBCDIC code pages:

Right brace (})
Left brace ({)
Backslash (\)
Right square bracket (])
Left square bracket ([)
Circumflex (^)
Tilde (~)
Exclamation point (!)
Pound sign (#)
Vertical bar (|)
Dollar sign ($)
Commercial at-sign (@)
Accent grave (`)

For example, the encodings for the square brackets do not match on code pages IBM-037 and IBM-1047:

- Left square bracket: [
- Right square bracket:]

Customizing the variant characters on your keyboard

Assuming that you are not using an APL character set, on many programmable workstations you can customize your keys so that you have hexadecimal encodings for the variant characters that match the shell-supported code pages. For example, for those brackets the compatible encodings would be:

X'AD' for a left square bracket ([)
X'BD' for a right square bracket (])

Using the CONVERT option on the OMVS command

The OMVS command has a CONVERT option that lets you specify a conversion table for converting between code pages. The table you want to specify depends on the code pages you are using in MVS and in the shell. For example, if you are using code page IBM-037 in MVS and code page IBM-1047 in the shell, specify the following when you enter the OMVS command:

```
OMVS CONVERT((BPXFX111))
```

For more information, see the OMVS command description in *z/OS UNIX System Services Command Reference*.

When do you need to convert between code pages?

If you are using code page IBM-037 in MVS and the shell is using code page IBM-1047, you need to convert from one code page to another when:

- Transferring files between a workstation and the file system.
- Copying data between MVS data sets and the file system.
- Passing JCL pathname data to z/OS UNIX programs—unless you restrict yourself to characters in the POSIX portable file name character set.
- Passing JCL parameters and pathnames to a shell invoked from a batch program—unless you restrict yourself to characters in the POSIX portable file name character set.
- Converting between ASCII and EBCDIC when using the **pax** utility.

Methods for converting data

There are several methods for converting data to or from a shell-supported code page:

- To convert data you are typing at a 3270 terminal, you specify a conversion table *other than* BPXFX100 (the null conversion table) with the OMVS command. The data you type at your workstation when you are working in the shell is converted to a shell-supported code page.
- To convert data between code pages IBM-037 and IBM-1047 when you are moving the data to or from the hierarchical file system, you can use the CONVERT option on the OPUT, OGET, and OCOPY commands.
- To convert double-byte or single-byte data to a selected code page while you are working in MVS, use the z/OS XL C/C++ **iconv** utility. For information on how to use this utility, see *z/OS XL C/C++ User's Guide*.
- To convert double-byte or single-byte data to a selected code page while you are working in the shell, use the shell **iconv** utility.

The POSIX portable file name character set

To simplify conversion requirements, use the POSIX portable file name character set when naming your files:

Uppercase A to Z
Lowercase a to z
Numbers 0 to 9
Period (.)
Underscore (_)
Hyphen (-)

The POSIX portable character set

The POSIX portable character set consists of

Uppercase A to Z
Lowercase a to z
Numbers 0 to 9

and these characters:

Characters			
+	<	=	>
$	`	^	~

Characters			
#	%	&	*
@	[	]	\
{	}	|	!
"	'	(	)
‚	_	-	.
/	:	;	?

Appendix D. Escape sequences for a 3270 keyboard

When using a 3270 keyboard, you can use escape sequences to type:

- Portable characters not included on your keyboard. See "Escape sequences for portable characters not on your keyboard."
- Control characters that are normally available on ASCII workstations, but not EBCDIC ones. See "Escape sequences for control characters" on page 328.

The notation *EscChar* coupled with another letter (for example, `<EscChar> m`) indicates an escape sequence.

Escape sequences for portable characters not on your keyboard

If you do not have keys on your keyboard for the following portable characters, you can use an escape sequence to obtain them.

Table 9. Portable characters: Escape sequences

z/OS UNIX escape sequence	Character	ASCII control sequence
<EscChar> @ <EscChar> 0	<NUL>	Ctrl-@
<EscChar> g <EscChar> G	<alert>	Ctrl-G
<EscChar> h <EscChar> H	<backspace>	Ctrl-H
<EscChar> i <EscChar> I	<tab>	Ctrl-I
<EscChar> j <EscChar> J	<newline>	Ctrl-J
<EscChar> k <EscChar> K	<vertical-tab>	Ctrl-K
<EscChar> l <EscChar> L	<form-feed>	Ctrl-L
<EscChar> m <EscChar> M	<carriage-return>	Ctrl-M
<EscChar> (	[	[
<EscChar>)	]	]

<tab> character: When you are writing makefiles for the **make** utility, you need to use a <tab> character. If you are using a shell editor, you can type a <tab> character as an <EscChar-I> sequence. After you press <Enter>, the tab displays as blank space.

If you are using the ISPF editor, you cannot type a <tab> character (ISPF handles only displayable characters).

Escape sequences for control characters

To obtain the following control characters, you must use an escape sequence.

Table 10. Control characters: Escape sequences

z/OS UNIX escape sequence	Character	ASCII control sequence
<EscChar> f <EscChar> F	<ACK>	Ctrl-F
<EscChar> x <EscChar> X	<CAN>	Ctrl-X
<EscChar> q <EscChar> Q	<DC1>	Ctrl-Q
<EscChar> r <EscChar> R	<DC2>	Ctrl-R
<EscChar> s <EscChar> S	<DC3>	Ctrl-S
<EscChar> t <EscChar> T	<DC4>	Ctrl-T
<EscChar> p <EscChar> P	<DLE>	Ctrl-P
<EscChar> y <EscChar> Y	<EM>	Ctrl-Y
<EscChar> e <EscChar> E	<ENQ>	Ctrl-E
<EscChar> d <EscChar> D	<EOT>	Ctrl-D
<EscChar> 2 <EscChar> [	<ESC>	Ctrl-[
<EscChar> w <EscChar> W	<ETB>	Ctrl-W
<EscChar> c <EscChar> C	<ETX>	Ctrl-C
<EscChar> 6 <EscChar> _	<IS1>	Ctrl-_
<EscChar> 5	<IS2>	Ctrl-^
<EscChar> 4 <EscChar>]	<IS3>	Ctrl-]
<EscChar> 3 <EscChar>	<IS4>	Ctrl-\
<EscChar> u <EscChar> U	<NAK>	Ctrl-U
<EscChar> o <EscChar> O	<SI>	Ctrl-O
<EscChar> n <EscChar> N	<SO>	Ctrl-N
<EscChar> a <EscChar> A	<SOH>	Ctrl-A
<EscChar> b <EscChar> B	<STX>	Ctrl-B

Table 10. Control characters: Escape sequences (continued)

z/OS UNIX escape sequence	Character	ASCII control sequence
<EscChar> z <EscChar> Z	<SUB>	Ctrl-Z
<EscChar> v <EscChar> V	<SYN>	Ctrl-V

Escape sequences unique to a conversion table

Depending on the conversion table that you specify with the CONVERT keyword on the OMVS command, you may need to type a unique escape sequence to enter a character. This information shows how unique escape sequences are translated by each of the character conversion tables. The translations for escaped alphabetic characters (which are the same for all tables—these are Ctrl-A through Ctrl-Z) are not shown in these tables.

BPXFX100 conversion table

This table shows the escape sequences for certain characters that may not be on your keyboard.

Table 11. Translation of selected escaped characters (BPXFX100)

z/OS UNIX escape sequence	Character	ASCII control sequence
<EscChar> ? <EscChar> # <EscChar> 7	<DEL>	Ctrl-?
<EscChar> {	[	[
]	]	
<EscChar> ¬	<IS2>	Ctrl-^

BPXFX111 and BPXFX211 conversion tables

This table shows the escape sequences for certain characters that may not be on your keyboard.

Table 12. Translation of selected escaped characters (BPXFX111 and BPXFX211)

z/OS UNIX escape sequence	Character	ASCII control sequence
<EscChar> ? <EscChar> # <EscChar> 7	<DEL>	Ctrl-?
<EscChar> {	[	[
]	]	
<EscChar> ¬	<IS2>	Ctrl-^

BPXFX437, BPXFX450, BPXFX471, BPXFX473, BPXFX477, BPXFX478, BPXFX480, BPXFX484, BPXFX485, BPXFX497 conversion tables

Conversion tables BPXFX437, BPXFX450, BPXFX471, BPXFX473, BPXFX477, BPXFX478, BPXFX480, BPXFX484, BPXFX485, and BPXFX497 have the following escape sequences for certain characters that may not be on your keyboard.

Table 13. Translation of selected escaped characters. (BPXFX437, BPXFX450, BPXFX471, BPXFX473, BPXFX477, BPXFX478, BPXFX480, BPXFX484, BPXFX485, and BPXFX497)

z/OS UNIX escape sequence	Character	ASCII control sequence
<EscChar> ? <EscChar> 7	<DEL>	Ctrl-?
<EscChar> -	~	
<EscChar> %	@	
<EscChar> &	$	
<EscChar> ; <EscChar> !	|	
<EscChar> '	^	
<EscChar> =	#	
<EscChar> "	`	
<EscChar> /	\	
<EscChar> :	!	
<EscChar> <	{	
<EscChar> >	}	
<EscChar> ^	<IS2>	Ctrl-^

Appendix E. Locale objects, source files, and charmaps

The z/OS shells and utilities support the locales listed in the appendix in *z/OS XL C/C++ Programming Guide*.

A *locale name* is the same as a *locale object name*. The suffix of the locale name, for example, IBM-277, indicates the code page that the locale is based on.

The *symbolic link* is a shortened name for the complete locale object name; You can use the *symbolic link* name when specifying a locale for an environment variable or with the **setlocale()** function. For example, you can specify

```
LANG=En_US
```

instead of

```
LANG=En_US.IBM-1047
```

The compiled locale object files are in the directory **/usr/lib/nls/locale**. The locale source definition files are in **/usr/lib/nls/localedef**. The source file name combined with the code page name results in the name of the locale object.

The charmap files are in **/usr/lib/nls/charmap**. The charmap file names are identical to code page names— for example, IBM-1047.

Appendix F. Accessibility

Accessible publications for this product are offered through IBM Knowledge Center (http://www.ibm.com/support/knowledgecenter/SSLTBW/welcome).

If you experience difficulty with the accessibility of any z/OS information, send a detailed message to the "Contact us" web page for z/OS (http://www.ibm.com/systems/z/os/zos/webqs.html) or use the following mailing address.

IBM Corporation
Attention: MHVRCFS Reader Comments
Department H6MA, Building 707
2455 South Road
Poughkeepsie, NY 12601-5400
United States

Accessibility features

Accessibility features help users who have physical disabilities such as restricted mobility or limited vision use software products successfully. The accessibility features in z/OS can help users do the following tasks:

- Run assistive technology such as screen readers and screen magnifier software.
- Operate specific or equivalent features by using the keyboard.
- Customize display attributes such as color, contrast, and font size.

Consult assistive technologies

Assistive technology products such as screen readers function with the user interfaces found in z/OS. Consult the product information for the specific assistive technology product that is used to access z/OS interfaces.

Keyboard navigation of the user interface

You can access z/OS user interfaces with TSO/E or ISPF. The following information describes how to use TSO/E and ISPF, including the use of keyboard shortcuts and function keys (PF keys). Each guide includes the default settings for the PF keys.

- *z/OS TSO/E Primer*
- *z/OS TSO/E User's Guide*
- *z/OS V2R2 ISPF User's Guide Vol I*

Dotted decimal syntax diagrams

Syntax diagrams are provided in dotted decimal format for users who access IBM Knowledge Center with a screen reader. In dotted decimal format, each syntax element is written on a separate line. If two or more syntax elements are always present together (or always absent together), they can appear on the same line because they are considered a single compound syntax element.

Each line starts with a dotted decimal number; for example, 3 or 3.1 or 3.1.1. To hear these numbers correctly, make sure that the screen reader is set to read out

punctuation. All the syntax elements that have the same dotted decimal number (for example, all the syntax elements that have the number 3.1) are mutually exclusive alternatives. If you hear the lines 3.1 USERID and 3.1 SYSTEMID, your syntax can include either USERID or SYSTEMID, but not both.

The dotted decimal numbering level denotes the level of nesting. For example, if a syntax element with dotted decimal number 3 is followed by a series of syntax elements with dotted decimal number 3.1, all the syntax elements numbered 3.1 are subordinate to the syntax element numbered 3.

Certain words and symbols are used next to the dotted decimal numbers to add information about the syntax elements. Occasionally, these words and symbols might occur at the beginning of the element itself. For ease of identification, if the word or symbol is a part of the syntax element, it is preceded by the backslash (\) character. The * symbol is placed next to a dotted decimal number to indicate that the syntax element repeats. For example, syntax element *FILE with dotted decimal number 3 is given the format 3 * FILE. Format 3* FILE indicates that syntax element FILE repeats. Format 3* * FILE indicates that syntax element * FILE repeats.

Characters such as commas, which are used to separate a string of syntax elements, are shown in the syntax just before the items they separate. These characters can appear on the same line as each item, or on a separate line with the same dotted decimal number as the relevant items. The line can also show another symbol to provide information about the syntax elements. For example, the lines 5.1*, 5.1 LASTRUN, and 5.1 DELETE mean that if you use more than one of the LASTRUN and DELETE syntax elements, the elements must be separated by a comma. If no separator is given, assume that you use a blank to separate each syntax element.

If a syntax element is preceded by the % symbol, it indicates a reference that is defined elsewhere. The string that follows the % symbol is the name of a syntax fragment rather than a literal. For example, the line 2.1 %OP1 means that you must refer to separate syntax fragment OP1.

The following symbols are used next to the dotted decimal numbers.

? indicates an optional syntax element
The question mark (?) symbol indicates an optional syntax element. A dotted decimal number followed by the question mark symbol (?) indicates that all the syntax elements with a corresponding dotted decimal number, and any subordinate syntax elements, are optional. If there is only one syntax element with a dotted decimal number, the ? symbol is displayed on the same line as the syntax element, (for example 5? NOTIFY). If there is more than one syntax element with a dotted decimal number, the ? symbol is displayed on a line by itself, followed by the syntax elements that are optional. For example, if you hear the lines 5 ?, 5 NOTIFY, and 5 UPDATE, you know that the syntax elements NOTIFY and UPDATE are optional. That is, you can choose one or none of them. The ? symbol is equivalent to a bypass line in a railroad diagram.

! indicates a default syntax element
The exclamation mark (!) symbol indicates a default syntax element. A dotted decimal number followed by the ! symbol and a syntax element indicate that the syntax element is the default option for all syntax elements that share the same dotted decimal number. Only one of the syntax elements that share the dotted decimal number can specify the ! symbol. For example, if you hear the lines 2? FILE, 2.1! (KEEP), and 2.1 (DELETE), you know that (KEEP) is the

default option for the FILE keyword. In the example, if you include the FILE keyword, but do not specify an option, the default option KEEP is applied. A default option also applies to the next higher dotted decimal number. In this example, if the FILE keyword is omitted, the default FILE(KEEP) is used. However, if you hear the lines 2? FILE, 2.1, 2.1.1! (KEEP), and 2.1.1 (DELETE), the default option KEEP applies only to the next higher dotted decimal number, 2.1 (which does not have an associated keyword), and does not apply to 2? FILE. Nothing is used if the keyword FILE is omitted.

*** indicates an optional syntax element that is repeatable**

The asterisk or glyph (*) symbol indicates a syntax element that can be repeated zero or more times. A dotted decimal number followed by the * symbol indicates that this syntax element can be used zero or more times; that is, it is optional and can be repeated. For example, if you hear the line 5.1* data area, you know that you can include one data area, more than one data area, or no data area. If you hear the lines 3* , 3 HOST, 3 STATE, you know that you can include HOST, STATE, both together, or nothing.

Notes:

1. If a dotted decimal number has an asterisk (*) next to it and there is only one item with that dotted decimal number, you can repeat that same item more than once.
2. If a dotted decimal number has an asterisk next to it and several items have that dotted decimal number, you can use more than one item from the list, but you cannot use the items more than once each. In the previous example, you can write HOST STATE, but you cannot write HOST HOST.
3. The * symbol is equivalent to a loopback line in a railroad syntax diagram.

+ indicates a syntax element that must be included

The plus (+) symbol indicates a syntax element that must be included at least once. A dotted decimal number followed by the + symbol indicates that the syntax element must be included one or more times. That is, it must be included at least once and can be repeated. For example, if you hear the line 6.1+ data area, you must include at least one data area. If you hear the lines 2+, 2 HOST, and 2 STATE, you know that you must include HOST, STATE, or both. Similar to the * symbol, the + symbol can repeat a particular item if it is the only item with that dotted decimal number. The + symbol, like the * symbol, is equivalent to a loopback line in a railroad syntax diagram.

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