Implementation of IBM® DB2® Universal Database™ and SAP in a Microsoft® Cluster environment

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Abstract

High availability has become one of the most discussed information management topics and one of the most sought-after capabilities in many industries. A highly advanced-technology that provides high availability in the Microsoft Windows® environment is the Microsoft cluster technology.

Recently SAP has implemented support for the Microsoft cluster environment, and more and more SAP customers have begun to implement it as their high-availability solution. This paper is designed to assist users in planning and installing an SAP system running DB2 as its database in a Microsoft Cluster Server (MSCS) environment. Users and administrators who want to understand the architecture of SAP R/3 and DB2 UDB in an MSCS environment and to implement this architecture on their systems are the target audience.
Overview

This paper is step-by-step guide to implementing and running an SAP system using DB2 UDB in a Microsoft cluster environment. Use this information as an extension to the information available in the SAP and DB2 UDB products manuals on MSCS implementation.

The paper is organized to cover the following topics:

- The first chapter introduces the concepts of high availability and clustering in general terms, as well as in an SAP and DB2 environment.
- The second chapter discusses implementation of DB2, SAP and MSCS.
- Chapters 4 through 6 outline the planning and pre-installation steps. They include checklists and step-by-step instructions, as well as details on setting up the cluster before installing DB2 and SAP.
- Chapters 6 and 7 detail the steps for installing DB2 UDB and SAP.
- Chapters 8 and 9 contain the MSCS-specific instructions on what to do after an SAP system is installed to complete the configuration.
- Chapters 10 through 12 discuss regular activities that should be performed on a newly-created system running MSCS. They discuss issues such as tuning, maintenance, security, and data backup.

This document focuses on DB2 UDB-specific details in a MSCS environment. You can find other supported database management systems not covered in this paper in the SAP manuals.

The tests conducted to produce this paper were performed on SAP Enterprise 4.7 Extension Set 2, running with DB2 UDB V8.1 and V8.2 with two nodes, using Windows 2003 Enterprise Sever Edition.

You should review the SAP OSS notes mentioned in this document and the Microsoft Knowledge base for the latest updates on this topic.
Chapter 1: Introduction

1.1 What is clustering?

High availability (HA) is becoming more and more essential for large organizations running DB2 and SAP. Downtime means lost sales, unhappy customers, and major financial losses to companies.

Clustering is the use of multiple computers connected to act as a single entity in order to run common tasks. If one computer fails, the others pick up the workload automatically. By adding more computers, you can increase the power and, hence, the design can support more users.

Within a high availability environment, clustering software is useful in providing a mechanism to ensure that all resources are continually available to an application. It can also go one step further and ensure that the application is continuously available.

Failover is the capability to automatically transfer the workload from one server to another if a hardware failure occurs, without affecting the workload or the users. Fault tolerance is the ability of a system to survive any failure in a hardware or software component and continue to function.

Clusters are useful not only to ensure availability, but also to enhance performance. Having multiple machines running and connected concurrently means more resources available to provide a higher performance ratio. For example, consider two machines running DB2 and SAP in a Microsoft cluster environment. The user can have both the SAP system and the database on one machine, leaving the other machine idle (until a failure occurs), but better yet, they can have the SAP system on one machine and the database active on the other. Thus both machines are used and the failover technique will work the same way.

Another advantage of clustering is that it gives you the ability to run system maintenance with little or no downtime. For instance, if an update of the DB2 software is necessary, the user can just move all the resources to one node and update the software on the other one, and then switch to the other node. Thus the system will always be online while the updates are running.

1.2 Sharing disks

Shared disks can be used for scalability as well as for high availability purposes. Figure 1 outlines a typical two-node HA cluster configuration. Both nodes have access to the same storage devices, but only one machine controls the disks at any one point in time.
In this architecture, if one server fails, the other server automatically assumes control of the resources of the failed server. The failed server can then be repaired offline with no loss of time or availability.

There is only one copy of the data, so the data accuracy is maintained and there is no redundancy.

1.3 MSCS Solution

Microsoft Cluster Server provides the capability for a server’s resources to fail over from one machine to another. Those resources could include disks, files shares, IP addresses, and network names. MSCS is part of the operating system in Windows Server 2003, Enterprise Edition and Datacenter Edition. This service provides high availability and scalability for mission-critical applications such as databases, messaging systems, and file and print services. After MSCS is installed successfully, a graphical administration tool that is part of the MSCS will show the machines in the cluster, the resources, the resource types, the groups, and the networks available to the cluster.

The cluster maintains a heartbeat between the nodes to determine which nodes in the cluster are available. The heartbeat communication usually flows through an internal private network while remote clients access the cluster over a public network. Multiple servers (nodes) in a cluster remain in constant communication. If one of the nodes in a cluster becomes unavailable as a result of failure or maintenance, another node immediately begins providing service. Users who are accessing the service continue to access the service, and are unaware that it is now being provided from a different server (node).

Windows Server 2003, Enterprise Edition and Datacenter Edition support server cluster
configurations of up to four nodes. This change (from two nodes support in Windows Advanced Server 2000) was made to allow increased flexibility for deployments, particularly for geographically dispersed cluster configurations, and to support N+1 configurations (N active with I spare). N+1 are particularly important for supporting larger Microsoft Exchange Server deployments using Windows Server 2003.

The shared disk implementation for MSCS uses an external disk enclosure to house the drives containing data, as you see in Figure 2. The disk can be connected to the nodes using SCSI Raid, SSA, or Netfinity fiber channel hardware. The external resources can be divided into groups so that each node can control a subset of them.

The shared disk configuration is also known as a swing-disk configuration. This configuration offers low cost and quick recover. Only one set of disks is required to keep the data that is used by both nodes.

There are two common cluster topologies: shared disks and shared nothing. MSCS is a shared disk clustering technology. However, this can be misleading because, from a cluster point of view, MSCS is a shared nothing technology. Indeed, disks are only shared in that they are accessible by both systems at a hardware level. MSCS allocates ownership of the disks to one server or the other. In normal operation, each disk is accessed only by the controlling machine. A system can access a disk belonging to the second system only after MSCS
has transferred ownership of the disk to the first machine. So the idea in essence is that none of the resources is shared by both machines at any point in time.

### 1.3.1 Resources

A resource is an application, service, IP address, or any other elements under the control of MSCS. Multiple related resources can be grouped together into resource groups. A resource can belong to only one group at any point in time.

A resource can exist in one of five states; online, online pending, offline, offline pending, and failed. The user can specify how long the resource should take to be brought online from offline; if that time is exceeded, the resource will go into the failed state.

A Resource Monitor controls the resources through resources dynamic link library (DLL) files. These resource DLLs detect any changes in the resources’ states and notify the MSCS administrator when a change in state occurs. If an application fails, the resource DLLs may malfunction, causing the Resource Monitor to fail as well. But the cluster service will still be available to report that failure.

MSCS defines 12 standard resource types. Some of the commonly used ones for our configurations are as follows:

- **Physical disk**
  Each disk configured on the cluster will be considered a physical disk resource. This resource does not have any dependencies.

- **IP address**
  This resource type is used to assign a static IP address to the network interface used in the system network.

- **File share**
  This resource type lets the user share a directory on a shared disk, giving access to that directory to the network clients. To create this resource, specify the name of the share, the network path, a comment, and the maximum number of users that can connect to the share concurrently. Generally, a file share resource requires a physical disk resource and a network name resource.

- **Network name**
  An identity to the group is given by this resource type. It allows the client to see the group as a single server. It is usually dependent on an IP address.

For example, if the user has created a group with a network name resource called SAP_NETNAME and a file share resource called SAPMNT, to access this group from a
client machine the user needs to enter the path \SAP_NETNAME\SAPMNT. Thus users have access to this directory regardless of which node actually owns the disk at the time.

Other resource types can be defined by the software installed. A suitable resource DLL must be created to accomplish this.

### 1.3.2 Dependencies

Dependencies inside the cluster define how resources relate to each other. They control the order in which the resources go online or offline. All dependent resources must be placed together in one group. This means that all dependent resources have to be on the same node at any point in time.

Figure 3 shows an example from the example SAP environment used in this article:

![Figure 3. SAP resources with dependencies](image)

In the SAP group, the SAP resource, file share, IP address and network name depend on the physical disk resource. The SAP resource depends on the physical disk resource, the IP address, the file share, and the network name.

If the physical disk resource goes down, all the resources will go down, and the user will be unable to start any of these resources until the disk comes back up. (Note that the network name resource depends on the IP address, so by default it also depends on the physical disk resource.)

If MSCS receives a request to bring the SAP group online, it uses the following sequence:
1. It first brings the physical disk resource online.
2. When the disk becomes available, it brings the IP address and the file share online simultaneously.
3. When all three are available it brings the network name online
4. When all 4 resources are online, it brings the SAP resource online.

All this work is done internally by MSCS. The user might not notice this sequence of events and should not intervene at any point during this process.

### 1.3.3 Quorum resource

The quorum resource is a physical disk resource that is accessible from both nodes and is used to keep information about the cluster and all the nodes activities. This resource maintains logs of all cluster activities. It is used to maintain cluster integrity and keep nodes in synchronization. Like any other resource, it can be owned by only one node at a time, and it determines which node takes ownership of the cluster in certain situations. The quorum disk should be defined as one of the shared disks so it can be accessible from both nodes.

### 1.4 SAP and MSCS

SAP supports the shared storage approach for a two-node clustering solution by default in its kernel. The model used is a *shared nothing* implementation. Each resource is at any point in time exclusively owned by only one of the cluster nodes.

With the integration of MSCS into the R/3 systems, the R/3 processes, services, addresses, and shares are configured as cluster resources and monitored by MSCS. A standard setting would have the database running on one node, and the central instance running on the other. So both nodes are active and each acts as a backup for the other node in case of a failure. In the event of failure, the surviving node takes ownership of the entire system (central and database instances).

A supported SAP cluster configuration must meet the following conditions:
- The hardware must be certified for SAP and must be approved by Microsoft for MSCS.
- The operating system must be approved for MSCS.
- The DBMS must be cluster-aware.

To find out if your system configurations are supported, please review OSS Note #106275: *Availability of R/3 on Microsoft Cluster Server.*
There are other approaches to high availability such as the cold standby server approach and the replicated database approach. These are beyond the scope of this paper.

Two Windows DLLs have been developed to make SAP R/3 a cluster-aware application: SAPRC.DLL, which allows the MSCS to check the status of the SAP R/3 system and to start and stop the SAP services in case of failover; and SAPRCEX.DLL, which allows MSCS to manage the SAP resources.

### 1.5 DB2 UDB and MSCS

DB2 UDB V8.2 is the latest edition of DB2 UDB. DB2 UDB V8.2 Enterprise Server Edition (ESE) offers users the ability to create single or multiple partition database environments. DB2 UDB ESE uses a highly scalable shared-nothing architecture that allows users to spread data across multiple database partitions that may reside on different physical machines. The data on each partition can be processed in parallel across partitions as well as in parallel within each partition.

For the purposes of this paper, we will only be looking at a single partition database. For more information about multiple partition support, please review the DB2 UDB online documentation.

There are a few Windows DLLs that have been developed to make DB2 UDB cluster-aware. The main one is DB2WOLF.DLL which controls the start and stop of the clustered DB2 database instance.
1.6 DB2/SAP integration into MSCS

DB2 and SAP use the ability of MSCS to create additional resource types to develop a resource type called “DB2 and SAP”. By grouping various resources together using the MSCS group feature, a virtual machine is created and thus can move among all the nodes in the cluster. If any resource fails, the whole group fails over to the other machine seemingly. (If there are processes that were running at the time of failover they will terminate and must be restarted.)

To illustrate how DB2 and SAP work within the MSCS environment, we will use a simple example.

- Initially the SAP system (central and database instance) is active on Node A, and Node B is idle.
- A hardware failure occurs on machine A. All the disk resources are automatically moved to machine B, along with the cluster groups.
- If a user is running a job at this specific time, it will fail, but the user can immediately restart it without having to restart his system.
- Users who log on to the SAP system will not realize that a failover has just happened and will not know which machine they are actually working on. Note that in an MSCS environment, the SAP GUI is always connecting to the SAP virtual host, regardless of which machine the R/3 central instance is running on.
- In a situation where SAP is running on Node A and DB2 is running on Node B, if Node B fails, the DB2 resources will fail over to Node A. An open SAP session will not terminate, but any transactions that were connecting to the database must be restarted. In that scenario, if Node A fails, then any open SAP session will terminate and a new session must be restarted.

1.7 MSCS groups and resources

SAP and DB2 require many resources, including disks to store information for each partition, an IP address for internal communications (when using an instance with multiple partitions), as well as optionally an IP address to allow for remote connections. DB2 and SAP use the group feature within MSCS to group multiple resources into a single logical entry, called a cluster group. The combination of a resource, disks, and TCP/IP addresses represent almost all the resources required to successfully run an instance. The instance will also use a network name and file share to store instance information that will be available to all partitions. The other resources that are required are processors and memory. These last two are obtained from the machine on which the group is currently active and do not fail over between machines.

The order by which the resources come online is critical when the group is brought online. If the resources start in the wrong order, the group will fail since it may require access to files on disk that are not online yet. Thus the dependency feature within MSCS is utilized. The dependency also applies to the stopping process of these resources.
In the following sections, you will learn about the groups and resources created to run a full SAP R/3 system using DB2 UDB Version 8.2. There are three main groups that are created; each group has a virtual IP address and hostname not connected to any particular node. This gives the user the advantage of moving the groups freely between nodes. Each group comprises a set of related resources that work together as one entity to perform a specific requirement of the system.

1.7.1 MSCS cluster group

This group is dependent on the DBMS software used for the system. For a standard installation, the group comprises two resources: the cluster network name and the cluster IP address.

The following figure shows that the cluster network name depends on the cluster IP address to start and stop.

![Figure 5. MSCS cluster group](image)

1.7.2 SAP-R3 <SID> group

The SAP-R3<SID> group is created by the SAP application after the SAP R/3 system has been installed and during Node A conversion to MSCS (more details will follow in later chapters). This group is database independent. The group consists of the following resources (in this order):

1. SAPEXE <DISK>: The physical disk where the group resides
2. SAP-R/3 IP: The IP address for the group (the SAP virtual host IP address)
3. SAPLOC: File share
4. SAPMNT: File share
5. SAP R/3 Netname: The network name for the group (the SAP virtual host network name)
6. SAP R/3 <SID>: The resource containing the central instance. If brought online, the central R/3 instance is started.

Figure 6 shows the contents and dependencies within this group.

![Figure 6. SAP-R/3 <SID> group](image)

### 1.7.3 DB2 <SID> group

The DB2 <SID> group is created by the DB2MSCS tool during the DB2 conversion to MSCS phase. This tool is responsible for converting the DB2 UDB database into an MSCS database. (More information about the tool will be discussed in later chapters.) This tool reads a configuration file, \texttt{db2mscs.cfg}, and creates all the resources accordingly.

One resource which is not created by the DB2MSCS tool is the SAPGW<GSID> resource, which is responsible for the SAP Gateway resource. This resource is created manually after the installation is completed and allows SAP’s communication to the database through the gateway. (More details about this resource will be explained later.)

The following resources comprise the DB2 <SID> group:
1. DB2 IP <SID>: IP address for the group (the database virtual host IP address)
2. DB2 Netname <SID>: The network name for the group (The database virtual host network name)
3. DB2<SID>-0: The database instance. If brought online, the instance is started.
4. SAPGW<GSID>: SAP gateway resource.
5. DB2<SID>: File share
6. DBLOG <DISK>/: Physical disk for the active logs
7. DATA <DISK>:/: Physical disk(s) for the data files
8. ARCHLOG <DISK>:/: Physical disk for the archive logs

Figure 7 shows the contents and dependencies within the DB2 <SID> group.

1.7.4 Quorum group

The quorum group contains one resource which is the resource responsible for monitoring the cluster activities and logging them. Any MSCS system should include a quorum group and physical disk resource independent of the software installed and the DBMS type.
Figure 8. Quorum group
Chapter 2: Overview of implementation

In this chapter you will find an outline of the implementation used for the testing project performed at the lab. The snapshots and values used in this chapter are to be used as an example for a full MSCS system implementation.

2.1 MSCS implementation:

A very important GUI tool delivered with Microsoft Windows 2000 Advanced Server Edition and later is the Cluster Administrator. Using this tool the user can create and manage a cluster. Figure 9 shows the Cluster Administrator tool.

Figure 9. Cluster Administrator

This figure will be the starting point for examples and screen shots used throughout this article. It will be helpful to refer back to it as you look at other screen shots.

Here are some of the characteristics of the cluster used in the examples:

- The name of the cluster is ISISCLUSTER.
- The two machines (also called nodes or cluster members) of this cluster are WOLGASE and WIRTHEIM.
- The DB2 virtual host, also called DB2 cluster group, is DB2CLUSTERGRP.
- The SAP virtual host, also called SAP cluster group, is SAPCLUSTERGRP.
A resource is an entity that is managed by the clustering software; it could be a disk, an IP address, or a service.

The cluster is divided into groups of resources (hardware, IP address, and so on). For example, in the next figure we can view in detail the contents of the group called ‘SAP-R/3 MSC’ that is created by SAP. This group contains many resources, including the IP address, the network name, and the actual physical disk.

![Figure 10. Resources](image)

From this figure you can also see which resources are online, and which node is in control of this resource at any specific point in time. Currently the SAP-R/3 MSC group is active and controlled by the machine ‘WOLGASE’.

A typical R/3 System running with DB2 UDB on MSCS will have four groups: the MSCS cluster group, the SAP group, the DB2 group and the Quorum group. A fifth group called Spare is used for illustration in this example.

Using the Cluster Administrator GUI, you can make any changes needed for each resource. For example, you can take a resource offline or bring it online, change the group where this resource will reside, or even delete and rename the resource.
There are dependencies between the resources within each group, and from other groups. For example in Figure 12 you can see that the resource called ‘SAP-R/3 IP’ depends on the resource ‘SAPEXE E:’ if the first is down, the second one immediately fails.
There are two networks in this setting, a private network and a public network. Every member of the cluster should be a member of both networks.
The SAP resources and groups are created during the SAP conversion to MSCS, and the DB2 resources and groups are created during the DB2 conversion to MSCS.

2.2 How does failover work?

MSCS will monitor all the resources that are brought online using the cluster administrator GUI. If a node member of the cluster fails, the cluster will move all the resources and groups to another cluster member and ensure they are brought online. When a resource fails, the cluster will attempt to bring that resource back online on the current machine first, and if the resource continues to fail, it will move the whole group associated with the resource to another cluster member and try to bring it online. The number of time MSCS will retry to bring the resource online is configurable within cluster administrator. Note that a hang situation within DB2 will not automatically trigger a restart of the DB2 resource.

MSCS is responsible for deciding whether resources and groups are restarted on the current machine, or whether they should fail over to another machine in the cluster. It is a good practice to bring resources online or offline using the cluster administration GUI so the cluster is aware of the resources’ availability. If DB2 or SAP is started without using the cluster interface, then MSCS is not aware that the resource has started and will not attempt to keep it up and running. And if any of the resources are stopped manually,
without using the Cluster Administrator, MSCS will consider this a failure and will try to bring the resource online immediately.

When a failover occurs due to a machine failure or another cause, the database may become in an inconsistent state. When the database is brought up on the surviving machine, it will go into crash recovery, and the resource will not be available until that process is completed.
Chapter 3: Planning and preparation

Before starting such a large project, many decisions must be made. Those involved in the planning process should consider all the limitations and all the possibilities in order to make informed decisions.

IBM recommends that you always install the latest version of DB2 UDB and the latest certified fixpak. We also recommend that you install the latest release of SAP along with the latest kernel and support packages. We strongly recommend that you check the SAP OSS notes regularly to get the latest updates.

Since MSCS is a fairly new product, many changes occur, and the user should check frequently for updates. As for the Microsoft Windows release, it’s important to check the latest available release and check the SAP/DB2 support for this release. Please make sure you install the latest Service Pack as well. For more details, please refer to SAP OSS note # 30478: Support Packs on Windows.

This article discusses the optimal configuration for the following software configuration:

- SAP Enterprise 470 Extension Set 2
- DB2 UDB Version 8.2

After you decide on software and fix levels, you will be ready for the following steps:

- Hardware setup, which includes choosing the hardware and confirming compatibility, and setting up the storage technology (section 3.2)
- Disk layout, adapting the disk to prepare for the MSCS installation of the system (section 3.3)
- Network setup, which includes setting up the private and public networks, creating the virtual machines and attaching to the domain (section 3.4)

3.1 Limitations

Please note the following limitations when setting up your MSCS environment. Be sure to review the latest publications on the latest releases and limitations.

- Windows NT Enterprise Edition and Windows 2000 Advanced server only support a maximum of two nodes in a cluster.
- Windows 2003 Datacenter supports as many as four nodes in a cluster.
• Windows .NET will support up to eight nodes.
• If a DB2 UDB ESE instance spans more nodes than are available in a single cluster, then multiple clusters can be used.
• Because MSCS does not support the use of raw partitions in a cluster, it is not possible to configure DB2 to use raw devices in an MSCS environment.
• The following DB2 products support MSCS:
  • DB2 Universal Database Workgroup Server Edition
  • DB2 Universal Database Enterprise Server Edition (DB2 ESE)
  • DB2 Universal Database Connect Enterprise Edition (DB2 CEE)

3.2 Hardware requirements

Configuring the hardware is one of the most critical steps in setting up the cluster system. Please take note of the following when setting up your hardware for MSCS:

• Two exactly identical Windows servers should be configured (for a two node configuration) and should be certified for clustering use on Windows. To confirm the hardware you’re using is certified, please check the following Web sites:
  o http://www.microsoft.com/whdc/hcl/default.mspx
  o http://saponwin.com

• Recommended paging space is four to five times the amount of RAM on the system, up to a maximum of 10 GB. However, on Windows 2000, the limit of a page file size is 4GB, so multiple page files should be created, preferably on separate physical disks.

• Each node must have access to the shared disks via a shared bus. A SCSI RAID controller or fiber channel controller should be used for the connection to the external disks. All disk controllers must be able to support hardware-based RAID.

• For the network configurations, the user will need two network adapters on each server, one for the private network and one for the public network

3.3 Disk layout

One of the basic differences between a non-clustered installation and a clustered installation is the strict separation of R/3 files and DB2 files on different shared disks. MSCS uses a shared-nothing architecture, which means that each system accesses its own disk resources. Since MSCS gives the option to run with R/3 and DB2 running on separate nodes, their disk space must not intersect.

The local disks will only contain the operating system and page file, as well as the DB2 software. All other information will be on the shared disks (SAP software, R/3 files, database files, log files, and MSCS quorum).

The MSCS quorum resource, which stores all information about MSCS, must be on separate disk. (Even though it does not occupy a lot of space, the extra space can be used
as temporary storage space if needed.) Figure 14 shows the disk layout for the two nodes.

![Diagram of disk layout]

**Figure 14. Disk layout**

### 3.3.1 Local disks

As explained earlier, the Operating System files and paging files must be on the local drives of every node. We recommend that you configure two separate disks. Since R/3 assumes a large paging space, a separating page file from the system file may improve performance.

You can also have a separate disk where you can install a second copy of the operating system for fast system repair and recovery. This can be used to restore the system in case of a failure.

Note the following when planning for your local disks:

- All partitions should be NTFS partitions.
- The local disks should have a minimum of 5 to 10GB.
- The following software will be installed on the local disks:
  - Operating system
  - MSCS Software
  - DB2 UDB software
  - Backup software (for example, Tivoli®)
  - SAP install directory
  - SAP DLLs and some executables

### 3.3.2 Shared disks

#### 3.3.2.1 SAP R/3 disk

The R/3 files (SAP executables, global software, profile directory, instance directory and central transport directory) should be placed on a separate disk. The directory created by SAP on this disk is `\usr\sap`. The cluster resources SAPMNT, SAPLOC point to this directory. You cannot have any database files on this disk.
3.3.2.2 DB2 UDB disks

The DB2 software should be installed locally on each node. Any new fix pack should be applied on each node (as described in section 6.6.2). The standard directory should be \sqllib. The DB2 instance information, the database data files and log files should all be placed on the shared drives to be used by both machines.

Plan to have the DB2 disks separate from the R/3 disks for better performance and for easy sharing of resources among the nodes. You should have separate disks for the data files, the active logs, and the archive logs. That way data loss is minimized in the event of disk failure, and performance is improved.

Also, you should plan for the active log to be on a separate disk from the disk that holds the archive logs in order to minimize traffic. Every time the userexit process is started to archive a full log, a log file is copied from the active log file disk to the archived log files disk, while the database is writing new log file data to the active log files disk.

To improve DB2 performance, the database data files should be distributed over striped disks sets.

3.3.2.3 Quorum disk

The quorum disks hold all MSCS-specific data. This should be a disk shared by all nodes to arbitrate for access in the case of connection loss on one of the nodes. The quorum disk also keeps a log of all MSCS activities.

The node owning the quorum disk is the node that has ownership of the cluster and controls the configuration at any point in time. This information is kept in the \MSCS directory on the quorum disk.

SAP recommends that no SAP-specific or DB2-specific files be stored on the quorum disk for safety reasons.

3.3.3. Disk layout recommendation for shared drives

Table 1 shows the recommended disk layout for shared drives.

<table>
<thead>
<tr>
<th>Disk Name</th>
<th>Directory Name</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBLOG</td>
<td>\DB2&lt;SID&gt;\log_dir</td>
<td>DB2 Active log directory</td>
</tr>
<tr>
<td>ARCHLOG</td>
<td>\DB2&lt;SID&gt;\log_archive \DB2&lt;SID&gt;\log_retrieve \db2&lt;sid&gt; \db2\db2&lt;sid&gt; \DB2PROFS\db2&lt;sid&gt;</td>
<td>DB2 Archived log directory DB2 retrieved log directory DB2 catalog information DB2 instance directory DB2 diagnostic files</td>
</tr>
<tr>
<td>DATA</td>
<td>\DB2&lt;SID&gt;\sapdata1 ... \DB2&lt;SID&gt;\sapdata6</td>
<td>Database data files</td>
</tr>
<tr>
<td>QUORUM</td>
<td>\MSCS</td>
<td>MSCS specific data, logs</td>
</tr>
<tr>
<td>N/A</td>
<td>\Spare</td>
<td>Spare disk</td>
</tr>
</tbody>
</table>
Table 1. Recommended disk layout

3.4 Network settings

The nodes in an MSCS cluster are connected using one or more shared storage buses and one or more physically independent networks. The network that connects only the servers but does not connect the clients to the cluster is referred to as a private network. The network that supports client connections is referred to as the public network. There are one or more local disks on each node. Each shared storage bus attaches to one or more disks. Each disk on the shared bus is owned by only one node of the cluster at a time.

3.4.1. Network components

There are two networks that should be running in an MSCS environment:
- **Public Network**
  The public network is the main network that connects all the machines. All the servers and clients should have access to this network. Any setting can be used to connect these machines together.
- **Private Network**
  The private network controls the private connection (heartbeat) between the MSCS nodes. MSCS uses this network to constantly check the status of each node; it is also used for private communication between the nodes. The use of 100BaseT cable is recommended for this connection.

When setting up the networking for your MSCS system, please note the following:
- **MSCS does not support DHCP; all members of the cluster must have static IP addresses.**
- **All members of MSCS should be members of the same domain and should reside on the same VLAN.**
- **There can be no routers between the MSCS nodes. However, routers can be placed between the cluster and its clients.**
- **For a two-node MSCS configuration, 7 IP addresses should be configured as follows:**
  - Every member of the cluster should have a public and a private IP. Since the private network is only used by the two participating nodes only, any IP can be used for the private network.
  - An IP address and a virtual server name should be assigned to the SAP cluster group.
  - An IP address and a virtual server name should be assigned to the DB2 cluster group.
  - A virtual server name and IP address should be assigned to the MSCS cluster group.

Please refer to section 3.6.5. Network IP assignment checklist for details on assigning the IP addresses.
3.4.2. Checking IP address to hostname resolution

Having two or more network adapters in the same server can lead to address requests resolving to the wrong IP address. After configuring the networks and assigning the IP addresses, check to verify that the IP addresses are assigned correctly. You may run the ping command against one of the nodes and find it resolving to the private network’s IP address when the correct address should be the one from the public network. To solve such a problem, follow these steps:

1. Click **Start → Control Panel → Network Connections**.
2. From the menu bar choose **Advanced → Advanced settings**.
3. Click the **Adapters and Binding** tab and choose the network adapter for the public adapter.
4. Use the up and down arrows at the right hand side of the screen to bring it to the top.

![Figure 15. Checking IP addresses](image)
3.4.3 Mapping host names to IP addresses

After obtaining 7 IP addresses as explained in section 3.4.2, you need to map the host names to their respective IP addresses so the system can associate the appropriate hostnames to the correct IP addresses. This can be done using the DNS server (if your system includes a DNS server) or by updating the hosts file. This file can be found in \%WINDIR\%\system32\drivers\etc. Note that the entries in this file are read in order. For the node members of the cluster, the public IP should be entered before the private into this file.

The advantage of using the DNS server is that you will only need to do this once. If you use the hosts file method, that file must be updated on every node member of the cluster. The host file must be identical on all members and on their clients. This step is crucial for the success of the MSCS operation and should not be omitted or skipped.

3.5 Checklists

3.5.1. Hardware requirement checklist

<table>
<thead>
<tr>
<th>Component</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machines</td>
<td>Two or more identical servers, all certified for clustering</td>
</tr>
<tr>
<td>Paging space</td>
<td>Four to five times the amount of RAM on the machine.</td>
</tr>
</tbody>
</table>
| Storage         | • **SCSI**: two SCSI RAID adapters  
                  | • **Fiber channel**: two SCSI RAID adapters, two fiber channel host adapters, one RAID controller, one fiber channel hub.  
                  | • External disk enclosure |
| Networking      | Two network cards for every machine |

3.5.2. Space requirements checklist

3.5.2.1 Local drives:

<table>
<thead>
<tr>
<th>Component</th>
<th>Default directory</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows operating system</td>
<td>%WINDIR%</td>
<td>1.5 to 2 GB</td>
</tr>
<tr>
<td>MSCS software</td>
<td>%WINDIR%\Cluster</td>
<td>8-10 MB</td>
</tr>
<tr>
<td>SAP cluster files</td>
<td>%WINDIR%SAPCluster</td>
<td>25 MB</td>
</tr>
<tr>
<td>DB2 UDB software</td>
<td>Program files\SQLLIB</td>
<td>600 MB</td>
</tr>
</tbody>
</table>

3.5.2.2 Shared drives:
3.5.3. Network IP assignment checklist

These values should be obtained from the system administrator and must be entered exactly as obtained. Note that the names must be spelled correctly; no spaces can be used for hostnames, and the case (upper and lower case) should be observed. The server name or computer name is different than the hostname, although they could both have the same value.

<table>
<thead>
<tr>
<th>Server</th>
<th>DNS hostname</th>
<th>IP address</th>
<th>Purpose</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Node A (public)</td>
<td>Hostname for Node A</td>
<td>IP address for Node A on the public network</td>
<td>Address used for public network</td>
<td>wolgase</td>
</tr>
<tr>
<td>Node A (private)</td>
<td>Same hostname</td>
<td>IP address for Node A on the private network</td>
<td>Address for used for Inter-node communication</td>
<td>wolgase</td>
</tr>
<tr>
<td>Node B (public)</td>
<td>Hostname for Node B</td>
<td>IP address for node B on the public network</td>
<td>Address used for public network</td>
<td>wirtheim</td>
</tr>
<tr>
<td>Node B (private)</td>
<td>Same hostname</td>
<td>IP address for node B on the private network</td>
<td>Address used for Inter-node communication</td>
<td>wirtheim</td>
</tr>
<tr>
<td>SAP cluster group</td>
<td>Hostname assigned by network administrator for the SAP virtual host</td>
<td>IP assigned by Network administrator for the SAP virtual host</td>
<td>Virtual host for the SAP group of resources.</td>
<td>sapclustergrp</td>
</tr>
<tr>
<td>DB2 cluster group</td>
<td>Hostname assigned by Network administrator for the DB2 virtual host</td>
<td>IP assigned by Network administrator for the DB2 virtual host</td>
<td>Virtual host for the DB2 group of resources.</td>
<td>db2clustergrp</td>
</tr>
<tr>
<td>MSCS cluster group</td>
<td>Hostname assigned by network</td>
<td>IP assigned by Network administrator for the MSCS cluster group</td>
<td>Virtual host for the MSCS cluster group</td>
<td>isiscluster</td>
</tr>
<tr>
<td>Action</td>
<td>Section</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review all documentation</td>
<td>Done</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check space requirements</td>
<td>Done</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check hardware and software requirement</td>
<td>Done</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obtain required CDs for the installation</td>
<td>Done</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Install DB2 UDB V8 locally on both nodes</td>
<td>Done</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Install the latest fixpak locally on both nodes</td>
<td>Done</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 3.5.5. SAP Installation checklist

<table>
<thead>
<tr>
<th>Action</th>
<th>Done</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review all documentation</td>
<td></td>
</tr>
<tr>
<td>Check space requirements</td>
<td></td>
</tr>
<tr>
<td>Check hardware and software requirement</td>
<td></td>
</tr>
<tr>
<td>Obtain required CDs for the installation</td>
<td></td>
</tr>
<tr>
<td>Obtain 7 IP addresses and network names</td>
<td></td>
</tr>
<tr>
<td>Make sure DB2 UDB is installed locally on both nodes</td>
<td></td>
</tr>
<tr>
<td>Run SAPinst and install the system on the shared drives from Node A</td>
<td></td>
</tr>
</tbody>
</table>

### 3.5.6. Post installation checklist

<table>
<thead>
<tr>
<th>Action</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB2 conversion to MSCS</td>
<td>8.1</td>
</tr>
<tr>
<td>Node A conversion to MSCS</td>
<td>8.2.1</td>
</tr>
<tr>
<td>Node B conversion to MSCS</td>
<td>8.2.2</td>
</tr>
<tr>
<td>Verifying the installation</td>
<td>9.1</td>
</tr>
<tr>
<td>Checking the services</td>
<td>9.2</td>
</tr>
<tr>
<td>Checking the system environment</td>
<td>9.3</td>
</tr>
<tr>
<td>Configuring the DB2 Administration Server</td>
<td>9.4</td>
</tr>
<tr>
<td>Creating the local user sap&lt;sid&gt; on Node B</td>
<td>9.5</td>
</tr>
<tr>
<td>Creating a local instance</td>
<td>9.6</td>
</tr>
<tr>
<td>Cataloging the database</td>
<td>9.7</td>
</tr>
<tr>
<td>Creating a standalone gateway</td>
<td>9.8</td>
</tr>
<tr>
<td>Configuring the SAPOSCOL destination</td>
<td>9.9</td>
</tr>
<tr>
<td>Installing and configuring the Admin Tools</td>
<td>9.10</td>
</tr>
<tr>
<td>Performing SAP’s post-installation activities</td>
<td>SAP install guide</td>
</tr>
</tbody>
</table>
Chapter 4: Windows installation

4.1 Installation notes

The installation process should be the default process for installing Windows on any machine. Here are a few additional notes that you should consider. Please refer to Microsoft’s documentation on how to install the operating system.

- Make sure you have the latest supported Windows Service Pack and security patches. For Windows 2000:
  - If using Service Pack 1, additional Hot Fixes must be installed as per OSS Note # 169468: Windows 2000 support.
  - If using Service Pack 2, Hot Fix Q265017 is required.
For the latest supported Service Packs, please review OSS Note #30478: Support Packs on Windows

- When installing the operating system, make sure you check the option Cluster Service.

- All node members of the cluster should be identical in all installation settings. All nodes should be on the same service pack level. (The latest is recommended.)

- Drive letters on both nodes should be identical for simplicity.

- If you’re installing a standby operating system, it should be installed before the active one.

- Do not install RAS.

- Do not install IIS.

- There is no need to install ADSI and MMC since they already exist on Windows 2000 and later releases.

- Network protocol should be TCP/IP.

- Assign static IP addresses to both nodes.

- Refer to section 3.4 to configure the disks on each node.

- At the end of the installation, you should configure DNS.

4.2 Windows tuning

SAP highly recommends that you configure the server service for the setting “Maximize Throughput for Network Applications”. This setting will reduce the threshold in systems that have large memory.

An important SAP requirement is to have a large page file. Generally it should be set to four times the RAM on each server. However, SAP recommends setting it to five times the RAM when both the central instance and the database instance are on the same node. We generally recommend setting it somewhere between four to five times the RAM, depending on the memory available on the system.
Chapter 5: Cluster creation and drive mapping

MSCS has become part of the standard Microsoft Windows package as of Windows 2000 Server Edition, so there is no extra step to install MSCS.

5.1 Cluster pre-installation testing

Verify hardware and software
Before creating the cluster, you should verify the validity of the hardware and operating system installation. A tool called MSCS cluster verification utility is shipped with the Windows NT Server 4.0 Resource Kit.

To run the tool, following these steps:
1. On Node A, run the command CLUSTSIM /S from the command prompt.
2. A message will be displayed saying that you can start the utility on Node B.
3. On Node B, run the command CLUSTSIM /N:NodeA from the command prompt.
4. Examine the output of the log files.

For more information, please review OSS Note #154700: MSCS Cluster Verification Utility

Confirm the mapping of the hostnames to IP address
The ping command should always return the public network address (refer to section 3.5.2. Checking IP address to hostname resolution). Perform these checks:
1. From Node A:
   a. Ping Node A.
   b. Ping Node B.
   c. Ping ClusterName.
   d. Ping DB2clusterserver.
   e. Ping SAPclusterserver.
   f. Ping –a both the private and public IP of Node A and node B as well as the IP for the cluster, the DB2 group and the SAP group.
2. Repeat the same steps from Node B.

Test the failover process
Test to see if the failover process occurs when you manually shut down the node currently holding all the disks. The disks should automatically be accessible from the other node.

5.2 Preparation

Follow these steps to prepare for cluster creation and drive mapping:
1. Assign drive letters and partition the shared drives using the computer management tool. This should be done from Node A for all the drives.

![Figure 16. Partitioning the shared drives](image)

2. Node B should be able to see the partitions but will not be able to access or modify them.

3. Both nodes should have access to the disks with the same drive letters.

4. Make sure all nodes that will be members of the cluster belong to the same domain and are all on the same VLAN.

5. Make sure you have obtained a virtual name for the cluster and assigned it an IP address. The cluster name should belong to the same domain as both nodes and as the SAP and DB2 virtual hosts. The IP address should be on the same VLAN as all the other machines.

### 5.3 Cluster creation

1. Logon to the domain at Node A as domain administrator.
2. Click **Start → Cluster Administrator**.
3. The first time you open the Cluster Administrator you will immediately be prompted to create a cluster using the wizard.
4. Click Next to continue.
5. Choose the domain that your cluster should belong to from the list and type the name of the newly created cluster.
6. Enter the name of Node A, as the first node in the cluster. You can browse from the list.
7. The wizard will now start to create the cluster.
8. The wizard then goes through the input and checks the connections and confirms that it is possible to create a cluster.
9. The next step is to provide an IP address for the cluster. Enter the IP address assigned for your cluster by the network administrator
10. Enter the name of the domain administrator user that will have the authority to run the cluster.
11. In the next step the wizard will list all the values for the configuration to create the cluster.
12. If not entered earlier, you will be asked for the disk to be used for the quorum resource. This resource will be the first to be created in the new cluster.
The wizard will now create the cluster, and if all the information is correct, you should see the screen shown in Figure 26 confirming the cluster has been created.
5.4 Post creation activities
When you create the cluster, Node A is already added as the first member of the cluster. Now Node B needs to be added to cluster.

After the cluster is successfully created, perform the following steps to add Node B to the cluster:
1. From Node A, click Start → Cluster administrator
2. You will automatically be connected to the cluster. If not, click on the file tab and choose Open connection to a cluster.
3. After you have successfully connected to the new cluster, add Node B to the newly created cluster by opening the file tab and choosing **New → Node**.

4. This will open a new wizard that will add a new node to the cluster.

![Figure 28. Add nodes wizard](image)

5. Click **Next**. Then enter the node name in the following screen. You can click browse to choose from a list. You can add more than one node in the same step, using the **Add** button after each entry.
6. When finished, click the **Next** button. The wizard will then start adding the node to the cluster.
7. The wizard then returns a notification that the node has been added successfully.
8. Once both nodes are added, the Cluster Administrator should display both nodes as active and part of the cluster.

5.5. **Cluster verification**

After the cluster has been created, it is a good practice to check to see if it is working properly. Here are some steps you can follow to check the functionality of the cluster and to familiarize yourself with the configuration.

1. Manually try to move the cluster groups from one node to another.
2. Manually stop the cluster service on one node and check to see if the resources fail over properly.
3. Shut down one of the nodes and check to see if the resources fail over properly with no errors.
4. Power off one of the nodes and check to see if the resources fail over properly with no errors.
Chapter 6: Installing DB2

6.1 Hot standby configuration

In a hot standby configuration, one machine in the MSCS cluster provides dedicated failover support, and the other machine participates in the database system. If the machine participating in the database system fails, the database server on that machine will be started on the failover machine. If, in a partitioned database system, you are running multiple logical nodes on a machine and it fails, the logical nodes will be started on the failover machine.

In this configuration, at least one machine is idle and dedicated as a backup in the event of a failure.

![Figure 32. Hot standby configuration](image)

6.2 Mutual takeover configuration

In a mutual takeover configuration, both workstations participate in the database system (that is, each machine has at least one database server running on it). If one of the workstations in the MSCS cluster fails, the database server on the failing machine will be started on the other machine. In a mutual takeover configuration, a database server on one machine can fail independently of the database server on another machine. Any database server can be active on any machine at any given point in time.
6.3 Other configurations

6.3.1 Mutual takeover load-balancing

A mutual takeover load-balancing configuration ensures that if one machine fails, the workload will be equally divided across the remaining machines. Each machine should be capable of handling the potential resource requirement of such a takeover. All machines should have the same configurations and settings.

6.3.2 Multiple cluster configuration

Since MSCS can only span up to four machines currently, and since DB2 ESE can span more machines, multiple clusters can be used to run one system. Each DB2 partition can only fail over to machines within the same cluster.

6.4 SAP and DB2 standard configuration

A standard SAP and DB2 configuration is one in which the R/3 system resides on one node and the database on the other.

For users to have access to a database (local or remote), they must have access to a local instance. In a clustered environment, the database is controlled by the instance db2<sid>. This instance is part of the DB2 cluster group and can be started on Node A and Node B. The work processes of the R/3 instance access the R/3 database through the local database instance db2l<sid>. A database instance with this name must be created locally on each node.
The database <SID> must be cataloged remotely in each local database instance db2l<sid>.

Figure 35 illustrates a typical scenario:

1. The R/3 cluster group is running on Node A and the DB2 cluster group (including the clustered database instance) is running on Node B. The local database instances db2l<sid> are running locally on both nodes. The environment variable DB2INSTANCE is set to db2l<sid> on both nodes.
2. The R/3 work process sends a request to connect to the database. This request is handled by db2l<sid>
3. db2l<sid> checks in the database catalog and finds that the database is remote on the database virtual server. So the local instance (db2l<sid>) routes the request via TCP/IP to the instance db2<sid> on the database virtual server. And because the database virtual server is currently running on Node B, the request is routed to Node B.
4. In the case of a failover, both virtual servers will be running the same node. Trying the same scenario, the local instance db2l<sid> doesn’t realize that the clustered instance db2<sid> resides on the same node, so it still sends a TCP/IP request to db2<sid>. In that case the request is routed back to the same node.

6.5 Preparation

Make sure that you have done the following in order to prepare for a successful installation:

- DB2 UDB software must be installed on each machine in the cluster.
- The installation must be on the local drive of each node member of the cluster.
- A minimum of 500 MB should be available for the SQLLIB directory.
- Refer to the DB2 installation documentation for installation pre-requisites.
6.6 Installation
All the following steps should be performed on both nodes. Perform all the steps on the first node, reboot it, then perform them again on the second node and reboot it. Make sure the cluster is offline while performing these operations.

6.6.1 Installing DB2 V8.2

1. Logon as the installation user.
2. Insert the DB2 UDB V8.1 or V8.2 CD-ROM and start the installation by running SETUP.exe.

![Figure 35. Beginning DB2 installation](image-url)
3. Click **Install Products** to start the installation process.
4. Choose **DB2 UDB Enterprise Server Edition**.
5. Click **Accept** to accept the terms and conditions of the license agreement.
6. Follow the installation process as prompted for a typical installation.
7. Accept the default values for the following screen and enter the parameters as you would for a normal DB2 installation.
8. Choose **Do not autostart the instance**. The instance must be started manually.

![Figure 36. Startup options](image)

9. At the end of the installation, the following screen will be displayed.
10. Do not restart the system after completion.

6.6.2 Installing the latest fixpak

1. Using the same CD, install the latest fixpak (it is always good practice to check SAP Marketplace for the latest fixpak available).
2. Installing the fixpaks could be done by running `setup.exe` from the fixpak directory or by running `hotfix.exe`, depending on the fixpak you are installing. (Please refer to the readme file for the fixpak you are installing.)
3. Do not select **Automatically start the DB2 instance at boot time**.
4. Do not restart the system after completion.
6.6.3. Dropping the sample instance

1. Log off and back on again to enable the changes of the environment variables to take effect.
2. Do not create a sample database as explained in the DB2 install documentation.
3. Drop the default instance “db2” from the system by running the command (from a DB2 CLP prompt):
   ```
   C:\> db2idrop db2
   ```
4. Remove the environment variable DB2INSTANCE from the system environment.
5. Reboot the machine.
Chapter 7: Installing SAP

The purpose of this chapter is not to replace the original SAP documentation, but rather to simplify the process. The information in this chapter is taken from the SAP installation guide and the latest update of the relevant OSS notes. (Appendix D contains a list of important notes.)

7.1 The basics

Installing an MSCS SAP system is basically the same as installing a standard SAP system with a few additional steps and changes. Some components must be installed on both nodes locally, and some installed on the shared drives.

The installation should be done by the domain administrator on both nodes.

If you need to reboot any of the nodes at any time during the installation, make sure you move all the resources back to their original state, as they will be moved to the other node by MSCS.

7.2 Installing the latest R/3 DLLs

Follow these steps to install the latest R/3 DLLs:
1. Obtain the latest version of the Dynamic Link Libraries R3DLLINS.EXE from SAP Marketplace
2. Install the R/3 DLLs on all nodes by running R3DLLINS.exe
3. The following DLLs must exist under %WINDIR%\System32 on both nodes:
   - saprc.dll
   - SapClus.dll
   - saprcex.dll
4. Run the program insaprc.dll (found on %WINDIR%\System32) to re-register these DLLs are being used. For more information, please review OSS Note #582859: Cluster installation on Windows based on Web AS 6.20

7.3 Accounts and users

7.3.1 Installation user account

Before you begin the installation, you need to create an account on the primary domain controller and add it to the Domain Administrators group. This account will be used for the installation process and should be removed once the installation has completed.
During the installation process, SAP will assign some local user policies on Node A and Node B to the installation account. This user can be substituted for the domain administrator.

### 7.3.2 <SID>ADM

This user account will be created by the SAP installation for the SAP system administrator, and should be a domain account. This user belongs to Domain administrators, Domain users, SAP_<SID>_GlobalAdmin, and SYSCTRL groups.

### 7.3.4 SAPSE<SID>

This user account will be created by the SAP installation, and should be a domain account. This user should have the user right: ‘Logon as a Service’ on each application server and DB server. This user belongs to Domain users, SAP_<SID>_GlobalAdmin, and SYSCTRL groups.

### 7.3.5 SAP_<SID>_GlobalAdmin

This group will be created on the domain by the SAP installation. This global group should be a sub-group of SAP_<SID>_LocalAdmin.

### 7.3.6 SAP_<SID>_LocalAdmin

This group will be created locally by the SAP installation on each application server and DB server.

### 7.3.7 DB2<SID>

This user account will be created by the SAP installation for the DB2 database administrator, and should be a domain account. This user belongs to SYSADM group.

### 7.3.8 SAP<SID>

This local user account will be created on each node. This user belongs to the USERS group.
7.4 Installing SAP R/3 on Node A

Follow these steps to install SAP R/3 on Node A:
1. Connect as the install user created above or as the domain administrator.
2. Using the cluster administrator tool, move all the groups to Node A, making sure all groups are online.
3. Start the installation using SAPinst by running setup.cmd.
4. When prompted, reboot Node A.
5. Connect to Node A as the same user.
6. Run the installation of the central instance and the database instance the same way, following the same steps as for a normal installation (please refer to the SAP installation guide for the steps to install SAP R/3 on Windows).
7. Choose **Central instance** or **Database instance** based on your installation, and enter the System ID for the new SAP system.

![SAP installation](image)

**Figure 38. SAP installation**
8. Choose the installation to be a domain installation.

Figure 39. Specifying the SAP instance host parameters
9. Choose the shared drives where the database files should go.

Figure 40. Specify shared drives for the database files
10. At the end of a successful installation the following screen should be displayed.

![Successful SAP installation](image)

**Figure 41. Successful SAP installation**

### 7.5 Installing SAP R/3 on Node B

The process of installing SAP is performed once on the shared drive. The installation is run from Node A and should not be repeated for Node B.

However, there is one step required on Node B, the running of `setup.cmd`. This will install the SAPinst and executable files required for the MSCS conversion (details can be found in section 8.2.2).

### 7.6 SAP transport Host

It is generally recommended to have the transport directory on the shared drives so all nodes can have access to it. After the installation, the transport host will be set to Node A by default. This should be changed to the SAP R/3 virtual host name.

If you are using an external system as the transport host, please do the following:

1. On the transport host create the directory `\usr\sap\trans` if it does not exist.
2. On this directory grant full control to the global group `SAP_<SID>_GlobalAdmin`.
3. Update the HOSTS file to make SAPTRANSHOST an alias for the transport host.
   The entry should look like this:
   ```
   192.168.1.1 hostname SAPTRANSHOST
   ```
4. Continue with the regular setup provided by SAP to configure the transport host.
7.7 Moving an existing SAP system

If you have an existing system and decide to convert it to an MSCS system you will need to follow the same steps as above. The only difference is that instead of performing a normal installation on the system, you will need to perform a system copy. If the original system and new system have the same operating system and DBMS, then you will perform a homogeneous system copy. If they are on different operating system or DBMS, then you will need to perform a heterogeneous system copy. Please refer to the SAP guides for homogeneous and heterogeneous system copy.
Chapter 8: Conversion to MSCS

After the installation has been completed, you have a full SAP R/3 system running on the shared drive. However the system is not enabled yet for the MSCS clustering functionalities. The database and the SAP R/3 system must be converted to be able to run the MSCS environment.

In this chapter you will learn how to convert a SAP R/3 system running on DB2 UDB from a non-clustered system to a clustered system. This will involve converting the DB2 instance and database as well as converting the R/3 system.

8.1 DB2 conversion - DB2MSCS

The DB2MSCS utility is a standalone command line utility used to transform a non-MSCS instance into an MSCS instance. The utility will create all MSCS groups, resources, and resource dependencies. It will also copy all DB2 information stored in the Windows registry to the cluster portion of the registry as well as moving the instance directory to a shared cluster disk. The DB2MSCS utility takes as input a configuration file provided by the user specifying how the cluster should be set up.

The user must be logged on as a domain user account that belongs to the Administrators group of each machine in the MSCS cluster to run this tool. The node running the tool must be the owner of all the MSCS resources at that time.

This tool can be run from any machine, but it is best to run it on Node A. It should be run once for the whole cluster.

To install and run the tool:

1. Copy the db2mscs.cfg file into the installation directory from the kernel CD, in the common directory (Only for older releases) or rename the file db2mscs.eee found in \sqlib\cfg to db2msc.cfg

2. Edit the db2mscs.cfg file. (a sample DB2MSCS.cfg file is provided in Appendix A). The following parameters must be set:

   GROUP_NAME: DB2 <SID> group
   DB2_INSTANCE: Name of the DB2 cluster instance (db2<sid>)
   DB2_LOGON_USERNAME: the name of the instance owner
   DB2_LOGON_PASSWORD: the password of the instance owner
   CLUSTER_NAME=ISISCLUSTER
   DB2_NODE: node number (0 in a single partition system, but must be specified)
   IP_ADDRESS: IP address of DB2 cluster group
   IP_SUBNET: Subnet mask of DB2 cluster group
   IP_NAME: DB2 IP <SID>
3. Stop the R/3 system.

4. Stop the instance db2<sid> by issuing db2stop at a command prompt.

5. Change directories to the installation directory and run the tool db2mscs:

   C:\> db2mscs -f:db2mscs.cfg

   This tool will create a group in the cluster for DB2 and add the corresponding resources, which will enable the DB2 instance to start running as a cluster instance.

8.2 SAP node conversion

8.2.1 Node A conversion

1. Log on to Node A as the domain administrator; make sure this user has local administrator rights.

2. For a 47 system, the files TOPLEVEL.XML and CONTROL.XML (found in the local install directory) must be replaced with the ones found in the package MSCS_PATCH.SAR, which can be found in the CD package or attached to OSS note 493828. For a Unicode installation, rename the file UC_TOPlEVEL.XML to TOPLEVEL.XML and move it along with CONTROL.XML into the install directory. Please review OSS Note 493828 for more details.

3. Start SAPinst as you would in a normal installation.
4. Choose the option: **Configure the MSCS Node A for IBM DB2 UDB for UNIX and Windows.**
5. Type the name for the virtual host names of SAP and DB2 respectively.

![Figure 43. Entering network names](Image)
6. Specify the system ID (SID) and instance number (already specified in the original installation).

![Specify SID and instance number](image)

**Figure 44. Specify SID and instance number**

7. Type the name of the SAP and DB2 System IDs.
8. Choose **Domain Installation**.
9. Type the encryption key (<SID>db2 virtual host) and choose the communication port and type `sap<sid>` as the connect user.
10. The system then will start the conversion of Node A.
11. After completing the conversion the following screen should appear.
8.2.2 Node B conversion

1. Log on to Node B as the domain administrator; make sure this user has local administrator rights.
2. Run setup.cmd to install the SAPinst files required for the conversion (these files should be on one of the local drives).
3. For a 47 system, the files TOLEVEL.XML and CONTROL.XML (found in the local install directory) must be replaced with the ones found in the package MSCS_PATCH.SAR which can be found in the CD package or attached to OSS note 493828. For a Unicode installation, rename the file UC_TOLEVEL.XML to TOLEVEL.XML and move it along with CONTROL.XML into the install directory. Please review OSS Note 493828 for more details.
4. On Node A, take the SAP-R/3 <SID> resource (created in the previous step) offline and move the database group DB2<SID> and SAP group to Node B.
5. Start SAPinst as you would for a regular installation.
6. Choose the option: **Configure the MSCS Node B for IBM DB2 UDB for UNIX and Windows**.
7. Enter the same parameters as for Node A conversion.
Chapter 9: Post installation activities

9.1 Check the services

9.1.1 Check the services file

The services file (found on %WINDIR%\system32\drivers\etc) should contain the following entries on all nodes:

- `sapmsMSC 3600/tcp` # SAP System Message Port
- `sapdp00 3200/tcp` # SAP System Dispatcher Port
- `sapdp00s 4700/tcp` # SAP System Dispatcher Security Port
- `sapgw00 3300/tcp` # SAP System Gateway Central Instance Port
- `sapgw00s 4800/tcp` # SAP System Gateway Security Port
- `sapdb2MSC 5912/tcp` # SAP DB2 Communication Port
- `DB2_DB2MSC 50001/tcp`
- `DB2_DB2MSC_1 50002/tcp`
- `DB2_DB2MSC_2 50003/tcp`
- `DB2_DB2MSC_END 50004/tcp`
- `sapgw97 3397/tcp`
- `sapgw97s 4897/tcp`

Where 00 is the System Number
97 is the Gateway System Number (Details about the gateway server can be found in section 9.7.)

9.1.2 Check the DB2-DB2<sid>-0 service setting

Because this service is controlled by the cluster software and cannot be running on both nodes at the same time, the startup for this service should be set to manual and the service has to be run under the domain user db2<sid>.

To do this, perform the following:
1. Click on **Start → Administrative Tools → Services**.
2. Right click on this service and choose **Properties**.
4. Under the Log On tab, change the logon user to the db2<sid> domain user.
9.2 Check the system environment

The following parameters must be set in the Windows system environment on all nodes:
- DB2INSTANCE must be set to db2l<sid>
- TEMP must be set to a local directory (e.g. D:\temp)
- PATH must contain the following string:
  - %WINDIR%\SapCluster; <drive>:\usr\sap\<SID>\sys\exe\run;
- ClusterLog must be set to a local directory

The following parameters must be set for the db2<sid> and the <sid>adm user environment (on both machines):
- DB2DB6KEY=<SID><DB virtual host>
- DB2DBDFT=<SID>
- DB2INSTANCE=db2l<sid>
- DBMS_TYPE=DB6
- DBS_DB6_SCHEMA=sap<sid>
• DIR_LIBRARY=<drive>:\usr\sap\<SID>\SYS\exe\run
• DSCDB6HOME=<SAP virtual host>
• INSTHOME=<drive>:\db2\db2<sid>
• SAPSYSTEMNAME=<SID>
• SESSIONNAME=RDP-Tcp#10

The following parameters must be set for the <sid>adm user environment:
• SAPEXE=%WINDIR%\SapCluster
• SAPLOCALHOST=<SAP Virtual host>
• SAPMNT=\<SAP virtual host>\sapmnt

The home directory of the users db2<sid> and <sid>adm should be set to %WINDIR%\SapCluster.

9.3 Configure the DB2 Administration Server

The DB2 Administration Server is used by the DB2 Control Center to administer DB2 instances and databases. If high availability of the Administration Server is desired, then it must also be clustered. The steps to cluster the Administration Server are as follows:

1. Make sure the Administration Server exists on the first machine (you can use the command db2admin create to create it).

2. Stop the Administration Server on all machines:
   C:\> db2admin stop

3. Drop the Administration Server on all the nodes except the first node:
   C:\> db2admin drop

4. On the first node where the Administration Server resides, go into the Windows services dialog box and modify the Administration Server instance so it is set to start manually. It will show up as ‘DB2DAS00’ in the services dialog.

5. Create a configuration input file to be used by the DB2MSCS utility to cluster the Administration Server:

   Example:
   DAS_INSTANCE=DB2DAS00
   CLUSTER_NAME=MYCLUSTER
   DB2_LOGON_USERNAME=MYDOMAIN\DB2MSC
   DB2_LOGON_PASSWORD=XXXX
   GROUP_NAME=DB2 MSC group
   DISK_NAME=DBLOG F:
   INSTPROF_DISK=DBLOG F:
Note that what you use for the group name here will be the group where the resource will be created; if you choose the same group name as your original DB2 group then the DAS will become part of this group. A generic service will be created which will allow the DAS to be monitored by MSCS.

6. Execute the DB2MSCS utility from Node A. You must be the DAS instance owner when you run this program.
   C:\> db2mscs –f:db2mscs.cfg

7. On all clients used for the administration, remove any reference to the Administration Server using the DB2 Control Center. Then use the DB2 Control Center to recatalog a reference to the Administration Server utilizing the Cluster IP address defined on the public network.

9.4 Create the local user: sap<sid> on Node B

The user sap<sid> is the only local user in an MSCS environment. It will be created on Node A during the regular installation process and it should be created manually on Node B. That user must have the same password on both nodes. For more information, please review OSS Note: 539523.

9.5 Create a local instance

On both nodes A and B, a local instance must be created which will act as a pointer to the actual clustered instance pointing to the location where the clustered instance resides at any point in time (an example describing the use of the local instance is explained in section 6.4). The instance name should be db2l<sid>.

The following steps must be performed on both nodes to create the local instance:

1. Login as user db2<sid>
2. From a command window enter the commands:
   C:\> db2icrt db2l<sid>
   C:\> set db2instance=db2l<sid>
   C:\> db2set DB2_FALLBACK=ON
3. Set the environment variable 'DB2INSTANCE' to db2l<sid> for the users <sid>adm, db2<sid>, and sapse<sid>

For more details please refer to OSS Note: 539523.

9.6 Catalog the databases

After creating the local instance, the databases <SID> and ADM<SID> should be cataloged as remote databases on this instance. To do that, follow these instructions on both nodes:
1. Log on as user db2<sid>
2. Start a DB2 command window using **Start → Run → db2cmd**.
3. List the database directory using the command `db2 list database directory`.
4. If you don’t see <SID> and ADM<SID> listed, catalog them using these commands:
   ```
   C:\> db2 catalog tcpip node <SID>NODE remote <Host name of virtual DB2 server> server sapdb2<SID> remote_instance db2<sid>
   C:\> db2 catalog database <sid> at node <SID>NODE
   C:\> db2 catalog db ADM<SID> at node <SID>NODE
   ```

### 9.7 Create a standalone gateway

Several R/3 transaction use external programs to perform tasks. (For example, transaction ST04 uses the program dmdb6rdi.) These programs must be run on the database server. R/3 uses an R/3 instance running on the database server to call these programs using SAPXPG.EXE. If no R/3 instance is found on the database server, the program is started via a gateway.

To install the gateway, the following tasks must be performed on both nodes:

1. Login as <sid>adm
2. Assign a System ID and system number for the gateway that is different from the system number of the SAP system (the same number should be used on both nodes).
3. Create a folder named ‘sapgw’ in the %windir%\sapcluster directory on all cluster nodes.
4. Create the subfolders ‘work’ and ‘log’ in the folder ‘sapgw’.
5. Copy the files ‘gwrk.exe’ and ‘sapxpg.exe’ from the exe directory to the newly created ‘sapgw’ folder.
6. Create default, start and instance profiles in the folder ‘sapgw’.
7. Create the file ‘default.pfl’ containing the entry:
   ```
   SAPDBHOST = <virtual DB hostname>
   ```
8. Create the file ‘startgw.pfl’ containing the entries:
   ```
   SAPSYSTEMNAME = <GW_SID>
   INSTANCE_NAME = GW<system number>
   ```
SAPSYSTEM = <GW system number>
DIR_EXECUTABLE = <\windir%>\sapcluster\sapgw
DIR_PROFILE = <\windir%>\sapcluster\sapgw
DIR_INSTANCE = <\windir%>\sapcluster\sapgw
_GW=gwrd.exe
Start_Program_00 = local $(DIR_EXECUTABLE)$(_GW)
pf=$(DIR_PROFILE)\gw <system number>.pfl

Example (startgw.pfl):

SAPSYSTEMNAME = CG1
INSTANCE_NAME = GW97
SAPSYSTEM = 97

DIR_EXECUTABLE = C:\windows\sapcluster\sapgw

DIR_PROFILE = C:\windows\sapcluster\sapgw

DIR_INSTANCE = C:\windows\sapcluster\sapgw

_GW=gwrd.exe

Start_Program_00 = local c:\windows\sapcluster\sapgw\gwrd.exe
pf=c:\windows\sapcluster\sapgw\gw97.pfl

9. Create the file ‘gw<system number>.pfl’ containing the entries:

SAPSYSTEMNAME = <GW-SID>
INSTANCE_NAME = GW<system number>
SAPSYSTEM = <GW system number>
DIR_PROFILE=<\windir%>\sapcluster\sapgw
DIR_EXECUTABLE=<\windir%>\sapcluster\sapgw
DIR_INSTANCE=<\windir%>\sapcluster\sapgw
SAPLOCALHOST = <virtual database hostname>
SAPLOCALHOSTFULL = <virtual database hostname>

Example (gw97.pfl):

SAPSYSTEMNAME = CG1
INSTANCE_NAME = GW97
SAPSYSTEM = 97
DIR_PROFILE = C:\windows\sapcluster\sapgw

DIR_EXECUTABLE = C:\windows\sapcluster\sapgw

DIR_INSTANCE = C:\windows\sapcluster\sapgw

SAPLOCALHOST = DB2CLUSTERGRP

SAPLOCALHOSTFULL = DB2CLUSTERGRP

Make sure that you do not split the parameters definitions into two lines when entering them into the three files. Also make sure that in both profiles there is at least one empty line behind the last line with parameter definitions in the profile.

10. Add the following entries to the services file found in
‘%windir%\system32\drivers\etc’:
sapgw<system number> 33<system number>/tcp
sapgw<system number>s 48<system number>/tcp

11. Set the following environment variables for user <sid>adm:

SAPMNT=\\<virtual R3 hostname>\sapmnt
SAPEXE=\%windir%\SapCluster

12. Create the service SAP<SID>_<system number>. To do this:
   A. Run the command %windir%\sapcluster\sapstartsrv.exe
   B. Choose the option: ‘Install Service + Register COM Interface + Start Service’.
C. Enter <SID>, <system number> and path in the start profile, the
   DOMAIN\SAPService<SID> user and the password (in this case use the same
   user which you used for the installation of the SAP system).
D. Check the box: User Environment of user and enter the DOMAIN\<sid>adm
   account.
E. Set the startup type to Manual and choose OK.

   It is very important that you start sapstartsrv.exe from the
   %windir%\sapcluster and not from another directory.

13. Move the DB group to node B and perform the same steps on node B.

14. On either node, add a gateway resource to the DB group using the Cluster
    Administrator as follows:
    A. Right-click the DB group in the Cluster Administrator.
    B. Select New -> Resource.
C. Enter the resource name SAPGW<SID>, select **SAP Resource** as resource type and click **Next**.
D. Select both node A and B as possible owners and click **Next**.
E. Add ‘Disk Resources’, ‘IP Address’ and ‘Network Name’ as resource dependencies and click **Next**.

![Dependencies](image)

**Figure 56. Specify resource dependencies**

F. Enter gateway `<SID>` and gateway `<system number>` as SAP resource parameters and click **Finish**.
G. Bring the gateway resource SAPGW<SID> online.

15. Create the event ID to describe the event in the application event log. Perform this step on Node A and Node B. Run the registry editor regedit.exe and create the new key ‘SAP<SID>_<system number>’ in ‘HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Eventlog\Application’ and create the following values for key ‘SAPGW<SID>_<system number>’:

- STRING value:
  EventMessageFile = <%windir%>\sapcluster\sapevents.dll

- DWORD value:
  TypesSupported = 7

CAUTION: If you use the registry editor incorrectly, your system may be damaged. Perform a registry backup before you make any changes.

For more information please refer to OSS Note: 657999.
9.8 Configure the SAPOSCOL destination

SAPOSCOL is used by R/3 to gather statistical information from the operating system. The SAPOSCOL destination is the definition of an R/3 application server running a SAPOSCOL service. The definition is internal to the R/3 system.

In a clustered environment, there must be two SAPOSCOL destinations:

- SAPOSCOL_<virtual db host>
- SAPOSCOL_<virtual SAP host>

To maintain the SAPOSCOL destinations, the following steps must be performed:

1. Start transaction SM59, select TCP/IP connections and open the available SAPOSCOL destination by double clicking.
2. Select **Destination → Copy** to copy the destination both to SAPOS COL_<virtual db host> and to SAPOS COL_<virtual SAP host>.
3. Adjust the name of the target machine accordingly.
4. Save the destination.

5. Click **Test Connection** to confirm the connection is working.
### Connection Test

**Connection type:** TCP/IP connection

<table>
<thead>
<tr>
<th>Logon</th>
<th>TCP/IP connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 KB</td>
<td>92 msec</td>
</tr>
<tr>
<td>10 KB</td>
<td>1 msec</td>
</tr>
<tr>
<td>20 KB</td>
<td>1 msec</td>
</tr>
<tr>
<td>30 KB</td>
<td>2 msec</td>
</tr>
</tbody>
</table>

**Figure 61. Test connection**
6. Start transaction AL15 and select **ADD SAPOSCOL dest**. Select the destination you just created and give it a suitable description.

![Select the destination](image1.png)

**Figure 62. Select the destination**

![Provide description](image2.png)

**Figure 63. Provide description**

7. Repeat the same steps to create the SAPXPG_DBDEST<virtual_DB_hostname> destination.
8. For all 3 destinations adjust Gateway Host and Gateway service accordingly.

Figure 64. Adjust gateway host and gateway service
9. Make sure for SAPXPG_DBDEST<virtual_DB_Hostname> you enter ‘sapxpg’ in the Program ID field and test the RFC connection.

![Figure 65. Set program ID](image)

You should always get the latest SAPOSCOL and latest kernel patches before going live with a new system.

### 9.9 Install and configure the admin tools

The DB2 administration tools are not automatically installed with the normal SAP R/3 installation. Therefore they must be installed manually on all nodes.

1. Log in as user <sid>adm.
2. Make sure all the cluster resources are on the node you’re working on.
3. From a command prompt set the environment variable DB2INSTANCE to db2<sid>:
   C:\> set DB2INSTANCE=db2<sid>
4. Confirm the folders log_archive and log_retrieve are created; if not then create them.
5. Run the program SDDB6INS:
   C:\> sddb6ins.exe –I 620 –s <SID>
6. Download and apply the latest admin tools patches.

For more details please review the document Database Administration Guide: SAP on IBM DB2 Universal Database for UNIX and Windows and OSS Note #455506: DB6: Installing the Latest 6NN DB2 Admin Tools.

9.10 Verify the installation

9.10.1 Verify the contents of the SapCluster directory

A directory called SapCluster will be created locally on all nodes by SAPinst under %windir%. This directory should contain the following files. (Some of these files must be manually copied from <drive>:\usr\sap\<SID>\SYS\exe\run.)
CPQCCMS.DLL
DSCDB6UP.EXE
MKSZIP.EXE
PSTAT.EXE
RFCOSCOL.EXE
SAPEVENTS.DLL
SAAPNTCHK.EXE
SAPOSCOL.EXE
SAPSTARTSRV.EXE
SAPXPG.EXE
UNCOMPRESS.EXE
SDDB6INS.EXE

9.10.2 Connection test

Install the SAP GUI interface and try to logon as user DDIC on client 000. Try the following scenarios:

- Keep all the resources on Node A and try to log on.
- Move the SAP resources from Node A to Node B (so that R/3 is running on one machine and the database is running on the other) and log on again.
- Move the DB2 resources from Node A to Node B (so both R/3 and the database are on Node B) and log on again.
All these attempts should be successful.

**9.10.3 SAP system check**

An SAP system check can be done by logging on to the R/3 system and running transaction SM28. It can also be done by clicking **Tools → Administration → Installation Check** or by running transaction SICK.

The output should look like this:

![SAP system check output](image)

**Figure 66. SAP system check**

**9.10.4. System log analysis**

It is important to check SAP’s system log which is continually updated with all the activities going on the server. You can check the system log using one of three methods:

- Checking the file `\usr\sap\<SID>\<instance>\SLOG00.LOG`
- Logging on the R/3 system then clicking **Tools → Administration → Monitor → System Log**
- Logging on the R/3 system and running transaction SM21.
9.10.5 Profile check

The directory \USR\SAP\<SID>\SYS\profile holds three profiles, the DEFAULT profile, the START profile, and the SID profile. It is important to import the profiles using transaction RZ10 (or by clicking ToolsÆCCMSÆconfigurationÆprofile maintenance) then choosing UtilitiesÆImport ProfilesÆOf Active Servers and confirm the parameters. During the import, a consistency check is performed. You can then review the profile log for errors.

Figure 67. System log analysis
9.10.6 SAPNTCHK

For Windows NT system, you can download and run the tool SAPNTCHK to perform sanity checks on the newly created system. For more details, check OSS Note #65761: *Configuration test tool for Windows, sapntchk.*

9.10.7 DB2 verification

A few important verifications to confirm the consistency of the newly created MSCS cluster system is to check the ability to log on to the database from all server nodes. Please follow these instructions for a two node environment:

1. Log on as user <sid>adm to Node A.

2. Move the DB2 cluster group to Node B and make sure it’s online.

3. Open a DB2 command window.

4. Try to connect to the database using the command:

   %db2 connect to <SID> user sap<sid> using <passwd>
5. Log on as user <sid>adm to Node B.

6. Move the DB2 cluster group to Node A and make sure it’s online.

7. Open a DB2 command window and try to connect using the same command:
   
   ```
   db2 connect to <SID> user sap<sid> using <passwd>
   ```

### 9.10.8 Cluster verification

Repeat the same steps listed in section 5.5 with all the different combinations. It is sometimes possible to have a working system in all possible configurations but one, due to installation errors. So plan to try all different failover scenarios and make sure they are working with no user intervention.

### 9.11 Installing a DB2 UDB FixPak

A *rolling upgrade* is a software upgrade on the cluster that occurs while still keeping the application online. An MSCS environment ideally lends itself for performing a rolling upgrade of DB2 because the partitions can be online on one machine while the other machine is being upgraded. Rolling upgrades are supported for DB2 installs that do not require either database or instance migration.

Remember that all members of the cluster must be actively running on the same code level. So the strategy for a rolling upgrade is to move all DB2 resources to one machine and then upgrade the other one. At that point, move the resources back to the upgraded machine, bring them online, and upgrade the second machine.

Here is the procedure to upgrade the system:

1. Move all DB2 resources to Node B.
2. Stop the cluster service on Node A.
3. Apply the DB2 FixPak on Node A.
4. Bring all the DB2 resources offline, then start the cluster service on Node A.
5. Move all the DB2 resources to Node A and bring them online.
6. Stop the cluster service on Node B.
7. Apply the DB2 FixPak on Node B.
8. Start the cluster service on Node B.

9. At this point you can move the resources to any of the nodes.
Chapter 10: Backing up your MSCS system

MSCS offers benefits of availability and performance. In this environment, a user is able to continue work when a failure occurs. Integrity of the data, however, is not maintained, so a good backup is always very important to protect the data.

There are a few restrictions you must observe when running a backup of an MSCS system:

- Tape devices cannot be cluster resources.
- If running the backup program on one node, the user might not be able to see all the disks in the configuration.
- Files unique to MSCS may not be handled correctly by the usual backup software.

To overcome some of these difficulties, the user is advised to move all the resources to one of the nodes before starting the backup, and to run the backup on both nodes.

Getting a full file system backup is divided into 3 major tasks:

1. Backing up the local disks on each node
2. Backing up the disks on the shared drives
3. Backing up MSCS special files

To be able to automate backups, your backup program should be able to perform pre- and post-backup activities so that you can arrange to have all resources under the control of one machine before running the backup, and so that you can return back to the original status after the backup.

A common backup approach is to use a dedicated backup server; both nodes acting as clients. The only inconvenience with this technique is that the server would treat the backups received from each node as different backups, even if some of the files are identical, thus creating data redundancy and causing more problems if incremental backup is used.

Review the following documents for more details on how to backup and restore a MSCS system:

- Microsoft Knowledge Base Article – 248998: How to properly restore cluster information

If Tivoli Storage Manager (TSM) is being used for the operating system backup, the user must create a special resource in the cluster to manage and run the backups and change some client option files. Please review Appendix D, Configuring the backup-archive

If you’re using a third party backup manager, consult with the vendor on the process to obtain a backup of an MSCS system, as it varies based on the product used.

**10.1 Backing up DB2**

As explained previously, the database service is monitored by MSCS like all the other resources. This means that the user cannot perform a manual stop of the database using the usual methods and then run a DB2 offline backup. If this is done the cluster will detect a failure and will automatically try to restart the resource, which in turn will cause the offline backup to fail. The database service must be stopped using the MSCS administrator GUI, and not the usual database management utility, to perform an offline backup. Only the database resource should be stopped, not the whole group, since the disks must be online so the backup can access the database files. Once the resource is offline, the user can easily get a DB2 backup using the usual method. For more information on how to obtain a DB2 backup, please review *DB2 UDB V8.2 Command Reference*.

Running an online backup using transaction ST04 should run without any problems and without having to stop or move any of the resources. It will be carried out from the active node.

**10.2 Backing up SAP**

Backing up SAP in an MSCS environment is no different than backing up any other SAP R/3 system. A normal OS level backup of both the local disks on both nodes as well as of the shared disks is sufficient. The backup should be taken as explained above using either the Microsoft tools or any third party tool.

**10.3 MSCS files**

An MSCS system maintains files that contain all the information about the cluster. These are:
- Files on the quorum disk (under the directory \MSCS)
- Two files CLUSDB and CLUSDB.LOG in the directory %WINDIR%\CLUSTER. These files are always open. Currently there is no mechanism to back these files up. Even The Windows Server 2003 Backup utility does not currently support the backing up of these files.
The cluster quorum disk can be recovered if the information in the CLUSDB file is correct. (For more information on how to restore the quorum disk, refer to the Microsoft Cluster Server Administrator’s Guide.)

To get a backup of the CLUSDB and CLUSDB.LOG files, you have three options:

- Create a service partition on the node and get a backup of the main partition that way. The service partition will not be part of the cluster, so these files will only be closed when the system is booted up from the service partition. You should shut down the other node while doing this.
- The two files contain the registry branch that sits below the key HKEY_LOCAL_MACHINE\Cluster. The user can export this tree using one of the standard Windows NT registry utility programs and recover by importing it back into the registry.
- You can use the Tivoli Data Protection for Workgroups with its logical replication to duplicate the files for backup.
Chapter 11: Security

11.1 Windows security

To learn more about Windows security please review the Microsoft Technet Document: “Microsoft Security and Privacy Policies.” I suggest that you frequently review the security headlines on the microsoft.com Web site for the latest updates on this topic.

11.2 Cluster security

To be able to run any cluster administration tasks, the user must have administrator permissions on both nodes or just specific permissions to administer the cluster. By default, the local administrator group on all nodes has such permission. To give a user permission to administer the cluster without giving the user administrator permission you need to do the following:

1. Bring up the Cluster Administrator GUI.
2. Right click on the cluster name, and then click Properties.
3. Click the Security tab.
4. Specify the users and/or groups that can administer the cluster

The users must also have access to the DB2 registry variables that are stored in the cluster registry under: `HKEY_LOCAL_MACHINE\cluster\IBM\db2\PROFILE`

By default, the local administrators group on all nodes has full control of the cluster registry. To give a user such permission you can do the following:

1. Click on **Start** → **Run** → **regedit**.
2. Click on **HKEY_LOCAL_MACHINE** → **Cluster** → **IBM** → **DB2** → **Profiles**.
3. Select that key then click **Edit** → **Permissions**.
Figure 70. Specify permissions in the Windows registry

The same steps can be performed for any parameter inside the cluster (for example groups, nodes, resources, and so on).

The cluster service account must be a domain user and belong to the local Administrators group in both nodes of the cluster. Using the Cluster Administrator GUI, you can give other users permission to update the cluster.

### 11.3 DB2 security

As discussed earlier, you should use domain users and groups to manage security. This is of particular benefit when one of the nodes fails over; the same user can connect to the database on the second machine with the same authorities.

By default, the domain administrator has full access to the database. To restrict SYSADM authority to domain users and groups, follow these steps:
1. Create a domain group.
2. Add the domain users to the group.
3. Update the database manager configuration parameter SYSADM_GROUP to the name of the domain group using the following DB2 command:
   C:\> db2 update dbm cfg using SYSADM_GROUP mydomgroup

4. Restart the DB2 instance.

More information on the topic of DB2 security can be found on the DB2 information management website: http://www-306.ibm.com/software/data/.

### 11.4 SAP security

There are a few recommendations for SAP security:

- Some publications recommend creating two different Windows domains to achieve a higher degree of security. The first domain would include the user accounts clients connecting to the cluster, and the second domain is for the SAP and DB2 accounts on the cluster.

- The `<sid>adm` user must be a domain user and belong to the domain administrators, domain users, and SAP_<SID>_global admin groups.

- The SAP service account must be a domain user.

More information on the topic of security can be found in the *SAP R/3 Security Guide*. 
Chapter 12: Tuning

This chapter will explain some basic techniques to help tune your newly created MSCS system. Consult the Microsoft, SAP, and DB2 documentation for a more extensive list of tuning parameters.

12.1 Hardware tuning

Hardware tuning includes having a properly configured disk subsystem, updating the BIOS and drivers. The disks should be laid out in way to ensure maximum performance. If RAID is used, it should be carefully designed for maximum performance. We recommend that you always check with the hardware manufacturer for the latest updates and drivers.

12.2 Windows tuning

Some of the basic Windows tuning steps have been explained earlier such as configuring the server service for maximum throughput for network applications and setting up the page file properly. More information on tuning your windows system can be found in the Microsoft Technet documents: *Windows 2000 Server Tuning* and *Windows 2003 Server Tuning*.

12.3 DB2 tuning

Tuning the database for an MSCS system is identical to tuning the database for any SAP system. Please review DB2’s online documentation for information on database tuning.

12.4 SAP tuning

The most important tuning is done by SAP during the “Going live” check. The basic SAP system tuning includes the following:

- Distribute the work processes correctly according to the system usage (DIA, UPD, UP2, BTC, ENQ, SPO) using transaction RZ10.
- Run the dialog, update and enqueue work processes on dedicated servers.
- Keep an optimal ratio between work processes.
- Distribute the users between the application servers during the logon phase. This can be achieved using the logon load balancing (described in the SAP R/3 system administration).
• A technique called *operation modes* can be set up to configure the system in two different modes and schedule a switch between them at specific times (for example, switch between daytime workload and night time).

• It is important to constantly monitor the system’s performance and observe what tuning it needs:
  
  o Use transaction ST03 to retrieve a detailed analysis of the workloads running on your system.

  ![Image of Workload in System MSC](image)

  **Figure 71. Workloads running**

  o Use transaction ST02 for a detailed buffer analysis
Use transaction DB13 to schedule and run a database reorganization.
Appendix A: The DB2MSCS tool

Command syntax

>>>-db2mscs--+-configuration_file--+-instance_name--'

The DB2MSCS.CFG file is an ASCII text file that contains parameters that are read by the DB2MSCS utility. You specify each input parameter on a separate line using the following format:

PARAMETER_KEY=PARAMETER_VALUE

The fields within the configuration file that are used are as follows:

DB2_INSTANCE
The name of the DB2 instance. If the instance name is not specified, the default instance (the value specified by the DB2INSTANCE environment variable) is used. This parameter has a global scope and should be specified only once in the DB2MSCS.CFG file.

DAS_INSTANCE
The name of the DB2 Admin Server instance. Specify this parameter to migrate the DB2 Admin Server to run in the MSCS environment. This parameter has a global scope and should be specified only once in the DB2MSCS.CFG file.

CLUSTER_NAME
The name of the MSCS cluster. All the resources specified following this line are created in this cluster until another CLUSTER_NAME parameter is specified.

DB2_LOGON_USERNAME
The user name of the domain account for the DB2 service (specified as domain\user). This parameter has a global scope and should be specified only once in the DB2MSCS.CFG file.

DB2_LOGON_PASSWORD
The password of the domain account for the DB2 service. This parameter has a global scope and should be specified only once in the DB2MSCS.CFG file.

GROUP_NAME
The name of the MSCS group. If this parameter is specified, a new MSCS group is created if it does not exist. If the group already exists, it is used as the target group. Any MSCS resource specified after this parameter is created in this group or moved into this group until another GROUP_NAME parameter is specified. Specify this parameter once for each group.
**DB2_NODE**
The partition number of the database partition server (or database partition) to be included in the current MSCS group. If multiple logical database partitions exist on the same machine, each database partition requires a separate DB2_NODE parameter. Specify this parameter after the GROUP_NAME parameter so that the DB2 resources are created in the correct MSCS group. This parameter is required for a multi-partitioned database system.

**IP_NAME**
The name of the IP Address resource. The value for the IP_NAME is arbitrary, but it must be unique in the cluster. When this parameter is specified, an MSCS resource of type IP Address is created. This parameter is required for remote TCP/IP connections. This parameter is optional in a single partition environment. A recommended name is the hostname that corresponds to the IP address.

**IP_ADDRESS**
The TCP/IP address for the IP resource specified by the preceding IP_NAME parameter. This parameter is required if the IP_NAME parameter is specified. This is a new IP address that is not used by any machine in the network.

**IP_SUBNET**
The TCP/IP subnet mask for the IP resource specified by the preceding IP_NAME parameter. This parameter is required if the IP_NAME parameter is specified.

**IP_NETWORK**
The name of the MSCS network to which the preceding IP Address resource belongs. This parameter is optional. If it is not specified, the first MSCS network detected by the system is used. The name of the MSCS network must be entered exactly as seen under the Networks branch in Cluster Administrator.

**Note:**
The previous four IP keywords are used to create an IP Address resource.

**NETNAME_NAME**
The name of the Network Name resource. It must be a unique name. Specify this parameter to create the Network Name resource. This parameter is optional for single partition database environment. You must specify this parameter for the instance owning machine in a partitioned database environment.

**NETNAME_VALUE**
The value for the Network Name resource. It must be a unique value. This parameter must be specified if the NETNAME_NAME parameter is specified.

**NETNAME_DEPENDENCY**
The name for the IP resource that the Network Name resource depends on. Each Network Name resource must have a dependency on an IP Address resource. This parameter is
optional. If it is not specified, the Network Name resource has a dependency on the first IP resource in the group.

**SERVICE_DISPLAY_NAME**
The display name of the Generic Service resource. Specify this parameter if you want to create a Generic Service resource.

**SERVICE_NAME**
The service name of the Generic Service resource. This parameter must be specified if the SERVICE_DISPLAY_NAME parameter is specified.

**SERVICE_STARTUP**
Optional startup parameter for the Generic Resource service.

**DISK_NAME**
The name of the physical disk resource to be moved to the current group. Specify as many disk resources as you need. The disk resources must already exist. When the DB2MSCS utility configures the DB2 instance for failover support, the instance directory is copied to the first MSCS disk in the group. To specify a different MSCS disk for the instance directory, use the INSTPROF_DISK parameter. The disk name used should be entered exactly as seen in Cluster Administrator.

**INSTPROF_DISK**
An optional parameter to specify an MSCS disk to contain the DB2 instance directory. If this parameter is not specified the DB2MSCS utility uses the first disk that belongs to the same group.

**INSTPROF_PATH**
An optional parameter to specify the exact path where the instance directory will be copied. This parameter must be specified when using IPSHAdisks, a ServerRAID Netfinity disk resource (for example, INSTPROF_PATH=p:\db2profs). INSTPROF_PATH will take precedence over INSTPROF_DISK if both are specified.

**TARGET_DRVMAP_DISK**
An optional parameter to specify the target MSCS disk for database drive mapping for a the multi-partitioned database system. This parameter will specify the disk the database will be created on by mapping it from the drive the create database command specifies. If this parameter is not specified, the database drive mapping must be manually registered using the DB2DRVMP utility.

**DB2_FALLBACK**
An optional parameter to control whether or not the applications should be forced off when the DB2 resource is brought offline. If not specified, then the setting for DB2_FALLBACK will be YES. If you do not want the applications to be forced off, then set DB2_FALLBACK to NO.
Tip: Ensure that the IP address used for IP_ADDRESS is a new IP address that does not already belong to any machine on the network. Also ensure all values used for DISK_NAME and IP_NETWORK are entered exactly as seen in cluster administration.

Sample db2mscs.cfg file (SID=MSC):

#**********************************************************************
# File Name: DB2MSCS.CFG
# Licensed Materials = Property of IBM
# (C) COPYRIGHT International Business Machines Corp. 1998
# All Rights Reserved.
# US Government Users Restricted Rights = Use, duplication or disclosure restricted by GSA ADP Schedule Contract with IBM Corp.
# Purpose: Sample DB2MSCS.CFG for a DB2 UDB v8 Workgroup Server Edition installation. This sample may not be used for a DB2 UDB v8 Enterprise Server Edition installation.
#**********************************************************************

# Global section
# DB2_INSTANCE=DB2MSC
DB2_LOGON_USERNAME=MyDomain\db2msc
DB2_LOGON_PASSWORD=db2sap
CLUSTER_NAME=ISISCLUSTER

# MSCS Group
# GROUP_NAME=DB2 MSC GROUP
DB2_NODE=0
IP_NAME=DB2 IP MSC
IP_ADDRESS=9.26.98.127
IP_SUBNET=255.255.255.0
NETNAME_NAME=DB2 NETNAME MSC
NETNAME_VALUE= db2_msc
NETNAME_DEPENDENCY=DB2 IP MSC
DISK_NAME=Data1 I:
DISK_NAME=Data2 J:
DISK_NAME=ARCHLOG H:
DISK_NAME=DBLOG L:
INSTPROF_DISK=ARCHLOG H:
Appendix B: Troubleshooting

B.1 MSCS Troubleshooting

The environment variable ClusterLog points to a location where a log file for the cluster is located. This log file contains a detailed analysis of activities going on the cluster and can be very useful in troubleshooting general MSCS problems after the system has been installed. Figure 74 shows a sample log file:

![Figure 74. Sample log file](image)

B.1.1 Trouble creating a cluster:

The cluster creation could fail for many reasons. During the creation using the wizard you may get a screen like the following:
In order to determine the problem, follow these steps:

1. Click on **View Log** to see a detailed log file. The log file keeps a list of all the steps to create the cluster.
2. If you don’t find a clear error in the log file, click on details. This shows a list of all the tasks in order in a GUI format. It shows the successful as well as the failed tasks. By clicking the arrows up and down you can scroll through the task details.

![Task Details](image)

**Figure 77. Task details**

3. Possible reasons for failure could be:
   - The node was not found on this domain. Make sure the node exists in the domain specified.
   - The cluster already exists. Make sure the cluster name is unique in this domain.
   - The disks are not accessible. Make sure all the disks are available to the same node you’re logged on, the same node you’re running the wizard from.
   - The node is member of a different cluster. Make sure the node does not belong to other clusters.
   - Network problems have caused the failure. Make sure your network settings are correct and that you are logged into the domain.
   - You don’t have the level of permission required to create the cluster on the domain. Make sure you are a domain administrator and you’re logged on to the domain as you perform this operation.
   - You’re using an incorrect domain name. Make sure you have the correct value for the domain and you are logged on to this domain.

**B.1.2. Adding a node to the cluster fails:**
When you are trying to add a node to the cluster using the add nodes wizard, the wizard could fail for any of the previous reasons, or for a new reason:

- The cluster does not exist. Make sure the cluster exists and you are connected to the cluster.
- You are unable to connect to the node. Check to see if the node is online and make sure you are able to connect to it. Verify that the node exists on the domain.

**B.1.3. The MSCS cluster does not start:**

After creating the cluster, you can view it in the Cluster Administrator but it does not come up. MSCS will try by default to bring it up; if that fails it will try moving the resources to any other node member of the cluster and try to bring them up there. You may notice in the Cluster Administrator that the resource is being moved across nodes.
In a situation like this to look at the Windows Event Viewer for any warnings or errors related to this problem. By looking at the Event Viewer you might find an error such as the following:
As you can see in Figure 80, the problem is in the authentication method used, and the user needs to enable Kerberos-based authentication. This can be done when you right-click on the failing resource, then click Parameters and check the box Enable Kerberos Authentication.
As suggested in the previous figure, by reviewing the log file R3CLUS.LOG located in the SAPinst directory the reason for the error can be identified.

**B.2 SAP R/3 installation troubleshooting**

There are a few log files that are created during the installation of R/3 and the MSCS conversion such as R3CLUS.log and SAPINST_DEV.log. These files can be found in the installation directory.

If the installation completes successfully but the instance does not start, a good log file to review is SAPSTART.log, which can be found in the work directory on the shared drive.

**B.2.1. The SAP node conversion fails:**

When attempting node conversions, you may receive an error as follows:
B.2.2. The SAP resource does not start:

After going through all the installation steps, you can try to start the SAP resource but it keeps failing. You can try the following to troubleshoot the problem:

1. Check the Windows Event Viewer for any clues as to the reason for the failure of this resource.
2. Check the developer traces found in
   
   `<drive>\usr\sap\<SID>\DVEBMGS##\work` for reasons why the SAP system fails to start.
3. It is possible that the file `dscdb6up.cfg` could have been corrupted. If this is the case, the developer trace will display the following error:

   ```
   ERROR in DB6Connect[dbdb6.c, 1441]
   ```
To fix this problem, make sure the executable `dscdb6up.exe` is copied locally to the SAPClust directory and run the command manually from there:

`%windir%\SAPCluster:>`

When trying to take any of the SAP resources online or offline you may receive this error:

![Figure 83. R/3 DLLs not found or registered](image.png)

Make sure you have installed the latest R/3 DLLs and run the program `insaprct.ext` to register them (refer to section 7.2 for more details).

### B.3 DB2MSCS troubleshooting

As explained previously, the DB2MSCS utility will convert a database into an MSCS database. A configuration file that is not up to spec will cause many errors to appear and can make the troubleshooting a little complicated.

- You can perform a diagnostic trace of this utility using the command:
  ```
  db2mscs -d:trace_file
  ```
  This will create a trace file that you can use to track down the error and sometimes find the solution.
- Run the tool with the following command:
  ```
  db2mscs -u:<instname>
  ```
  This is used to de-cluster the database instance, and will undo any actions performed by the tool previously. This option is particularly important if the utility terminated abnormally and the user ended up with half the configuration only.
Some of the frequent errors reported by the tool are as follows:

- **DB21524E Failed to create the resource “msc”. Win32 error: “”**

  The IP address corresponding to this resource is already in use on the network. Specify a unique IP address.

- **DB21526E Failed to move resource “F:”. Win32 error: “The cluster resource could not be found”**

  The physical disk resource does not exist within the cluster. Ensure the name of the disk is correct and it’s identical to the name in the Cluster Administrator.

- **Warning: The message file is missing**

  DB2MSCS processing complete, rc =126

  You did not reboot the machine after installing DB2. After DB2 has been installed, each machine in the cluster must be rebooted before running the DB2MSCS utility.

Please refer to the DB2 online message reference for more return codes.

**B.4 Repairing a cluster after a machine failure**

If one of the nodes of the cluster is damaged beyond repair, the operating system might need to be re-installed or even the machine might need replacement. You can use the following steps to bring the cluster back up in a working state. Let’s assume for this example that we have a 2-node cluster. Node B went down while Node A is still up:

1. Move all groups from Node B to Node A.
2. From NodeA, open the Cluster administration, right click on Node B under the tree in the left window and select Evict Node to remove Node B from the cluster.
3. If the environment variable DB2CLUSTERLIST is set, it should be showing the two nodes in the cluster. On Node A, remove Node B from the cluster list by setting this parameter:

C:\> db2set DB2CLUSTERLIST
NodeA NodeB
C:\> db2set DB2CLUSTERLIST='NODEA'

If this parameter was not set then you can skip this step.

4. On Node B, re-install the operating system, or replace the machine if needed.
5. On Node B, reinstall MSCS software (if required) and add the Node back to the cluster.
6. On Node B, reinstall the DB2 and SAP software as per the original install.
7. On Node A, add Node B back to the cluster list.
8. To make sure everything was successful, use the move group option to move the groups to Node B and make sure they will run.
Appendix C: FAQ

Q. I can’t connect to the cluster. Every time I try, the connection fails. What could be the problem?

A. There could be many reasons why a user cannot connect to the cluster. Check the network connection on your machine, and check the connection to the domain. Try to ping the cluster name or IP address and see if there is a response. When you connect to the cluster, try using the IP address. If that’s not possible either, you can put a ‘.’ instead of the cluster name. This will take you inside the configuration; then you can right click on the resources to bring them online.

Q. My DB2 instance does not start on the cluster. What’s wrong?

A. Make sure the DB2 group/resources are owned by the node you are trying to start the instance from. Check the dependencies of the resources you are trying to bring up.

Q. Why doesn’t my system fail over?

A. Make sure none of the resources are being used locally by the node. Also make sure the node you want to fail over to, is online and available. In addition, make sure you have started your system (both R/3 and DB2) using the Cluster Administrator, not manually. Otherwise MSCS will not be aware that it must try to keep it online and will not fail over in case of any problems.

Q. How long does failover take? Can I run any transactions during that time?

A. Depending on how fast the machine and the network connections are, an average of 10-30 seconds is expected. You will not be able to run any transactions during the failover period, but as soon as the resources fail over to the other machine, you can run transactions immediately without making any changes on the SAP side.

Q. I try to stop my R/3 system from the MMC Interface and it restarts immediately. What is wrong?

A. Once the cluster is established on your machines, MSCS becomes the controller of the R/3 system and you should not be using the MMC interface to stop and start the R/3 system; rather, the Cluster Administrator should be used to stop and start the SAP resources. Once you stop the system manually (not using the Cluster Administrator), MSCS will assume the SAP resource has failed so it will automatically try to restart it as an attempt to fix the problem. That’s why you will see the system being restarted in the MMC interface.
Q. I try to stop the DB2 instance using ‘db2stop’ but it immediately restarts. What is wrong?

A. Once the cluster is established on your machines, MSCS becomes the controller of all the DB2 services and you should not try to stop and start the instance manually; rather, the Cluster Administrator should be used to stop and start the DB2 instance. Once you stop the instance manually, MSCS will assume there is a problem and the DB2 resource has failed so it will automatically try to restart it as an attempt to fix the problem. That’s why you will see the instance restarting immediately.

Q. How do I remove a node from the cluster?

A. Stop the cluster service on that node by right-clicking on the node in the cluster administrator and choosing **Stop Cluster Service**. Then right click on the node again and choose “Evict Node”. Please note that you have to delete all the resources before you can evict the last node in the Cluster.

Q. How do I drop a cluster?

A. All nodes members of the cluster must be removed from the cluster first. Use the instructions from the previous question to evict all nodes. Login to the domain controller and remove the cluster from the domain members. (double check when Benita tries it)

Q. I have rebooted both machines, but one of them does not come back up.

A. To reboot one or both machines you have to completely stop the cluster services on both machines. Otherwise the first machine will come up, and MSCS will automatically try to bring up the cluster services on the other machine at the same time it is rebooting which will put it in a freeze state.

Q. I try to take the group down in the Cluster Administrator but it does not go offline.

A. Check the dependencies of all the resources in this group. There could be a dependency on another resource that belongs to another group. Also, check the physical disk (or disks) associated with this group; if there is a file in use inside that physical disk, the whole resource will not go offline.

Q. When I issue db2 commands locally from the DB2 CLP, I get the error:

```
SQL1039 An I/O error occurred while accessing the database directory. SQLSTATE=58031
SQL6048 A communication error occurred during start or stop database manager processing
```

A. Make sure the database is on the local machine. Issue the command on the machine where the database resides.
Appendix D: Useful publications

D.1. Important OSS NOTES

1. OSS Note #169468: Windows 2000 support
2. Note # 30478: Support Packs on Windows
3. Note # 138765: Cluster migration: Terminology and procedure
4. Note # 106275: Availability of R/3 on Microsoft Cluster Server
5. Installation Notes:
   a. 106275: Availability of R/3 on Microsoft Cluster Server
   b. 660118: INST: SAP R/3 Enterprise 4.70, Ext. 2.0 on Windows - Cluster
   c. 493828: DB6: SAP Web AS Inst. on Windows - Release 6.20
   d. 658134: INST: SAP R/3 Enterprise 4.70 Ext. Set 2.00 on Windows
   e. 539523: DB6: MSCS Installation on IBM DB2 UDB for UNIX and Windows
   f. 529118: INST: SAP R/3 Enterprise 4.70 on Windows – MS Cluster Server
   g. 549993: Cluster Upgrade of an SAP System based on 6.20: Windows
   h. 676073: MSCS Installation for SAP Web AS 6.40 on Windows
   i. 582859: Cluster installation on Windows based on Web AS 6.20 systems
   j. 410252: DB6: Installing the Latest 4.6D DB2 Admin Tools

D.2 Microsoft publications

- Microsoft Technet:
  o MSCS Administrator’s guide
  o Microsoft Cluster Server Troubleshooting and Maintenance
  o Deploying Microsoft cluster server
  o The Management of MS Cluster Server (MSCS) Computing Environments
  o Writing MS Cluster Server (MSCS) Resource Dynamic-Link Libraries (DLLs)
  o MS Cluster Server Troubleshooting and Maintenance
- Knowledge Base References:
  o Article #259267: Networking in MSCS
  o Article #257928: How to manually remove the Cluster service
  o Article #810220: Windows Server 2003 Clustering: New Features
D.3 SAP publications

- SAP R/3 Enterprise on Windows Install guide: IBM DB2 Universal Database for UNIX and Windows Using SAP R/3 Enterprise Core 4.70, SAP R/3 Enterprise Extension Set 2.00
- SAP R/3 Database Administration Guide.
- SAP R/3 Security Guide.

D.4 DB2 publications

White papers (can be found on http://www.ibm.com/software/data/pubs/papers/):

- An Overview of High Availability and Disaster Recovery for DB2 UDB
- Implementing IBM DB2 Universal Database V8.1 Enterprise Server Edition with Microsoft Cluster Server
- DB2 Universal Database for Windows: High Availability Support Using Microsoft Cluster Server - Overview

D.5 Important Web sites

- Microsoft Cluster Server General Questions:
- Cluster Hardware FAQ:
  http://www.microsoft.com/ntserver/support/faqs/clusterfaq_hardware.asp
- Windows NT - Managing MSCS:
- Deploying Microsoft Cluster Server Questions:
- SAP service Marketplace:
  http://service.sap.com