Care and Feeding of Monitor APPLDATA

SESSION O761

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Disclaimer

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This presentation was put together in order to take the mystery out of APPLDATA. It has been presented at the following places:

- October 1991 - members of OV/VM Performance area visiting EPL from Dallas.
- November 1991 - SHARE 77.5 Pittsburgh PA.
- March 1992 - SHARE 78.0 in Anaheim, CA.

Feel free to re-use this presentation. Please let me (Bill Bitner) know of any major group or area (inside or outside of IBM) that you present it to and any comments that resulted. I plan on getting a lot of mileage out of this, and will spend time making improvements. I enjoyed pulling this pitch together. I hope it's of value to you.

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Introduction

- In order to do performance management and analysis, it is becoming more and more important to understand what is going on inside the virtual machines.
- Use of CP Monitor APPLDATA can help.
- Agenda
  - Why do we need APPLDATA?
  - What is APPLDATA?
  - How does it work?
  - How is it currently being used?
  - Next Steps
- Presentation will center around APPLDATA in VM/ESA 1.0 ESA Feature.

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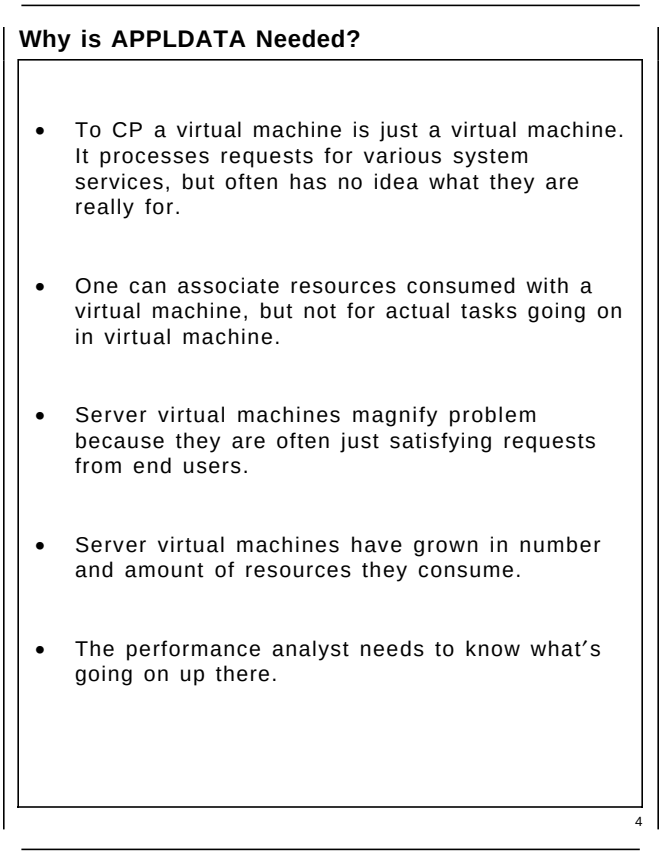
VM Development has been saying APPLDATA is the cure for a lot of performance headaches. With the size and complexity of performance analysis growing, these headaches are becoming very painful. APPLDATA is a relatively simple concept and that's part of what this presentation is meant to show. At the same time, it isn't perfect and we'll cover that as well. I'll put my money where my mouth is and go thru a real example of using APPLDATA.

A little bit of APPLDATA in other releases will be covered. Unless otherwise noted, the material is based on VM/ESA 1.0 ESA feature as well as VM/ESA 1.1 which is now generally available. It wasn't at the time this pitch was first put together.



Growing up, I shared a room with an older brother. It was on the second floor. There were a number of times we would disagree and next thing you know we were fighting. Dad would yell up from the first floor, "what are you boys doing up there?". It was a good thing he didn't know.

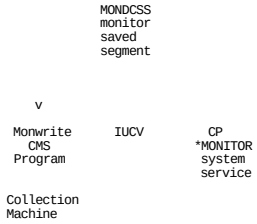
To CP, the happenings of a virtual machine are the same way. CP can see there is a lot of activity (I/Os, paging, privops, etc.), but has no way to associate them with "what's going on up there". If the performance analyst is to understand the system performance, they need to be able to see it all.

As the use of server machines grows, this becomes more and more important.

VM Monitor Review

VM/ESA (ESA Feature)

Domain	Name	Event	Sample	HiFreq
0	System		Sample	Hi Freq
1	Monitor	Event	Sample	
2	Scheduler	Event		
3	Storage	Event	Sample	
4	User	Event	Sample	Hi Freq
5	Processor	Event	Sample	
6	I/O	Event	Sample	Hi Freq
7	Seek	Event		
10	Appldata	Event	Sample	



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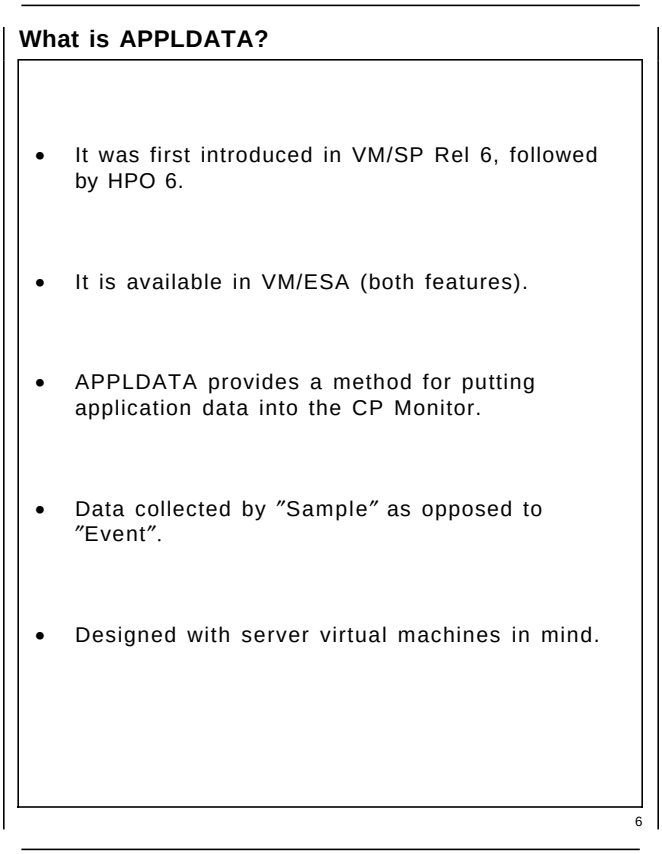
This is a brief overview of what the VM Monitor is and how it works. The table shows the various Domains and the type of data found in them. Event means we cut records when certain events occur. Sample means we gather the data at fixed intervals. HiFreq means some form of state sampling is used.

The figure illustrates how an application (in this case the IBM supplied MONWRITE) connects to the CP System Service *MONITOR with IUCV. *MONITOR and MONWRITE handshake in order to know when and what data is placed in the special DCSS for monitor data.

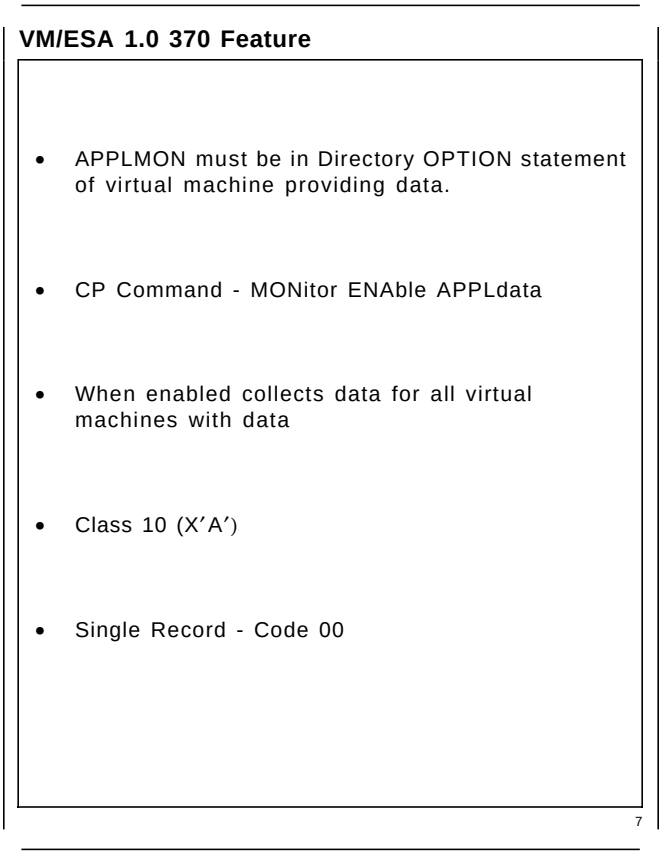


APPLDATA was introduced in VM/SP 6 for support of SFS and is also used in HPO 6. With VM/ESA, it is available in both features. There are some differences which will be pointed out.

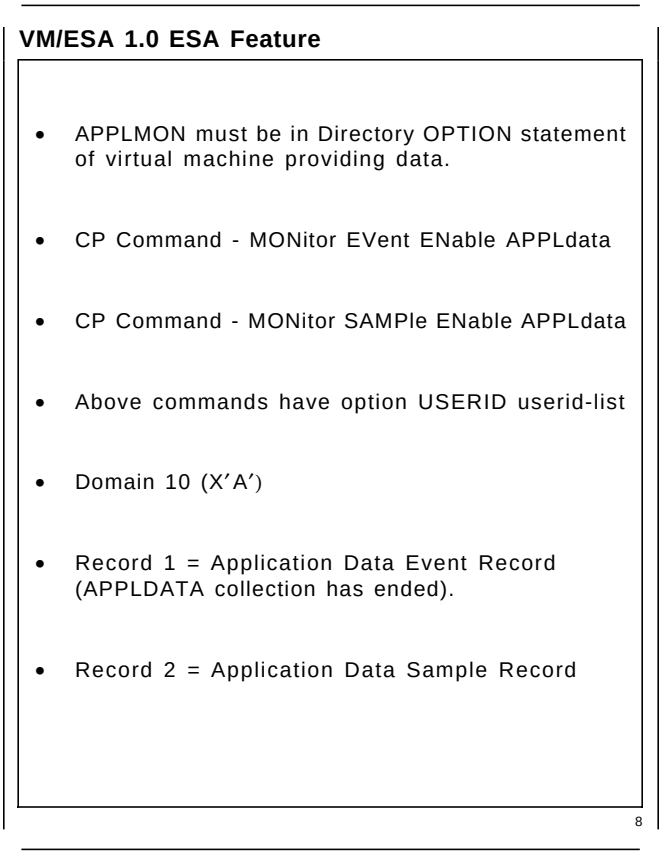
The main purpose is to allow an application to add data to the CP Monitor. In a common place, it is easier to analyze and combine with other performance data. Nothing is worse than having so many sources of performance data you don′t have room on the desk to take notes.

The current implementation is based on sampling data (SAMPLE), not tracing (EVENT). Sampling keeps the amount of data to a manageable size and provides the necessary info for the majority of cases.

As mentioned, it was introduced with SFS (Shared File System) and therefore designed with the server virtual machine in mind. Since the growth and importance of server virtual machines in VM has grown, this is golden opportunity to manage them.



This foil gives the basics of APPLDATA in 370 feature (also SP and HPO 6). To be allowed to produce APPLDATA, a virtual machine must have the APPLMON operand in the directory OPTION statement. The CP Monitor command was extended to include the new class of APPLDATA. In this class there is a single record.

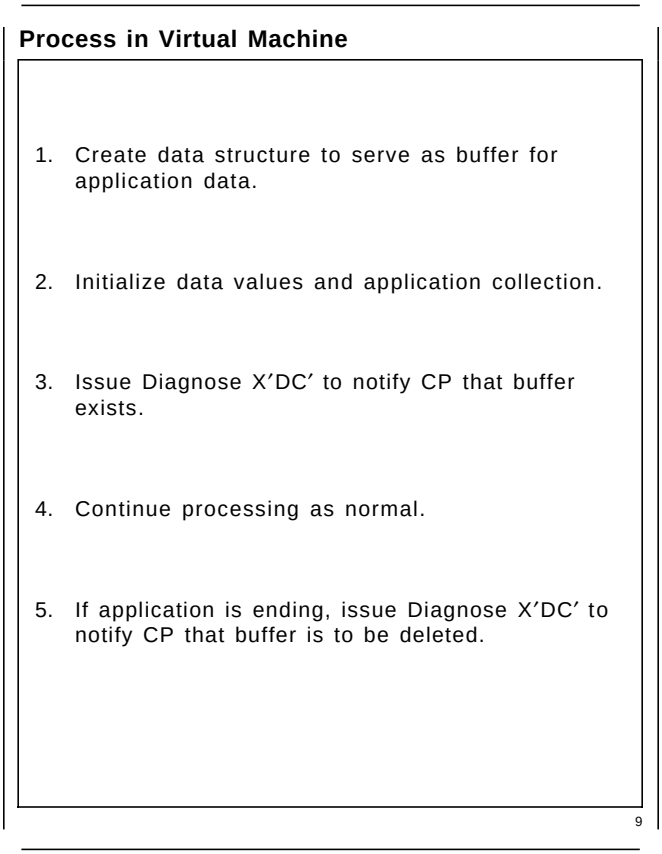


In the ESA feature, again APPLMON must appear in the OPTION statement. Both the Monitor Event and Sample commands were extended to include the new domain (ESA monitor uses domains, not classes). There are two records in this domain.

Wait a second, I said APPLDATA was for Sampling only, what's this Event thingy?? That is merely a record to signal that APPLDATA collection has ended. This is important during reduction, since knowing whether there was a problem with data collection is valuable.

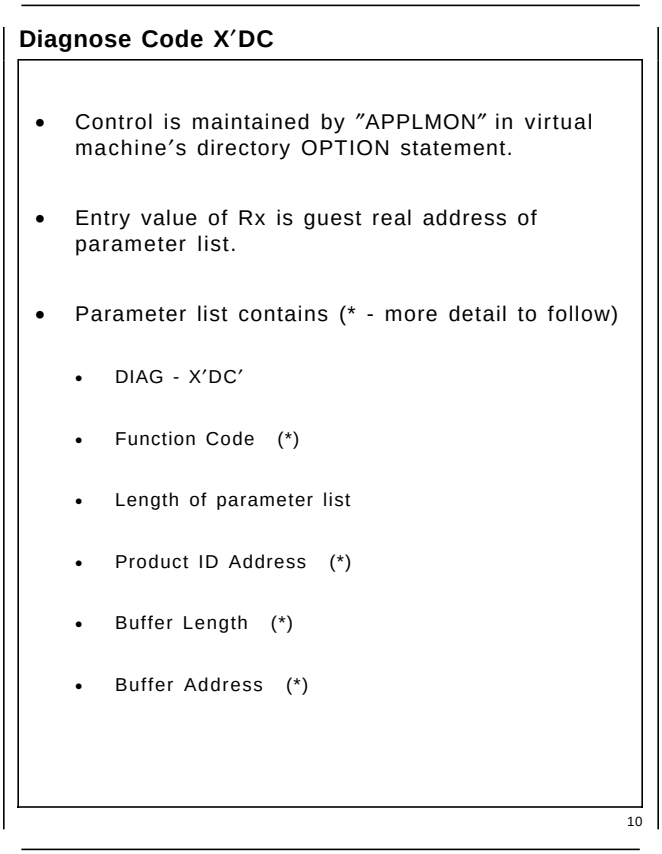
Two differences from 370 feature to note:

- The event data for collection ending.
- The ability to select individual userids of APPLDATA in ESA and not in 370. In 370, it is an all or nothing scenario. This isn't bad since the number of APPLDATA applications in those environments is low. However, that selection can be important in large systems to control amount of data collected.

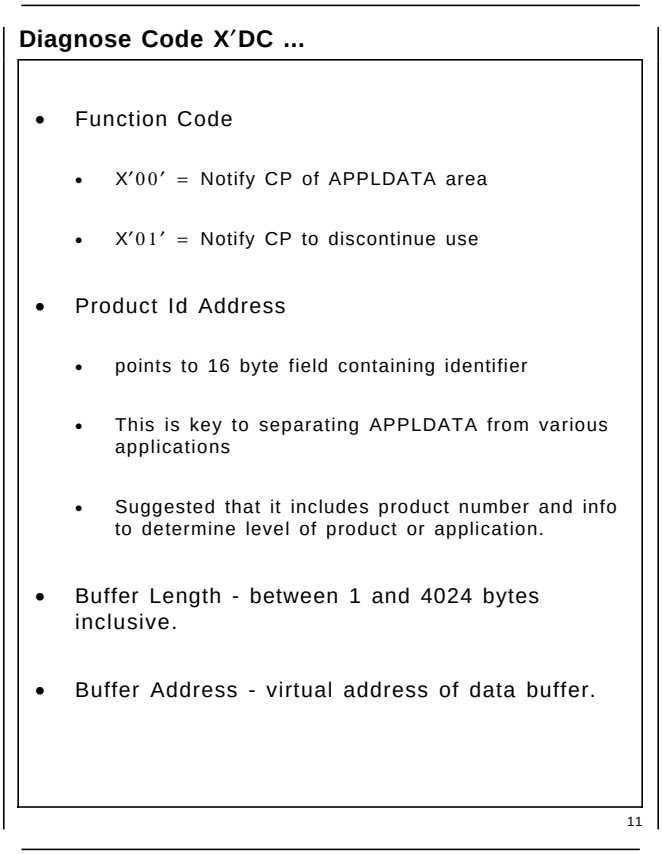


We′ll look at first at the process in a virtual machine (application) and then at the process in the system as a whole. There are basically five steps:

1. you need to have some storage structure for the ″performance data″ you are interested in. This can be hardcoded or something created dynamically.
2. You′ll want to initialize the structure (counters, timers, whatever) and the collection process.
3. A Diagnose x′DC′ is used to signal CP that you are interested in having APPLDATA collected. This will be covered in much more detail later.
4. Processing continues as normal with the ″performance data″ being updated by the application as appropriate.
5. The Diagnose x′DC′ can be reissued when application terminates. This signals CP that you are no longer interested in data collection.



The APPLMON entry in directory OPTION statement is what allows you to issue Diagnose x′DC′. Diag DC is structured like most diagnoses, with the Rx register pointing to parameter list with above items.

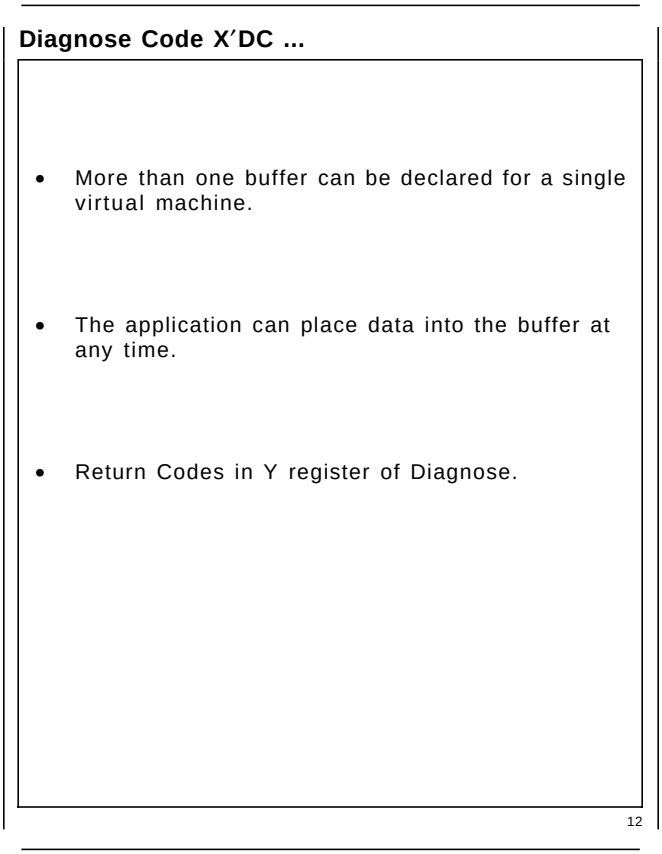


The function code is the flag for CP of whether you (the application) are interested in data collection. The wording in some manuals is a little confusing. It says Start is ″Start Interval Recording″, this doesn′t mean CP will at that very moment cut a sample record. It only means CP will include this APPLDATA at the next sample interval. More on this later.

The Product Id is the method we′re going to use to tell all this data apart. We could have 100s of virtual machines providing APPLDATA with different meanings.

The buffer length is such that it will fit in 4K frame with monitor record header.

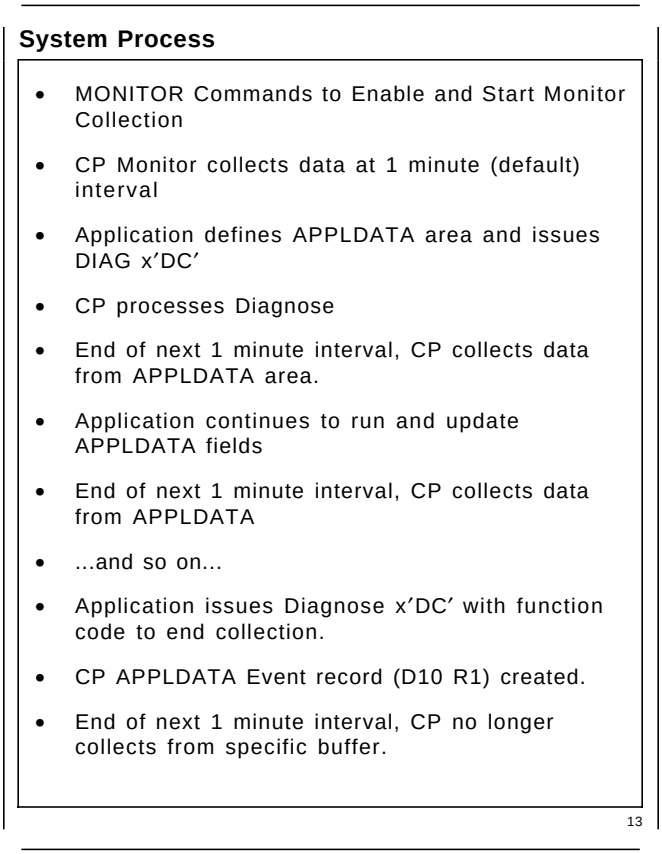
The storage is just your application′s virtual storage.



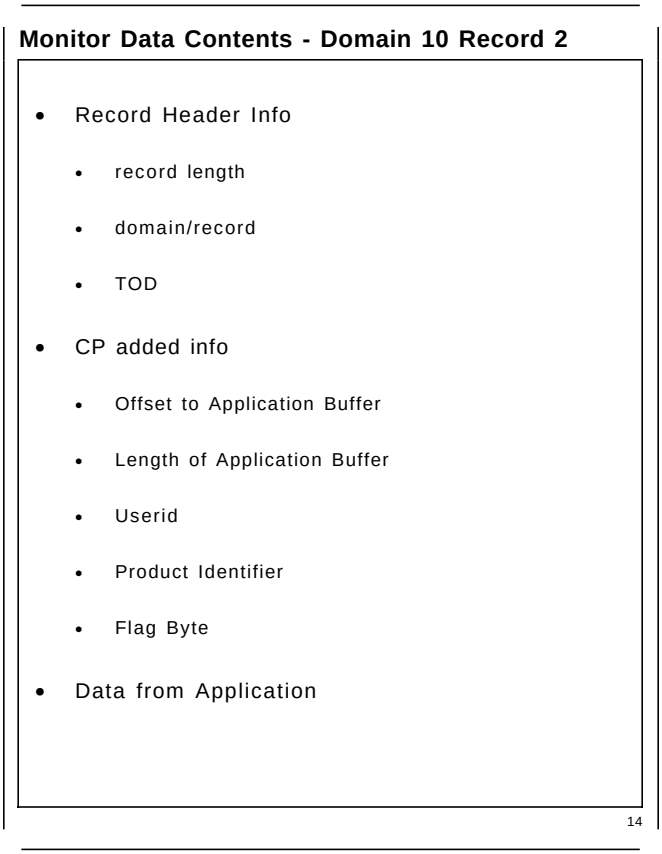
You may need more than one buffer and this is allowed. However, you'll need to do a Diagnose DC for each. There is no need to be concerned with CP blocking you from updating the buffers.

Ry of Diag DC is return code. Possibilities include (not all):

- 0 = okie dokie
- 2 = invalid function code
- 5 = not authorized to use Diag DC
- 6 = buffer length not in allowable range.



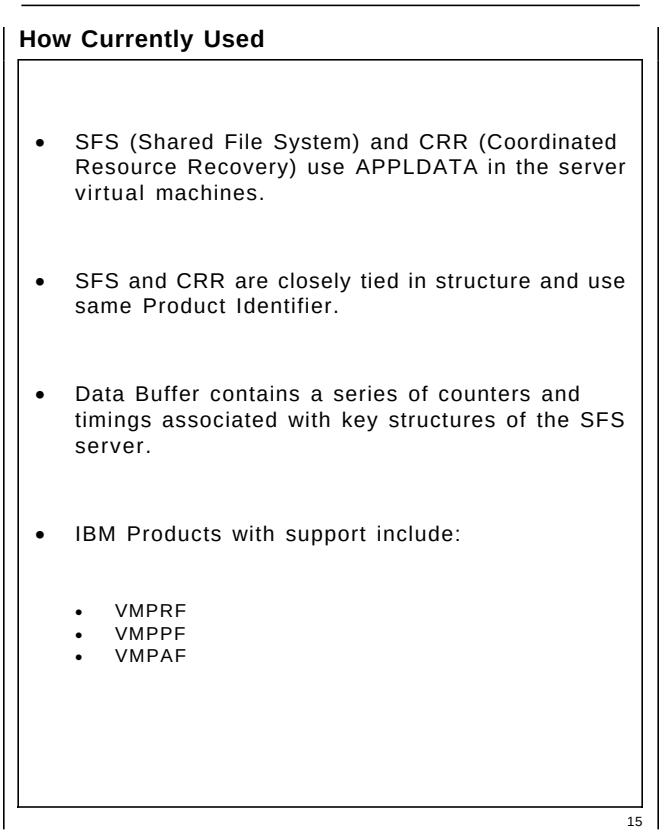
Now that we know what the application must do, we′ll fit it into the system as a whole. Monitor domains and intervals would be set up as normal. Also Monwrite or other *MONITOR application could be running. Monitor would be collecting sample data at a preset interval. After the application issues Diag DC to start, CP will take a snapshot of the APPLDATA buffer at the next sample interval. This continues until the Application issues Diag DC to stop or the monitor itself is stopped. If the Application stops and APPLDATA Event is enabled, CP will cut a record to indicate APPLDATA collection for that buffer has terminated.



There are three parts to Sample Record for APPLDATA. The first is just the normal record header info. Note the TOD, we'll use that later.

CP also adds some info that is useful. The offset should be used to get to the data, since over time CP may change size of the CP added data. The userid is userid that issued Diag DC. The prod id is what was passed with the diag. The flag byte contains things like "this is the very first sample interval for this buffer".

Finally, there is a copy or snapshot of the user supplied data.



As great as APPLDATA is; it hasn't caught on very fast. Hopefully, this pitch will help turn that around. Two components of VM currently use APPLDATA (SFS and CRR). They use APPLDATA to hold a series of counters and timings. There are a number of IBM PPs that support this data. VMPRF uses a subset of data to produce SFS specific reports, and includes all values in the SUMMARY/TREND files. With these files, VMPAF can surface any of the variables and also includes a large number of pre-defined equations based on them.

Example VMPRF SFS APPLDATA Support

```
PRF083  Run 02/14/1992 08:49:13          SFS_BY_TIME
                                         SFS Activity by time
From 09/26/1991 21:49:02
To   09/26/1991 22:31:02
For   2520 Secs 00:42:00                 Example SFS APPLDATA
_____________________________________________________________________________

                                    <     Time Per File Pool Request    >

From  To              FPR    FPR                    Block
Time  Time  Userid  Count   Rate  Total    CPU  Lock   I/O   ESM Other

21:49 22:31 CRR       893  0.354  0.000  0.002     0 0.000     0 0.001
21:49 22:31 SFS1    91865 36.453  1.629  0.003 0.355 0.583     0 0.689
21:49 22:31 SFS2    86963 34.507  1.750  0.003 0.388 0.646     0 0.713


_____________________________________________________________________________

                  <       Server Utilization       > <   Agents  >

                                                                      Dead
From  To                          Page Check                          locks
Time  Time  Userid  Total   CPU   Read  point   QSAM Active   Held  w/ RB

21:49 22:31 CRR       1.4   0.1    1.3      0      0    0.0    0.0    0
21:49 22:31 SFS1     51.0  10.8   32.3    7.9      0   59.4  271.4    0
21:49 22:31 SFS2     51.0  10.5   32.8    7.8      0   60.4  267.3    0
```

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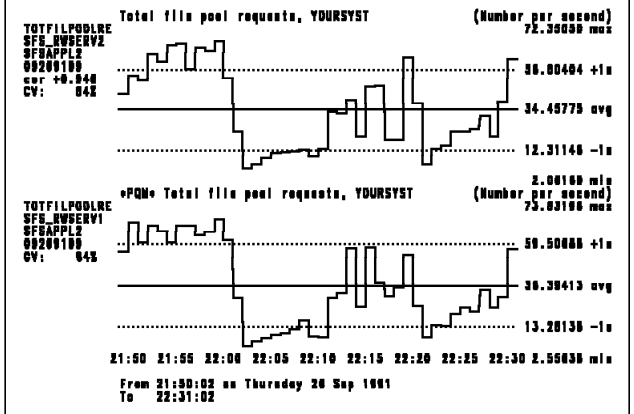
This is an example VMPRF report. It has been editted to fit onto a single page. There are two other VMPRF reports for SFS, but I chose this one since it does something unique. It combines APPLDATA from SFS with other monitor data for the server machines.

In this report, three server machines are shown. The first, CRR, is the CRR Recovery Server. The next two are SFS File Pool servers. The ″Time per File Pool Request″ area shows CPU time normalized to filepool requests. CPU time comes from normal monitor records for virtual machines and the file pool request rate comes from APPLDATA.

Example VMPAF SFS APPLDATA Support



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This is an example of VMPAF support for SFS APPLDATA. In addition to all the counters and timings put in APPLDATA that VMPAF exposes, there are several pre-defined equations that make analysis easier. This example shows the file pool request rates for each of the two file pool servers. VMPAF could be used to compare any of the APPLDATA statistics with any other monitor (or other source) available.

What to include in APPLDATA?

- Two things -
  - Running Count of requests
  - Timing of requests (stop watch)
- Third item = time stamp when Sample is taken which is included in Monitor data.
- Deltas of three items from sample to sample give:
  - Count - delta of count of requests
  - Usage - delta of timings
  - Interval - delta of time stamps
- From these we can calculate:
  - Rate = count / interval
  - Response Time = usage / count
  - Utilization = usage / interval

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This foil was interesting to put together. It tries to answer the question of ″what is good performance data?″. Anyone knowing the VM monitor knows we don′t always answer that question correctly.

For the majority of the cases, it is three simple things. Two we′ll ask the application to provide; and the third is provided by CP. We need to know how many requests are made (simple clicker as people go thru turnstile) and how long it takes (start stopwatch on way in and stop on way out). Take those two and include TOD from CP.

We′ll periodically sample the current values for those three items. Taking the deltas of each from two adjacent samples gives us the Count (how many people), Usage (how much time for handling them), and Interval (how long between samples). Then simple division gives us important data: Rate (how many people per minute), Response Time (how long to handle each request), and Utilization (how busy are we).

What to include in APPLDATA? ...

- If the requests can be served by multiple servers, include count of servers or individual counters for each server.
- Every option should be included somewhere. Example -
  - There are five types of requests.
  - Do not just include counters for 3 of them.
  - Unless you include a ″TOTAL″ or ″OTHER″ category.
- If there are other methods of getting ″performance″ data, be sure to use the same values and meanings for all methods.
- Be careful of wrapping values.
- May be worthwhile to create set of macros for ″counting″ and ″timing″.

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A few more things to consider in data collection. Things do get more complicated with multiple servers, but can be managed if you think about it. Please don′t leave things out that you think are unimportant. The one time they become important may be when you′re system is running on its knees. (VM has some spots like this).

Be consistent. If you have a QUERY PEOPLE command, make sure the data returned has the same meaning and value as the PEOPLE variable in monitor.

You can only count so high with 2 bytes. Anticipate ranges needed to avoid unnecessary wrapping. A single wrap per interval is nasty, but containable. Multiple wraps per interval leaves useless data.

Since counting and timing is most of what you need, macros might make life easier.

What to include in APPLDATA? ...

- Any constants in APPLDATA should be initialized prior to issuing Diagnose x′DC′.
- Update performance fields in APPLDATA area. Do not manage else where and move. This helps keep data current when it goes into monitor.
- Various timing mechanisms exist -
  - STCK instruction
  - DIAG x′0C′ - Pseudo Timer

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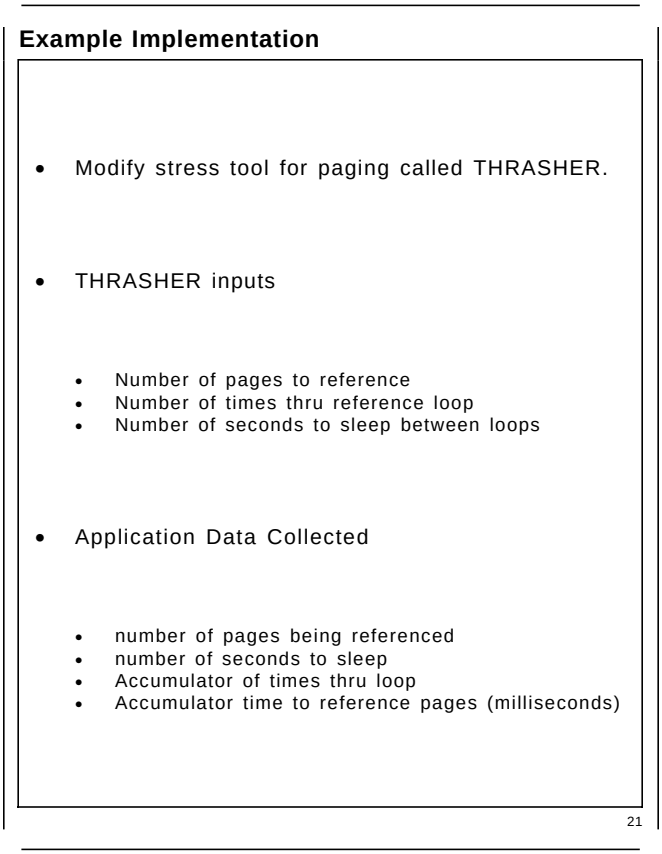
Some APPLDATA specific thoughts. Constants should be set in APPLDATA buffer before Diag DC since CP could sneak in between Diag and initialization. Update the values right in the buffer. If you keep them else where and move them, there can be anomalies caused by timing between CP sampling and your moving of the data.

Two ways to get at time are STCK and DIAG C. The Store Clock instruction is nonprivileged and gets TOD. DIAG C (Psuedo Timer) gets some different data, but is much more expensive. The data from DIAG C may be obtainable from other CP Monitor records.



Talk is cheap, so lets try a real example. We (performance evaluation) have a program to help stress the paging system. I've modified it to use APPLDATA. It will collect 4 items. The first two are just initialization or config data. The second two are the two items we talked about earlier: Accumulator of times thru loop (Running count of requests) and Accumulator of time to reference pages (timing of requests). Later we'll throw in TOD to get the other things I talked about.

Example Implementation ...

Create data structure to serve as buffer for application data.

```
*    Definitions for Diagnose x¢DC¢ and the APPLDATA buffer
DCPARML  DS    0F
DIAGDC   DC    X¢00DC¢
FUNCCODE DC    X¢00¢
LENPARML DC    X¢10¢
PRODIDAD DC    A(PRODID)
         DS    CL2
BUFLEN   DC    H¢20¢
BUFADDR  DC    A(APPLBUF)
         DS    0F
STRTINT  EQU   X¢00¢              Func code to indicate APPLDATA use
STOPINT  EQU   X¢01¢              Func code to indicate stopping
PRODID   DC    C¢PPPPPPPPFFNVVRRMM¢  Product Identifier
APPLBUF  DS    0D                 Start of actual APPLDATA Buffer
ADSLEEP  DS    CL8                Appldata value for seconds in sleep
ADPAGES  DS    F¢0¢               Appldata pages referenced in loop
ADTIMER  DS    F¢0¢               Appldata total time to process loop
ADLOOPS  DS    F¢0¢               Running count of times thru loop
APPLBLEN EQU   * APPLBUF          Length of Buffer
```

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The entire program is included in the APPLDATA package, and is usually handed out with the presentation.

This shows data structures for Diag DC parm list and the actual APPLDATA buffer the program uses.

Example Implementation ...

Initialize data values and application collection.

```
*
*   Set up APPLDATA area and issue Diagnose x¢DC¢ to tell CP
*   1. We initialize some values in our APPLDATA buffer area
*   2. Set up parmlist for Diagnose
*   3. Issue Diagnose and check for errors
*
        MVC   ADSLEEP,SLEEPVAL      Initialize Sleep Time in APPLDATA
        MVC   ADPAGES,NUMPAGES      Initialize Page counts in APPLDATA
        MVI   FUNCCODE,STRTINT      Set function code to start
        LA    R4,DCPARML            Set Rx to address of parm list
        SLR   R5,R5                 Clear Ry for return code
        DC    X¢83¢,X¢45¢,X¢00DC¢   Issue Diag DC
        LTR   R5,R5                 Check for 0 Return Code
        BNE   DCFAILED              Branch if Diag failed
```

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This sample of code shows the setup and issuing of the Diag DC. First we initialize the constants in the buffer, set the function code to start, and then issue the Diagnose. My example program does do nominal error checking for Diag DC.

Example Implementation ...

Stop watch example.

```
*
* Compute time difference
*
         STCK  TODEND             Store time of day clock
         LM    R8,R9,TODEND       get ending TOD
         SLR   R9,R3              Subtract low words
         BC    11,NOBORROW        Branch if not borrowed
         S     R8,=F¢1¢           Subtract for borrow
NOBORROW DS    0H
         SLR   R8,R2              Subtract high words
         SRDL  R8,12              Shift to get microseconds
         D     R8,=F¢100¢         Divide to get milliseconds into R9
         A     R9,ADTIMER         Add to running timing
         ST    R9,ADTIMER         Store running timer in APPLDATA buff
         L     R9,ADLOOPS         Get running count of passes
         LA    R9,1(R9)           Bump running counter up one
         ST    R9,ADLOOPS         Store in APPLDATA Buffer
```

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Registers 2 and 3 contain the TOD from when we started the request. In this code section, we first get the ending TOD via STCK into Register pair 8 and 9. This code shows how to subtract the two. It then goes on to get the delta into more manageable units (microseconds to start, and then milliseconds). Value is stored into APPLDATA buffer (ADTIMER) along with the loop counter (ADLOOPS).

Example Implementation ...

- Home grown exec used to extract info from Monitor data. (250 lines)
- Home grown exec to report info. (125 lines)
- Home grown execs to input to VMPAF. (150 lines)

Example output -

```
    THRASHER Monitor Report           13 Feb 1992 19:36:37

Sleep value (seconds)   :  3
Pages in reference loop :  3000

                     Loop       Usage          Response     pct.
Time     Interval    Count       (ms)   Rate    Time (ms)   Util.

18:37:05       30       10       5191   0.333     519.1     17.3
18:37:35       30       10       3355   0.333     335.5     11.2
18:38:05       30       10       3377   0.333     337.7     11.3
18:38:35       30       10       1024   0.333     102.4      3.4
18:39:05       30       10       1034   0.333     103.4      3.4
          ...
19:03:35       30        9        448   0.300      49.8      1.5
19:04:05       30       10        635   0.333      63.5      2.1
19:04:35       30       10        723   0.334      72.3      2.4
19:05:05       30       10        474   0.333      47.4      1.6
19:05:36       30       10        503   0.331      50.3      1.7
19:06:06       30       10        704   0.333      70.4      2.3

Total/Average         588    50202   0.332     85.4      2.8
```

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Collecting the data is the first step. To be of value we'll want to reduce the data and report some how. I've put together some execs for my example. First I use an EXEC to pull out all the APPLDATA records from the monitor data. Then a second EXEC is run to produce the report shown on this foil. I hope to add an exec in future to pass data on to VMPAF.

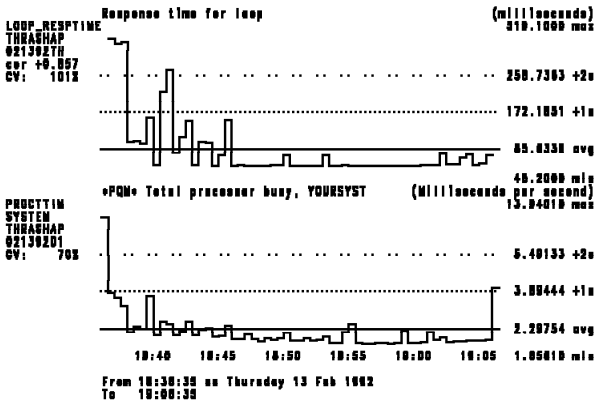
I admit these are quick and dirty to some extent. I don't do a lot of error checking and I currently don't take advantage of other related monitor data for reports. However, as an example, these EXECs show that reduction is capable with a little effort. In addition, for PPs that are common, I believe the owners of reduction packages will take care of the reporting. Just tell them what is there.

My execs are available upon request.

The Report example shows the time stamp, the three deltas for the interval, and the three simple calculations. In addition, the configuration information is included up top.

Example Implementation ...

VMPAF example results



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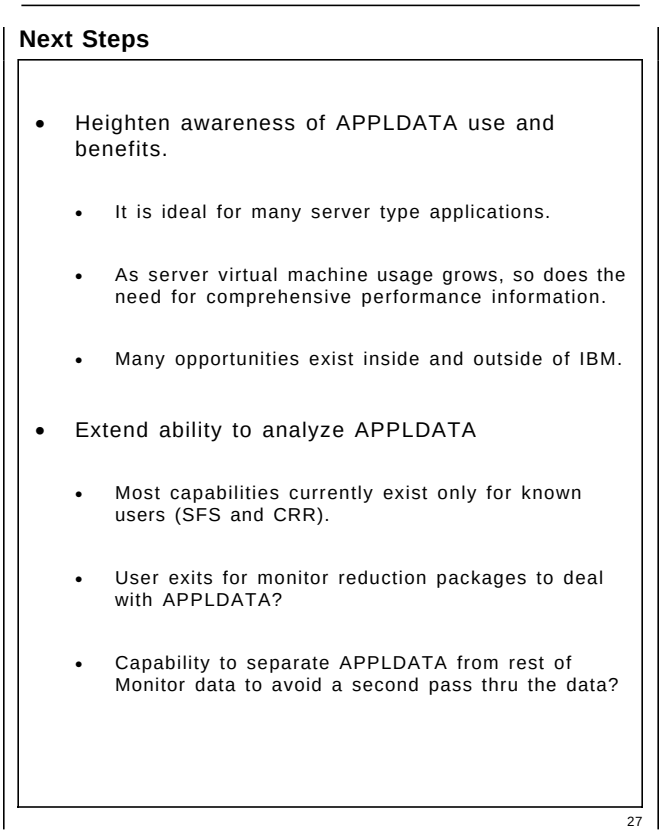
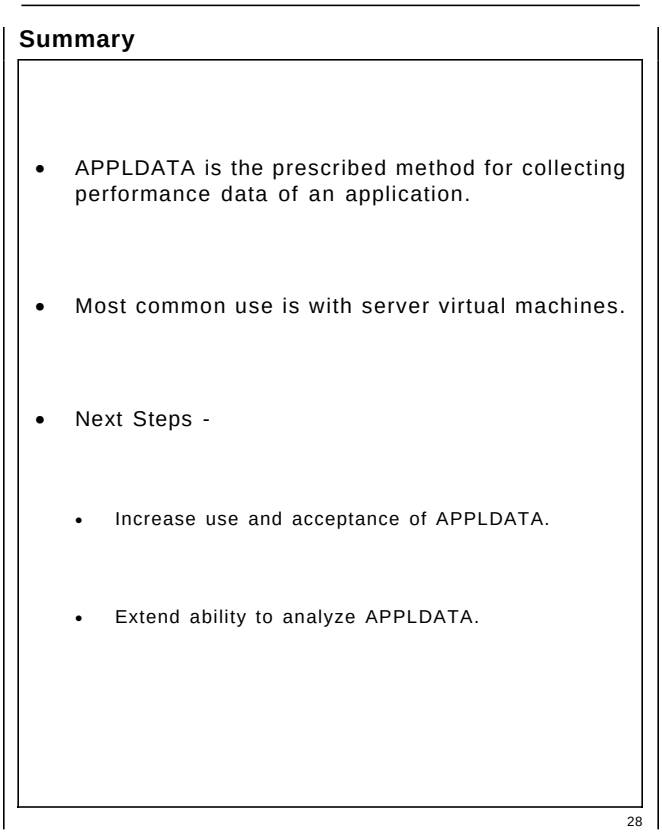
For those of you who don't like looking at rows or numbers (and I don't know too many who do), VMPAF can be used to show graphics of the data and do correlation. The example here shows two graphs. The top is Response time for a loop (time it took to reference all 3000 pages in the reference loop). This comes from the APPLDATA info the program provided. The bottom graph is Total processor busy time. This comes from the VMPRF summary file. When THRASHER first starts up, it takes a little more to get started. Therefore both Response time for Loop and Processor busy time are higher at the start. Some of the other spikes are caused by background jobs that were running.



The VM community has work to do in order to realize the full potential of APPLDATA. This includes getting more products to use it and the reduction packages to report what is collected. In addition, for APPLDATA to be worthwhile for installation specific use, the reduction packages need to be extended.



I didn't spend a lot of time showing how APPLDATA can be useful. I would hope anyone that has tried to do performance analysis on a system with complex applications and/or servers realizes this. Performance analysis has become more complex. In order to avoid it becoming impossible, we need to address performance management across the board.

I plan to continue working to increase the awareness of APPLDATA and its use. If anyone knows of a product that should use it, let me know. If anyone has a product where they think it might help, let me know. I'm willing to work with them to make it a reality.

Acronyms

APPLDATA Application Data

CMS Conversational Monitor System

CP Control Program

ESA Enterprise Systems Architecture

HPO High Performance Option

SFS Shared File System

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Bibliography

1. ″CP Planning and Administration for 370″ VM/ESA 1.0, SC24-5430

2. ″CP System Command Reference for 370″ VM/ESA 1.0 SC24-5434

3. ″CP Command and Utility Reference″ VM/ESA 1.0 SC24-5519

4. ″CP Programming Services″ VM/ESA 1.0 SC24-5520

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APAFOIL Processing Options

APAFOIL **August 31, 1990** **Release 3.0**

Runtime values:

DEVICE 3820A
BIND (Odd, Even) 1.00i, 1.00i
TWOPASS ..... YES
INDEX ..... NO

Foil Set: 1

Input File (Current) ..... APPLDATA

Layout of Heading (FOILHD Tag or Default)
FOILHD ..... NULL NULL NULL
FRAME ..... NONE
FOILHD1 ..... HEAD NULL NULL

Layout of Body (LAYOUT Tag or Default)
FRAME ..... BOX
FRAMEWT ..... LIGHT
RULE ..... SOLID
BORDER ..... NONE
RUBRICWT ..... LIGHT

Layout of Footing (FOILFT Tag or Default)
FOILFT ..... NULL NULL NUMBER
FRAME ..... NONE

Statistics:
Title Page 1
Contents 0
Parts 0
Foils 30
Notes 0
Overflow 0
Total Pages 31

APAFOIL Messages:
Information 0
Warning 0
Error 0

System Variables:
SYSVAR D ..... YES
SYSVAR F MIN4
SYSVAR G ..... NO
SYSVAR H ..... NO
SYSVAR I ..... NO
SYSVAR M ..... &zsvmsv(1).
SYSVAR N ..... INCLUDE

Imbed Trace