IBM Systems & Technology Group

# z/VM Performance Introduction

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# Overview

- Performance definition
- Guidelines
- Native CP commands
- Other performance tools
- I/O performance concepts
- Case study
- Final thoughts

# Definition of Performance

Performance definitions:

- ❑Response time
- ❑Batch elapsed time
- ❑Throughput
- ❑Utilization
- ❑Users supported
- ❑Phone ringing
- ❑Consistency
- ❑All of the above

# Performance Guidelines

- Processor
- Storage
- Paging
- Minidisk cache
- Server machines

# Processor Guidelines

- Dedicated processors - mostly political
  - Absolute Share can be almost as effective
  - A virtual machine should have all dedicated or all shared processors
  - Gets wait state assist and 500ms minor time slice
- Share settings
  - Use absolute if you can judge percent of resources required
  - Use relative if difficult to judge and if lower share as system load increases is acceptable
  - Do not use LIMITHARD settings unnecessarily
- Do not define more virtual processors than are needed.
- If you use absolute LIMITHARD and need accuracy, use SET SRM LIMITHARD CONSUMPTION (requires VM64721)
- Small minor time slice keeps CP reactive.

# Memory Guidelines

- Virtual:Real ratio should be ≤ 3:1 or make sure you have robust paging system.
  - To avoid any performance impact for production workloads, you may need to keep ratio to 1:1
  - See also http://www.vm.ibm.com/perf/tips/memory.html
- Use SET RESERVE instead of LOCK to keep users pages in storage
- Define some processor storage as expanded storage to provide paging hierarchy For more background, see
  - http://www.vm.ibm.com/perf/tips/storconf.html
- Exploit shared memory where appropriate
- Size guests appropriately
  - Avoiding over provisioning
  - Do not put them in a high guest paging position

# Paging Guidelines

- DASD paging allocations less than or equal to 50%.
  - QUERY ALLOC PAGE
- Watch blocks read per paging request (keep >10)
  - Monitor data (Performance Toolkit FCX103)
- Multiple volumes and multiple paths
- Do not mix Page extents with other extents on same volume.
- Paging volumes should all be of the same geometry and performance characteristics.
- Paging to FCP SCSI may offer higher paging bandwidth with higher processor requirements
- In a RAID environment, enable cache to mitigate write penalty.
- See also http://www.vm.ibm.com/perf/tips/prgpage.html

# Minidisk Cache Guidelines

- Configure some real storage for MDC.
- In general, enable MDC for everything.
- Disable MDC for
  - Minidisks mapped to VM data spaces
  - write-mostly or read-once disks (logs, accounting)
  - Backup applications
- In large storage environments, may need to bias against MDC.
- Set maximum MDC limits
- Better performer than vdisks for read I/Os

# Server Machine Guidelines

- Server Virtual Machine (SVM)
  - TCP/IP, RACFVM, etc.
- QUICKDSP ON to avoid eligible list
- Higher SHARE setting
- SET RESERVED to avoid paging
- NOMDCFS in directory option
- Ensure performance data includes these virtual machines

# CP INDICATE Command

- LOAD: shows total system load.
  - (STORAGE value not very meaningful and was removed in z/VM 5.2.0)
- USER EXP: more useful than Indicate User
- QUEUES EXP: great for scheduler problems and quick state sampling
- PAGING: lists users in page wait.
- IO: lists users in I/O wait.
- ACTIVE: displays number of active users over given interval

# CP INDICATE LOAD Example

```
INDICATE LOAD
AVGPROC-088% 03
XSTORE-000000/SEC MIGRATE-0000/SEC
MDC READS-000035/SEC WRITES-000001/SEC HIT RATIO-099%
PAGING-0023/SEC STEAL-000%
Q0-00007(00000)                           DORMANT-00410
Q1-00000(00000)           E1-00000(00000)
Q2-00001(00000) EXPAN-002 E2-00000(00000)
Q3-00013(00000) EXPAN-002 E3-00000(00000)

PROC 0000-087%          PROC 0001-088%
PROC 0002-089%
LIMITED-00000
```

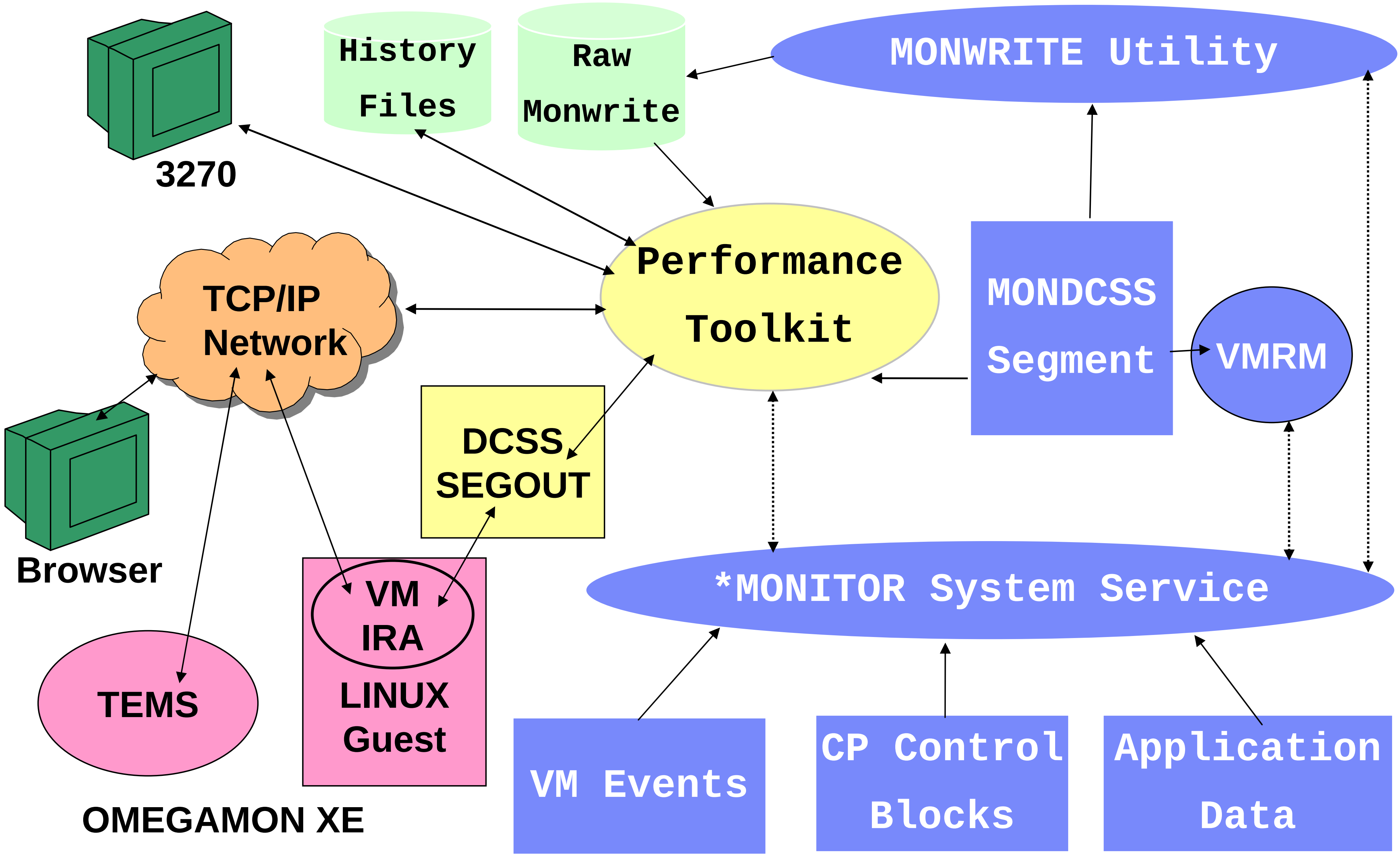
# CP INDICATE QUEUE Example

```
INDICATE QUEUE EXP
EDLLIB14      Q3 IO  00002473/00002654 ..D. -.0217 A00
KAZDAKC       Q3 IO  00003964/00003572 .... -.0190 A02
BITNER        Q1 R00 00001073/00001054 .I.. -.0163 A01
LCRAMER       Q3 IO  00003122/00002850 ....  .0259 A00
DSSERV        L0 R   00007290/00007289 ....  .3229 A00
RSCS          Q0 PS  00001638/00001616 .I..  99999 A00
SICIGANO      Q3 PS  00000662/00000662 .I..  99999 A00
VMLINUX1      Q3 PS  00018063/00018063 ....  99999 A02
LNXREGR       Q3 PS  00073326/00073210 ....  99999 A02
VMLINUX       Q3 PS  00031672/00031672 ....  99999 A01
TCPIP         Q0 PS  00018863/00018397 .I..  99999 A02
EDLLNX2       Q3 PS  00032497/00032497 ....  99999 A01
EDLLNX1       Q3 PS  00015939/00015939 ....  99999 A02
```

# Selected CP QUERY Commands

- Users: number and type of users on system
- SRM: scheduler/dispatcher settings
- SHARE: type and intensity of system share
- FRAMES: real storage allocation
- PATHS: physical paths to device and status
- ALLOC MAP: DASD allocation
- XSTORE: assignment of expanded storage
- MONITOR: current monitor settings
- MDC: MDC usage
- VDISK: virtual disk in storage usage
- SXSPAGES: System Execution Space (5.2.0)

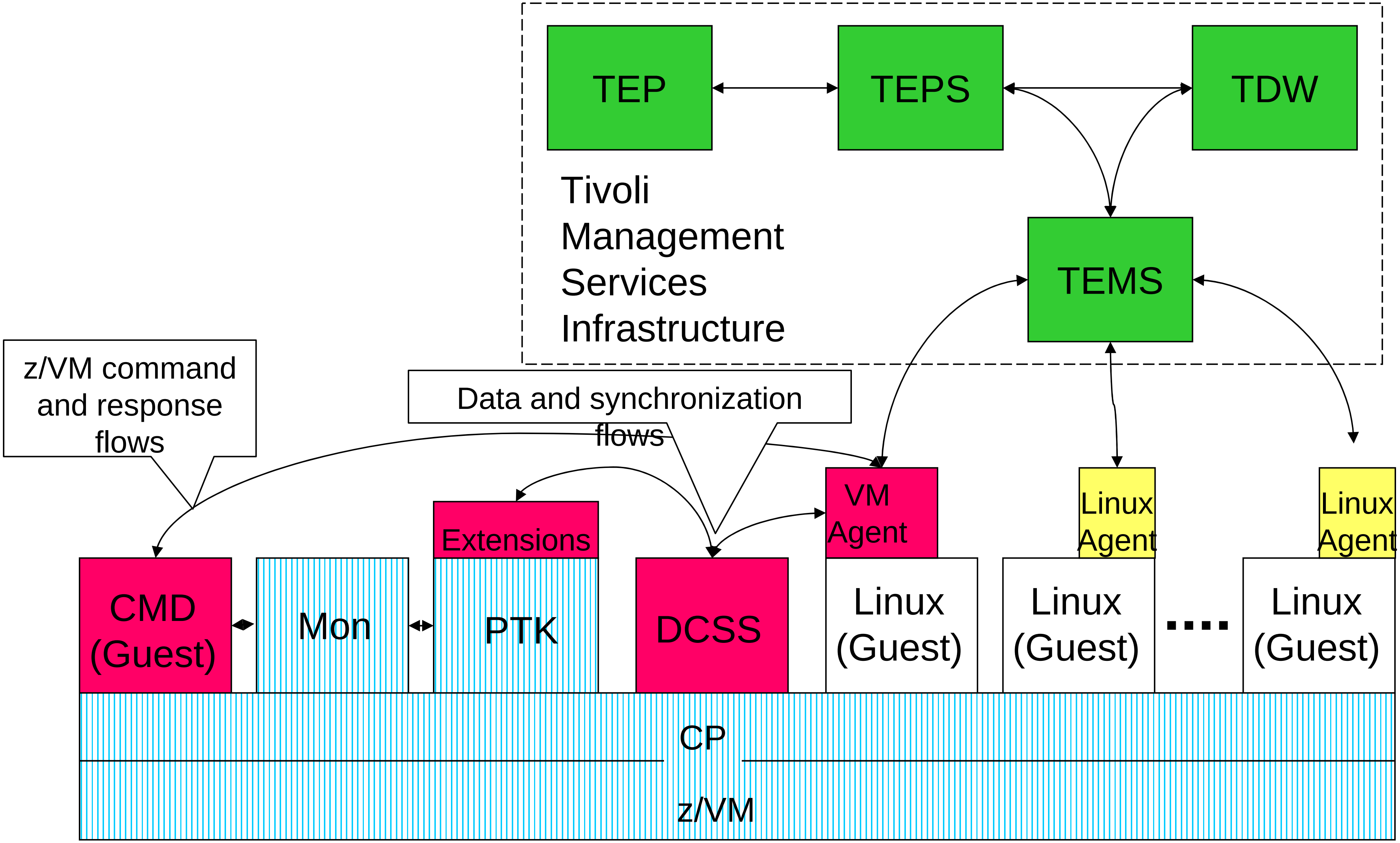
# 5,000 Foot View



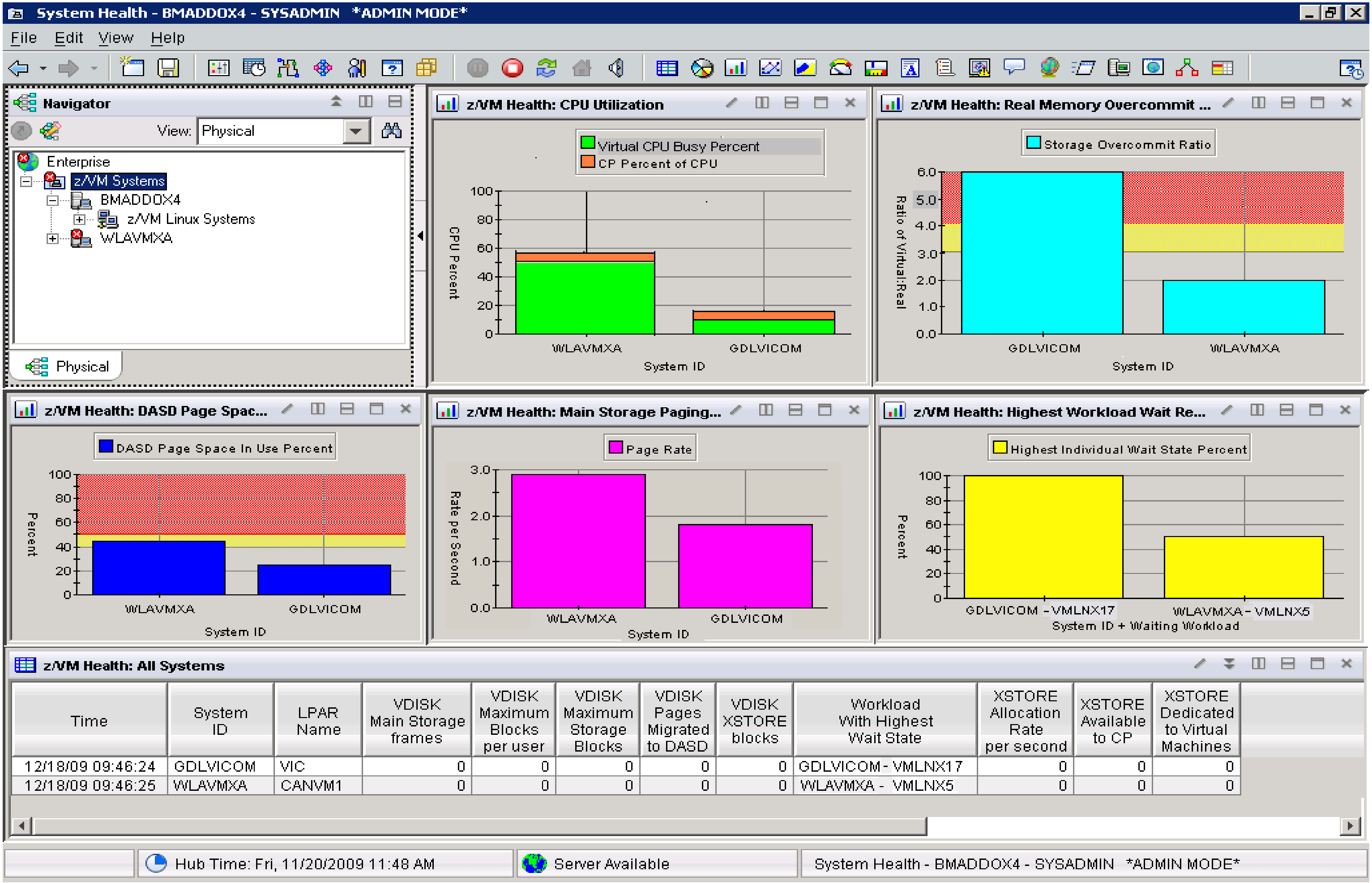
# OMEGAMON XE on z/VM and Linux

- **Provides performance monitoring for z/VM and Linux guests**
- **Linux agents gather detailed performance data from Linux guests**
- **z/VM agent gathers performance data from z/VM and Linux**
  - Including z/VM view of guests
  - Uses IBM Performance Toolkit as its data source
- **Executes automated actions in response to defined events or situations**
- **Part of the Tivoli Management Services infrastructure and OMEGAMON family of products.**
  - Integrates performance management for your entire enterprise
- **Tivoli Data Warehouse (TDW) allows you to analyze trends and look at historical data**

# OMEGAMON XE Basic Architecture



# System Health Workspace



System Health - BMADDOX4 - SYSADMIN *ADMIN MODE*

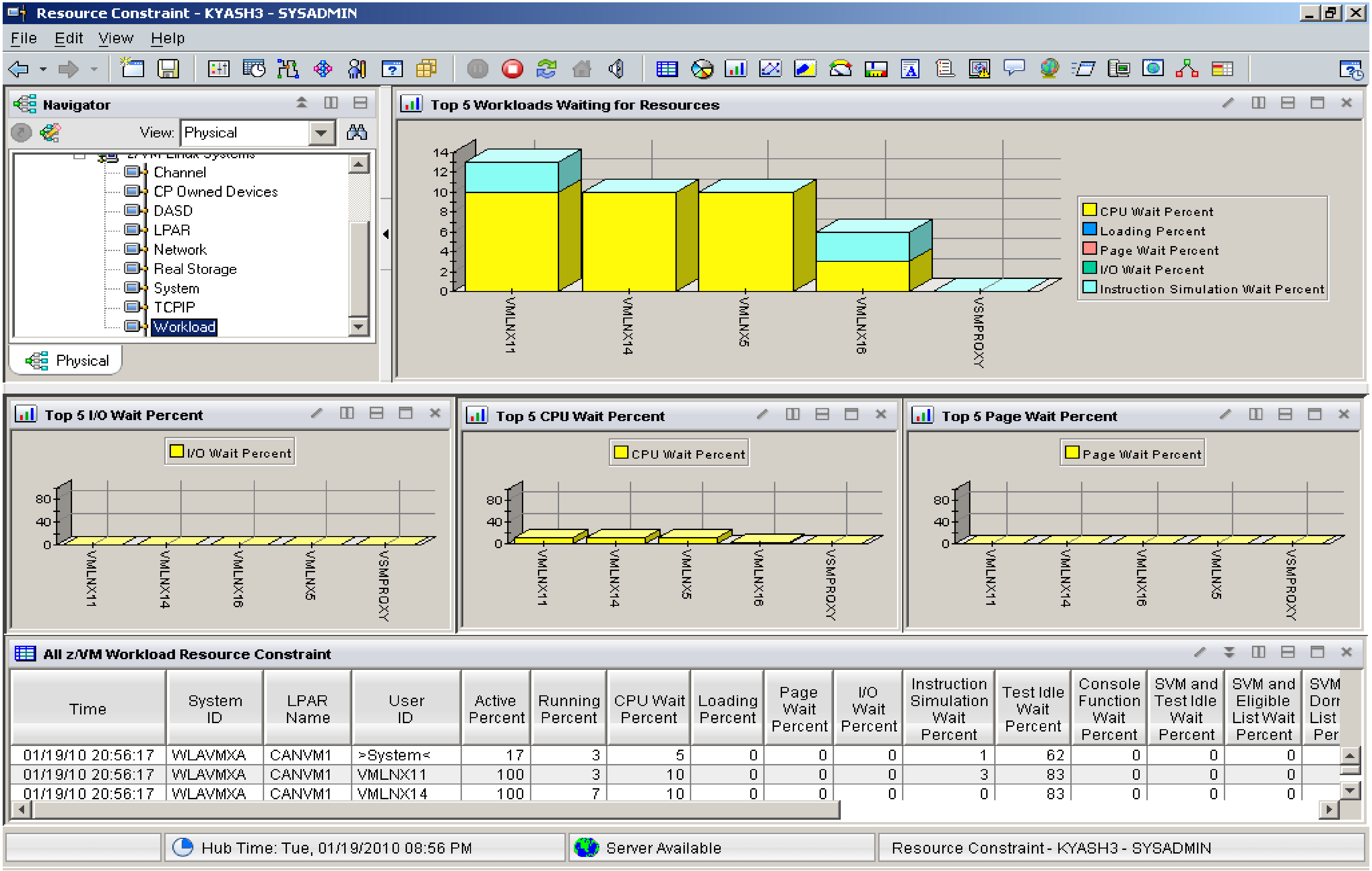
| Time | System ID | LPAR Name | VDISK Main Storage frames | VDISK Maximum Blocks per user | VDISK Maximum Storage Blocks | VDISK Pages Migrated to DASD | VDISK XSTORE blocks | Workload With Highest Wait State | XSTORE Allocation Rate per second | XSTORE Available to CP | XSTORE Dedicated to Virtual Machines |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/18/09 09:46:24 | GDLVICOM | VIC | 0 | 0 | 0 | 0 | 0 | GDLVICOM - VMLNX17 | 0 | 0 | 0 |
| 12/18/09 09:46:25 | WLAVMXA | CANVM1 | 0 | 0 | 0 | 0 | 0 | WLAVMXA - VMLNX5 | 0 | 0 | 0 |

Hub Time: Fri, 11/20/2009 11:48 AM

Server Available

System Health - BMADDOX4 - SYSADMIN *ADMIN MODE*

# V4.1.2 IF 1: Resource Constraint Analysis (Waits)



All z/VM Workload Resource Constraint

| Time | System ID | LPAR Name | User ID | Active Percent | Running Percent | CPU Wait Percent | Loading Percent | Page Wait Percent | I/O Wait Percent | Instruction Simulation Wait Percent | Test Idle Wait Percent | Console Function Wait Percent | SVM and Test Idle Wait Percent | SVM and Eligible List Wait Percent | SVM Dorr List Per |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01/19/10 20:56:17 | WLAVMXA | CANVM1 | >System< | 17 | 3 | 5 | 0 | 0 | 0 | 1 | 62 | 0 | 0 | 0 | |
| 01/19/10 20:56:17 | WLAVMXA | CANVM1 | VMLNX11 | 100 | 3 | 10 | 0 | 0 | 0 | 3 | 83 | 0 | 0 | 0 | |
| 01/19/10 20:56:17 | WLAVMXA | CANVM1 | VMLNX14 | 100 | 7 | 10 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 0 | |

Hub Time: Tue, 01/19/2010 08:56 PM

Server Available

Resource Constraint - KYASH3 - SYSADMIN

# State Sampling

- Find the state of given user or device
  - Consolidation of samples gives useful info
- Low frequency:
  - INDICATE QUEUES
- High frequency:
  - Monitor: user, processor, and I/O domains
  - CP MONITOR SAMPLE RATE
- In Performance Toolkit
  - FCX108 DEVICE
  - FCX114 USTAT

# I/O Response Time

Resp Time = Service Time + Queue Time

Service Time = Pending + Connect + Disconnect

- Queue Time: from hi-frequency sampling of queue in RDEV. Reported in monitor.
- Function Pending: time accumulated when a path to device cannot be obtained.
  - < 1 ms, unless contention at channels or control units.
- Connect: time device logically connected to channel path
  - proportional to amount of data per I/O

# I/O Response Time *(continued)*

- Disconnect: time accumulated when device is logically disconnected from channel while subchannel system is active.
  - Cache miss
  - CU management
- Device Active: time accumulated between return of channel-end and device-end
  - Often reported as part of Disconnect Time

# Definitions

- WSS = working set size
  - ►Comp-Sci Definition: Set of pages a workload needs to run effectively
  - ►VM Definition: Estimated working set size based primarily on resident page count
- Transaction
  - ►Comp-Sci Definition: End user interaction
  - ►VM Definition: transaction ends when scheduler detects end of processing

# Other Sources

- Performance Manual - Part of z/VM Library
  - ►SC24-6208-00 z/VM 6.1.0
- http://www.vm.ibm.com/perf/
  - ►links to documents, tools, reference material
- http://www.vm.ibm.com/perf/tips/
  - ►common problems and solutions
  - ►guidelines
- http://www.vm.ibm.com/devpages/bitner/
  - ►presentations with speaker notes

# A Case Study

# The Grinch That Stole Performance

```
From Performance Toolkit USTAT FCX114 Report January 5:
                                   <-SVM and->
%CPU %LDG %PGW %IOW %SIM %TIW %CFW %TI %EL %DM %IOA
   0    0    0   19    2   10    0   3   0  51    8
```

```
From Performance Toolkit DEVICE FCX108 Report January 5:
     <-Rate/s-> <------- Time (msec) -------> Req. <Pct>
Addr  I/O Avoid Pend Disc Conn Serv Resp CUWt Qued Busy
1742 26.7   .0   1.3 18.4  4.7 24.5 69.0   .0  1.2 65.4
```

Went to check Toolkit CACHEXT FCX177 Report for control unit cache stats, but it didn’t exist!

It is a good thing I keep historical data -- let's go back and see what's going on...

# When Did We Last See Cache?

```
From Performance Toolkit DEVICE FCX108 Report:
     <-Rate/s-> <------- Time (msec) --------> Req. <Pct>
Addr  I/O Avoid Pend Disc Conn Serv Resp CUWt Qued Busy
Dec8 41.0    .0  0.3 0.2   2.0  2.6  2.9   .0  .0 10.5
Jan5 26.7    .0  1.3 18.4  4.7 24.5 69.0   .0 1.2 65.4
```

```
From Performance Toolkit CACHEXT FCX177 Dec. 8th Report:
<--------- Rate/s ----------> <------Percent----------->
Total Total  Read  Read Write     <------ Hits ------>
Cache SCMBK N-Seq   Seq    FW Read Tot RdHt Wrt DFW CFW
53.0   41.0  52.3     0   0.6   99  99   99  96  96  ..
```

# Down for the 3-Count

```
q dasd details 1742
1742 CUTYPE = 3990-EC, DEVTYPE = 3390-06,
VOLSER=USE001
      CACHE DETAILS:  CACHE NVS CFW DFW PINNED CONCOPY
           -SUBSYSTEM   F    Y   Y   -    Y       N
           -DEVICE      Y    -   -   Y    N       N
      DEVICE DETAILS: CCA = 02, DDC = 02
      DUPLEX DETAILS: SIMPLEX
```

Pinned data! Yikes! I had never seen that before!

# Performance Toolkit Device Details

```
FCX110    CPU 2003   GDLVM7    Interval INITIAL. - 13:08:47   Remote Data

Detailed Analysis for Device 1742 ( SYSTEM )
Device type :  3390-2    Function pend.:     .8ms   Device busy    :   27%
VOLSER      :  USE001    Disconnected  :   20.3ms   I/O contention:    0%
Nr. of LINKs:     404    Connected     :    5.4ms   Reserved      :    0%
Last SEEK   :    1726    Service time  :   26.5ms   SENSE SSCH    :  ...
SSCH rate/s :    10.5    Response time :   26.5ms   Recovery SSCH :  ...
Avoided/s   :    ....    CU queue time :     .0ms   Throttle del/s:  ...
Status: SHARABLE

Path(s) to device 1742:    0A     2A     4A
Channel path status   :    ON     ON     ON

Device           Overall CU-Cache Performance           Split
DIR ADDR VOLSER  IO/S %READ %RDHIT %WRHIT ICL/S BYP/S   IO/S %READ %RDHIT
08  1742 USE001    .0     0      0      0    .0    .0   'NORMAL' I/O only
```

# Performance Toolkit Device Details

```
MDISK Extent Userid   Addr  Status LINK MDIO/s
----------------------------------------------
 101 -  200  EDLSFS   0310   WR       1     .0
 201 -  500  EDLSFS   0300   WR       1     .0
 501 -  600  EDLSFS   0420   WR       1     .0
 601 - 1200  EDLSFS   0486   WR       1     .0
1206 - 1210  RAID     0199   owner
             BRIANKT  0199   RR       5     .0
1226 - 1525  DATABASE 0465   owner
             K007641  03A0   RR       3     .0
1526 - 1625  DATABASE 0269   owner
             BASILEMM 0124   RR      25     .0
1626 - 1725  DATABASE 0475   owner
             SUSANF7  0475   RR       1     .0
1726 - 2225  DATABASE 0233   owner  366   10.5
```

# Solution

- Use **Q PINNED** CP command to check for what data is pinned.
- Discussion with Storage Management team.
- Moved data off string until corrected.

Pinned data is very rare, but when it happens it is serious.

# Some Final Thoughts

- Collect data for a base line of good performance.
- Implement change management process.
- Make as few changes as possible at a time.
- Performance is often only as good as the weakest component.
- Relieving one bottleneck will reveal another. As attributes of one resource change, expect at least one other to change as well.
- Latent demand is real.