IBM Systems & Technology Group

z/VM Performance Introduction
Session 9115

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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.
- Small minor time slice keeps CP reactive.

Storage Guidelines

- Virtual:Real ratio should be ≤ 3:1 or make sure you have robust paging system
- 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 to FCP SCSI may offer higher paging bandwidth with higher processor requirements
- In a RAID environment, enable cache to mitigate write penalty.

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%
STORAGE-017% 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
```

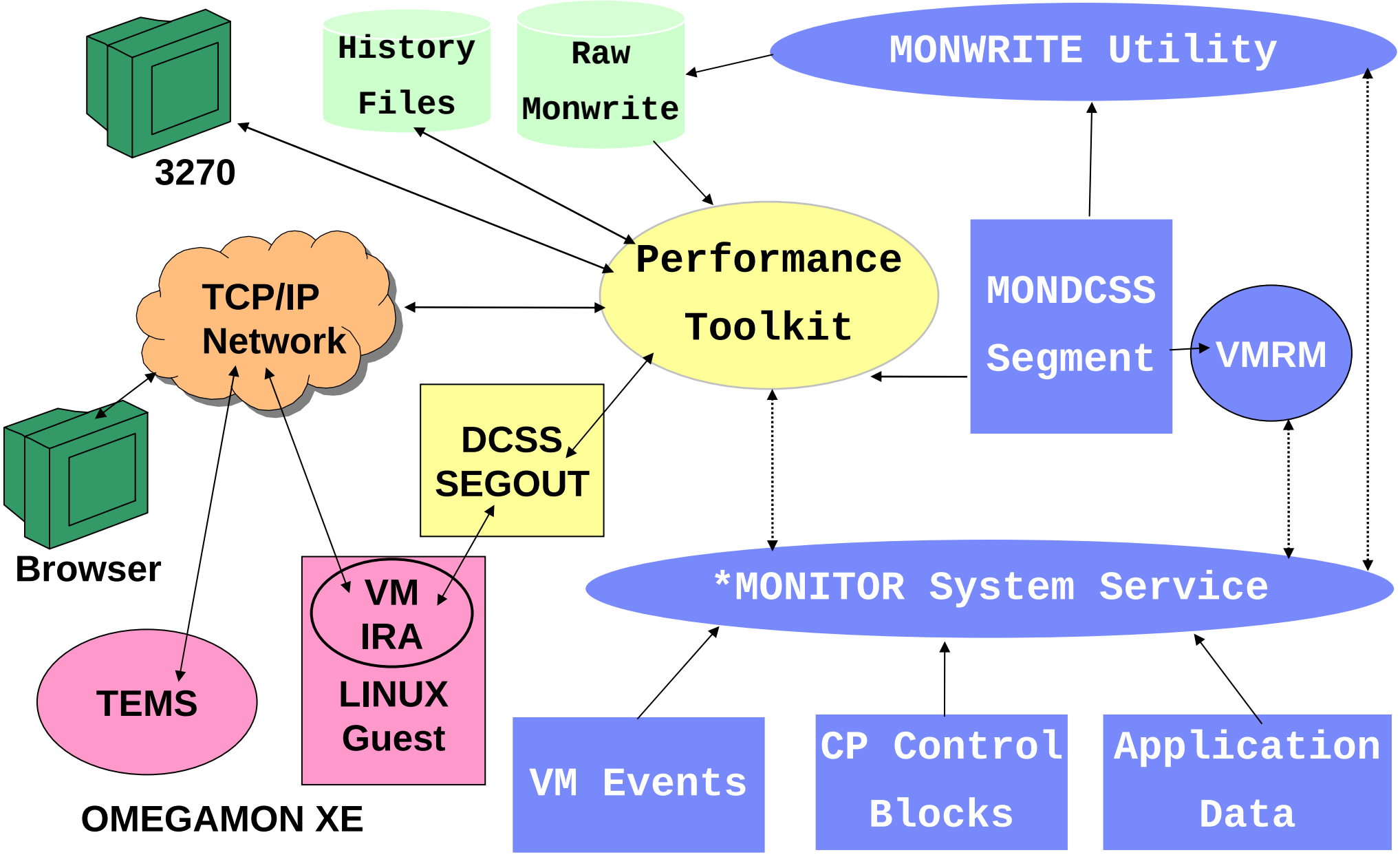
CP INDICATE QUEUE Example

```
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
```

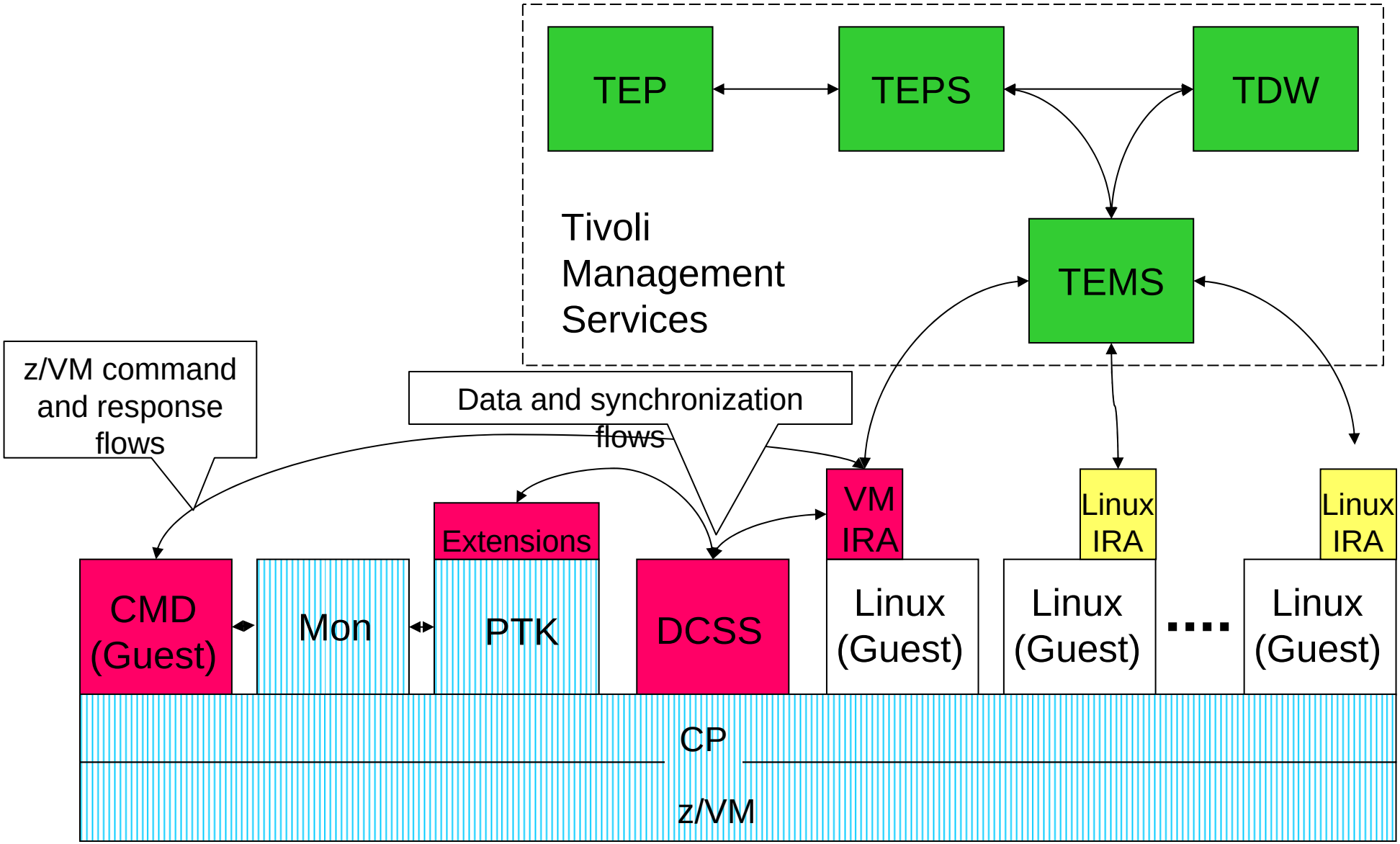
Selected CP QUERY Commands

- 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 Basic Architecture



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
  - SC24-6109-03 z/VM 5.3.0
- 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 Cache	Total SCMBK	Read N-Seq	Read Seq	Write FW	<------ Hits ------> 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.