Introduction to Performing a z/OS DASD I/O Subsystem Performance Health Check

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Abstract and Reports Offer

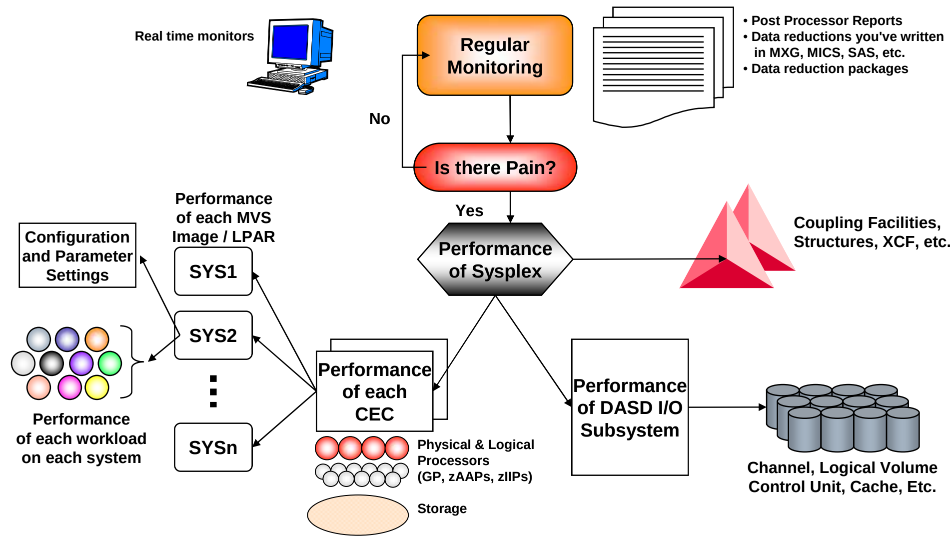
- **Abstract**
  - Yes- I/O does still matters.
  - During this session Peter Enrico will present the approach he uses when performing a DASD I/O subsystem performance analysis. During this session Peter will discuss how to look at DASD I/O performance from at DASDplex level, physical control unit level, LCU level, and logical volume level.
  - Peter will also discuss how to identify the problem logical volumes that are impacting the DASD I/O subsystem the most.

Current 2012 Class Schedule

- WLM Performance and Re-evaluating of Goals
  - Instructor: Peter Enrico
  - June 11 - 15, 2012 Saint Louis, Missouri, USA
  - September 17 – 21, 2012 Stamford, Connecticut, USA
- Essential z/OS Performance Tuning
  - Instructor: Peter Enrico and Tom Beretvas
  - September 10 –14, 2012 Minneapolis, Minnesota, USA
- Parallel Sysplex and z/OS Performance Tuning
  - Instructor: Peter Enrico
  - July 17 - 19, 2012 Online
  - August 21 – 23, 2011 Online
- z/OS Capacity Planning and Performance Analysis
  - Instructor: Ray Wicks
  - No scheduled at this time

Top-Down Approach to Performance Health Check®

- The following is a simplified view of performance management



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Cookbook Approach to Performing a DASD I/O Subsystem Performance Health Check®

- Step 1: Inventory Your Managed Resources
  - DASD I/O Configuration and Hardware
- Step 2: Inventory System Workloads
- Step 3: Collect the necessary measurements
- Step 4: Understand the basic formulas of interest
- Step 5: Analysis at the DASDplex level
- Step 6: Analysis at the Physical Control Unit Level
- Step 7: Analysis at the LCU Level
- Step 8: Analysis at the Logical Volume Level
  - Select interesting Logical Volumes
- Step 9: Identify problem logical volumes
- Step 10: Start attacking the other areas of interest
  - Channels
  - Etc.
- Step 11: Analyze DASD I/O Activity from a Workload point-of-view
- Step 12: Analyze DASD I/O Activity from a file point-of-view
- Step 13: Write a report

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Inventory Your Managed Resources

- It is always important know the current set of resources
  - The resources are the boundaries of the limited capacity available to the workloads
- Examine the configuration from a hardware point-of-view
  - Vendor
  - Physical Control Unit
  - RAID ranks
  - Channels
- From a z/OS system and Sysplex point-of-view
  - Logical Control Units
  - Logical volumes
- From an inter-Sysplex point-of-view
  - Virtualized environment
  - PPRC
  - XRC

Inventory System Workloads

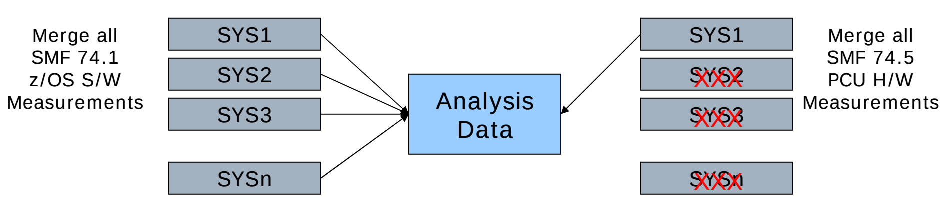
- It is always important understand which workloads are performing the I/O, and what the requirements of those workloads are
  - If we think of the resources as the boundaries of the limited capacity, then it is the workloads that make use of that limited capacity
- Examine the workloads and workload I/O performance
  - Understand I/O performance from the WLM workload point-of-view
  - Understand I/O performance from the dataset point-of-view
- Examine the workload requirements
  - A night time batch stream that must complete by a specified time?
  - A online workload in I/O response time affects end user response time
  - A support workload such as logging, archrivals, data processing, etc?
  - A duplexing strategy for recovery
    - Such as XRC and PPRC

Collect the Necessary Measurements

- Many I/O measurements are available in standard SMF records
  - Understanding all the measurements is beyond the scope of this presentation
  - Some base measurements will be discussed
- For a basic DASD I/O analysis from the I/O subsystem point-of-view the following SMF records are of most interest:
  - SMF 74.1 – Device Activity measurements
  - SMF 74.5 – Cache Control Unit measurements
- Additional peripheral measurements include:
  - SMF 73 – Channel Path Activity
  - SMF 74.7 – FICON Director statistics
    - FCD switch, Port, and Connector data
  - SMF 74.8 - Enterprise disk system statistics
    - Link statistics, Extent pool statistics, Rank statistics
  - SMF 78.3 - I/O queuing activity and HyperPAV activity

Collect the Necessary Measurements

- When processing DASD I/O SMF data it is important to note that source of the data matters:
  - Hardware data
    - Hardware data comes directly from the hardware
    - Is duplicated if the data collector is running on multiple systems, so must eliminate all but one system's view of the measurements (Otherwise double counting)
    - Example: SMF 74.5 – Cache Control Unit measurements
  - Software data
    - Software data is derived from the z/OS system or its workloads
    - Must be collected from each system to gain an accurate measurement summary
    - Example: SMF 74.1 – Device Activity measurements



The Hierarchical structure of DASD world

- DASDPLEX level (all DASD in the Sysplex)
  - Sysplex, but from a DASD point of view. Data from all LPARs summarized
  - Contains multiple PCUs
- Physical Control Units (PCUs)
  - Sold by DASD vendors
  - Contains one or more SSIDs or LCUs (they are interchangeable)
- Logical Control Units (LCUs)
  - A z/OS construct
  - Multiple (up to 256) Logical Volumes (LVs) in an LCU
- Logical Volume (LV)
  - A named entity (volser), used to be a pretend 3390-3 or 3390-9, but can be 3390-27, or 3390-54 or even larger
  - Multiple files in a logical volume (LV)
- File (Dataset)
  - Basic container of data
- There are also nonhierarchical parts of the DASD subsystem to consider such as channels, RAID, links, etc.

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RMF DASD reports and simplification

- Next few slides show sample RMF reports
- Advantages
  - RMF reports provide lots of useful performance information (but not all)
  - Easy to obtain
- Disadvantages
  - RMF reports are incredibly voluminous
    - With 2000 logical volumes there are 40 pages of DASD reports and 40 pages of cache reports for each (15 minute?) interval.
    - There are 96 intervals in a day and 480 intervals in a work week. Thus, we would have close to 40,000 pages for a week. No human being can scan this.
  - Only few items are summarized
- Simplification
  - What is required some software that scans through the data, reduces to it to its main points, summarizes key items in a form understandable and scannable by a human being
  - Such software produced the charts and tables as examples presented in this discussion

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RMF Report Example – Device Activity

D I R E C T   A C C E S S   D E V I C E   A C T I V I T Y

```
        z/OS V1R11              SYSTEM ID SYS1           DATE 05/09/2011           INTERVAL 15.00.
                                RPT VERSION V1R11 RMF    TIME 09.45.00             CYCLE 1.000 SEC

TOTAL SAMPLES =    900   IODF = 32   CR-DATE: 04/10/2011   CR-TIME: 07.22.53     ACT: ACTIVATE
```

STORAGE GROUP	DEV NUM	DEVICE TYPE	NUMBER OF CYL	VOLUME SERIAL	PAV	LCU	DEVICE ACTIVITY RATE	AVG RESP TIME	AVG IOSQ TIME	AVG CMR DLY	AVG DB DLY	AVG PEND TIME	AVG DISC TIME	AVG CONN TIME	% DEV CONN	% DEV UTI
	600C	33909	10017	PRDC03	1.0H	000B	12.783	.546	.000	.058	.000	.189	.202	.155	0.20	0.4
	600D	33909	10017	PRDC01	1.0H	000B	27.474	.440	.000	.055	.000	.185	.061	.193	0.53	0.7
	600E	33909	10017	PRDC02	1.0H	000B	17.504	.436	.000	.056	.000	.188	.097	.151	0.26	0.4
SMSDB2P	6010	33909	10017	DBP179	1.0H	000B	14.164	1.34	.000	.085	.000	.214	.859	.266	0.38	1.5
SMSDB2P	6011	33909	10017	DBP136	1.0H	000B	1.341	4.31	.000	.207	.000	.336	3.55	.425	0.06	0.5
	6012	33909	10017	PRDHSM	1.0H	000B	0.119	1.38	.000	.011	.000	.142	1.06	.178	0.00	0.0
SMSDB2P	6013	33909	10017	DBP109	1.0H	000B	31.665	2.82	.000	.071	.000	.197	2.31	.306	0.97	8.3
SMSDB2P	6014	33909	10017	DBP162	1.0H	000B	10.358	2.33	.000	.113	.000	.238	1.75	.343	0.35	2.1
SMSDB2P	6015	33909	10017	DBP146	1.0H	000B	6.089	3.37	.000	.088	.000	.212	2.70	.457	0.28	1.9
DB2PLRG	6016	33909	10017	DBP321	1.0H	000B	2.044	1.59	.000	.065	.000	.194	1.15	.239	0.05	0.2
DB2PLRG	6017	33909	10017	DBP322	1.0H	000B	2.658	1.30	.000	.070	.000	.198	.850	.250	0.07	0.2
DB2PLRG	6018	33909	10017	DBP323	1.0H	000B	1.759	4.02	.000	.129	.000	.255	3.33	.440	0.08	0.6
SMSDB2P	6019	33909	10017	DBP180	1.0H	000B	8.926	1.65	.000	.087	.000	.208	1.05	.391	0.35	1.2
SGDB2WIX	601B	33909	10017	DBPI0R	1.0H	000B	0.020	.412	.000	.263	.000	.377	.000	.036	0.00	0.0
	601C	33909	10017	PRDH14	1.0H	000B	0.019	.843	.000	.693	.000	.806	.000	.038	0.00	0.0
DB2PLRG	601D	33909	10017	DBP324	1.0H	000B	7.568	2.41	.000	.068	.000	.198	1.94	.272	0.21	1.6

RMF Report Example – Cache Subsystem

```
                              C A C H E   S U B S Y S T E M   A C T I V I T Y
                                                                                                  PAGE
        z/OS V1R11              SYSTEM ID FBPA             DATE 05/09/2011             INTERVAL 14.59.942
                                RPT VERSION V1R11 RMF      TIME 10.00.00
SUBSYSTEM  2107-01     CU-ID  6083     SSID 2000     CDATE  05/09/2011     CTIME 10.00.01      CINT  14.59
TYPE-MODEL 2107-921    MANUF  EMC      PLANT  07     SERIAL 000000004286
--------------------------------------------------------------------------------------------------------------
                                               CACHE SUBSYSTEM STATUS
--------------------------------------------------------------------------------------------------------------
SUBSYSTEM STORAGE          NON-VOLATILE STORAGE        STATUS
CONFIGURED       29642M    CONFIGURED        192.0M    CACHING                    - ACTIVE
AVAILABLE        29642M    PINNED              0.0     NON-VOLATILE STORAGE       - ACTIVE
PINNED             0.0                                 CACHE FAST WRITE           - ACTIVE
OFFLINE            0.0                                 IML DEVICE AVAILABLE       - YES
--------------------------------------------------------------------------------------------------------------
                                               CACHE SUBSYSTEM OVERVIEW
--------------------------------------------------------------------------------------------------------------
TOTAL I/O     2096K    CACHE I/O     2096K    CACHE OFFLINE        0
TOTAL H/R     0.955    CACHE H/R     0.955

CACHE I/O     -------------READ I/O REQUESTS-------------    ----------------------WRITE I/O REQUESTS----------------------
REQUESTS        COUNT      RATE       HITS      RATE     H/R      COUNT      RATE      FAST      RATE      HITS     RATE     H/R      REA
NORMAL          1936K      2154      1845K      2052   0.953      75282      83.7     75282      83.7     75233     83.7   0.999      96.
SEQUENTIAL      39752      44.2      37699      41.9   0.948      44861      49.9     44861      49.9     44861     49.9   1.000      47.
CFW DATA            0       0.0          0       0.0     N/A          0       0.0         0       0.0         0      0.0     N/A      N/

TOTAL           1976K      2198      1882K      2094   0.953     120143     133.6    120143     133.6    120094    133.6   1.000      94.

------------------------CACHE MISSES-----------------------        ------------MISC------------         ------NON-CACHE I/O----
REQUESTS        READ     RATE    WRITE     RATE   TRACKS     RATE                       COUNT    RATE                    COUNT   RAT
                                                                   DFW BYPASS              0     0.0           ICL          0    0.
NORMAL         91281    101.5       49      0.1        0      0.0  CFW BYPASS              0     0.0           BYPASS     622    0.
SEQUENTIAL      2053      2.3        0      0.0    12533     13.9  DFW INHIBIT             0     0.0           TOTAL      622    0.
CFW DATA           0      0.0        0      0.0                    ASYNC (TRKS)        10680    11.9

TOTAL          93383     RATE    103.9

----CKD STATISTICS---     ---RECORD CACHING---                     ----HOST ADAPTER ACTIVITY---      --------DISK ACTIVITY------
                                                                                      BYTES   BYTES                  RESP    BYTES   BYTE
WRITE          123644     READ MISSES        0                                         /REQ    /SEC                  TIME     /REQ   /SE
WRITE HITS     118556     WRITE PROM         0                     READ                9.3K   20.4M       READ      4.127    42.1K   8.9
                                                                   WRITE              10.0K    1.3M       WRITE     4.849    41.0K   2.5
```

RMF Report Example – Cache Subsystem Device

```
                                 C A C H E   S U B S Y S T E M   A C T I V I T Y
                                                                                                        PAGE    2
            z/OS V1R11             SYSTEM ID FBPA            DATE 05/09/2011           INTERVAL 14.59.942
                                   RPT VERSION V1R11 RMF     TIME 10.00.00
SUBSYSTEM  2107-01     CU-ID  6083     SSID 2000     CDATE  05/09/2011     CTIME 10.00.01      CINT  14.59
TYPE-MODEL 2107-921    MANUF  EMC      PLANT  07     SERIAL 000000004286
-------------------------------------------------------------------------------------------------------------------
                                              CACHE SUBSYSTEM DEVICE OVERVIEW
-------------------------------------------------------------------------------------------------------------------
```

VOLUME SERIAL	DEV NUM	XTNT POOL	% I/O	I/O RATE	---CACHE HIT RATE-- READ	DFW	CFW	----------DASD I/O RATE---------- STAGE	DFWBP	ICL	BYP	OTHER	ASYNC RATE	TOTAL H/R	READ H/R	WRITE H/R	% READ
*ALL			100.0	2332	2094	133.6	0.0	103.9	0.0	0.0	0.7	0.0	11.9	0.955	0.953	1.000	94.3
*CACHE-OFF			0.0	0.0													
*CACHE			100.0	2332	2094	133.6	0.0	103.9	0.0	0.0	0.7	0.0	11.9	0.955	0.953	1.000	94.3
PRDC03	600C	0000	0.6	14.3	13.1	0.8	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.970	0.968	1.000	94.6
PRDC01	600D	0000	1.7	40.5	37.8	2.5	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.995	0.995	1.000	93.8
PRDC02	600E	0000	1.0	22.8	20.6	1.7	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.977	0.975	1.000	92.5
DBP179	6010	0000	0.6	13.2	9.4	0.7	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.768	0.755	1.000	94.6
DBP136	6011	0000	0.0	0.9	0.3	0.1	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.474	0.391	1.000	86.4
PRDHSM	6012	0000	0.0	0.6	0.5	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.755	0.747	1.000	96.7
DBP109	6013	0000	1.2	29.0	13.7	0.5	0.0	14.9	0.0	0.0	0.0	0.0	0.0	0.487	0.478	1.000	98.4
DBP162	6014	0000	0.4	8.5	4.8	0.6	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.641	0.613	0.995	92.6
DBP146	6015	0000	0.2	5.6	3.3	0.1	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.615	0.608	1.000	98.1
DBP321	6016	0000	0.1	3.1	2.6	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.836	0.835	1.000	99.4
DBP322	6017	0000	0.1	2.2	1.9	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.886	0.885	1.000	99.0
DBP323	6018	0000	0.1	2.0	0.9	0.2	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.548	0.504	0.994	91.1
DBP180	6019	0000	0.4	9.6	7.6	0.3	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.819	0.814	1.000	97.4
DBPI0R	601B	0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	N/A	N/A	N/A

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Understand the basic measurements and formulas of interest

- Key measurements
  - Measurement interval time
  - Number of I/Os (start subchannels)
  - Connect Time
  - Disconnect Time
  - Pend Time
  - IOSQ Time
- From these we can derive the following:
  - Activity Rate = I/Os per second
  - Average Connect Time
  - Average Disconnect Time
  - Average Pend Time
  - Average IOSQ Time
- From these we can derive further
  - Average Response Time = CONN + DISC + PEND + IOSQ
  - Average Queue Time = DISC + PEND + IOSQ
  - *Averages are applicable to an RMF interval*

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Understand the basic measurements and formulas of interest

- DASD Response Time is made up of 4 primary Components
  - IOSQ
    - IOSQ time is a delay time accumulated while the I/O is still in MVS and is waiting for a UCB to allow the I/O against the device. (UCB an MVS control block)
  - PEND
    - PEND is a delay time that usually occurs on devices with connection to multiple systems, and I/O is delayed by waiting for the other system (or LPAR) to complete its I/O
    - Includes delays such as device busy delay, command response delay (usually CU delay) and channel busy delay
  - DISC
    - Disconnect time for read occurs when data is not in cache
    - Disconnect time for write occurs when synchronous remote copy is active
    - There can be (some times) DISC delays due to CU contention
  - CONN
    - Connect times occur as the data is being written out. High connect times occur because of lengthy transfers or because of contention in FICON.

Summary of response time guidelines

- Rules established by author

RT Component	ESCON	FICON
IOSQ	< 0.5 ms	< 0.5 ms
PEND	< 0.5 ms	< 0.5 ms
DISC	< 0.5 ms	< 0.5 ms
CONN	~ 2.0 ms	~ 1.0 ms
Approximate Average RT	< 3.0 ms	~2-3 ms

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Understand the basic measurements and formulas of interest

- There are many formulas related to DASD I/O performance, but the most basic formulas of interest include the following:
  - **Average Response Time (RT)** = CONN + DISC + PEND + IOSQ
    - Our guideline says that *RT should not exceed 3* ms with modern DASD
  - **Average Queue Delay Time (QDT)** = DISC + PEND + IOSQ
  - **I/O Rate (S)** = Number of Start Subchannels / Interval Time
- Other formulas of great interest are as follows:
  (See next slide)
  - **I/O Intensity** = (I/O Rate / Response Time) = (S * RT)
  - **Queuing Intensity** = (I/O Rate / Queue Delay Time) = (S * QDT)

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IO Response Time, RT

IOSQ	PEND	CONN	DISC	CONN
LV in use by this MVS	**CH DLY** **DPB DLY** **CUB DLY** **DB DLY**	CH data XFER Protocol	Cache miss Reconnect miss Synchronous remote copy Contention internal to CU	CH data XFER

Note: In FICON environments DPB DLY and CUB DLY are replaced by CMR

Concept of Intensity

- When it comes to I/O many analysts make the mistake on concentrating on the following:
  - Poor I/O response times
  - Logical volumes with the most activity
- It is better to look at the calculated *Intensity* values
  - A great measurement to gain insight into what component / workload to concentrate your analysis on
  - The greater the intensity, the greater the impact
- Intensity = (I/O Rate) * (Average Response Time)
  - Example: I/O Intensity (Int) = (I/O Rate) * (CONN + DISC + PEND + IOSQ)
  - Example: Queuing Intensity (QI) = (I/O Rate) * (DISC + PEND + IOSQ)
    - *This value is particularly useful because it focuses on delays*
    - *In our analysis we usually use this value as a filter*

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Analysis at the DASDplex level

- Evaluate performance at the DASDplex level
  - The general concept here is to summarize the measurements so that we have a since set of condensed numbers such that the DASDplex is treated as a single entity
  - Example: S = I/O Rate = I/O Rate of all Logical Volumes in entire DASDplex
- Value of looking at measurements at the DASDplex level (next 2 charts)
  - I/O Rate (S) helps to understand overall rate of I/Os across DASDplex
    - Easy to identify peak periods
    - Over time can trend growth in I/O activity
  - Response times (RT, QDT, CONN, DISC, PEND, IOSQ)
    - Provides insights into whether average DASDplex response times are within guidelines
  - Intensities (Int, QI)
    - Provides insights into periods of time where I/O is experiencing the greatest impact to performance

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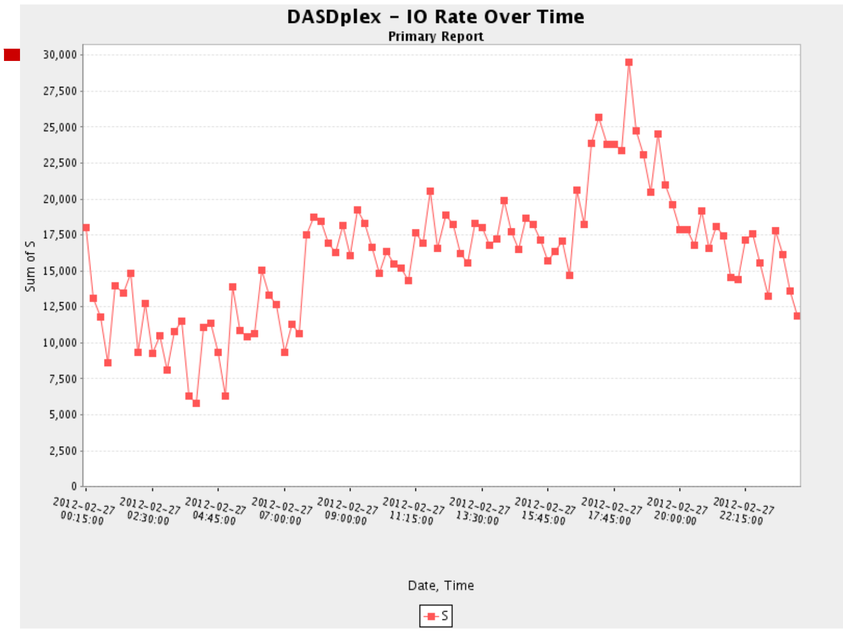

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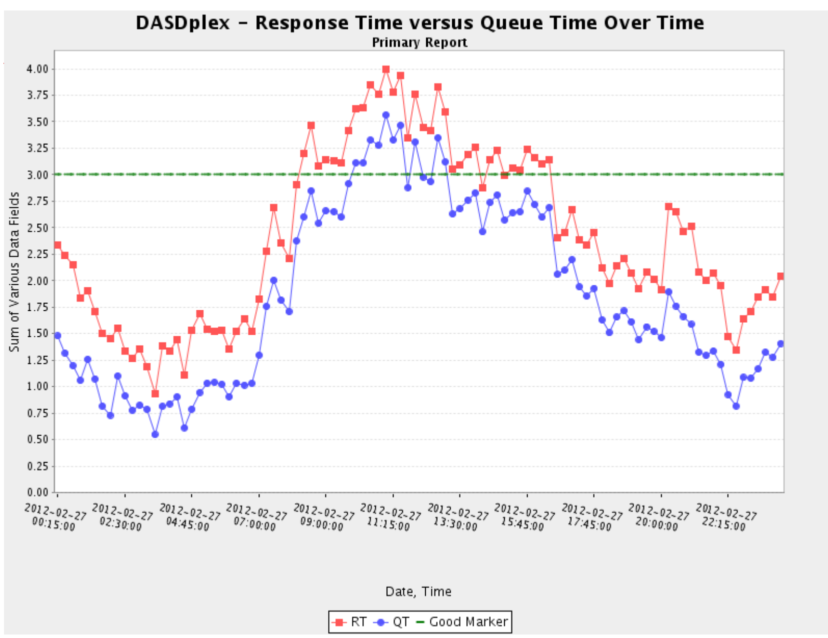

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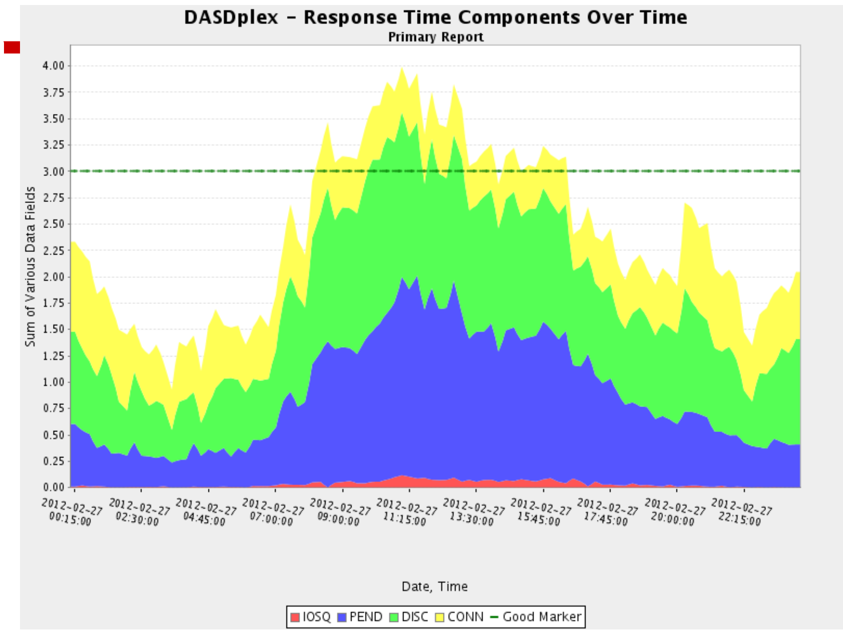


Analysis at the DASDplex level – continued

- The first DASDPLEX chart showed DASDPLEX I/O rate of 20,000 IO/s for first shift, rising to 30,000 IO/s in second shift
- The second DASDPLEX chart showed DASDPLEX Response Time, RT, and Queue Delay Time, QDT, over a 24 hour period
- The second DASDPLEX chart showed DASDPLEX Response Time, RT, over a 24 hour period
- RT exceeded 3 ms (Our guideline stipulates 3 ms) between 9:00 and 17:00
  - PEND is almost 2 ms
  - DISC is almost 2 ms
- Conclusion: Must determine why PEND and DISC are so high, why we breach the 3 ms guideline

Analysis at the PCU / LCU level

- These are two stages: first PCU, then LCU levels, but the analysis is similar
- Evaluate performance at the PCU/LCU level
  - The general concept here is to summarize the measurements to the physical/logical control unit level
- Value of looking at measurements at the PCU/LCU level
  - In an configuration made up of multiple PCUs/LCUs, examining the measurements at the PCU/LCU level helps to identify overloaded or unbalanced conditions
    - Often we find that given the multiple PCUs/LCUs load is not balanced appropriately
- Cache measurements are also available at the PCU/LCU level

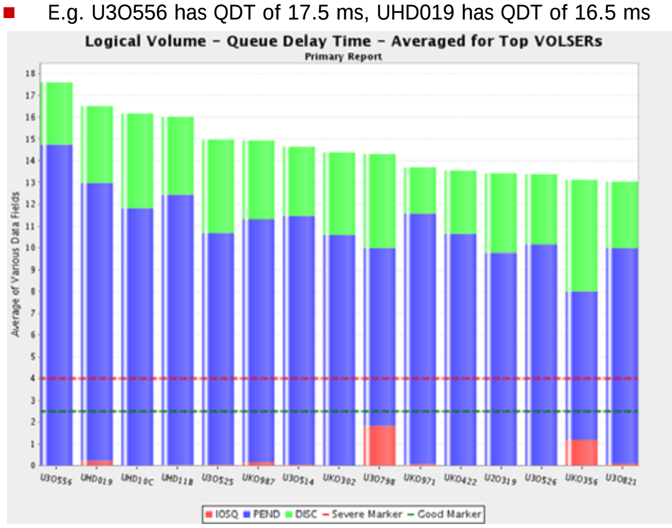
Analyzing Performance Data at the LV Level

- Summarize performance at the Logical Volume level
  - Summarize the measurements to obtain a *single* set of condensed numbers for each logical volume (LV).
    - Measurements exist separately for each LV in each LPAR in each interval
    - Consolidation (across LPARS or independent CPUs) means *one* set of numbers for *each* LV in *each* measurement interval
- There are many (typically thousands) of logical volumes to examine
  - Identify problem LVs
  - List of LVs must be narrowed down based on performance criteria
  - Our primary filter mechanism is Queuing Intensity, QI
    - LVs with the highest QI have bad impact because of the highest delays
- Select the worst volumes (by QI)
  - Examine cause for high QI (usually combination of high QDT and high S)
    - Analyze reasons: high DISC, high PEND, high IOSQ
    - Possibly high CONN (usually CONN is productive)

One installation's LV performance as an example

LVs with worst QDT *averaged* over the day

- Very large PEND (CMR) times resulting in very large RTs
  - E.g. U3O556 has QDT of 17.5 ms, UHD019 has QDT of 16.5 ms

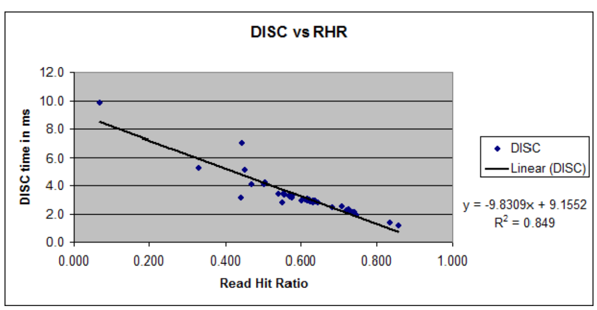


Extract of LVs with worst QI instances

Time	VolSer	QI	S	RT	IOSQ	PEND	DISC	CONN	RHR	CMR
23:45	U2O239	432	133.8	3.8	0.0	0.4	2.9	0.6	0.551	0.2
11:30	U1O796	400	37.8	11.1	0.1	7.6	3.0	0.5	0.618	6.8
11:15	U1O796	398	37.0	11.3	0.1	7.7	3.0	0.5	0.610	6.9
23:30	U1O954	381	68.7	6.3	0.0	0.4	5.1	0.7	0.452	0.3
12:15	U1O796	378	36.6	10.8	0.0	7.3	3.0	0.5	0.615	6.6
11:45	U1O796	375	37.9	10.4	0.0	7.0	2.9	0.5	0.630	6.4
11:00	U1O796	353	37.8	9.8	0.0	6.4	2.9	0.5	0.622	6.1
17:01	UKP252	350	46.5	15.0	0.0	0.5	7.1	7.4	0.445	0.3
19:15	U1O230	349	77.7	4.8	0.0	0.3	4.2	0.3	0.502	0.2
12:00	U1O796	347	36.0	10.2	0.0	6.6	3.0	0.5	0.630	6.1
17:01	U2O508	344	58.4	6.3	0.0	0.6	5.3	0.4	0.328	0.4
12:45	U1O796	344	34.6	10.4	0.0	7.1	2.8	0.5	0.644	6.3
10:30	U1O796	343	36.8	9.8	0.0	6.0	3.3	0.5	0.569	5.6
12:30	U1O796	343	34.9	10.3	0.0	6.8	3.0	0.5	0.634	6.4
11:15	U1O798	338	34.4	10.5	0.0	6.3	3.5	0.7	0.541	5.9
9:15	U1O798	337	111.5	3.4	0.0	1.6	1.4	0.4	0.833	1.4

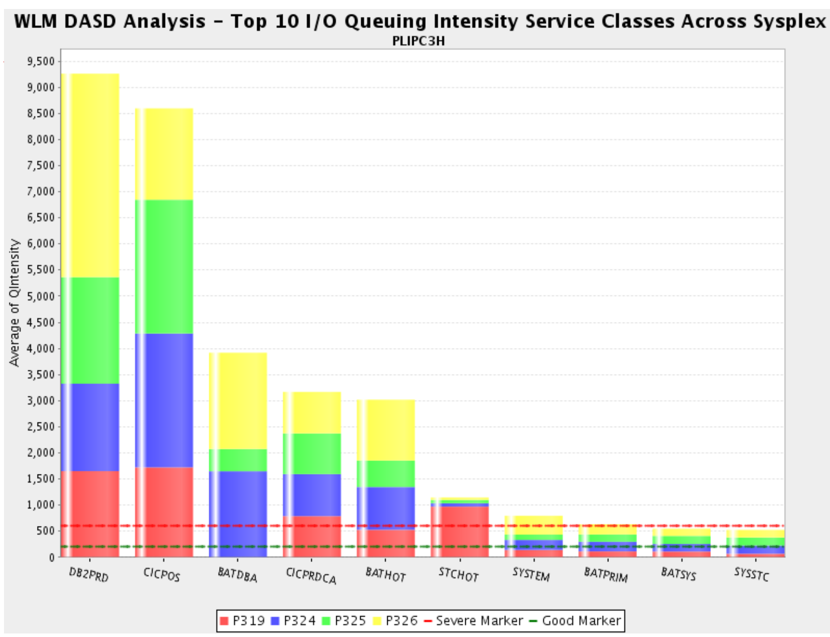
An example of the worst LVs

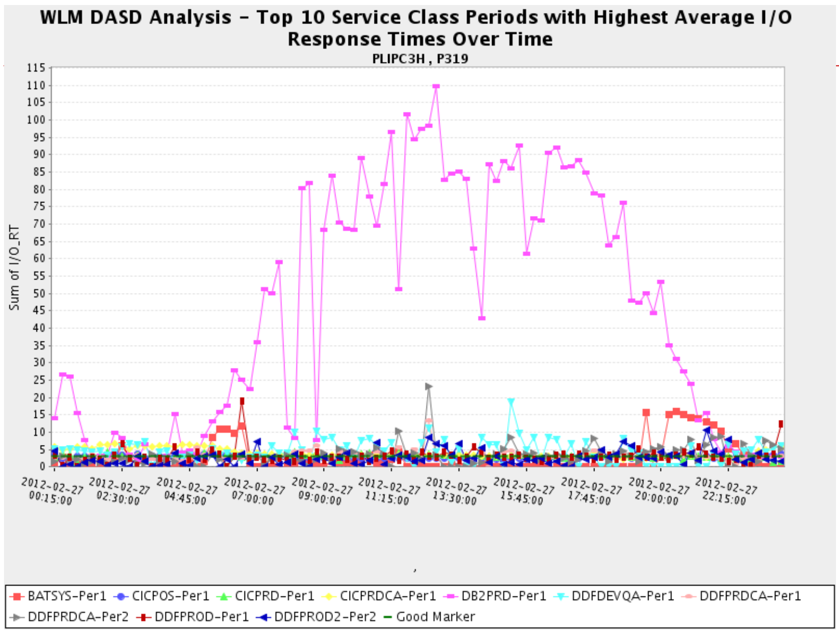
- QI ranges between 337 and 432
  - In 10 cases out of 16 PEND is higher than 6 ms (Very high)
    - We observe a matching high CMR value
    - We expect a typical PEND time value of 0.5 ms or less to reach our RT target of 3 ms or less
  - In 15 cases out of 16 DISC is 2.8 ms or higher (too high).
    - We observe that correspondingly Read Hit Ratio (RHR) ranges between 0.328 and 0.634. (very low). Graph below shows DISC (linear) dependence on RHR
    - We expect a typical DISC time value of 1.5 ms or less to reach our RT target of 3 ms or less



Start attacking the other areas of interest

- After identifying DASD I/O volumes with the highest impact, it is worth looking to see what workloads may be affected by poor performing logical volumes
  - On a Service class basis (*next two slides*)
    - Badly impacted workloads are DB2PROD (DB2) and CICPOS (CICS)
    - During first shift DB2PROD receives an I/O response time as high as 110 ms, typically hovering around 80 ms
  - On a Report class basis
- Items of interest:
  - DASD I/O performance response time components for each workload
- What can be done with these values:
  - Introduce I/O enhancement techniques as applicable
    - Enablement of I/O priority management,
    - Parallel Access Volumes (PAVs), etc.
  - Modernize the I/O gear (more cache, more and more advanced PCUs)





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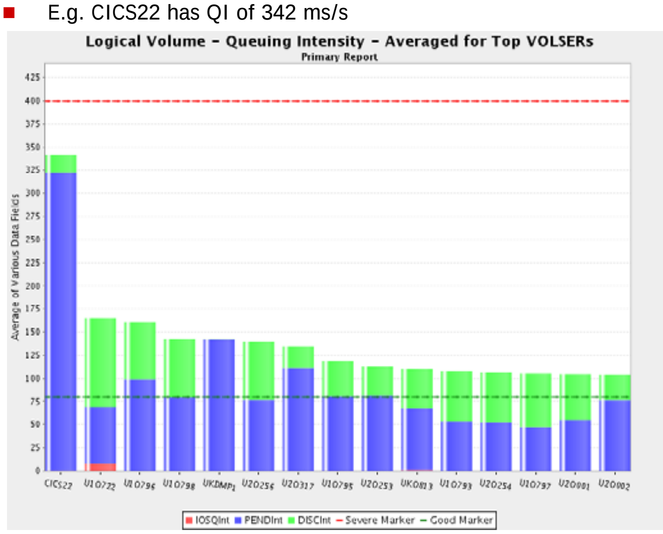
LVs with worst QI *averaged* over the day

- Very large PEND (CMR) times resulting in very large QIs
  - E.g. CICS22 has QI of 342 ms/s



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Solving the specific Performance Problems

- Since we know that DISC and PEND time are worse culprits in this case, the possible solutions are not too difficult to identify.
- High PEND (CMR) time indicates control unit contention.
  - There are 4 LPARs (P319, P324, P325, P326) in 2 CPUs generating I/O requests to the single Physical Control Unit
  - This results in contention on the paths to the Physical Control Unit, i.e., requests are being delayed because other requests are already being processed.
- High DISC time indicates inadequate cache sizes.
- **Solve both the PEND and DISC time problems**
  - Needs *more cache* in control unit and *more (or faster) paths* to the control unit
    - Replace existing control unit with a more modern version
    - Add another control unit and distribute the volumes and load

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Write a Report for Your Manager!

- One of the biggest failures of performance analyst is to communicate their accomplishments
- Performance recommendations
  - Let others know what you are doing!
  - Let others know what you are finding!
  - Let others know what can be saved!
  - Let others know what you achieved!
- Document
  - The problem or area of concern
  - A proposed solution
  - An estimate in savings
    - Try to put this value in real monetary terms
- Let others know you accomplishments!

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Current 2012 Class Schedule

- WLM Performance and Re-evaluating of Goals
  - Instructor: Peter Enrico
  - June 11 - 15, 2012 Saint Louis, Missouri, USA
  - September 17 – 21, 2012 Stamford, Connecticut, USA
- Essential z/OS Performance Tuning
  - Instructor: Peter Enrico and Tom Beretvas
  - September 10 –14, 2012 Minneapolis, Minnesota, USA
- Parallel Sysplex and z/OS Performance Tuning
  - Instructor: Peter Enrico
  - July 17 - 19, 2012 Online
  - August 21 – 23, 2011 Online
- z/OS Capacity Planning and Performance Analysis
  - Instructor: Ray Wicks
  - No scheduled at this time

Reference charts

What Key SMF Records Exist for File I/O

- SMF 42.6
  - Records DASD data set level I/O statistics
  - There are two events that cause subtype 6 to be generated:
    - Close
    - Immediately after the recording of the type 30 interval record.
    - There is one type 42 subtype 6 record for each type 30 interval record.
  - Key point… With a little work, it is possible to tie the SMF 42.6 record back to the associated SMF 30
- SMF 64
  - Record type 64 is written when
    - A VSAM component or cluster is closed
    - VSAM must switch to another volume to continue to read or write
    - There is no more space available for VSAM to continue processing
- SMF 92
  - File system activity for UNIX System Services Environment

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SMF 42.6 – Some More Information

- The SMF 42.6, when associated with the SMF 30 records, is invaluable
- Contains the following type of information
  - Job identification information
  - Dataset name
  - Type of dataset (PDS, PDSE, Linear, ISAM, HFS, etc.)
  - Dataset allocation information (volume, block size, storage class, etc)
  - LPAR where the job ran (since the file may be shared among multiple systems)
  - I/O count per interval (so can sum to get total I/Os)
  - Response time statistics (Connect time, Disconnect time, Pend time, IOSQ time)
  - Cache statistics
    - Cache candidates
    - Cache hits
    - Write hits
    - Etc.
  - Access method statistics (sequential reads and write, direct reads and writes, etc.(

SMF 42.6 – Some More Information

- The SMF 42.6, when associated with the SMF 30 records, is invaluable

Field	Description
S42DSIOR	Average response time.
S42DSIOC	Average I/O connect time.
S42DSIOP	Average I/O pending time.
S42DSIOD	Average I/O disconnect time.
S42DSIOQ	Average control unit queue time.
S42DSION	Total number of I/Os.
S42DSCND	Number of cache candidates.
S42DSSHTS	Number of cache hits.
S42DSWCN	Number of write candidates.
S42DSWHI	Number of write hits.
S42DSSEQ	Number of sequential I/O operations.
S42DSRLC	Number of record level cache I/O operations.
S42DSICL	Number of inhibit cache load I/O operations.
S42DSDA0	Average I/O device-active-only time.
S42DSMXR	Maximum data set I/O response time.
S42DSMXS	Maximum data set service time.

SMF 42.6 Grid Example – Reads/Writes by Volser

SMFDate	SMFTime	SMFHour	Prefix	VolSer	Writes	Reads
10/19/2009	0:45:00	0	DB2	DB2A02	173	6
10/19/2009	1:00:00	1	DB2	DB2A02	5	0
10/19/2009	2:15:00	2	DB2	DB2A02	14765	1194
10/19/2009	2:30:00	2	DB2	DB2A02	763	0
10/19/2009	2:45:00	2	DB2	DB2A02	520	3
10/19/2009	3:00:00	3	DB2	DB2A02	507	1
10/19/2009	3:15:00	3	DB2	DB2A02	3313	109
10/19/2009	3:30:00	3	DB2	DB2A02	407	0
10/19/2009	3:45:00	3	DB2	DB2A02	256	0
10/19/2009	4:00:00	4	DB2	DB2A02	205	0
10/19/2009	4:15:00	4	DB2	DB2A02	355	0
10/19/2009	4:30:00	4	DB2	DB2A02	310	0
10/19/2009	4:45:00	4	DB2	DB2A02	246	0
10/19/2009	5:00:00	5	DB2	DB2A02	302	0
10/19/2009	5:15:00	5	DB2	DB2A02	443	72
10/19/2009	5:30:00	5	DB2	DB2A02	338	6
10/19/2009	5:45:00	5	DB2	DB2A02	276	4923

SMF 42.6 Grid Example – Reads/Writes by Job

SMFDate	SMFTime	SMFHour	Job_Prefix	Job_Name	Writes	Reads
10/19/2009	0:45:00	0	DB2	DB2ADBM1	323	44
10/19/2009	0:45:00	0	DB2	DB2AMSTR	332	0
10/19/2009	1:00:00	1	DB2	DB2ADBM1	4	0
10/19/2009	1:00:00	1	DB2	DB2AMSTR	2	0
10/19/2009	2:15:00	2	DB2	DB2ADBM1	2432	4832
10/19/2009	2:15:00	2	DB2	DB2AMSTR	29518	6
10/19/2009	2:30:00	2	DB2	DB2ADBM1	711	12
10/19/2009	2:30:00	2	DB2	DB2AMSTR	1526	0
10/19/2009	2:45:00	2	DB2	DB2ADBM1	94	15
10/19/2009	2:45:00	2	DB2	DB2AMSTR	1020	4
10/19/2009	3:00:00	3	DB2	DB2ADBM1	13	4
10/19/2009	3:00:00	3	DB2	DB2AMSTR	1008	0
10/19/2009	3:15:00	3	DB2	DB2ADBM1	4384	1568
10/19/2009	3:15:00	3	DB2	DB2AMSTR	6626	2
10/19/2009	3:30:00	3	DB2	DB2ADBM1	917	2
10/19/2009	3:30:00	3	DB2	DB2AMSTR	814	0
10/19/2009	3:45:00	3	DB2	DB2ADBM1	42	0
10/19/2009	3:45:00	3	DB2	DB2AMSTR	492	0
10/19/2009	4:00:00	4	DB2	DB2ADBM1	0	2
10/19/2009	4:00:00	4	DB2	DB2AMSTR	410	0

Possible Reports

- Data summary in many different ways
  - By Job, by File
  - By File by Job
- Example:
  - For each file, broken down by job
  - Number of I/Os to file per job
    - Number of reads and writes
    - Number of sequential access and direct accesses
  - I/O response times breakdown
  - etc

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