

z/VM Paging with SSD and Flash-Type Disk Devices

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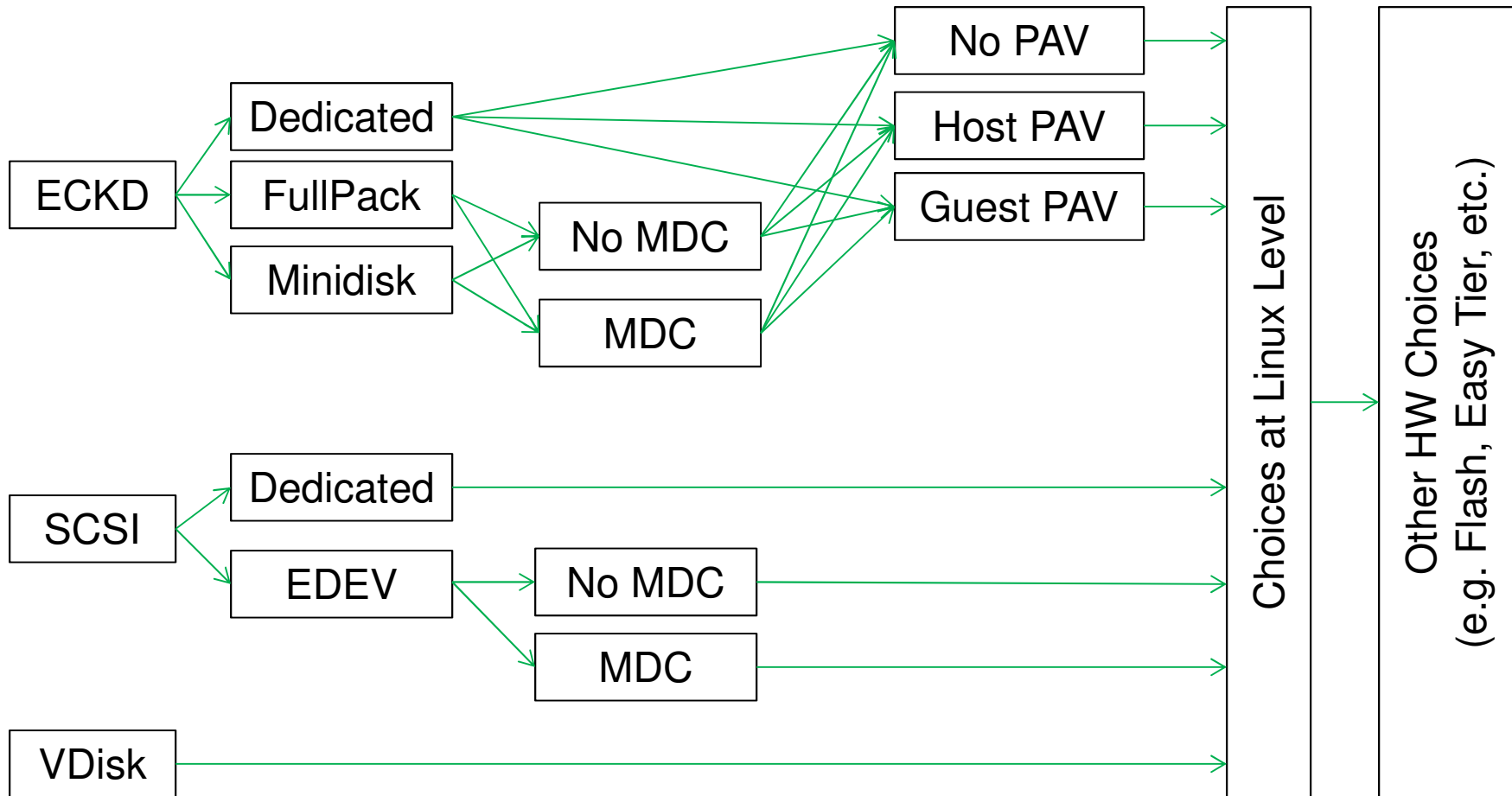
Agenda

- Choosing the right disk storage
- High Performance Paging Options
- The Need for Faster Paging
- Case Study

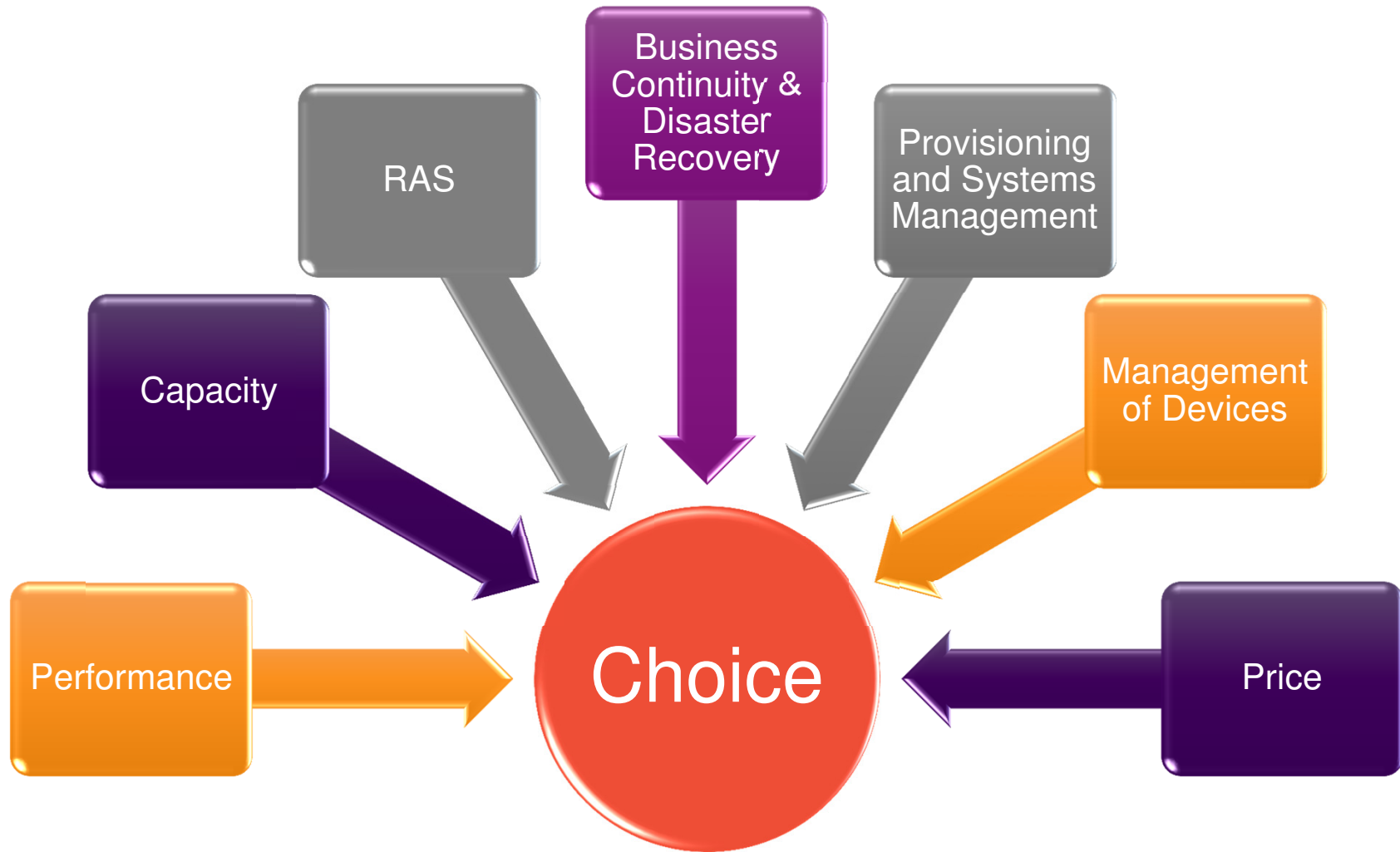
Choosing the Right Disk Storage



So Many Choices



Look at All Attributes – Not Just One



A Few More Things to Think About

- Lack of PAV & HyperPAV support makes the size of ECKD DASD for z/VM paging important. We want to not have I/Os queued up on these volumes but at same time balance this with work to administer the number of DASD volumes involved.

- Even if ECKD volumes could be infinitely large and infinitely fast, we would probably still want as many as there are logical processors for z/VM.

- FCP SCSI for z/VM Paging provides a level of parallelism but at a cost in processor time
 - Greater Bandwidth
 - Higher CPU costs

High Performance Paging Options



Flash vs. SSD and Terminology

- Purists will say “Flash” is not the equivalent of “SSD”
 - Solid State Disk – most often used to describe a device where the access is through an existing disk interface
 - Flash – access to it via direct interface to the memory

- Common Attributes:
 - Storage capacity
 - Write speed
 - Read speed
 - Active power
 - Standby power
 - Write endurance or wear-out
 - Type: NAND, NOR

Flash Express

- Flash Express Feature of zEC12 and zBC12 processors
- PCIe I/O Adapter with NAND Flash SSDs
- Accessed using Extended Asynchronous Data Mover Facility (EADMF)
- RAID 10 mirrored Pairs
- Protected with 128-bit AES encryption
- Maximum of 4 Cards provides 5.6 TB of usable storage
- **Not supported by z/VM at this time. ☹️**



IBM FlashSystem

- IBM FlashSystem V840 - Based off technology from acquired Texas Memory System
 - Uses eMLC Flash

- FCP SCSI Only

- For use as z/VM Paging volumes, must be behind an SAN Volume Controller (SVC)
 - Some models of FlashSystem include SVC

- Various Features:
 - Easy Tier support
 - Compression
 - Data replication



DS8870

- Part of the IBM DS8000® Series
- Can be equipped with SSD drives
- HPFE (High Performance Flash Enclosure) – Newest Option
- ECKD or FCP SCSI
- Lots of features/capabilities
 - RAID 5,6,10
 - Easy Tier
 - GDPS
 - Encryption
 - Etc.
- Maximum configuration 3072 TB

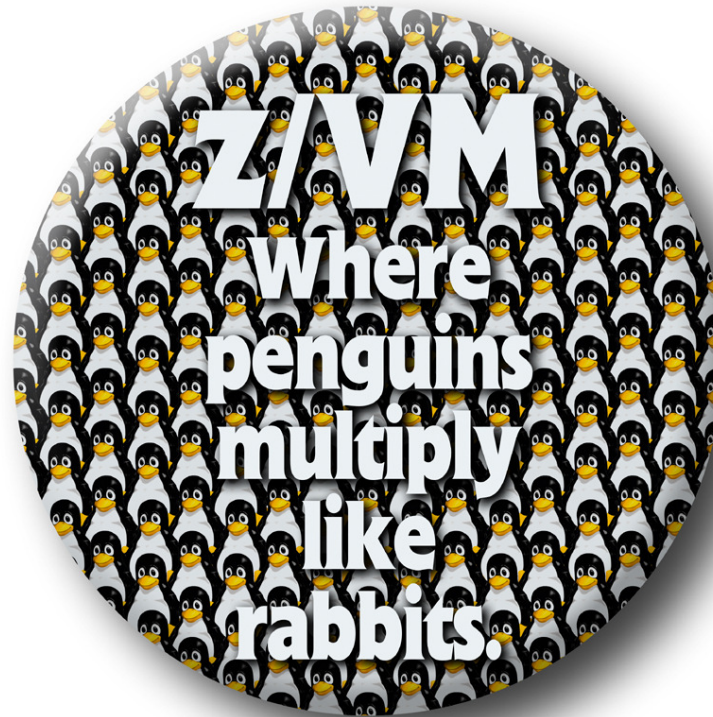


Flash also Available for Other Options

- Storwize V7000
 - Internal flash drives available
 - External IBM FlashSystem Storage

- XIV
 - Flash optimized options

The Need



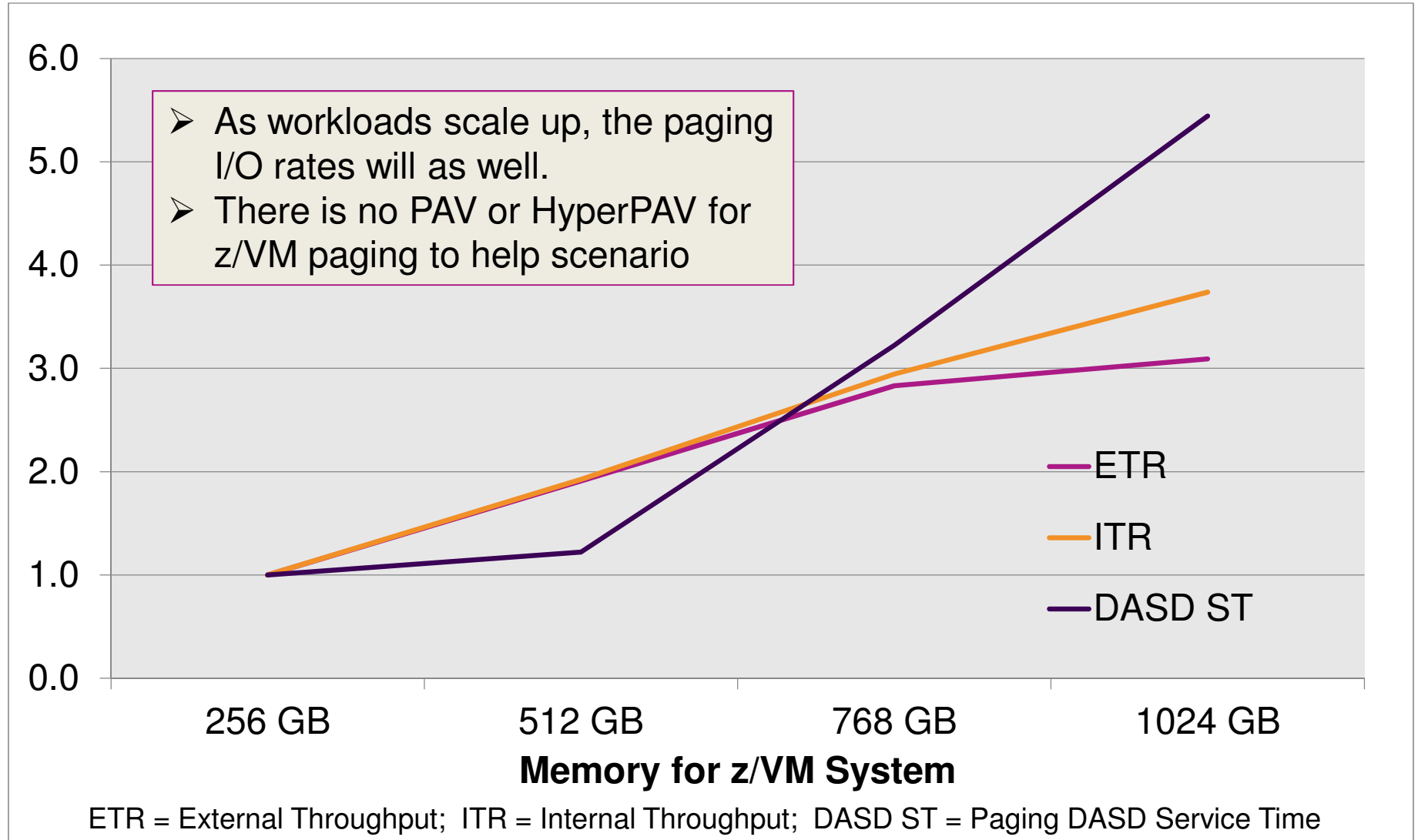
I/O Rates and Latency

- Two aspects of paging I/O
 - Overall capacity: IOPS or MB/Second
 - Performance or Latency: delay per page read

- Historically, top-end storage servers could not be saturated by z/VM Paging

- Changing History:
 - Larger amount of memory supported and page rates increasing
 - If z/VM 6.3 allows 4 times number of virtual machines, then 4 times the page rate when you add those virtual machines.
 - Elimination of scaling problems in z/VM that allow greater paging rates
 - Better determination of the actual disk paging bandwidth
 - z/VM 6.3 algorithms changed to better estimate and utilize disk paging bandwidth

Apache Workload in Scaling Overcommitted



Virtual to Real Memory Overcommitment

- One of the factors often forgotten is the performance (capacity and bandwidth) of the paging configuration.

- A 100 GB real memory system with 125 GB of active virtual memory basically means being able to constantly turn over 25 GB
 - Potentially more based on the amount of memory that is changing and resulting in page writes in addition to page reads.

- As virtual machines are delayed for paging, pages that are resident tend to be needed longer, creating more demand and potential spiral-effect.

Paging Best Practices

- All paging volumes should have the same attributes: Size, Performance, etc.

- Do not mix page space with other data types

- Do not mix FCP SCSI and ECKD paging volumes

- Be aware of any shared hardware in the path (channels, control units) and who/what is sharing them

- Follow planning guidelines for amount of space

Case Study



Customer Proof of Concept

- Customer moved paging volumes from multiple z/VM LPARs and CECs to a DS8870

- For this study, everything was placed in one Logical Control Unit (LCU)
 - This is not recommended but for part of the experiment
 - Limiting to one LCU restricted full use of DS8870 cache and processing power

- The area that came under question what happens when you IPL multiple z/VM systems and need to restart 100s and 100s of virtual machines?

Key Observations

- Performance of DS8870 is a significant improvement over spinning disk.

- No single number can really portray that performance

- Factors that will be examined:
 - Peaks across different LPARs
 - Data per I/O
 - Read / Write Ratio

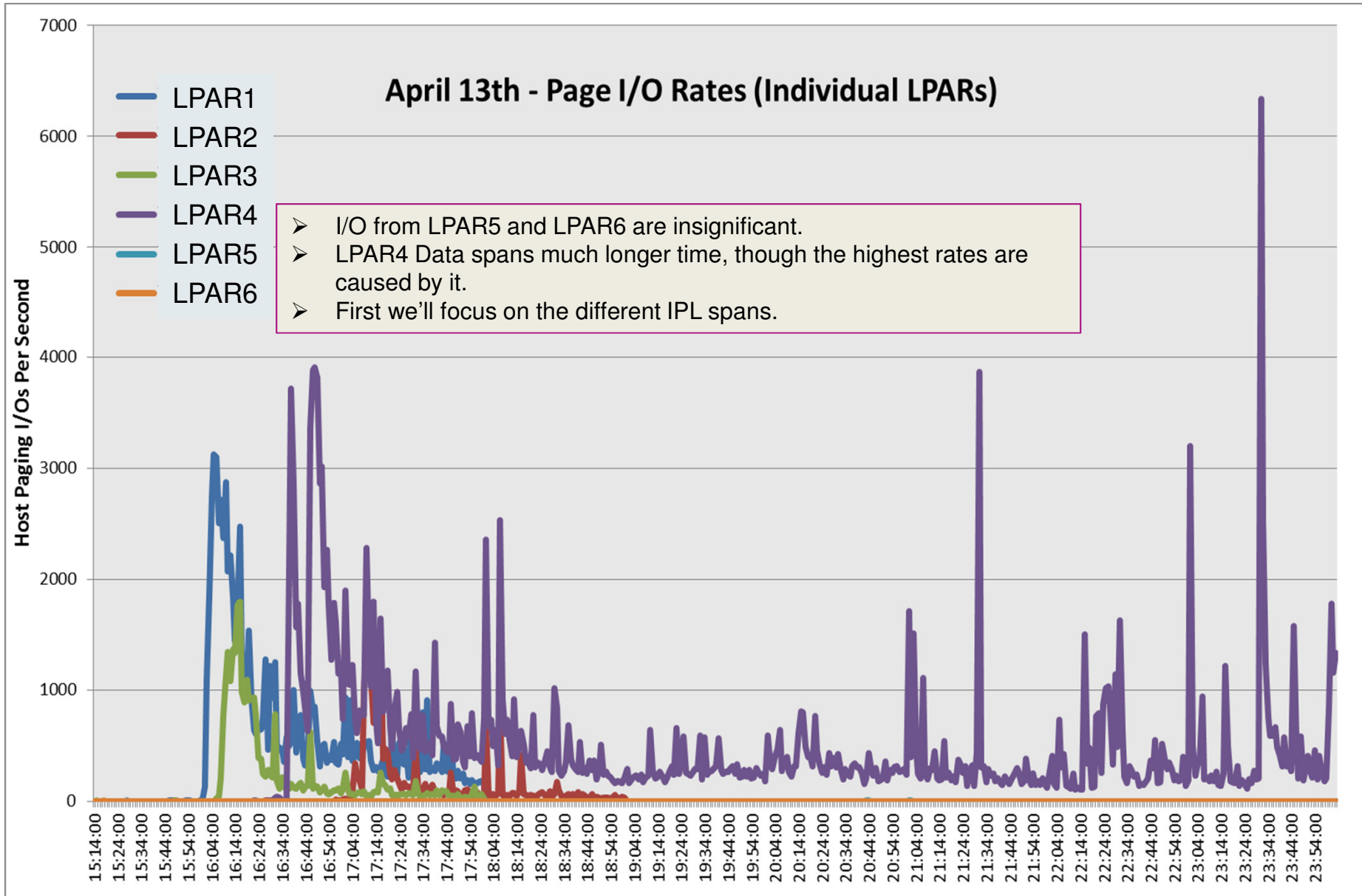
- Study will explore the data in the different dimensions above

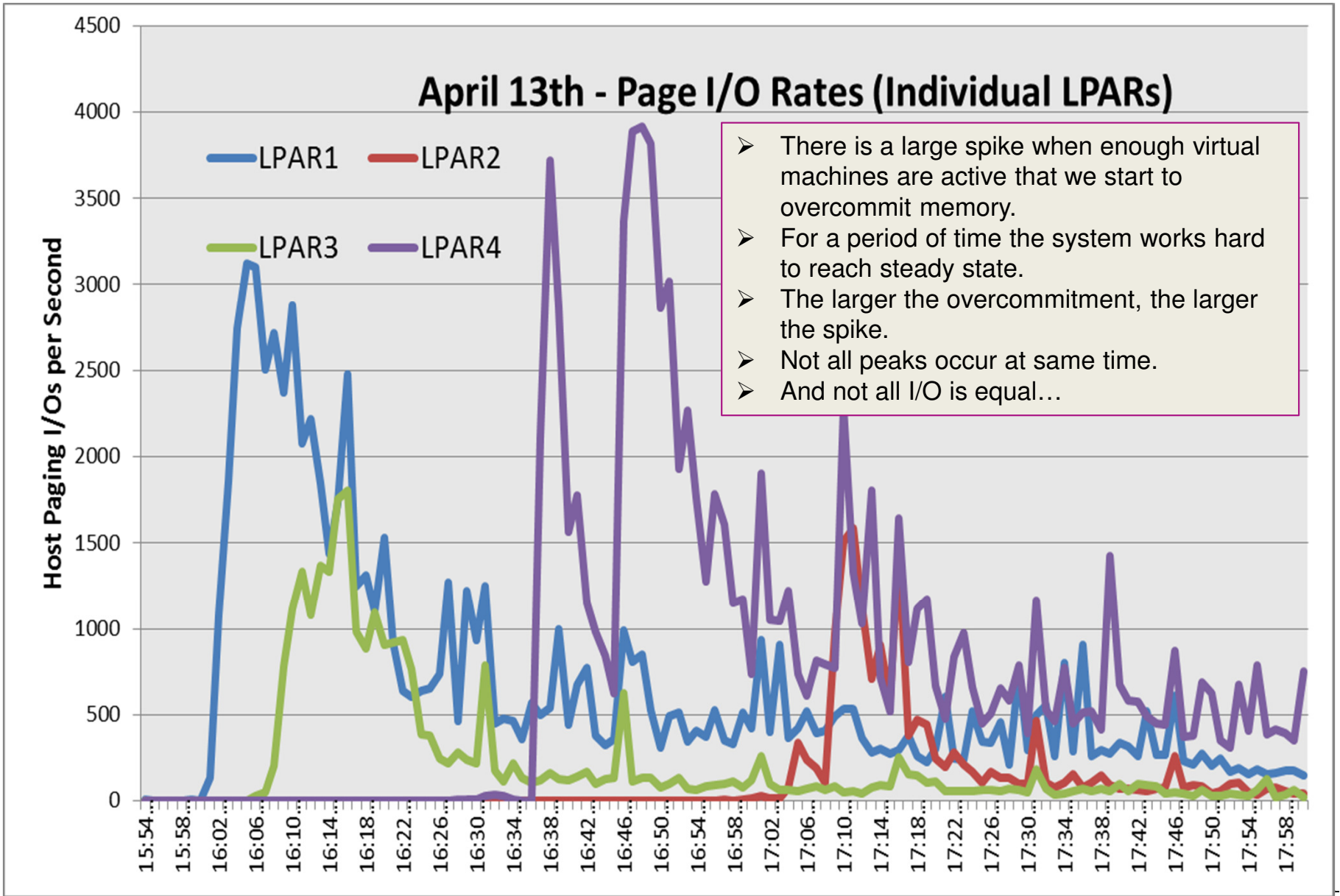
- Brief comparison to the non SSD storage servers

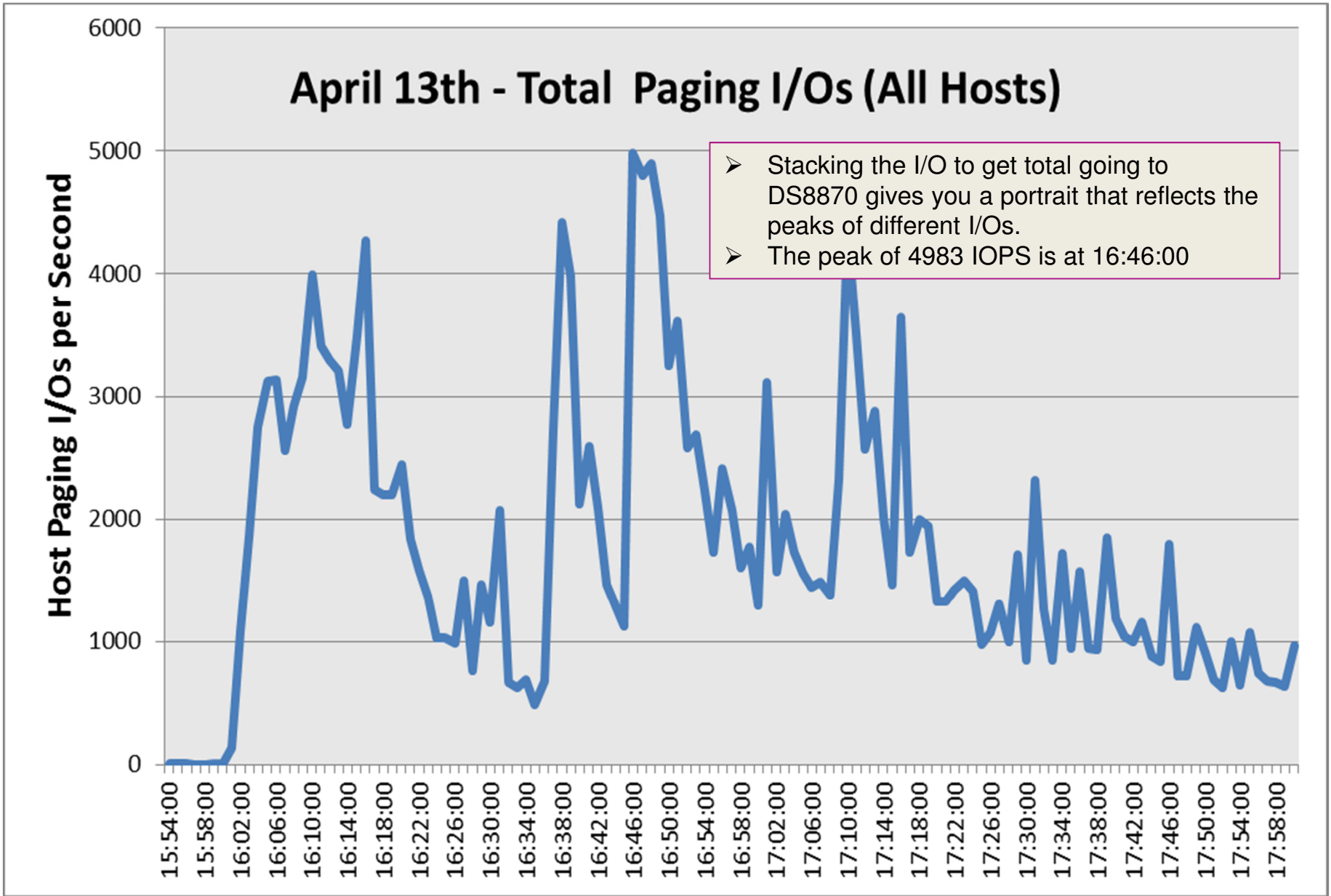
Summary of Systems from April 13th Data

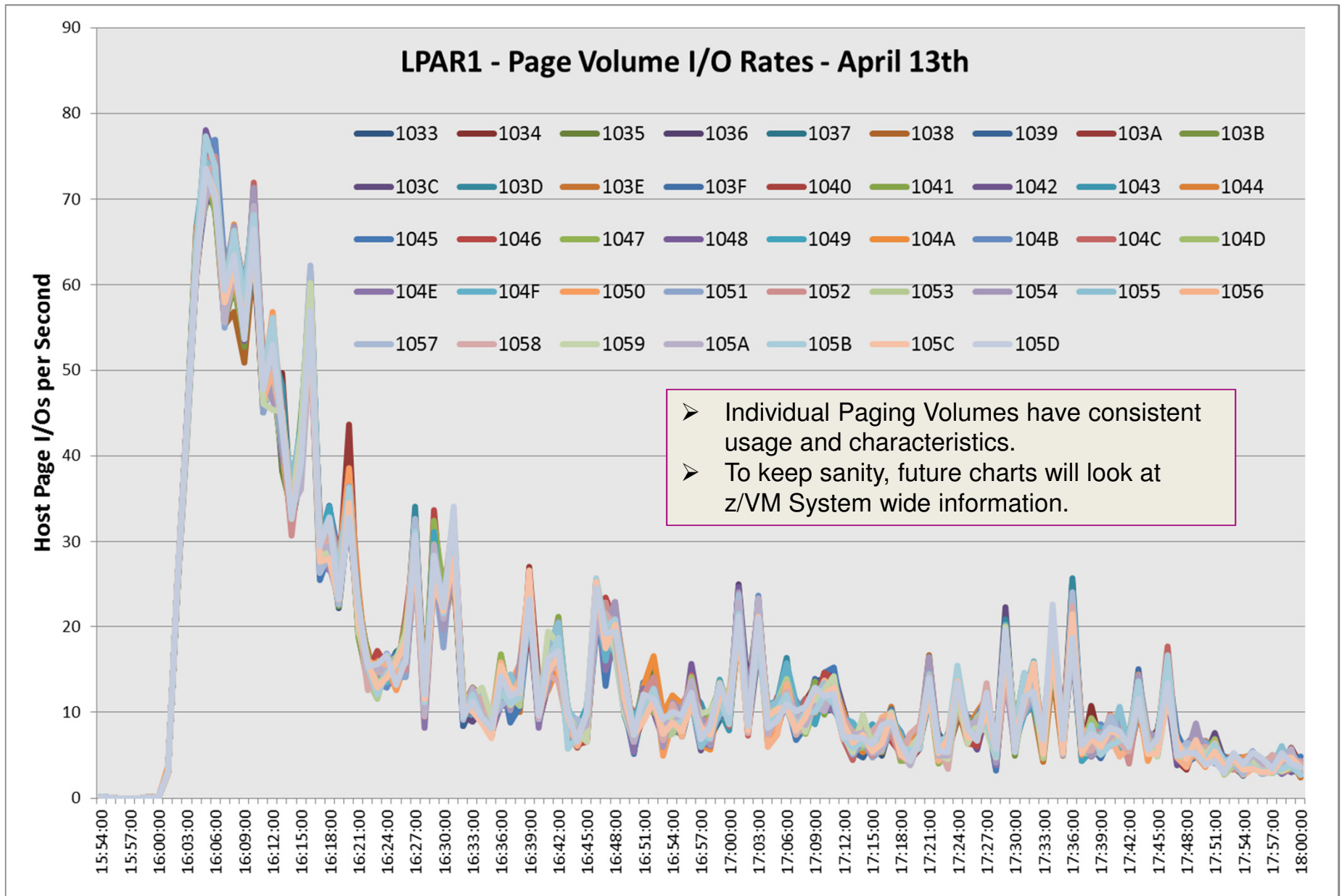
LPAR	z/VM	Page Vols	Memory Virt:Real	IPL Time	Peak Page Rate	Peak Page Time
LPAR1	6.3.0	43	2.36	15:11:14	73690	16:04:00
LPAR2	6.3.0	41	2.34	15:51:33	39865	17:10:00
LPAR3	6.3.0	29	1.76	15:11:30	39800	16:16:00
LPAR4	6.3.0	49	2.48	15:41:23	93229	16:38:00
LPAR5	6.3.0	27	2.36	15:11:34	170	21:01:00
LPAR6	6.3.0	10	0.87	15:11:10	30	15:26:00

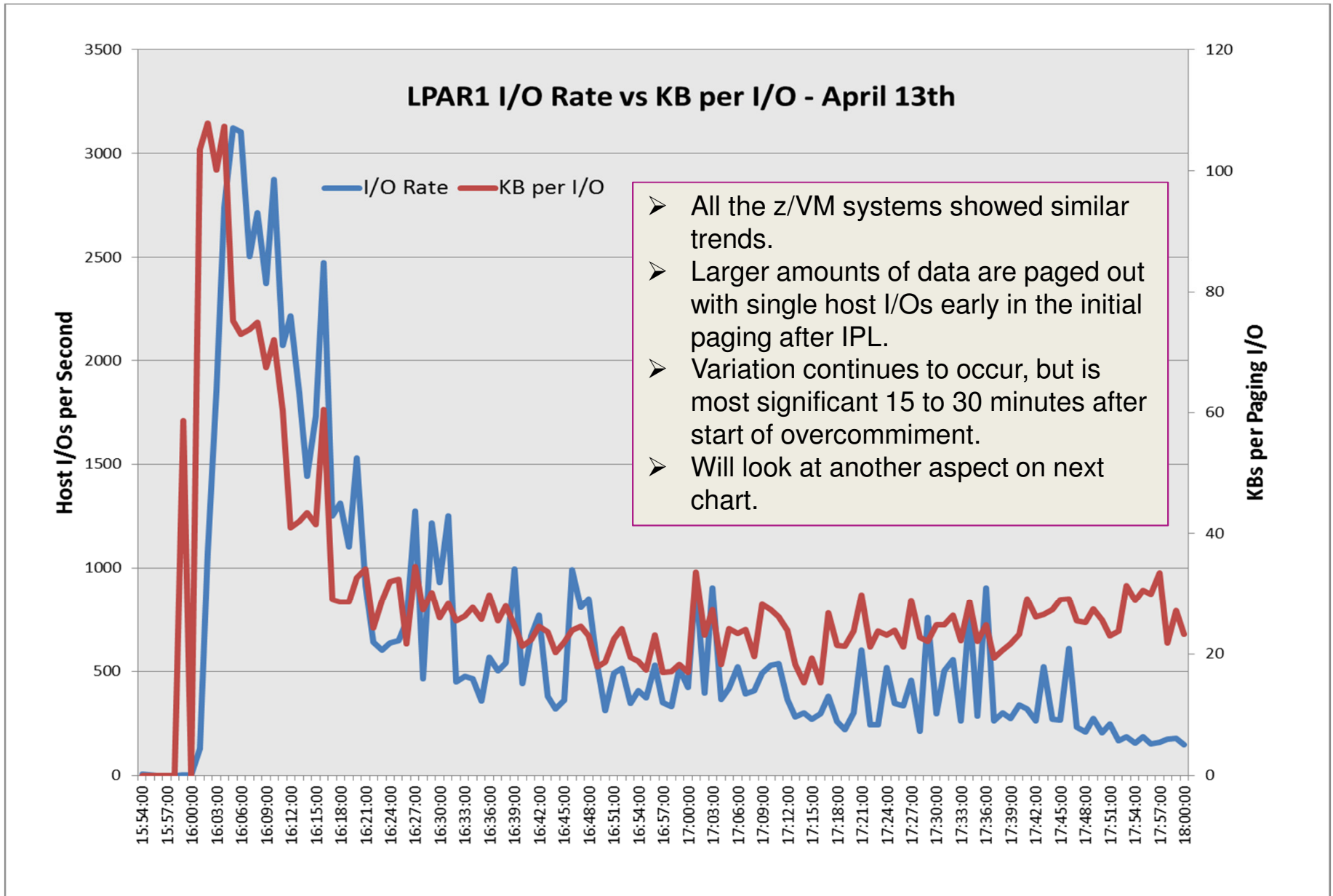
- Peak Page Rate: 4KB Pages/Second, includes read and write
- IPL Time: Time at which z/VM system was IPLed, not necessarily when all virtual machines were brought online.
- LPAR5 and LPAR6 are boring, from a performance perspective.

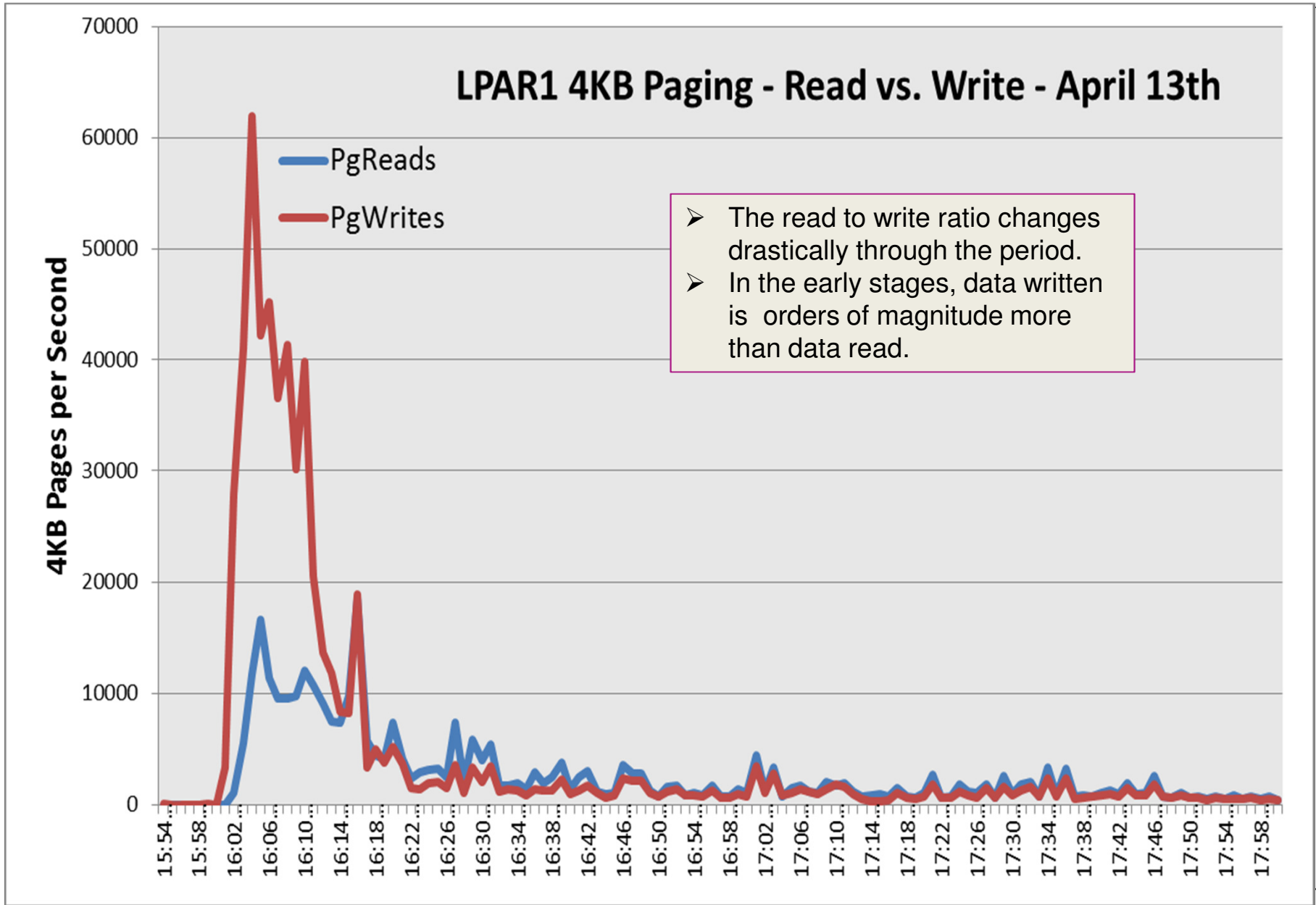




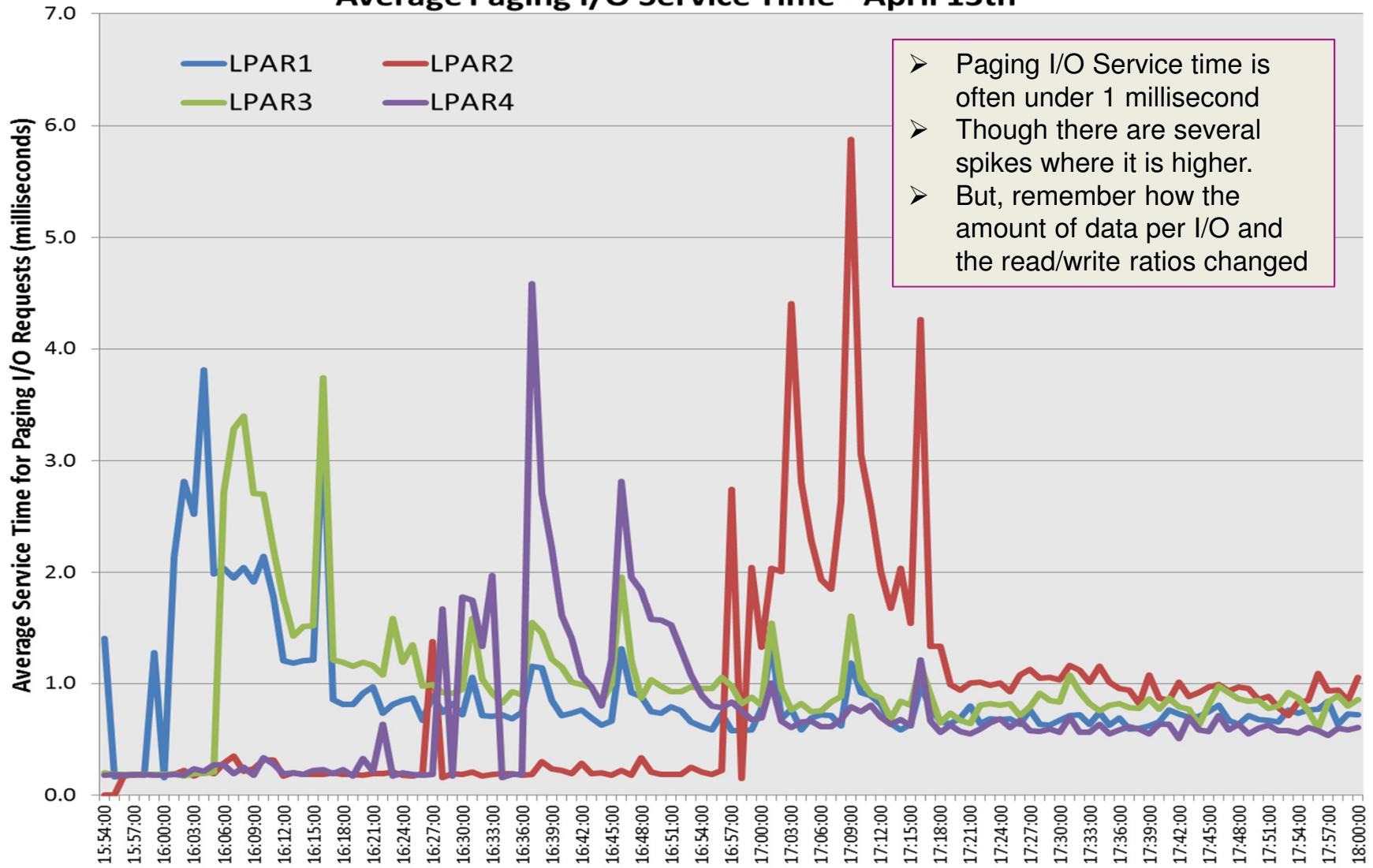




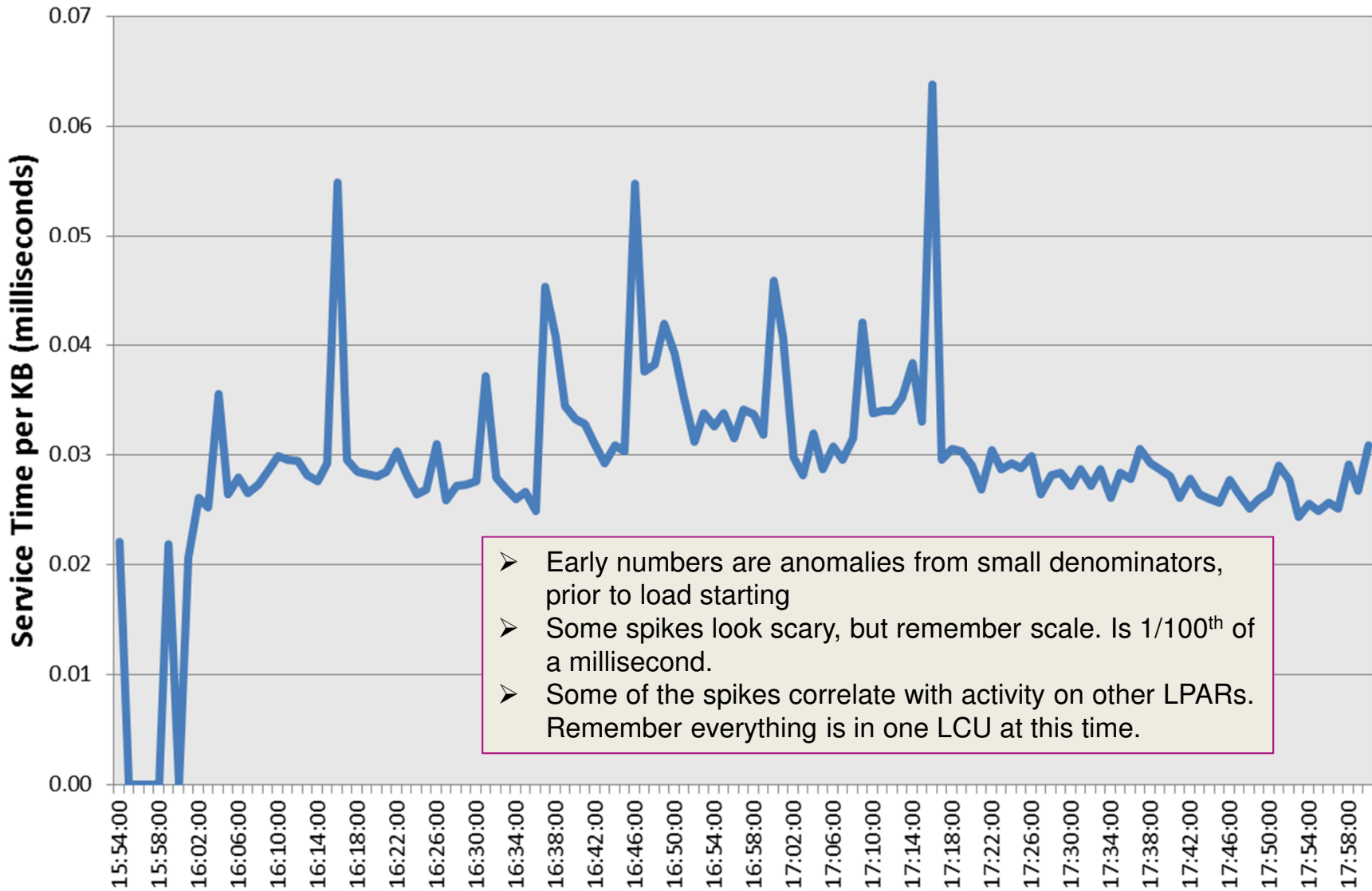




Average Paging I/O Service Time - April 13th

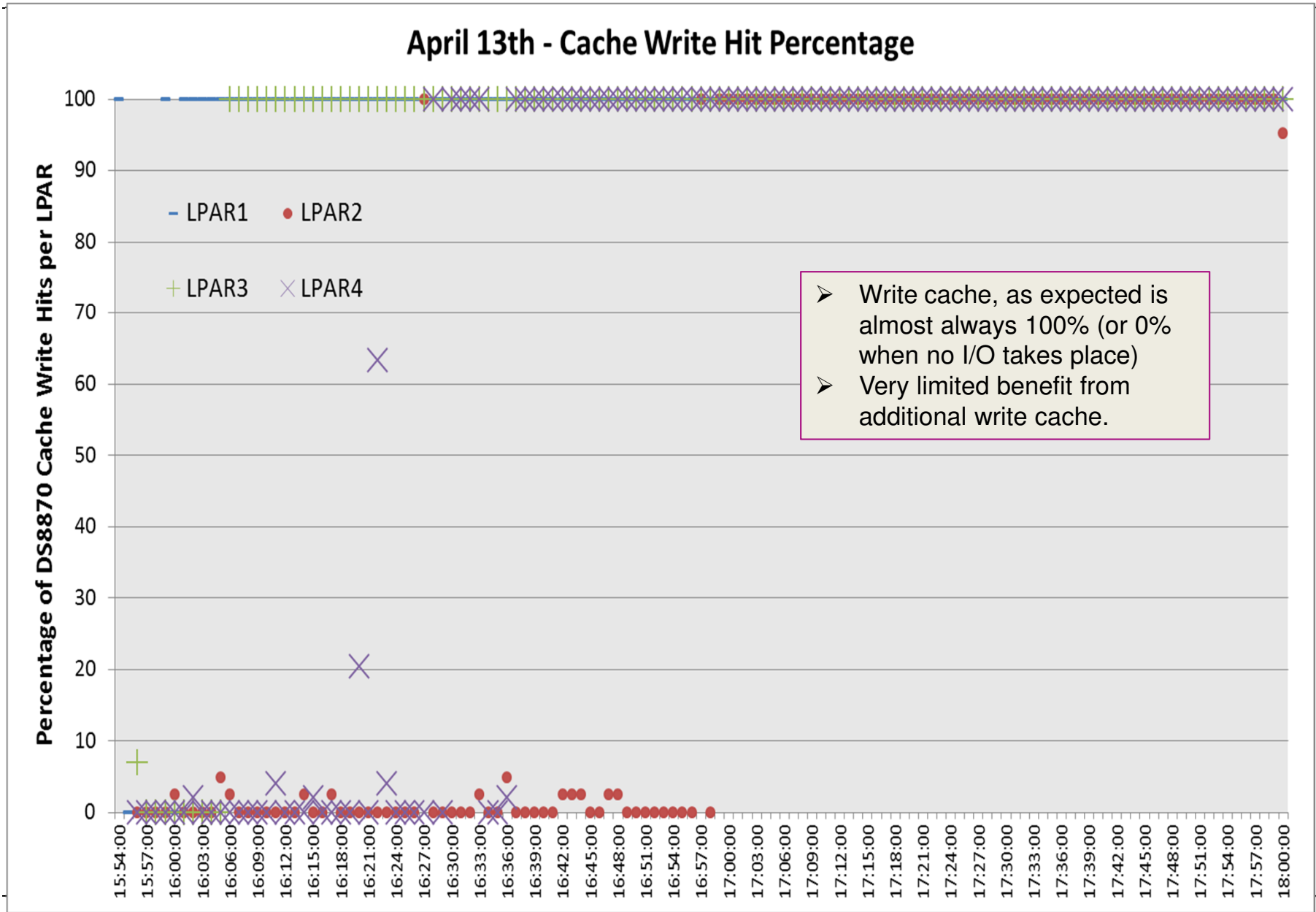


LPAR1- Service Time per KB - April 13th

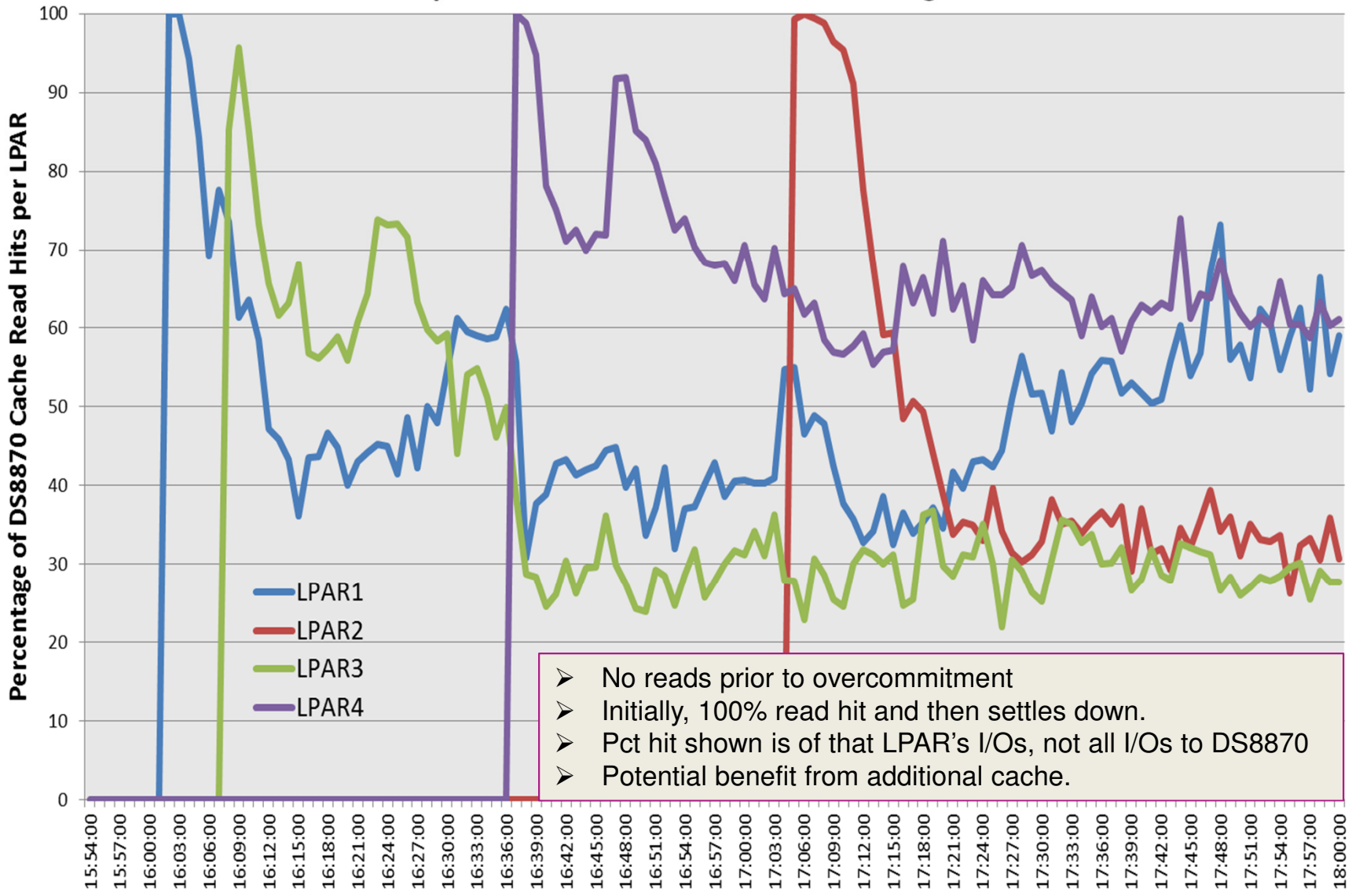


- Early numbers are anomalies from small denominators, prior to load starting
- Some spikes look scary, but remember scale. Is 1/100th of a millisecond.
- Some of the spikes correlate with activity on other LPARs. Remember everything is in one LCU at this time.

April 13th - Cache Write Hit Percentage



April 13th - Cache Read Hit Percentage



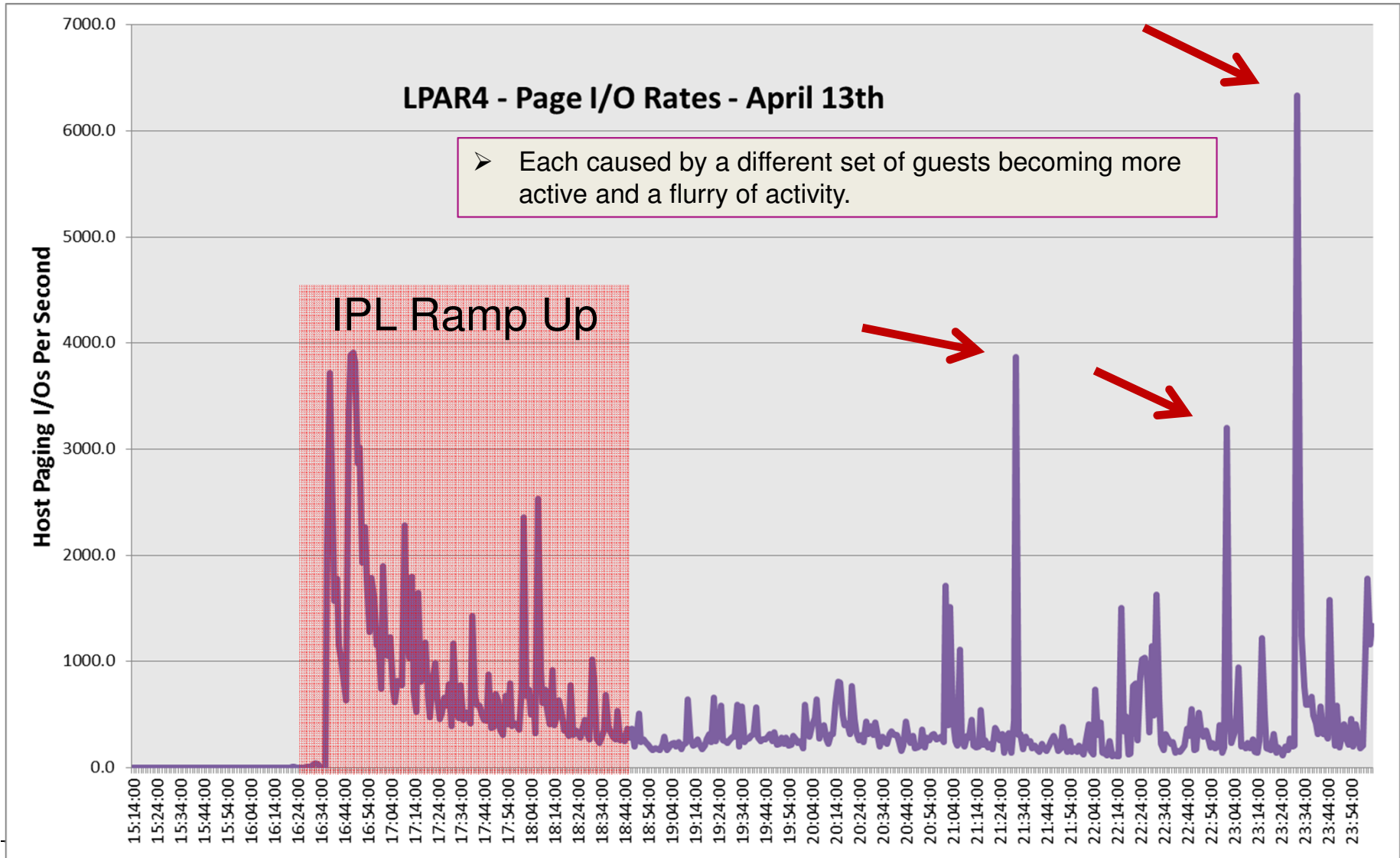
- No reads prior to overcommitment
- Initially, 100% read hit and then settles down.
- Pct hit shown is of that LPAR's I/Os, not all I/Os to DS8870
- Potential benefit from additional cache.

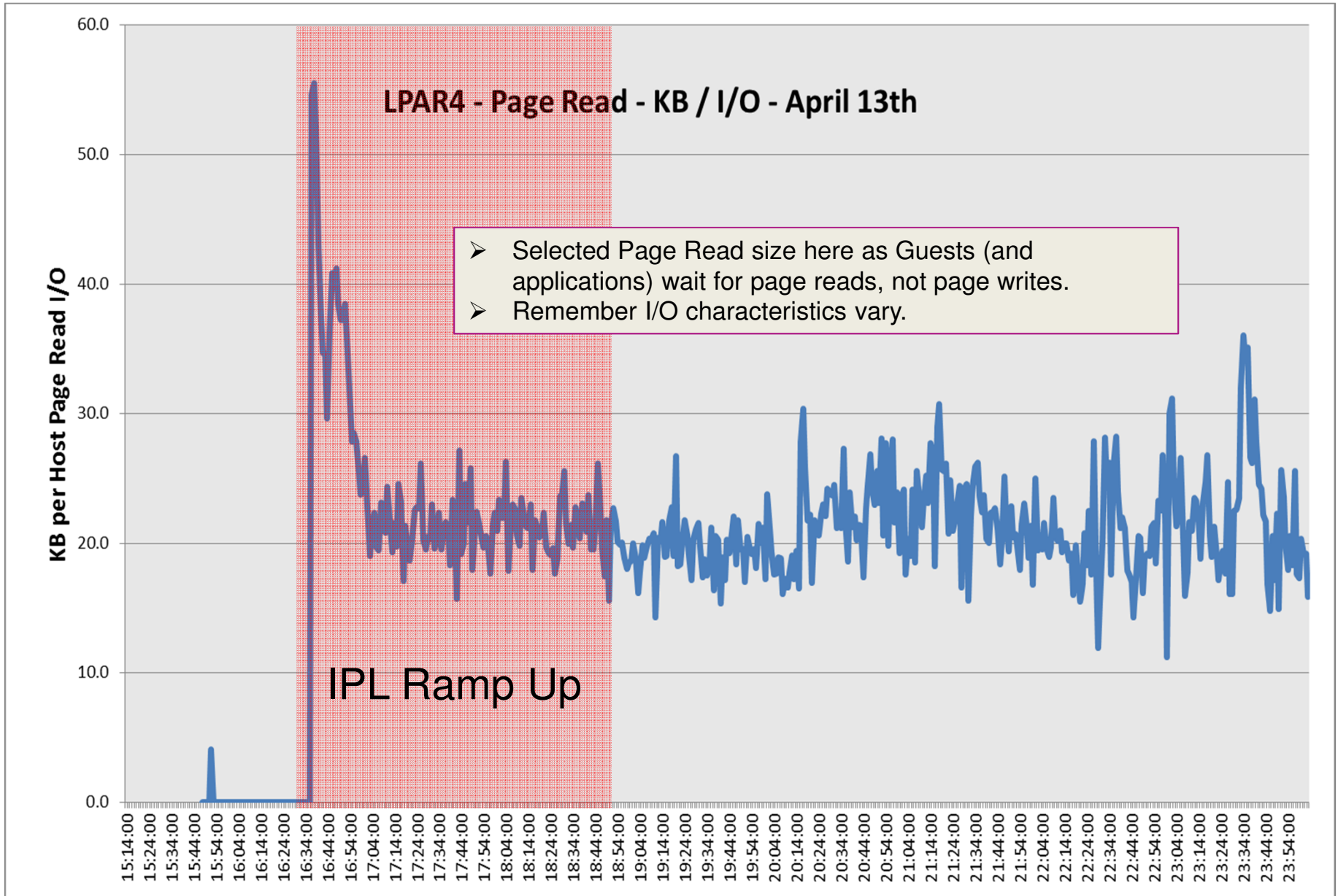
Does the new DS8870 Make a Difference?

- Yes!
- How much is always hard to quantify without perfectly controlled environment.
- A few items from LPAR1 (Remember not apples to apples)
 - Shutdown processing is as “interesting” as IPL processing

Metric	w/o DS8870	w/ DS8870	Difference
Mload (z/VM Measurement of Paging Subsystem Performance)	36.8	3.7	-90%
Average Queue Length of Paging Volumes	12.9	0.44	-97%
Average %PGW from State Sampling	6%	0%	-100%
Average Service Time on Paging Volumes (milliseconds)	17.4	0.21	-99%

Remember Other Spikes on LPAR4?





Perfect Storms

- The z/VM systems are started at different offsets, but spent some time looking at what would happen if they did align.
- It would be significantly more activity, still containable, but I would recommend holding to the staggered start.

Metric	Actual Peak	Perfect Storm
Host Page I/Os	4983/second	11,963/second
Paging MB/second	385 MB/Second	963 MB/Second

Summary



- DS8870 with SSD is providing much better I/O performance characteristics compared to spinning disk.
 - Bonus benefit in Processor resource savings
- The process of restarting 100s of Linux guests impacts paging performance significantly, though the characteristics can be different from high paging rates after the system has stabilized.
- Need to continue to track I/O operations and data rates, as well as the normal performance metrics:
 - Page wait
 - Asynchronous Page wait
 - Available List management
- The need for higher IOPS and bandwidth can be important to z/VM
 - Other limits eliminated
 - Higher consolidation workloads

QUESTIONS & DISCUSSION

Please remember to fill out an evaluation. Thanks!



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