IBM Systems & Technology Group

z/VM Performance Update

Session 9106

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z/VM Performance Evaluation

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Agenda

- **z/VM performance update**
  - z/VM 5.4 major items
  - z/VM 5.4 minor items
  - Interesting APARs
- **Hardware notes**
- **z10 performance**

z/VM 5.4 – Enhancements and Notes

- **Enhancements**
  - Specialty engines
  - Dynamic memory upgrade
  - Virtual CPU share redistribution
  - DCSS above 2 GB
  - TCP/IP layer 2
  - Telnet IPv6
  - Linux install from HMC
  - Upper DAT tables
  - Other changes
  - Service: VMRM “safety net”
  - Service: MDC
- **Notes**
  - Long eligible list stays
  - Reorder processing
  - VMDUMP

z/VM 5.4: Specialty Engines

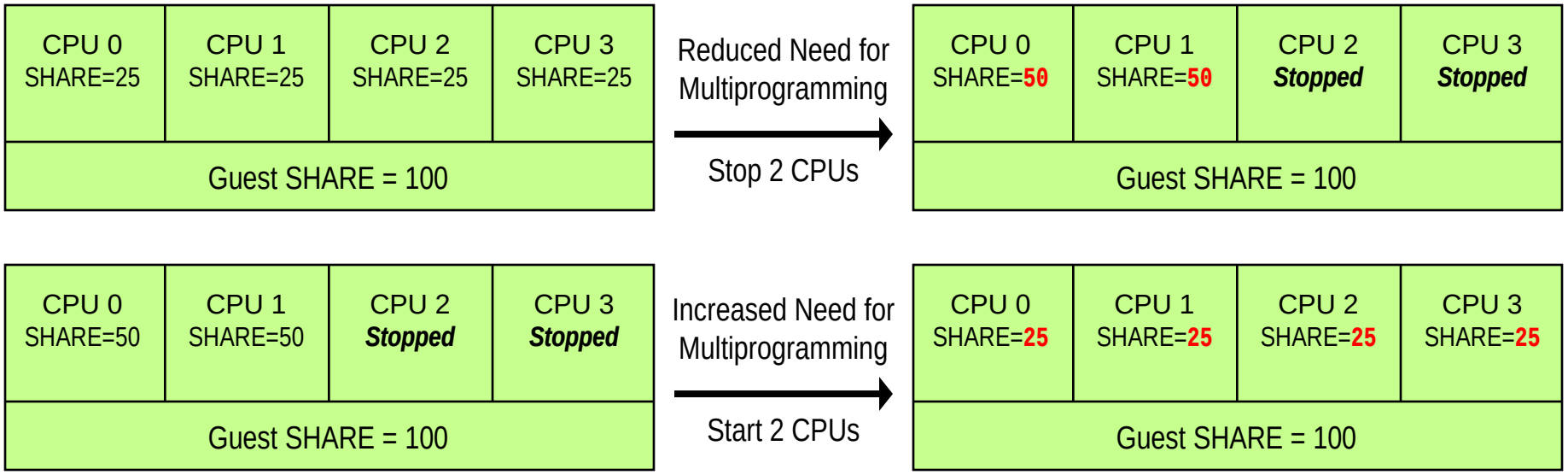
- **Now allow environment with real IFLs and real CPs in same LPAR (as well as other specialty engines)**
  - Called “VM Mode LPAR” – be careful this phrase can be ambiguous at times
- **New options to SET SHARE allow a value for each processor type in a mixed virtual machine.**
- **CPUAFFINITY OFF will result in virtual specialty engines being dispatched on CPs**
- **Merging CP LPAR with IFL LPAR requires thought:**
  - First step, make virtual machines on IFL LPAR have virtual IFLs
  - For duplicated work (RACF, TCP/IP, etc.), need to determine which to use or in some cases which to duplicate
  - Remember that in some environments, the IFLs may be faster than the CPs.
  - You may need to revisit your charge back model.
- **See the z/VM Performance Report**

z/VM 5.4: Dynamic Memory Upgrade

- **Aka Dynamic Storage Reconfiguration**
- **Dynamically add real central storage**
  - No removal; no expanded storage
- **SET STORAGE command response may be delayed**
  - Request for small increase in comparison to memory available to partition
- **Memory is not all initialized instantaneously**
- **Also virtualizes for guests that support it**
- **Some monitor event record anomalies exist**
  - Not surfaced in Performance Toolkit
  - Query commands are correct
  - Fixed in service stream with VM64483
- **See the z/VM Performance Report**

z/VM 5.4: Virtual CPU SHARE Redistribution

- **Allows z/VM guests to expand or contract the number of virtual processors it uses without affecting the overall CPU capacity it is allowed to consume**
  - Guests can dynamically optimize their multiprogramming capacity based on workload demand
  - Starting and stopping virtual CPUs does not affect the total amount of CPU capacity the guest is authorized to use
  - Linux CPU hotplug daemon starts and stops virtual CPUs based on Linux load average value
- **Helps enhance the overall efficiency of a Linux-on-z/VM environment**
- **Previously, stopped virtual processors were given a portion of the guest share.**



Note: Overall CPU capacity for a guest system can be dynamically adjusted using the SHARE setting

z/VM 5.4: DCSSs Above 2 GB

- **DCSSs can be loaded above 2 GB**
  - Each DCSS is still limited to 2047 MB
  - Continue to allow multiples, thus aggregate > 2 GB
- **Requires additional Linux support:**
  - To use a segment above 2 GB
  - To let Linux use ‘stacked’ contiguous DCSSs as one large block device
- **Benefits of sharing much larger amounts of memory**
  - Varies significantly based on configuration and workload.
  - Example: throughput improvements of ~35% for static web serving observed with prototype Linux code.
- **See the z/VM Performance Report**

z/VM 5.4: DCSS Loading Time & Tradeoffs

- **Support for DCSSs above 2 GB means great amount of memory can be used for DCSSs.**
- **Performs well once DCSS is built and data saved.**
- **Placing at higher than necessary addresses results in more memory required for data structures in guest and in z/VM.**
- **Time required to save or fill a DCSS is non-trivial.**
- **Two primary methods of defining segments for use by Linux with unique pros and cons**
  - SR: Shared read-only access.
  - SN: Shared read/write access, no data saved.

z/VM 5.4: DCSS Tradeoffs, SN vs. SR

DCSS Attribute	SN: Shared R/W; not saved[2]	SR: Shared R/O
Non-Volatile (Saved to spool)	NO	YES
Initial elapsed time to 'make ready' the file system[1]	Tends to be faster (not necessarily writing to DASD)	Tends to be slower (must write to DASD)
Spool processing for DCSS can delay other spool activity	NO	YES

[1] Making ready the file system involves various steps of defining, copying data into the DCSS, and saving as necessary.

[2] The DCSS itself is read-write. After data is loaded into the DCSSs, one mounts the file system read-only.

z/VM 5.4: TCP/IP Ethernet Mode

- **TCP/IP stack can now run a real OSA in Ethernet mode (aka "layer 2" mode)**
- **It can also [of course] run a QDIO virtual NIC in Ethernet mode**
  - … thereby letting it couple to an Ethernet-mode guest LAN or Ethernet-mode VSWITCH
- **Key findings: for VSWITCH case, according to workload,**
  - 0% to 13% improvement in throughput
  - 0% to 7% decrease in CPU time per unit of work
- **See the z/VM Performance Report**

z/VM 5.4: Telnet IPv6

- **Our Telnet server can now support IPv6 clients**
  - New Pascal APIs for IPv6
  - Telnet server calls *only* these new IPv6 APIs
    - Uses IPv6-mapped IPv4 addresses if necessary
- **Key findings:**
  - IPv4 regression: impact is “around zero”
  - From IPv4 to IPv6:
    - 12% to 23% increase in throughput
    - 3% to 13% decrease in CPU per unit of work
- **See the z/VM Performance Report**

z/VM 5.4: HMC Linux Install

- **The HMC DVD can now be used to install Linux**
  - z/VM FTP server will communicate with it
  - Alternative to LAN-based server
- **Elapsed time for install is much greater than LAN-based server install**
  - 11 to 12 times slower
  - Up to 3 hours to do base install
- **Do apply the service from the GA RSU**
  - APAR PK69228

z/VM 5.4: Upper DAT Structures Above 2 GB

- **z/VM 5.3 let page tables (PGMBKs) reside above 2 GB**
- **z/VM 5.4 further lets segment tables and region tables reside above 2 GB**
  - These structures tend to require multiple contiguous frames.
  - Helps reduce fragmentation and long searches
    - Resulting in better performance for some configurations
  - Prereq for increasing supported real memory (which we did not do this release)

z/VM 5.4: CMS Based SSL Server

- **Previously, z/VM SSL Server was based on Linux**
  - Required customers to install Linux in a virtual machine
  - Now a CMS based server is used instead of Linux
- **APARs shipped in December for this support:**
  - PK65850 & PK73085
- **Performance**
  - Now exploits the CP Assist for Cryptographic Functions (CPACF) feature where available.
  - Very sensitive to the “maximum session” parameter. Do not set this higher than necessary.
  - Future performance enhancements are planned.

z/VM 5.4: Other Changes

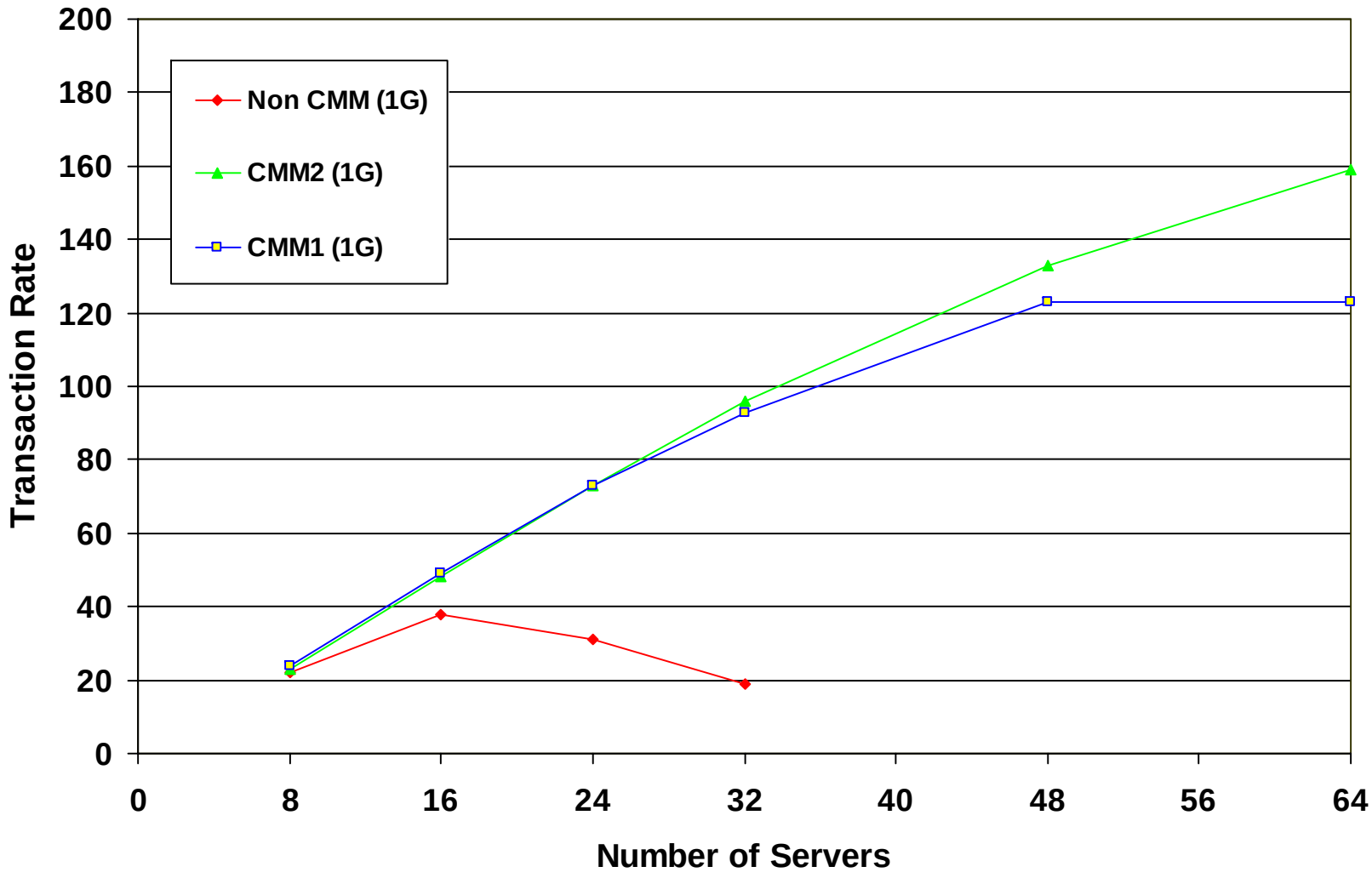
- **PLDV push-through stack: improved efficiency in dequeueing from PLDVs**
- **Virtual CTC: buffering changes help workloads that do > 32 KB writes to VCTCs**
- **VSWITCH changes: improved dispatching, suppressed unnecessary load rebalance calculations, increased packet queuing limits**
- **MDC 8 GB: once MDC reached 8 GB, it stopped doing inserts. Not anymore. ☺**
- **Contiguous available lists: moved low-water and high-water marks closer together – seemed like the right thing for the workloads we tried**

VM64439: CMM–VMRM Change

- **CMM1 aka CMM & VMRM aka ballooning aka Cooperative Memory Management**
- **CMM2 aka MEMASSIST aka CMMA aka Collaborative Memory Management**
- **New CMM-VMRM 64 MB "safety net" –**
  - In base of z/VM 5.4.0
  - As APAR VM64439 for z/VM 5.2.0 & z/VM 5.3.0
    - z/VM 5.2.0 PTF UM32427
    - z/VM 5.3.0 PTF UM32428
- **For additional details see:**
  http://www.vm.ibm.com/perf/reports/zvm/html/530cmm.html

Transaction Rate vs. Number of Servers

for various Storage Management Products using Apache servers with a virtual storage size as shown in parentheses in the legend; z9 6 GB / 2 GB



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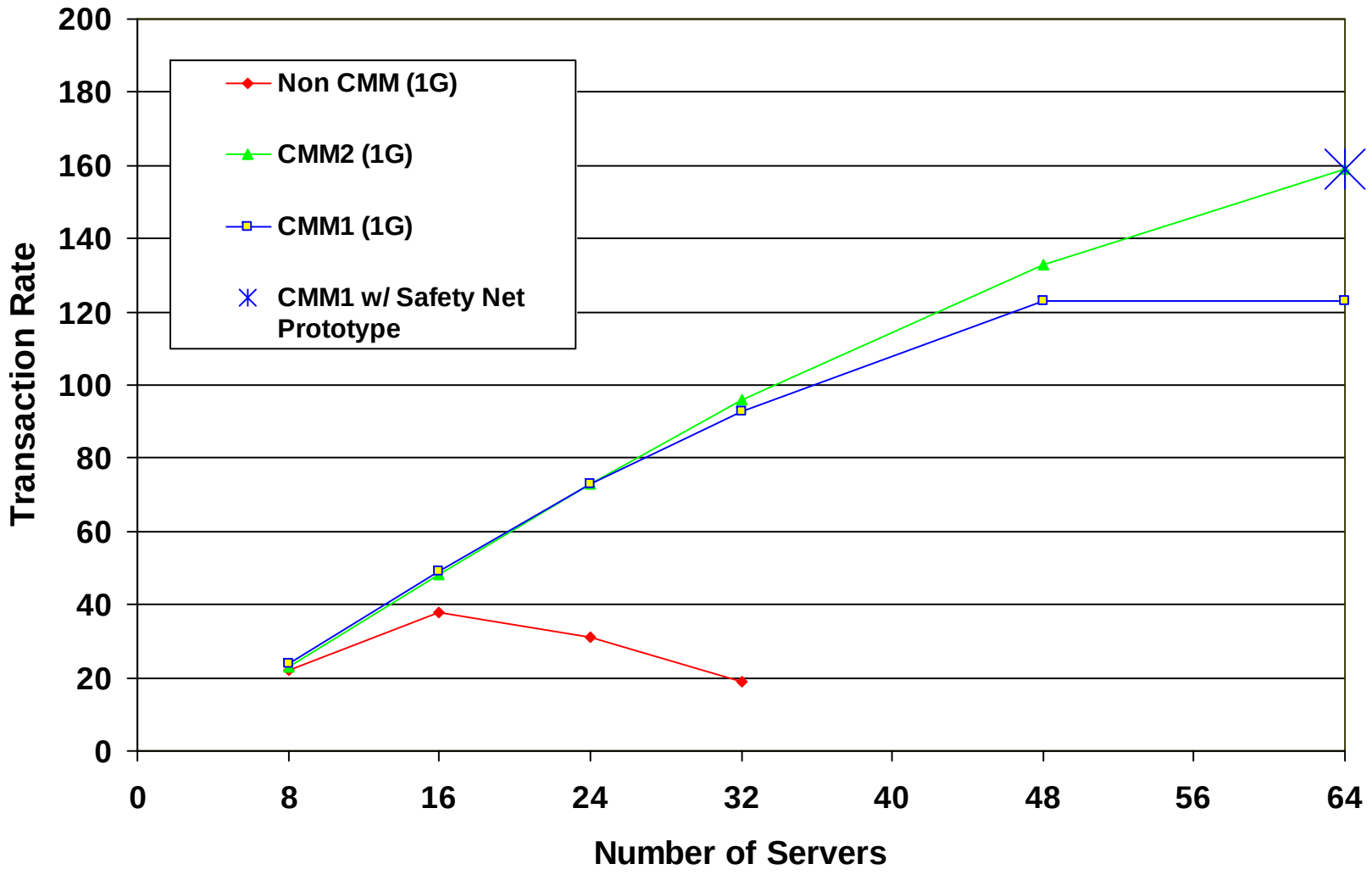

VM64082 and VM64510: MDC Changes

- **VM64082**
  - (z/VM 5.2.0 & 5.3.0). Not on any RSU.
  - Rolled into base of z/VM 5.4.0
  - This change improves MDC Arbiter choices in some environments (doesn't overbias for MDC).
  - Also, makes other environments worse by biasing too much against MDC.
  - Use SET MDC command to bound the range of memory to avoid problems.
- **VM64510: VM64082 had problems on z/VM 5.3 and 5.4**
  - Caused too-frequent steal of pages from MDC
  - VM64510 fixes it

z/VM 5.4: Long Eligible List Stays

- ***Eligible list*** **is where the scheduler keeps virtual machines to prevent them from running and causing thrashing.**
- **SET SRM and SET QUICKDSP tuning options can be used to keep the proper guests from being trapped in eligible list.**
- **There have been known cases of virtual machines trapped in the eligible list for longer than acceptable times in past releases.**
- **There is evidence that in z/VM 5.4 there is a greater tendency for virtual machines to get trapped when system is not properly tuned.**

z/VM: Reorder Processing & Large Resident Counts

- ***Page reorder* is the process of managing user frame owned lists as input to demand scan processing.**
  - It includes resetting the HW reference bit.
  - Serializes the virtual machine (all virtual processors).
  - In all releases of z/VM
- **It is done periodically on a virtual machine basis.**
- **The cost of reorder is proportional to the number of resident frames for the virtual machine.**
  - Roughly 130 ms/GB resident
  - Delays of ~1 second for guest having 8 GB resident
- **Development is investigating improvements**

z/VM: VMDUMP Processing

- **VMDUMP is a very helpful command for problem determination.**
- **Some weaknesses:**
  - Does not scale well, can take up to 40 minutes per GB.
  - It is not interruptible
- **Linux provides a disk dump utility which is much faster relative to VMDUMP.**
  - It is disruptive
  - Does not include segments outside the normal virtual machine.

Hardware Concerns

- **ECPMF and FCP chpids**
- **LPAR monitor records**
- **z10 performance compared to z9**

HW: Monitor – Some FCP channels have incorrect data

- **Domain 0 Record 20 reports Extended Channel Path Measurement Facility information**
- **This data appears incorrect for some FCP channels.**
- **Reference z/VM internal problem number FC01043**
- **Resolved in hardware:**
  - z9 with Driver 67L + MCLs G40938.004 and G40939.004
  - z10 with Driver 76D + MCLs available 2/23/2009

HW: LPAR Monitor Records, z10 + z/VM 5.2

- **z/VM 5.2 customers running on z10 will not get LPAR monitor records for other partitions on the CEC.**
- **z/VM 5.3 and z/VM 5.4 are fine.**
- **Other processors are fine.**
- **A hardware problem ODT S5619 is open to correct this.**
- **Corrected with:**
  - EC Level: F85901
  - MCL No: 006
  - Driver: D73G

HW: z10 Performance

- **Processor cycle time greatly improved over z9**
  - ~2.6 times faster (4.4 GHz)
  - Comparable to other platforms
- **Laws of physics must be obeyed**
- **Tradeoffs made in order to achieve above**
  - Memory differences
  - Key ops
- **ITR ratios (examples see LSPR for most current numbers)**
  - z/OS: z10 EC 701 up to **1.62 times** that of the z9 EC 701
  - LSPR z/VM measurements: 1.30 to 1.60
  - z/VM Endicott lab measurements: 1.23 to 2.05

HW: z10 Performance Depends On….

- **Number of processors**
  - Fewer processors, better ITRR
- **Storage references**
  - Smaller memory footprints, better ITRR
- **Data movement**
  - Less data movement, better ITRR
- **Virtual I/O to real devices**
  - Less virtual I/O, better ITRR
- **Storage overcommitment**
  - Less over commitment, better ITRR
- **Amount of memory involved in long searches**
  - Shorter & less frequent searches, better ITRR
- **Exploitation of new features**
  - More exploitation of features, better ITRR

HW: z10 Performance: Setting Proper Expectations

- **z10 is a great machine, with a number of excellent attributes.**
- **Care must be taken when sizing migrations from z9 to z10.**
- **Additional Information:**
  - LSPR Q & A (complete)
    - Discuss range and factors affecting
    - Pointer to z/VM web page
  - z/VM web page
    - http://www.vm.ibm.com/perf/z10.html
  - "To MIPS or Not to MIPS, That is the Question!" by Gary King
    - http://shareew.prod.web.sba.com/proceedingmod/abstract.cfm?abstract_id=17583

Summary

- **Specialty engines and DMU help z/VM keep up with hardware's capabilities**
- **Several other enhancements in z/VM 5.4**
- **z10 is a good machine, but attention to detail is required**
- **Check out the z/VM performance report: http://www.vm.ibm.com/perf/reports/zvm/html/**
  - z/VM 5.4 topics published on September 19, 2008