E43

VSE Performance update

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IBM eServer zSeries

VSE Performance update

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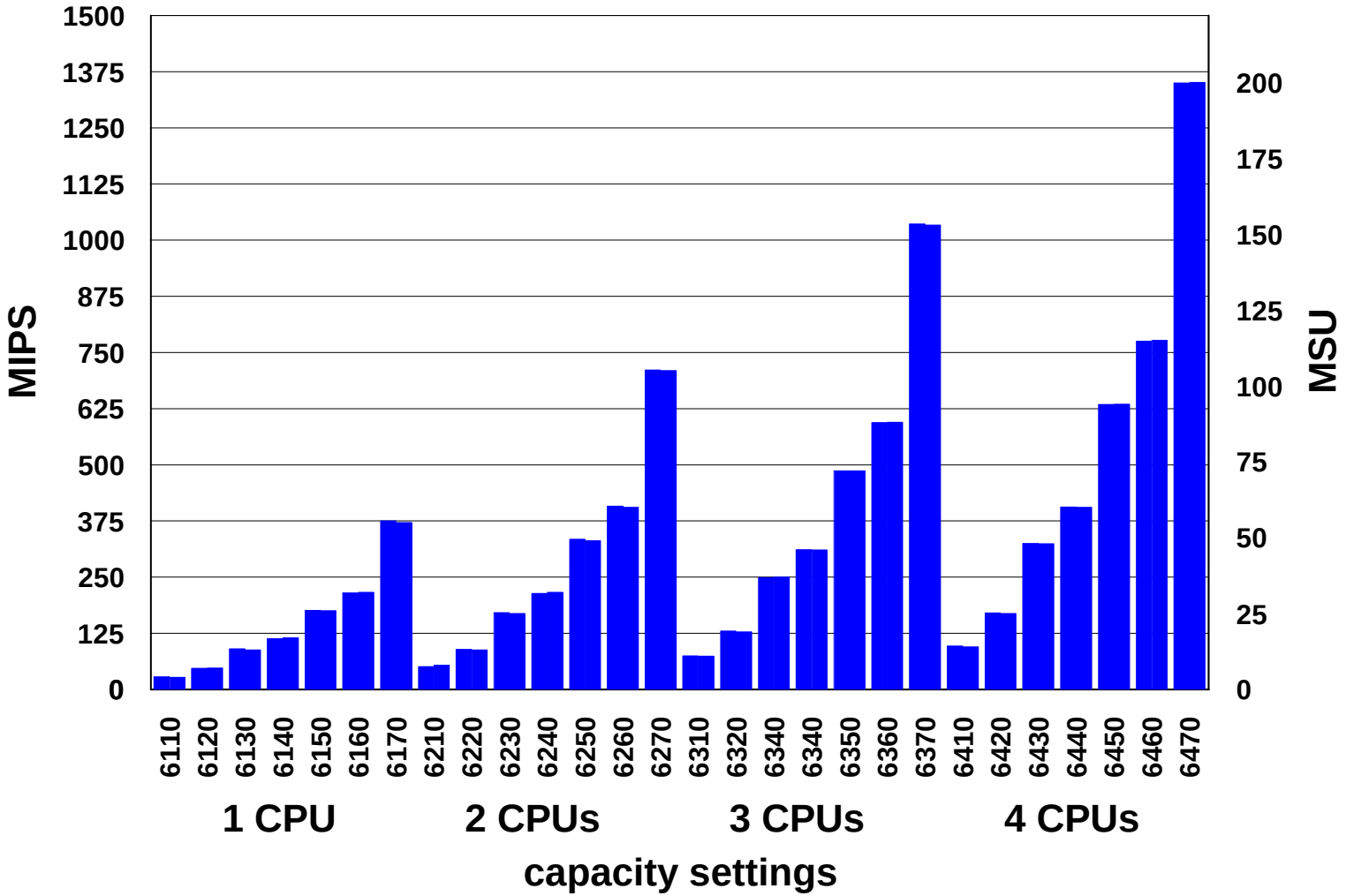
Agenda

- **News**
- **Hardware support**
- **HiperSockets**
- **Hardware Crypto support**
- **Dependencies for VSE/ESA Growth**
- **Turbo Dispatcher**
- **VSE health check**
- **Hints and Tips**

New: z/VSE 3.1 preview announcement

- **z/VSE 3.1 is planned to be able to support:**
  - z890, z800, z900, z990
  - Multiprise 3000, G5 and G6
  - Fibre Channel Protocol for SCSI — FCP channels
- **IBM plans to continue to ship CICS/VSE V2.3 together with CICS TS for VSE/ESA**
  - at no additional charge.
- **z/VSE plans to offer simplified packaging**
  - LE will become a component of VSE Central Functions
- **Fast Service Upgrade possible from VSE 2.7 and 2.6**
  - using equivalent ECKD disks
  - NOT: from ECKD to SCSI-FCP disks.

New: IBM eServer zSeries 890



z890 consists of one Model (A04) and 28 capacity settings

New: Enterprise Storage Server Model 750 (Baby-Shark)

- **The ESS Model 750 is based on the same architecture as the ESS Model 800 to support functionality, stability, and reliability**
- **up to 64 disk drives**
- **4.6 terabytes (TB) of physical capacity**
- **A two-way processor**
- **8 GB of cache**
- **2 GB of Non Volatile Storage (NVS)**
- **up to 6 Fibre Channel/FICON or ESCON host adapters**
- **Support for 72.8 GB and 145.6 GB 10,000 rpm drives**
- **configured as RAID 5, RAID 10, or a combination of both**

VSE/ESA 2.7 Hardware support

- **VSE/ESA 2.7 runs on the following machines**
- **zSeries: z800, z900, z990, z890**
- **9672 Parallel Enterprise Server (G5/G6)**
- **Multiprise 3000 (7060)**
- **equivalent emulators (Flex-ES)**
- **VSE/ESA 2.7 is based on the hardware instruction set described in the manual 'ESA/390 Principles of Operation' (SA22-7201).**
- **With VSE/ESA 2.7 it is assumed that all the ESA/390 instructions and facilities described in that manual can be used.**

Supported VSE Releases

- **VSE/ESA 2.4/2.3: already out of service**
  - runs also on zSeries (z800, z900)
  - does not run on z990, z890 (Hardwait during IPL)
- **VSE/ESA 2.5: end of service 12/31/2003**
  - runs also on zSeries (z800, z900)
  - runs also on z990 with additional PTF
- **VSE/ESA 2.6**
  - runs also on zSeries (z800, z900)
  - runs also on z990, z890 with additional PTF
- **VSE/ESA 2.7**
  - runs on zSeries (z800, z900, z990, z890, G5/G6, MP3000)
- **OSA Express: Supported with VSE/ESA 2.6 and 2.7**
- **HiperSockets and PCICA (Crypto)**
  - Supported with VSE/ESA 2.7

zSeries Remarks

- **Prior to zSeries there is one cache for data and instructions**
- **zSeries has splited data and instruction cache**
- **Performance implications:**
  - If program variables and code that updates these program variables are in the same cache line (256 byte)
    - Update of program variable invalidates instruction cache
    - Performance decrease if update is done in a loop
  - See APAR PQ66981 for FORTRAN compiler

Hardware Support

- **Queued Direct I/O**
  - Designed for very efficient exchange of data
  - Uses the QDIO Hardware Facility, without traditional S/390 I/O instructions
  - Without interrupts (in general)
  - Use of internal queues
  - With pre-defined buffers in memory for asynchronous use
- **Exploitation by TCP/IP for VSE/ESA**

HiperSockets hardware elements ('Network in a box')

- **Synchronous data movement between LPARs and virtual servers within a zSeries server**
  - Provides up to 4 "internal LANs" HiperSockets accessible by all LPARs and virtual servers
  - Up to 1024 devices across all 4 HiperSockets
  - Up to 4000 IP addresses
  - Similar to cross-address-space memory move using memory bus
- **Extends OSA-Express QDIO support**
  - LAN media and IP layer functionality (internal QDIO = iQDIO)
  - Enhanced Signal Adapter (SIGA) instruction
    - No use of System Assist Processor (SAP)

HiperSockets hardware elements ('Network in a box')

- **HiperSockets hardware I/O configuration with new CHPID type = IQD**
  - Controlled like regular CHPID
  - Each CHPID has configurable Maximum Frame Size
- **Works with both standard and IFL CPs**
- **No physical media constraint, no physical cabling, no priority queuing**
- **Secure connections**

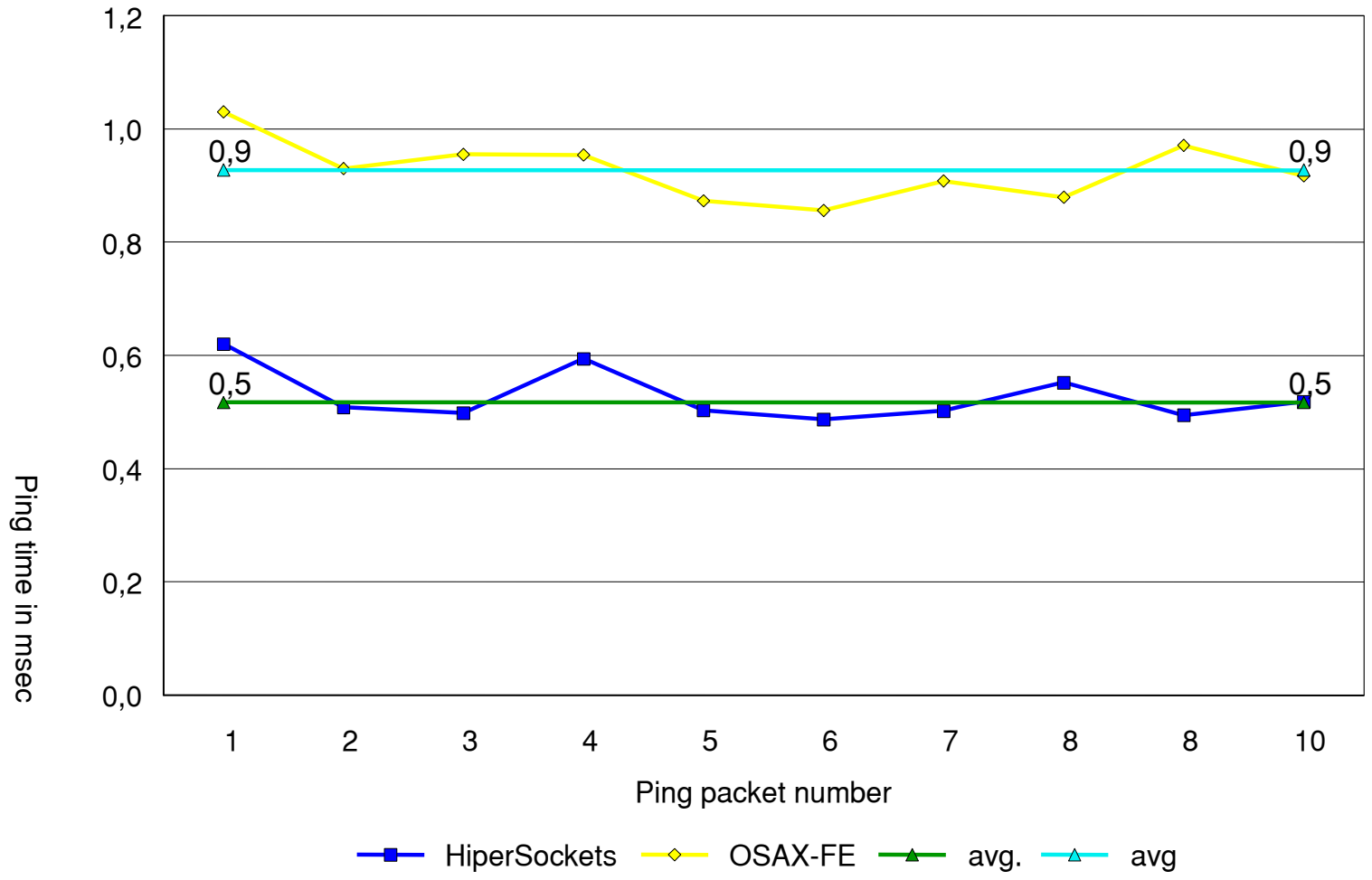
Measurement Environment

- **z800 (2066-004)**
  - 4 processors
- **VSE/ESA 2.7 GA Driver in a LPAR (native)**
  - 1 CPU active (~2066-001)
  - TCPIP00 (F7): OSA Express Fast Ethernet
  - TCPIP01 (F8): HiperSockets
- **Linux for zSeries in a LPAR (native)**
  - 3 CPUs active (shared)
  - eth0: OSA Express Fast Ethernet
  - hsi10: HiperSockets

Latency (Round trip time) - results

- **Measurements has been done with PING command**
  - Issued at Linux side
  - 10 Pings
  - PING sends a datagram to VSE
  - VSE sends a answer back to Linux
  - Time until answer arrives is measured
    - Round trip time

Latency (Round trip time) - results

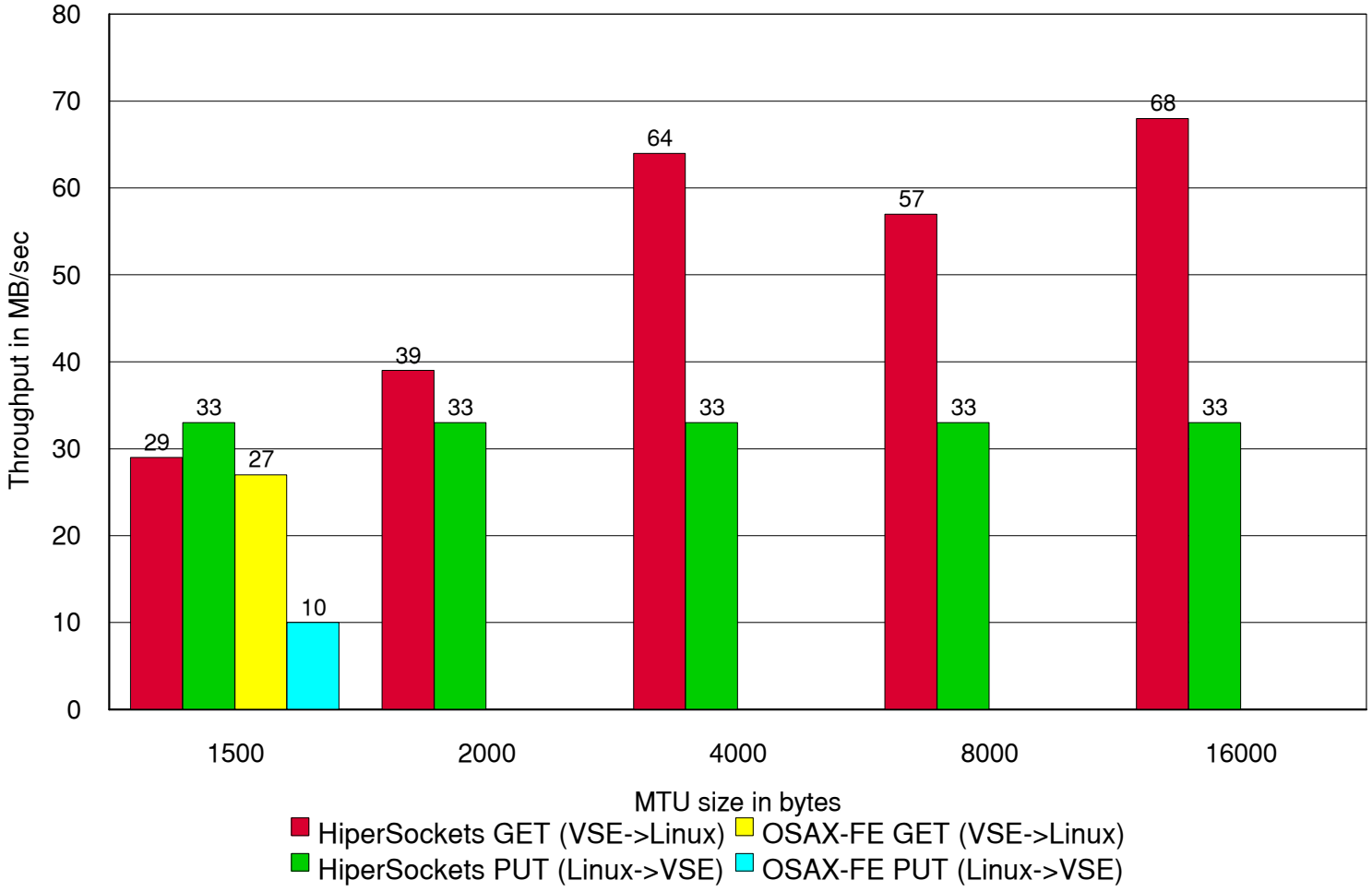


HiperSockets is about 1.8 times faster in terms of latency

Throughput (MB/sec)

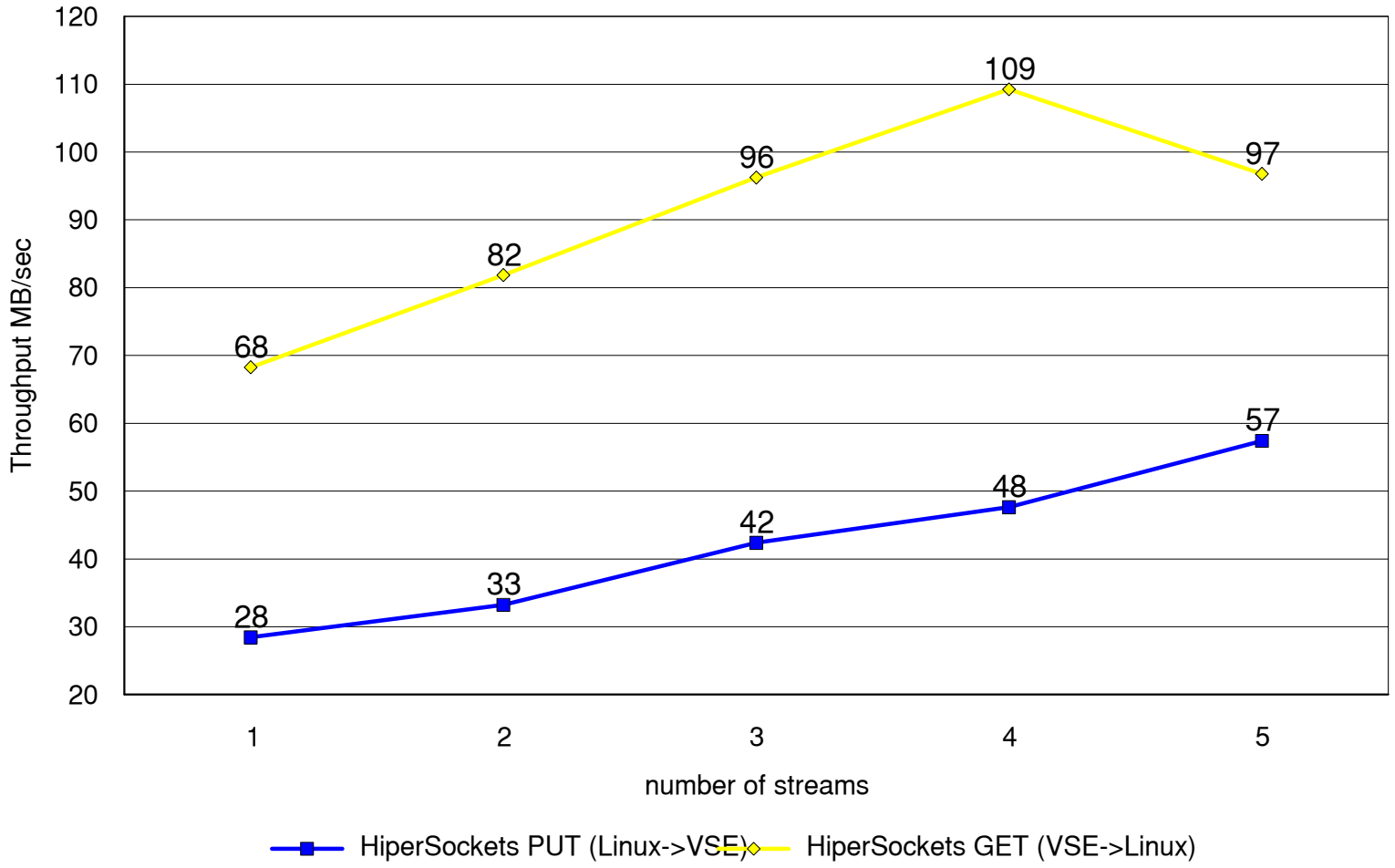
- **Measurements has been done with FTP**
  - Initiated at the Linux side
  - Transferring 1GB (1000MB)
    - without translation (binary)
    - 1 to 5 parallel streams
  - PUT: send data to VSE
    - VSE inbound
    - sending a 1GB file to $NULL file (in memory file)
    - No file I/O is done by VSE/Linux
  - GET: receive data from VSE
    - VSE outbound
    - receiving $NULL file (in memory file) into /dev/null
    - No file I/O is done by VSE/Linux

Throughput (MB/sec) - results



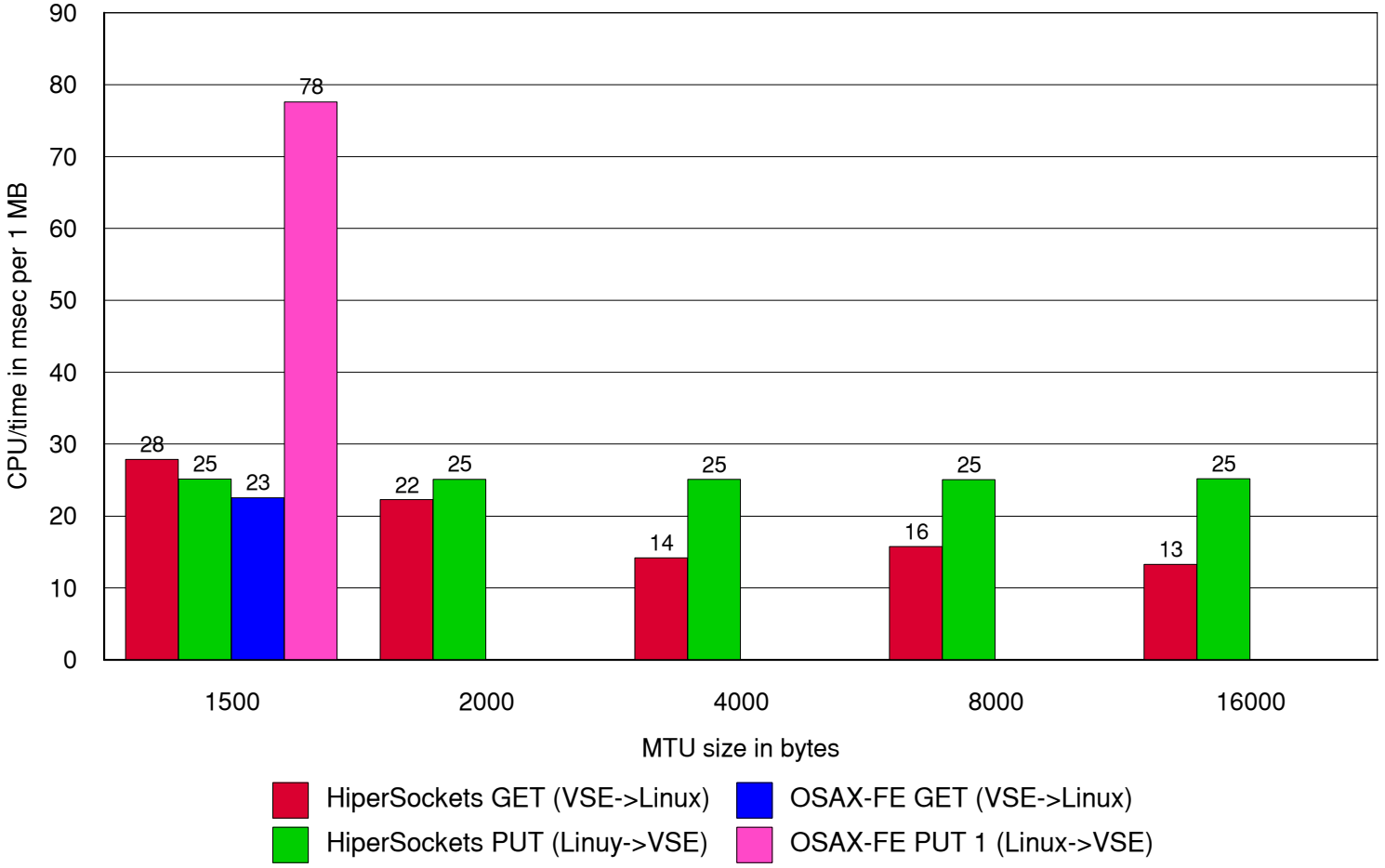
HiperSockets throughput is between 30-80 MB/sec

Throughput (MB/sec) - results (2)



Maximum HiperSockets throughput of 109 MB/sec at 4 concurrent connections

CPU time per MB - results

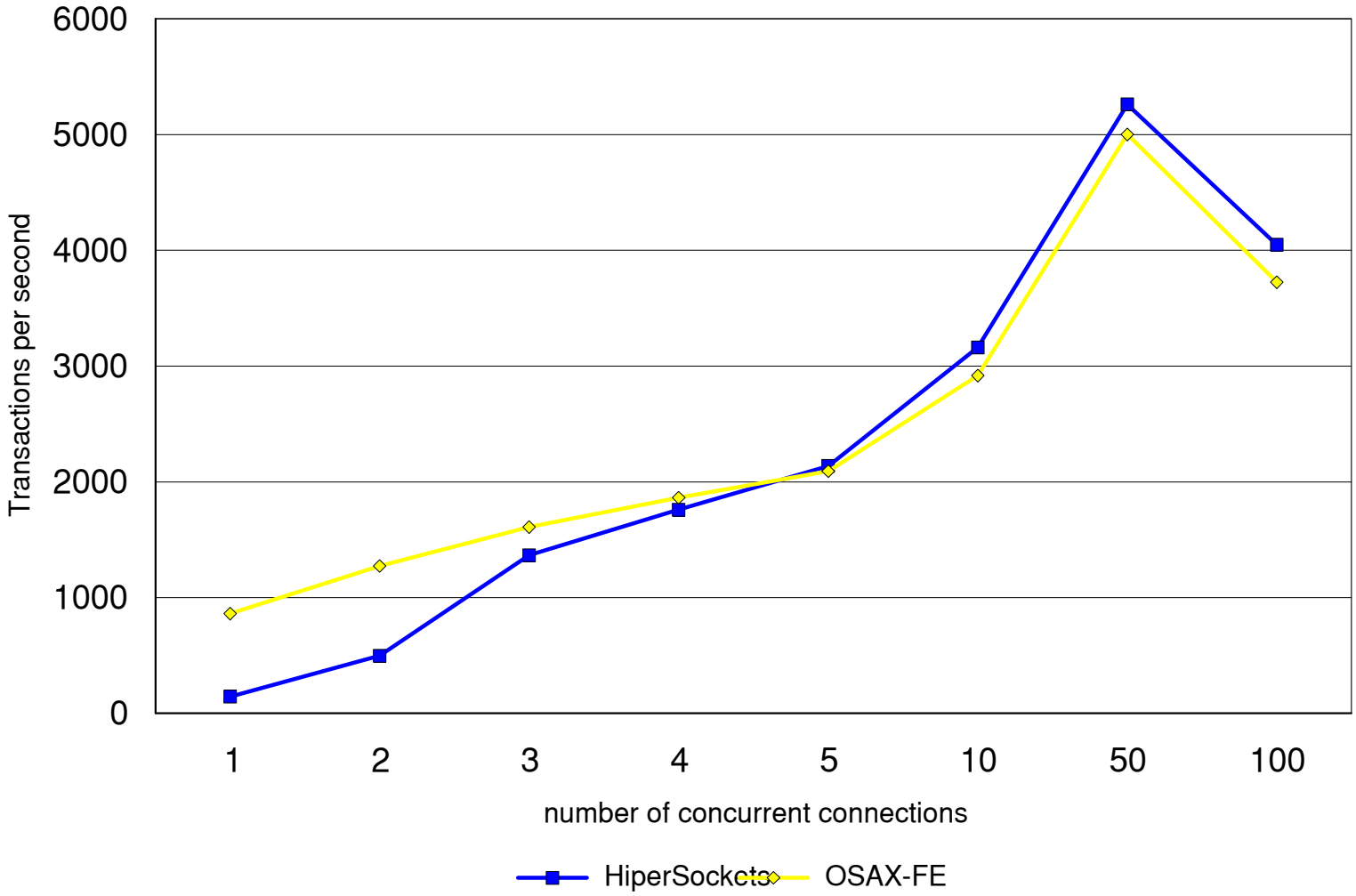


About 15-30 msec CPU time per MB for HiperSockets
(on a z800 2066-001)

Transaction per second

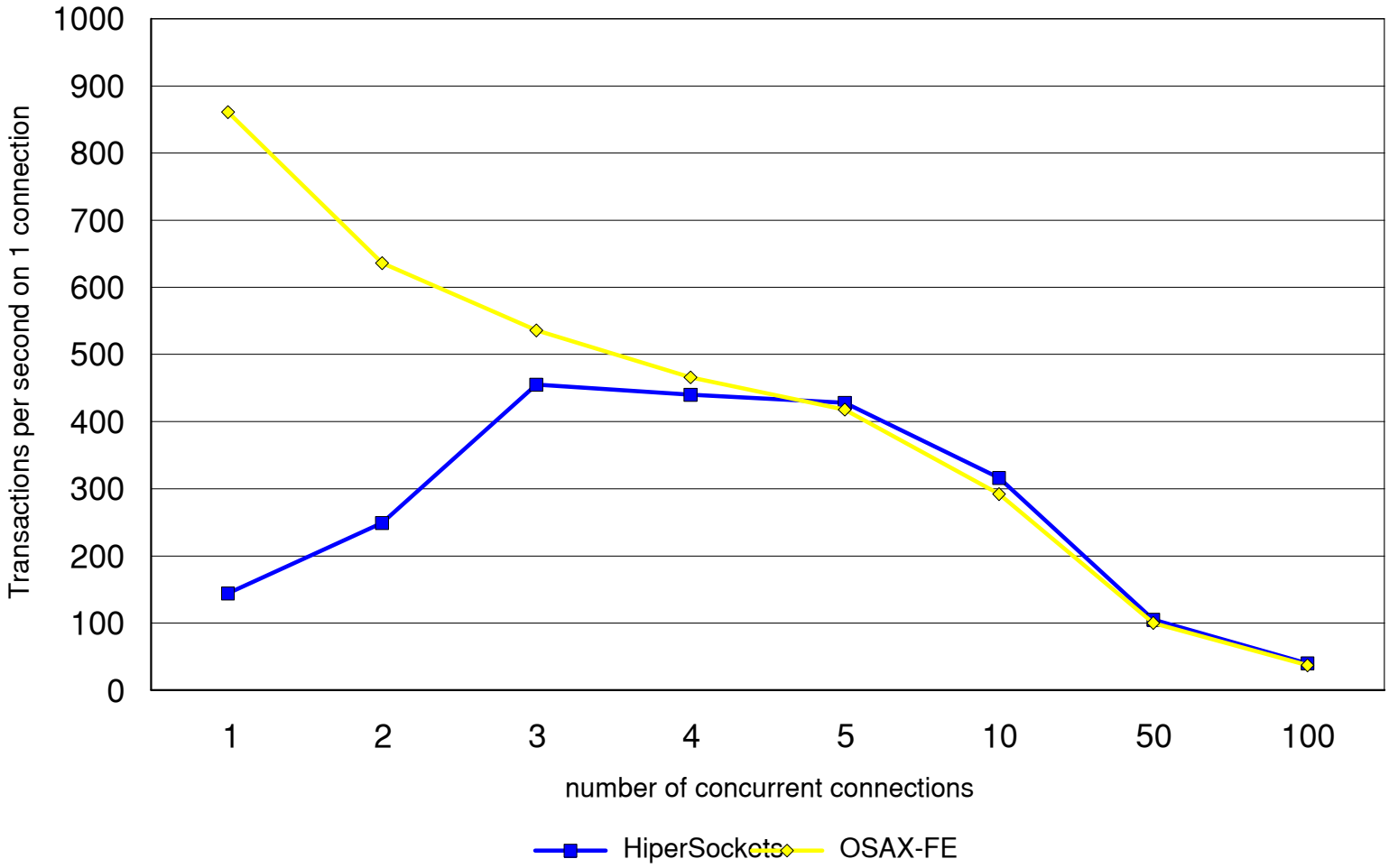
- **Measurements has been done with an ECHO server**
  - Client on Linux sends 100 bytes to server
  - Server on VSE echoes 100 bytes
  - Per TCP connection 10000 transactions are driven
  - Variations: Number of TCP connections
    - 1,2,3,4,5
    - 10,50,100
  - Measurements
    - Transactions per second
    - CPU time per transaction

Transactions per second – results



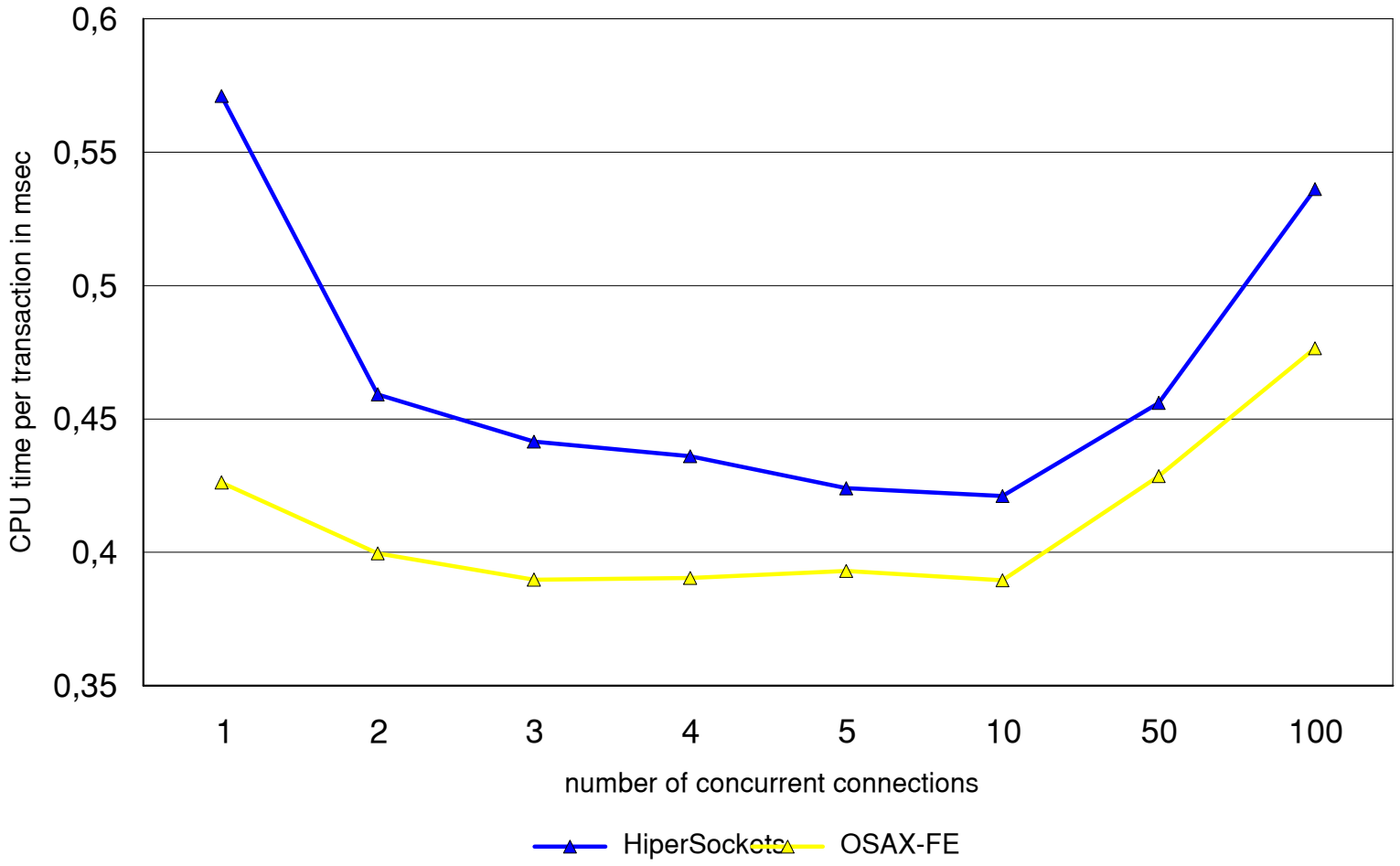
Maximum of 5200 transactions per second at 50 concurrent connections

Transactions per second on 1 connection - results



HiperSockets: Maximum of about 450 transactions per second on 1 connection (= about 2 msec response time)

CPU time per transaction



HiperSockets: About 0.45 msec CPU time per transaction for 2-50 connections

Measurement Results - conclusion

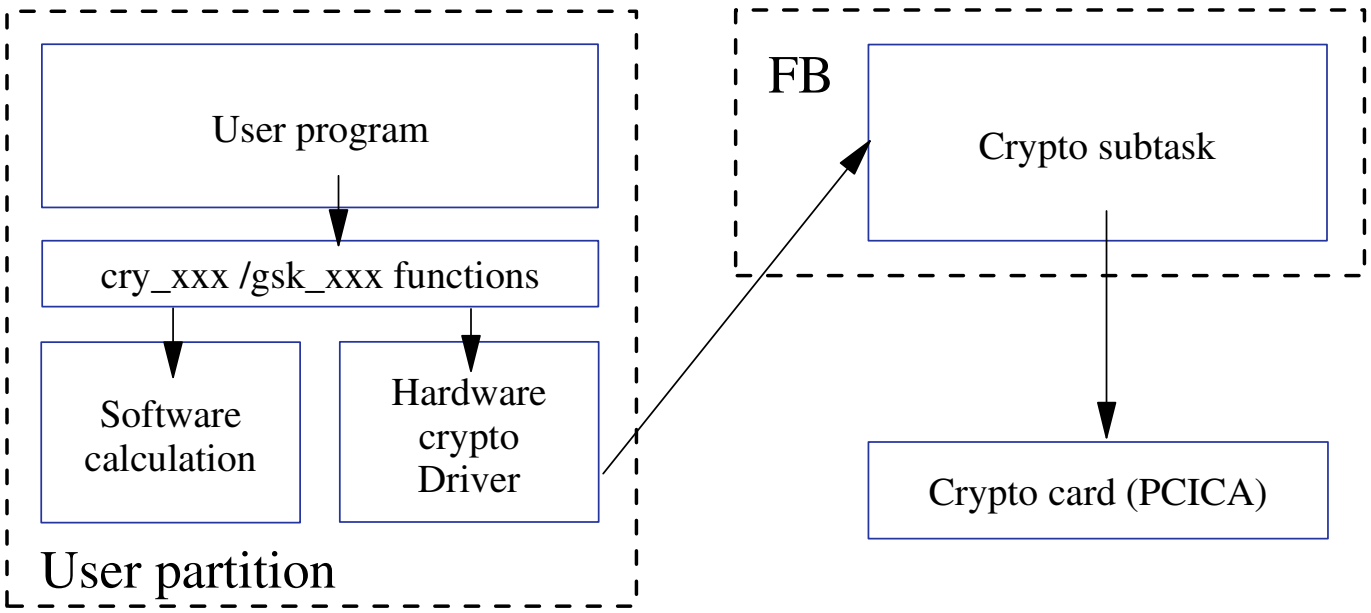
- **HiperSockets**
  - Throughput
    - Between 30-80 MB/sec
    - Maximum throughput of 109 MB at 4 connections
    - About 15-30 msec CPU time per MB
  - Transactions per second
    - Maximum of 5200 Transactions per second at 50 connections
    - About 0.4-0.45 msec CPU time per transaction

Hardware Crypto Overview

- **Requires VSE/ESA 2.7 and TCP/IP for VSE/ESA 1.5**
- **Supported crypto cards**
  - PCI Cryptographic Accelerator (PCICA)
    - Feature code 0862
    - Available for zSeries (z800, z900)
- **The crypto card is plugged into the Adjunct Processor**
- **Currently only RSA (asymmetric) is supported**
  - Of benefit for Session initiation (SSL-Handshake)
- **Also supported with**
  - z/VM 4.2 + APAR VM62905
  - z/VM 4.3

Hardware Crypto Overview - continued

- **New crypto subtask in Security Server (SECSERV) running in FB**
  - Or as separate job if no SECSERV is running
  - Crypto card is polled by crypto task



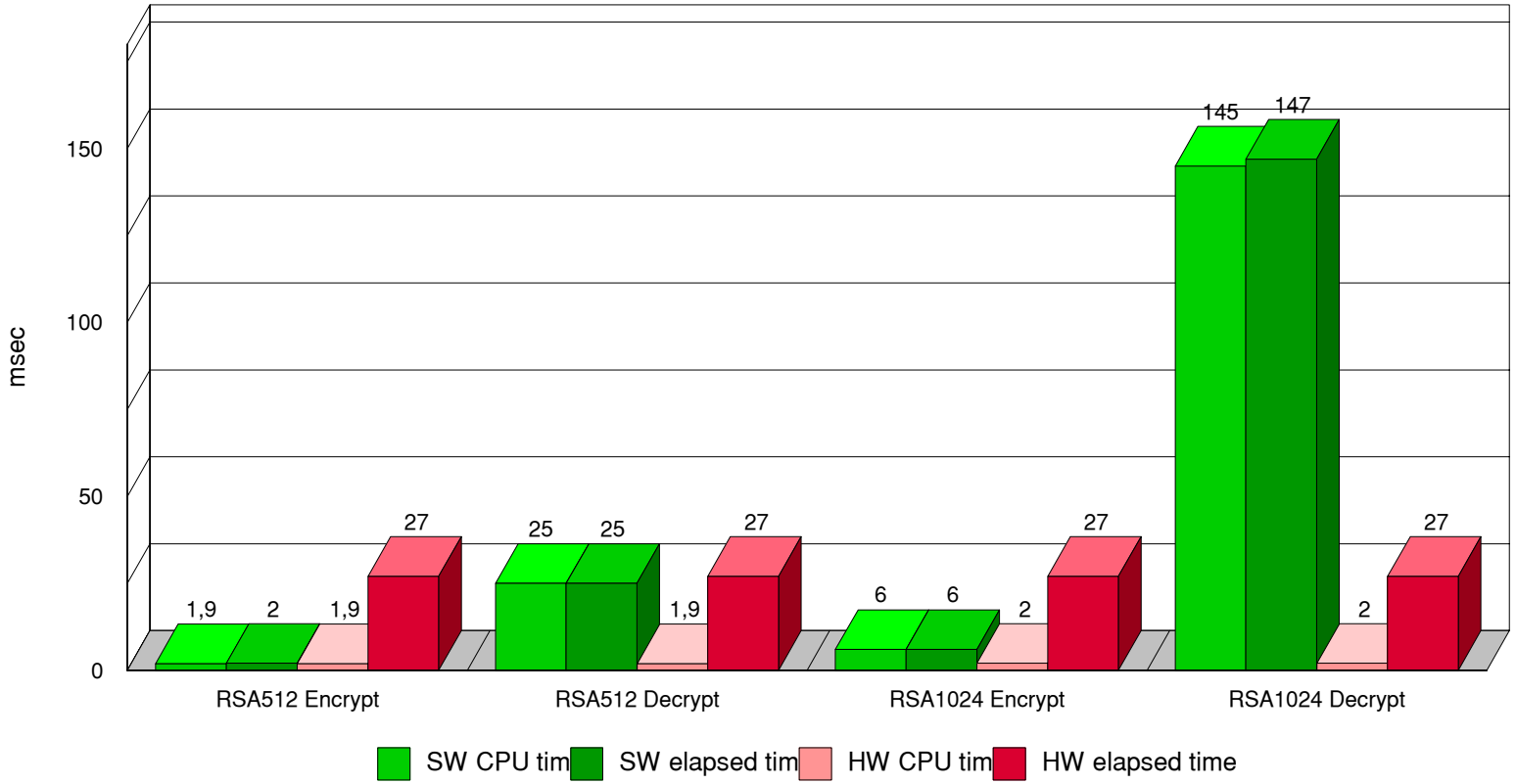
Measurement Environment

- **VSE/ESA 2.7 running on a z900 (2064-109)**
  - on 1 processor (~2064-101)
  - with a PCI Cryptographic Accelerator
- **Test case programs on VSE**
  - Crypto operations measurements
    - calling cry_xxx functions (RSA, DES, SHA, MD5)
    - each crypto operation is performed 10000 times
  - Secured data transfer (SSL)
    - performs SSL handshake
    - performs encrypted data transfer
    - counterpart program running on Windows (SSL-client)
- **All RSA operations are measured**
  - with Hardware Crypto support
  - with Software Crypto
    - (support already available with TCP/IP 1.4/1.5 as shipped in VSE/ESA 2.6)

Measurement Environment - continued

- **Variations**
  - RSA encrypt/decrypt
    - 512 / 1024 bit key
  - DES, DES CBC, 3DES CBC encrypt/decrypt
    - software crypto only
    - message length (128, 256, 512 bytes)
  - SHA Hash, MD5 Hash, SHA HMAC, MD5 HMAC
    - software crypto only
    - message length (128, 256, 512, 1K, 2K bytes)
  - SSL handshake/data transfer
    - 01 RSA512_NULL_MD5
    - 02 RSA512_NULL_SHA
    - 08 RSA512_DES40CBC_SHA
    - 09 RSA1024_DES_CBC_SHA
    - 0A RSA1024_3DES_EDE_CBC_SHA

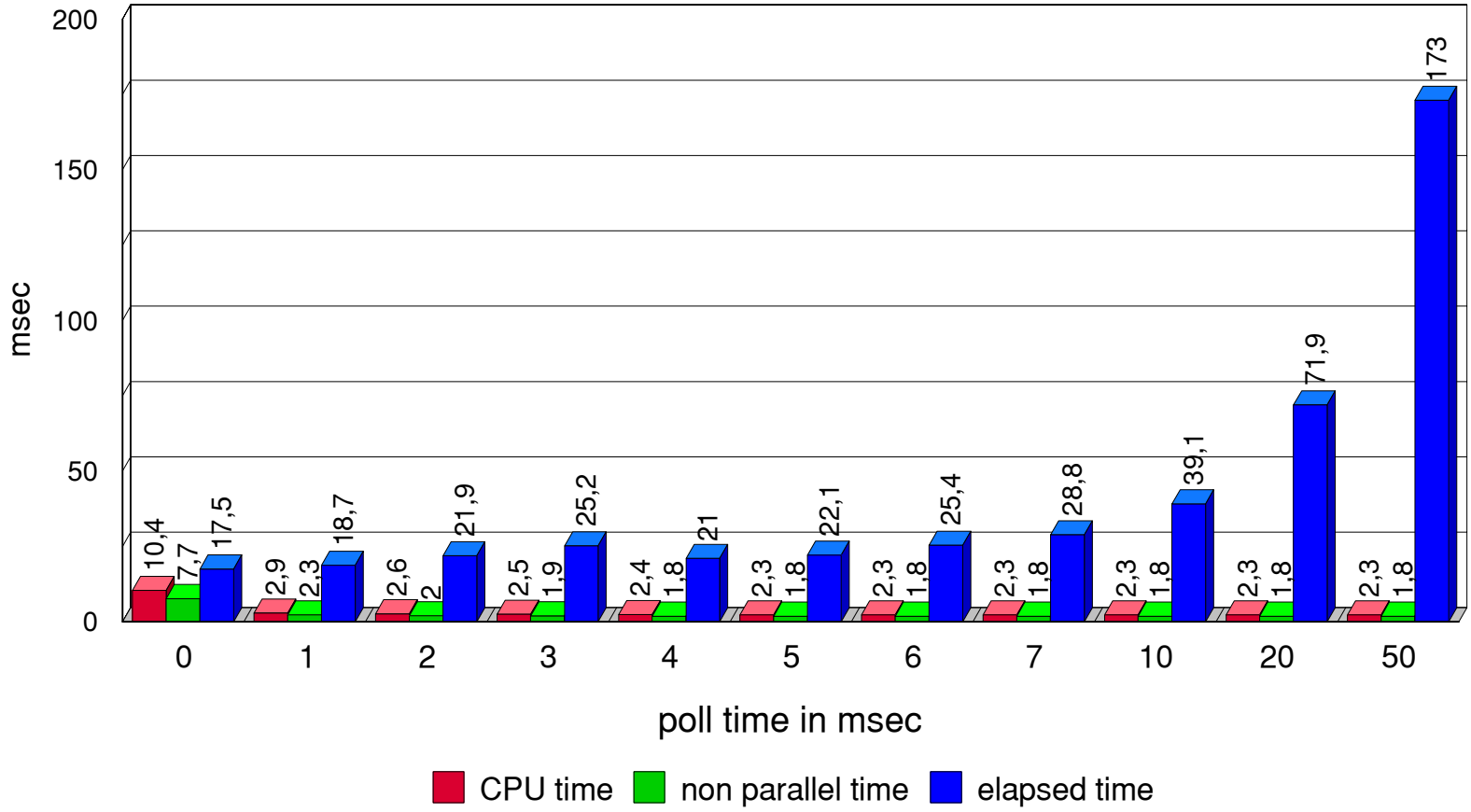
Measurements Results - RSA



HW Crypto:

- CPU time and elapsed time is independent of operation / key length
- RSA operation takes about 2 msec CPU time and 28 msec ellapsed time
- CPU time is always less than software crypto

Measurements Results - RSA polltime

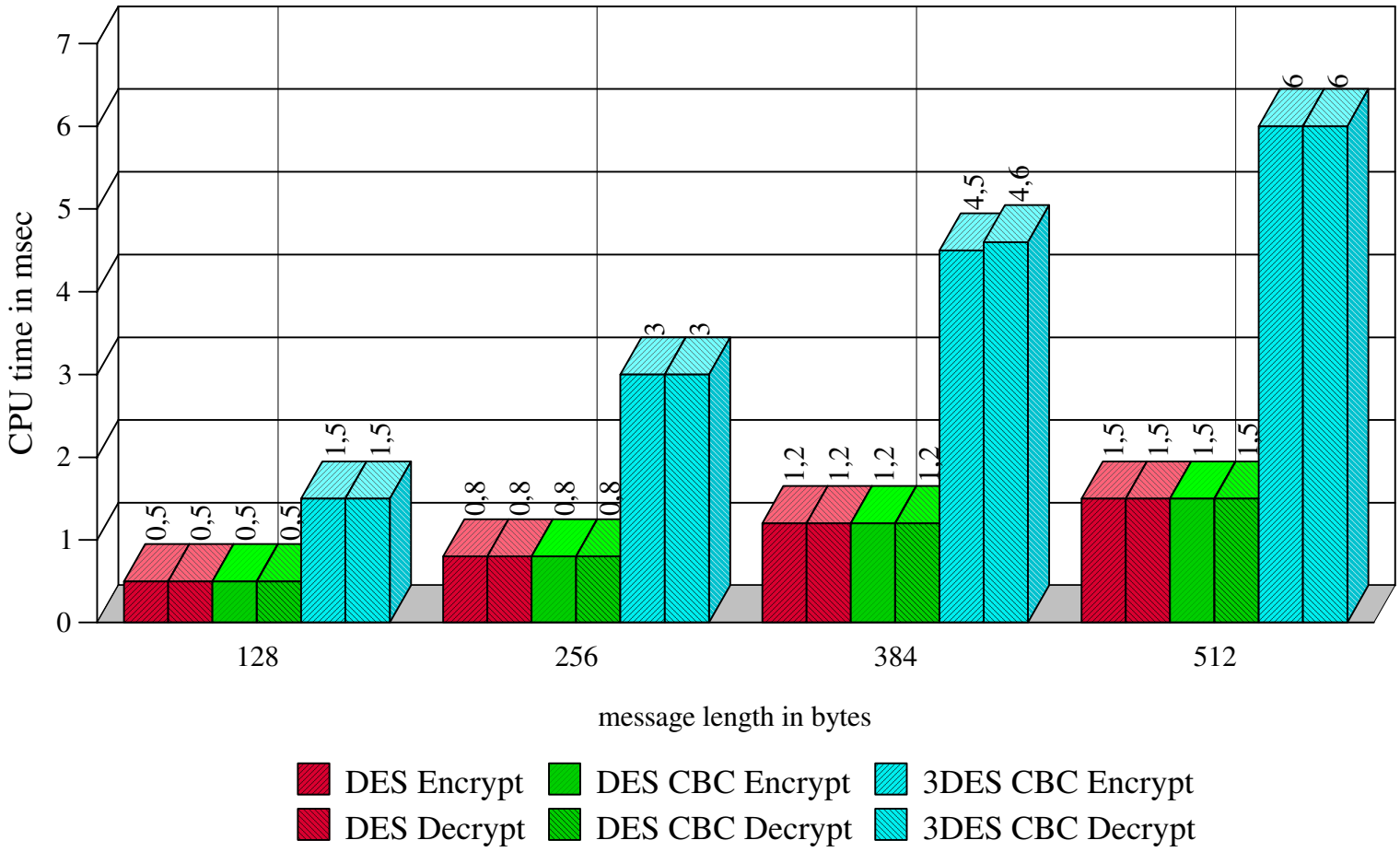


Per default a polltime of 7 msec is used.

Can be changed with: MSG FB,DATA=WAITTIME=nn

Smaller values increases CPU time, higher values increases ellapsed time

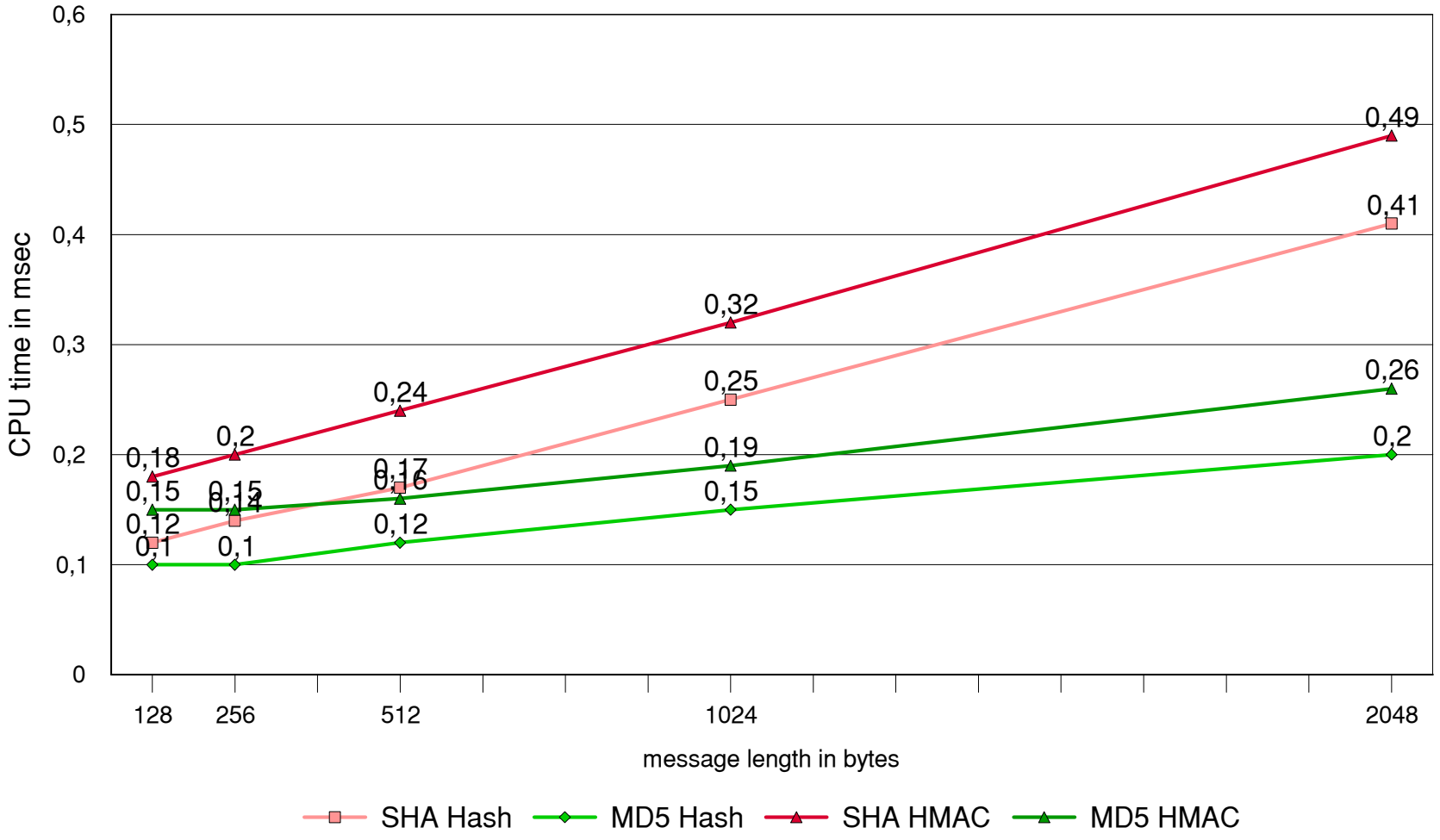
Measurements Results - DES, DES CBC, 3DES CBC



Software Crypto only!

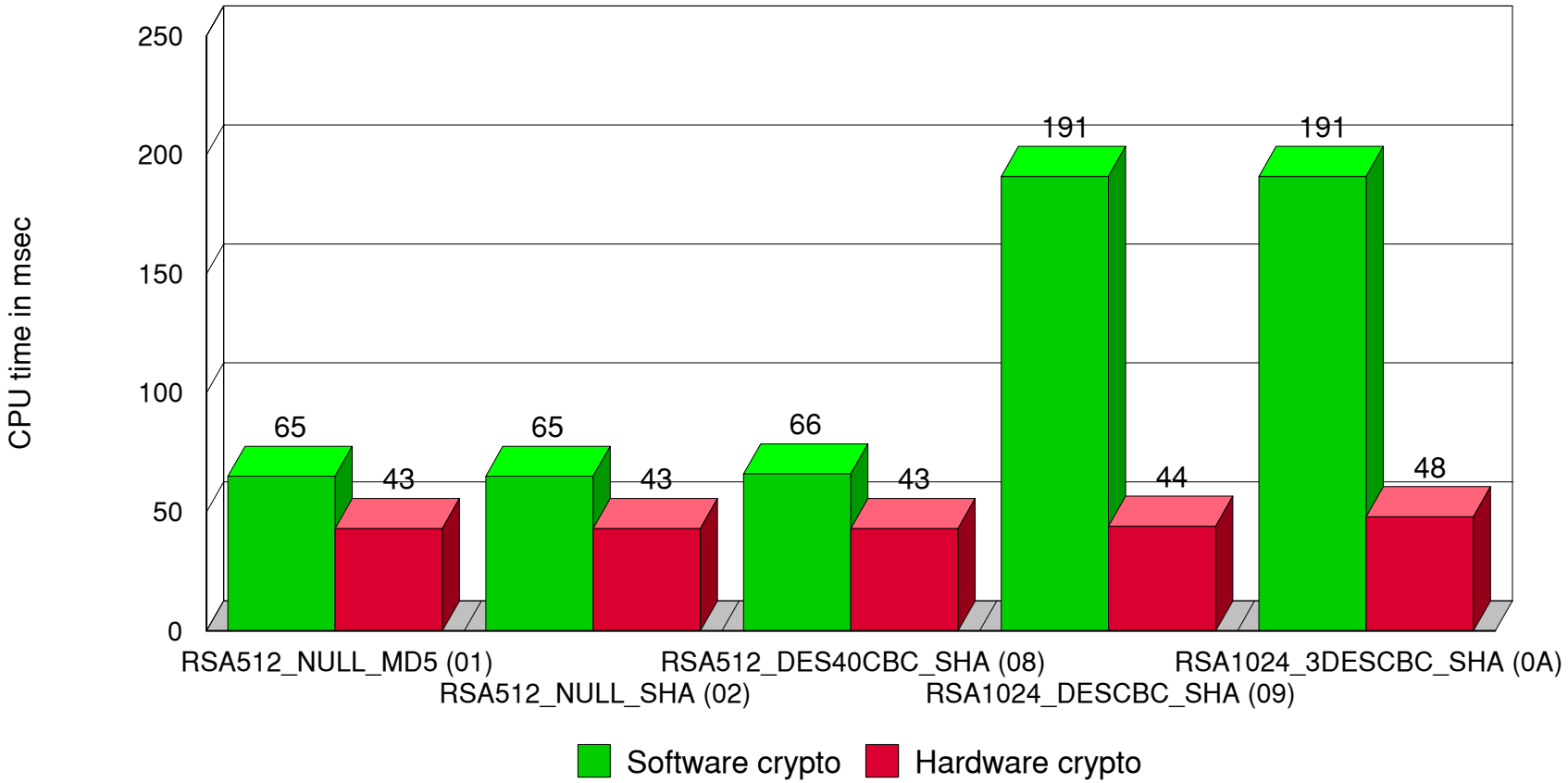
DES and DES CBC takes similar CPU times, 3DES CBC about 3.8 times

Measurements Results - SHA, MD5



SHA takes about 1.8 times more CPU time compared to MD5

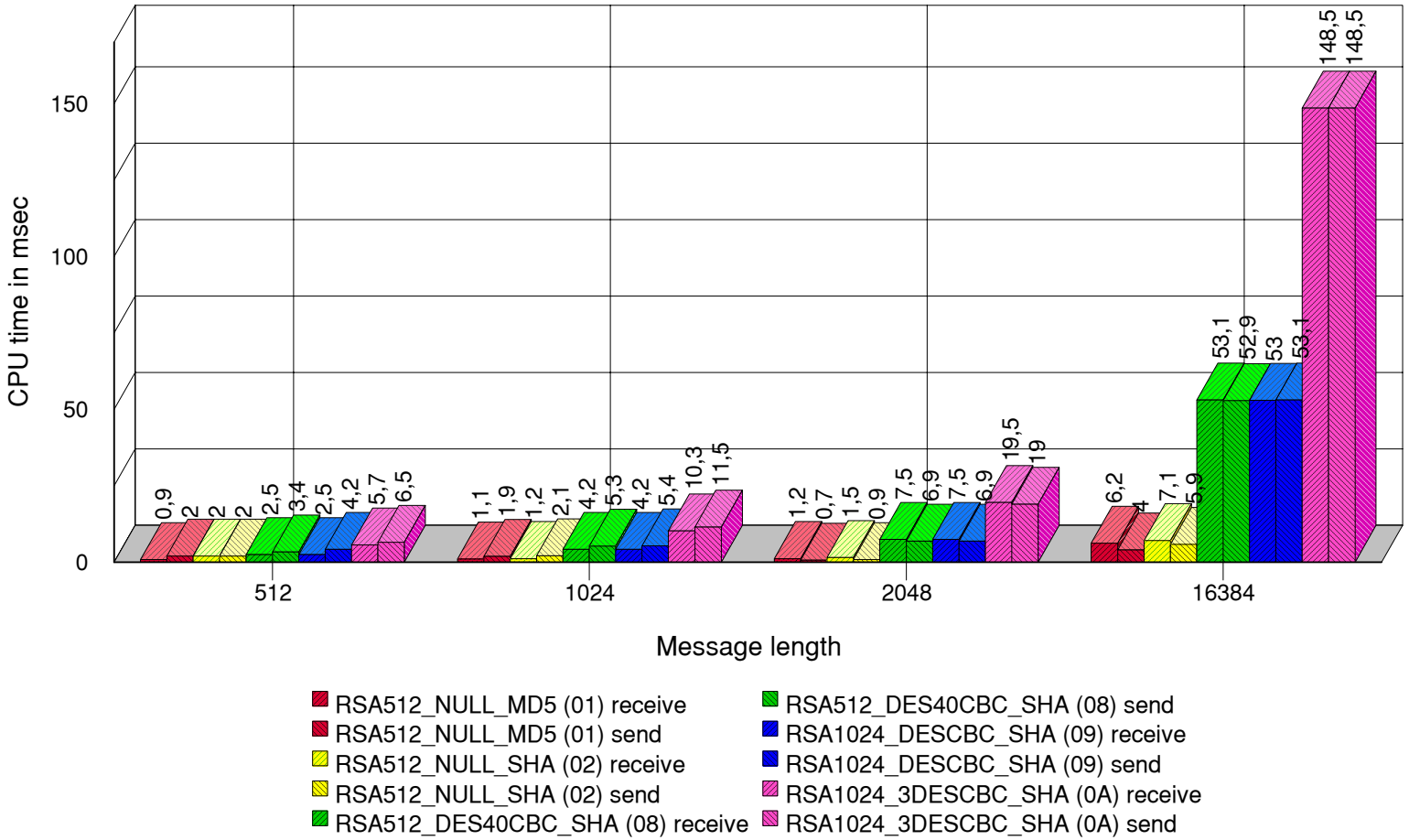
Measurements Results - SSL Handshake



HW Crypto:

- CPU time and elapsed time is independent of cipher suite used
- SSL handshake takes about 43-48 msec CPU time (connection establishment)

Measurements Results - SSL data transfer



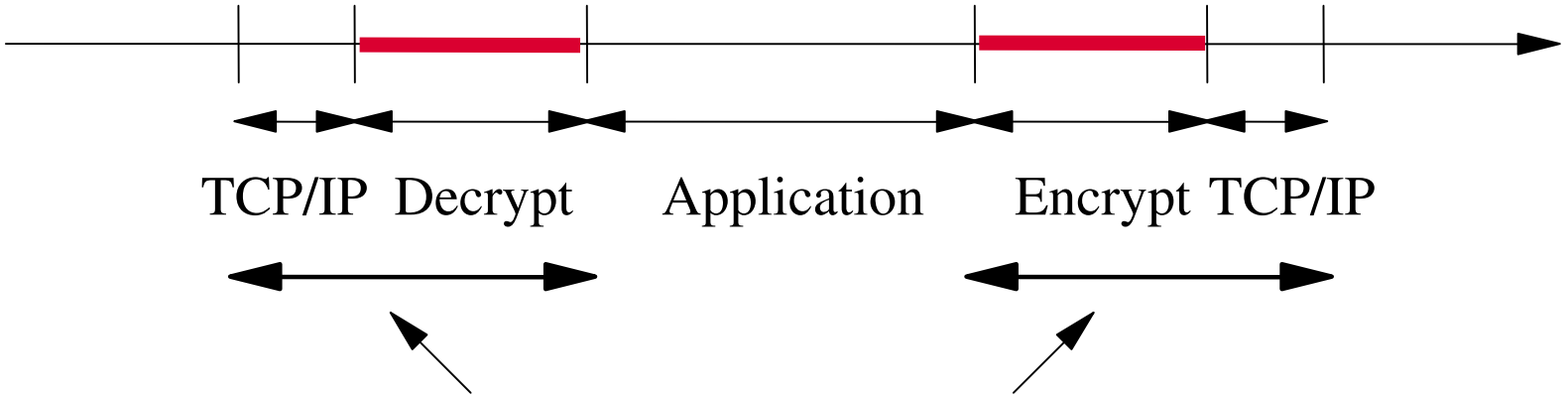
CPU time depends on used hashing (SHA/MD5) and encryption algorithm (DES/3DES)

Software Crypto only!

SSL data transfer overhead

Non SSL

SSL



this has been measured

Measurements Results - conclusion

- **HW Crypto**
  - Supports RSA operations only (e.g. used by SSL handshake)
  - CPU time/elapsed time is independent of operation and key length
  - Software RSA encryption is faster in terms of elapsed time (on large processors)
    - but hardware crypto saves CPU time
- **SW Crypto**
  - CPUtime /elapsed time is very dependent on CPU speed and utilization

SSL Performance Recommendations

- **Use SSL only if there is a need for**
  - If at least one of the following is required
    - Keeping secrets
    - Proving identity
    - Verifying information
- **Cipher Suites 01 and 02 has less CPU-time consumption, but NO data encryption**
  - RSA512_NULL_MD5, RSA512_NULL_SHA
- **If data encryption is required**
  - Use cipher suites 08, 09 or 0A
  - 08 uses 512 bit keys, others 1024
  - 1024 bit RSA key length is recommended (from a security point of view)

Turbo Dispatcher - Overview

- **Turbo Dispatcher**
  - available since 1995
  - VSE/ESA 2.1-2.3 Standard and Turbo Dispatcher
  - since VSE/ESA 2.4 only Turbo Dispatcher
  - last changes:
    - VSE/ESA 2.6.2 (APAR DY45869)
    - VSE/ESA 2.7.0 (APAR DY45926)
  - Supports basic (native), LPAR and VM mode
  - Runs on Uni- and n-Way-procerssors
    - CPUs have "equal" rights
    - more than 3 CPUs are not recommended

Turbo Dispatcher - Overview (2)

- **IPL is done on 1 CPU only**
  - after IPL other CPUs can be started
  - CPUs can be started or stopped without re-IPL
  - at least 1 CPU (IPL CPU) must always be active

```
SYSDEF TD,START=n|ALL
SYSDEF TD,STOP=n|ALL
SYSDEF TD,STOPQ=n|ALL
 QUERY TD
```

Turbo Dispatcher - Quiesced CPUs

- **SYSDEF TD,STOPQ=n to set a CPU in quiesced mode**
  - Implemented for z/VM guest systems
    - Not started guest CPUs stop IOASSIST
    - STOPQ remains IOASSIST active, and avoids TD Overhead, (CPU will no longer participate in work unit selection)
    - quiesced CPUs will not process any work units
    - quiesced CPUs will not handle any interrupt
    - quiesced CPUs can be started with SYSDEF TD,START

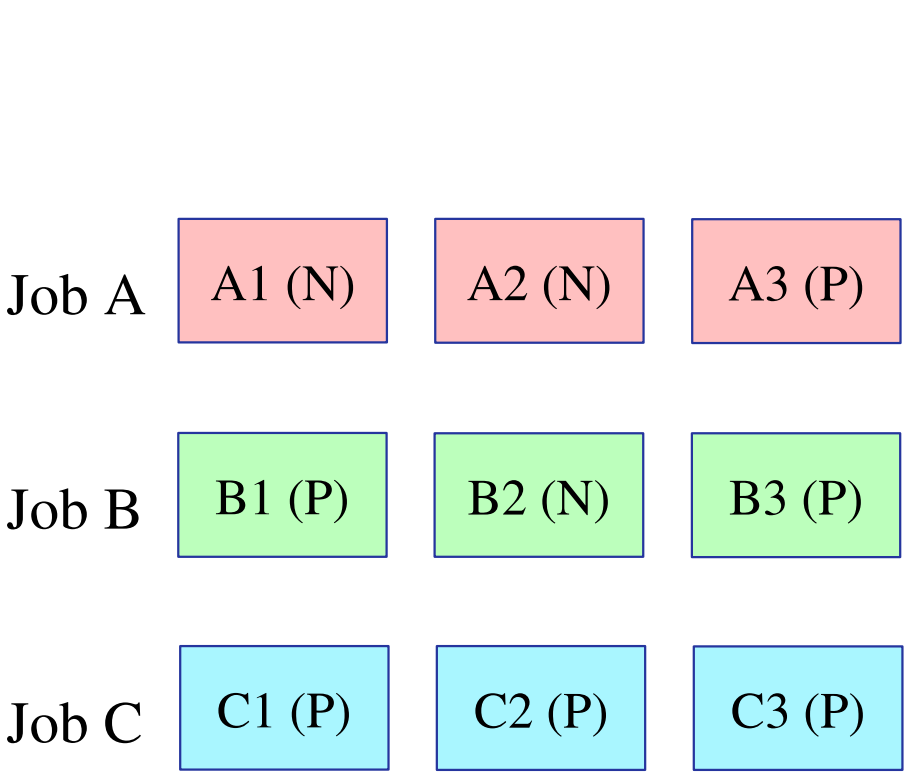
Turbo Dispatcher - Design

- **TD dynamically assigns partitions to CPUs**
  - Work unit = from assignment to one CPU until next interrupt/SVC
  - If one task (subtask) of a partition is active, no other task of the same partition will be selected
  - TD dispatches on partition-basis, not on task-basis
  - A job running in a partition is processed in several work units.

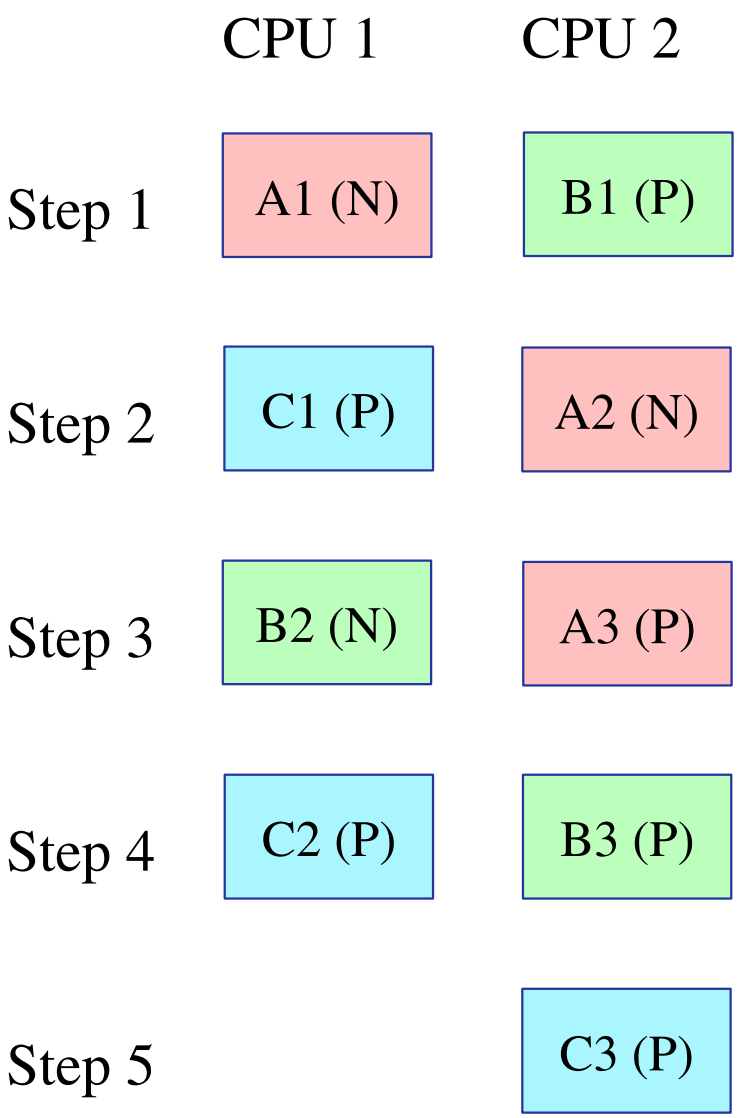
Turbo Dispatcher - Design (2)

- **parallel work units**
  - application code (CICS, Batch)
  - may run on any CPU concurrently with other parallel or non-parallel work units.
- **non-parallel work units**
  - system code (Services, VTAM, Vendor code)
  - As long as one non-parallel work unit is active on one CPU, no other non-parallel work unit can execute on any other CPU.

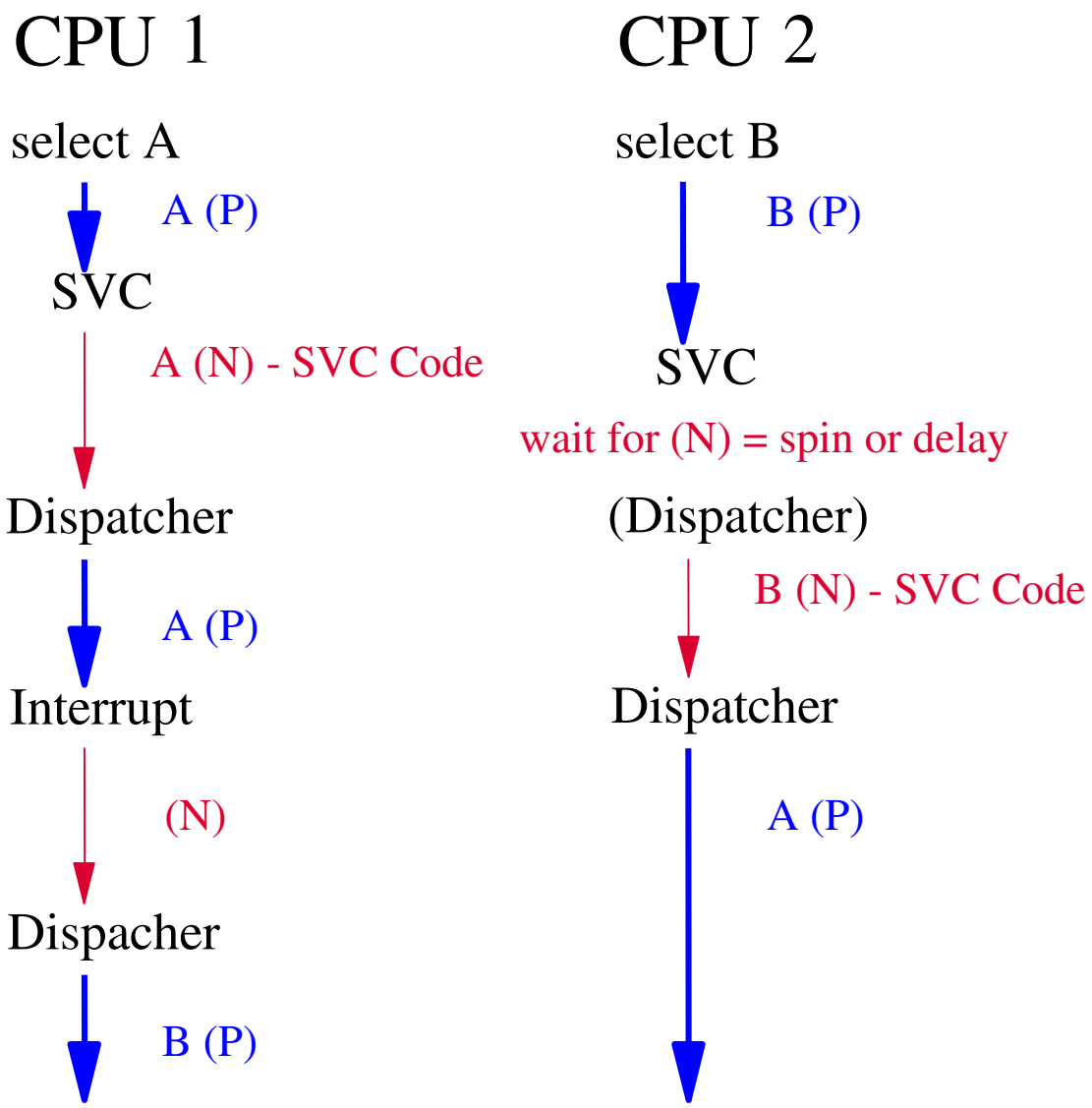
Turbo Dispatcher - Design - Example 1



Ax, Bx, Cx = workunits of job A, B, C
(N) = non-parallel work unit
(P) = parallel work unit



Turbo Dispatcher - Design - Example 2



Turbo Dispatcher - Exploitation

- **Uni-Processor**
  - new Partition Balancing Concept
    - Helps to set priorities of partitions
  - Determination of non-parallel share, to find out if a 2. or 3. CPU would be of use
- **n-Way Processors (2-3 CPUs)**
  - System tuning required for exploitation
  - Increased Capacity (dependent on workload)
    - Exploitation increases by reduction of non-parallel work units

Turbo Dispatcher - CPU time measurement

- **CPU time measurement (overall system)**
  - SYSDEF TD,RESETCNT
  - Workload (e.g. run a job)
  - QUERY TD (QUERY TD,INTERNAL)

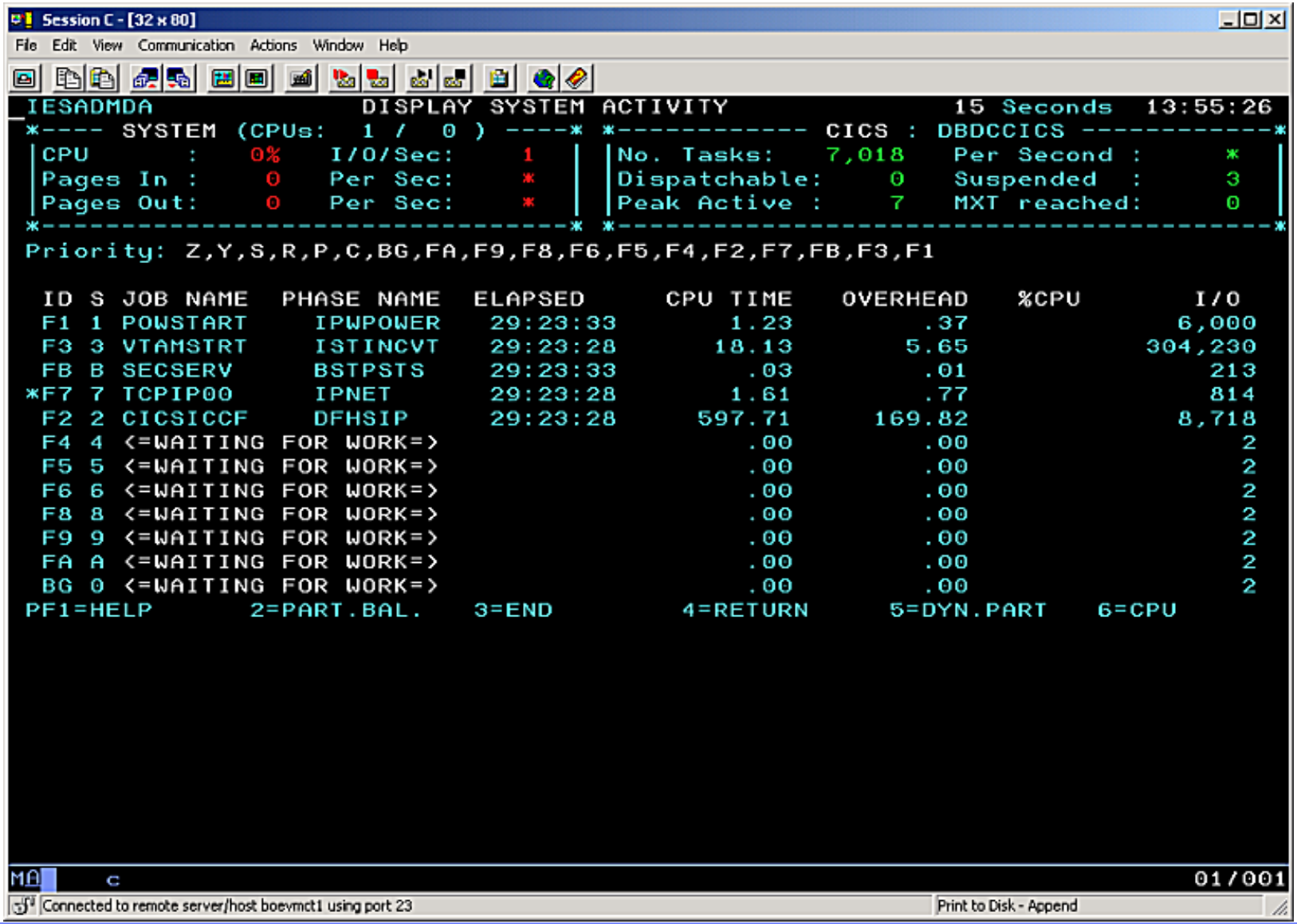
```
 CPU    STATUS     SPIN_TIME     NP_TIME TOTAL_TIME NP/TOT
  00    ACTIVE             0      237100     416698  0.568
  01    ACTIVE             0      157556     415229  0.379
  02    QUIESCED           0           0          0  *.***
  03    INACTIVE
                ---------------------------------------
TOTAL                      0      394656     831927  0.474

               NP/TOT: 0.474       SPIN/(SPIN+TOT): 0.000
 OVERALL UTILIZATION: 179%         NP UTILIZATION:  85%

 ELAPSED TIME SINCE LAST RESET:        463433
```

NP/TOT = non-paralell share (NPS)
SPIN_TIME = CPU time waiting for NP

Display System Activity Dialog



Migration aspects

- **Consider hard-/software requirements:**
  - Does my largest partition still fit into a single CPU of the target processor?
    - Note: a partition can only run on 1 CPU at a time!
  - Is the processor capacity and speed still sufficient to run the workload?
  - Does multiprocessing help to run the workload?
    - What about non-parallel share (on 1-Way)?
    - Are there many parallel batch jobs?
      - A large CICS partition does not benefit of a 2. CPU

Migration overhead

- **Uni-Processor**
  - increased overhead because of
    - Release migration (VSE/ESA 2.6 vs. 2.7)
    - TD overhead (Standard Dispatcher vs. TD)
    - CICS/VSE vs. CICS TS
- **N-Way Processor**
  - CPU time increases when migrating from uni to n-Way Processor (for the same workload)
    - For PACEX Workload: Factor 1.4 (2 CPUs)
    - TD overhead for multiprocessor exploitation
    - z/VM Overhead

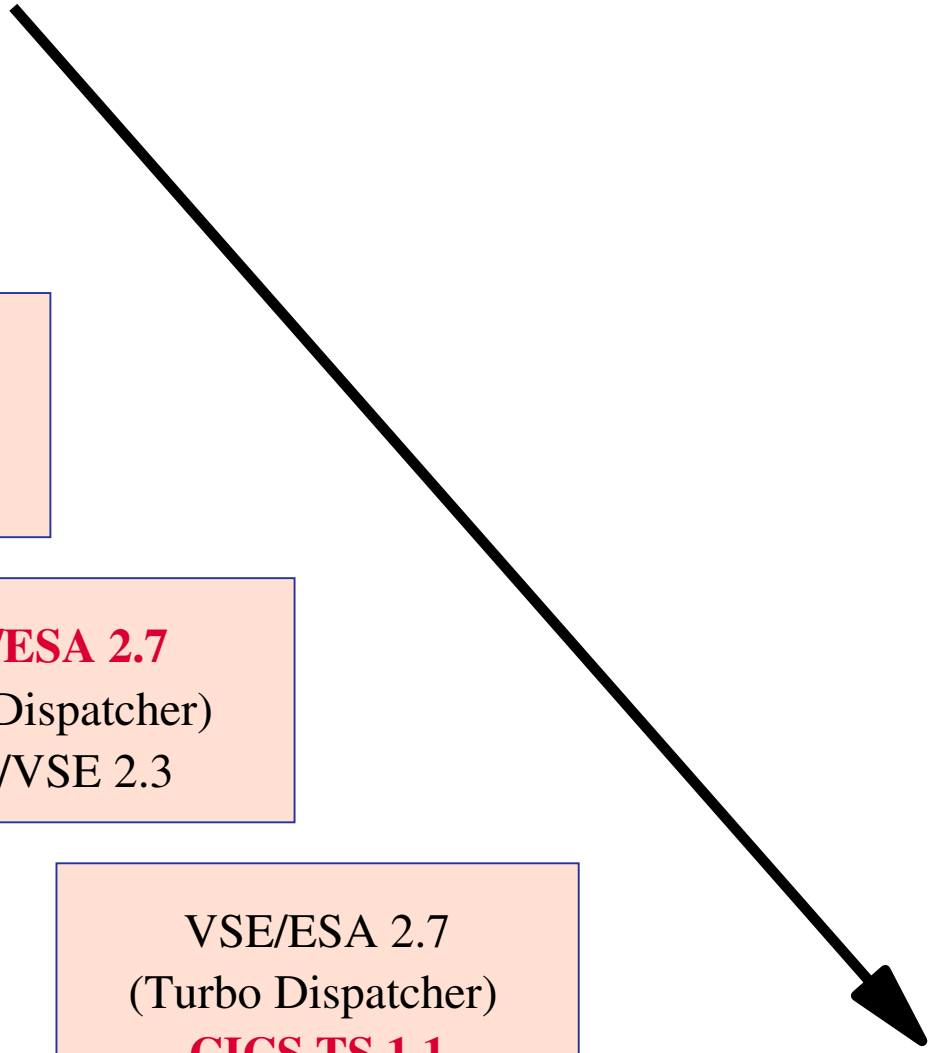
Migration path

VSE/ESA 2.3
Standard Dispatcher
CICS/VSE 2.3

VSE/ESA 2.3
Turbo Dispatcher
CICS/VSE 2.3

VSE/ESA 2.7
(Turbo Dispatcher)
CICS/VSE 2.3

VSE/ESA 2.7
(Turbo Dispatcher)
CICS TS 1.1



Change only
one thing at a time!

Allows you to see which step
has introduced a problem.

Performance Tips

- **A partition can only exploit 1 CPU at a time**
  - 2 CPUs do not have any benefit for a CICS partition
  - Use as many partitions as required for selected n-way
- **Use/define only as many CPUs as really needed**
  - additional CPUs create more overhead, but no benefit
- **Partitions setup**
  - Set up more batch and/or (independent) CICS partitions
  - Split CICS production partitions into multiple partitions

Performance Tips (2)

- **1 CPU must be able to handle all non-parallel workload**
- **Non-parallel code limits the n-Way exploitation**
  - QUERY TD: NP/TOT = NPS
  - Measure NPS before migration
  - max CPUs = 0.9 / NPS

NPS	#CPUs	NPS	#CPUs
0.20	4.5 (4)	0.40	2.2 (2)
0.25	3.6 (3)	0.45	2.0 (2)
0.30	3.0 (3)	0.50	1.8 (1)
0.35	2.6 (2)	0.55	1.6 (1)

Performance Tips (3)

- **Non-parallel code limits the maximum MP exploitation**
- **System code (Key 0) increases non-parallel share**
  - Vendor code can have significant impact
- **Overhead increases when NP code limits throughput**
- **Data In Memory (DIM) reduces non-parallel code**
  - less system calls (I/Os)
  - may increase throughput
- **In general ONE faster CPU is better than multiple slower ones**
  - Even if sum of slower CPUs is higher than one faster CPU

CICS Implications

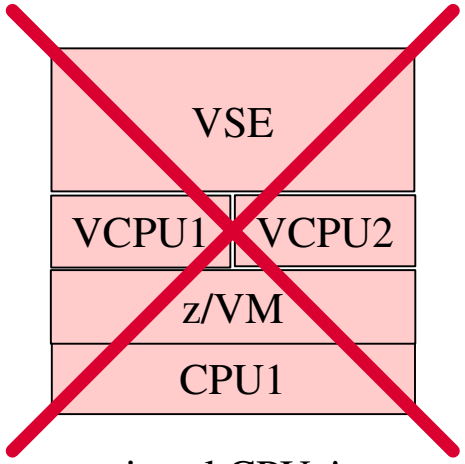
- **Single CICS**
  - Can consume processing power of one CPU only
  - parallel batch jobs may exploit 2. CPU
- **Multiple CICS partitions**
  - Number of CPUs depends on non-parallel share (NPS)
  - Function shipping and Transaction routing
    - AOR, TOR, FOR

Partition Balancing

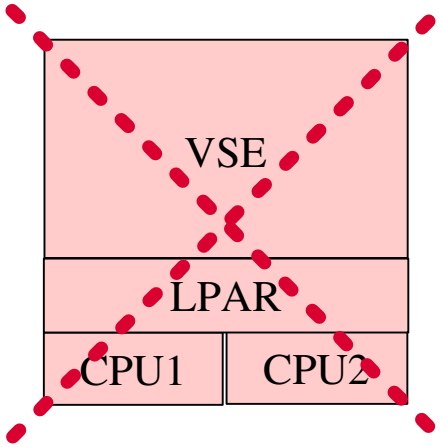
- **Balanced Group is defined with PRTY:**
  - PRTY BG,C=F5=F8,F2,F3,F1
  - Each partition/class of the group has a default-SHARE (100)
  - Dynamic partitions gets the SHARE of its class
- **To set a SHARE (1-1999)**
  - PRTY SHARE,F5=50
  - SHARE = 0 means the lowest priority within the group

```
PRTY
AR 0015 PRTY BG,C=F5=F8,F2,F3,F1
AR 0015
AR 0015 SHARE F5=  50, F8= 100,  C= 100
MSECS
AR 0015 MSECS    976      <---- influences task selection
```

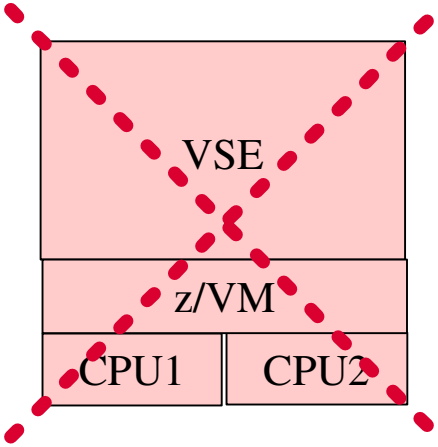
Do's and Don't Do's



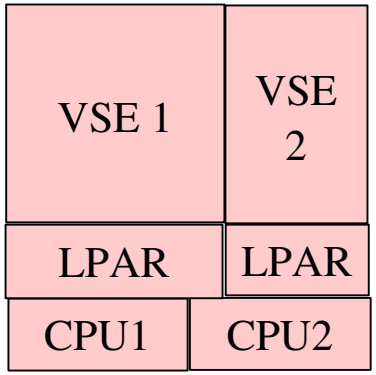
no virtual CPUs!
(creates overhead)



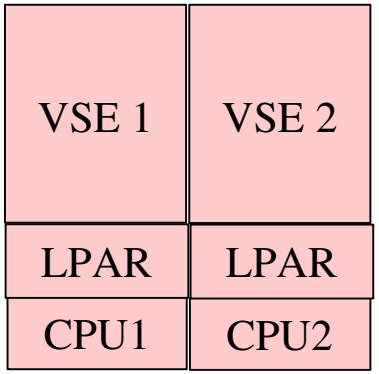
only if NPS < 4.5



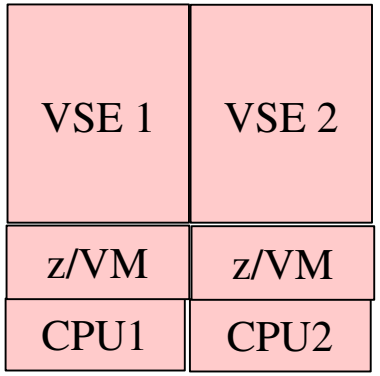
only if NPS < 4.5



VSE 1 = Production
VSE 2 = Test



dedicated CPU
per VSE

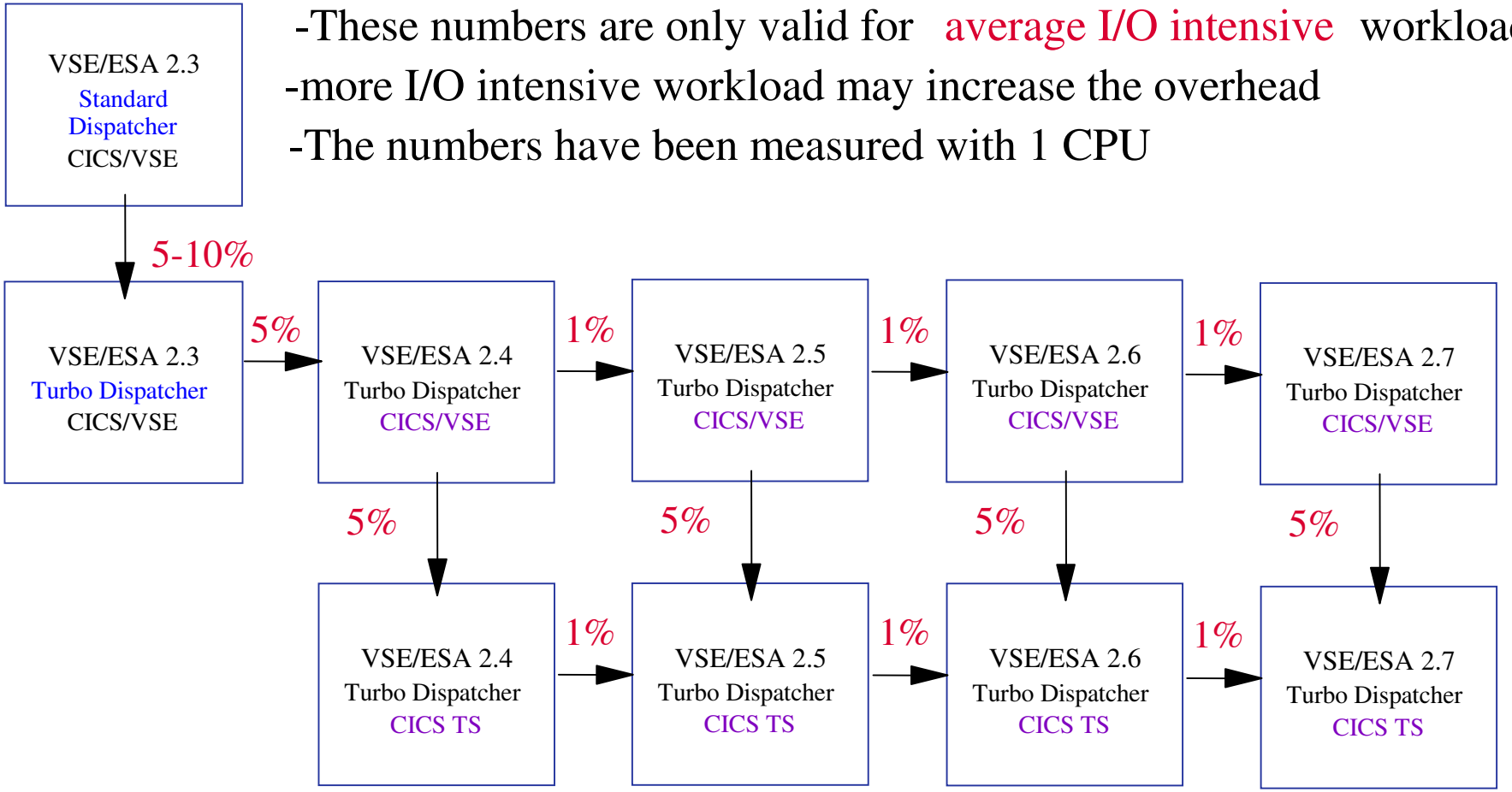


dedicated CPU
per VSE

Do's and Don't Do's (2)

The fastest uni-processor is (almost always) the best processor !

Overhead Deltas for VSE Releases



-These numbers are only valid for average I/O intensive workload

-more I/O intensive workload may increase the overhead

-The numbers have been measured with 1 CPU

New releases with new functions may increase the system overhead

BUT: Exploitataion of the new functions can increase the system throughput

VSE Health Check

- **Goals**
  - Recognize actual/upcoming problems
  - Optimize the system for new/current workload
- **A-B-C analysis**
  - A - concentrate on the essentials
    - 20 % work for 80 % results
  - B - more detailed analysis
    - 30 % work for 15 % results
  - C - analyze all details
    - 50 % work for 5 % results
- **A-B analysis takes about 2 days**
- **C analysis takes about 1 week**
- **Should be done about once a year**

VSE Health Check - continued

- **What should be checked?**
  - Processor (utilization, dispatching, z/VM, ...)
  - DASD, Tapes (I/O rate, cache, ...)
  - Network (network load, misrouted packets, ...)
  - System software
    - Turbo Dispatcher (PRTY, PRTY SHARE, ...)
    - VSAM (CA/CI sizes, share options, buffers, ...)
    - CICS (MXT, DSA/EDSA sizes, SOS, ...)
    - Storage Layout (GETVIS 24, SVA, partitions, DSPACE, ...)
    - VTAM (buffer pool)
    - POWER (DBLK, DBLKGP, ...)
    - LE runtime options (Heap size, ...)
  - Application software

Hints and Tips for Performance

- **Try to exploit Turbo Dispatcher functions**
  - Priority settings
  - Partition balancing
  - Partition balancing groups
- **Use as much data in memory (DIM) as possible**
  - CICS Shared Data Tables
  - Large/many VSAM Buffers (with buffer hashing)
  - Virtual Disks
- **Switch tracing/DEBUG off for production**

Hints and Tips for Connector and TCP/IP-Performance

- **Reduce amount of data transferred**
  - Transfer only data that is needed
  - Issue only requests that are needed
- **Use connection pooling**
  - Reduce overhead of connection establishment
- **Performance of connectors depends on**
  - Network performance
  - Performance of "server"
  - Performance of "client" or middle tier
- **Reduce misrouted packets**
- **Use a packet filter**
  - Unwanted packets increases TCP/IP and CPU load

Further Information

- **VSE Homepage:**
  - http://www.ibm.com/servers/eserver/zseries/os/vse/
- **VSE Performance Homepage: http://www.ibm.com/servers/eserver/zseries/os/vse/library/vseperf.htm**
- **Performance Documents from W. Kraemer**
  - available on the Performance Homepage

Questions ?

RETURN TO INDEX