z/VSE V4.3 Performance Update

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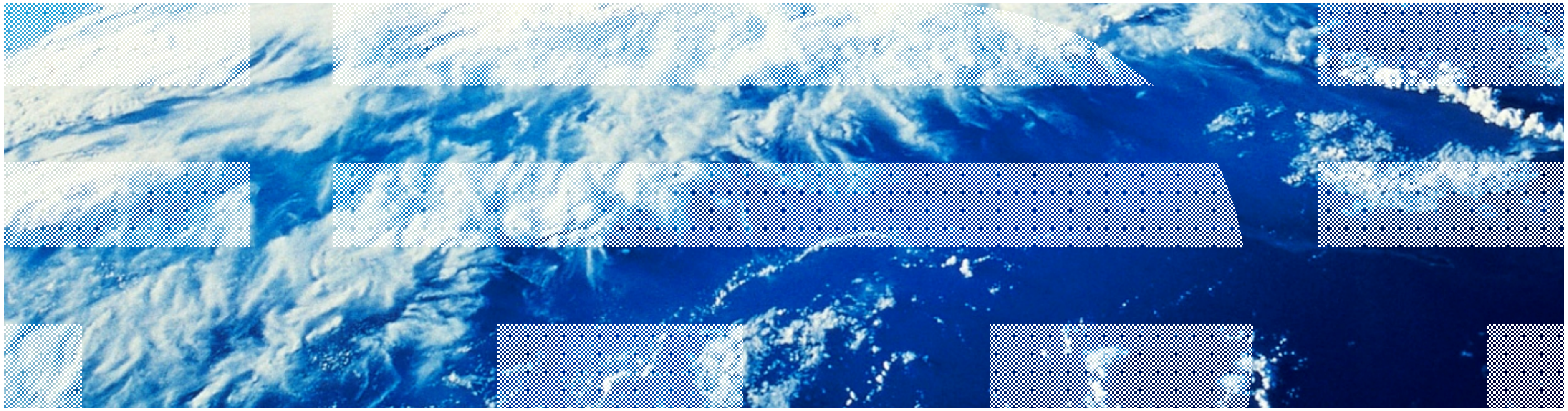

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Agenda

- **z/VSE V4.3 Performance Considerations**
  - Release Overhead Deltas
  - Support for 4 digit device addresses
  - GETVIS constraint relief
  - Dynamic start/stop of CPUs
  - 1 MB frames for data spaces
  - Fast Path to Linux on System z
  - Queue-I/O Assist (QIOASSIST)
  - Crypto Express3 and AP queue interrupt support
  - FICON Express8
  - SNMP Agent support
  - VSAM Redirector executed in subtask under CICS
- **z/VM and Linux considerations**
- **Sizing a System for z/VSE**
- **Performance Measurement Tools**

Supported VSE Releases

VSE Release	Available	End of Marketing	End of Service
z/VSE 5.1	preview		
z/VSE 4.3	11/26/2010		
z/VSE 4.2	10/17/2008	11/26/2010	
z/VSE 4.1	03/16/2007	10/17/2008	04/30/2011
z/VSE 3.1	03/04/2005	05/31/2008	07/31/2009 (out of service)
VSE/ESA 2.7	03/14/2003	09/30/2005	02/28/2007 (out of service)
VSE/ESA 2.6	12/14/2001	03/14/2003	03/31/2006 (out of service)
VSE/ESA 2.5	09/29/2000	12/14/2001	12/31/2003 (out of service)
VSE/ESA 2.4	06/25/1999	09/29/2000	06/30/2002 (out of service)
VSE/ESA 2.3	07/12/1997	06/30/2000	12/31/2001 (out of service)

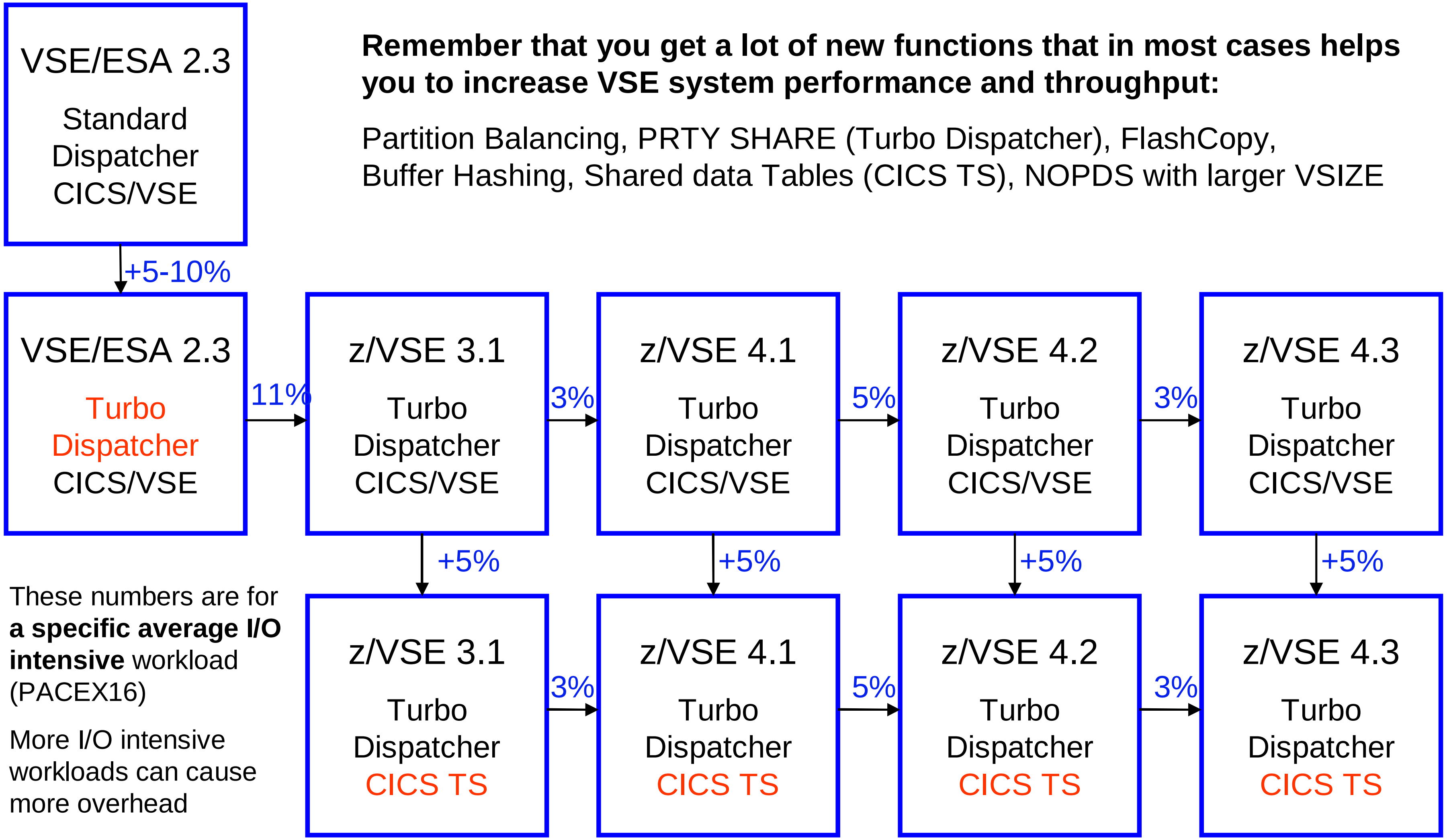
This is very soon!

http://www.ibm.com/systems/z/os/zvse/about/status.html

Overhead Deltas for VSE Releases

Remember that you get a lot of new functions that in most cases helps you to increase VSE system performance and throughput:

Partition Balancing, PRTY SHARE (Turbo Dispatcher), FlashCopy, Buffer Hashing, Shared data Tables (CICS TS), NOPDS with larger VSIZE



These numbers are for **a specific average I/O intensive** workload (PACEX16)

More I/O intensive workloads can cause more overhead

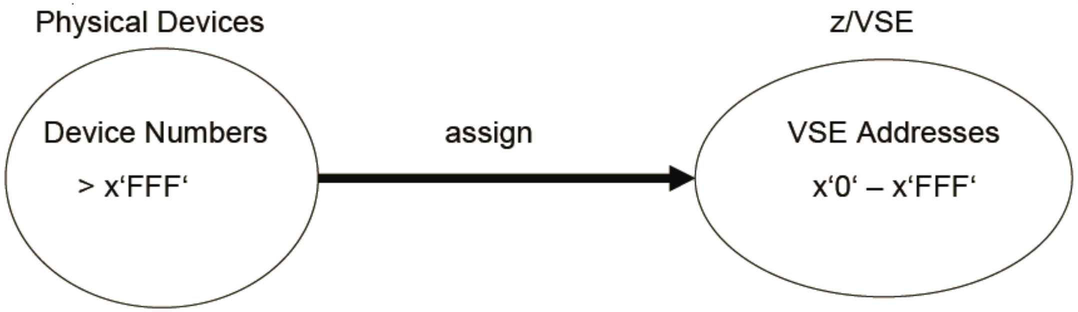
z/VSE V4.3 – Support for 4 digit device addresses

- I/O devices can have physical device numbers in the range of x‘0000‘ to x‘FFFF‘

- z/VSE V4.2 or earlier supported only device addresses from x’000’ to x’FFF’
  - I/O devices with device numbers > x‘FFF‘ were ignored during the z/VSE installation process and cannot be added in the IPL procedure

- z/VSE V4.3 now supports device addresses in the range of x‘0000‘ to x‘FFFF‘
  - I/O devices with device numbers > x‘FFF‘ are recognized during the z/VSE installation process and can be added into the IPL procedure

- If the physical device address of an I/O device is <= x‘FFF‘ nothing changes.
- If the physical device address of an I/O device is > x‘FFF‘ then the user has to assign a so called VSE address to the device



z/VSE V4.3 – Support for 4 digit device addresses

Extended ADD Statement:

```
ADD <physical device address > as <VSE address>,<device type>

ADD <phy_addr1> : <phy_addr2> as <VSEaddr1> : <VSEaddr2>, <device type>

ADD <phy_addr1> .. <phy_addr2> as <VSEaddr1> .. <VSEaddr2>, <device type>
```

Notes:

§ The physical device address must be > x‘FFF‘ if you want to assign a VSE address

§ If the physical device address is lower or equal than x’FFF’ then the VSE address is equal to the physical device address by default. This assignment cannot be changed

§ The VSE address must be unique: You cannot assign the same VSE address twice.

Examples:

§ `ADD 1555 as 555, ECKD`

§ `ADD 1010:1020 as 200:210, 3480`

§ `ADD 1010..1020 as 200..210, 3480`

§ `ADD 300 as 500, ... à NOT allowed !`

z/VSE V4.3 – Support for 4 digit device addresses

Addressing devices in z/VSE Jobs

§ IOCP:

– Control Unit:

```
CNTLUNIT CUNUMBR=8000,PATH=(A1,B1,A2,B2,A3,B3,A4,B4), X
         UNITADD=((00,256)),CUADD=0,UNIT=2105
4 DASDs of type 3390 with the physical device addresses 8000-8003:
IODEVICE ADDRESS=(8000,4),CUNUMBR=(8000),FEATURE=(SHARED),UNIT=3390B
```

§ z/VSE:

– IPL Procedure:

```
ADD 8000:8003 as 800:803,ECKD
```

– Job:

```
// JOB CLRDK
* DLBL DISK,'DISK.FILE.1',1,SD,DSF
// ASSGN SYS012,801
// DLBL UOUT,'DISK.XXXXX',9999
// EXTENT SYS012,,,,2590,5
// EXEC CLRDK
// END
/*
/&
```

In z/VSE Jobs, you always use the 3 digit VSE address !

z/VSE V4.3 – GETVIS constraint relief

§ **I/O Constraint Relief:**

– The z/VSE I/O supervisor routines will run in AMODE(31)

– Depending on the IODEV statement, the control blocks will be allocated either in 24-bit area or in 31-bit area:

- Specifying IODEV=1023 will result in an allocation of the control blocks below the line (24-bit area)
- Specifying IODEV=1024 will result in an allocation of the control blocks above the line (31-bit area)

à *Note: in either way the z/VSE limit of 1024 devices does apply and is as well maintained !*

– *Example:*

```
…
BG 0000 $$A$SUPI,VSIZE=264M,VIO=512K,VPOOL=64K,LOG,IODEV=1024
…
```

– The z/VSE 4.3 system is shipped with IODEV=1024

– If you FSU to z/VSE 4.3, the value remains IODEV=1023

z/VSE V4.3 – Dynamic Starting/Stopping of CPUs

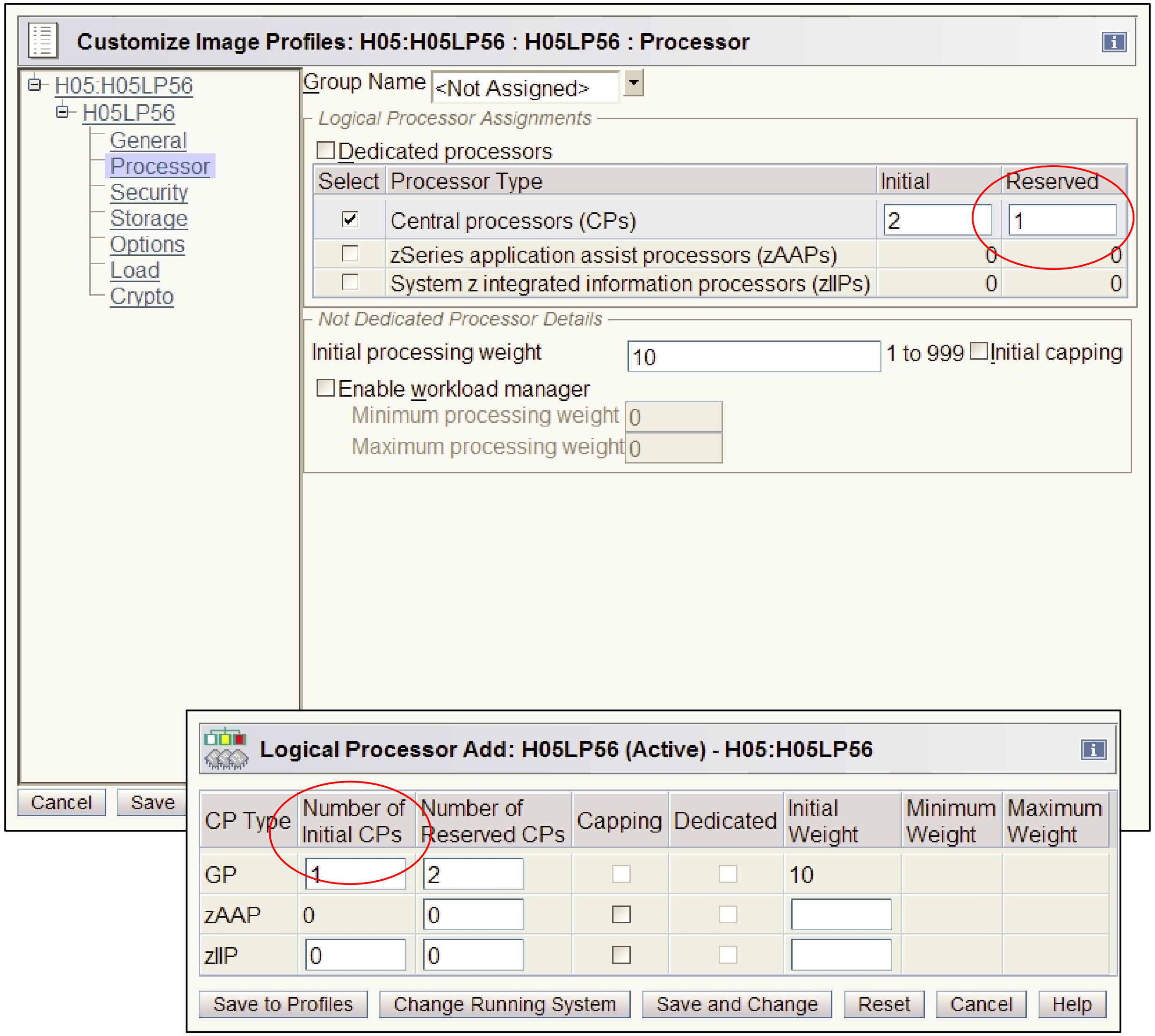
- **z/VSE allows you to start CPUs that were not online at IPL**
- **These can be either:**
  - CPUs that were in a “standby” state at IPL
  - CPUs that were added to the z/VSE LPAR profile after IPL
- Note that z/VSE uses the term CPU to refer to Central Processors (CPs).

- **Using the HMC/SE “Logical Processor Add” task, you can add CPUs to an LPAR after IPL. This feature is available on IBM z10 and z196 platforms**.
  - When CPUs are added to an LPAR, z/VSE automatically updates its CPU configuration.

- **You can then use the:**
  - SYSDEF TD,STARTSBY=cpuaddr command to set CPUs that are in a “standby” state to an “online” state and start these CPUs
  - SYSDEF TD,STOPSBY=cpuaddr command to change the CPU state from “online” to “standby”.
- **These functions allow you to exploit z10 and z196 technology and update the CPU configuration depending on workload needs**

- Note: “Standby” CPUs do not consume any CPU share of their LPAR

z/VSE V4.3 – Dynamic Starting/Stopping of CPUs



Customize Image Profiles: H05:H05LP56 : H05LP56 : Processor

Group Name <Not Assigned>

Logical Processor Assignments

☐ Dedicated processors

Select	Processor Type	Initial	Reserved
☑	Central processors (CPs)	2	1
☐	zSeries application assist processors (zAAPs)	0	0
☐	System z integrated information processors (zIIPs)	0	0

Not Dedicated Processor Details

Initial processing weight 10 1 to 999 ☐ Initial capping

☐ Enable workload manager

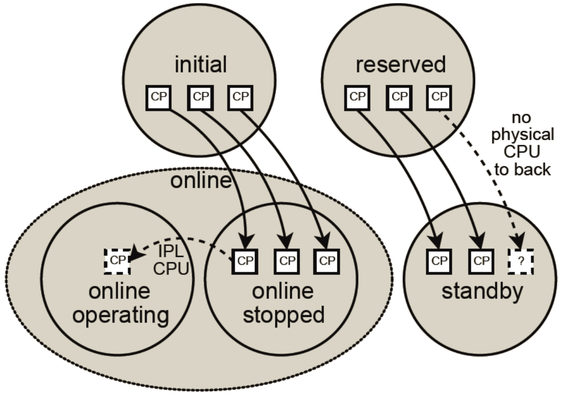
Minimum processing weight 0

Maximum processing weight 0

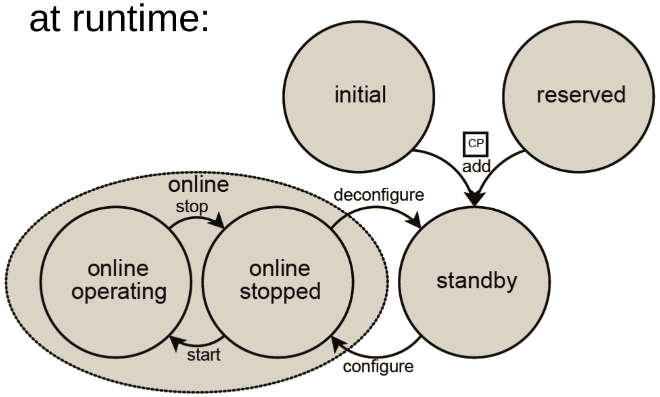
Logical Processor Add: H05LP56 (Active) - H05:H05LP56

CP Type	Number of Initial CPs	Number of Reserved CPs	Capping	Dedicated	Initial Weight	Minimum Weight	Maximum Weight
GP	1	2	☐	☐	10		
zAAP	0	0	☐	☐			
zIIP	0	0	☐	☐			

LPAR CPU state transitions during LPAR activation and IPL:



LPAR CPU state transitions at runtime:



z/VSE V4.3 – Dynamic Starting/Stopping of CPUs

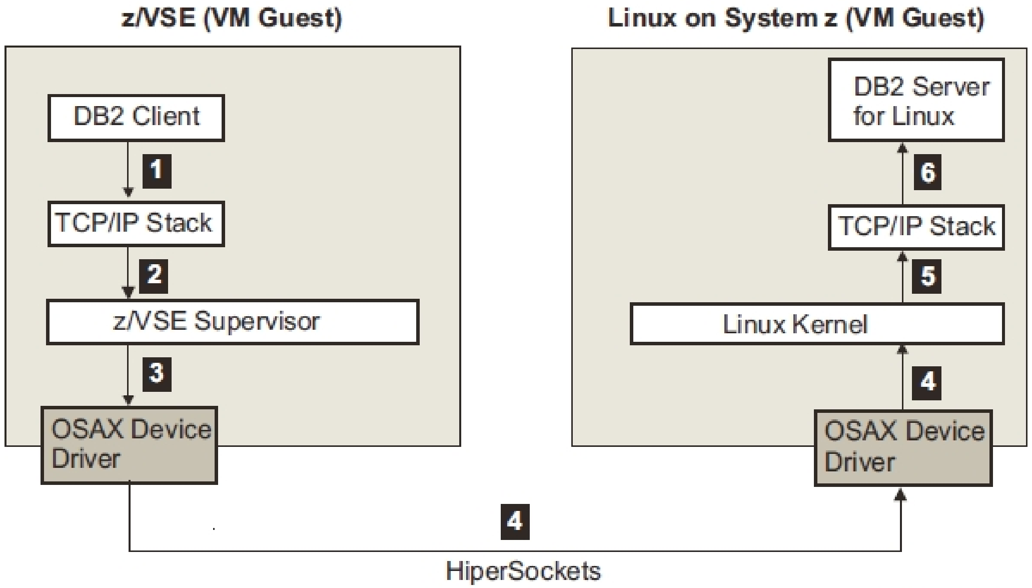
```
query td
AR 0015 CPU STATUS SPIN_TIME NP_TIME TOTAL_TIME NP/TOT
AR 0015 00  ACTIVE 0         43      23070      0.001
[…]

AR 0030 0W03I 00002 STANDBY CPUS HAVE BEEN ADDED TO THE CONFIGURATION

query td
AR 0015 CPU STATUS SPIN_TIME NP_TIME TOTAL_TIME NP/TOT
AR 0015 00  ACTIVE 0         65      23095      0.002
AR 0015 01  STANDBY
AR 0015 02  STANDBY
[…]

sysdef td,startsby=01
AR 0015 1YH7I NUMBER OF CPU(S) - ACTIVE: 1 - QUIESCED: 0 - INACTIVE: 0 -
              STANDBY: 1
AR 0015 1I40I READY
```

z/VSE V4.3 – Fast Path to Linux on System z (LFP)

- **The Linux Fast Path uses an IUCV connection between z/VSE and Linux, where both systems run in the same z/VM-mode LPAR on IBM z10 or z196 servers**
- **It allows selected TCP/IP applications to communicate with the TCP/IP stack on Linux without using a TCP/IP stack on z/VSE**
- **All socket requests are transparently forwarded to a Linux on System z system running in the same z/VM**
- **On Linux on System z, the LFP daemon must run**
  - This daemon fulfills all socket requests by forwarding them to the Linux TCP/IP stack.
- **The fast path to Linux on System z provides standard TCP/IP socket APIs for programs running on z/VSE:**
  - LE/C socket API via an alternative $EDCTCPV.PHASE (IJBLFPLE)
  - EZA SOCKET and EZASMI interface via an alternative EZA interface phase IJBLFPEZ
  - CSI’s (Connectivity Systems, Incorporated) assembler socket interface via the SOCKET macro
  - Other than the basic socket API, no other tools are provided.

- **Possible performance increase due to:**
  - Less overhead for TCP/IP processing on z/VSE (TCP, sequence numbers and acknowledging, checksums, resends, etc)
  - More reliable communication method (IUCV) compared to HiperSockets, which is a network device, with all its packet drops, resends, etc.

z/VSE V4.3 – Fast Path to Linux on System z (LFP)

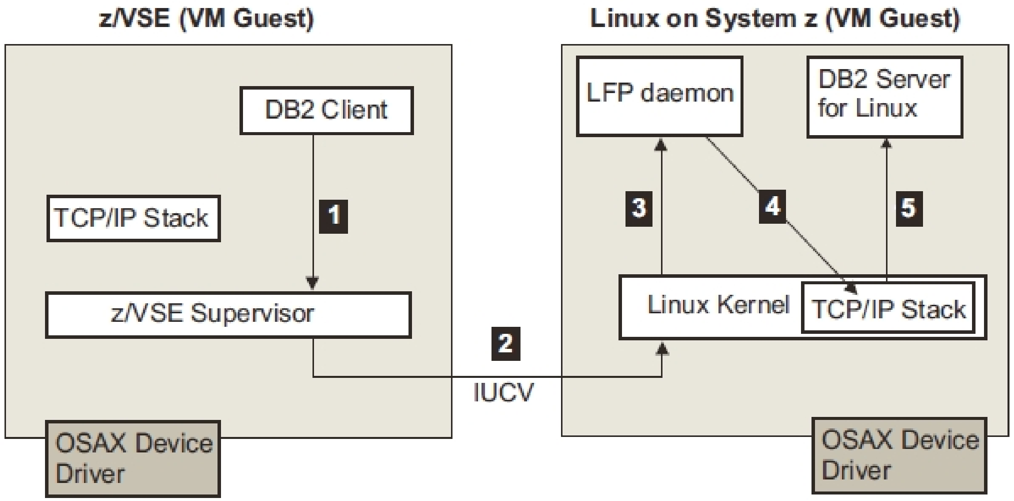


Communication using TCP/IP

- Data is passes from the application to the TCP/IP stack partition (involves dispatching)
- TCP/IP builds IP packets (including TCP, checksums, sequence numbers, etc) and sends it through the OSAX device driver
- Linux TCP/IP stack receives the packets and passes it to the application
- Application receives the data
- Response is going the reverse way

Communication using Linux Fast Path

- Data is passes from the application to the LFP
- LFP builds IUCV packets and sends it through to IUCV channel
- Linux IUCV device driver receives the packets and passes it to the LFP daemon LFPD.
- LFPD translates it into the appropriate socket calls against the TCP/IP stack
- TCP/IP passes the data to the application
- Response is going the reverse way



Performance measurements using Linux Fast Path

Comparison TCP/IP for VSE versus Linux Fast Path:

Workload	TCP/IP for VSE	Linux Fast Path (LFP)	Difference
FTP (BSI FTP server)			
§VSE à Linux (1GB) (NULL file, no I/O)	19 MB/sec 29% CPU (5% App + 24% TCPIP)	72 MB/sec 20% CPU (App)	3.7 times faster 9% less CPU
§Linux à VSE (1GB) (NULL file, no I/O)	21 MB/sec 55% CPU (11% App + 44% TCPIP)	70 MB/sec 20% CPU (App)	3.3 times faster 35% less CPU
Socket Application (running 3 times)			
§VSE à Linux (100MB)	4.6 MB/sec (*3 = 13.8 MB/sec)	14.6 MB/sec (*3 = 43.8 MB/sec)	3.2 times faster
§Linux à VSE (100MB)	9.7 MB/sec (*3 = 29.1 MB/sec)	16.2 MB/sec (*3 = 48.6 MB/sec)	1,7 times faster
	26% CPU (3*1% App + 23% TCP/IP)	9 % CPU (3*3% App)	17% less CPU

Environment: IBM System z10 EC (2097-722). TCP/IP connection via shared OSA adapter.

à Significant benefits in transfer rate as well as CPU usage

z/VSE V4.3 – Fast Path to Linux on System z (LFP)

- **Most existing applications run unchanged with Linux Fast Path**
  - Provided they use one of the supported Socket API (LE/C, EZA or ASM SOCKET)
    - And they do not use any CSI specific interface, features or functions
- **IBM Applications supporting Linux Fast Path**
  - VSE Connector Server
  - CICS Web Support
  - VSE Web Services (SOAP) support (client and server)
  - CICS Listener
  - DB2/VSE Server and Client
  - WebSphere MQ Server and Client
  - VSAM Redirector
  - VSE VTAPE
  - VSE LDAP Support
  - VSE Script Client
  - POWER PNET
  - TCP/IP-TOOLS included in IPv6/VSE product (e.g. FTP Server/Client)
- **Customer applications should run unchanged:**
  - Provided they use one of the supported Socket API (LE/C, EZA or ASM SOCKET)

z/VSE V4.3 – Queue-I/O Assist (QIOASSIST)

- **The z/VM function queue-I/O assist (QIOASSIST) provides performance improvements for V=V guests using real adapters and real networking devices that use the Queued Direct I/O (QDIO) facility**

- **z/VSE exploits the queue-I/O assist function for:**
  - OSA Express devices (CHPID type OSD)
  - HiperSockets devices (CHPID type IQD)

- **To use the queue-I/O assist (QIOASSIST) function in z/VSE, use the z/VM CP command:**
  - SET QIOASSIST ON

- **After you have enabled the queue-I/O assist function, each z/VSE DEFINE LINK,TYPE=OSAX command will then automatically exploit the queue-I/O assist function**

- **If you do not wish to use the queue-I/O assist (QIOASSIST) function in z/VSE, disable it using this z/VM CP command:**
  - SET QIOASSIST OFF

z/VSE V4.3 – Crypto Express3 and AP queue interrupt support

- **Support for AP-interrupts is a new function of IBM System z10 and IBM zEnterprise 196**

- **A hardware interrupt is issued when a response is ready for de-queueing from a card.**
  - Removes the need for the formerly used polling mechanism
  - User can switch between polling and interrupts (default: polling)
  - Using interrupts increase throughput for certain workloads without increasing CPU load

- **Not available under z/VM!**

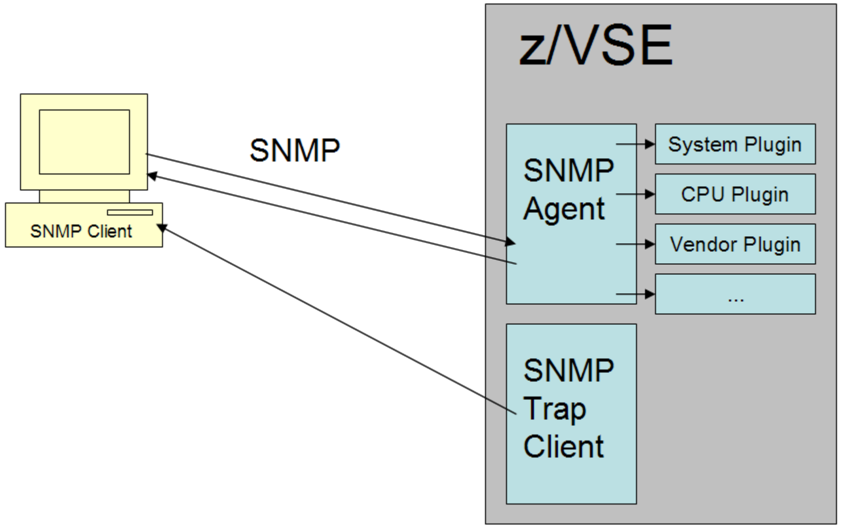
- **Supported cards are:**
  - Crypto Express2 and
  - Crypto Express3

- **The VSE crypto device driver provides new commands:**
  - APEAI, enable AP interrupts for all APs
  - APDAI, disable AP interrupts for all APs

z/VSE V4.3 – SNMP Monitoring Agent support

- **z/VSE Monitoring Agent enables customers to monitor z/VSE systems using standard monitoring interfaces (SNMP V1)**
  - It also includes an open interface, which enables customers or vendors to use own programs (plugins) to collect additional data

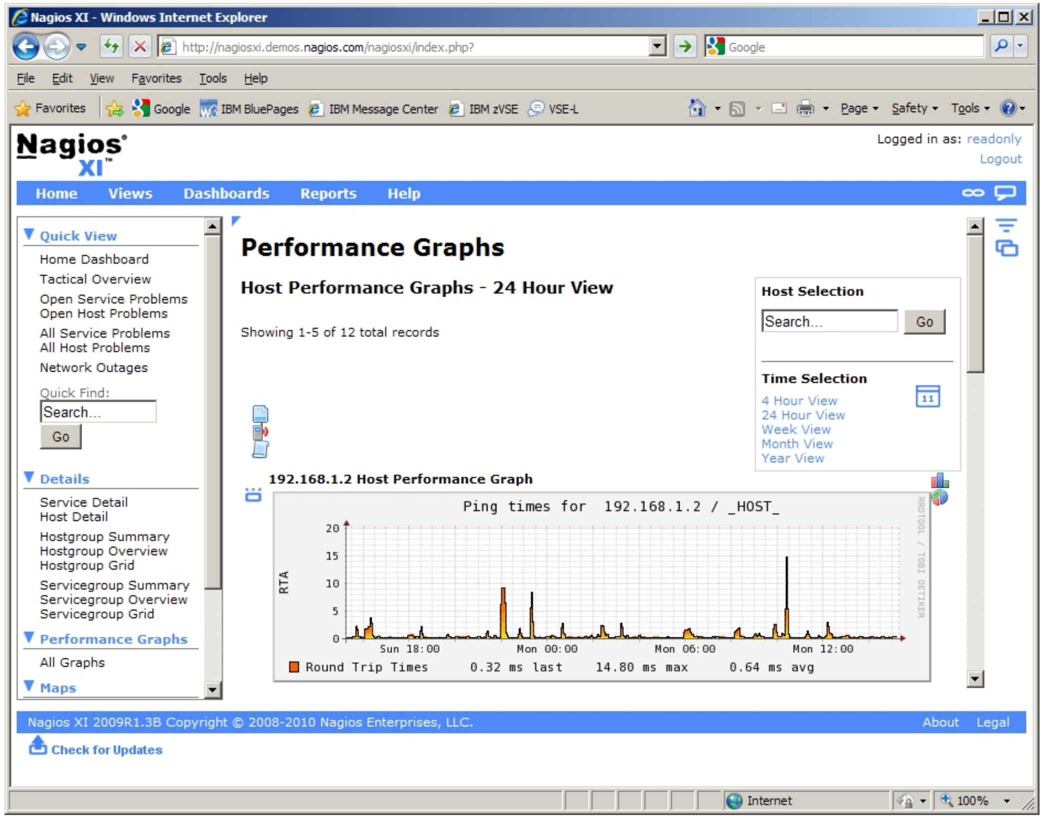
- **Data collected by the IBM provided plugins contains**
  - Information about the environment (e.g. Processor, LPAR and z/VM information)
  - Number of partitions (static, dynamic, total, maximum)
  - Partition priorities
  - Number of CPUs (active, stopped, quiced)
  - Paging (page ins, page outs)
  - Performance counters overall and per CPU
  - CPU address and status
  - CPU time, NP time, spin time, allbound time
  - Number of SVCs and dispatcher cycles



z/VSE V4.3 – SNMP Monitoring Agent support

- **A MIB (Measurement Information Base) is provided describing the data collected**
  - IESMPMIB.Z in PRD1.BASE (plain text member)

- **Standard SNMP based monitoring tools can be used to collect, display and analyze z/VSE performance monitoring data**
  - e.g. Nagios (www.nagios.org)



Performance Graphs

Host Performance Graphs - 24 Hour View

Showing 1-5 of 12 total records

192.168.1.2 Host Performance Graph

Ping times for 192.168.1.2 / _HOST_

■ Round Trip Times 0.32 ms last 14.80 ms max 0.64 ms avg

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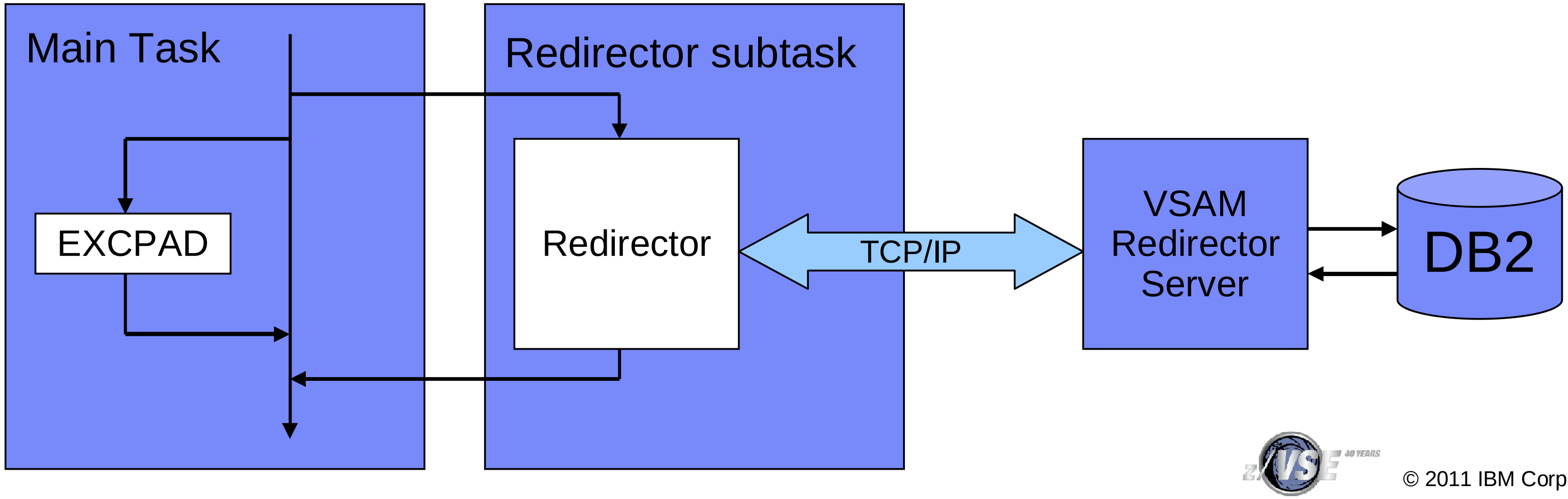
Check for Updates

- **z/VSE SNMP Trap client**
  - Sends SNMP V1 traps to inform one or more monitoring stations or servers about important events
  - For example:
    - The end of a job stream is reached.
    - An error has occurred during a job stream

z/VSE V4.3 – Redirector EXCPAD - Overview

- **Prior to z/VSE 4.3 the VSAM Redirector was executed in the same subtask as VSAM and the application (caller)**
  - Redirector activities may be time consuming (network transfers, database operations, ...)
    - During this time, no other activities are possible for this subtask
  - Under CICS, VSAM normally returns back via EXCPAD exit when waiting for an I/O
    - Allows CICS to perform other activities concurrently
- **Since z/VSE 4.3 VSAM executes the Redirector under a separate subtask**
  - VSAM now also returns back to CICS via EXCPAD when waiting for Redirector
    - Allows CICS to perform other activities concurrently
  - This capability is primarily implemented for CICS TS transactions.
    - The Redirector EXCPAD is not used for VSAM files opened by CICS/VSE.



z/VSE V4.3 – Redirector EXCPAD - Benefits

- **Benefits:**
  - **Prior to z/VSE 4.3 heavy use of VSAM Redirector could slow down transaction processing in CICS**
    - Due to VSAM requests block the CICS I/O task when Redirector is active
  - **With the new subtask the VSAM Redirector handling no longer blocks the CICS I/O task**
    - Allowing other transactions to do its work
    - Multiple redirected requests will be queued up for processing in the new subtask

- **The EXCPAD user exit is enabled automatically under the following conditions:**
  - a VSE/VSAM cluster is enabled for the Redirector
  - the EXCPAD exit is defined during the OPEN request

- **VSAM will attach only one Redirector subtask per partition even if multiple redirected files are opened in the partition with an active EXCPAD**

- **Support is transparent**
  - No need to configure or setup anything
  - All types of Redirector activities are processed in subtask (except OPEN/CLOSE)
    - VSAM Redirector OWNER=VSAM or REDIRECTOR
    - VSAM Capture Exit
    - Customer/Vendor implemented Redirector Exit

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  - FICON Express8
  - SNMP Agent support
  - VSAM Redirector executed in subtask under CICS
- **z/VM and Linux considerations** ←
- **Sizing a System for z/VSE**
- **Performance Measurement Tools**

Shared OSA Adapter versus HiperSockets

To connect a z/VSE system with a Linux on System z you have 2 options:

1. Using a shared OSA Adapter

- All traffic is passed through the OSA Adapter
- The OSA Adapter has its own processor
  - Processing occurs asynchronous
  - Processing in OSA Adapter does not affect host processors

2. Using HiperSockets

- Direct memory copy from one LPAR/Guest to the other
- Memory copy is handled by the host processors
  - Processing occur synchronous
  - Consider mixed speed processors (full speed IFLs and throttled CPs)
    - à Memory copy performed by throttled CP is slower than memory copy performed by full speed IFL

Performance tuning for HiperSockets

§ **When using HiperSockets to communicate between z/VSE and Linux, you may run into a “Target Buffer Full” condition**

- This happens when z/VSE sends faster/more than Linux can receive
- Per default Linux has 16 inbound buffers (64K per buffer = 1M per link)
- To increase the number of buffers on Linux, use QETH option “buffer_count=128”
  - Use YAST to configure, or sysconfig scripts
  - Maximum of 128 buffers require 8MB of storage per link

§ **When TCP/IP for VSE encounters this situation (BUSY), it waits 500 msec until it retries to send the packet**

- Any additional packets to be sent are queued up
- Problem can become dramatic, if more than 16 packets are queued up to be sent after BUSY situation
  - The resend will immediately flood the Linux buffers again, leading to the next BUSY situation, and so on....

§ **You can check via QUERY STATS,LINKID=xxxx [,RESET] if you have ever run into the BUSY situation** (RESET resets the counters)

```
C1 0065 0004: IPL615I  Busy mode.............................0   ß see here
C1 0065 0004: IPL615I  Busy mode, longest....................0
```

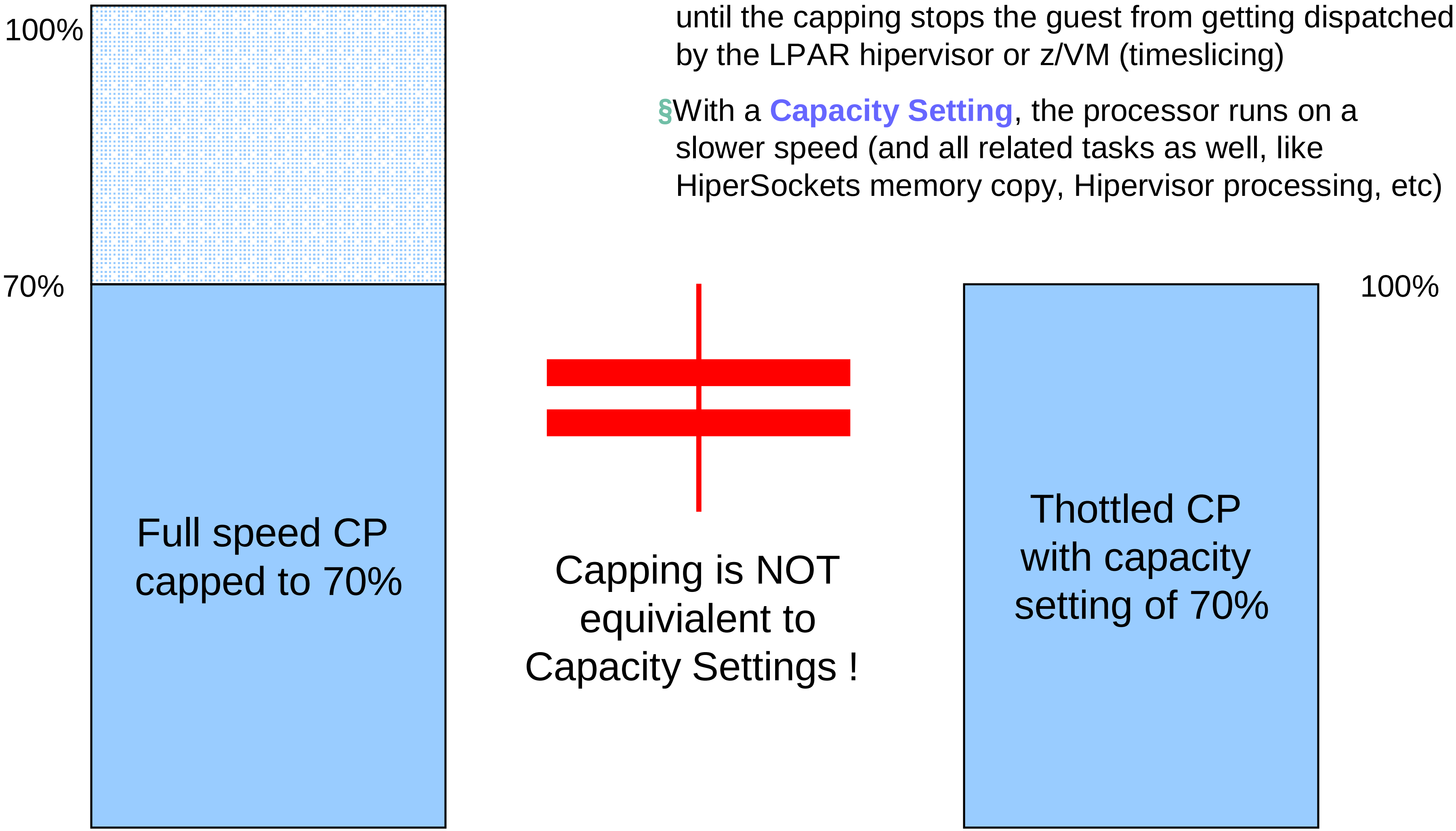
§ **You can configure a shorter BUSY wait time via DEFINE LINK command**

- BUSY=nnn (shortest possible wait time is 100 msec)

Capping versus Capacity Settings

Attention: Do not use Capping to simulate Capacity Settings !

- With **Capping**, the processor runs on its full speed, until the capping stops the guest from getting dispatched by the LPAR hipervisor or z/VM (timeslicing)
- With a **Capacity Setting**, the processor runs on a slower speed (and all related tasks as well, like HiperSockets memory copy, Hipervisor processing, etc)



100%

70%

Full speed CP capped to 70%

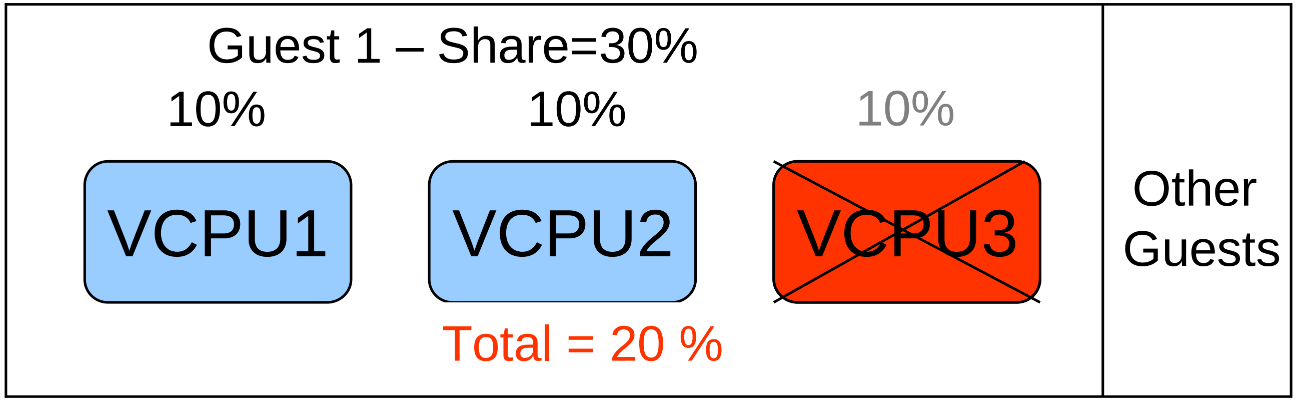
Capping is NOT equivilalent to Capacity Settings !

100%

Thottled CP with capacity setting of 70%

z/VM 5.4 Considerations

<= z/VM 5.3



Guest 1 – Share=30%

10% 10% 10%

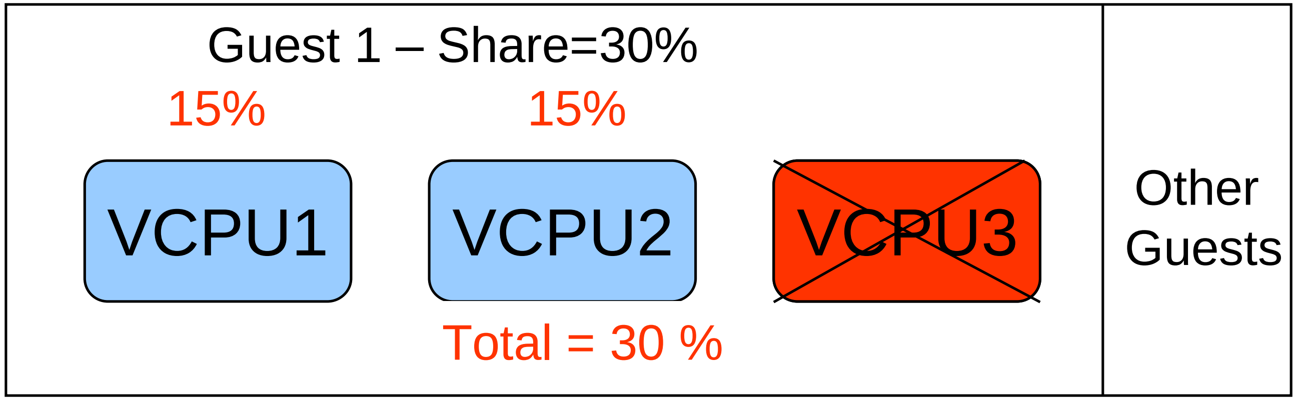
VCPU1 VCPU2 ~~VCPU3~~

Total = 20 %

Other Guests

A guest's CPU share is distributed equally among its virtual processors by dividing its share value by the number of processors, regardless of whether the virtual processors were in a stopped or started state.

z/VM 5.4 or later



Guest 1 – Share=30%

15% 15%

VCPU1 VCPU2 ~~VCPU3~~

Total = 30 %

Other Guests

z/VM V5.4 performs share redistribution whenever a virtual processor is started or stopped and no longer includes stopped virtual processors in the calculation of how much share to distribute to each virtual processor.

Sizing a system for z/VSE

- Sizing a system for z/VSE is different from sizing a system for z/OS
  - Although z/VSE supports multiprocessing, z/VSE does not scale as good as z/OS does
    - Do not use more than 3 active processors per z/VSE LPAR or z/VM Guest
- In general, a faster single CPU is better than multiple smaller CPUs
  - One partition can only exploit the power of one CPU
    - The largest partition (e.g. CICS) must fit into one single CPU
  - Dependent on nonparallel share (NPS) value
- Additional CPUs can be useful when multiple LPARs or z/VM Guests are used
  - Define only up to 3 CPUs per LPAR or z/VM Guest, even if more than 3 CPUs are available on the CEC
- Do **not** use MIPS tables for capacity planning purposes
  - Use zPCR Tool instead with the z/VSE workloads Batch, Online or Mixed
  - Use free of charge Capacity Planning Services from IBM

Sizing a system for z/VSE

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

(*) from a single VSE-image point o view

IBM Processor Capacity Reference for zSeries (zPCR)

- The zPCR tool was released for customer use on October 25, 2005
  - http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/PRS1381
  - 'As is', no official support, e-mail to zpcr@us.ibm.com

- PC-based productivity tool under Windows

- It is designed to provide capacity planning insight for IBM System z processors running various workload environments

- Capacity results are based on IBM's LSPR data supporting all IBM System z processors
  - Large System Performance Reference: http://www.ibm.com/systems/z/advantages/management/lspr/

- For VSE use z/VSE workloads Batch, Online or Mixed

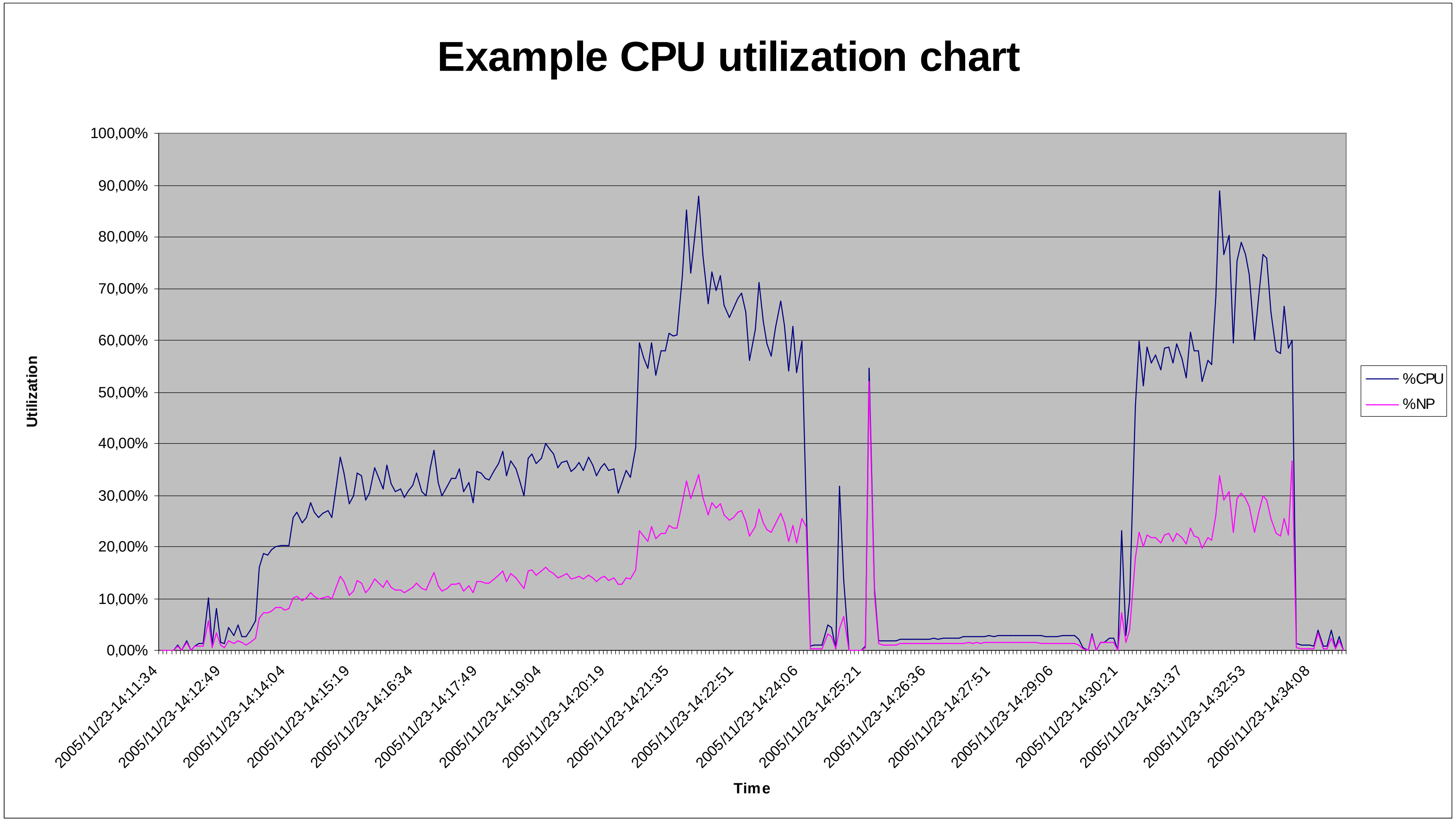
z/VSE CPU Monitor Tool

- Intended to help customers to measure the CPU utilization of their VSE system over a period of time.
- When you plan for a processor upgrade it is very important to know the CPU utilization of your VSE system over a day or a week.
  - Helps you to estimate the size of the new processor.

- The VSE CPU Monitor Tool is not intended to replace any existing monitoring product provided by partners.
- It provides only very basic monitoring capabilities on an overall VSE system level.
- No details about CPU usage of certain applications are provided
- New version available (XML Output) for z/VSE Capacity Planning

- Download
  - http://www.ibm.com/systems/z/os/zvse/downloads/tools.html
  - ‘As is’, no official support, e-mail to zvse@de.ibm.com

z/VSE CPU Monitor Tool



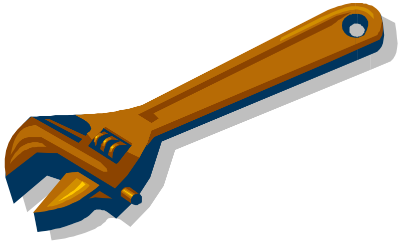
z/VSE Capacity Planning Offering

- **A new z/VSE Capacity Planning Offering is now available**
  - Available for Business Partners
  - and Customers
- **Performance data collection is based on a new version of the CPUMON Tool**
- **Analysis is done using zCP3000**

- **Contact techline@us.ibm.com** and ask for z/VSE Capacity Planning Support

z/VSE monitoring tools

- System Activity Dialogs (SYS fast path 361 and 362)
  - Displays real-time performance information about the System, CPU, partitions and I/O
- QUERY TD command
  - Displays information about CPU usage on the console
- SIR SMF command
  - Displays I/O related performance information on the console
- Job Accounting Exit (SKJOBACC in ICCF library 59)
  - Prints performance related information (CPU, I/O) to SYSLST after each job step
- MAP and GETVIS commands
  - Displays memory related information on the console
- z/VSE CPUMON Tool
  - Monitors overall system CPU usage and performance counters
- CICS Statistics
  - Prints CICS statistics
- CICS built-in tools like CEMT INQUIRE
  - Displays information about CICS ressources
- A z/VSE performance monitor product for batch and CICS
  - Like CA Explore, ASG TMON, etc.
- z/VSE V4.3 SNMP Agent



Documentation

- z/VSE homepage:
  - http://www.ibm.com/systems/z/os/zvse/
- z/VSE Performance:
  - http://www.ibm.com/systems/z/os/zvse/documentation/performance.html
- z/VM homepage:
  - http://www.ibm.com/vm
- z/VM Performance:
  - http://www.vm.ibm.com/perf/
- z/VM Preferred Guest Migration Considerations
  - http://www.vm.ibm.com/perf/tips/z890.html
- IBM System z Software Pricing
  - http://www-03.ibm.com/systems/z/resources/swprice/
- IBM's MSU ratings for IBM System z
  - http://www.ibm.com/systems/z/resources/swprice/reference/exhibits/hardware.html

Questions ?

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