Processor Analysis and Tuning

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Processor Topics

- **What is CPU utilization**
- **Theory of processor speed**
- **Common problems**
- **LPAR, HiperDispatch, Horizontal**
- **Overview of Processors**
- **Processor measurements**
- **Steal time**
- **Master Processor**
- **PLDV, Dispatch rates**
- **MFC, SMT**

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Processor Performance Concepts - Utilization

What is important?

- TOTAL IFL Utilization
- LPAR Utilization
- “My” share

CPU Utilization used for:

- Performance Analysis
- Capacity Planning
- Accounting/Chargeback

Utilization measured in many ways

- Virtual Linux measures what? Percent of something.
- z/VM under LPAR measures what? CPU Seconds
- Hardware measurement only valid method of measuring CPU

Processor Performance Concepts - Utilization

What is “CPU Utilization”?

Percent of Percent misleading

- Can not be used directly for capacity planning
- Can not be used directly for accounting/chargeback
- Often misleading for performance analysis

All zVPS numbers are measured in CPU Seconds

- Percent is always based on CPU seconds divided by wall clock

Impacts measurements of

- LPAR
- z/VM Virtual Machines
- Linux processes
- zVSE Jobs/Partitions

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Servers per LPAR

- How many LPARs
- 150 maximum seems common

Servers per IFL

- Server replacement count
- Size of server?
- One java heap vs 4 java heaps
- SAP vs Oracle vs Java

VCPU per IFL

- Core replacement
- Software prices based on cores
- 20:1 common

Processor CAPACITY Concepts – Adding IFLs

Adding processors in MP environment reduces MSU / CP in z/OS

Adding processors in z/VM MP environment (LPAR, CECs)

- Reduces queuing time
- increases CPU available
- Cost money

Service levels comparison at 50% CPU Queue time

- One CPU: 50% busy, queue time = cpu time
- Two CPUs: 70% busy, queue time = cpu time
- Three CPUS: 79% busy, queue time = cpu time
- Four CPUs: 84% busy, queue time = cpu time

The 2nd CPU almost triples the capacity at target service level

The 3rd CPU adds 70% to capacity

More processors operate at higher utilization with good performance

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Processor speed

Many performance issues based on mis-understanding

More hardware costs money, financial choices

Understand Impacts (common mistakes)

- Number of vcpu in LPAR (impact on relative weight?)
- Number of vcpu in virtual machine (impact on relative share)?
- ALL single threaded large CPU Consumers! MP doesn't help?
- ALL CPU intensive applications

CPU response time is a function of processor speed and CPUs.

- Faster processors mean shorter service time.
- More processors means lowering queuing time.

Which provides better response time,

- 2 x 20 MIP engines, or 1 x 40 MIP engine?
- at what percent utilization?

Processor Performance Concepts

Which provides better response time multi-process workload,

- 2 x 20 MIP engines, (LESS QUEUEING)
- 1 40 MIP engine? (SMALLER SERVICE TIME)

At what percent utilization? ("x" is cpu requirement)

- MM1: 2x20: resp(10%) = 2x/(1-(.1*.5)) = 2.1x
- MM1: 1x40: resp(10%) = x / (1-.1) = 1.1x
- MM1: 2x20: resp(50%) = 2x/(1-(.5*.5)) = 2.66x
- MM1: 1x40: resp(50%) = x / (1-.5) = 2x
- MM1: 2x20: resp(90%) = 2x/(1-.9*.9) = 10.52x
- MM1: 1x40: resp(90%) = x/(1-.9) = 10x
- MM1: 2x20: resp(95%) = 2x/(1-.95*.95) = 20.51*x
- MM1: 1x40: resp(95%) = x/(1-.95) = 20x

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Processor Performance Concepts

Which provides better response time for SINGLE THREAD?

- 2 x 20 MIP engines, (LESS QUEUEING)
- 1 40 MIP engine? (SMALLER SERVICE TIME)

at what percent utilization? ("x" is cpu requirement)

- MM1: 2x20: resp = 2x
- MM1: 1x40: resp = x

Common error made by sales people and financial people

The 2x20 is less expensive in hardware and software

- Fine for high multitasking,
- bad for single thread or batch

What problem is to be solved?

NOTE, SMT Lowers Queueing / CPU Wait, but….

Common Reported CPU Performance Problems

Performance Issues:

- Workload timing out,
- Application running slow
- Workload/Server in CPU Wait

Causes - Tuning

- LPAR Weights vs utilization
- LPAR VCPU vs SHARE
- Share settings poor
- Operating on GP, not IFL
- Processor Utilization high

Causes - Workload

- Master processor
- Cron jobs synchronized
- Agents, sysprog tools

BC12 Example, Mixed Mode

```
Report: ESAMFC        MainFram
-----------------------------
                <CPU Busy> <----
                <percent>  Speed
Time       CPU  Totl User  Hertz
-------- ---  ---- ----   -----

00:15:00    0 31.1 24.2    287M
            1  4.2  3.5   4196M
            2  2.8  2.3   4196M
```

Processor Distribution Management

Objective: operate at high utilization

- **Requires management decisions, prioritization**
- **Alternative to management is more hardware/licensing**

Managing distribution:

- **z/VM LPAR share of IFLs**
  - **Based on weight of LPAR**
  - **Based on number of IFLs (1 40 mip vs 2 20 mip)**
- **Linux server's share is**
  - **Share of z/VM LPAR (relative/absolute)**
  - **Based on number of vcpu**
- **Process "niced", "priority"**

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z/VM share of IFLs

Report: ESALPARS Logical Partition Summary

Time	<--Complex--> Phys CPUs	Dispatch Slice	<--------Logical Partition-------> Name	Nbr	Virt CPUs	CPU Type	<%Assigned> Total	Ovhd	<Assigned <---LPAR--> Weight	Pct
00:15:00	23	Dynamic	Totals:	0	22	CP	506.0	4.5	999	100
			Totals:	0	23	IFL	903.1	8.6	1000	100
			ZVMQA	11	6	IFL	374.8	0.9	150	15.0
			MVSPRD	7	10	CP	320.1	3.2	860	86.1
			MVSQA	1	6	CP	181.8	1.1	71	7.1
			ZVMDEQ	9	4	IFL	131.6	2.0	100	10.0
			ZVMPRD	8	10	IFL	333.7	4.9	650	65.0
			ZVMSHR	12	3	IFL	63.0	0.8	80	8.0
			MVSTST	17	3	CP	5.1	0.1	8	0.8

Totals by Processor type:

<---------CPU-------> Type	Count	Ded	shared	<-Shared Processor busy-> Total	Logical	Ovhd	Mgmt
CP	7	0	7	511.9	501.5	4.5	5.9
IFL	10	0	10	915.6	894.5	8.6	12.5
ZIIP	3	0	3	23.9	22.3	0.4	1.2

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Processor Utilization Components

LPAR Time

- Physical Overhead
- Logical Partition Logical Overhead
- LPAR logical time

z/VM (LPAR logical time)

- System Time (z/VM Control Program)
- User Overhead (allocated system time)
- Emulation (z/VM Guest time)

Linux (Emulation time)

- System time (kernel time)
- IRQ Time (Interrupt Request)
- User time

IDLE

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z/VM share of IFLs

Report: ESALPARS Logical Partition Summary

	<--Complex-->		<--------Logical Partition------->			<%Assigned>		<-Assigned	
	Phys	Dispatch		Virt	CPU			<---LPAR-->	
Time	CPUs	Slice	Name	Nbr	CPUs	Type	Total	Ovhd	Weight	Pct
00:15:00	23	Dynamic	Totals:	0	22	CP	506.0	4.5	999	100
			Totals:	0	23	IFL	903.1	8.6	1000	100
			ZVMQA	11	6	IFL	374.8	0.9	150	15.0
			ZVMDEQ	9	4	IFL	131.6	2.0	100	10.0
			ZVMPRD	8	10	IFL	333.7	4.9	650	65.0
			ZVMSHR	12	3	IFL	63.0	0.8	80	8.0

Totals by Processor type:

<---------CPU------->				<-Shared Processor busy->			
Type	Count	Ded	shared	Total	Logical	Ovhd	Mgmt
IFL	10	0	10	915.6	894.5	8.6	12.5

- ZVMQA is allocated 150/1000 of 10 SHARED IFLs
- ZVMQA is using 37.5% of 10 SHARED IFLs
- IFLs running 91.6% busy

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LPAR Weights

Each LPAR gets a weight

LPAR's share:

- (LPAR Weight) / SUM(LPAR Weights)

Processor share of system:

- (LPAR Share) / (Number CPUs in LPAR)

Processor share of a CPU is

- (Processor share of system) * (Number physical processors)

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LPAR Options

Time Slice: Dynamic, used exclusively

Weights: Sets priority between Logical Partitions

Virtual processors

Capping

- Limits Assigned time to LPAR
- Useful for outsourcing, fixed contracts

Wait Completion

- “no” gives up processor if idle (default)
- “yes”, Partition keeps processor even if idle (rarely/never used)

CEC Processor Utilization:

- Physical overhead
- Assigned time (physical cpu assigned to logical cpu)
  - Logical overhead
  - Assigned time (work)

Each LPAR gets a “Share”

LPAR was based on CP, much of LPAR has the same concepts as CP

Physical overhead is cost of dispatching lpar vcpus

LPAR Weights Example

ESALPAR (Partial report)

Note each vcpu running at 10%?

z/VM can dispatch 8 concurrent virtual machines

- Less queueing, slower service
- But, each single vcpu runs “slow”

	<--Complex-->		<--Logical->		<--------Logical Processor--------					
Time	Phys CPUs	Dispatch Slice	<-Partition> Name	VCPU No.	Addr	<%Assigned> Total	Ovhd	Weight	Cap-ped	Wait Comp
Average:	8	Dynamic	ZVM	6	0	8.3	0.2	10	No	No
					1	10.2	0.2	10	No	No
					2	11.0	0.2	10	No	No
					3	11.1	0.2	10	No	No
					4	10.5	0.2	10	No	No
					5	10.5	0.2	10	No	No
					6	10.5	0.2	10	No	No
					7	10.6	0.2	10	No	No
						-----	----			
					LPAR	82.8	1.4			

LPAR Share Example

Processor Details

- 30 LPARs configured
- 4 LPARs active
- Total of all active lpar shares: 60
- z/VM Weight: 10 (out of 60)
- z/VM Logical Processors: 8
- Physical processors online: 8

Guaranteed processor share (speed)

- (Share of system / nbr logical processors) * nbr phys
- ((10 / 60) / 8) * 8 = .16

Each virtual cpu at peak runs at 16% rated spead

(go back to processor performance concepts)

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LPAR Share Example

Processor Details: If change to 4 logical processors:

- 4 LPARs active
- Total of all shares: 60
- z/VM Weight: 10 (out of 60)
- z/VM Logical Processors: 4
- Physical processors online: 8

Guaranteed processor share (speed)

- **((10 / 60) / 4) * 8 = .32**
- **Real problem in many installations**

Too many logical processors will slow you down!

- Specifically the master processor….
- The same concept applies to Linux virtual processors
- SEE DISCUSSION ON HIPERDISPATCH!!!

LPAR Summary Report

```
Report: ESALPARS     Logical Partition Summary                          TEST MAP
Monitor initialized: 08/04/03 at 18:52:10 on 2084 serial 4B54A     First recor
-------------------------------------------------------------------------------
          <--Complex--> <-------Logical Partition--->  <-Assigned Shares---->
          Phys Dispatch              Virt <%Assigned>  <---LPAR--> <VCPU Pct>
Time      CPUs    Slice Name     Nbr CPUs Total  Ovhd  Weight  Pct /SYS /CPU
--------  ---- -------- -------- --- ---- -----  ----  ------ ---- ---- ----
Average:     8  Dynamic Totals:    0   22 188.7   2.1      60  100
                        ZVM         6    8  82.8   1.4      10 16.0 2.00 16.0
                        CF01        1    1  99.9   0.0      10 16.0 16.0  128
                        LINUXSW     2    2     0     0      10 16.0 8.00 64.0
                        S01         3    4   4.6   0.4      10 16.0 4.00 32.0
                        S02         4    0
                        VMTPC       5    5   1.2   0.2      10 16.0 3.00 24.0
                        ZVMCSS1    16    2   0.2   0.0      10 16.0 8.00 64.0
```

“ZVM” Allocated 16% of 8 CPUs
Each virtual cpu allocated 2% of system (8 CPUs)
Each processor rated at 16% speed of real processor

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Stated Purpose of HiperDispatch and vertical scheduler:

- Localize work to L1/L2 cache
- Reduce impact of installation LPAR configuration errors

Impact

- Virtual CPUs disabled, share redistributed
- Faster master processor
- L1/L2 cache impact negligible

ESAOPER:

```
07:00:41 CPU Park from 15 to  13 CPUUtil= "12.9",
07:00:43 CPU Unpark from  13 to  15 CPUUtil= "12.5
07:05:35 CPU Park from 15 to  13 CPUUtil= "12.2",
07:05:37 CPU Unpark from  13 to  15 CPUUtil= "12.0
07:05:53 CPU Park from 15 to  12 CPUUtil= "12.0",
07:05:55 CPU Unpark from  12 to  15 CPUUtil= "10.4
07:07:13 CPU Park from 15 to  13 CPUUtil= "12.5",
07:07:15 CPU Unpark from  13 to  15 CPUUtil= "11.9
07:07:19 CPU Park from 15 to  13 CPUUtil= "12.1",
07:07:21 CPU Unpark from  13 to  15 CPUUtil= "11.8
07:07:29 CPU Park from 15 to  13 CPUUtil= "12.1",
```

HiperDispatch requires Vertical scheduling

```
Report: ESALPAR      Logical Partition Analysis
Monitor initialized: 05/31/16 at 00:00:00 on 2827 serial 2F5A7
-------------------------------------------------------------------
         <--Complex--> <--Logical-> <----------Logical Processor-
         Phys Dispatch <-Partition> VCPU <%Assigned> VCPU
Time     CPUs    Slice Name     No. Addr Total  Ovhd TYPE Weight
-------- ---- -------- -------- --- ---- -----  ---- ---- ------
07:15:00   19  Dynamic R3SYSG     2    0  87.9   0.8 IFL      400
                                    1  89.3   0.7 IFL      400
.....
                                   11  81.9   0.8 IFL      400
                                   12  77.5   1.0 IFL      400
                                   13  75.5   0.9 IFL      400
                                   14  60.9   0.7 IFL      400
                                      -----  ----
                                 LPAR  1245  11.8

                          R3SYS1   3    0  48.6   2.1 IFL      500
                                    1  35.5   1.6 IFL      500
                                    2  40.4   1.7 IFL      500
                                    3  38.9   1.5 IFL      500
                                    4  36.8   1.7 IFL      500
                                    5  38.8   1.7 IFL      500
                                    6  40.1   1.3 IFL      500
                                    7  32.5   1.3 IFL      500
                                    8  30.0   1.2 IFL      500
                                    9  18.6   0.9 IFL      500
                                   10  17.8   1.4 IFL      500
                                   11   0.0   0.0 IFL      500
                                   12   0.0   0.0 IFL      500
                                   13   0.0   0.0 IFL      500
                                   14   0.0   0.0 IFL      500
                                      -----  ----
                                 LPAR 378.1  16.4
```

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Linux Servers

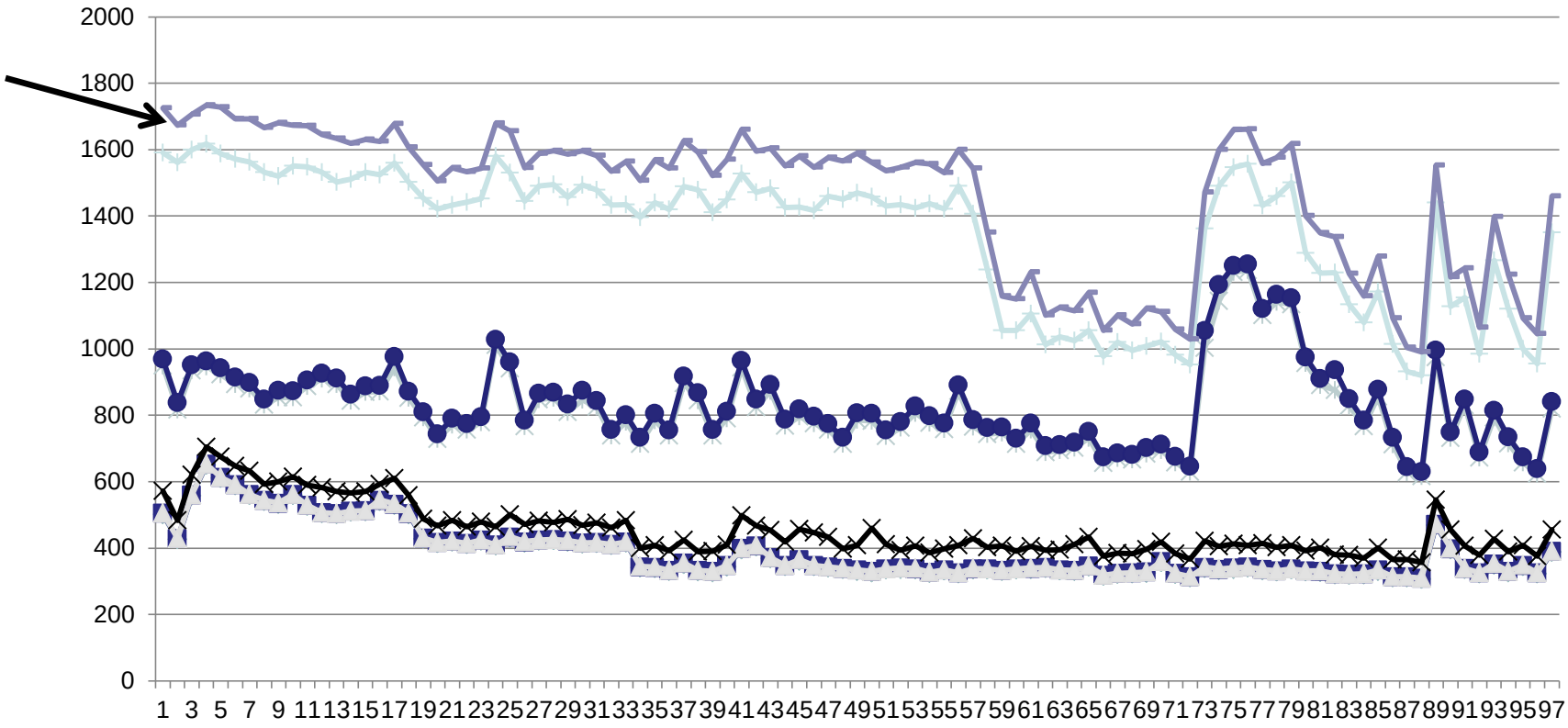
- 120 servers total (Big, ORACLE)
  - 4gb-40gb

    (1 / 2 size from original SUN servers)

Hardware

- 17 IFLs
  - 7 servers per IFL
  - 395 vcpus (23:1 overcommit)
- 7 LPARs, each with 17 VCPU
  - Worst case possible for overhead

LPAR Configuration Overhead



17 IFLs, 7 lpars, 17 vcpus each, 7:1 overcommit

Physical Overhead significant from real processor overcommit

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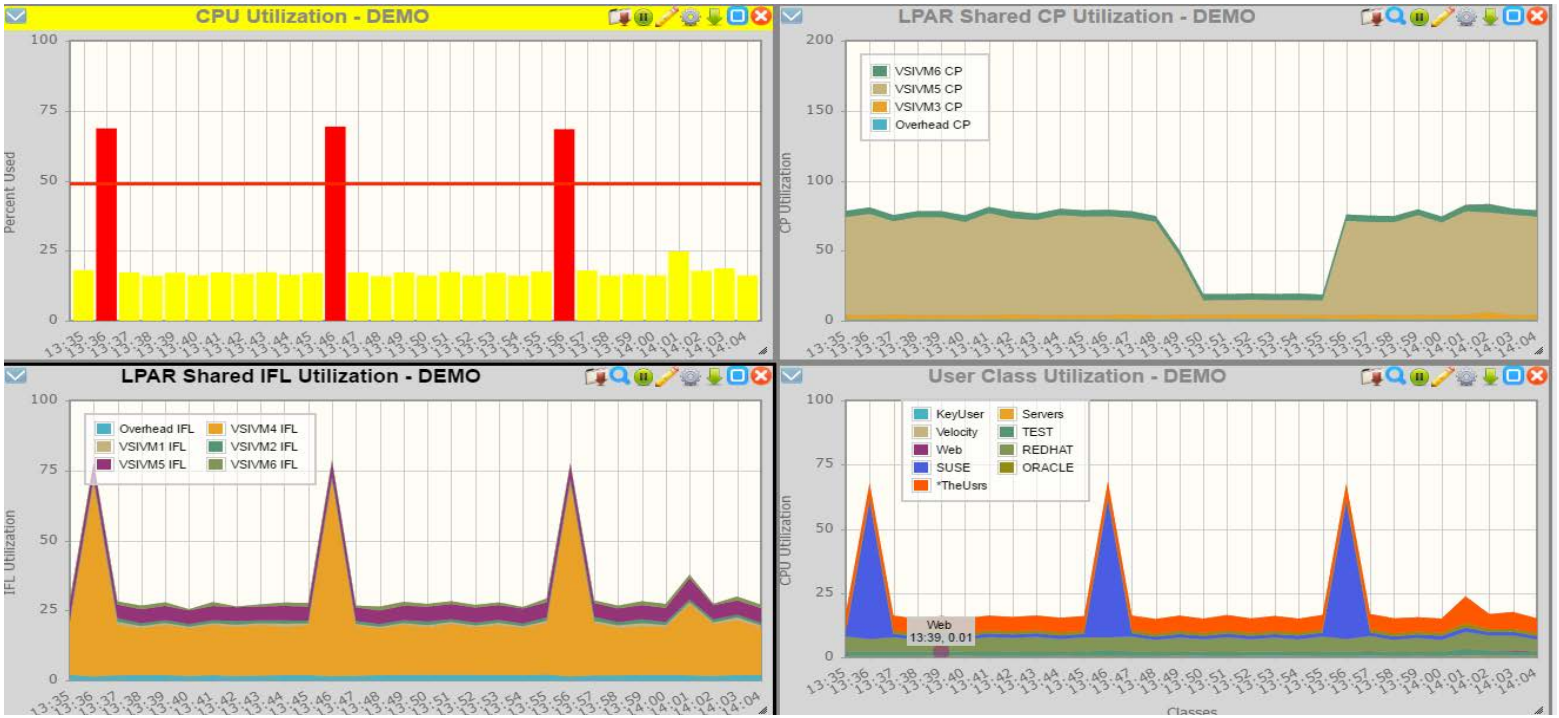
Samples of Management Overhead

```
Totals by Processor type:
<---------CPU-------> <-Shared Processor busy->
Type Count Ded shared  Total  Logical Ovhd Mgmt
---- ----- --- ------ ------ -------- ---- ----
IFL     86   0     86 3084.6   2784.4  111  189       6%     z13


Totals by Processor type:
<---------CPU-------> <-Shared Processor busy->
Type Count Ded shared  Total  Logical Ovhd Mgmt
---- ----- --- ------ ------ -------- ---- ----
CP      10   0     10  885.6    867.4  7.4 10.8
IFL     14   0     14  800.8    776.2  9.7 14.9       2%     z13
ZIIP     6   0      6  161.9    158.6  1.1  2.3


Totals by Processor type:
<---------CPU-------> <-Shared Processor busy->
Type Count Ded shared  Total  Logical Ovhd Mgmt
---- ----- --- ------ ------ -------- ---- ----
CP       3   0      3  163.9    160.1  2.2  1.5
IFL     22   0     22  899.8    867.0 15.5 17.3       6%     z13
ICF      1   1      0    0.0        0    0  0.0
ZIIP     3   0      3    9.6      9.5  0.1  0.1

Totals by Processor type:
<---------CPU-------> <-Shared Processor busy->
Type Count Ded shared  Total  Logical Ovhd Mgmt
---- ----- --- ------ ------ -------- ---- ----
IFL     88   0     88 6046.3   3698.7  393 1955      32%     z13    SMT Enabled
```

Analyzing IFL Consumption

- zVIEW, 4 charts (default subset)
- IFL utilization, CP utilization
- z/VM LPAR utilization, by workload (classes)



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Managing Distribution - What is my share?

CPU distribution depends on

- LPAR Weight (and impact of other LPARs)
- Share within z/VM LPAR
- Impact of other virtual servers

Measure “wait for CPU” on ESAXACT

Share analysis:

- ESALPARS for LPAR / IFL utilization
- ESALPARS for LPAR allocation
- ESACPUU / ESACPUA for z/VM perspective
- ESAUSRC for share settings
- ESAUSP2 for how much am I getting

“z” Processor Overview (ESAHDR)

```
System Identifier                          VSIVM5
Checkpoint/Warmstart Volumes            VM5RES/VM5RES
Machine Model/Type                      BC12:2828/A02
System Sequence Code                  0000000000714C7
Processor  0 model/serial             2828-A02  /0514C7 Master
Processor  1 model/serial             2828-A02  /0514C7
Processor  2 model/serial             2828-A02  /0514C7

 Power of processor in terms of service Units:  2338
 CPU Capability Factor:       16784
 CPU(GP) Capability Factor:     788
 Operating on IFL Processor(s)
 Channel Path Measurement Faclity(CPMF) Extended is installed
```

Service units from table

Understand the

- **CEC**
- **z/VM (IFLs)**

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Processor Measurement

```
Report: ESACPUU      CPU Utilization Report                          Linux Test
Monitor initialized: 05/06/08 at 12:00:00 on 2094 serial AEA7D     First record analyzed:
-------------------------------------------------------------------------------------
         <----Load---->     <-----CPU (percentages)-----> <------External (per second)---
         <-Users-> Tran     Total  Emul  User   Sys  Idle <--Page---> <--Spool-->  RSCH+
Time     Actv In Q /sec CPU  util  time ovrhd ovrhd  time  Read Write  Read Write  SSCH
-------- ---- ---- ----  -  ----- ----- ----- ----- ----- ----- -----  ----- -----  -----
12:01:00  103  118  9.1  0   92.8  88.6   2.3   1.9   7.2    11    52      0     0   220
                        1   93.8  90.5   2.2   1.0   6.2    14     0      0     0   182
                        2   94.4  90.9   2.2   1.2   5.6    17     0      0     0   196
                        3   94.5  90.9   2.1   1.5   5.5    13     0      0     0   179
                           ----- ----- ----- ----- ----- ----- -----  ----- -----  -----
System:                    375.4 361.0   8.9   5.5  24.4    55    52      0     0   778
```

Processor utilization has three components:

- Emulation time – running users in Interpretive Execution
- User overhead – CP time performing services for a user
- System overhead – CP “housekeeping”
- (Note master processor – only problem if architecturally constrained)

Processor Measurements User View

ESAUSP2:

CPU Consumption in percent

- Total all user
- By user
- By Class

Note

- one server dominates CPU
- Capture ratio

T:V Ratio is Total to Virtual, 1.0 is good

```
Report: ESAUSP2      User Resource Rate Report
Monitor initialized: 05/06/08 at 12:00:00 on 2094 serial
-------------------------------------------------------
         <---CPU time--> <----Main Storage (pages)----->
UserID   <(Percent)> T:V <Resident> Lock <-----WSS----->
/Class    Total  Virt Rat Totl Activ  -ed Totl Activ  Avg
-------- ----- ----- --- ---- ----- ---- ---- ----- ----
12:01:00 369.9 361.0 1.0  17M   17M  417  17M   17M 129K
 ***User Class Analysis***
*Servers  1.95  1.72 1.1 7566  7555   49 8674  7444  207
*CMSUser  0.00  0.00  23    0     0    0   63    63   63
*Linux   184.0 180.6 1.0  15M   15M  305  15M   15M 185K
*Misc    183.7 178.5 1.0   2M 1642K   11   2M 1642K 328K
 ***Top User Analysis***
LXPWK001 183.5 178.4 1.0   2M 1641K    3   2M 1641K   2M
LXWKB215 37.63 37.01 1.0 782K  782K    1 782K  782K 782K
LXWKB211 33.97 33.88 1.0 514K  514K    0 514K  514K 514K
LXWKB210 17.64 17.55 1.0 298K  298K    2 298K  298K 298K
LXWKB214 16.86 16.68 1.0   1M 1188K    0   1M 1254K   1M
LXWKB228  6.01  5.98 1.0 731K  731K    3 731K  731K 731K
LXWKB222  5.06  4.94 1.0 621K  621K    5 621K  621K 621K
ESATCP    0.45  0.35 1.3 1038  1038    1 1037  1037 1037
TCPIP2    0.02  0.01 2.0 1142  1142   48  198   198  198
```

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Much system code NOT re-entrant

- Must be single threaded
- Can not update one control block by multiple processors simultaneously

Implementation

- hardware locks: TS, CS, CDS instructions
- software locks: “ownership” of resources
  - (such as in database)
- running on the Master Processor

SPIN Locks

- Test for lock, if fail, test for lock
- Linux uses “spin lock”, replaced with Diag44 -> DIAG9C
- Linux spin locks an issue, cost in CPU
- Diag44 “brain dead”, Diag9C gives dispatch to CPU owning lock

[redacted]ialization Master Processor

M[redacted]master only" to ensure the integrity of th[redacted]

[redacted]RPI, *ACCOUNT from CP)

[redacted]

execution of ALL CP commands

Line mode console I/O

Master processor utilization shows up as higher System Overhead and User Overhead on the Master Processor.

Higher Master CPU busy is worse on a system with more processors.

Master calls is measured

Simulation wait is measured

Processor imbalance can be a problem

CPU Example

- User overhead high on master
- System overhead high on master
- Master processor can be a limiter

```
Report: ESACPUU      CPU Utilization
-------------------------------------------------------------------------------------------
         <----Load---->     <-----CPU (percentages)-----> <------External (per second)------->
         <-Users-> Tran     Total  Emul  User   Sys  Idle <--Page---> <--Spool--->  RSCH+
Time     Actv In Q /sec CPU  util  time ovrhd ovrhd  time  Read Write  Read Write  SSCH  ExInt
-------- ---- ---- ---- -  ----- ----- ----- ----- ----- ----- ----- ----- ----- -----  -----
09:19:12    7  5.0  0.1  1   99.4  20.9  58.8  19.8     0     0     0     0     0     3    140
                          2   84.7  43.6  30.7  10.3  15.0     0     0     0     0     0    154
                          3   84.2  43.2  30.9  10.1  15.5     0     0     0     0     0    153
                          4   84.5  43.6  31.1   9.7  15.2     0     0     0     0     0    155
                              ----- ----- ----- ----- ----- ----- ----- ----- ----- -----  -----
System:                     352.7 151.3 151.6  49.9  45.7     0     0     0     0     3    602
```

Would adding another processor help this system?

MASTER Processor Analysis

Investigating Master Overhead

- User overhead high on master
- System overhead high on master
- All spool I/O performed by master Note I/O lower on master?

ESAIUCV: RPI, MSG IUCV

ESACPUA: Page migration, Spool I/O

```
          <----Load--->     <-----CPU (percentages)-----> . <---External (per second)->
         <-Users> Tran     Total  Emul  User   Sys  Idle . <--Page--> <-Spool--> RSCH+
Time      Actv InQ /sec CPU  util  time ovrhd ovrhd  time . Read Write Read Write SSCH
-------- ---- --- ---- -  ----- ----- ----- ----- ----- . ---- ----- ---- ----- ----
10:21:09  255  20 23.9  0   86.4  16.7  53.6  16.2  13.4 .   60    71    9     4   86
                        1   67.9  35.9  23.7   8.4  31.9 .   82    56    0     0  135
                        2   69.5  36.4  24.5   8.7  30.3 .   89    58    0     0  140
                        3   67.0  35.4  23.2   8.4  32.8 .   76    71    0     0  134
                           ----- ----- ----- ----- ----- . ---- ----- ---- ----- ----
System                     290.9 124.3 124.9  41.7 108.4 .  307   256    9     4  496
```

Processor Local Dispatch Vectors

Users are selected for dispatch from a PLDV.

Each processor has a local PLDV.

Master ONLY PLDV

- Some work for users
- Some System work
- The System VMDBK

The System VMDBK and users on the Master Only PLDV are dispatched on the Master Processor.

VELOCITY SOFTWARE

Dispatch Vector Activity

```
Report: ESAPLDV      Processor Local Dispatch Vector Activity  Linux Test  ESAMAP 3.7.4
-------------------------------------------------------------------------------------------
         <----Users----->   Tran       <VMDBK Moves/sec>  <--------PLDV Lengths------> Dispatcher
Time     Logged Actv In Q   /sec  CPU  Steals  To Master   Avg  Max Mstr MstrMa %Empty Long Paths
-------- ------ ---- ----  -----   -   ------  ---------  ----  --- ---- ------ ------ ----------
12:01:00    129  103  118    9.1   0       0        2.5   3.2  4.0  0.0     1.    8.3     4497.1
                                   1       0          0   2.1  4.0    .          38.3     3942.1
                                   2       0          0   2.0  4.0    .          41.7     3942.7
                                   3       0          0   1.8  3.0    .          38.3     3741.7
                                       ------  ---------  ----  --- ---- ------ ------ ----------
System:                                0        2.5   9.2 15.0  0.0     1.  126.7    16123.5
```

The Dispatcher selects users from the CPU's Processor Local Dispatch Vector (PLDV).

Each processor has a Local PLDV.

The Master Processor has a special PLDV from which "master only" work for users is selected.

Dispatch Vector Activity

```
Report: ESAPLDV      Processor Local Dispatch                      Z
Monitor initialized: 09/13/16 at 06:48:00 on 2ord analyzed: 09/13/16
-------------------------------------------------------------------
         <----Load---->                                  <-CPU Steals
         <-Users-> Tran     <VMDBK Moves/sec>  Dispatcher <-From Nesting level>
Time     Actv In Q /sec CPU Steals  To Master  Long Paths Same  NL1
-------- ---- ---- ---- --- ------  ---------  ---------- ---- ----
06:52:00  104  298  1.6   0  18833       19.1     41987.5  14K 5041
                         1  14558          0     39037.3  10K 4271
                         2  14622          0     37494.3  11K 3879
                         3  15607          0     38517.3  12K 3846
                         4  15499          0     35614.6  12K 3695

                        14  13560          0     33040.5  11K 2680
                        15  33239          0     61527.9    0  33K
                            --     ------     ------- ---- ----
System:                     203287       19.1    469112.9 130K  74K
```

Seems to be a problem? 40K per thread, big impact on SMT!

Dispatch Vector Activity

```
Report: ESAUSR3       06/15/17   Page   69
-------------------------------.----------
                 DASD <Message> . <Dispatch>
UserID    DASD Block <Errors-> . <Rate/Sec>
/Class     I/O   I/O IUCV VMCF . Disp Waits
-------- ----- ----- --- ----- . ---- -----
06:49:00  6683  1548    0     0 . 348K  348K
***User Class Analys             .
Servers     35     9    0     0 .    1     1
ZVPS       343     0    0     0 .  357   357
TheUsers  6305  1539    0     0 . 347K  347K
 ***Top User Analysis            .
CV52D019    22     0    0     0 .  26K 25632
CV52D024    16     0    0     0 .  26K 25694
CV52D021    22     0    0     0 .  26K 25786
CV52D030    19     0    0     0 .  24K 24039
CV52D020    18     0    0     0 .  23K 23069
CV52D018    26     0    0     0 .  24K 23615
CV52D023    20     0    0     0 .  23K 23014
CV52D001    39     0    0     0 .  17K 16642
CV52D005    48     0    0     0 . 3149  3149
CV52D003    29     0    0     0 . 4584  4584
```

z/VM 6.3 adds metrics

VELOCITY SOFTWARE

Processor Utilization (Is it correct?)

Why is the Linux LPAR always 100% busy? (RMF)

- Dedicated processors show up as 100%

Processor utilization measurements are NOT consistent between products/commands

- This matters when running second level, or in an LPAR
- CP Indicate shows percent of what is available
- CP Does NOT KNOW what is available

ZMON/ZMAP show absolute utilization

- LPAR information is available

Measuring Linux CPU under VM was “bogus”

Linux reported a percent of a percent busy – fixed with steal timer

Effects of Logical Partitioning

```
Report: ESASSUM Subsystem Activity Velocity Software, Inc.
-------------------------------------------------------------------------------------------------------------
         <---Users----> Transactions <Processor> Storage (MB) <-Paging--> <-----I/O-----> <MiniDisk> Spool
         <-avg number->    Per  Avg. Utilization Fixed Active <pages/sec> <-DASD--> Other <-Cache--> Page
Time       On Actv In Q Minute  Resp Total Virt.  User Resid. XStore DASD Rate Resp  Rate  Rate %Hit Rate
-------- ---- ---- ---- ------ ----- ----- ----- ----- ------ ------ ---- ---- ---- ----- ----- ---- -----
08:00:08 1479  244 34.3 1310.1 0.603   124    87  36.9  192.0    888  451  641 15.4    40 687.9 49.3    36
08:01:08 1500  248 46.0 1260.9 0.543   147   110  37.3  192.7    904  494  732 20.1    37 881.6 53.9    32
*************************************************Summary*************************************************
Average: 1483  245 37.3 1297.8 0.589   130    93  37.0  192.1    892  461  664 16.7    39 736.4 50.7    35
```

A high-level view of processor utilization shows a system with some capacity to spare.

Next step, look at processor configuration

Effects of Logical Partitioning

Report: ESACPUU CPU Interval Analysis Velocity Software, Inc.

	<----Load---->				<-----CPU (percentages)----->					<---Internal (per second)---->				
	<-Users->		Tran		Total	Emul	User	Sys	Idle	Diag-	Inst.	SIE	Fast	Page
Time	Actv	In	Q /sec	CPU	util	time	ovrhd	ovrhd	time	nose	sim.	intrcp	path	fault
08:00:08	244	34.3	24.6	0	48.5	27.3	16.7	4.5	9.9	1449	1478	1753	0	18
				1	35.9	28.8	5.2	1.9	11.8	818	599	716	0	9
				2	39.5	31.4	5.9	2.2	13.5	902	682	815	0	11
System:					124.0	87.4	27.9	8.7	35.3	3170	2758	3284	0	37
08:01:08	248	46.0	24.0	0	53.6	32.5	16.7	4.4	7.1	1557	1588	1806	0	24
				1	44.6	37.2	5.4	1.9	6.5	843	594	685	0	11
				2	48.8	40.2	6.4	2.2	7.4	903	704	817	0	12
System:					147.0	109.9	28.5	8.6	21.0	3303	2886	3308	0	48

A more detailed view of processor utilization seems to confirm this hypothesis. CPU to spare.

VELOCITY SOFTWARE

Effects of Logical Partitioning

Report: ESAXACT Transaction Analysis Velocity Software, Inc.

			<-------------Percent non-dormant----------------->															
UserID	<-Samples->								E-	D-	T-		Tst				Lim	Pct
/Class	Total	In Q	Run	**Sim**	**CPU**	SIO	Pg		SVM	SVM	SVM	CF	Idl	I/O	Ldg	Oth	Lst	Elig
System:	5936	149	5.4	**34**	**8.7**	0	3		0	0	6.0	2	36	4.7	.	0	.	0
Hi-Freq:	176K	7057	2.0	**17**	**2.8**	0	1		0	3.8	4.2	49	17	3.1	0	0	.	0
***Resource use by User Class																		
*Servers	3720	568	3.0	**29**	**4.2**	0	0		0	21	6.9	1	28	7.6	0	0	.	0
*Keys	1080	490	1.6	**0.6**	**6.7**	0	0		0	16	19	1	43	13	0	0	.	0
*TheUsrs	172K	6108	1.9	**16**	**2.6**	0	1		0	1.2	3.0	57	14	2.5	0	0	.	0

User state sampling shows significant amount of CPU wait as compared to “Running”, Simulation wait even greater.

VELOCITY SOFTWARE

Effects of Logical Partitioning

```
Report: ESALPAR Logical Partition Analysis Velocity Software, Inc.
-------------------------------------------------------------------------------
---
         <----Load----> <--Complex--> <--Logical-> <--------Logical Processor---------->
         <-Users-> Tran Phys Dispatch <-Partition> VCPU <%Assigned>       Cap- Wait
                        Slice    Name     No. Addr Total Ovhd Weight  ped Comp      e
-------- ---- ---- ---- ---- -------- -------- --- ---- ----- ---- ------ ---- ----
08:00:08  244 34.3 24.6    3  Dynamic CMS2       1    0  58.7  0.2    155   No  Yes
                                                    1  47.8  0.1    155   No  Yes
                                                    2  53.2  0.1    155   No  Yes
                                                       ----- ----
                                                 LPAR 159.7  0.4

                                        SWCF       2    0  36.6  0.1    130   No  Yes
                                                    1  43.0  0.1    130   No  Yes
                                                    2  46.7  0.1    130   No  Yes
                                                       ----- ----
                                                 LPAR 126.3  0.3

                                        CMS8       3    0   9.1  0.1     15   No  Yes
                                                    1   4.6  0.2     15   No  Yes
                                                       ----- ----
                                                 LPAR  13.7  0.3

Total Logical Partition busy:                              299.6
Total Physical Management time: 0.366
```

This system does not have access to 100% of each processor.

Reducing CMS2 LPAR to 2 processors will perform better

- Master processor will run 50% faster, reduces SIM Wait.

Processor Capture Ratio

```
Report: ESASSUM      Subsystem Activity
-------------------------------------------------------
         <---Users----> Transactions <Processor>  Captur
         <-avg number->    Per  Avg. Utilization   Ratio
Time       On Actv In Q Minute  Resp Total Virt.  (pct)
-------- ---- ---- ---- ------ ----- ----- -----  ------
16:26:00  741  154 27.0  765.0 0.521   799   678   99.96
16:27:00  738  136 41.0  602.0 0.356   693   585   99.99
16:28:00  740  131 31.0  695.0 0.318   688   589   99.99
16:29:00  739  159 32.0  665.0 0.437   858   735  100.09
16:30:00  738  154 34.0  783.0 0.435   656   558  100.04
***********************************************
Average:  738  157 35.9  793.6 0.416   740   632   99.50
```

Capture ratio is CPU accounted for / CPU used

Capture ratio critical for capacity planning, chargeback

Unique methodology

VELOCITY SOFTWARE

Managing the delivery of CPU Resource

Options for tuning processor

Reducing overhead

- Application tuning to reduce processor demand
- Reducing system overhead

Reallocating resources

- Adjust SHARE values
- Limit DSPBUF occupancy
- Dedicate processors
- Interactive BIAS (SET SRM IABIAS)

VELOCITY SOFTWARE

Limiting Shares

```
Q  share vmservu
USER VMSERVU :RELATIVE SHARE= 100 MAXIMUM SHARE= NOLIMIT
Ready; T=0.01/0.01 16:58:54
```

LIMITs

- LIMITHARD caps resource consumption regardless of other user demands
- LIMITSOFT caps resource consumption unless all users have received their target minimum, and there are no unlimited users who can consume resources

```
set share vmservu relative 200 500 limitsoft
USER VMSERVU : RELATIVE SHARE= 200 MAXIMUM SHARE=LIMITSOFT
RELATIVE 500
Ready; T=0.01/0.01 17:01:12
```

```
set share mvsys1 abs 5% abs 20% limithard
USER MVSYS1 : ABSOLUTE SHARE = 5%
MAXIMUM SHARE = LIMITHARD ABSOLUTE 20%
Ready; T=0.01/0.01 14:40:49
```

Adjusting DSPBUF values

The purpose of the Dispatch Buffer (DSPBUF) is the limit on the number of users of each Scheduler class allowed in the Dispatch List – thereby controlling CPU utilization

If CPU is 100% busy, try lowering the Q3 value.

- Watch CPU busy very carefully.

What happens if DSPBUF is lowered too far for Q3?

- (Hint: How is Elapsed Time Slice determined?)

Experimenting with DSPBUF is not for the casual tuner or the faint of heart.

I/O Processor is another type of processor

If I/O processor overloaded, determine why.

- **Is I/O Slow with no explanation?**
- **Could be iop….**
- **ESCON and Ficon mixed channels?**
- **DASD Cache performing poorly?**

```
Report: Report: ESAIOP        I/O Processor Analysis
-------------------------------------------------------------------
          I/O  <-----------------I/O Processor-------------------->
          Proc <Pct Util> <Rate/Second>  <-Percent of Strts busy->
Time      Nmbr Busy  Idle  SSCH Intrpts  chan switch CtlUnit Device
--------  ---- ---- ----- ----- -------  ---- ------ ------- ------
21:22:00    0  65.8  34.2  2690    2402  1488   12.7     0.3    1.5
            1  55.6  44.4  2939    3686   837    4.3     0.3    0.1
            2  54.2  45.8  1684    2979  1756    0.6     0.5    0.4
21:27:00    0  50.6  49.4  2227    2190  1374   12.6     0.4    0.9
            1  39.8  60.2  2540    2997   648    3.6     0.4    0.2
            2  41.2  58.8  1711    2691  1334    0.7     0.4    0.5
```

User's complain, InQueue skyrockets, why?

- **Impact really is quickdsp and Q3 –Really long running transactions.**

```
Report: ESAUSRQ      User Queue and Load Analysis                    Veloc
-------------------------------------------------------------------------
         <-----------User Load------------>     <-----------Average Num
UserID   Logged  Non-           Disc- Total  Tran <-------Dispatch List--
/Class       on  Idle  Active  conn  InQue  /min    Q0    Q1    Q2    Q3
-------- ------ ----- ------- ------ -----  ---- ----- ----- ----- -----
14:01:00 1061.0     .   156.0      .  20.0  1175   5.0   6.0   2.0   7.0
14:02:00 1063.0     .   157.0      .  25.0  1184  10.0   5.0   4.0   6.0
14:03:00 1064.0     .   188.0      .  52.0  1423   3.0   2.0   8.0  39.0
…….
14:18:00 1064.0     .   154.0      .  31.0  1185  10.0   5.0   6.0  10.0
14:19:00 1065.0     .   161.0      .  36.0  1130   6.0   4.0   3.0  23.0
14:20:00 1065.0     .   186.0      .  47.0  1143  13.0   3.0   1.0  30.0
14:21:00 1066.0     .   190.0      .  72.0  1140  25.0  15.0   8.0  24.0
14:22:00 1065.0     .   213.0      .  73.0  1189  35.0   3.0   1.0  34.0
14:23:00 1067.0     .   243.0      .  88.0  1157  31.0   3.0   1.0  53.0
14:24:00 1067.0     .   259.0      .  81.0  1105  11.0   2.0   5.0  63.0
14:25:00 1067.0     .   215.0      .  46.0   932  12.0   6.0   3.0  25.0
…..
14:30:00 1069.0     .   266.0      . 108.0  1227  34.0   6.0   7.0  61.0
14:31:00 1069.0     .   274.0      . 116.0  1183  30.0   2.0   2.0  82.0
14:32:00 1067.0     .   266.0      . 126.0   960  47.0   4.0   5.0  70.0
14:33:00 1067.0     .   257.0      . 105.0  1230  43.0   7.0  13.0  42.0
```

VELOCITY SOFTWARE

Check processor, cpu is a constant, I/O is constant

Report: ESASSUM Subsystem Activity Velocity Software

	<---Users---->			Transactions		<Processor>		Storage (MB)		<-Paging-->		<-----I/O----->		
	<-avg number->			Per	Avg.	Utilization		Fixed	Active	<pages/sec>		<-DASD-->		Other
Time	On	Actv	In Q	Minute	Resp	Total	Virt.	User	Resid.	XStore	DASD	Rate	Resp	Rate
14:01:00	1061	156	20.0	763.0	0.733	41	35	18.5	999.5	5	5	536	1.0	27.5
14:02:00	1063	157	25.0	803.0	0.594	41	35	18.5	1022.0	7	4	634	1.0	27.8
14:03:00	1064	188	52.0	981.0	1.112	41	35	18.5	1162.0	7	5	318	1.0	33.4
14:18:00	1064	154	31.0	729.0	1.055	41	36	18.5	986.5	0	3	277	1.0	26.3
14:19:00	1065	161	36.0	727.0	0.704	41	34	18.5	1061.1	226	3	303	1.3	35.3
14:20:00	1065	186	47.0	773.0	1.954	41	35	18.5	1315.9	432	2	377	1.1	30.8
14:21:00	1066	190	72.0	843.0	2.160	41	34	18.7	1308.9	1	2	769	0.8	38.9
14:22:00	1065	213	73.0	833.0	2.367	41	35	18.7	1394.9	1	3	548	0.9	31.1
14:23:00	1067	243	88.0	830.0	2.824	41	35	18.9	1537.0	1	3	858	0.8	29.8
14:24:00	1067	259	81.0	775.0	2.389	41	34	18.7	1660.4	13	3	683	0.8	18.2
14:25:00	1067	215	46.0	509.0	1.095	41	34	18.7	1452.4	8	2	583	0.8	28.5
14:30:00	1069	266	108	838.0	1.623	41	35	19.2	1618.2	5	3	511	0.8	28.8
14:31:00	1069	274	116	787.0	0.655	41	35	19.2	1630.7	8	3	569	0.8	29.0
14:32:00	1067	266	126	650.0	1.191	41	34	19.2	1580.9	4	3	774	0.8	30.7

VELOCITY SOFTWARE

Check LPAR Configuration

- Check weights
- VM shares with MVS and TEST, share is 179 / (179+260+5) = 40%
- (Only one CP defined)
- VM LPAR is capped!!!! At 40% of one CPU. VM running 100%

```
Report: ESALPARS     Logical Partition Summary   Velocity Software
-------------------------------------------------------------------------------------------
          <--Complex--> <-------Logical Partition--->  <-Assigned Shares---->             Proce
          Phys Dispatch              Virt <%Assigned>  <---LPAR--> <VCPU Pct> Cap-  Wait Type
Time      CPUs    Slice Name     Nbr CPUs Total  Ovhd  Weight  Pct /SYS /CPU  ped   Comp
--------  ---- -------- -------- --- ---- -----  ----  ------ ---- ---- ----  ----  ---- ----
14:01:00     1  Dynamic Totals:    0    3  80.4   0.5     444  100                          
                       VM         1    1  41.2   0.1     179 40.0 40.0 40.0   Yes    No CP
                       MVS        2    1  39.2   0.4     260 59.1 59.1 59.1    No    No CP
                       TEST       3    1     0     0       5  1.0 0.96 0.96    No    No CP
                       TESTTEST   5    0
```

Check User Wait States

- **Running went down as percent of non-dormant, inqueue time.**
- **CPU wait stayed the same**
- **Asynchronous I/O wait is bottleneck – but DASD I/O was constant?**
- **Clue – something was on the Limit List – this is result of SHARE CAP**
- **Wait state sampling tests I/O Wait before testing Limit. If I/O wait, stops.**

```
Report: ESAXACT      Transaction Delay Analysis                    Velocity Software
-------------------------------------------------------------------------------------
                     <--------------Percent non-dormant---------------------->        Times
UserID   <-Samples->                        E-  D-  T-     Tst <Asynch>        Lim  Pct     I/O
/Class   Total  In Q Run Sim CPU SIO Pag SVM SVM SVM  CF Idl I/O Pag Ldg Oth Lst Elig  Throttl
-------- ----- ----- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ----  -------
14:01:00  1061    20 5.0 5.0  40   0   0   0   0  10   0  35   0       .   0   0    0        .
Hi-Freq: 62599  1880 3.1 1.5  39 2.8   0   0  23 4.3 3.3  22 0.8   0   0   0 3.0    0        0
-------------------------------------------------------------------------------------
14:31:00  1069   116 0.9 0.9  34   0   0   0   0 1.7   0 3.4  59       .   0   0    0        .
Hi-Freq: 64140  7755 0.7 1.2  39 1.0   0   0 9.1 2.1 0.3 4.0  42   0   0 0.5   0    0        0
-------------------------------------------------------------------------------------
14:32:00  1067   125   0 4.0  46   0   0   0   0 2.4   0 5.6  42       .   0   0    0        .
Hi-Freq: 64020  7508 0.8 1.2  42 1.0   0   0 8.7 2.1 0.3 3.7  40   0   0 0.5   0    0        0
```

Check User Share settings

- **Cap on the database servers**
- **CPU consumption reaches point where database servers are limited**
- **Fall over the cliff**
- **Solution: Remove all caps. z/VM does a better job**

```
Report: ESAUSRC      User Configuration
-------------------------------------------------------------
                                    <---------SHARE--------->
                 Account  ACI Grp  <Normal> <-Maximum>
UserID   ClassID Code     Name       Rel Abs Type Share Limit
-------- -------- -------- -------- ---- --- ---- ----- -----
TIFSHRE  *BMAdmn  SYSTEMS          .  200   .  Abs  10.0  Soft
TIFSHRE2 *BMAdmn  SYSTEM           .  200   .  Abs  10.0  Soft
TIFSHRE3 *BMAdmn  SYSTEMS          .  200   .  Abs  10.0  Soft
TIFSHRE4 *BMAdmn  SYSTEM           .  200   .  Abs  10.0  Soft
```