

Capture Ratios and the Cost of Virtualization

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“If you can’t Measure it,
I am Just Not Interested™”

The Cost of Virtualization

Multiple levels of Virtualization:

- LPAR
- z/VM
- Linux/VSE

Management costs at each level of virtualization

Virtualization benefits – Higher utilization

- Dedicated idle resources are wasted

Two concepts:

- Is the data correct?
- Do I know where my resource is going?

Data correct? Sources must agree

Data complete? Need 100% capture ratio

If multiple data sources for the same “thing”:

- Should they agree?
- If they don't, who is right?

Metrics that agree (single thread):

- LPAR assigned time (source HMC SYTCUP)
- z/VM CPU utilization (source z/VM SYTPRP)
- User data (virtual machine data) plus system overhead
- Linux system metrics via SNMP (VSI MIB)
- Linux process metrics via SNMP (VSI MIB)

Objective is to know where the resources go:

- Can you capture 100%?
- How much **fudge factor**?
- **Which metrics are impacted by SMT???**

Capture Ratios – LPAR/HMC (ESALPAR)

```
<----Logical Processor---->
VCPU CPU <----%Assigned-->
Addr Type Total Ovhd Emul
-----
```

zVM	Addr	Type	Total	Ovhd	Emul
0	0	IFL	15.7	0.5	15.2
1	1	IFL	18.8	0.5	18.3
2	2	IFL	20.7	0.4	20.3
3	3	IFL	25.1	0.4	24.7
4	4	IFL	27.2	0.4	26.8
5	5	IFL	38.4	0.4	38.0
6	6	IFL	64.8	0.6	64.3
7	7	IFL	1.1	0.2	0.9*
8	8	IFL	0.8	0.0	0.7*

Total	IFL		212.6	3.3	209.3

* Vertical Lows

Physical CPU Management time:

CPU	Percent	Type
140	0.468	IFL
141	0.623	IFL
142	0.606	IFL
143	0.506	IFL
144	0.488	IFL
145	0.449	IFL
146	0.323	IFL
148	0.632	IFL
149	0.263	IFL
150	0.909	IFL
151	0.968	IFL
152	0.940	IFL

Start at CEC level with 100%

LPAR provides SYTCUP monitor record for each vCPU

- System (**Physical**) overhead – not assigned (SYTCUG)
- LPAR (**Logical**) overhead – assigned to LPARs
- Emulation time – Time LPARS operate (**209.3**)

Capture Ratios – z/VM (Non-SMT)

z/VM provides capture ratio of 100%

- System overhead – not assigned to users
- User overhead – assigned to users
- Emulation time – user work

User data (ESAUSP2) from USEACT/USELOF

Report: ESACPUU CPU Utilization Report

<-----CPU (percentages)----->

CPU	Type	Total util	Emul time	User ovrhd	Sys ovrhd	Idle time	Steal time
0	IFL	14.9	12.0	1.3	1.6	84.3	0.7
1	IFL	17.9	16.0	1.5	0.5	81.3	0.8
2	IFL	20.0	18.1	1.4	0.5	79.3	0.6
3	IFL	24.4	22.5	1.5	0.4	75.0	0.6
4	IFL	26.5	24.6	1.4	0.5	72.9	0.6
5	IFL	37.7	35.5	1.7	0.6	61.7	0.6
6	IFL	64.0	60.4	2.8	0.8	35.2	0.8
7	IFL	0.7	0.1	0.1	0.5	99.0	0.3
8	IFL	0.7	0.6	0.0	0.1	99.2	0.1
		206.9	189.8	11.6	5.4	688.0	5.1

Report: ESAUSP2 User data

<---CPU time-->

UserID /Class	Total	Virt	T:V Rat
11:06:00 Servers	201.4	189.8	1.1
ZVPS	1.32	1.27	1.0
Linux	199.6	188.2	1.1
IBMStuf	0.17	0.13	1.3
TheUsers	0.23	0.16	1.5

Capture Ratios – System

CEC Example (9 IFLs = 900%):

- Physical Management time (5%)
- IDLE time (about...680%)
- LPAR Assigned time (212.6%)
 - LPAR Management time (3.3%)
 - Emulation time (209.3%)

z/VM Time

- Uncaptured ($209.3 - 206.9 = 2.4\%$)
- System Overhead (5.4%)
- User Overhead (11.6%)
- User Emulation (189.8%)
- 189% attributed to users -> capture ratio is 100%

Capture Ratios – z/VM (Non-SMT)

ESACAPT Logical Partition Analysis											
<----Logical Processor---->					<----CPU (percentages---->				Capture%		
VCPU	CPU	<---%Assigned-->			Total	Emul	User	Sys	LPAR		
Addr	Type	Total	Ovhd	Emul	util	time	ovrhd	ovrhd			
0	IFL	15.7	0.5	15.2	14.9	12.0	1.3	1.6	0.98		
1	IFL	18.8	0.5	18.3	17.9	16.0	1.5	0.5	0.98		
2	IFL	20.7	0.4	20.3	20.0	18.1	1.4	0.5	0.98		
3	IFL	25.1	0.4	24.7	24.4	22.5	1.5	0.4	0.99		
4	IFL	27.2	0.4	26.8	26.5	24.6	1.4	0.5	0.99		
5	IFL	38.4	0.4	38.0	37.7	35.5	1.7	0.6	0.99		
6	IFL	64.8	0.6	64.3	64.0	60.4	2.8	0.8	1.00		
7	IFL	1.1	0.2	0.9	0.7	0.1	0.1	0.5	0.76		
8	IFL	0.8	0.0	0.7	0.7	0.6	0.0	0.1	0.95		
Total		IFL	212.6	3.3	209.3	206.9	189.8	11.6	5.4	6	0.99

Compare LPAR (SYTCUP) to z/VM (SYTPRP) – Capture 99%

- CPU by CPU comparison is accurate
- Some scheduling time is likely lost

Capture Ratios – Linux

Report: ESALNXV

LINUX Virtual Processor Analysis Report

Node/ Name	VM ServerID	Node GroupID	<Linux Pct CPU>			<Process Data>			Capture Ratio
			Total	Syst	User	Total	Syst	User	

09:28:00									
lxbmq001	LXQM001	TheUsers	0.6	0.2	0.3	0.5	0.2	0.3	0.912
lxbpc001	LXQPC001	TheUsers	2.2	0.9	1.3	2.2	1.0	1.3	1.011
lxbsb001	LXQSB001	TheUsers	2.3	0.7	1.6	2.3	0.7	1.6	0.993
lxvmb101	PXVMQ101	TheUsers	1.6	0.5	1.1	1.8	0.6	1.2	1.082
lxvmb102	PXVMQ102	TheUsers	1.7	0.5	1.2	1.6	0.5	1.0	0.922

Capture ratio concept for Linux process table

- Add all the processes, compare to the system
- Much more difficult problem than z/VM

Charge back model is NOT 100%

Data requires “fudge factor”

- PRSM Overhead: 1%?
- LPAR Overhead: 3%?
- LPAR Capture ratio: 1% (capture ratio 99%)
- z/VM System Overhead
- z/VM Virtual Machine Overhead
- Virtual Machine real work – this is what we charge for

What does SMT do?