Capture ratios for SMF

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Agenda

Who Am I

Why do I care

- Bogus data in = bogus data out….

Where is data from

- Platform standard interfaces

What did I learn

- PRSM,z/VM,z/VSE,Linux,z/OS,CICS,DB2

When do we meet in person?

Who Am I

Washington System Center (3 years)

- VM Performance responsibilities
- Author “HPO Tuning Guide”

Senior Manager IBM Systems Evaluation Lab

Founder / CTO Velocity Software (33 years)

Performance Management Development for:

- VM/XA, VM/ESA, z/VM
- Linux, WAS, Oracle
- Network data
- z/VSE
- Now, z/OS, CICS, DB2

My Focus

Providing Correct Data for System Performance Mgmt:

- Capacity Planning
- Performance Analysis
- Chargeback/Accounting
- Operational Alerts

Business decisions are (hopefully) made based on data

- Better decisions are made on **correct data**…
- Validate the data (Challenge very old "traditional wisdom")
- Understand what is missing – and how much

- When Linux first virtualized, Linux reported CPU incorrectly by up to 2 ORDERS OF MAGNITUDE…. (conclusion: mainframe bad)
- SMT does not exactly add up…. (topic for different presentation)

What is (my) definition of capture ratio?

Objective is to know where 100% of resource is used

- System management time (“Physical” overhead)
- Workload management time (“logical” overhead)
- Workload
- IDLE time
- Uncaptured (hopefully zero)

Does platform instrumentation provide 100%?

- PRSM / LPAR: yes
- z/VM: yes
- Linux: yes
- VSE: yes
- z/OS???? DB2?? CICS??

What is the overhead of the platform?

Why care about capture ratios?

Capture ratios validate the data and instrumentation

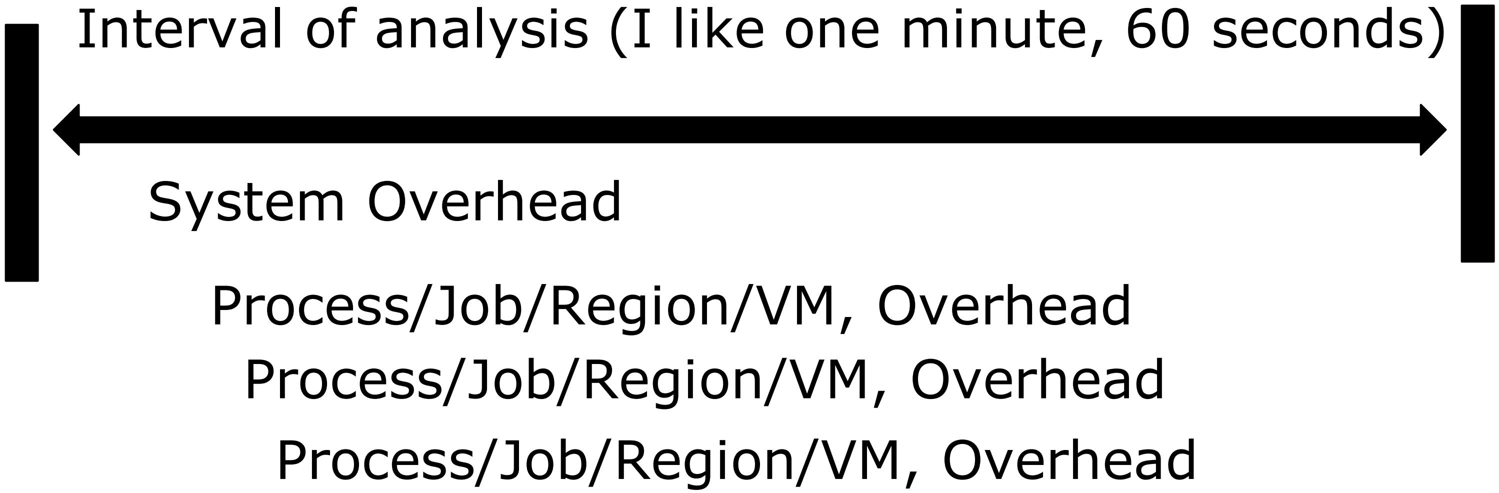
CPU Data has multiple data sources – do they agree?

- If not, what was missed? Validate the instrumentation …
- PRSM / LPAR – Assigned time vs Operating System reported utilization
  - z/OS smf 70 – what fields show true system overhead?
  - z/VM monitor sytprp – provides measured system overhead

LPAR (HMC data) provides instrumentation for:

- Physical Overhead
- Assigned time
  - Logical Overhead
  - Virtual Assigned time (The Real Work)
- Non-captured time at next level, not reported – about 1%
- But the analysis was very interesting???

How to Get Capture Ratio



Interval of analysis (I like one minute, 60 seconds)

System Overhead

Process/Job/Region/VM, Overhead

Process/Job/Region/VM, Overhead

Process/Job/Region/VM, Overhead

Capture Ratio –

- Accumulate all interval process data available
- Compare to system total values
- (Inconsistent intervals make life difficult)

Watch for my analysis of CICS, DB2, MQ for next year

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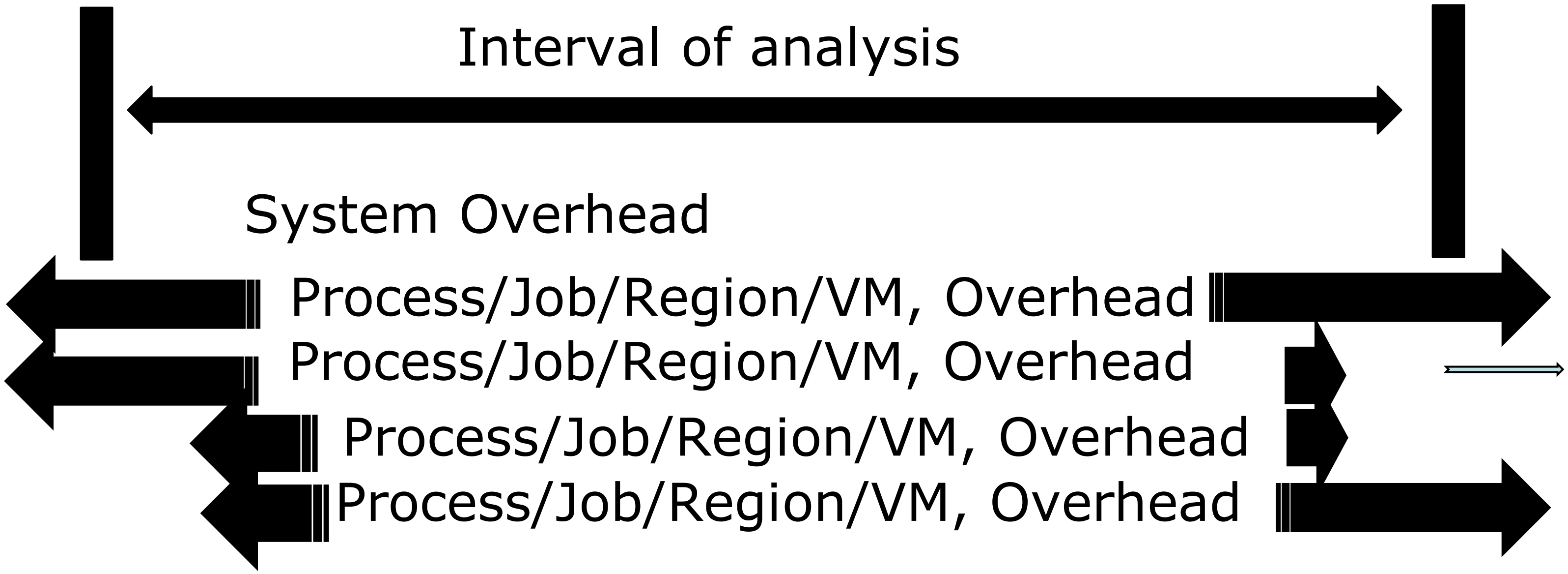
Capture Ratio Process


Interval of analysis
System Overhead
Process/Job/Region/VM, Overhead
Process/Job/Region/VM, Overhead
Process/Job/Region/VM, Overhead
Process/Job/Region/VM, Overhead

Workload Capture Ratio – Always 4 types

- Work that starts prior to interval and ends after
- Work that starts prior to interval and ends during
- Work that starts within interval and ends during
- Work that starts within interval and ends after

Compare Multiple Data Sources

CPU Data has multiple data sources

Do they agree? If not, what was missed?

- z/VM:
  - LPAR data (SYTCUP, SYTCUM)
  - z/VM System CPU (sytprp)
  - z/VM User / Virtual Machine CPU (USEACT,USELOF)
  - Hardware PRCMFC (SMF 113)
- Linux (virtualized linux cpu data was bogus…)
  - Virtual machine data
  - Kernel cpu / irq cpu
  - Process data
- VSE
  - Virtual machine data (normally)
  - System data
  - Partition data

z/OS Data Sources

z/OS Data source is SMF records

Very highest level is from PRSM / LPAR:

- LPAR data Physical Time (SMF 70)
- LPAR Logical Overhead (SMF 70)
- LPAR Logical Time (SMF 70)
- Hardware SMF 113 – measures cycles consumed

z/OS Data Comparisons:

- LPAR Logical Time (smf 70)
- z/OS Job data (SMF 30)
- Hardware (SMF 113)
- CICS (SMF 110)
- DB2 (SMF 100/102)

NOTE: All metrics in absolute terms of one CPU

Transaction Analysis

CICS / DB2 For example

- Many Transactions
- Long running “system” transactions
- Some transactions cross interval start or end

Objective

- Capture all transaction CPU (100%) in interval
- What transaction ID is consuming the CPU
- Group for capacity planning
- Group transactions for chargeback
- What is missing and why? Iterative process…

Building the "Capture Model"

Every platform has 5 CPU Components

- Hypervisor/OS Management Time (physical overhead)
- Work Management (logical overhead)
- Work time
- IDLE, vs steal time
- Uncaptured – Platform does not define or report

Steal Time

- Virtualized environment, underlying CPU "stolen"
- Not relevant for capture analysis, CPU not utilized

PARK Time

- Not relevant (to me) for capture analysis – CPU not utilized
- But measure unparked time and cycles consumed

Objective is to know what / who is using CPU

z/vm Capture Ratio model

5.2 billion cycles per second per cpu

- Where did they all go?
- Set interval = 1 minute to understand variations

For every platform, objective is to show:

- System overhead – Not related to applications
- Application associated overhead
- Application CPU
- Uncaptured – to be identified, objective is zero

If uncaptured CPU is zero (or very low)

- Platform is fully instrumented
- Data can be "trusted" for business decisions
- No "guessing" or "crystal balls"

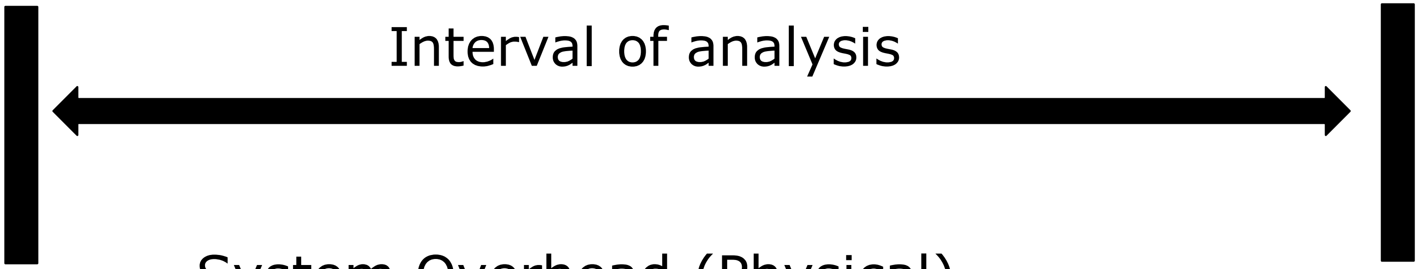
Building the "Capture Model"

Every platform has 4 CPU Components plus IDLE

At end of day, what do we know for sure?

	Mgmt	**Logical**	**Work**	**Uncaptured**
HMC/LPAR				
z/VM				
z/VSE				
Linux				
z/OS				
CICS				
DB2				

Capture Ratio – LPAR Level



Interval of analysis

System Overhead (Physical)

LPAR Consumption VSI1, Overhead

LPAR Consumption VSI2, Overhead

LPAR Consumption VSI3, Overhead

Capture Ratio – Highest level

- Accumulate all LPAR data by CPU TYPE
- LPAR data Highest level – simplest case
- LPARs don’t “start” and “end” during intervals

z/VM (and z/OS) LPAR / CEC Data Source

Every z has LPAR data, **One record per VCPU:**

- Assigned Time to LPARs: SYTCUP.LCUCACTM
- LPAR Time (exclude ovhd: SYTCUP.LCUCLPTM
- Add data by LPAR, by Engine Type

```
<--------Logical Partition------->
                Virt CPU  <%Assigned>
Name       Nbr CPUs Type Total   Ovhd
--------- --- ---- ---- -----   ----
VSIVM5     05     2   CP   84.2    0.0    (VSE, z/OS)
VSIVM5     05     2 IFL     1.5    0.1
VSIVC1     07     1 IFL    23.3    0.1
VSIVC2     08     1 IFL     0.7    0.0
VSIVC3     09     1 IFL     0.5    0.0
VSIVC4     0A     1   CP    2.4    0.0    (VSE)
VSIVC4     0A     1 IFL     0.5    0.1     (linux)
VSIVM1     01     1 IFL     1.3    0.0
VSIVM2     02     1 IFL     1.2    0.0
VSIVM3     03     1 IFL     0.4    0.0
VSIVM4     04     2 IFL    85.5    0.4
ZOSLP1     0E     2   CP   56.6    0.0    (z/OS)
ZOSLP2     0F     2   CP   56.7    0.0    (z/OS)
```

LPAR / CEC Capture Ratio model

Full picture of CEC, Add by CPU TYPE (z/VM Model)

- Physical Overhead : SYTCUM.LCUMGTM
- Assigned Time to LPARs: SYTCUP.LCUCACTM
- LPAR Time (exclude ovhd: SYTCUP.LCUCLPTM

Working example (LPARs for z/VM, z/OS, cloud)

```
Totals by Processor type:
<---------CPU-------> <-Shared Processor busy->
Type Count Ded shared  Total  Logical Ovhd Phys
---- ----- --- ------ ------ -------- ---- ----
CP       2   0      2  200.0    199.8  0.1  0.1
IFL      4   0      4  116.0    114.0  0.8  1.1
ZIIP     1   0      1    0.6      0.5  0.0  0.0
```

CEC Level LPAR Capture ratio – 100%
We DO Know What LPAR consumes the CPU

Building the “Capture Model”

LPAR Layer (highest layer)

- Overhead “low” – set an alert, high overhead happens
- Capture Ratio 100%
- We know exactly what LPAR is consuming what….

	Mgmt	**Logical**	**Work**	**Uncaptured**	**Capture Ratio**
HMC/LPAR	.1%	.1%	99%+	0%	100%
z/VM					
z/VSE					
Linux					
z/OS					
CICS					
DB2					

z/VM system data

CP Monitor provides **One record per CPU/Thread:**

- System CPU: sytprp.pfxtmsys (physical overhead (1%)
- User Ovhd: sytprp.pfxutime – sytprp.pfxprbtm (1-2%)
  - (Same concept as PRSM, total assigned time , logical assigned time)
- User CPU: sytprp.pfxprbtm
- IDLE: sytprp.pfxtotwt
- Steal: 100 – (system cpu + user cpu – idle)

```
               <--CPU  (percentages)-->
     CPU     Total  Emul  User    Sys
CPU  Type     util  time ovrhd  ovrhd
 -   ----    ----- ----- -----  -----
 0   IFL      47.0  45.9   0.6    0.4
 1   IFL      50.0  48.9   0.7    0.4
 2   IFL      45.5  44.4   0.7    0.4
 3   IFL      47.3  46.1   0.8    0.4
 4   IFL      42.5  41.0   0.8    0.7
 5   IFL      53.6  52.7   0.6    0.3
 6   IFL      44.3  43.3   0.6    0.4
 7   IFL      56.3  55.3   0.6    0.3
             ----- ----- -----  -----
             386.4 377.7   5.4    3.4
```

z/vm Capture Ratio Hierarchy

First level Platform analysis

- PRSM / HMC (SYTCUP) vs z/VM (SYTPRC)

Compare Assigned time to reported utilization

- PRSM reports by LPAR by VCPU
- z/VM reports by VCPU

z/VM Capture Ratio model

CP Monitor CPU vs PRSM?

- LPAR / PRSM data 100%, What does z/VM see?
- LPAR Data vs z/VM CPU Data: 99.3% (for every CPU…)
- Discrepancy likely setting up and dispatching

```
 <PRSM / LPAR Measurements> <---z/VM-CPU (percentages)->  VM/
 VCPU  CPU <---%Assigned--> Total  Emul  User   Sys  Stl  PRSM
 Addr Type Total Ovhd  Emul  util  time ovrhd ovrhd  Pct CaptR
 ---- ---- ----- ---- ----- ----- ----- ----- ----- ---- -----

    0  IFL  62.4  0.7  61.6  61.2  58.4   1.2   1.6 8.71  0.99
    1  IFL  62.4  0.6  61.7  61.3  58.6   1.1   1.5 8.59  0.99
    2  IFL  62.2  0.6  61.7  61.3  58.7   1.1   1.5 8.20  0.99
.........
    8  IFL  62.3  0.7  61.5  61.1  57.6   1.2   2.2 8.70  0.99
    9  IFL  62.6  0.8  61.7  61.3  58.6   1.2   1.5 8.66  0.99
   10  IFL  62.5  1.0  61.5  61.1  58.3   1.2   1.6 8.82  0.99
   11  IFL  62.6  0.6  62.0  61.6  59.0   1.1   1.5 8.60  0.99
   12  IFL  62.5  0.9  61.6  61.2  58.4   1.2   1.6 8.77  0.99
   13  IFL  62.2  0.8  61.5  61.1  58.4   1.2   1.5 8.67  0.99
 ---- ---- ----- ---- ----- ----- ----- ----- ----- ---- -----
Total  IFL 873.5 10.5 863.1 857.2 818.6  16.4  22.2  121  0.99
```

Charge back model is NOT 100%

Data for chargeback requires "fudge factor"

- PRSM Overhead: 1% ?
- LPAR Overhead: 2%?
- 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? Not a top here…

Building the "Capture Model"

LPAR Layer (highest layer)

- Overhead "low" – set an alert, high overhead happens
- Capture Ratio 100%
- We know exactly what LPAR is consuming what….

	Mgmt	Logical	Work	Uncaptured	Capture Ratio
HMC/LPAR	.1%	.1%	99%+	1%	99%
z/VM					
z/VSE					
Linux					
z/OS					
CICS					
DB2					

z/VM Capture Ratio model

Compare "system data" to "virtual machine data"

One Record per CPU / Thread

- Virtual Machine "user" CPU Time: sytprp.pfxutime
- VM Problem Time: sytprp.pfxprbtm
- User Overhead: pfxutime - pfxprbtm
- System overhead: sytprp.pfxtmsys
- Idle, "steal"

One Record per Virtual Machine VCPU

- Virtual Machine CPU Time by VM: USEACT.VMDTTIME
- Problem (Virtual) Time: USEACT.VMDVTIME
- USELOF: Logoff
- Add up all the virtual machines, Compare:
- Note: (USEACT.VMATTIME_PRO – SMT Prorated – off topic)

z/VM system data

CP Monitor provides **One record per CPU/Thread:**

- System CPU: sytprp.pfxtmsys (physical overhead (1%)
- User Ovhd: sytprp.pfxutime – sytprp.pfxprbtm (1-2%)
  - (Same concept as PRSM, total assigned time , logical assigned time)
- User CPU: sytprp.pfxprbtm
- IDLE: sytprp.pfxtotwt
- Steal: 100 – (system cpu + user cpu – idle)

```
                 <--CPU  (percentages)-->
     CPU    Total  Emul  User   Sys
CPU  Type    util  time ovrhd ovrhd
 -   ----  ----- ----- ----- -----
 0   IFL    47.0  45.9   0.6   0.4
 1   IFL    50.0  48.9   0.7   0.4
 2   IFL    45.5  44.4   0.7   0.4
 3   IFL    47.3  46.1   0.8   0.4
 4   IFL    42.5  41.0   0.8   0.7
 5   IFL    53.6  52.7   0.6   0.3
 6   IFL    44.3  43.3   0.6   0.4
 7   IFL    56.3  55.3   0.6   0.3
           ----- ----- ----- -----
           386.4 377.7   5.4   3.4
```

z/VM Virtual Machine Data

CP Monitor, **One record per Virtual Machine/CPU:**

- Add up all the virtual machines, Compare:
- User overhead: Total assigned – total virtual
- User overhead = 383.1 – 377.7 = 5.4
- Add up all users for totals

```
<---CPU time--->
UserID    <(Percent)> T:V
/Class    Total  Virt  Rat
--------- ------ ------ ----
09:01:00 383.1 377.7 1.01

WASM8096 82.95 82.86 [illegible]
WWAS8042 28.56 28.24 1.0[illegible]
WWAS8038 25.22 24.97 1.01
WWAS8046 24.45 24.20 1.01
WWAS8000 23.82 23.51 1.01
WWAS8005 23.48 23.15 1.01
DB2M8002 23.18 22.81 1.02
.
.
.
```

```
<--CPU (percentages)-->
     CPU    Total  Emul  User   Sys
CPU  Type   util   time  ovrhd  ovrhd
-    ----  ------ ------ -----  -----
 0   IFL    47.0   45.9   0.6    0.4
 1   IFL    50.0   48.9   0.7    0.4
 2   IFL    45.5   44.4   0.7    0.4
 [illegible]   IFL    47.3   46.1   0.8    0.4
 [illegible]   [illegible]FL    42.5   41.0   0.8    0.7
 5   [illegible]    53.6   52.7   0.6    0.3
 6   IF[illegible]    44.3   43.3   0.6    0.4
 7   IFL    [illegible]   55.3   0.6    0.3
           ------ ------ -----  -----
           38[illegible].4  377.7   5.4    3.4
```

z/VM Capture Ratio Analysis

System data by CPU (sytprp)

Virtual Machine Data (USEACT)

Virtual Machine logon (Delta “zero”, vmdttime)

Virtual Machine interval (Delta start,stop vmdttime)

Virtual Machine logoff (Delta start, logoff vmdttime)

	Syst Ovhd	Emulation	User Ovhd
sytprp	3.4	377.7	5.4
USEACT		377.7	5.4

Capture Ratio from z/VM is 100.0% consistently

- **Two data sources agree**

Building the "Capture Model"

LPAR Layer (highest layer)

- Overhead "low" – set an alert, high overhead happens
- Capture Ratio 100%
- We know exactly what LPAR is consuming what….

	Mgmt	**Logical**	**Work**	**Uncaptured**	**Capture Ratio**
HMC/LPAR	.1%	.1%	99%+	1%	99%
z/VM	< 1%	<2%	97%+	0%	100%
z/VSE					
Linux					
z/OS					
CICS					
DB2					

z/vm Capture Ratio Hierarchy

CEC/LPAR Management

- z/VM Reporting (CP Monitor)
  - Guest Reporting
    - CMS Virtual Machines
    - VSE: Partitions (GP processors)
    - Linux: Processes (IFL processors)
    - z/OS Guests, regions

CEC/LPAR Management

- z/OS Reporting (SMF 70)
  - Region / Job Reporting (smf 30)
    - CICS: Transactions (110)
    - DB2: Transactions (100,102)

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zVSE Capture Ratio model

zVSE Virtual Machine Metrics Technology

- z/VM Guest machine data provided by IBM CP Monitor
- (USEACT.VMDTTIME – Traditional, non SMT)
- (useact.vmdvtime) – VSE Dispatch time

zVSE Metrics Technology – 4 data sources

- System data provided by IBM via SNMP
- Virtual Processor data provided by IBM via SNMP
- Partition data provided by IBM's SNMP
- Job Data provided by Velocity's SNMP

Note: snmp data does not perfectly align with z/VM data collection interval.

zVSE Capture Ratio model

Compare z/VM Virtual Machine CPU to VSE System

- Is VSE Capturing all CPU?

Compare VSE System data to Partition data

- Is data model complete?

Compare VSE Job data to VSE System data

- Is chargeback model complete?

zVSE z/VM Capture Ratio model

zVM Metrics Technology – accurate to microsecond

- Virtual machine data – minute by minute, exactly on minute!

z/VM Virtual Machine management CPU

- T:V Ratio, total to virtual, shows overhead (I/O, memory)
- z/VM MANAGEMENT OVERHEAD: about 2% for this guest

```
          <-VM-CPU time->
UserID    <(Percent)> T:V
/Class    Total  Virt  Rat
--------- ----- ----- ----
ZVSE61B   30.58 30.04 1.02
ZVSE61B   30.44 29.87 1.02
ZVSE61B   30.29 29.71 1.02
ZVSE61B   29.29 28.71 1.02
ZVSE61B   29.00 28.46 1.02
ZVSE61B   28.47 27.94 1.02
```

zVSE z/VM Capture Ratio model

zVSE Analysis, z/VM to VSE System

- z/VM Virtual Machine data accurate to microsecond
- Both average over 6 minutes: 29.1%
- Capture Ratio: 99.9++% (over time)
- VSE Captures CPU as provided by z/VM

```
         <---CPU time--->
UserID   <(Percent)> T:V
/Class   Total  Virt  Rat
-------- ----- ----- ----
ZVSE61B  30.58 30.04 1.02
ZVSE61B  30.44 29.87 1.02
ZVSE61B  30.29 29.71 1.02
ZVSE61B  29.29 28.71 1.02
ZVSE61B  29.00 28.46 1.02
ZVSE61B  28.47 27.94 1.02
```

```
<---CPU time--->
NODE       <CPU
/Time      Total
--------   -----
zvse61b     27.3
zvse61b     30.6
zvse61b     30.2
zvse61b     29.3
zvse61b     29.2
zvse61b     28.1
```

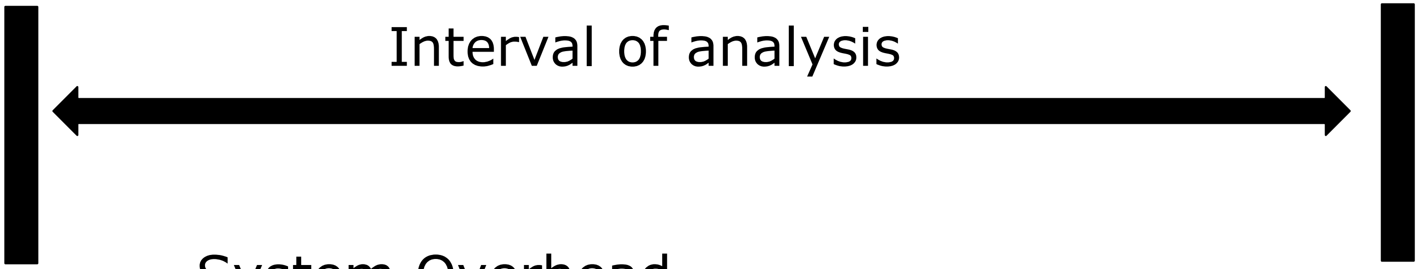
Building the "Capture Model"

LPAR Layer (highest layer)

- Overhead "low"
- Capture Ratio 100%

	Mgmt	Logical	Work	Uncaptured	Capture Ratio
HMC/LPAR	.1%	.1%	99%+	1%	99%
z/VM	1-2%	1-2%	95%+	0%	100%
z/VSE	<.1%				99.9%
Linux					
z/OS					
CICS					
DB2					

Capture Ratio – z/VSE



Interval of analysis

System Overhead

Partition/job, Overhead

Partition/job, Overhead

Partition/job, Overhead

Capture Ratio –

- Accumulate all process data,
- compare to system
- Inconsistent intervals make life difficult

zVSE Capture Ratio model

VSE Partition Metrics, total the partitions

- CPU for “work”, Overhead

```
NODE       Part Job       Phase      <-CPU Pct-->
/Time      ID   Name      Name       CPU   Overhd
---------  ---- --------- ---------  ----- ------
ZVSE61B         Totals                21.7    1.4
            FB  SECSERV   BSTPSTS        0      0
            F1  POWSTART  IPWPOWER     0.0    0.0
            F2  CICSICCF  DFHSIP       0.0    0.0
            F3  VTAMSTRT  ISTINCVT     0.0    0.0
            O1  CICSJA60  DFHSIP      18.7    1.2
            R1  STARTVCS  IESVCSRV     0.0    0.0
            R2  STARTMAS  IESMASNM     0.3    0.0
            T1  BSTTINET  BSTTINET     1.4    0.1
            T2  BSTTVNET  BSTTVNET     1.3    0.1
            T3  BSTTFTPD  BSTTFTPS       0      0
            Z1  DMFSTART  DFHDFSIP     0.1    0.0
```

zVSE z/VM Capture Ratio model

zVSE Analysis

- z/VM Virtual Machine data accurate to microsecond
- VSE System Data (via IBM snmp)
- VSE Partition data (via VSI snmp)
- Intervals are one minute, but not synchronized exactly
- Compare (partition total plus ovhd) to (total)
- PARTITION DATA Capture Ratio: 99.9% (over time)

```
NODE         <CPU Utilization> <Partn CPU>  Capture
/Time        Total  Mstr  Spin TOTal  Ovhd  Ratio
---------    ----- ----- ----- ----- -----  -------
zvse61b       27.3   4.5     0  25.6   1.6     99.7
zvse61b       30.6   5.1     0  28.5   1.8     99.0
zvse61b       30.2   5.2     0  28.5   1.8    100.5
zvse61b       29.3   5.2     0  27.7   1.8    100.8
zvse61b       29.2   5.0     0  27.4   1.7     99.7
zvse61b       28.1   4.9     0  26.3   1.7     99.9
```

Building the "Capture Model"

LPAR Layer (highest layer)

- Overhead "low"
- Capture Ratio 100%

	Mgmt	Logical (srb)	Work	Uncaptured	Capture Ratio
HMC/LPAR	.5-1%	.5-1%	98%+	1%	99%
z/VM	1-2%	1-2%	95%+	0%	100%
z/VSE	<.1%	6-8%	92-94%	0%	99.9%
Linux					
z/OS					
CICS					
DB2					

Linux Capture Ratio model

Linux data captured via snmp

- System CPU Data by cpu, by system:
- Process Data by process

System data provides

- IRQ, SoftIRQ, Kernal,
- Nice

Process data provides

- CPU data by process, for process and "children"
- Parent process information

Challenge in Linux when process terminates

- CPU added to parents when process terminates

Capture Ratios – Linux

Linux system data vs z/VM data

- Linux Includes IRQ, Krnl time (2%)
- Linux collection time 5-10 seconds prior to z/vm monitor pop

z/VM time (78%)

```
 <---CPU time-->
UserID   <(Percent)> T:V
/Class   Total  Virt Rat
-------- ----- ----- ---
RLNX08P0 78.64 74.67 1.1
RLNX08P0 72.33 66.01 1.1
RLNX08P0 53.09 48.31 1.1
RLNX08P0 61.48 56.38 1.1
RLNX08P0 84.47 79.56 1.1
RLNX08P0 93.25 88.30 1.1
RLNX08P0 120.7 116.7 1.0
RLNX08P0 96.25 91.80 1.0
RLNX08P0 83.71 78.61 1.1
```

Linux time (78%)

```
<Processor Pct   <CPU Overh
Total Syst User  Krnl IRQ
----- ---- ----  ---- ----
 78.5  5.5 71.5   0.3  1.3
 80.3  5.6 73.0   0.4  1.3
 41.0  4.9 34.6   0.3  1.1
 63.4  7.2 54.0   0.4  1.7
 68.4  5.8 61.0   0.3  1.3
 65.5  5.3 59.1   0.3  0.9
127.7  7.1  119   0.4  1.5
 98.0  6.5 89.7   0.4  1.4
 79.6  6.5 71.4   0.4  1.4
```

Building the "Capture Model"

LPAR Layer (highest layer)

- Overhead "low"
- Capture Ratio 100%

	Mgmt	**Logical (srb)**	**Work**	**Uncaptured**	**Capture Ratio**
HMC/LPAR	.5-1%	.5-1%	98%+	1%	99%
z/VM	1-2%	1-2%	95%+	0%	100%
z/VSE	<.1%	6-8%	92-94%	<1%	99.9%
Linux	2%				
z/OS					
CICS					
DB2					

Capture Ratios – Linux

Capture ratio concept for Linux process table

- When Linux process terminates, where does CPU go? – the
- Does "crond" get charged anything? No, "children"
- Must build process tree

```
node/       <-Process Id <------CPU Percents---->
 Name       ID     PPID    Tot  sys user syst usrt
---------  -----  -----   ---- ---- ---- ---- ----
 snmpd      1919      1   0.10 0.08 0.02    0    0
 crond      2116      1   0.03    0    0 0.02 0.02
 seosd      2515      1   0.02 0.02    0    0    0
 selogrd    2549      1   0.02    0 0.02    0    0
 db2sysc    3097   3095   1.24 1.01 0.24    0    0
 db2fmp     3118   3095   0.02 0.02    0    0    0
 db2sysc    3248   3246   0.05 0.02 0.03    0    0
 dsmc      30061      1   0.02    0 0.02    0    0
```

```
Node/           <----Proces
 Name            ID    PPID
------------    ----- -----
init                1     1
  kthreadd          2     1
   migratio         3     2
  crond          2116     1
   crond        30034  2116
    sh          30035 30034
    sendmail    30086 30034
     postdro    30087 30086
  db2syscr       3095     1
   db2sysc       3097  3095
   db2syscr      3103  3095
   db2syscr      3104  3095
   db2syscr      3105  3095
   db2vend       3107  3095
   db2fmp        3118  3095
  db2syscr       3246     1
   db2sysc       3248  3246
   db2syscr      3254  3246
   db2syscr      3255  3246
   db2syscr      3256  3246
   db2vend       3258  3246
   db2fmp        3266  3246
  login          3326     1
   bash          3332  3326
```

Capture Ratios – Linux

Capture ratio concept for Linux process table

- Compare "linux system data" to "Linux Process Data"
- Typically 100%....
- Collecting 1000 processes synchronously has "variation"…
- "system Time" 7-10% ?

```
Node/     <Linux Pct CPU> <Process  Data> Capture
 Name     Total Syst User Total Syst User   Ratio
--------- ----- ---- ---- ----- ---- ---- -------
RLNX01p1    1.7  0.8  0.9   1.8  0.9  0.9   1.056
RLNX02p1    1.3  1.0  0.3   1.3  1.0  0.3   1.000
RLNX03p0    2.0  0.6  1.4   2.0  0.6  1.4   1.000
RLNX04p0   10.6  1.7  8.9  10.7  1.8  8.9   1.007
RLNX05p0    9.0  1.5  7.5   9.0  1.5  7.5   1.000
RLNX06p0   11.6  1.7  9.9  11.6  1.7  9.9   1.000
RLNX07p0   18.3  2.9 15.4  18.3  2.9 15.4   1.000
RLNX08p0   78.4  6.3 72.0  79.8  6.7 73.0   1.018
```

Linux Capture Results

Linux process data, applications

- Capture ratio 100%
- Applications identified and quantified
  - (db2 vs was vs oracle)
- System overhead is provided by standard metrics
- Process Data straight from Linux process table
- Arithmetic is complicated but doable

Building the "Capture Model"

LPAR Layer (highest layer)

- Overhead "low"
- Capture Ratio 100%

	Mgmt	**Logical**	**Work**	**Uncaptured**	**Capture Ratio**
HMC/LPAR	.5-1%	.5-1%	98%+	0%	100%
z/VM	1-2%	1-2%	95%+	0%	99%
z/VSE	<.1%	6-8%	92-94%	0%	99.9%
Linux	2%	7-10%	90%	< 1%	99% +
z/OS					
CICS					
DB2					

z/OS Capture Ratio model

For every platform, objective is to show:

- System overhead – Not related to applications
- Application associated overhead
- Application CPU
- Uncaptured – to be identified, objective is zero

If uncaptured CPU is zero:

- Platform is fully instrumented
- Data can be "trusted" for business decisions
- No "guessing" or "crystal balls"

If multiple data sources, validate….

z/OS Capture Ratio model

At each layer, something is lost

PRSM / LPAR Layer

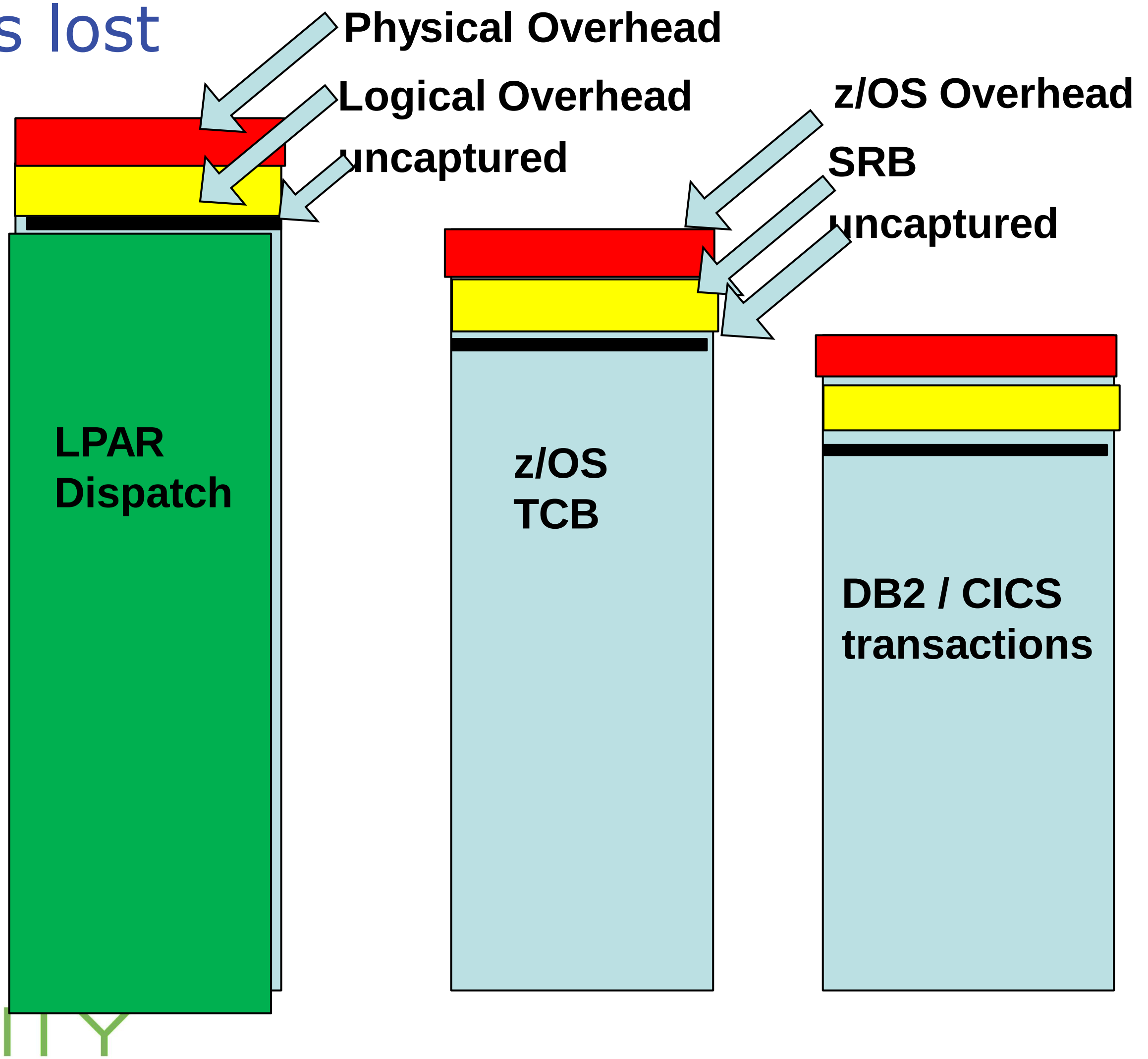
- PRSM Overhead (Physical overhead)
- PRSM Assigns a physical CPU (smf70pdt)
- PRSM has Logical overhead (pdt-edt)
- LPAR is dispatched (smf70edt)

z/OS Layer

- Uncaptured: Smf 113 metrics shows less cpu than smf70edt
- System overhead?
- Regions / jobs (smf 30) shows uncaptured

z/OS Capture Ratio model

At each layer,
something is lost



z/OS Capture Ratio model

SMF 70 Subtype 1

- CPU Data:
  - SMF70WAT (wait / idle time?)
- LPAR Data
  - SMF70PDT (assigned, includes logical overhead)
  - SMF70EDT (the real work)

Since z/OS CPU data comes from PRSM

- Can't compare "z/OS CPU data" to "PRSM CPU data"
- Can compare "z/OS CPU data" to hardware data
- SMF 113 comparison shows a loss of about 3%

- This would be 3% uncaptured time from PRSM to z/OS

z/OS Capture Ratio model

SMF 113 analysis, PRSM CPU vs Cycles consumed

```
<Percent> <-------Processor------>
             <CPUBusy> Speed/<-Rate/Sec->
Time     CPU LPAR  MFC Hertz Cycles Instr Ratio
-------- --- ---- ---- ----- ------ ----- -----
J90        0 79.7 78.5  5200M  4080M 1416M 2.882
           2 82.0 79.9  5200M  4156M 2025M 2.053
           4 67.4 65.4  5200M  3400M 2043M 1.665
           6 68.4 65.7  5200M  3417M 1345M 2.540
           ............
          24 46.7 43.7  5200M  2273M 1466M 1.550
          26 18.2 16.6  5200M   861M  324M 2.660
          28 10.9  9.8  5200M   509M  161M 3.169
          ......
          36  0.6  0.0  5200M  65265 465.5 140.2 ←low entitled
          38  0.1  0.0  5200M  65368 459.1 142.4
          40 39.1 37.8  5200M  1963M 1715M 1.145 <-ziip
          ............
          48 20.6 19.9  5200M  1033M  900M 1.148
             ---- ----  ------ ----- ----- -----
GPCPUs:       846  824  5200M  42.8G 17.8G 2.407
zIIPs         142  138  5200M  7200M 6212M 1.159
```

z/OS Capture Ratio model

SMF 30 – Next step is to compare jobs data:

```
SYSID <------JOB----------> <CPU Percents---
      Name     JobID    Step
                         Nbr Total   STD   SRB
----  -------- -------- --- ----- ----  ----
VSI1  Totals               . 24.88 21.5   3.2
      CATALOG  CATALOG     1  0.02  0.0     0
      CICSJZ1  STC01591    1  0.05  0.0     0
      CICSJZ2  STC08736    1 20.20 19.7   0.5
      JES2     JES2        1  0.22  0.2     0
      JES2MON  JES2MON     1  0.17  0.1   0.0
      JES2S001 JES2S001    1  0.02  0.0     0
      MSTJCL00 MSTR        1  0.03  0.0   0.0
      RMF      STC08659    1  0.13  0.1     0
      SDSF     STC08666    1  0.02  0.0     0
      SDSFAUX  STC08682    1  0.10  0.1   0.0
      SMF      SMF         1  0.03  0.0     0
      SMS      SMS         1  0.05  0.0   0.0
      SYSLOGD  STC08661    1  0.03  0.0   0.0
      TCPIP    STC08662    1  0.95  0.2   0.8
      TN3270   STC08696    1  1.78  0.1   1.7
      WLM      WLM         1  0.30  0.2   0.1
      ZOSMNVM2 STC00547    1  0.12  0.1     0
      ZOSMNVM4 STC00548    1  0.13  0.1     0
```

z/OS Capture Ratio model

SMF 70 Subtype 1

- CPU Data:
  - SMF70WAT (wait / idle time?)
- LPAR Data
  - SMF70PDT (assigned, includes logical overhead)
  - SMF70EDT (the real work)

SMF 30 – add up all jobs during interval

- Job Data CPU =
  - smf30CPT + /* General*/
  - smf30CPS + /*CPU Time SRB*/
  - smf30ICU + /*InitiatorTCB*/
  - smf30ISB + /*InitiatorSRB*/
  - smf30IIP + /*I/O */
  - smf30RCT + /*RegionCntrl */
  - smf30HPT ; /*Hyperexstore*/

z/OS Capture Ratio model

SMF 30 CPU Capture

- Types 2,3,6 capture all CPU for an interval
- Must respect 4 activity type models

Break out CPU BY Function

- Job/Region CPU Data = SUM
  - smf30CPT +   /* General CPU*/
  - smf30CPS +   /*CPU Time SRB*/
  - smf30ICU +   /*InitiatorTCB*/
  - smf30ISB +   /*InitiatorSRB*/
  - smf30IIP +   /*I/O   */
  - smf30RCT + /*RegionCntrl */
  - smf30HPT ; /*Hyperexstore*/

If capture ratio 100%, Chargeback model is valid

cics Capture Ratio model

SMF 30 – jobs data:

```
SYSID <------JOB----------> <CPU Percents---
      Name     JobID   Step
                        Nbr Total   STD  SRB
----  -------- -------- --- ----- ---- ----
VSI1  Totals                .  24.88 21.5  3.2
      CATALOG  CATALOG    1  0.02  0.0    0
      CICSJZ1  STC01591   1  0.05  0.0    0
      CICSJZ2  STC08736   1 20.20 19.7  0.5
      JES2     JES2       1  0.22  0.2    0
      JES2MON  JES2MON    1  0.17  0.1  0.0
      JES2S001 JES2S001   1  0.02  0.0    0
      MSTJCL00 MSTR       1  0.03  0.0  0.0
      RMF      STC08659   1  0.13  0.1    0
      SDSF     STC08666   1  0.02  0.0    0
      SDSFAUX  STC08682   1  0.10  0.1  0.0
      SMF      SMF        1  0.03  0.0    0
      SMS      SMS        1  0.05  0.0  0.0
      SYSLOGD  STC08661   1  0.03  0.0  0.0
      TCPIP    STC08662   1  0.95  0.2  0.8
      TN3270   STC08696   1  1.78  0.1  1.7
      WLM      WLM        1  0.30  0.2  0.1
      ZOSMNVM2 STC00547   1  0.12  0.1    0
      ZOSMNVM4 STC00548   1  0.13  0.1    0
```

z/OS Capture Ratio model

SMF 70 Subtype 1

- CPU Data:

Break out CPU BY Function

- TCB
- Local SRB
- Global SRB
- Supervisor
- Program

If uncaptured CPU is zero:

- Platform is fully instrumented
- Data can be “trusted” for business decisions
- No “guessing” or “crystal balls”

z/OS Jobs Capture Ratio model

SMF 70, CPU Utilization

```
TIME/    <--CPU--> Sample  <-CPU
SYSID    ID   Type Count   Total
-------  ---- ---- ------  -----
VSI1        0   GP      1   17.2
            1   GP      1    9.6
          --- ---- ------  -----
          Tot   GP      2   26.9
```

SMF 30, CPU Utilization capture = 92%

- Logical overhead 3.2 / 24.88 = 13%

```
SYSID <------JOB----------> <CPU Percents--
      Name     JobID    Step
                         Nbr Total  STD  SRB
----  -------- -------- --- ----- ---- ----
VSI1  Totals               . 24.88 21.5  3.2
      CATALOG  CATALOG     1  0.02  0.0    0
      CICSJZ1  STC01591    1  0.05  0.0    0
      CICSJZ2  STC08736    1 20.20 19.7  0.5
      IOSAS    IOSAS       1  0.03  0.0  0.0
      IXGLOGR  IXGLOGR     1  0.03  0.0  0.0
      IZUSVR1  STC08689    3  0.10  0.1    0
```

z/OS Jobs Capture Ratio model

SMF 30 / 70 Ratios over time?

- Ratio consistent across LPARs 92%, 88%
- No effective measurement of system overhead???

```
SYSID SYSPLEX   <-Physical  Capt  <Job
      Name      <CPU Util>  Ratio  CPU
                Total  Wait        Total
----  --------  ---- -----  ----- -----
16:51:00 - 16:52:00
VSI1  VSIPLEX    26.9 172.5  92.7  24.9
V24A  VSIPLEX    33.8 122.6  85.2  28.8
---------------------------------------
16:52:00 - 16:53:00
VSI1  VSIPLEX    26.3 173.5  92.6  24.4
V24A  VSIPLEX    29.9 129.4  88.2  26.4
---------------------------------------
16:53:00 - 16:54:00
VSI1  VSIPLEX    25.0 174.8  92.0  23.0
V24A  VSIPLEX    34.6 124.7  85.1  29.4
---------------------------------------
16:54:00 - 16:55:00
VSI1  VSIPLEX    24.7 175.1  92.2  22.8
V24A  VSIPLEX    37.9 118.1  88.7  33.6
---------------------------------------
16:55:00 - 16:56:00
VSI1  VSIPLEX    26.4 173.3  92.4  24.4
V24A  VSIPLEX    45.8  92.0  86.4  39.6
```

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Building the "Capture Model"

LPAR Layer (highest layer)

- Overhead "low"
- Capture Ratio 100%

	Mgmt	Logical	Work	Uncaptured	Capture Ratio
HMC/LPAR	.5-1%	.5-1%	98%+	0%	100%
z/VM	1-2%	1-2%	95%+	0%	99%
z/VSE	<.1%	6-8%	92-94%	0%	99.9%
Linux	2%	7-10%	90%	< 1%	99% +
z/OS	????	13%	85-92%	8-15%?	85-92%
CICS					
DB2					

cics Capture Ratio model

SMF 110 subtype 1 (cics transactions)

- CpuTime = USRCPUT (tcb) + RLSCPUT(srb)
- Add up transactions on the fly for one minute interval

```
Time/     Transaction <-Response Time-> <Disp
SYSID                 Total  Susp  Disp   CPU
 APPLID      ID  Count  Resp  Time  Time  Time
--------  ----  ----- ----- ----- ----- -----
VSI1
 CICSZA2  Total  1192 0.015 0.005 0.010 0.010
          CSSY      6 0.203 0.203 0.000 0.000
          STRH    149 0.005 0.001 0.004 0.004
          STR1    126 0.003 0.000 0.003 0.002
          STR2    109 0.005 0.001 0.004 0.004
          STR3     90 0.006 0.000 0.006 0.005
          STR4     81 0.010 0.000 0.009 0.009
          STR5    109 0.014 0.003 0.011 0.011
          STR6    117 0.015 0.002 0.013 0.013
          STR7    125 0.018 0.003 0.015 0.015
          STR8    148 0.023 0.006 0.016 0.016
          STR9    132 0.035 0.016 0.019 0.018
```

cics Capture Ratio model

SMF 30 (CICS job / region cpu) – 1 minute sample

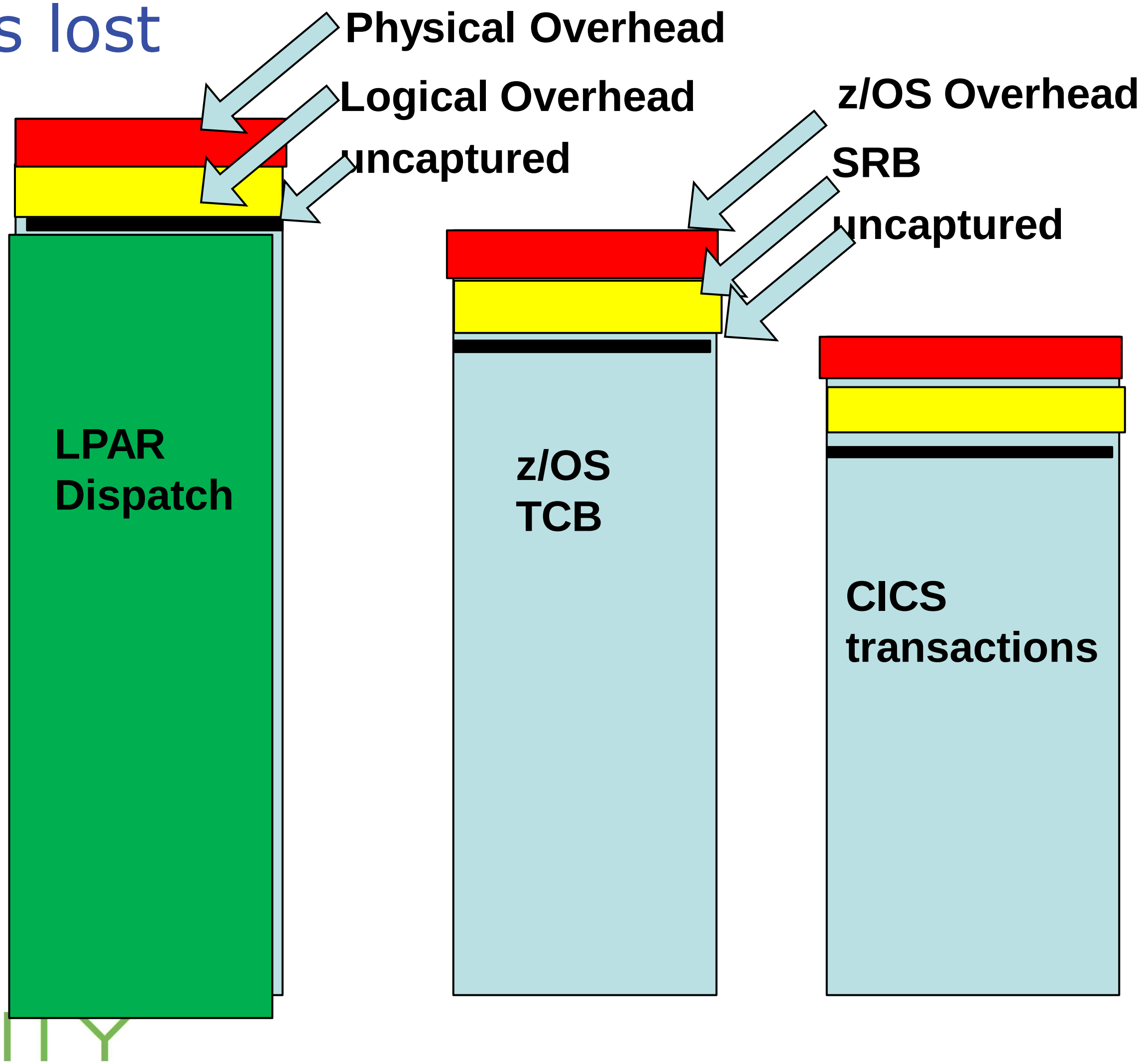
```
SYSID <------JOB----------> <CPU Percents---
      Name     JobID    Step
                        Nbr Total  STD  SRB
----  -------- -------- --- ----- ---- ----
VSI1  Totals              . 24.88 21.5  3.2
      CICSJZ2  STC08736   1 20.20 19.7  0.5
V24A  Totals              . 28.83 25.4  3.2
      C24ASTND STC01838   1 20.22 19.6  0.6
```

SMF 110 (CICS capture ratio: 19.5 / 20.2 = 97%?

```
Time/          <Transactions>  <-Total->  <-Response Time->
SYSID/ APPLID  Group    Count  <--CPU-->  Total  Susp  Disp
Time                           Secs  Pct   Resp  Time  Time
----  ------- -------- -----  ---- ----  ----- ----- -----
VSI1  CICSZA2  Totals    1192  11.7 19.5  0.015 0.005 0.010
V24A  C24ASTND Totals    1156  11.6 19.3  0.037 0.021 0.016
```

z/OS Capture Ratio model

At each layer,
something is lost



CICS Capture Ratio model

Question: how much CPU left for CICS transactions?

- SMF 70, LPAR Loss: 2%
- SMF 70, z/OS loss: 10%
- SMF 30 Logical Overhead/srb: 3%

What is left for transactions? 85%?

The major deficiency in this model is z/OS system time

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Building the "Capture Model"

LPAR Layer (highest layer)

- Overhead "low"
- Capture Ratio 100%

	Mgmt	Logical	Work	Uncaptured	Capture Ratio
HMC/LPAR	.5-1%	.5-1%	98%+	0%	100%
z/VM	1-2%	1-2%	95%+	0%	99%
z/VSE	<.1%	6-8%	92-94%	0%	99.9%
Linux	2%	7-10%	90%	< 1%	99% +
z/OS	????	3-13%	85-92%	8-15%?	85-92%
CICS		3%	96-97%	< 1%	99+%
DB2					

DB2 Capture Ratio model

SMF 30 – CPU by region

- CPU Data by region:

SMF 100 -

- QWSA – DB2 Statistics by region
- TCB,SRB,I/O CPU metrics

SMF 101

- CPU By DB2 Transaction
- QWACEJST – QWACBJST (total cpu per transaction)
    - (db2 time: qpacajst)
    - (package: qpactjst)
- Add up all transactions by transaction name, total

DB2 Capture Ratio model

SMF 30 – CPU by region

```
SYSID <------JOB----------> <---CPU Percent
      Name      JobID    Step
                          Nbr Total  STD  SRB
---- -------- -------- --- ----- ---- ----
V24A Totals                 .  7.22  5.8  1.3
     DSN1DBM1 STC04803    1  0.05 0.04 0.01
     DSN1DIST STC04804    1  0.02 0.02 0.00
     DSN1MSTR STC04801    1  0.64 0.61 0.01
     IRLMPROC STC04802    1  0.13    0 0.13 ←SRB
```

SMF 100 (db2 statistics) – Match SMF 30 100%….

```
Date/          DB2  <Percent>
Time/               Intervl
Sysid   SSID   Proc      CPU
----    ------ ---- --------
V24A    DSN1   DBM1   0.050
               DIST   0.023
               MSTR   0.642
               IRLM   0.132
```

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DB2 Capture Ratio model

SMF 101 (db2 transactions - Capture low, needs work?)

```
<--------Transaction--------->
Name         Count Type Total
                        CPUPct
-----------  ----- ---- ------
trantotal     2477    0   0.60 <--- vs .84 from smf100
POOLZDHD       753    4   0.16
POOLZDCD       747    4   0.16
POOLZDCU       741    4   0.23
POOLADCD       119    4   0.02
POOLADHD       117    4   0.02
```

SMF 100 (db2 statistics)

```
Date/         DB2   <Percent>
Time/               Intervl
Sysid   SSID  Proc      CPU
----    ----- ----  -------
V24A    DSN1  DBM1   0.050
              DIST   0.023
              MSTR   0.642
              IRLM   0.132
```

Building the "Capture Model"

LPAR Layer (highest layer)

- Overhead "low"
- Capture Ratio 100%

	Mgmt	Logical	Work	Uncaptured	Capture Ratio
HMC/LPAR	.5-1%	.5-1%	98%+	0%	100%
z/VM	1-2%	1-2%	95%+	0%	99%
z/VSE	<.1%	6-8%	92-94%	0%	99.9%
Linux	2%	7-10%	90%	< 1%	99% +
z/OS	????	3-13%	85-92%	8-15%?	85-92%
CICS		3%	96-97%	< 1%	99+%
DB2		16%	70%+		70%

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Recap and Thankyou

Capture Ratios validate the data for

- Capacity Planning – know consumption by app
- Chargeback – who consumed exactly what?
- Performance analysis – who is using cpu now?

Complementary data evaluation for anyone who sat thru 65 slides in 58 minutes

Thank you for your time!! See you in person next year

Questions and suggestions can be sent to ‘barton@velocitysoftware.com’

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