z/VM HiperDispatch Deep Dive

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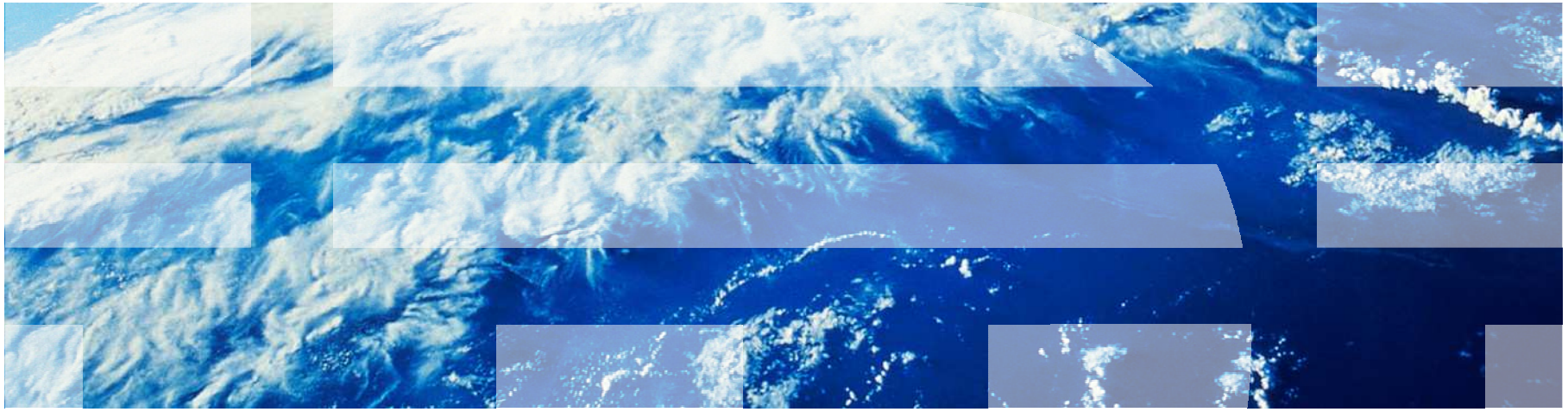


Agenda

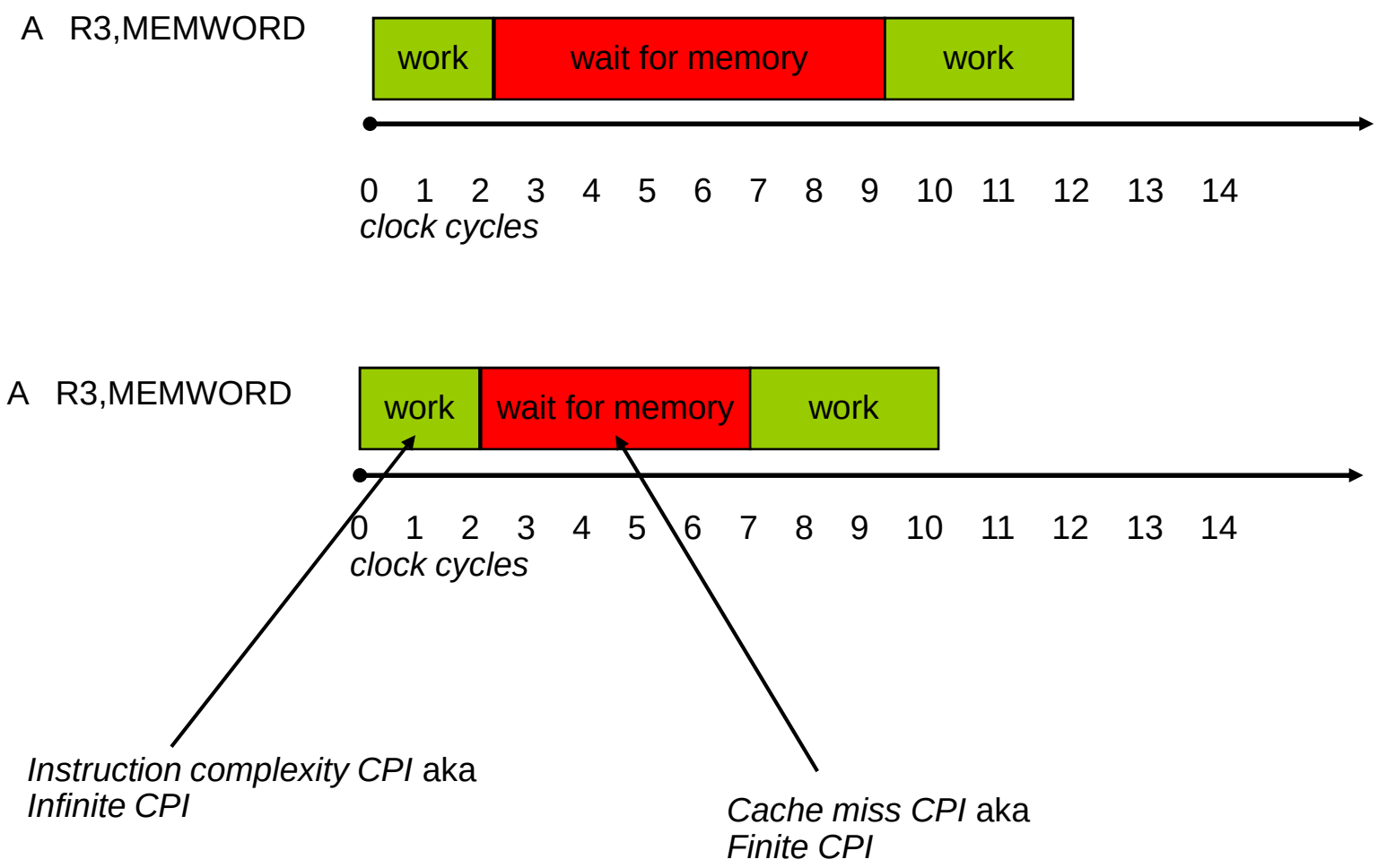
- Objectives of the z/VM HiperDispatch enhancement
- A little about System z hardware and the PR/SM hypervisor
  - Machine structure
  - Behavior and features available in the hypervisor
- Key features of z/VM HiperDispatch
  - Use of vertical mode partitions
  - Running as widely as available power suggests
  - Reducing MP level when it appears z/VM overhead is a problem
  - Dispatching guests in a manner aware of physical and virtual topologies
  - Knobs you can twist or set
- Planning for z/VM HiperDispatch
- Workloads
  - Those that will benefit
  - Those that won't
- CP Monitor and z/VM Performance Toolkit
- Summary

Objectives and Strategies

Objectives and Strategies of z/VM HiperDispatch

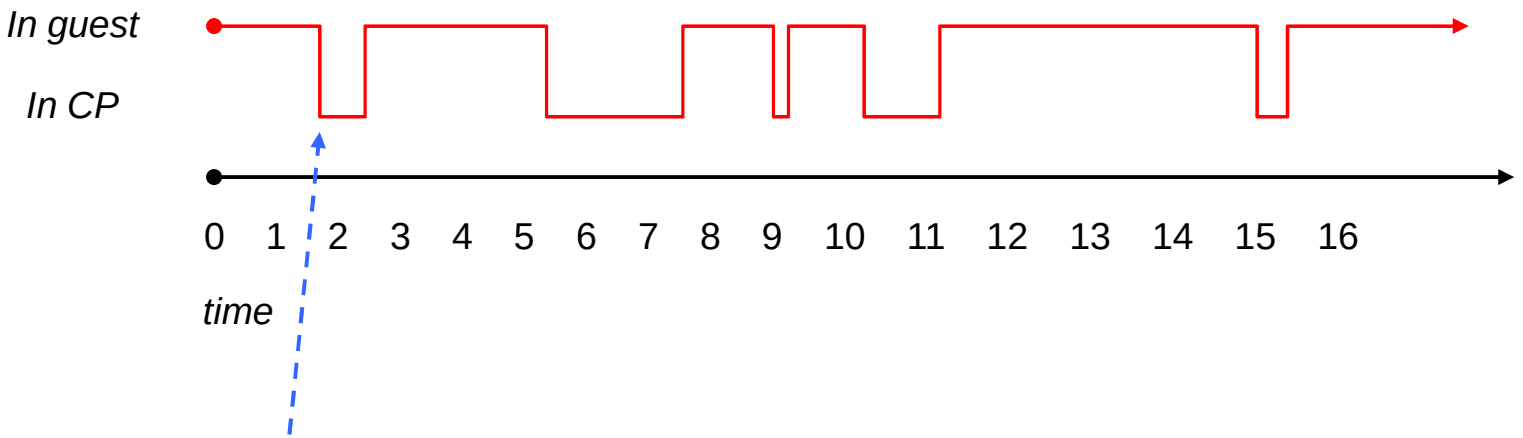
- Improve performance of your workloads, by …
  - Reducing CPU time needed per unit of work done, by …
  - Reducing the time needed for each instruction to run, by …
  - Reducing the time the CPU waits for memory contents to be brought to it.
- Improve performance of your workloads, by…
  - Sensing situations where z/VM Control Program overhead is a problem, and...
  - Changing the LPU configuration to try to reduce the overhead.
- Strategies:
  - Exploit PR/SM hypervisor features meant to help instruction speed
  - Be smarter about what the right MP-level is for the partition at the moment
  - Be smarter about the dispatching of guest virtual CPUs

What It Means to Reduce CPU Wait Time



What It Means to Reduce z/VM Overhead

CPU Consumption Timeline of a Virtual CPU



Some reasons guests go into CP:
- Issue a Diagnose
- Perform I/O
- Issue some other priv op
- Incur a page fault

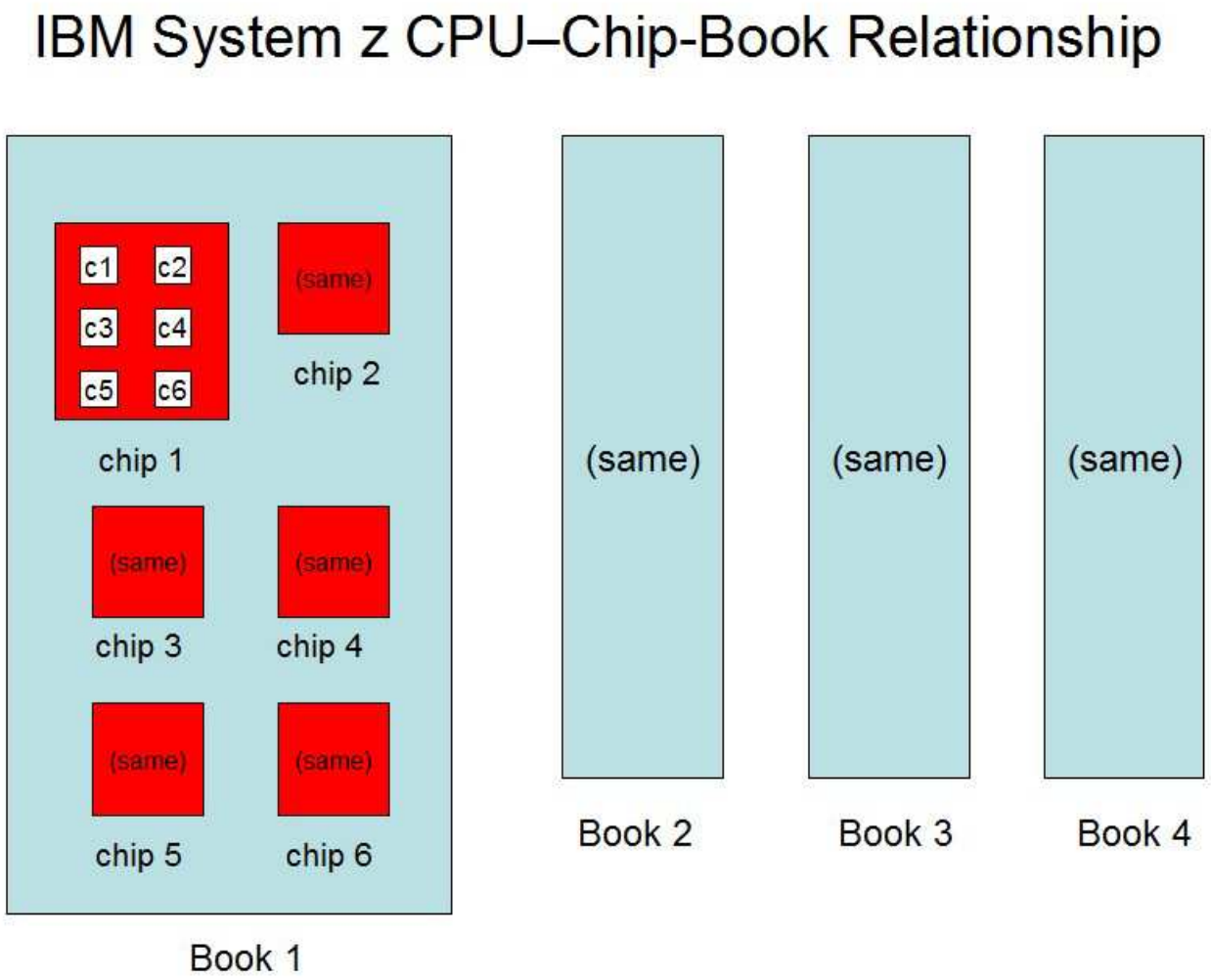
$$\text{T/V ratio} = \frac{\text{(CP time + guest time)}}{\text{guest time}}$$

Things CP often does “down there”:
- Acquire a lock, for serialization
- Do some processing
- Release the lock
- Eventually, run the guest again

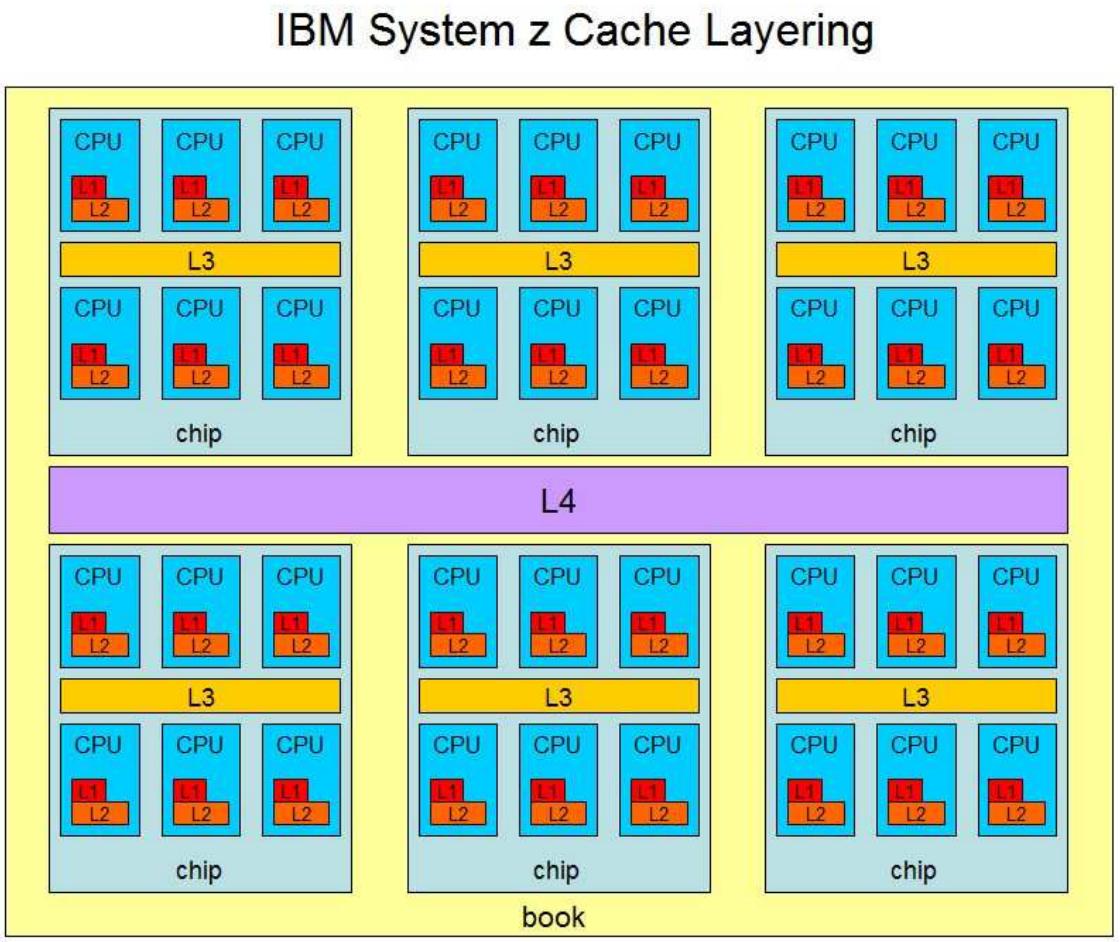
← Time spent spinning on locks is wasted time.
We can reduce it by reducing the partition’s MP level.

A Few Things About System z and PR/SM

IBM System z: Cores, Chips, and Books



IBM System z: Layered Cache Structure



Cache mantra:

- Closer, smaller, faster.

- Farther, larger, slower.

- Try to run a context in the same place over and over.

- Try to run related contexts near to one another.

- Try to run unrelated contexts apart from one another.

IBM System z: Partition Entitlement vs. Logical CPU Count

Suppose we have 12 physical IFLs: 2 dedicated, 10 shared.

Partition	Weight	Weight Sum	Weight Fraction	Physical Capacity	Entitlement Calculation	Entitlement	Maximum Achievable Utilization
FRED, a logical 10-way	63	100	63/100	1000%	1000% x (63/100)	630%	1000%
BARNEY, a logical 8-way	37	100	37/100	1000%	1000% x (37/100)	370%	800%

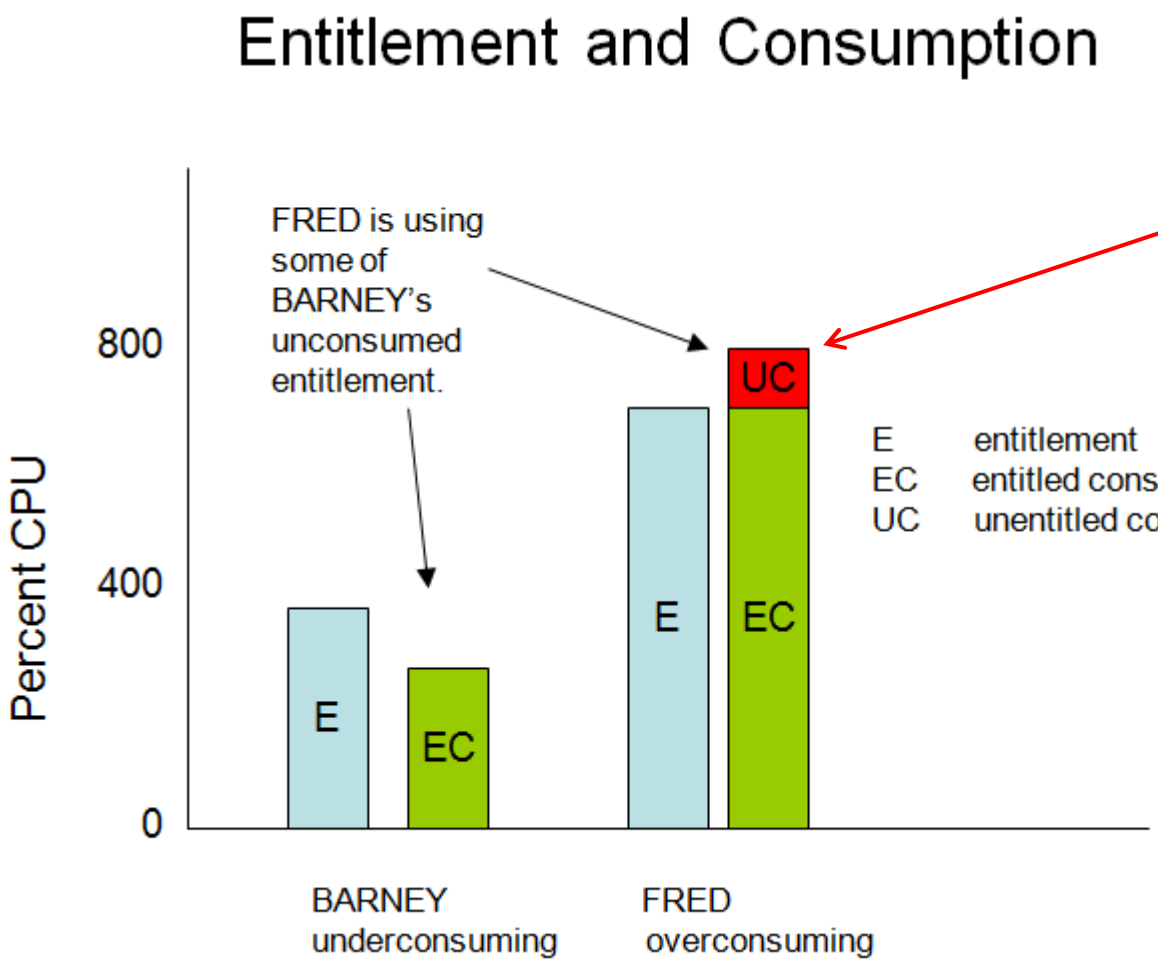
FRED can always run up to 630% busy. That's what *entitlement* means.

But for FRED to run *beyond* 630% busy, BARNEY has to leave some of its entitlement *unconsumed.*

Keep this in mind: (CEC's excess power XP) = (total power TP) - (consumed entitled power EP).

Excess power XP will become very important later.

IBM System z: Entitlement and Consumption



*We call your share of XP your "excess power fraction" or your **XPF**.*

When you overconsume, you are competing against other overconsuming partitions for XP.

IBM System z: A Little More About XP and XPF

Suppose there is 180% left after all entitled consumptions are satisfied. XP=180%.
Suppose P1, P2, and P3 (me), all equal weights, are competing for it.
Their first-pass weight fractions of XP are therefore each 60%.

Case 1:
- P1 is overconsuming 15%
- P2 is overconsuming 25%

P3 can have (180-(15+25)) = 140%
if it wants it. XPF=140

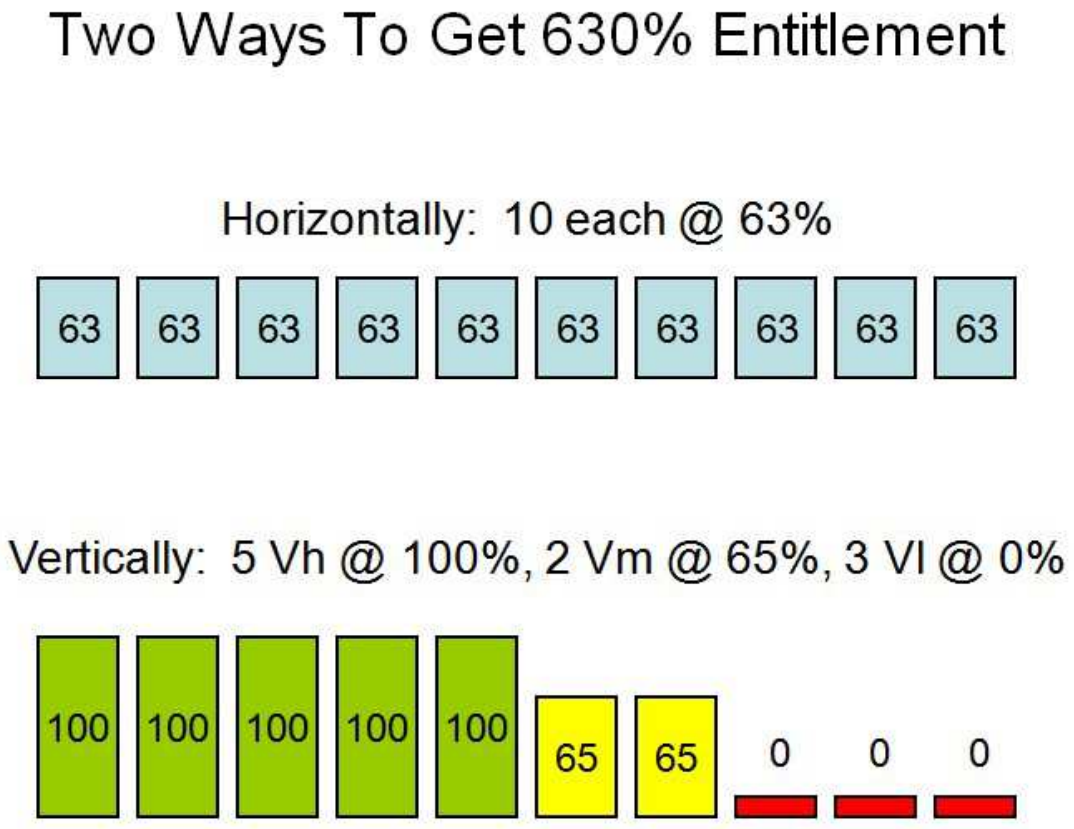
Case 2:
- P1 is overconsuming 90%
- P2 is overconsuming 90%

P3 can have 60% if it wants it. XPF=60

Case 3:
- P1 is overconsuming 135%
- P2 is overconsuming 10%

Round 1: P1+=60, P2+=10, P3+=60, s=130, r=50
Round 2: P1+=25, P3+=25, s=50, r=0
P3 can have 85% if it wants it. XPF=85

IBM System z: Horizontal and Vertical Partitions



In vertical partitions:

- Entitlement is distributed unequally among LPUs.

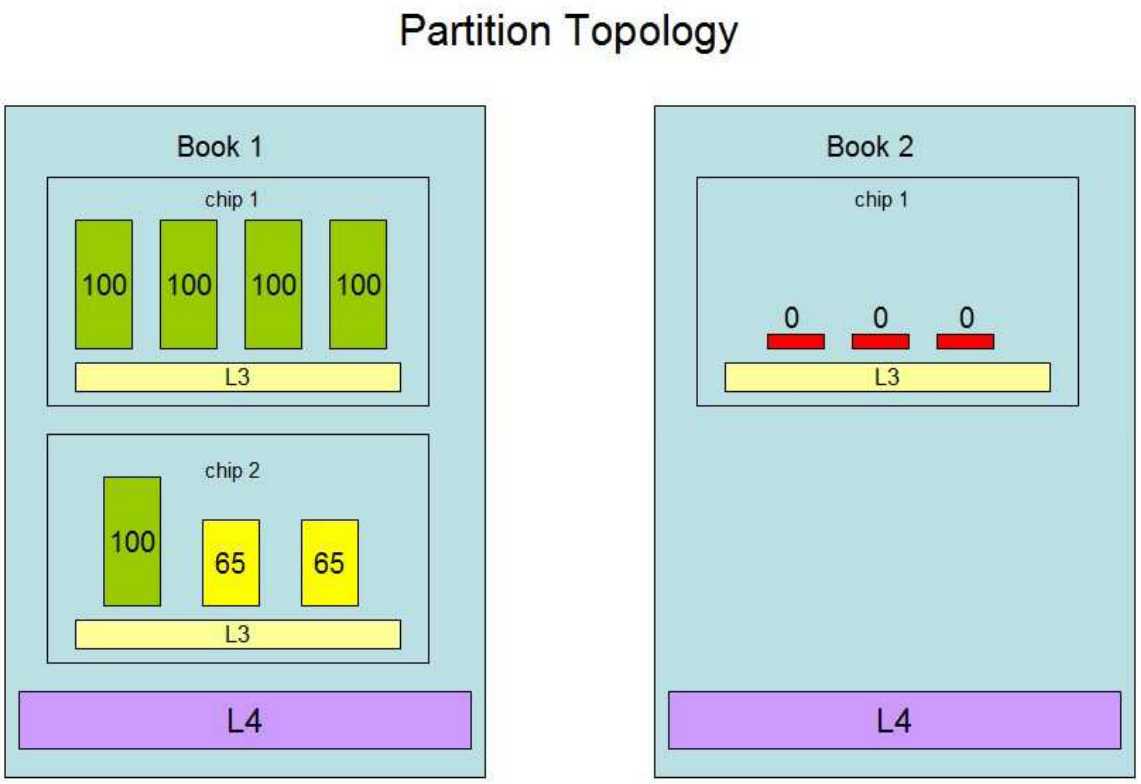
- The unentitled LPUs are useful only when other partitions are not using their entitlements.

- PR/SM tries very hard not to move Vh LPUs.

- PR/SM tries very hard to put the Vh LPUs close to one another.

- Partition consumes its XPF on its Vm and Vl LPUs.

IBM System z: The Partition Knows Its Placement



In vertical partitions:

- Sense your placement
- Run work smartly in light of your placement
- Sense unentitled power
- Use LPUs smartly in light of unentitled power

Notice PR/SM has given this partition a "quiet place" to do its work, provided the partition runs its work on its Vh LPUs.

What z/VM HiperDispatch Does With All This

z/VM HiperDispatch: Use of Vertical Mode

```
indicate load
AVGPROC-000% 24
XSTORE-000000/SEC MIGRATE-0000/SEC
MDC READS-000000/SEC WRITES-000000/SEC HIT RATIO-000%
PAGING-0/SEC
Q0-00000(00000)                                DORMANT-00000
Q1-00000(00000)            E1-00000(00000)
Q2-00000(00000) EXPAN-000 E2-00000(00000)
Q3-00000(00000) EXPAN-000 E3-00000(00000)

PROC 0000-000% CP   VH     PROC 0001-000% CP   VH
PROC 0002-000% CP   VH     PROC 0003-000% CP   VH
PROC 0004-000% CP   VH     PROC 0005-000% CP   VH
PROC 0006-000% CP   VH     PROC 0007-000% CP   VH
PROC 0008-000% CP   VH     PROC 0009-000% CP   VH
PROC 000A-000% CP   VH     PROC 000B-000% CP   VH
PROC 000C-000% CP   VH     PROC 000D-000% CP   VH
PROC 000E-000% CP   VH     PROC 000F-000% CP   VH
PROC 0010-000% CP   VH     PROC 0011-000% CP   VH
PROC 0012-000% CP   VH     PROC 0013-000% CP   VH
PROC 0014-000% CP   VM     PROC 0015-000% CP   VM
PROC 0016-000% CP   VL     PROC 0017-000% CP   VL

LIMITED-00000
Ready; T=0.01/0.01 13:13:39
```

Here we see an assortment of LPUs:
- 20 Vh
- 2 Vm
- 2 Vl

If I recall correctly this was a 24-way with 2130% entitlement.

Note: these percent-busies are now *percent of a physical CPU*, not percent-not-deliberately-waiting as they used to be:
- Older releases: if the logical CPU never loaded a wait PSW, it showed 100% busy no matter what it was truly using.
- New release: these percentages are the *fraction of the capacity of a physical CPU* being used by the logical CPU.

z/VM HiperDispatch: Awareness of Topology

```
q proc topology
13:14:59 TOPOLOGY
13:14:59   NESTING LEVEL: 02  ID: 01
13:14:59     NESTING LEVEL: 01  ID: 01
13:14:59       PROCESSOR 00  PARKED     CP    VH  0000
13:14:59       PROCESSOR 01  PARKED     CP    VH  0001
13:14:59       PROCESSOR 12  PARKED     CP    VH  0018
13:14:59     NESTING LEVEL: 01  ID: 02
13:14:59       PROCESSOR 0E  MASTER     CP    VH  0014
13:14:59       PROCESSOR 0F  ALTERNATE  CP    VH  0015
13:14:59       PROCESSOR 10  PARKED     CP    VH  0016
13:14:59       PROCESSOR 11  PARKED     CP    VH  0017
13:14:59     NESTING LEVEL: 01  ID: 03
13:14:59       PROCESSOR 02  PARKED     CP    VH  0002
13:14:59       PROCESSOR 03  PARKED     CP    VH  0003
13:14:59       PROCESSOR 04  PARKED     CP    VH  0004
13:14:59     NESTING LEVEL: 01  ID: 04
13:14:59       PROCESSOR 05  PARKED     CP    VH  0005
13:14:59       PROCESSOR 06  PARKED     CP    VH  0006
13:14:59       PROCESSOR 07  PARKED     CP    VH  0007
13:14:59     NESTING LEVEL: 01  ID: 05
13:14:59       PROCESSOR 08  PARKED     CP    VH  0008
13:14:59       PROCESSOR 09  PARKED     CP    VH  0009
13:14:59       PROCESSOR 0A  PARKED     CP    VH  0010
13:14:59     NESTING LEVEL: 01  ID: 06
13:14:59       PROCESSOR 0D  PARKED     CP    VH  0013
13:14:59   NESTING LEVEL: 02  ID: 02
13:14:59     NESTING LEVEL: 01  ID: 02
13:14:59       PROCESSOR 14  PARKED     CP    VM  0020
13:14:59     NESTING LEVEL: 01  ID: 04
13:14:59       PROCESSOR 15  PARKED     CP    VM  0021
13:14:59       PROCESSOR 16  PARKED     CP    VL  0022
13:14:59       PROCESSOR 17  PARKED     CP    VL  0023
13:14:59     NESTING LEVEL: 01  ID: 05
13:14:59       PROCESSOR 0B  PARKED     CP    VH  0011
13:14:59       PROCESSOR 0C  PARKED     CP    VH  0012
13:14:59       PROCESSOR 13  PARKED     CP    VH  0019
Ready; T=0.01/0.01 13:14:59
```

Here we see the placements of our LPUs on the physical topology.

For example,
- LPU 00: Vh, book 1, chip 1
- LPU 15: Vm, book 2, chip 4

Nesting level just refers to book, chip, etc. They are numbered from smallest to largest:

- z10: book=1
- z196, zEC12: chip=1, book=2

CP Monitor has been updated to log out logical CPU polarity.

z/VM HiperDispatch: What Does “Parked” Mean?

- A *parked* logical CPU is simply not participating in the running of the system’s work.
- It is still varied-on
- It is still a configured logical CPU as far as PR/SM is concerned
- It still counts as far as software licensing is concerned
- It is sitting in a barely-enabled wait-state PSW waiting for somebody to wake it up
- It might sit there in a wait for a really long time
- When we need it, we will signal it aka *unpark* it.
- Unparking requires a SIGP and some wakeup processing. Much faster than VARY ON.

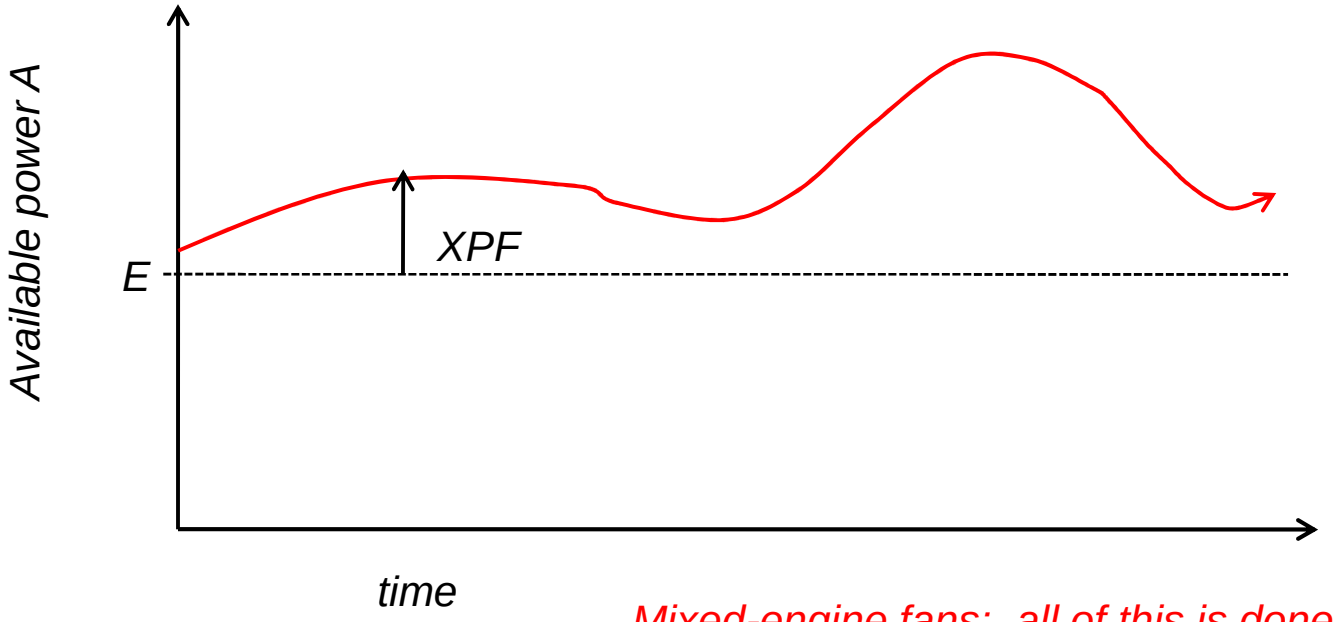
z/VM HiperDispatch: Running According to Available Power

Your available power A = your entitled power E + your excess power fraction XPF.

In other words, you can use your E plus what PR/SM will let you use from the excess power XP.
-- You can have all of the XP no one else wants, or your weight-fraction among your competitors.

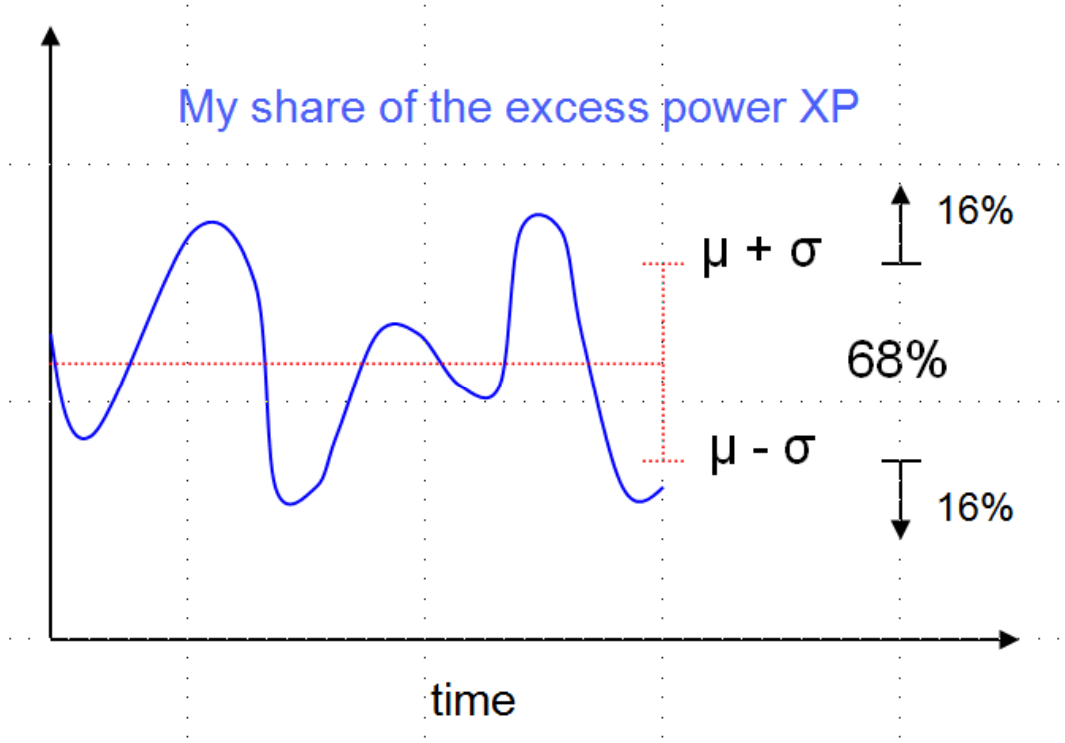
You want to run with just the right number of CPUs to be able to consume E + XPF if you need it.
-- For example, if E+XPF = 1458%, you need 15 CPUs unparked to consume it.

The trick in selecting the number of CPUs to use is to guess well about how much XPF you are likely to have for the next little bit of time.



Mixed-engine fans: all of this is done by CPU-type-pool.

z/VM HiperDispatch: How We Calculate XPF'



CP Monitor has been updated to log out all of the observations and all of the predictions.

Every two seconds, we:

- Query all partitions' weights and consumptions, so we can…

- Figure out how much excess power is available to compete for, and…

- Who our competitors for it are…

- And this tells us what our XPF is.

We keep a history of our last 10 observations of XPF.

Using the observation history we statistically project a *floor* for XPF, called XPF', for the next two seconds.

And we then *park* or *unpark* according to the engines needed to consume predicted A' = E + XPF'.

z/VM HiperDispatch: Importance of Global Performance Data

- "Global Performance Data" is a setting in the partition's activation profile, "Security" category
  - Look for the checkbox labelled "Performance Data Control"
  - Also you can use the SE's "Change LPAR Security" function to change it while the partition is up
  - z/VM can handle changes in GPD without a re-IPL

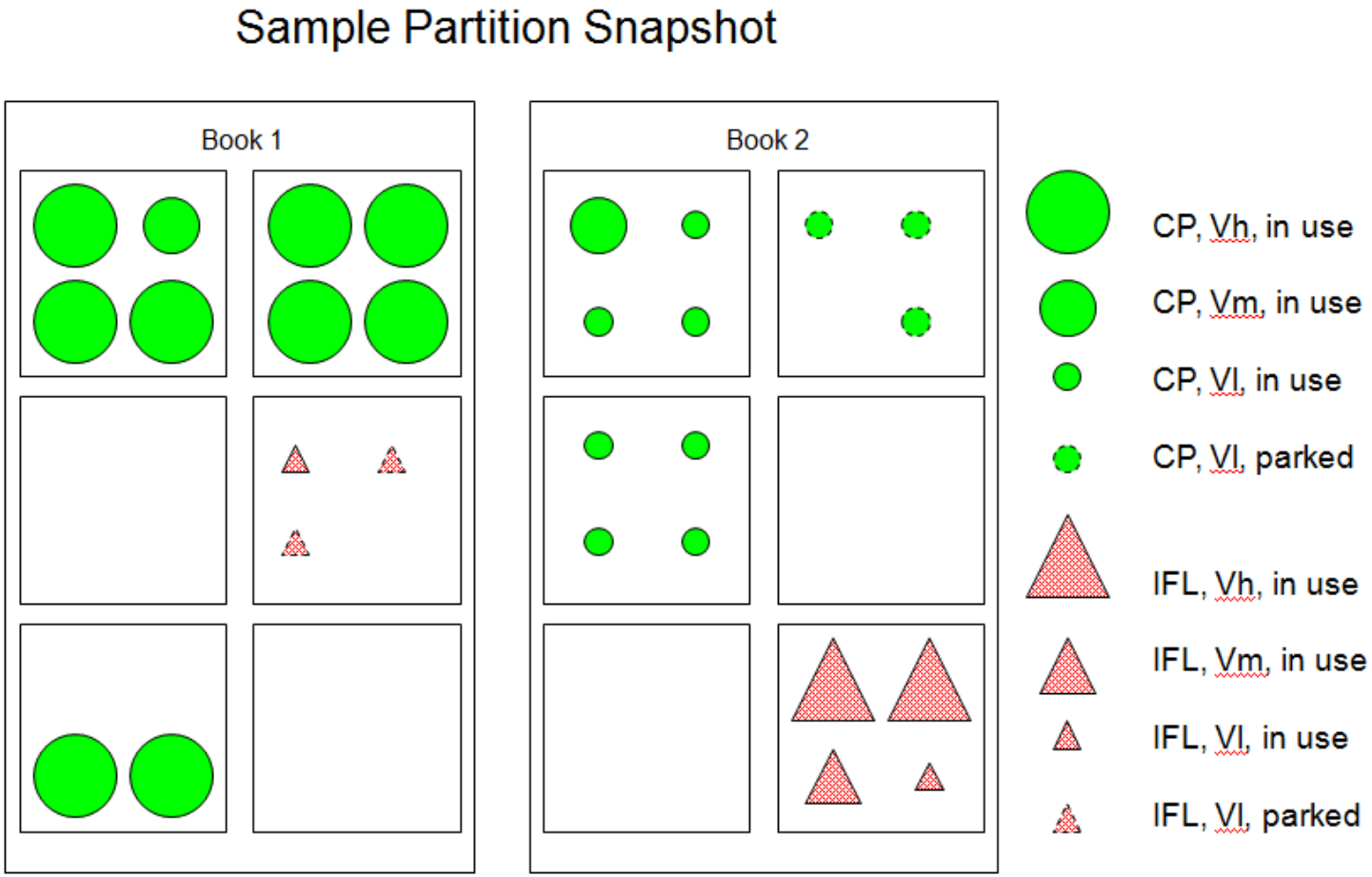
- GPD is on by default (in DR scenario, ask your partition provider about it)

- When it is on, the partition can see performance data about all partitions
  - Their weights
  - How much CPU they are consuming

- That performance data lets the z/VM system do all of these things:
  - Determine every partition's entitlement
  - Determine how much entitled power is being consumed
  - Determine how much excess power is available (XP = TP – EP)
  - Determine which partitions are overconsuming
  - Calculate the z/VM system's XPF

- z/VM HiperDispatch is substantially crippled if you fail to enable GPD for the partition
  - You might see HCP1052I, "Global performance data is disabled. This may degrade system performance."
  - You can always use CP QUERY SRM to find out whether GPD is on for your partition

z/VM HiperDispatch: Which LPUs Do We Park?

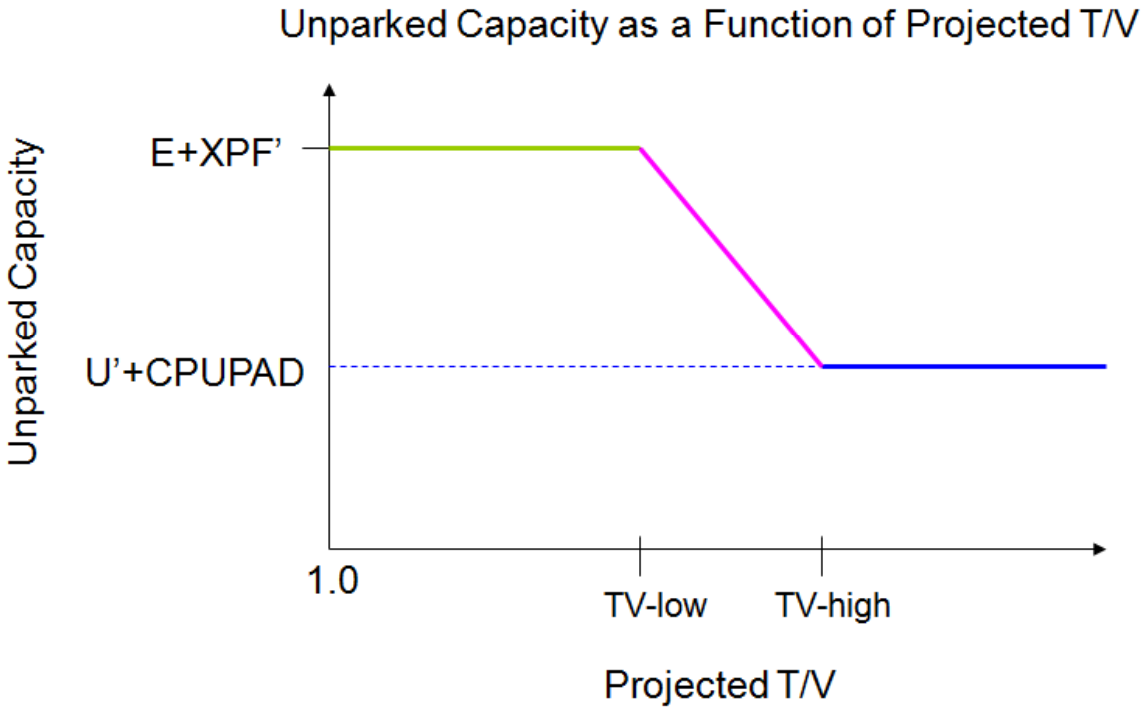


We park topological outliers.

CP Monitor has been updated to log out the park/unpark state every two seconds.

z/VM HiperDispatch: Reducing MP Level to Avoid Overhead

Sometimes, less is more.



Just as we project a floor on XPF, we also project:

- A *ceiling* U' on partition's CPU utilization.

- A *ceiling* T' on partition's T/V ratio.

Then, if U' is small enough and T' is large enough, we *park* LPUs to try to get rid of overhead.

Severity of parking below E+XPF' can be controlled by setting a safety margin or CPUPAD value that we add to U'.

CP Monitor has been updated to log out all of the observations and all of the predictions.

We do not park below E+XPF' on low T' because being wide is not hurting us and the parallelism is apparently there for us to use.

z/VM HiperDispatch: Guest Dispatch Objectives and Strategy

- Objectives: compared to earlier z/VM releases,
  - Reduce movement of virtual CPUs
  - Try to place the virtual CPUs of an N-way guest close to one another

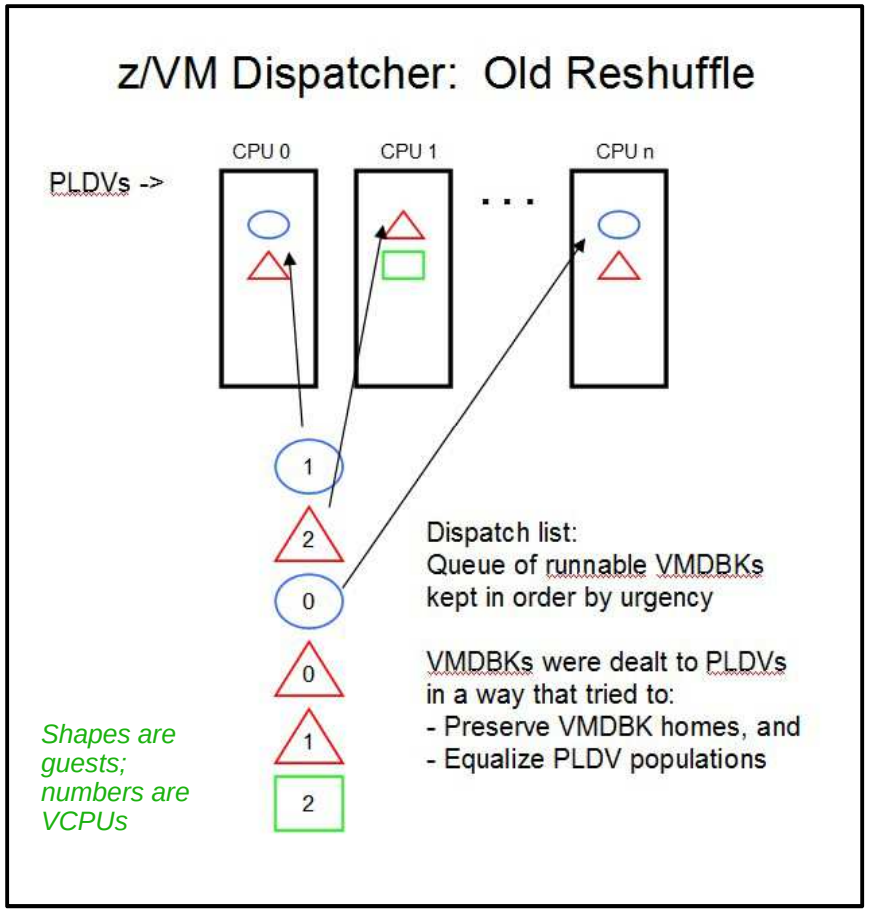
- Strategies:

  - We made several small changes or additions:
    - Reshuffle
    - VMDBK steal
    - Work stacking wakeup
    - Needs help

  - We added a new work distribution algorithm:
    - Rebalance

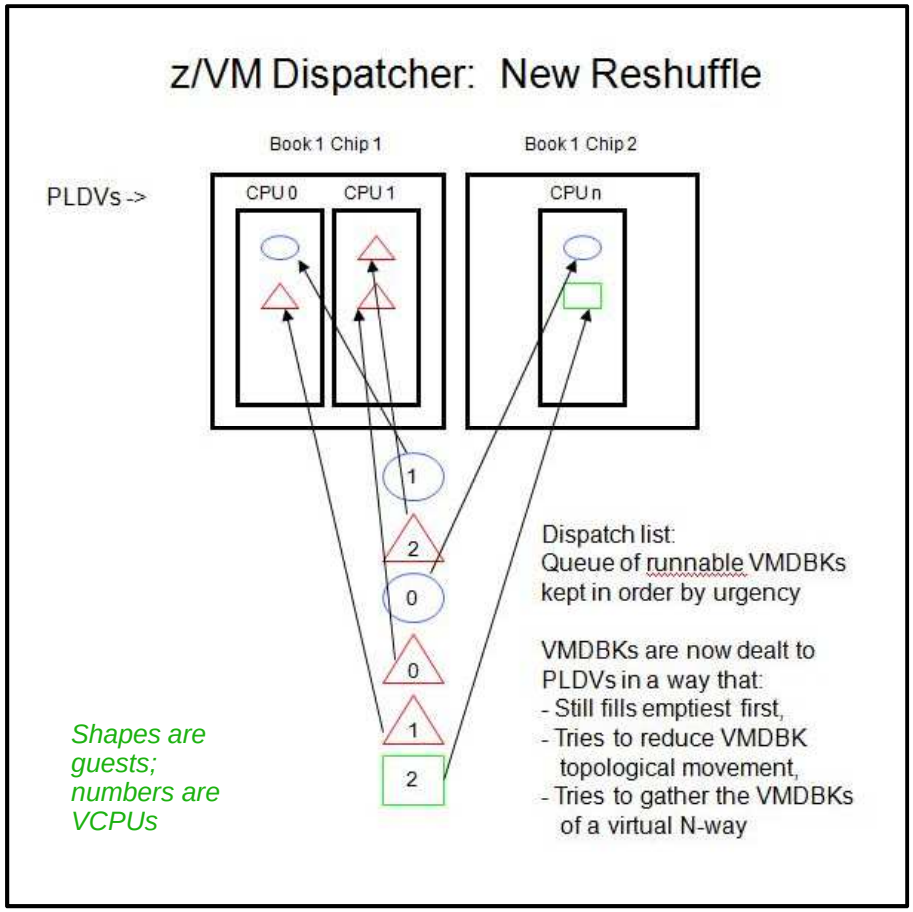
z/VM HiperDispatch: Reshuffle Changes

Horizontal mode



- Balances PLDV populations.
- If not home, then anywhere.
- No awareness of virtual N-ways.

Vertical mode



- Still balances PLDV populations.
- If not home, then hunt outward topologically.
- Collects virtual N-ways.

z/VM HiperDispatch: VMDBK Steal

OLD WAY

0 → 1 → 2 → 3 → 4 … → 19 → 0

Steal from neighbor by CPU number.

Work your way around the ring.

This is not topologically informed.

NEW WAY

(Easy) Steal within your chip.

(Harder) Steal within your book.

(Still harder) Steal across books.

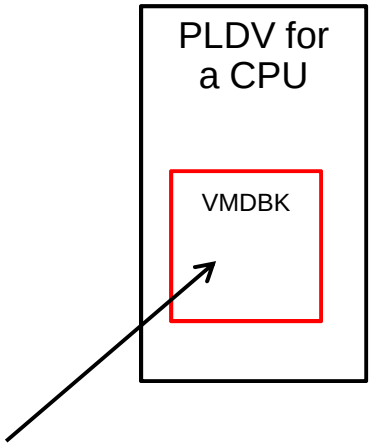
This is topologically informed.

Barriers are for
vertical mode only.

CP Monitor has been updated to log out steal behavior as a function of topology drag distance.

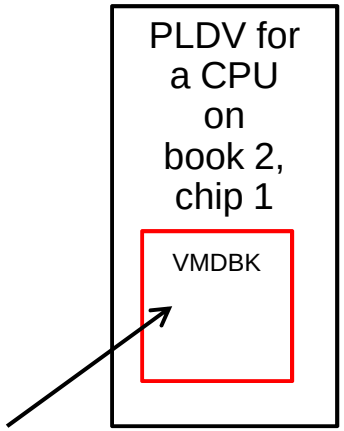
z/VM HiperDispatch: Work Stacking CPU Wakeup

Horizontal mode



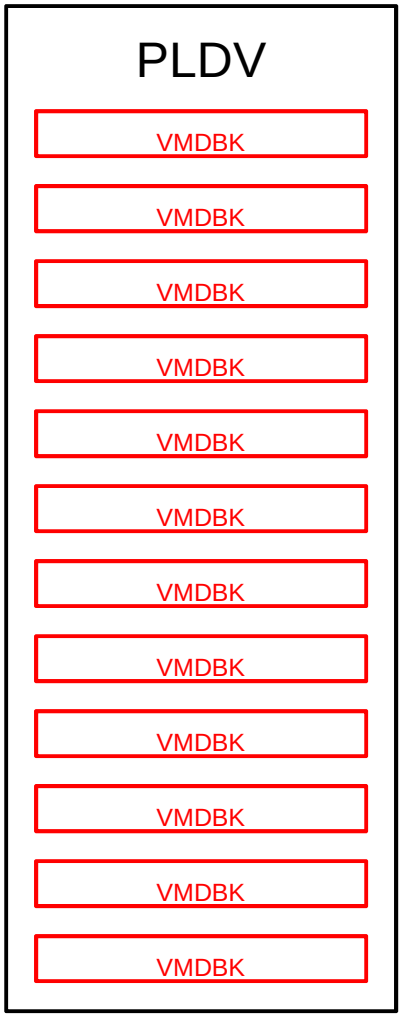
- Stack work on PLDV
- If target CPU is busy,
- Find first wait-state CPU right of stack target (CPU 0, 1, 2, 3, …)
- Wake up the found CPU to prowl for steal

Vertical mode



- Stack work on PLDV
- If target CPU is busy,
- Is there a wait-state CPU in this chip?
- Is there a wait-state CPU in this book?
- Is there a wait-state CPU anywhere?

z/VM HiperDispatch: Needs Help



- Come out of wait

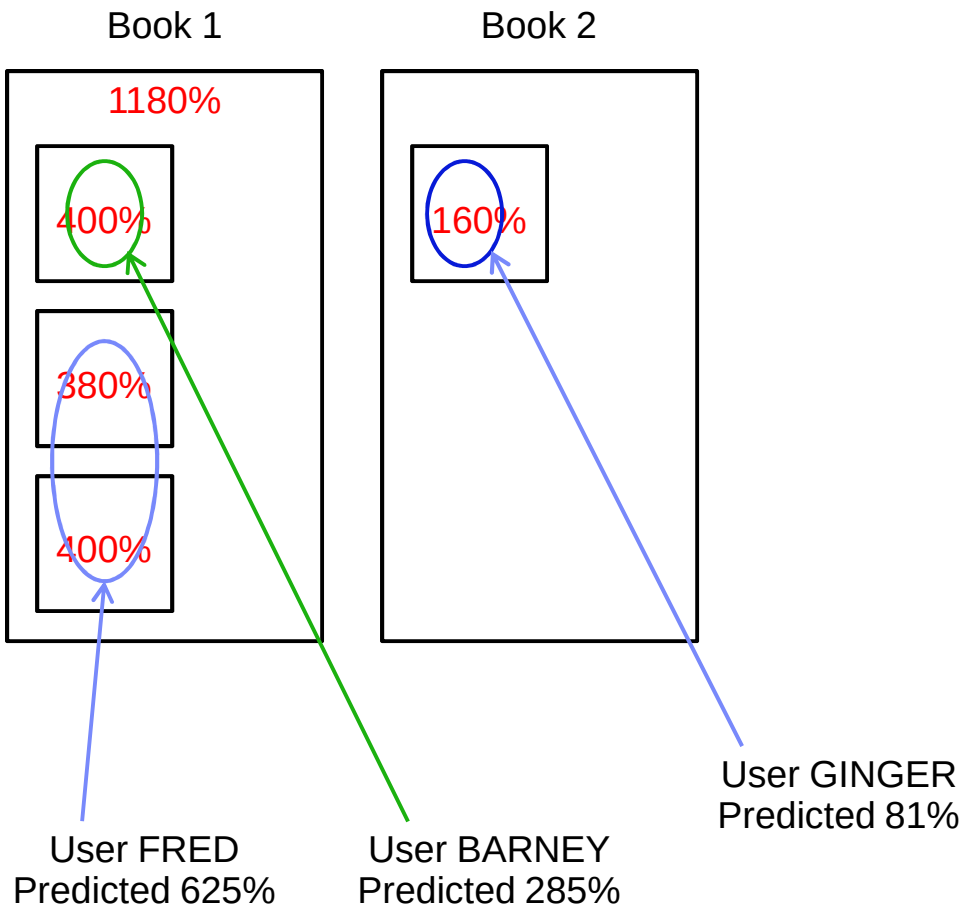
- Start working off my PLDV's VMDBKs

- About every minor time slice, calculate, "How long since I woke up?"

- If greater than a very long time, wake up the topologically closest waiter anywhere in the system so as to start him prowling to steal

- If greater than only a moderate time, wake up the topologically closest waiter in my book so as to start him prowling to steal

z/VM HiperDispatch: Rebalance



CP Monitor has been updated to log out the decisions of rebalance.

Rebalance highlights:

- Periodic rework of the assignments of all guests to the topological containers

- Reassigns every guest every pass, not just the VMDREADY, dispatch-list-resident VMDBKs as reshuffle does

- Predicts all guests' near-future utilizations

- Assigns guests to containers like this:
  - Predicted heaviest guests first
  - Spreads load over all containers
  - Tries not to split guests

- Good for situations where:
  - Guests' utilizations are easily distinguished from one another
  - A few heavy guests need not to move around
  - Movement of light users is OK
  - VCPU:LCPU ratio not too big

z/VM HiperDispatch: Knobs

Concept	Knob
Horizontal or vertical	SET SRM POLARIZATION { HORIZONTAL | VERTICAL }
How optimistically to predict XPF floors	SET SRM [TYPE cpu_type] EXCESSUSE { HIGH | MED | LOW }
How much CPUPAD safety margin to allow when we park below available power	SET SRM [TYPE cpu_type] CPUPAD nnnn%
Reshuffle or rebalance	SET SRM DSPWDMETHOD { RESHUFFLE | REBALANCE }

Defaults:

- Vertical mode
- EXCESSUSE MEDIUM (70%-confident floor)
- CPUPAD 100%
- Reshuffle

CP Monitor has been updated to log out the changes to these new SRM settings.

z/VM HiperDispatch: Horizontal Mode vs. Vertical Mode

- Horizontal mode
  - All unparked all the time
  - Reshuffle, but old-style
    - Not topologically aware
    - Does not gather virtual N-ways
  - Steal prowls topologically outward
  - Barrier-free steal
  - Work-stack wakeup is not topologically aware
  - Needs-help is in effect
  - LPU dedicate to guest is OK
- It's very much like z/VM 6.2

- Vertical mode
  - Unparks according to A' = E+XPF'
  - Parks below A' if U' seems low and T/V' seems high
  - Reshuffle is new-style
    - Knows system topology
    - Knows about virtual N-ways
  - Steal prowls topologically outward
  - Difficulty barriers in steal
  - Work-stack wakeup is topologically aware
  - Needs-help is in effect
  - *Cannot dedicate an LPU to a guest*
- More topological awareness

z/VM HiperDispatch: Aspects of Dedicated Partitions

- The physical PUs backing the partition are not part of the shared physical CPU pool
- If it is a mixed-engine partition, all CPU types are dedicated
- There's no such thing as "weight"
- Its entitlement E is N * 100%
- A dedicated partition never consumes from XP. XPF=0 always.
- If you run a dedicated partition in vertical mode,
  - All of the logical PUs are vertical highs (Vh)
  - z/VM will park a logical PU only because of high T/V projections

Planning for z/VM HiperDispatch

z/VM HiperDispatch: Planning for It

- Normal best practices for migrating from an earlier release certainly apply
- While you are still on the earlier release, collect measurement data:
  - Know what your key success metrics are and what their success thresholds are
  - Transaction rates – *only you* know where these are on your workloads
  - MONWRITE files – some tips:
    - When: Daily peaks? Month-end processing? Quarter-end processing?
    - Collection tips: http://www.vm.ibm.com/devpages/bkw/monwrite.html
    - CPU MF tips: http://www.vm.ibm.com/perf/reports/zvm/html/620con.html
    - CPU MF reduction: http://www.vm.ibm.com/perf/tips/cpumf.html
- Remember to turn on Global Performance Data for your z/VM partition
- Then go ahead and try z/VM 6.3
  - Remember the default for z/VM 6.3 is vertical mode
  - Consider asking IBM whether your workload is amenable to using rebalance
- When you start running on z/VM 6.3, collect the very same measurement data
- Compare z/VM 6.3 back to z/VM 6.2 to see what the effect is on your workload
- If you like, you can revert to horizontal mode with these means:
  - CP SET SRM POLARIZATION HORIZONTAL
  - SRM statement in the system configuration file

Comments on Workloads

z/VM HiperDispatch: Traits of Workloads

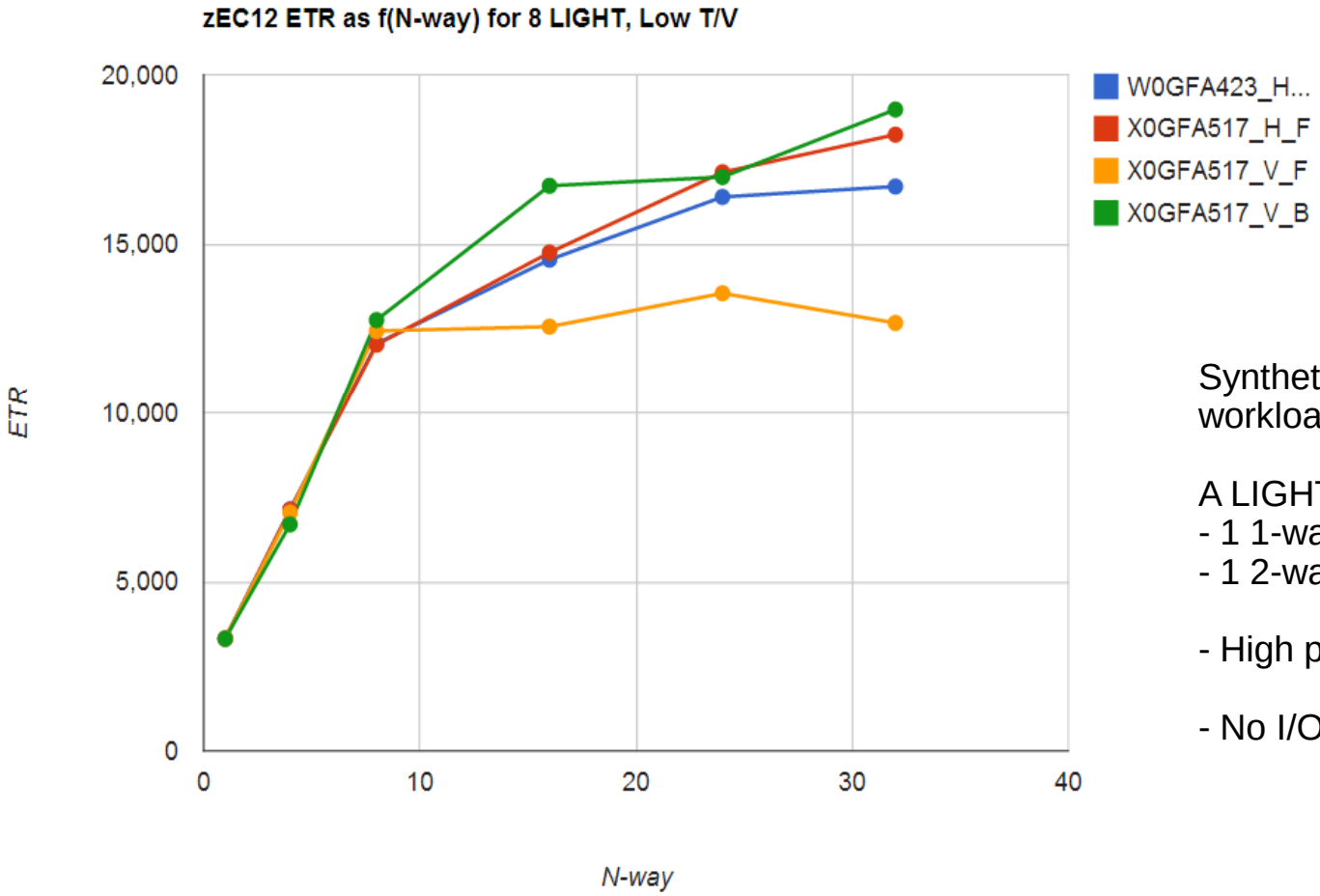
- Amenable workloads for z/VM HiperDispatch:
  - High-CPU, CPU-constrained workloads
    - Improving cache behavior stands to improve performance
  - Active VCPU:LCPU ratio isn't too large
    - High ratio has too much context switching to feel much effect
  - Runs in a partition having multiple topology containers
    - Gives z/VM an opportunity to separate guests from one another

- Compare those statements to IBM's statements about PR/SM and partitions

- Indifferent workloads for z/VM HiperDispatch
  - Constrained by something else, such as I/O
  - Memory-overcommitted
  - High VCPU:LCPU ratio with every virtual CPU active just a little bit
  - Workloads with bad memory access habits

- Remember that vertical mode also keeps your partition away from the other partitions

z/VM HiperDispatch: Various Numbers of LIGHT Tiles



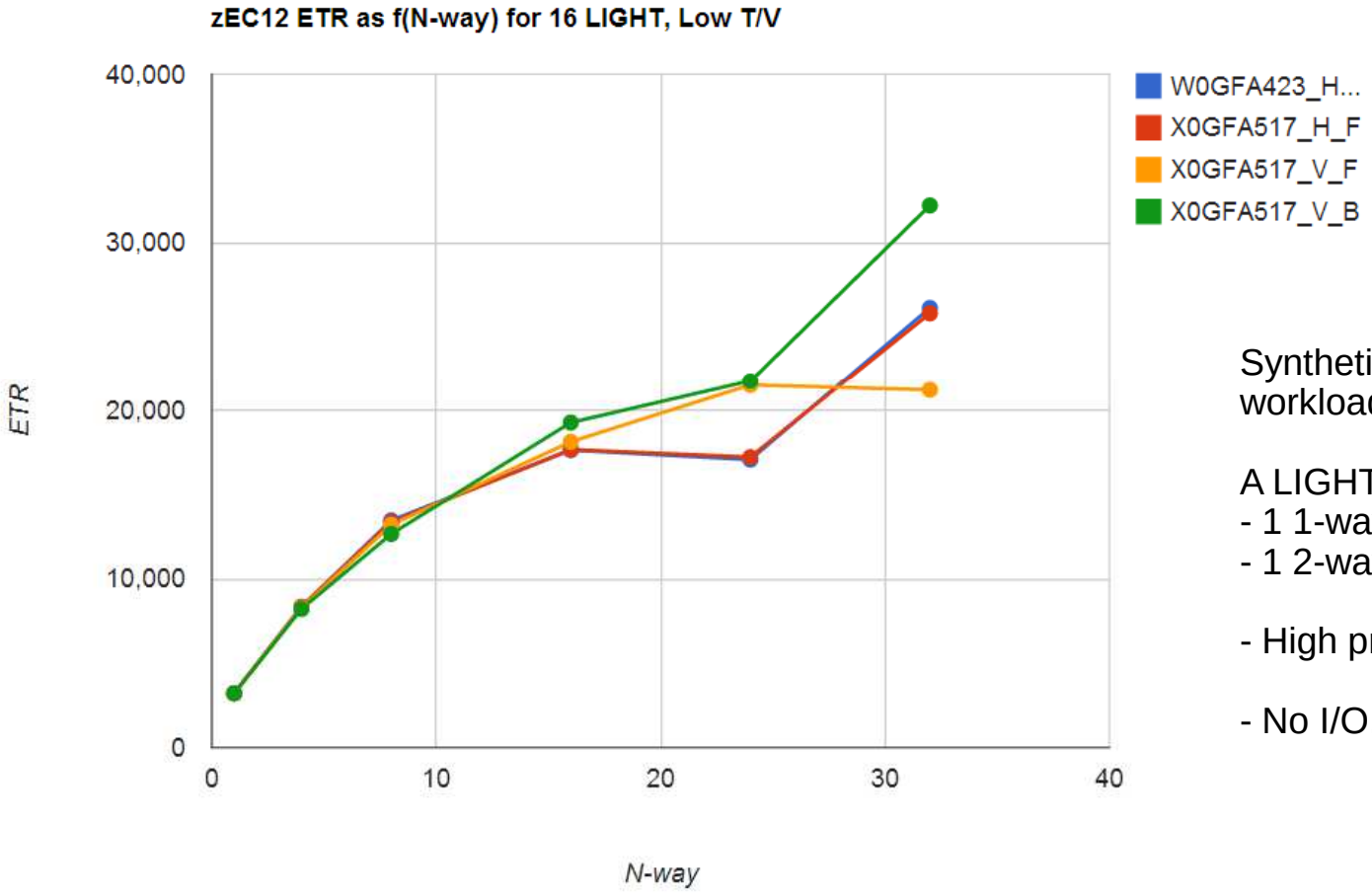
Synthetic, memory-touching workload

A LIGHT tile is 81% busy:
- 1 1-way @ 15% each
- 1 2-way @ 33% each

- High pressure on nest

- No I/O, paging, etc.

z/VM HiperDispatch: Various Numbers of LIGHT Tiles



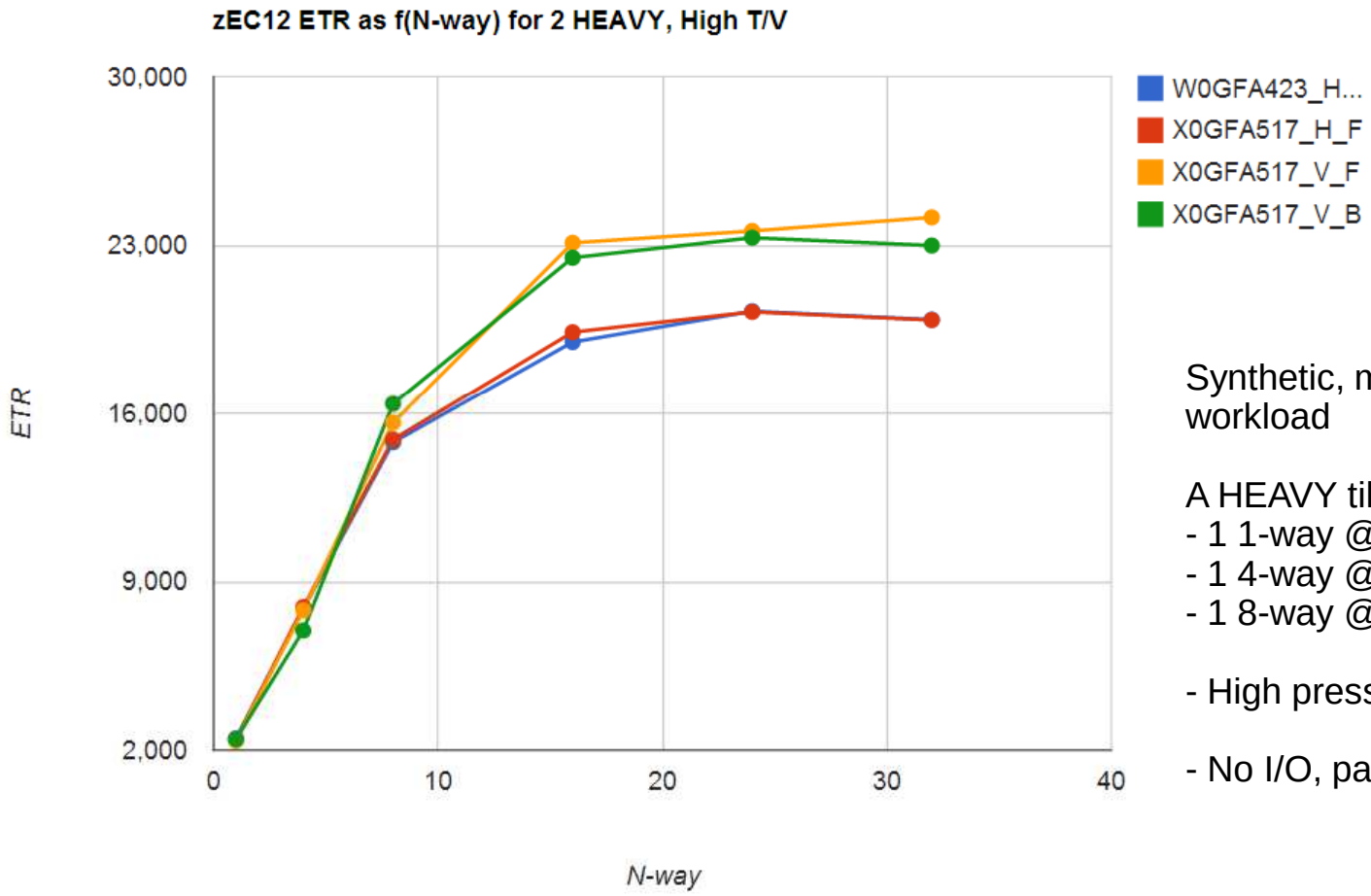
Synthetic, memory-touching workload

A LIGHT tile is 81% busy:
- 1 1-way @ 15% each
- 1 2-way @ 33% each

- High pressure on nest

- No I/O, paging, etc.

z/VM HiperDispatch: Various Numbers of HEAVY Tiles



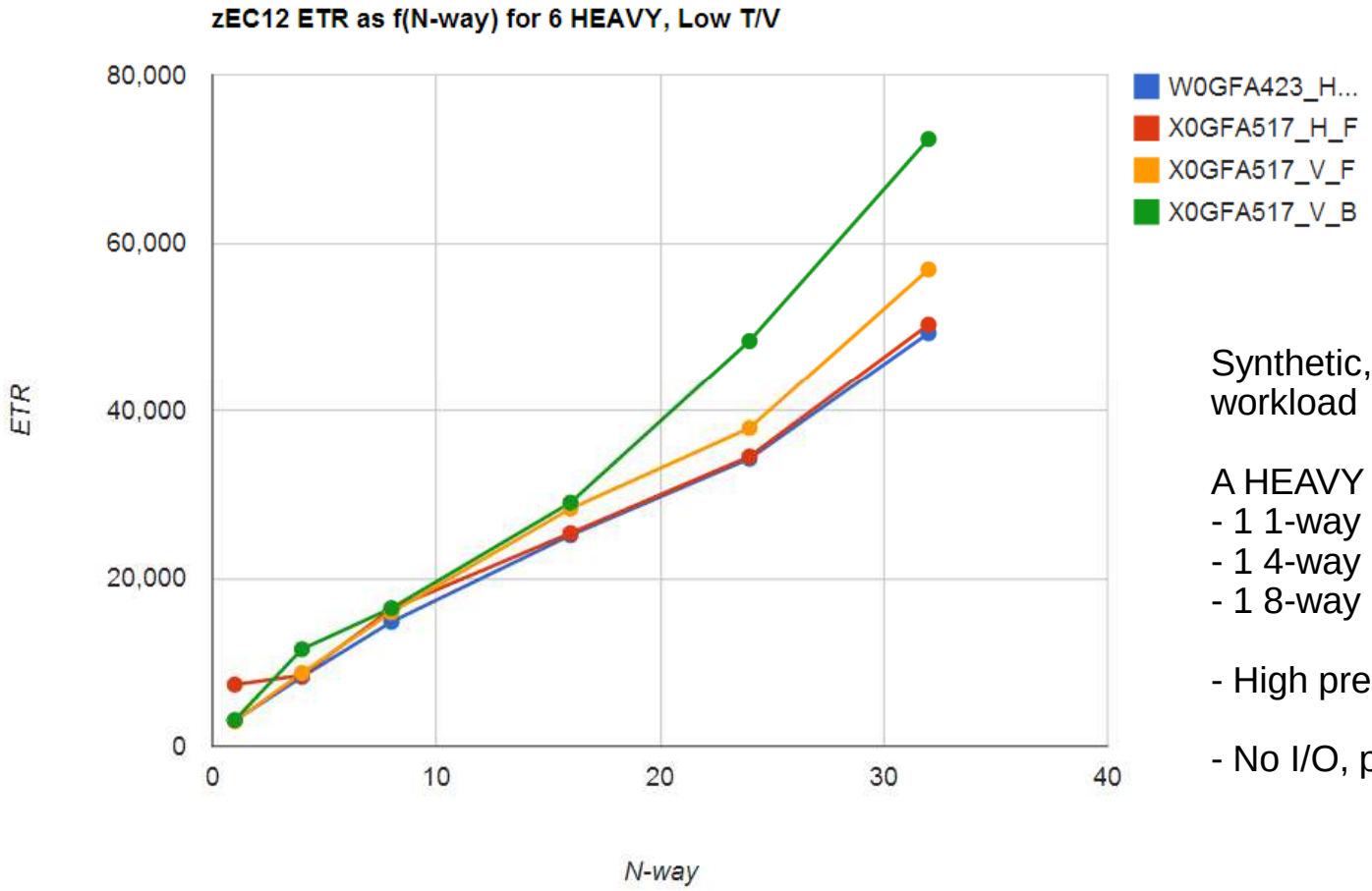
Synthetic, memory-touching workload

A HEAVY tile is 540% busy:
- 1 1-way @ 15% each
- 1 4-way @ 31% each
- 1 8-way @ 50% each

- High pressure on nest

- No I/O, paging, etc.

z/VM HiperDispatch: Various Numbers of HEAVY Tiles



Synthetic, memory-touching workload

A HEAVY tile is 540% busy:
- 1 1-way @ 15% each
- 1 4-way @ 31% each
- 1 8-way @ 50% each

- High pressure on nest

- No I/O, paging, etc.

CP Monitor and z/VM Performance Toolkit

z/VM HiperDispatch: CP Monitor Records

Domain	Record	Name	Type	Description of Change
D0	R2	MRSYTPRP	sample	Added polarity, entitlement, and park-time accumulator
D0	R16	MRSYTCUP	sample	Added partition current weight
D0	R23	MRSYTLCK	sample	Added the HCPDSVTL topology lock
D1	R4	MRMTRSYS	config	Added bit indicating whether system is horizontal or vertical
D1	R5	MRMTRPRP	config	Added park state, polarization, entitlement, and topological location
D1	R16	MRMTRSCH	config	Added h/v bit, CPUPAD settings, and EXCESSUSE settings
D2	R7	MRSCLSRM	event	Added h/v bit, CPUPAD settings, and EXCESSUSE settings
D4	R2	MRUSELOF	event	Added rebalance results and steal results
D4	R3	MRUSEACT	sample	Added rebalance results and steal results
D5	R2	MRPRCVOF	event	Added park/unpark failure as reason varied off
D5	R3	MRPRCVON	event	Added parked as a state; use iff neither D5 R17 nor D5 R18 are seen
D5	R15 (new)	MRPRCDSV	event	Records assignment of processors to dispatch vectors
D5	R16 (new)	MRPRCPUP	event	Records park/unpark decision
D5	R17 (new)	MRPRCRCD	sample	Records processor's VMDBK steal behavior
D5	R18 (new)	MRPRCDHF	sample	Records PLDV population trends

As usual, the monitor records will be on www.vm.ibm.com at GA.

z/VM HiperDispatch: z/VM Performance Toolkit

- Themes in the changes in existing Perfkit screens
  - CPU entitlement appears in sensible places, e.g. FCX100 CPU
  - Percent-parked appears in sensible places, e.g. FCX100 CPU
  - Parked time is correctly accounted for, e.g. FCX126 LPAR %Susp
  - SRM settings are reported where they ought to be, e.g. FCX154 SYSSET
  - Interesting events are reported in FCX180 SYSCONF as they should
  - Number of unparked CPUs appears in sensible places, e.g. FCX225 SYSSUMLG
  - Counts of new monitor records appear in FCX155 MONDATA as they should
  - Obsolete data is compatibly deleted in certain places, e.g. FCX144 PROCLOG
- New reports sure to attract interest:
  - FCX287 TOPOLOG shows a log of partition topology, container-major
  - FCX298 PUORGLOG shows a log of partition topology, CPU-major
  - FCX299 PUCFGLOG shows a log of the park/unpark state
  - FCX301 DSVBKACT replaces the PLDV emptiness columns on FCX144 PROCLOG
  - FCX302 PHYSLOG shows a physical CPU utilization log of the CEC by type pool
  - FCX303 DSVSLOG replaces the PLDV steal columns on FCX144 PROCLOG
  - FCX304 PRCLOG is where you should now look instead of FCX144 PROCLOG
  - FCX306 LSHARACT reports the partitions' entitlements vs. logical CPU counts
- Obsolete reports
  - FCX144 PROCLOG is still there for now, but start using FCX304 PRCLOG instead

z/VM HiperDispatch: Interesting New Report PUORGLOG

```
1FCX298  Run 2013/05/20 10:39:48          PUORGLOG
                                          Processor Unit organization log
 From 2013/05/19 03:39:31
 To   2013/05/19 03:41:31
 For    120 Secs 00:02:00                  Result of GF003855 Run
 ____________________________________________________________________________

  Logical PU organization for Partition PPRF1    (GDLBOFVM)

  Date  Time      CPU Type PPD Ent. Location
  05/19 03:39:31    0 CP   VhD  100 1:6
  05/19 03:39:31    1 CP   VhD  100 1:6
  05/19 03:39:31    2 CP   VhD  100 1:5
  05/19 03:39:31    3 CP   VhD  100 1:5
  05/19 03:39:31    4 CP   VhD  100 1:5
  05/19 03:39:31    5 CP   VhD  100 1:5
  05/19 03:39:31    6 CP   VhD  100 1:5
  05/19 03:39:31    7 CP   VhD  100 1:4
  05/19 03:39:31    8 CP   VhD  100 1:4
  05/19 03:39:31    9 CP   VhD  100 1:4
  05/19 03:39:31   10 CP   VhD  100 1:4
  05/19 03:39:31   11 CP   VhD  100 1:2
  05/19 03:39:31   12 CP   VhD  100 1:2
  05/19 03:39:31   13 CP   VhD  100 1:2
  05/19 03:39:31   14 CP   VhD  100 1:2
  … truncated …
```

Notes:

Vh: vertical high
Vm: vertical medium
Vl: vertical low
VhD: vertical high, dedicated partition

Ent: entitlement wrt a physical CPU

Location: book:chip (z10: book)

z/VM HiperDispatch: Interesting New Report LSHARACT

```
1FCX306   Run 2013/06/24 09:36:54          LSHARACT
                                           Logical Partition Share
 From 2013/02/19 11:49:58
 To   2013/02/19 11:56:10
 For     372 Secs 00:06:12                 Result of GFCM0107 Run
```

LPAR Data, Collected in Partition RPRF2

```
Physical PUs, Shared: CP- 40  ZAAP-  2  IFL- 16  ICF-  1  ZIIP-  3
           Dedicated: CP-  4  ZAAP-  0  IFL-  0  ICF-  0  ZIIP-  0
```

Proc Type	Partition Name	LPU Count	LPAR Weight	Entlment	TypeCap	<LPU Total,%> Busy	Excess	LPU Conf
CP	RCPX4	10	10	59.3	...	3.0	.0	o
CP	RCTS1	5	10	59.3	...	311.9	252.6	o
CP	RCTS2	5	30	177.8	...	1.0	.0	o
CP	RCT1	20	30	177.8	...	111.3	.0	o
CP	RCT2	10	10	59.3	...	11.2	.0	o
CP	REXT1	5	10	59.3	...	.0	.0	o
CP	REXT2	4	10	59.3	...	.0	.0	o
CP	RINS	10	10	59.3	...	.0	.0	o
CP	RPRF1	4	DED	...	...	...	...	.
CP	RPRF2	24	335	1985.2	...	1548.4	.0	o
CP	RSPX1	6	40	237.0	...	481.3	244.3	o
CP	RSPX2	6	40	237.0	...	499.7	262.7	o
CP	RSPX5	6	40	237.0	...	126.5	.0	o
CP	RST1	10	10	59.3	...	16.2	.0	o
CP	RST1X	6	10	59.3	...	102.5	43.2	o
CP	RST2	6	50	296.3	...	.9	.0	o
CP	RST3	3	30	177.8	...	1.2	.0	o
ICF	RCTS2	1	10	25.0	...	.0	.0	-
ICF	RCT1	1	30	75.0	...	.0	.0	-
IFL	RCTS2	2	10	188.2	...	.0	.0	-
IFL	RCT1	2	30	564.7	...	.0	.0	u
IFL	RSTL1	16	45	847.1	...	449.2	.0	o
ZAAP	RCPX4	1	10	40.0	...	.1	.0	-
ZAAP	RCTS2	1	10	40.0	...	.0	.0	-
ZAAP	RCT1	1	30	120.0	...	.0	.0	u
ZIIP	RCPX4	1	10	60.0	...	.3	.0	-
ZIIP	RCTS2	1	10	60.0	...	.0	.0	-
ZIIP	RCT1	1	30	180.0	...	.0	.0	u

You now have an easy way to see the entitlements of your partitions.

Features:

- Reports by partition and CPU type
- Reports entitlement in percent
- Reports percent-busy of the partition's CPUs of that type
- Reports whether the partition is consuming beyond its entitlement ("Excess")
- Reports LPU configuration wrt entitlement:
  - "o" – overconfigured
  - "u" – underconfigured
  - "-" – apparently just right

z/VM HiperDispatch: Interesting New Report PUCFGLOG

```
1FCX299  Run 2013/06/24 09:36:54          PUCFGLOG                                                    Page    6
                                          Processor Unit Configuration log
 From 2013/02/19 11:49:52                                                                    GFCM0107
 To   2013/02/19 11:56:10                                                                    CPU 2817-744   SN B6D85
 For    378 Secs 00:06:18                  Result of GFCM0107 Run                            z/VM   V.6.3.0 SLU 0000
```

				Type		<--- Last --->				<--- Next --->						
Date	Time	Type	OnL	Entitl	Cap	CPUPAD	EX	Load	XP	XPF	T/V	LCei	XPF	T/V	N	NotVh	UpCap	LPU Unparked mask
02/19	11:49:54	CP	24	1985.2	...	100.0	70	2.2	1159.4	892.8	3.519	3.9	885.9	200.5	2	.0	200.0	00300000_00000000
02/19	11:49:56	CP	24	1985.2	...	100.0	70	.5	1153.3	888.1	256.0	1.7	883.4	201.3	2	.0	200.0	00300000_00000000
02/19	11:49:58	CP	24	1985.2	...	100.0	70	.5	1159.7	893.1	122.3	1.7	885.2	204.2	2	.0	200.0	00300000_00000000
02/19	11:50:00	CP	24	1985.2	...	100.0	70	.7	1136.7	875.4	53.45	1.7	857.7	172.5	2	.0	200.0	00300000_00000000
02/19	11:50:02	CP	24	1985.2	...	100.0	70	.9	1128.6	869.2	4.531	1.7	863.0	172.5	2	.0	200.0	00300000_00000000
02/19	11:50:04	CP	24	1985.2	...	100.0	70	1.3	1034.5	778.8	1.822	1.8	688.3	172.4	2	.0	200.0	00300000_00000000
02/19	11:50:06	CP	24	1985.2	...	100.0	70	.6	1157.1	891.1	38.57	1.8	856.4	168.5	2	.0	200.0	00300000_00000000
02/19	11:50:08	CP	24	1985.2	...	100.0	70	.5	1162.9	895.5	250.8	1.7	856.9	211.1	2	.0	200.0	00300000_00000000
02/19	11:50:10	CP	24	1985.2	...	100.0	70	44.8	1161.8	894.7	2.214	89.1	858.9	211.1	2	.0	200.0	00300000_00000000
02/19	11:50:12	* CPU Park/Unpark State changed																
02/19	11:50:12	CP	24	1985.2	...	100.0	70	199.7	1145.1	881.9	1.517	354.6	858.5	197.6	5	.0	500.0	00300000_00000000
02/19	11:50:14	* CPU Park/Unpark State changed																
02/19	11:50:14	CP	24	1985.2	...	100.0	70	501.6	1155.6	890.0	1.009	803.5	858.3	197.5	10	.0	1000.0	013C0000_00000000
02/19	11:50:16	* CPU Park/Unpark State changed																
02/19	11:50:16	CP	24	1985.2	...	100.0	70	999.6	1147.4	883.6	1.001	1497.6	857.9	146.5	16	.0	1600.0	0FFC0000_00000000
02/19	11:50:18	* CPU Park/Unpark State changed																
02/19	11:50:18	CP	24	1985.2	...	100.0	70	1599.3	1155.1	889.6	1.001	2199.1	857.7	130.3	23	100.0	2300.0	FFFF0000_00000000
02/19	11:50:20	* CPU Park/Unpark State changed																
02/19	11:50:20	CP	24	1985.2	...	100.0	70	2297.6	1179.7	908.5	1.001	2995.8	860.2	125.6	24	100.0	2400.0	FFFFFE00_00000000
02/19	11:50:22	* CPU Park/Unpark State changed																
02/19	11:50:22	CP	24	1985.2	...	100.0	70	2397.1	1144.5	881.4	1.005	2496.6	854.3	125.4	24	100.0	2400.0	FFFFFF00_00000000
02/19	11:50:24	CP	24	1985.2	...	100.0	70	2080.5	1181.8	910.1	1.002	2569.2	887.6	125.3	24	100.0	2400.0	FFFFFF00_00000000
02/19	11:50:26	CP	24	1985.2	...	100.0	70	1681.3	1140.0	878.0	1.002	2660.9	845.8	122.1	24	100.0	2400.0	FFFFFF00_00000000
02/19	11:50:28	CP	24	1985.2	...	100.0	70	1632.4	1169.6	900.7	1.002	2684.7	886.2	1.660	24	100.0	2400.0	FFFFFF00_00000000
02/19	11:50:30	CP	24	1985.2	...	100.0	70	1587.7	1149.4	885.2	1.002	2635.4	869.6	1.252	24	100.0	2400.0	FFFFFF00_00000000
02/19	11:50:32	CP	24	1985.2	...	100.0	70	1878.3	1129.6	869.9	1.011	2560.8	854.7	1.008	24	100.0	2400.0	FFFFFF00_00000000
02/19	11:50:34	CP	24	1985.2	...	100.0	70	1824.3	1176.2	905.8	1.002	2425.8	884.3	1.007	24	100.0	2400.0	FFFFFF00_00000000

- *Shows what can happen to T/V when utilization is really low*
- *Shows parking because of high projected T/V*
- *Shows unpark when workload ramps up*
- *Shows how a varying U produces a high U'*
- *Shows XPF and XPF' in action*
- *Shows that the T/V projections level right out once the guest workload is well underway*
- *Shows what a non-Vh LPU will be "truly worth" during the next interval*

z/VM HiperDispatch: Interesting New Report DSVSLOG

```
1FCX303  Run 2013/05/20 10:32:38          DSVSLOG
                                          DSVBK Steals per logical CPU Log, by Time
 From 2013/05/19 02:03:25
 To   2013/05/19 02:05:19
 For    114 Secs 00:01:54                  Result of GF003820 Run
 ____________________________________________________________________________________

           C                     Pct
 Interval  P                    Park <----- DSVBK Steal /s ------------------>
 End Time  U Type PPD Ent. DVID Time Lvl-00 Lvl-01 Lvl-02 Lvl-03 Lvl-04 Lvl-05
 >>Mean>>  0 CP   Vh   100 0000    0  4.404  4.088   .000   ....   ....   ....
 >>Mean>>  1 CP   Vh   100 0001    0  2.456  2.561   .000   ....   ....   ....
 >>Mean>>  2 CP   Vh   100 0002    0  6.877   .921   .000   ....   ....   ....
 >>Mean>>  3 CP   Vh   100 0003    0  7.596   .930   .000   ....   ....   ....
 >>Mean>>  4 CP   Vh   100 0004    0  4.500   .482   .000   ....   ....   ....
 >>Mean>>  5 CP   Vh   100 0005    0  3.614   .228   .000   ....   ....   ....
 >>Mean>>  6 CP   Vh   100 0006    0  4.518   .482   .000   ....   ....   ....
 >>Mean>>  7 CP   Vh   100 0007    0  2.912   .386   .000   ....   ....   ....
 >>Mean>>  8 CP   Vh   100 0008    0  1.412   .421   .000   ....   ....   ....
 >>Mean>>  9 CP   Vh   100 0009    0  1.386   .184   .000   ....   ....   ....
 >>Mean>> 10 CP   Vh   100 000A    0  2.070   .544   .000   ....   ....   ....
 >>Mean>> 11 CP   Vh   100 000B    0  2.114   .149   .000   ....   ....   ....
 >>Mean>> 12 CP   Vh   100 000C    0  5.886  1.623   .000   ....   ....   ....
 >>Mean>> 13 CP   Vh   100 000D    0  3.772   .702   .000   ....   ....   ....
 >>Mean>> 14 CP   Vh   100 000E    0  3.026   .675   .000   ....   ....   ....
 >>Mean>> 15 CP   Vh   100 000F    0  2.658   .360   .000   ....   ....   ....
 >>Total> 16 CP   Vh  1600  MIX    0 59.202 14.737   .000   ....   ....   ....
```

Reports VCPU steal behavior by the distance the steal dragged the VCPU.

- Lvl-00: you stole it from a CPU in your chip (z10: … in your book)
- Lvl-01: you stole it from a CPU in your book (z10: … in another book)
- Lvl-02: you stole it from a CPU on another book (z10: … not applicable)

z/VM HiperDispatch: Interesting New Report PHYSLOG

```
1FCX302  Run 2013/06/24 09:36:54          PHYSLOG
                                          Real CPU Utilization Log
 From 2013/02/19 11:49:58
 To   2013/02/19 11:56:10
 For    372 Secs 00:06:12                 Result of GFCM0107 Run
```

Interval End Time	Type	<PU Num> Conf	Ded	Total Weight	%LgclP	%Ovrhd	LpuT/L	%LPmgt	%Total	TypeT/L
>>Mean>>	CP	44	4	675	3387.1	27.947	1.008	31.870	3446.9	1.018
>>Mean>>	ZAAP	2	0	50	.093	.042	1.451	.424	.559	6.015
>>Mean>>	IFL	16	0	85	448.16	1.017	1.002	2.108	451.28	1.007
>>Mean>>	ICF	1	0	40	.004	.003	1.624	2.257	2.263	563.66
>>Mean>>	ZIIP	3	0	50	.193	.090	1.465	1.204	1.487	7.694
>>Mean>>	>Sum	66	4	900	3835.5	29.099	1.008	37.864	3902.5	1.017
11:50:04	CP	44	4	675	1963.9	33.262	1.017	36.226	2033.4	1.035
11:50:04	ZAAP	2	0	50	.004	.001	1.306	.037	.042	10.107
11:50:04	IFL	16	0	85	501.44	1.087	1.002	2.372	504.90	1.007
11:50:04	ICF	1	0	40	.007	.004	1.566	2.277	2.289	312.13
11:50:04	ZIIP	3	0	50	.005	.002	1.334	.093	.100	19.003
11:50:04	>Sum	66	4	900	2465.4	34.356	1.014	41.006	2540.7	1.031
11:50:10	CP	44	4	675	2074.2	25.632	1.012	28.117	2127.9	1.026
11:50:10	ZAAP	2	0	50	.004	.001	1.340	.003	.008	2.013
11:50:10	IFL	16	0	85	502.09	.993	1.002	2.130	505.21	1.006
11:50:10	ICF	1	0	40	.007	.004	1.568	2.165	2.176	322.32
11:50:10	ZIIP	3	0	50	.004	.001	1.354	.096	.102	24.829
11:50:10	>Sum	66	4	900	2576.3	26.632	1.010	32.511	2635.4	1.023
11:50:16	CP	44	4	675	2753.4	23.553	1.009	25.725	2802.7	1.018
11:50:16	ZAAP	2	0	50	.003	.001	1.352	.002	.007	2.015
11:50:16	IFL	16	0	85	502.84	.728	1.001	1.603	505.17	1.005
11:50:16	ICF	1	0	40	.006	.003	1.508	2.168	2.178	335.01
11:50:16	ZIIP	3	0	50	.004	.001	1.317	.093	.098	27.041
11:50:16	>Sum	66	4	900	3256.3	24.287	1.007	29.592	3310.1	1.017
11:50:22	CP	44	4	675	3859.2	16.099	1.004	20.018	3895.4	1.009
11:50:22	ZAAP	2	0	50	.004	.001	1.326	.003	.008	2.022
11:50:22	IFL	16	0	85	500.49	.947	1.002	2.817	504.25	1.008
11:50:22	ICF	1	0	40	.007	.003	1.510	1.797	1.807	264.49
11:50:22	ZIIP	3	0	50	.043	.032	1.742	.126	.201	4.685
11:50:22	>Sum	66	4	900	4359.8	17.082	1.004	24.760	4401.6	1.010

You now have an easy way to see how busy your CEC is. (At last!)

Features:

- Tallied by CPU type (CP, IFL, …)
- One group of rows every sample interval
- Reports all three ways CPU gets used:
  - By logical CPUs
  - By PR/SM, chargeable
  - By PR/SM, unchargeable
- New concepts:
  - LPU T/L: like “guest T/V”
  - Type T/L: like “system T/V”

Summary

z/VM HiperDispatch: Summary

- Objective: try to help CPU performance
- Strategies: pay attention to topology and to z/VM system overhead
- z/VM can now run in vertical mode
  - Runs just widely enough to be able to consume available power
  - Runs more narrowly when it looks like system overhead is a problem
  - Guest dispatch pays more attention to recent run location and to virtual N-way
  - CPU wakeup tries to be topologically friendly
  - VCPU steal tries to be topologically friendly
- Planning: not too difficult, just remember to measure before and after
- Amenable workloads should see improvements
- CP Monitor conveys the new information
- z/VM Performance Toolkit has been updated

- Thank you

z/VM HiperDispatch: References

- z/VM Planning and Administration – nice abstract writeup on HiperDispatch
- z/VM Performance – points to P&A
- z/VM CP Commands and Utilities – descriptions of the new commands
- z/VM Performance Report on www.vm.ibm.com/perf/
- “Understanding z/VM HiperDispatch” article on www.vm.ibm.com/perf/tips/
- This presentation cites two www.vm.ibm.com articles describing z/VM and the CPU Measurement Facility.