IBM Systems Technology Group

z/VM Tuning Revisited with Specialty Engines for z/OS Session 9122

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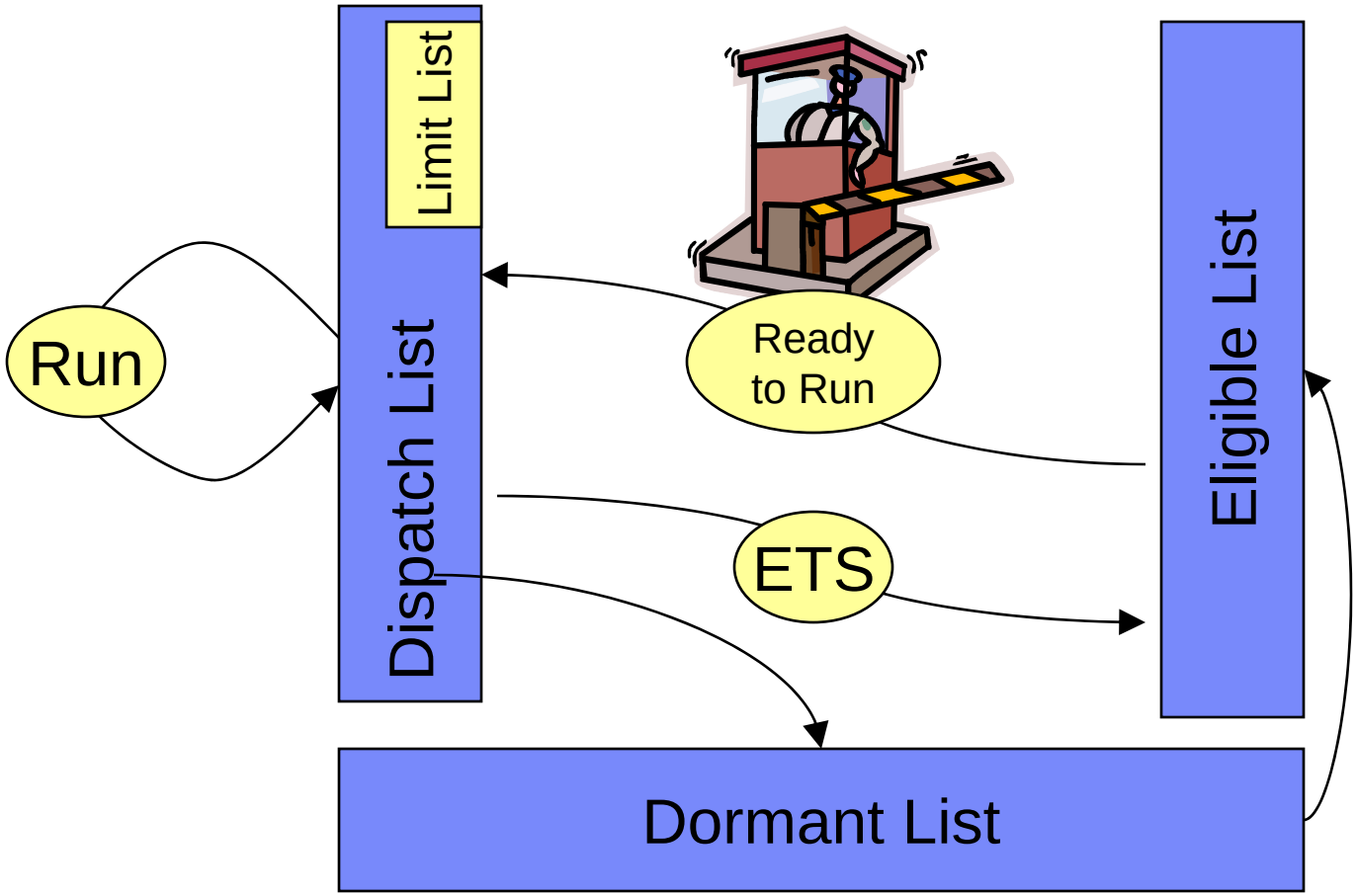
Agenda

- **Some general z/VM Scheduling and Dispatching Discussion**
- **Some general z/OS Guest Tuning Discussion**
- **Background on Specialty Engine support in z/VM**
- **Tuning of Specialty Engines**
- **Miscellaneous z/OS Tuning**

z/VM Scheduling & Dispatching at the High Level

- **Objectives of the z/VM Scheduler**
  - Protect the system from over committing resources to where the system thrashes
  - Prioritize access to system resources
- **Objectives of the z/VM Dispatcher**
  - Effectively run virtual processors based on their priorities

Scheduler Protection from Thrashing



Three Main Controls to Entering Dispatch List

```
cp q srm
IABIAS : INTENSITY=90%; DURATION=2
LDUBUF : Q1=100% Q2=75% Q3=60%
STORBUF: Q1=125% Q2=105% Q3=95%
DSPBUF : Q1=32767 Q2=32767 Q3=32767
DISPATCHING MINOR TIMESLICE = 5 MS
MAXWSS : LIMIT=9999%
...... : PAGES=999999
XSTORE : 0%
Ready;
```

LDUBUF: protects from thrashing DASD Paging

STORBUF: protects from general thrashing of real memory

DSPBUF: Absolute number allowed in dispatch list for each scheduling class

Comments on SRM Value for z/OS Systems

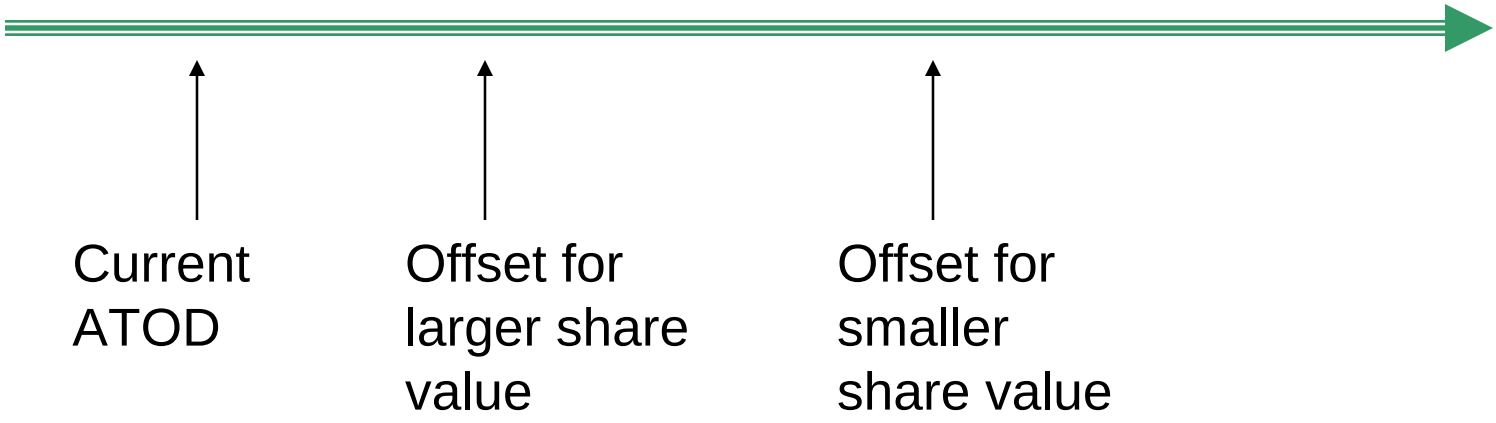
- **Defaults were determined based on traditional workload with mix of interactive CMS and Guest work.**
- **Potential benefit from changing SRM values.**
  - If having problems, investigate STORBUF first
  - Second, look at LDUBUF
  - Keep your hands off DSPBUF unless you really know what you are doing.
  - Avoid temptation to increase/change several values at once
- **Increasing DSPSPLICE was considered clever at one time. The overhead from dispatching these days probably isn't worth the downside of increasing it. Leave it alone.**

Deadline Scheduling – Prioritizing Work

- **Each virtual processor has a priority computed as a 'deadline' for when a unit of work should be completed.**
- **This 'deadline' is a time value on an artificial TOD often referred to as ATOD**
- **The 'deadline' is computed based on several factors, but the most significant is the normalized Share value**
- **Therefore the share setting is a big knob**
- **Virtual processors get ordered for dispatching based on their deadlines**

ATOD and Deadline

ATOD



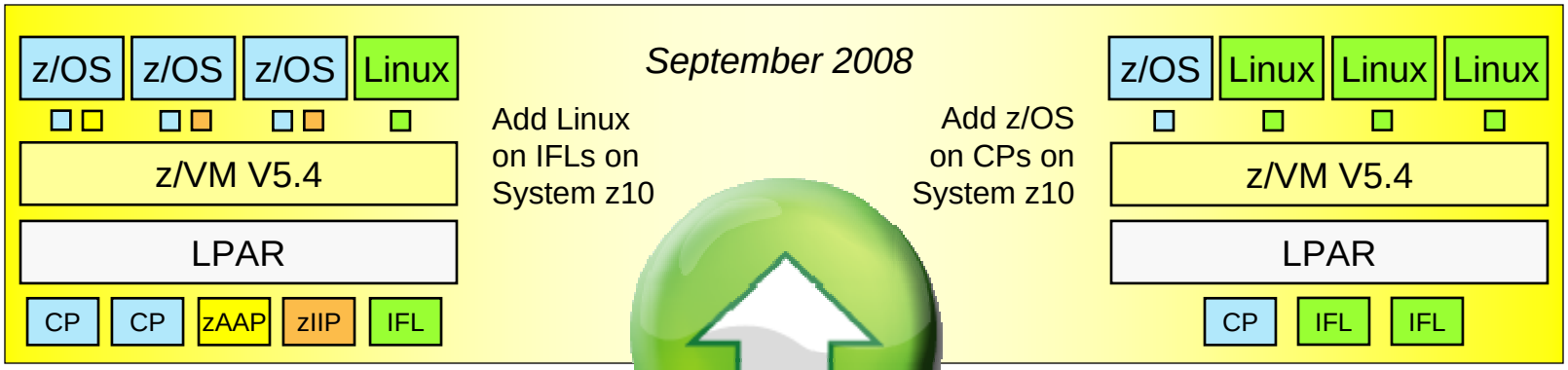
Simplified offset formula used to set deadline 'offset' from current ATOD:

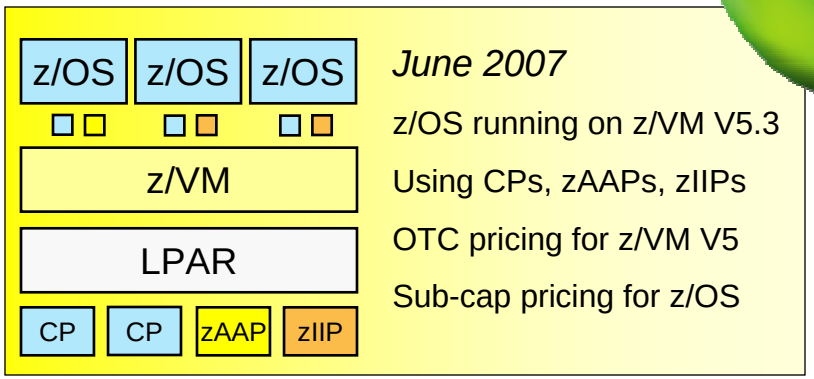
$$OFFSET = \frac{Minor\_TimeSlice + Previous\_TimeSlice\ Overrun}{Normalized\_Share \times Number\_PUs}$$

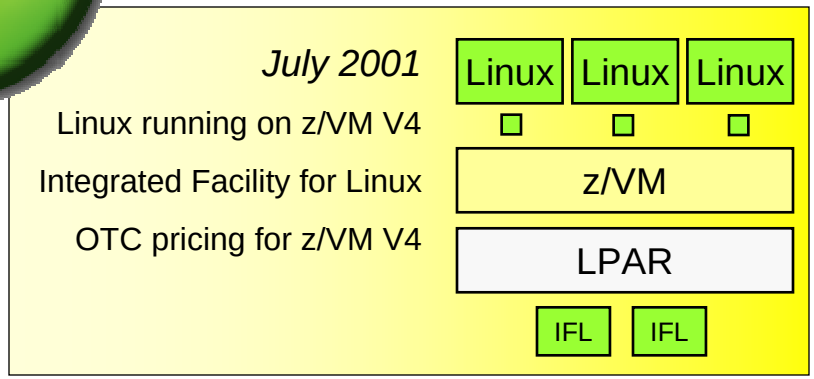
A Word About QUICKDSP

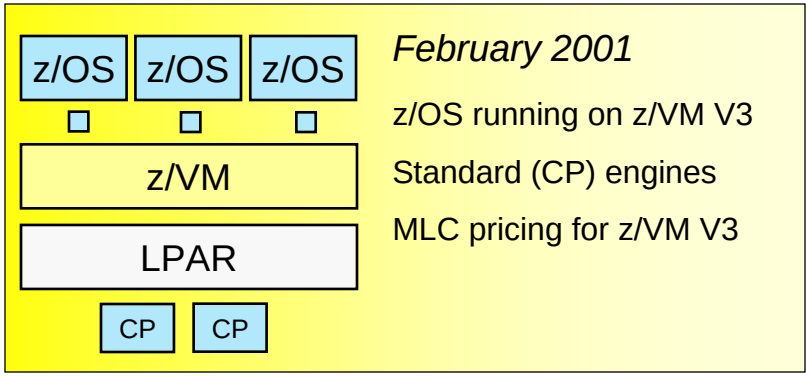
- **Quick Dispatch (SET QUICKDSP) for a virtual machine allows it to pass from eligible list to dispatch list without going through the system resource checks.**
- **Does NOT turn off the scheduler completely.**
- **Should be set on for:**
  - Mission Critical Virtual Machines
  - Virtual Machines that are extensions of Operating System (e.g. RACF, TCP/IP)
  - A virtual machine you have access to for tuning and problem determination.

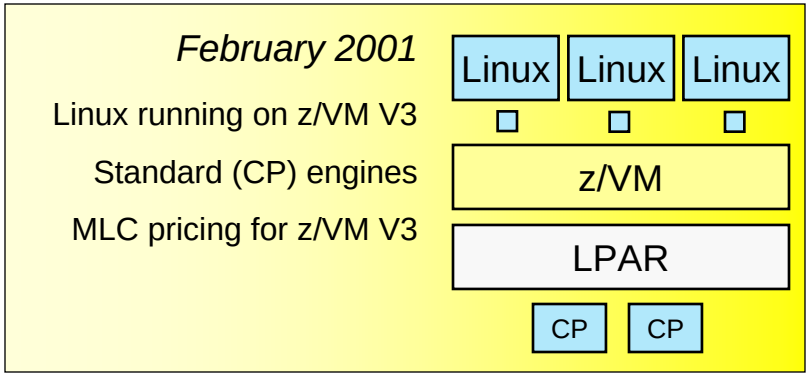
z/VM and Specialty Engine Support











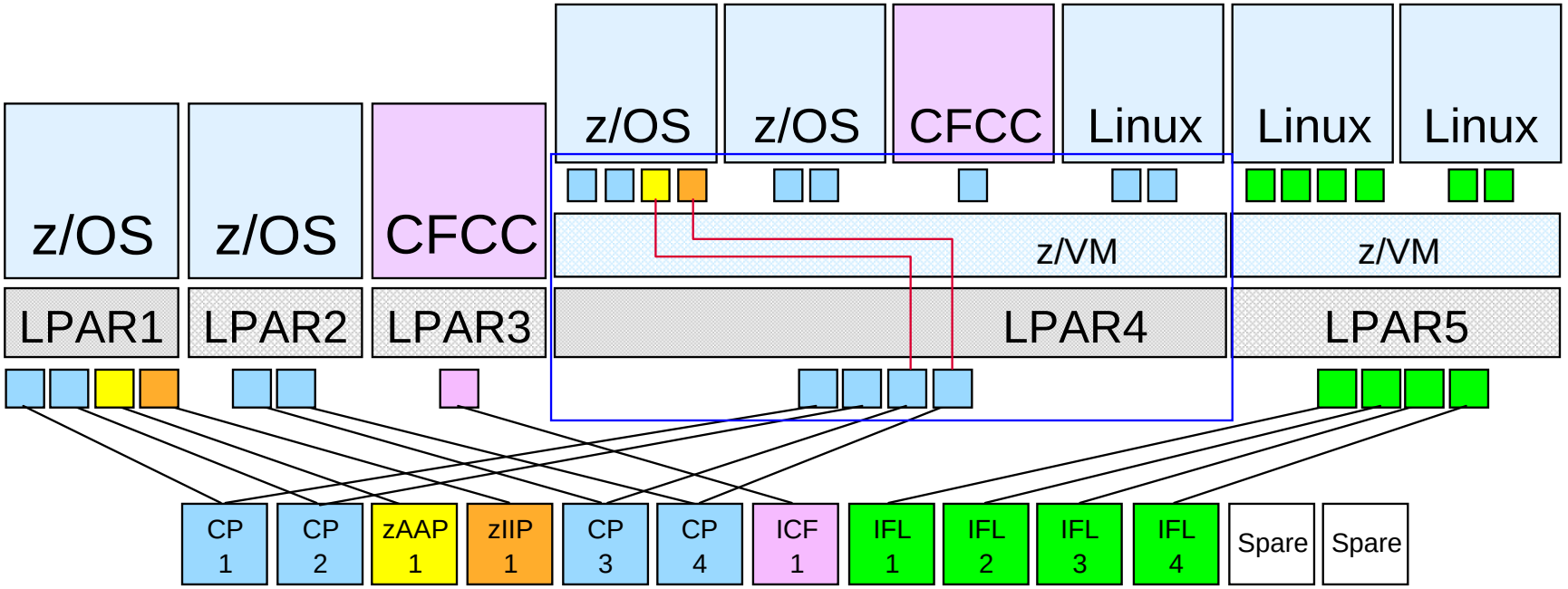
z/VM 5.3.0 Support for Specialty Processors

- **z/VM V5.3 introduces support for zAAP and zIIP specialty processors**
  - System z Application Assist Processors (zAAPs) – provide an economical Java execution environment for z/OS and z/OS.e
  - System z9 Integrated Information Processors (zIIPs) – designed to help improve resource optimization and lower the cost for eligible z/OS and z/OS.e workloads by offloading software system overhead from standard Central Processors (CPs); this includes certain DB2 processing
- **z/VM support is provided for z/OS guest exploitation**
  - Offers additional hardware support for z/OS-on-z/VM development and test support
- **Two levels of z/VM support:**
  - *Simulation support*
    - z/VM dispatches virtual zAAPs and zIIPs on real CP engines
    - Only possible if the underlying hardware is capable of supporting the real engine type
    - Does not require activation of real specialty engine(s) within the mainframe server
  - *Virtualization support*
    - z/VM dispatches virtual zAAPs and zIIPs on corresponding real specialty engines
- **Consistent with z/OS, there are no z/VM license fees associated with real zAAP or zIIP processors**

z/VM 5.3.0 Specialty Processor Support Example

Simulating Specialty Engines in Virtual Machines

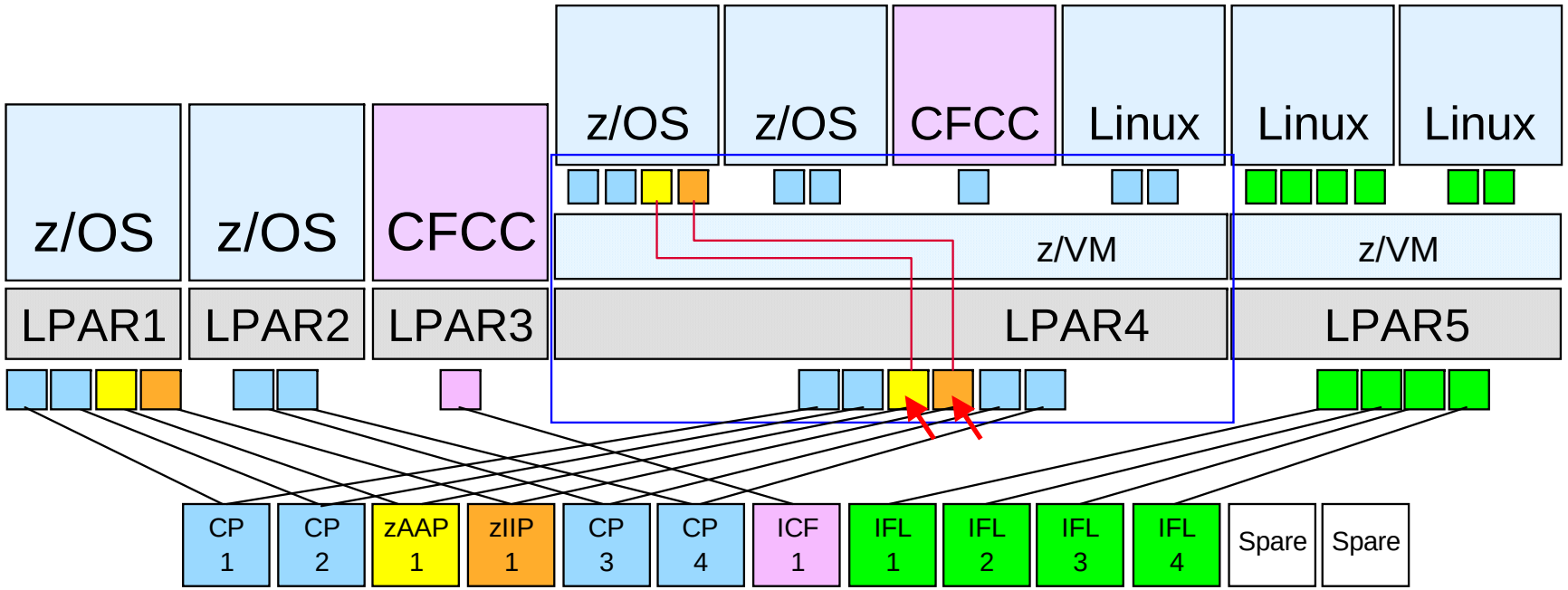
- Allows users to discover the operational aspects of using zAAPs and zIIPs in a z/OS environment without having to purchase real specialty processors
- May help users assess specialty-processor eligible workloads in a z/OS environment
- Provides a function test environment for z/OS workloads that use specialty processors
- Consumes CP processor capacity to host virtual zAAP and zIIP processor cycles



z/VM 5.3.0 Specialty Processor Support Example

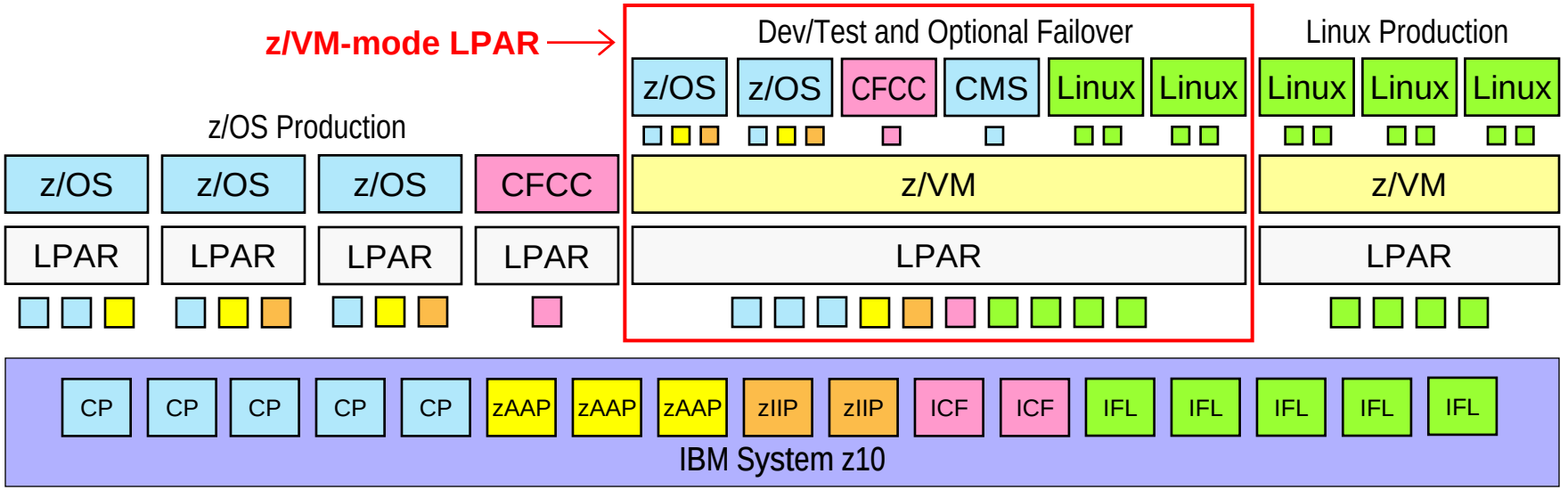
Using Real Specialty Engines in Virtual Machines

- Allows users to test and verify z/OS specialty processor support on the real hardware
- Users can maximize real specialty processor utilization by sharing processors among production and test LPARs
- Consumes specialty processor capacity to host virtual zAAP and zIIP processor cycles



z/VM-Mode LPAR Support for IBM System z10

- **New LPAR type for IBM System z10: *z/VM-mode***
  - Allows z/VM V5.4 users to configure all CPU types in a z10 LPAR
- **Offers added flexibility for hosting mainframe workloads**
  - Add *IFLs* to an existing standard-engine z/VM LPAR to host Linux workloads
  - Add *CPs* to an existing IFL z/VM LPAR to host z/OS, z/VSE, or traditional CMS workloads
  - Add *zAAPs* and *zIIPs* to host eligible z/OS specialty-engine processing
  - Test integrated Linux and z/OS solutions in the same LPAR
- **No change to software licensing**
  - Software continues to be licensed according to CPU type



Some Additional Background

- **CPU Affinity**
  - Setting to control whether virtualized Specialty Engines must be dispatched on real processors of that type
  - ON means virtual type must equal real type
  - Suppressed: you have asked for ON, but we don't have processors of that type to use
- **Processor Type Pools**
  - Scheduling is done within a pool for CPUAFFINITY ON
  - Capacity Planning of each type
  - ATOD, ATOD2, etc. for each Processor Type Pool
- **Primary vs. Secondary Processor**
  - Primary: CP or IFL
  - Secondary: zAAP, zIIP, and sometimes IFL (secondary to CPs)
- **Different Speed Processors**
  - Specialty engines are full-speed on all z9 and z10 machines, while some general purpose run at a fractional speed.
- **The z/VM Scheduler is a deadline scheduler, not a consumption scheduler**

Considerations for z/VM-mode LPARs

- **Merging IFL only and CP only partitions in a z/VM-mode partition requires planning**
  - First step, make virtual machines on IFL LPAR have virtual IFLs
  - For duplicated work (RACF, TCP/IP, etc.), need to determine which to use or in some cases which to duplicate
  - Remember that in some environments, the IFLs may be faster than the CPs.
  - Determine any changes you want to make to the charge back model.

Output from INDICATE USER EXPanded

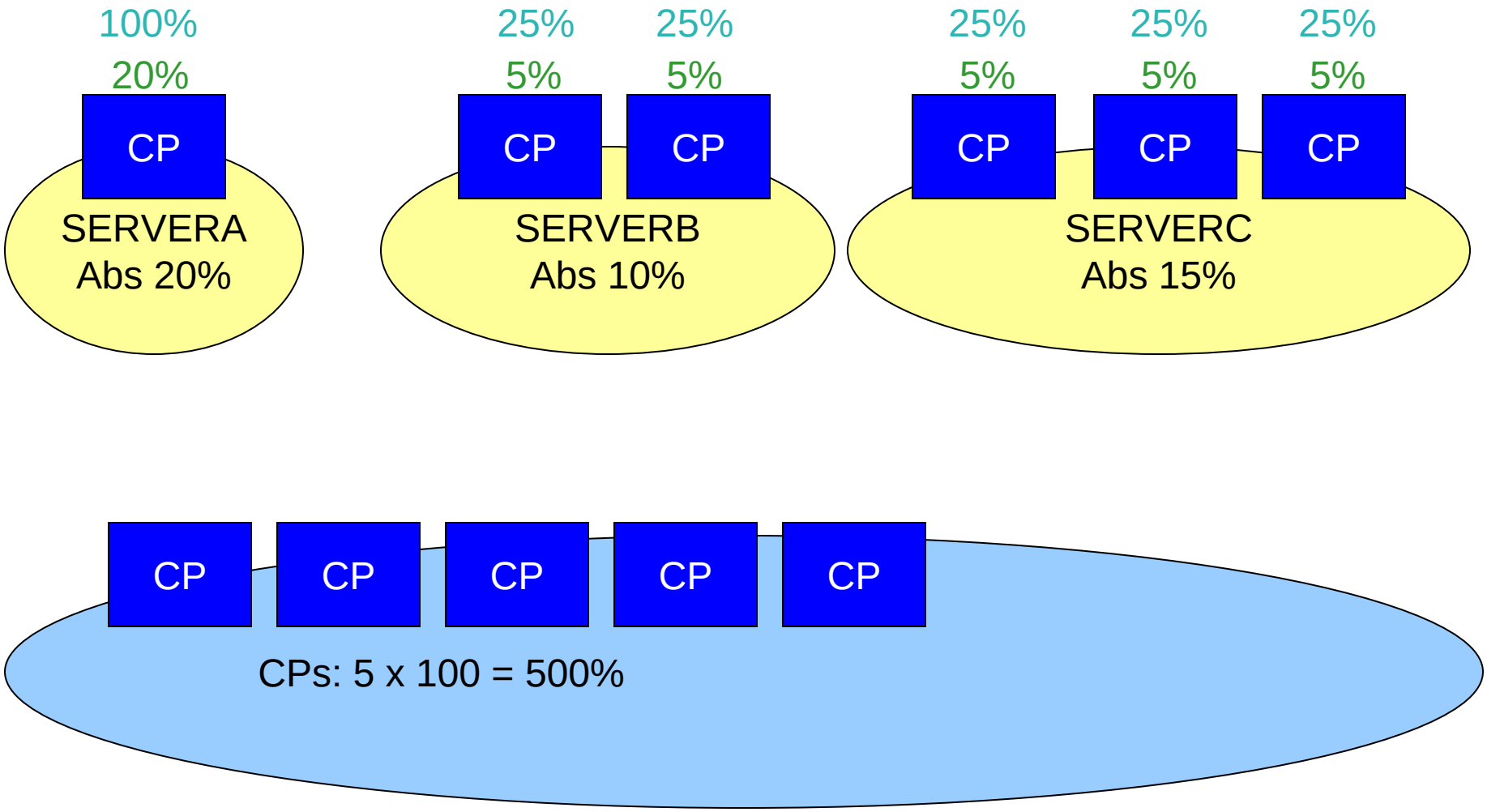
```
CPU 00: Ctime=0 00:00:53  Vtime=0 00:00:00  Ttime=0 00:00:00
        Rdr=0  Prt=0  Pch=0  IO=332
        Type=CP  CPUAffinity=ON
        VtimePrimary=0 00:00:00    TtimePrimary=0 00:00:00
        VtimeSecondary=0 00:00:00  TtimeSecondary=0 00:00:00
CPU 01: Ctime=0 00:00:30  Vtime=0 00:00:00  Ttime=0 00:00:00
        Rdr=0  Prt=0  Pch=0  IO=0
        Type=ZAAP  CPUAffinity=SUPP
        VtimePrimary=0 00:00:00    TtimePrimary=0 00:00:00
        VtimeSecondary=0 00:00:00  TtimeSecondary=0 00:00:00
CPU 02: Ctime=0 00:00:20  Vtime=0 00:00:00  Ttime=0 00:00:00
        Rdr=0  Prt=0  Pch=0  IO=0
        Type=ZIIP  CPUAffinity=SUPP
        VtimePrimary=0 00:00:00    TtimePrimary=0 00:00:00
        VtimeSecondary=0 00:00:00  TtimeSecondary=0 00:00:00
```

Specialty Engines and Share Settings

- **The Share setting for a virtual machine applies to each pool of the processor types**
  - CP, IFL, zIIP, zAAP, etc.
- **z/VM 5.3.0 one share setting for all types**
- **z/VM 5.4.0 added support to set a separate share setting for each processor type pool**
  - Default is TYPE ALL and results in one setting for all types, effectively like z/VM 5.3.0
- **Normalized to the sum of shares of virtual machines in dispatch list for each pool of the processor types**
- **Absolute (and normalized) is percentage of resources of a given processor type.**

NN% = (IPW) In Perfect World percentage of real processor

NN% = split of share per virtual processor



NN% = IPW percentage of real processor
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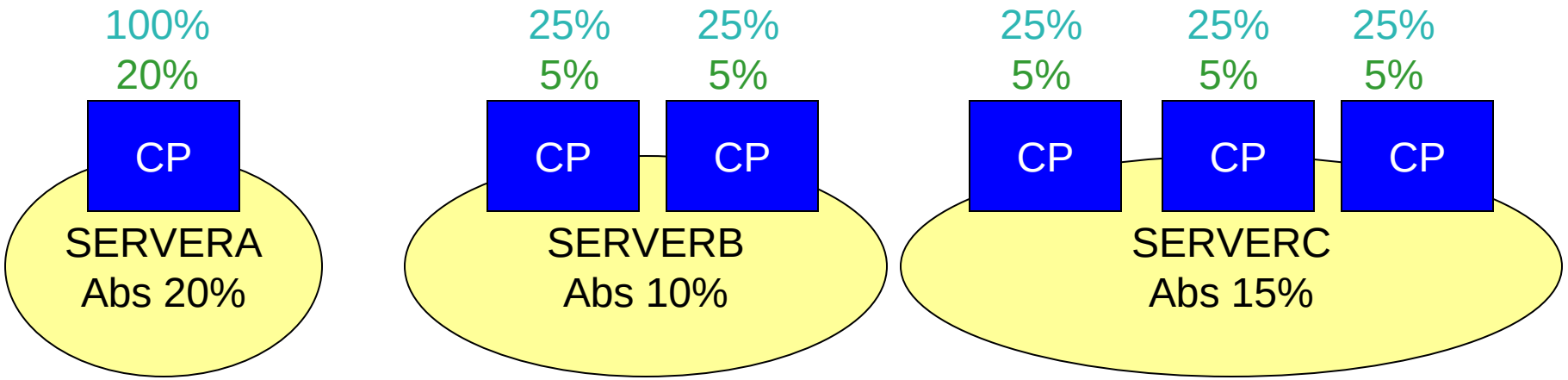

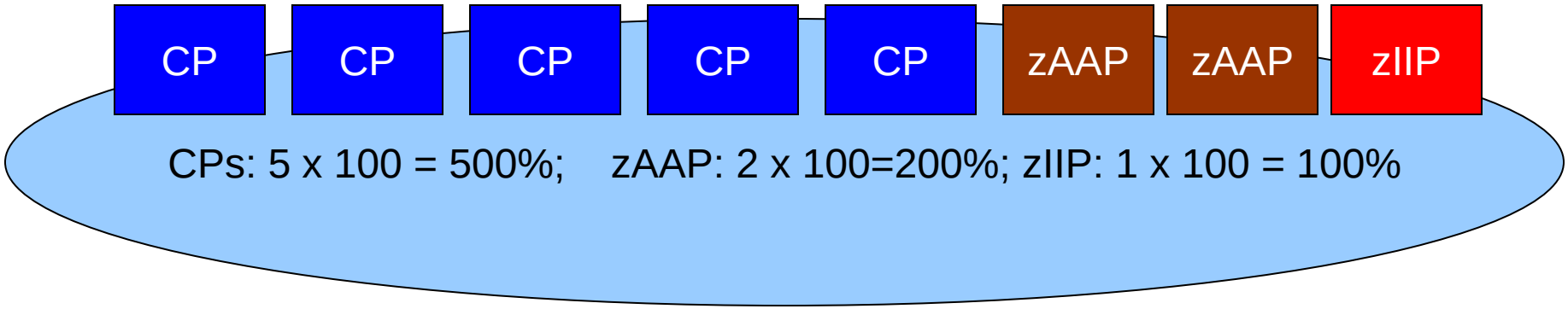

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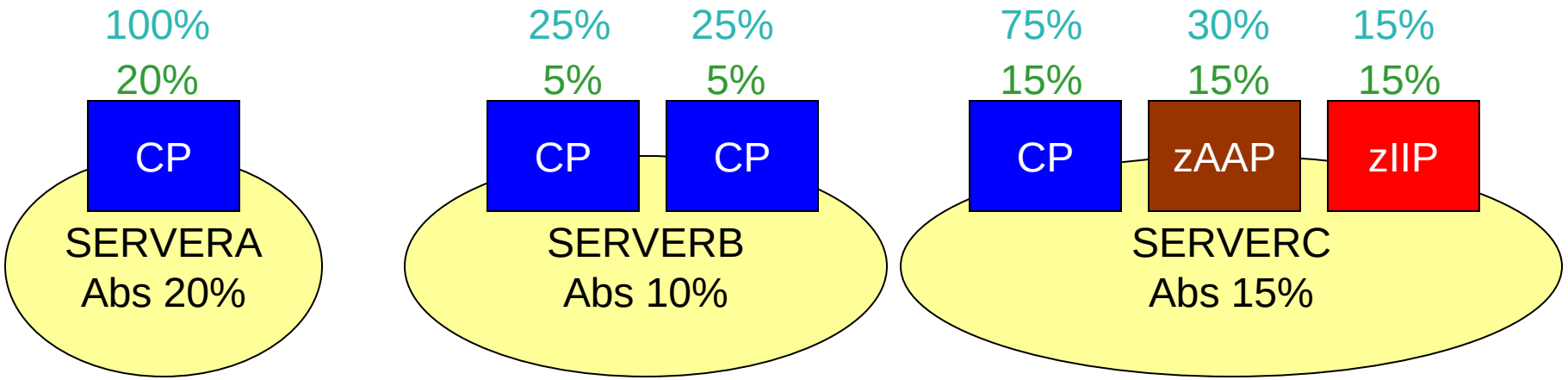

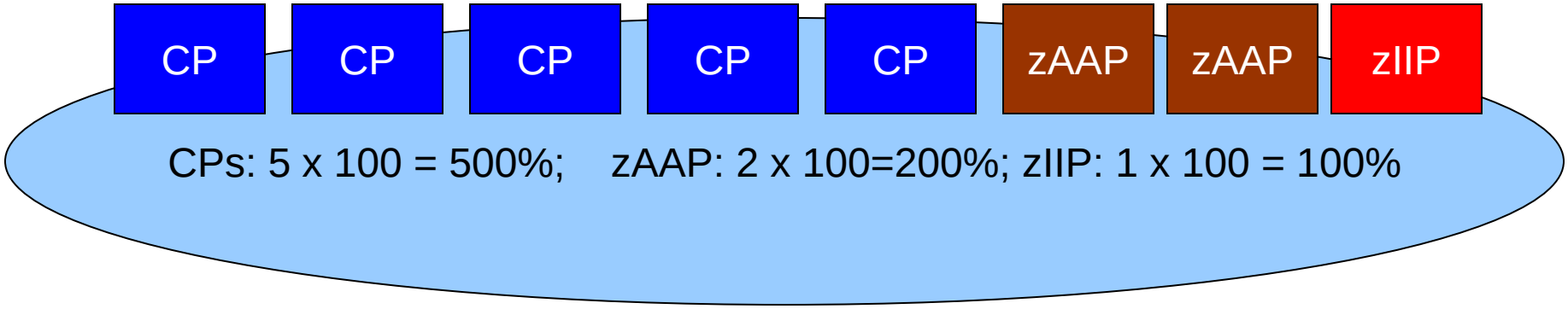

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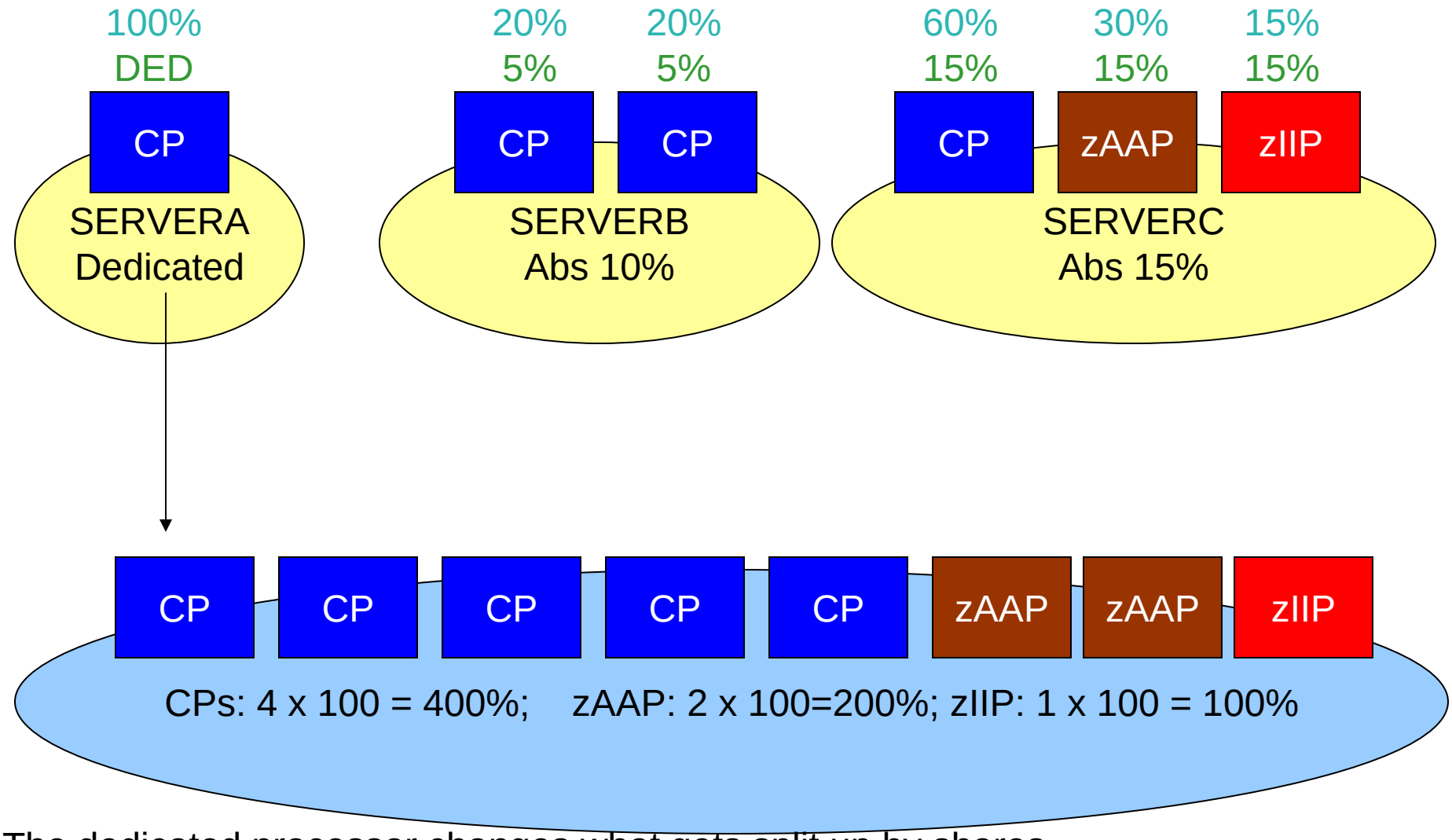
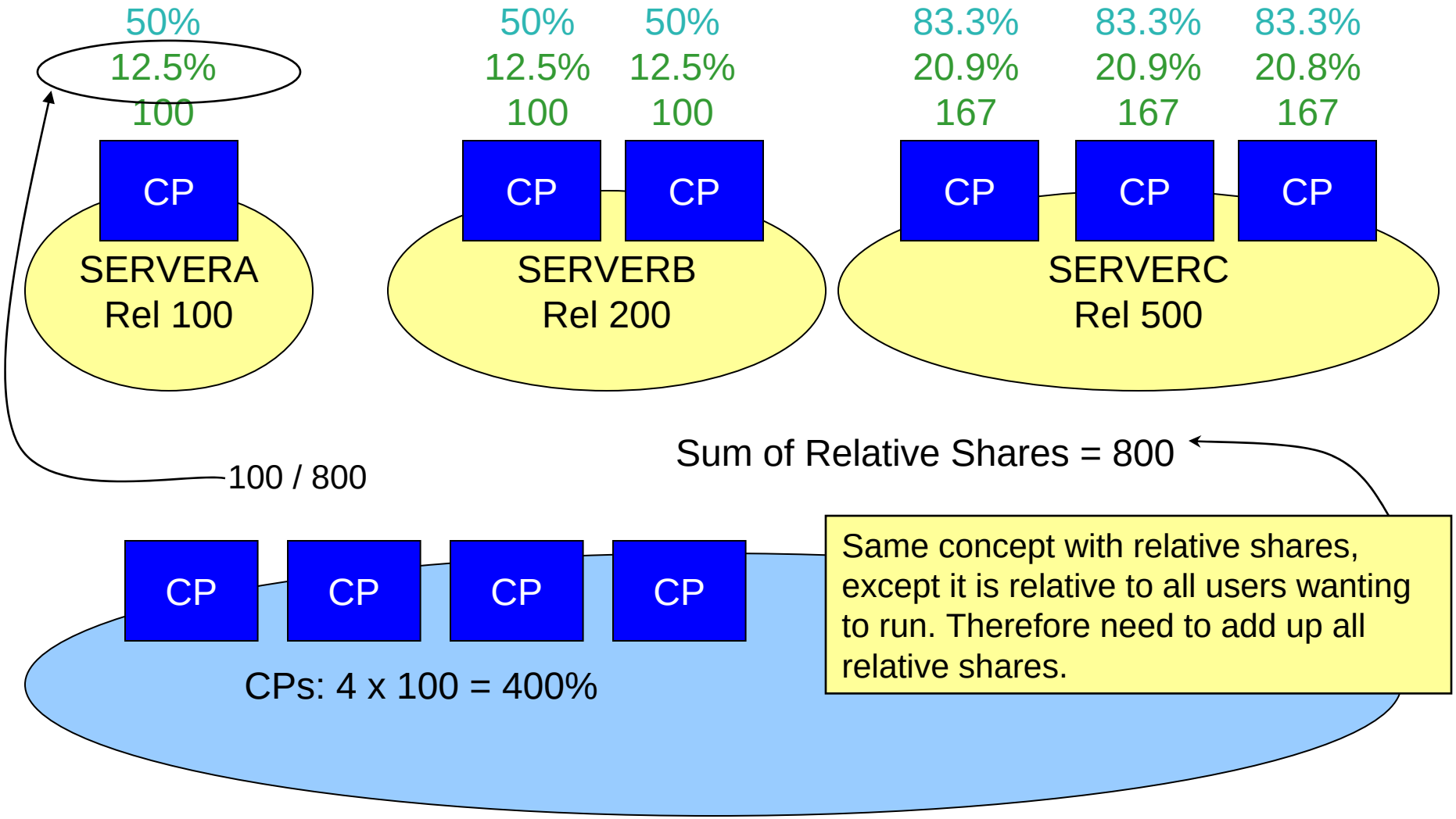
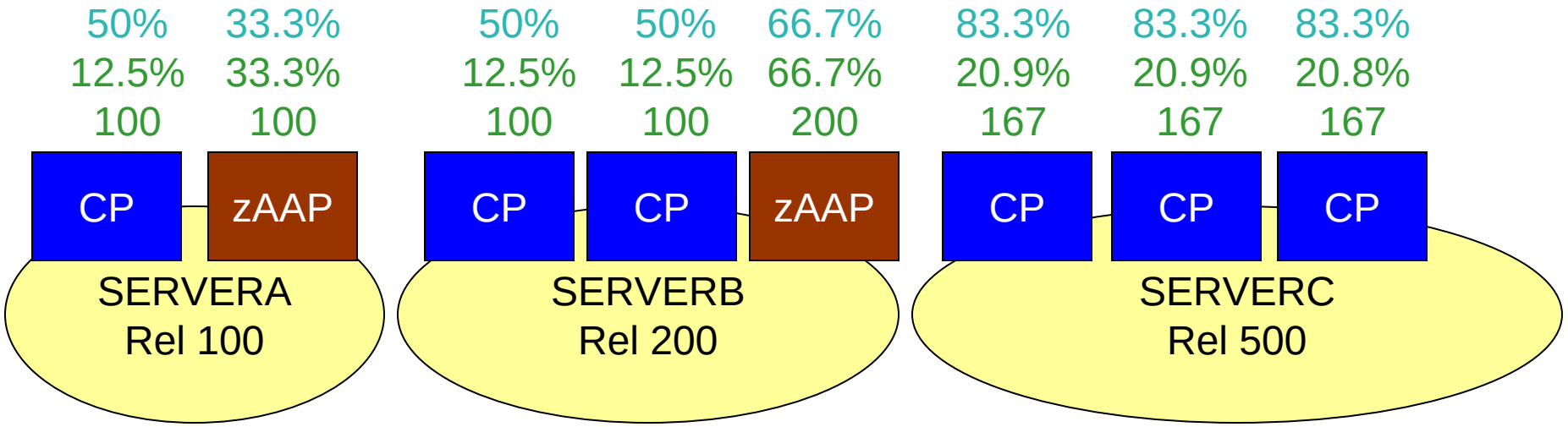


The dedicated processor changes what gets split up by shares.

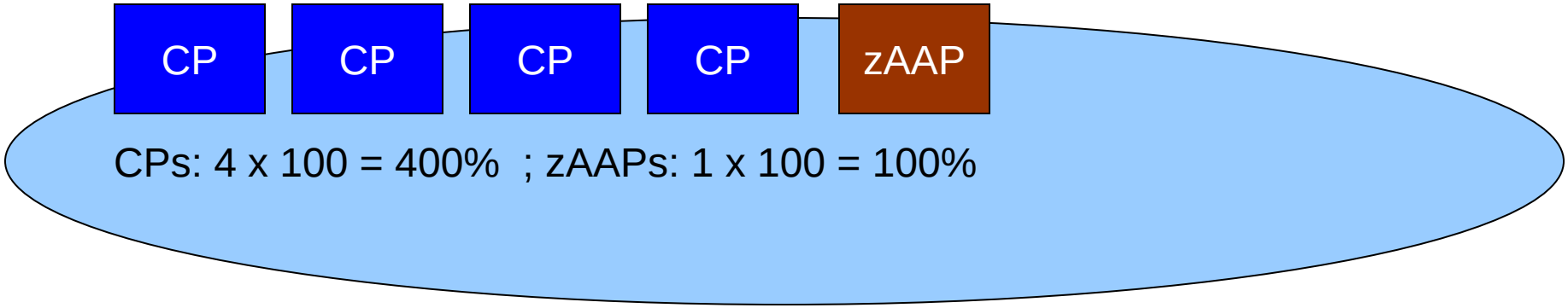
NN% = IPW percentage of real processor
NN% = split of share per virtual processor
NN = relative split of share per virtual processor



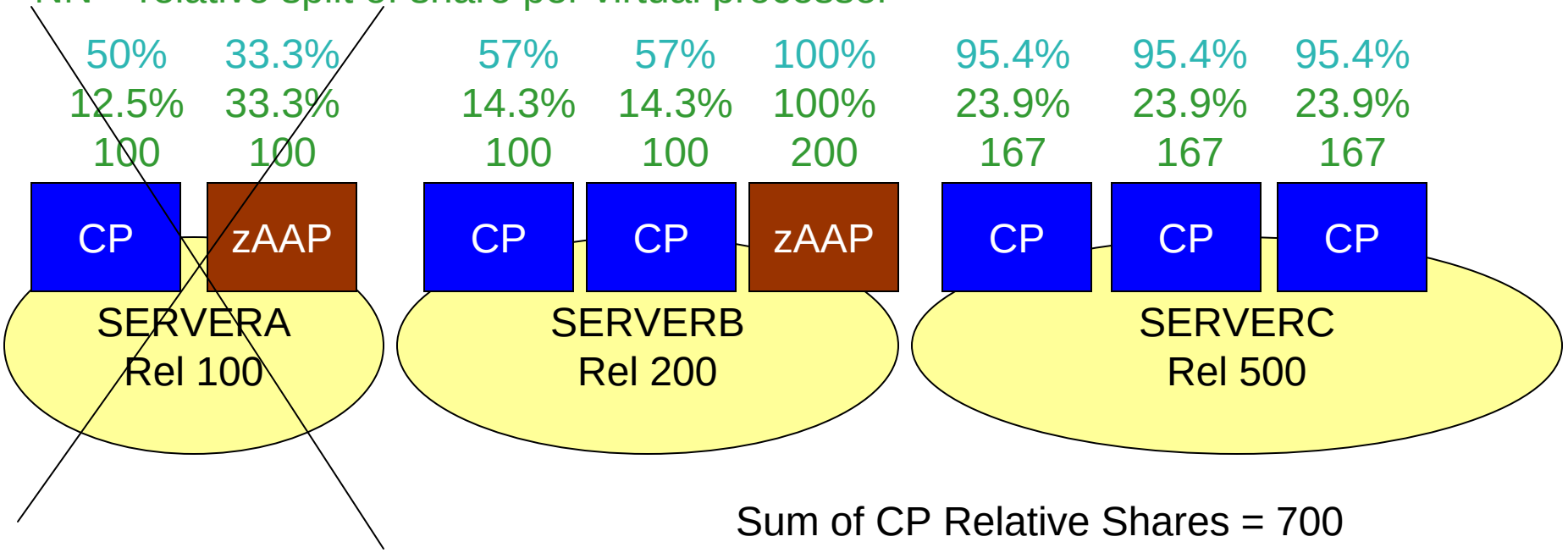
NN% = IPW percentage of real processor
NN% = split of share per virtual processor
NN = relative split of share per virtual processor



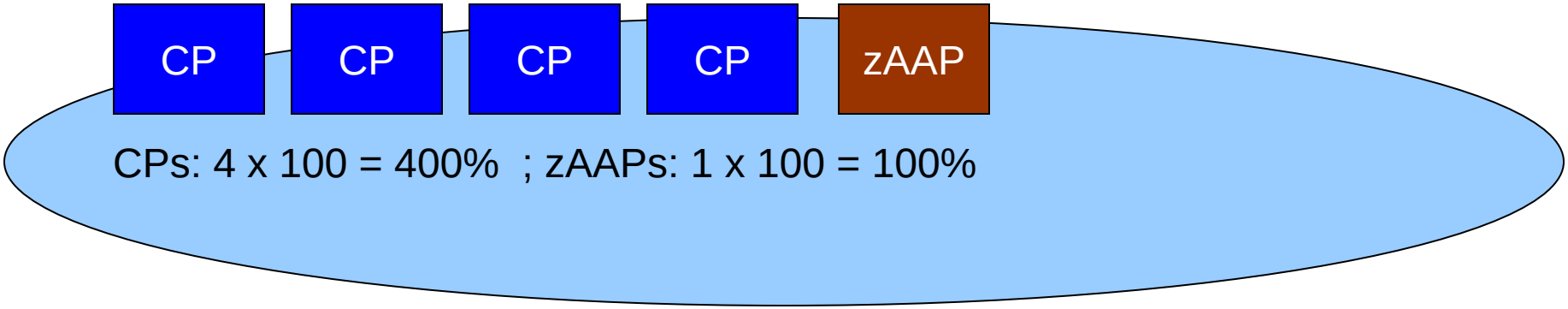
Sum of CP Relative Shares = 800
Sum of zAAP Relative Shares = 300



NN% = IPW percentage of real processor
NN% = split of share per virtual processor
NN = relative split of share per virtual processor



Sum of CP Relative Shares = 700
Sum of zAAP Relative Shares = 200



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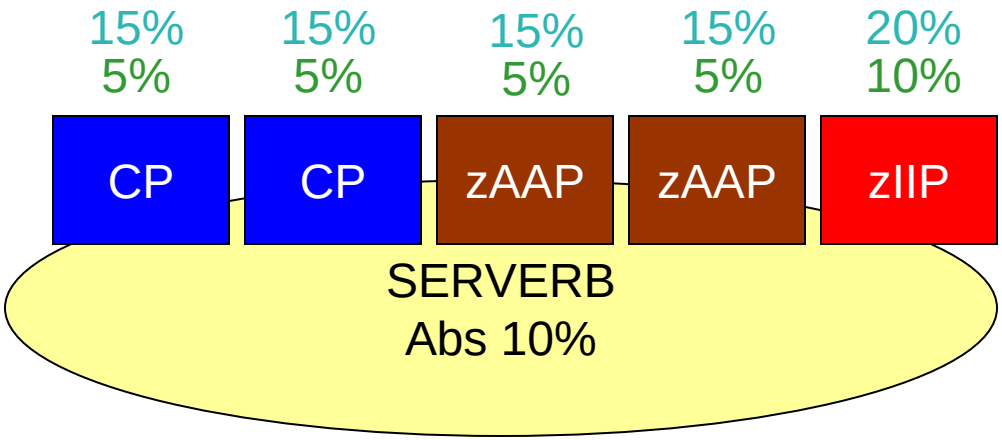
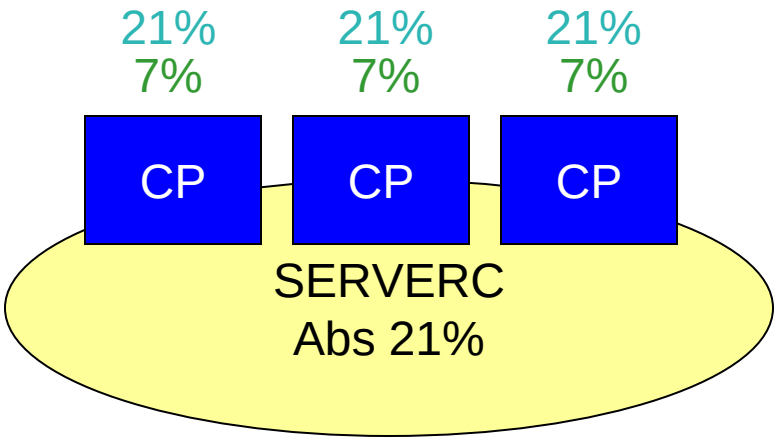
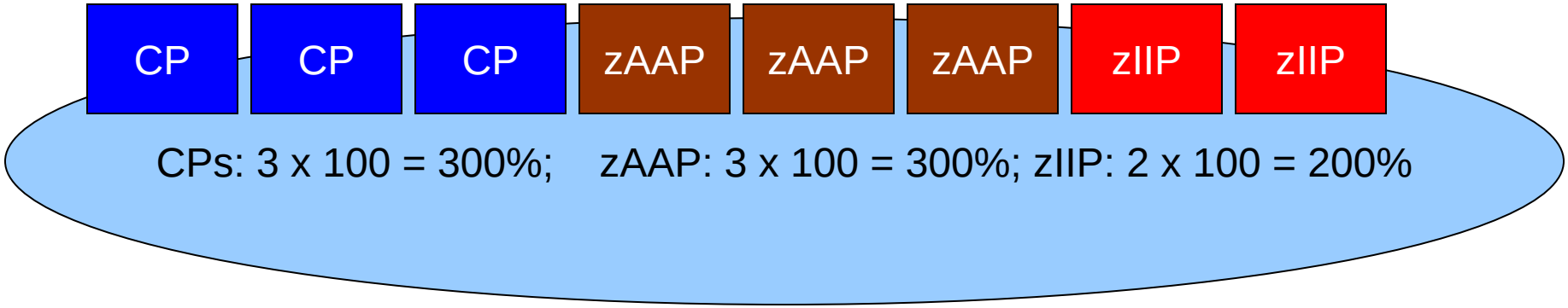


Tricky Scenario



Total Processor for SERVERB is 15+15+15+15+20 = 80%

Total Processor for SERVERC is 21+21+21 = 63%



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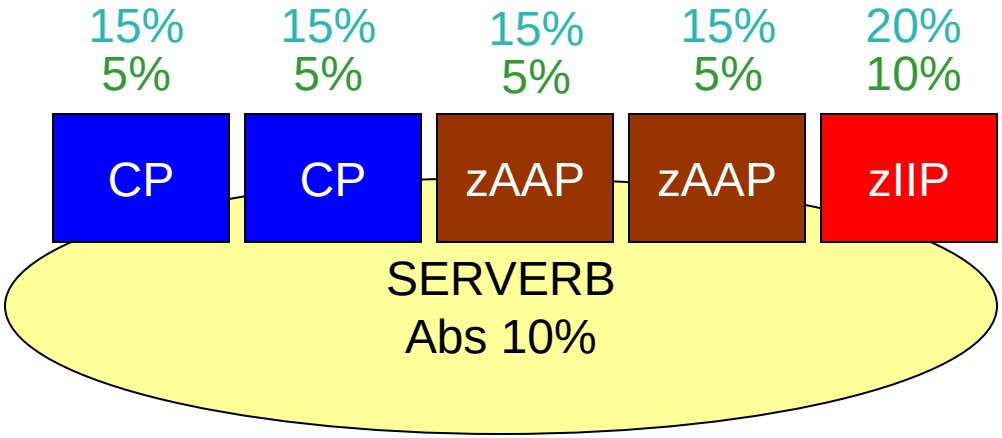
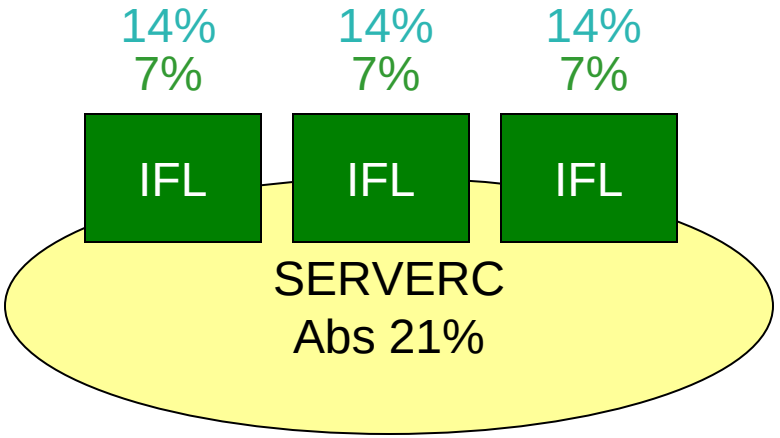
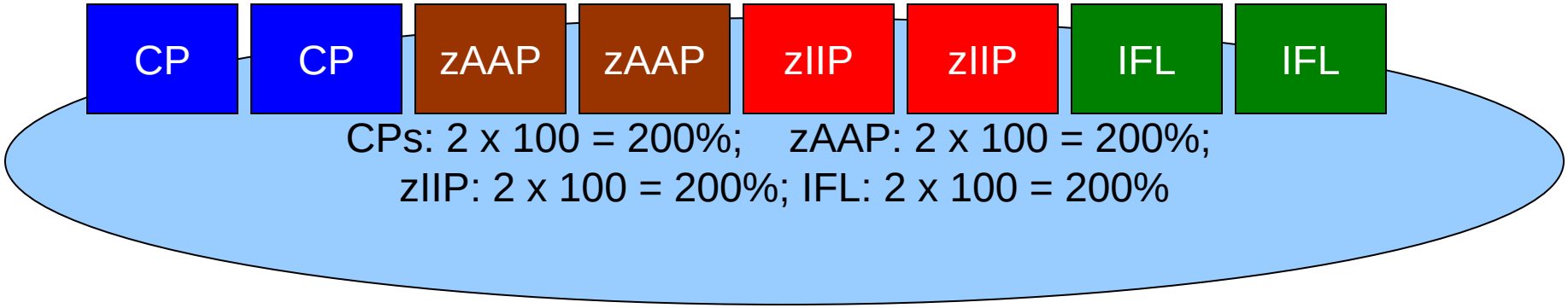


z/VM-Mode LPAR





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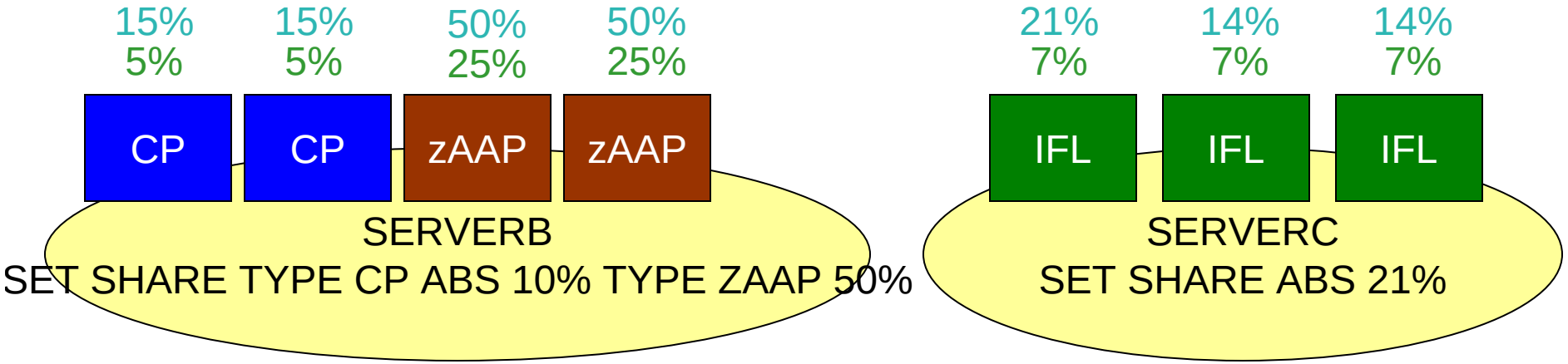
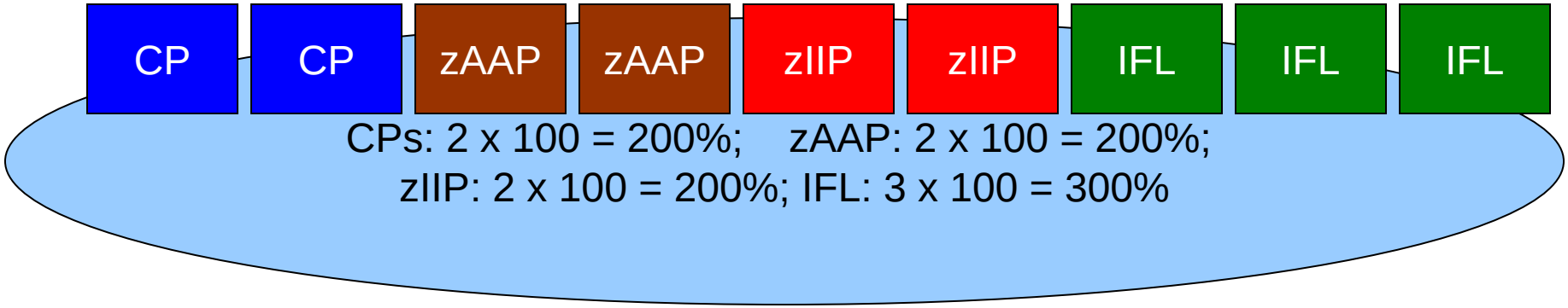
z/VM-Mode LPAR





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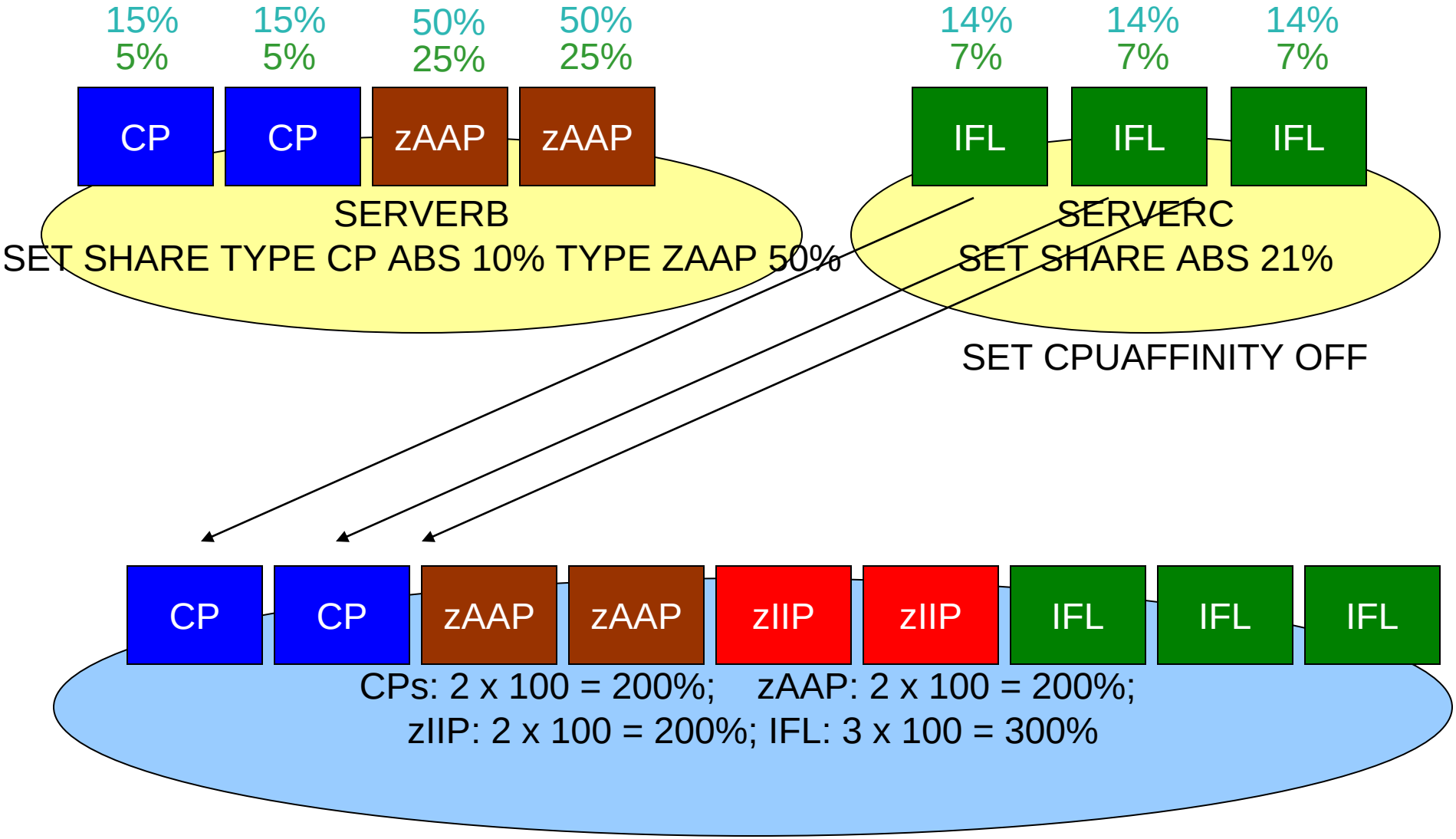
z/VM-Mode LPAR



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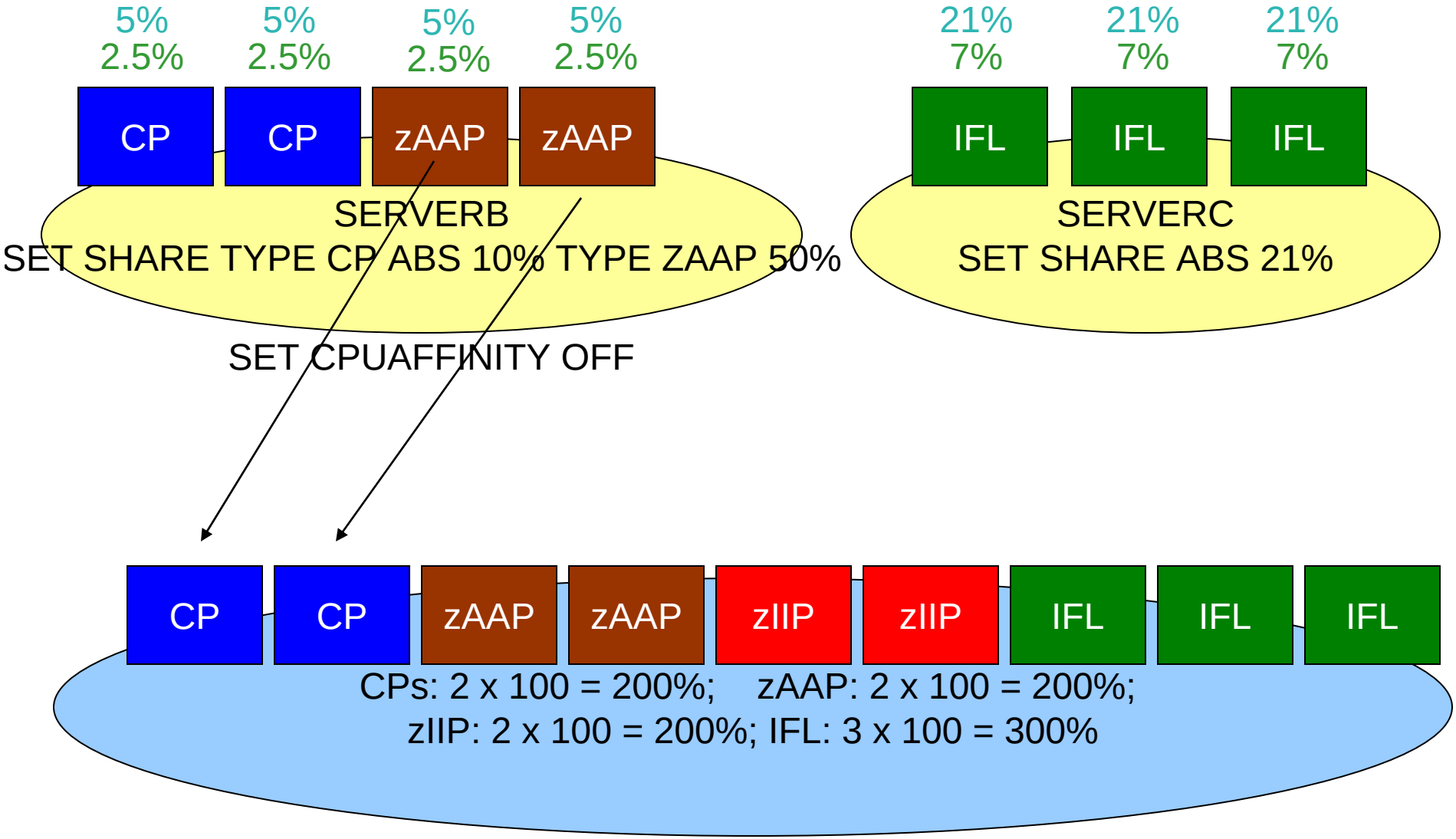

FCX126 LPAR – updated

```
FCX126  Run 2007/06/20 09:55:12          LPAR
                                         Logical Partition Activity
```

Partition Nr.	Upid	#Proc	Weight	Wait-C	Cap	%Load	CPU	%Busy	%Ovhd	%Susp	%VMld	%Logld	Type
KST1 4	04	5	20	NO	NO	51.5	0	99.9	.0	.1	99.9	99.9	CP
			20		NO		1	99.9	.0	.1	99.8	99.9	CP
			20		NO		2	99.9	.1	.1	99.8	99.9	CP
			80		NO		3	.0	.0	.4	.0	.0	ZAAP
			80		NO		4	9.3	.2	.3	9.0	9.0	ZIIP

Summary of physical processors:

Type	Number	Weight	Dedicated
CP	3	100	0
ZAAP	1	100	0
IFL	1	0	0
ZIIP	1	100	0

- New Type for each processor
- Totals for Processor types
- One IFL on machine, but no active partitions using it.

FCX202 LPARLOG – updated

```
FCX202  Run 2007/06/20 09:55:12          LPARLOG
                                    Logical Partition Activity Log
```

```
Interval <Partition->                                          <- Load per Log. Processor -->
End Time Name    Nr.  Upid #Proc Weight Wait-C Cap %Load  %Busy %Ovhd %Susp %VMld %Logld Type
>>Mean>> KST1      4    04     5     80     NO  NO   ...   61.8    .1    .2  61.7   61.7 MIX
>>Mean>> Total    ..    ..     6    100     ..  ..    .1   30.9    .0   ...   ...    ... ..
```

FCX180 SYSCONF

```
FCX180  Run 2007/06/20 09:53:49          SYSCONF
                                         System Configuration

Initial Status on 2007/03/07 at 21:30, Processor 2096-X03
Real Proc: Cap  2224, Total  7, Conf  3, Stby  0, Resvd  4
Sec. Proc: Cap  1760, Total  3, Conf  3, Stby  0, Resvd  2
```

- With new Specialty Engine support, your z/VM system may include processors that are different speeds.
- Smaller “Cap” number indicates faster Processor.

FCX144 PROCLOG – updated

FCX144 Run 2007/06/20 09:53:49 PROCLOG
Processor Activity, by Time

			<------ Percent Busy ------->					<--- Rates per Sec.--->			
Interval End Time	CP U	Type	Total	User	Syst	Emul	Vect	Inst Siml	DIAG	SIGP	SSCH
>>Mean>>	0	CP	99.8	99.5	.3	97.9	....	125.0	12.6	.7	71.6
>>Mean>>	1	CP	99.8	99.5	.2	98.0	....	120.9	4.5	.8	58.4
>>Mean>>	2	CP	99.8	99.5	.3	98.0	....	123.4	3.2	.7	59.5
>>Mean>>	3	ZAAP	96.0	96.0	.1	95.8	....	1.1	.0	36.6	1.4
>>Mean>>	4	ZIIP	8.8	8.4	.4	8.1	....	1.0	.0	289.9	7.5
>>Mean>>	.	CP	99.7	99.5	.2	98.0	....	123.0	6.7	.7	63.1
>>Mean>>	.	ZAAP	96.0	96.0	.1	95.8	....	1.1	.0	36.6	1.4
>>Mean>>	.	ZIIP	8.8	8.4	.4	8.1	....	1.0	.0	289.9	7.5

Virtual Sysplex Environments

- **Key is tuning effectively for the virtual coupling machines**
  - QUICKDSP ON
  - Sufficiently High Share setting
  - Using real ICFs in z/VM-mode LPARs in z/VM 5.4.0 where appropriate
- **Beware of scenarios with both a large number of systems in a virtual sysplex and the systems join and leave the sysplex frequently.**
  - High CP CPU overhead as the z/OS systems that are not changing state issue large number of messages while the coupling machine is busy making updates for the system that is leaving/joining.
  - Privileged Operations count will be very high (>10,000s/second)

Miscellaneous Tuning Thoughts

- **Disable IRD for z/OS virtual machines**
- **PAV Usage & Trade-offs**
  - Dedicating volumes to z/OS guests and letting them use PAV can be the best performance
  - More flexibility in sharing volumes and using PAV volumes through the minidisk support
  - Analysis of where the I/Os are queued up may require looking at both z/VM data and z/OS data
- **HiperDispatch**
  - Does not apply in z/VM guests

Summary

- **Specialty Engines enhance z/VM's virtualization capabilities**
- **A few things to keep in mind…**
  - Share for virtual machine applies to each processor type pool
  - There are scenarios where processors can be different speeds
  - Looking at averages takes on new meaning
  - CPU Affinity Setting is important
- **Monitor and Accounting records updated to provide needed information**
- **For more on scheduling, see VM Scheduler Made Simple**
  - http://www.vm.ibm.com/devpages/bitner/presentations/vmsched.html
- **For more on Specialty Engine Performance, see Performance Report**
  - http://www.vm.ibm.com/perf/reports/zvm/html/530se.html