z/VM CPU Pooling and ILMT – Part of a Foundation for Cloud Computing

GSE 2014 – Session IS03 (VM03) Part 1

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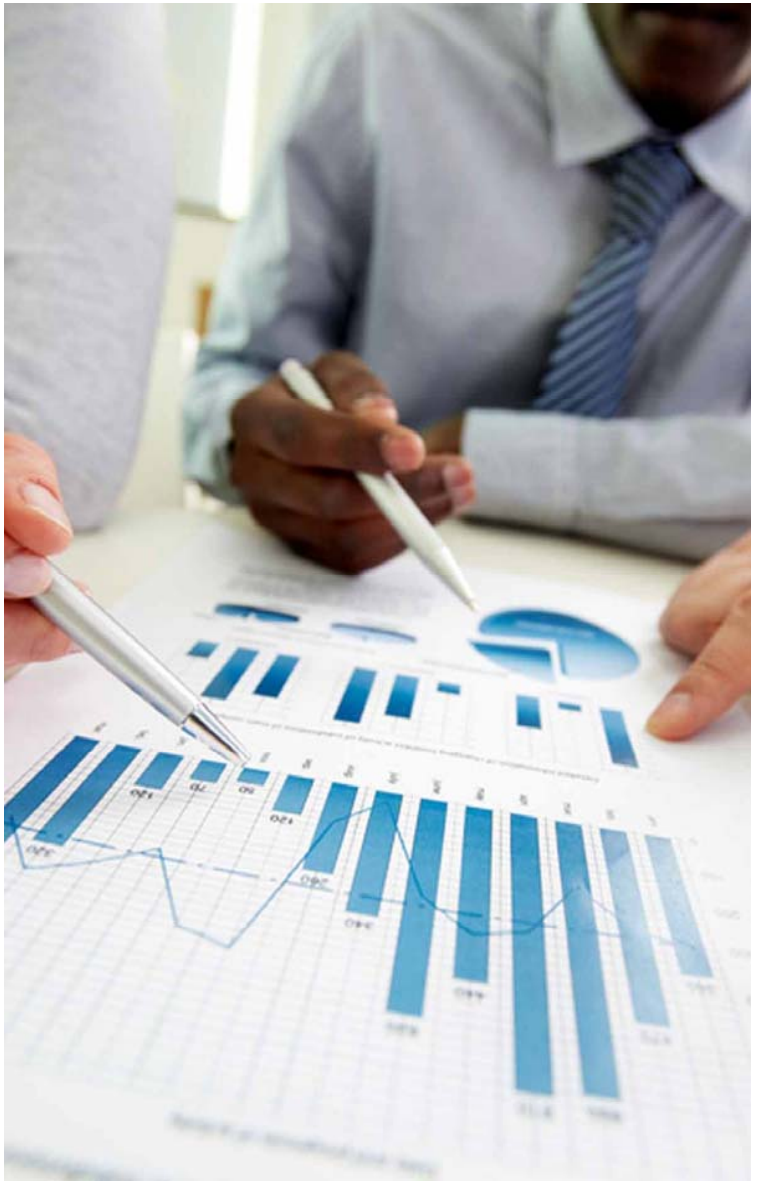
System z software pricing methodologies offer:

- Price-to-value
- Flexibility to run software where it is most efficient
- Capability to predict software charges
- Help with cost of new applications
- Flexibility to pay for software based on workload requirements

Pricing metrics for z/VM IPLA products:

- z/VM V5 and V6 and certain z/VM related products have pricing based on the number of engines. ***Engine-based Value Unit*** pricing allows for a lower cost of incremental growth with additional engine-based licenses purchased.
- Most IBM middleware for Linux is also priced based on the number of engines. The number of engines is converted into ***Processor Value Units*** (PVUs) under the Passport Advantage® terms and conditions.
- z/VM 6.3 (with APAR) will allow ***CPU pooling***. ***ILMT enhancements*** available August 12, 2014 enable using ILMT for pooling.



Limiting single virtual machines

- **LIMITHARD** option on **SET SHARE** bounds CPU resource given to a guest

  SET SHARE *userid* RELATIVE 2000 ABSOLUTE 40% LIMITHARD

  - RELATIVE 2000 defines entitlement: if the guest can consume it, it can receive 20 times as much CPU resource as the default (RELATIVE 100) user.
  - ABSOLUTE 40% LIMITHARD sets the cap: this guest is forbidden from using more than 40% of the CPU resource on the z/VM system (e.g. 2 IFLs in a 5-IFL VM partition)
- This is an existing feature in all supported VM releases
- Applies to CPU resource of the type on which guest is dispatched
- Scheduler divides this limit evenly among virtual CPUs in a virtual MP
  - Omits stopped vCPUs e.g. via *cpuplugd*

Limiting single virtual machines

- Customers have used **SET SHARE LIMITHARD** to
  - Prevent “runaway” virtual machines
  - Limit consumption by less important virtual machines (e.g. test)
  - Help to ensure departmental budgets are not exceeded

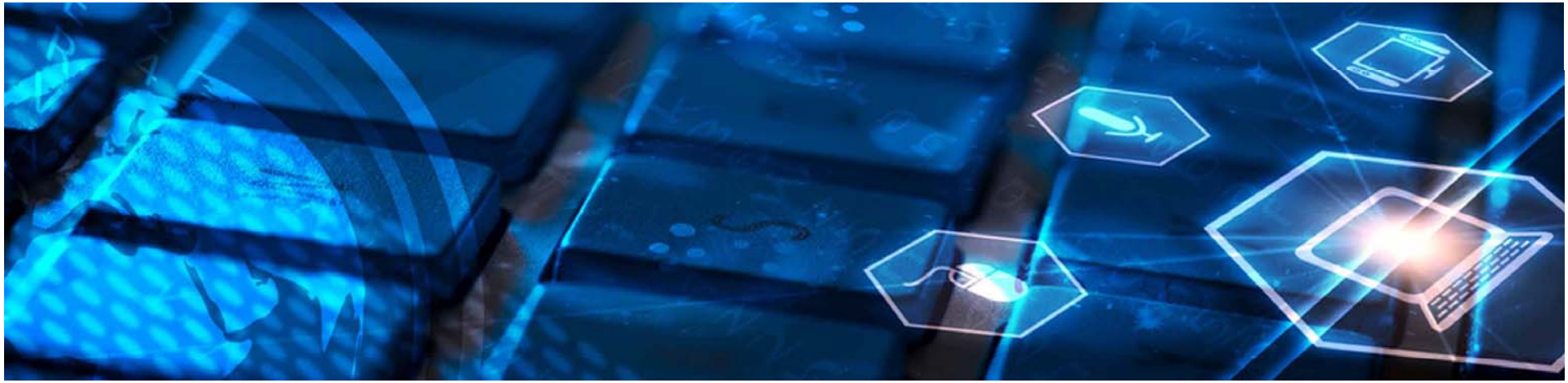
- Some drawbacks:
  - Change in number of logical CPUs (Capacity on Demand, VARY PROCESSOR ON/OFF) affects actual limit imposed
  - Imposed at the individual guest level. Limiting a set of guests may require over-limiting of the individuals.
  - Not recognized as a means of limiting capacity for IBM sub-capacity software license purposes

NEW

Environment Information Interface

- New interface allow guest to capture execution environment
  - Processor configuration and capacity information
  - Various Levels: Machine, logical partition, hypervisor, virtual machine
- New unprivileged instruction Store Hypervisor Information (STHYI)
- Includes support for CPU Pooling enhancement
- Exploited by ILMT 9.0.1 for sub-capacity pricing of Linux on System z middleware
- Support details:
  - z/VM 6.3 with APAR VM65419 – available

CPU Pooling with z/VM V6.3



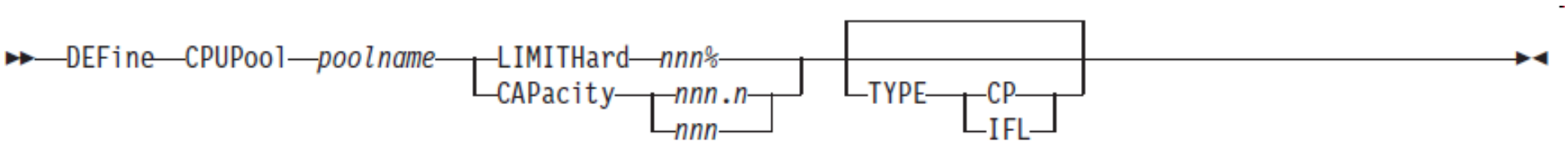
- Create a pool of CPU resources available for a group of virtual machines in a z/VM system
- Allows capping of CPU utilization for a set of guests to better balance resource utilization
- Allows Live Guest Relocation (LGR) as long as both definitions are compatible
  - Pools are defined and managed independently on each SSI member system
- New with z/VM V6.3 and APAR VM65418

Flexible configuration of pools

- Define named CPU pools with associated capacity
  - Number of CPUs of particular type (CP, IFL)
  - Percentage of CPUs of particular type
- Associate guests with CPU pools
- Limit aggregate guest consumption to pool capacity
  - Coexists with individual guest LIMITHARD setting; both limits enforced
  - Otherwise, resource allotted to group members on demand (“first come, first served”)
- Allows overcommit – no restriction on number of pools or aggregate capacity
- New z/VM facility obtains pool capacity information
  - Eliminates manual configuration

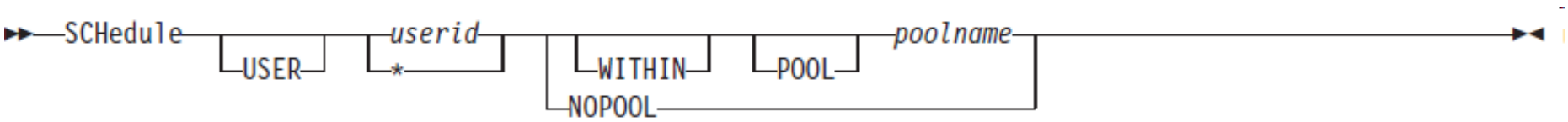
Defining CPU Pools

- Use the **DEFINE CPUPOOL** command to define named pools
  - Define for a particular **TYPE** of CPU (**CP** or **IFL**)
    - Default is the primary CPU type (IFL in an IFL-only partition, otherwise CP)
  - **CAPACITY** – number of CPUs
    - Limit recognized for sub-capacity licensing purposes
    - Can overcommit (i.e. Sum of CPUPOOL CPUs > Logical CPUs
  - **LIMITHARD** - % of system CPU resources of that type
    - Same enforcement mechanism as SET SHARE LIMITHARD
    - Does not qualify for sub-capacity licensing



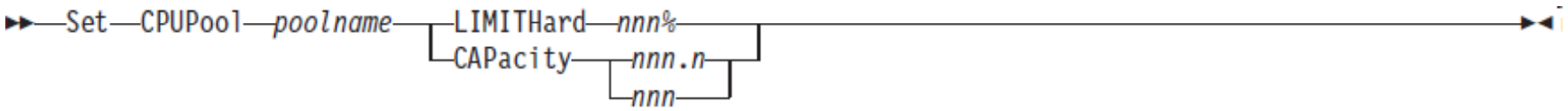
Enrolling virtual machines in a pool

- Assign a guest to or remove it from a CPU pool with the **SCHEDULE** command



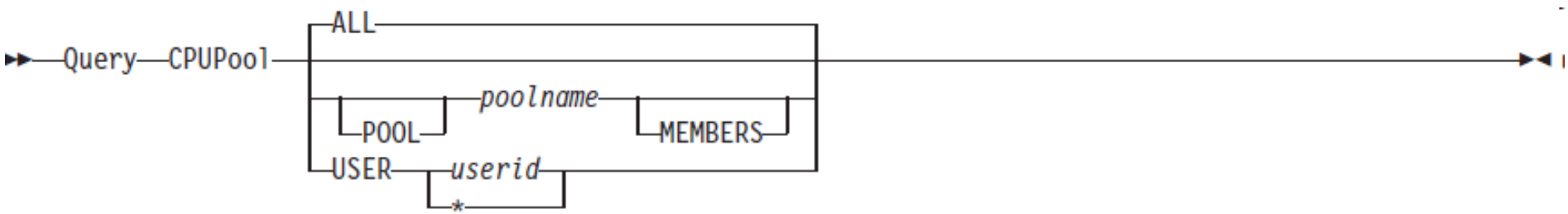
Changing CPU allocation to a pool

- Limits can be changed with the **SET CPUPOOL** command



Displaying CPU Pool information

- Use **QUERY CPUPOOL** to see information about the pools defined on your system



Displaying CPU Pool information

- Display all pool definitions:

```
query cpupool all
CPU pool    Limit        Type        Members
LINUXP2  8.0 CPUs    IFL                  0
CPPOOL10  12 %            CP              8
LINUXP3   30 %           IFL             20
LINUXP1  2.5 CPUs        IFL              6
```

- Display one pool definition and member names:

```
query cpupool linuxp1 members
CPU pool Limit          Type        Members
LINUXP1  2.5 CPUs        IFL              6
The following users are members of CPU pool LINUXP1:
D70LIN12 D79LIN03 D79ADM D79LIN10 D79LIN07
D79LIN04
```

- Display user's pool name:

```
query cpupool user d79adm
User D79ADM is in CPU pool LINUXP1
```

DELETE CPUPOOL

- Use **DELETE CPUPOOL** to delete a pool definition

- Pool must be empty.
  - Use SCHEDULE … NOPOOL first to remove each member.

Automating CPU Pool Management

- Complication:
  - At VM IPL, no pools are defined. (Not remembered from prior IPL.)
  - Can't add users to the pool until the pool is defined.
- One solution:
  1. COMMAND statements in directory definition of OPERATOR or AUTOLOG1 to define CPU pools

```
USER OPERATOR . . .
     . . .
     COMMAND DEFINE CPUPOOL WEBSPH CAPACITY   5  TYPE IFL
     COMMAND DEFINE CPUPOOL DB2    CAPACITY   3  TYPE IFL
     COMMAND DEFINE CPUPOOL QADEPT LIMITHARD 10% TYPE CP
```

Or include 'CP DEFINE …' commands in AUTOLOG1's PROFILE EXEC.

  2. COMMAND statements in virtual machine definitions to place them into pools as they log on

```
USER WASPROD1 . . .
     . . .
     COMMAND SCHEDULE * WITHIN POOL WEBSPH
```

Single System Image considerations

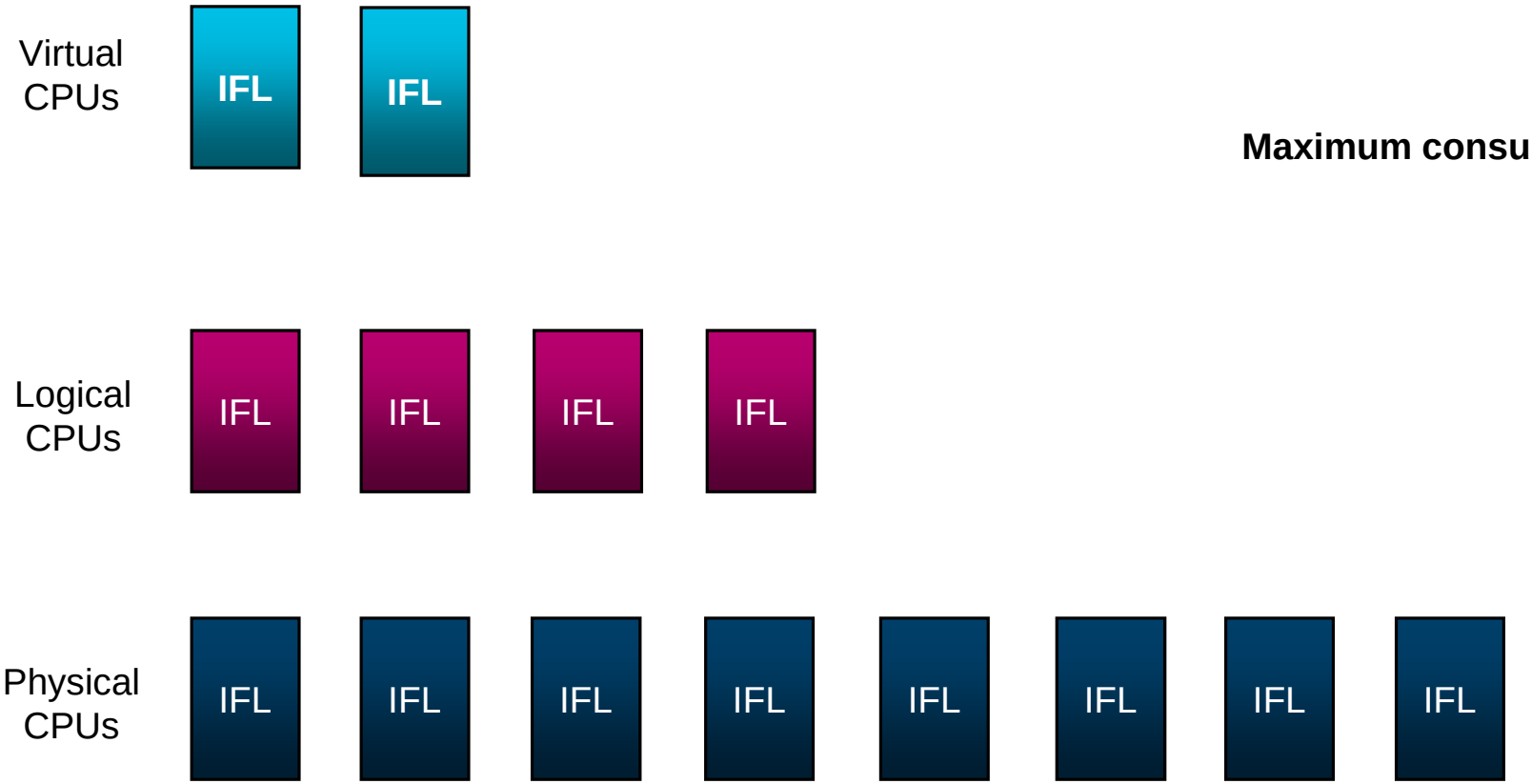
- CPU pools are defined and managed independently on each member of an SSI cluster
- A virtual machine in a CPU pool can relocate to another system if a CPU pool with the same name and CPU type is defined on the target system
  - Need not have the same capacity limit
- Administrator is responsible for adjusting pool limits if needed
  - May affect software license requirements

Track License Requirements with IBM License Metric Tool

- IBM License Metric Tool (ILMT) is a no-charge tool used to determine PVU licensing requirements
- New Linux interface will be exploited by ILMT to assess software license conformance
  - Invokes z/VM Execution Environment Interface
- Ability to track CPU pools available in ILMT 9.0.1 available August 12, 2014
  - Improvements also made to reduce CPU overhead incurred with ILMT
- Using ILMT you are only charged for the CPU pool capacity assigned to Passport Advantage PVU-based software

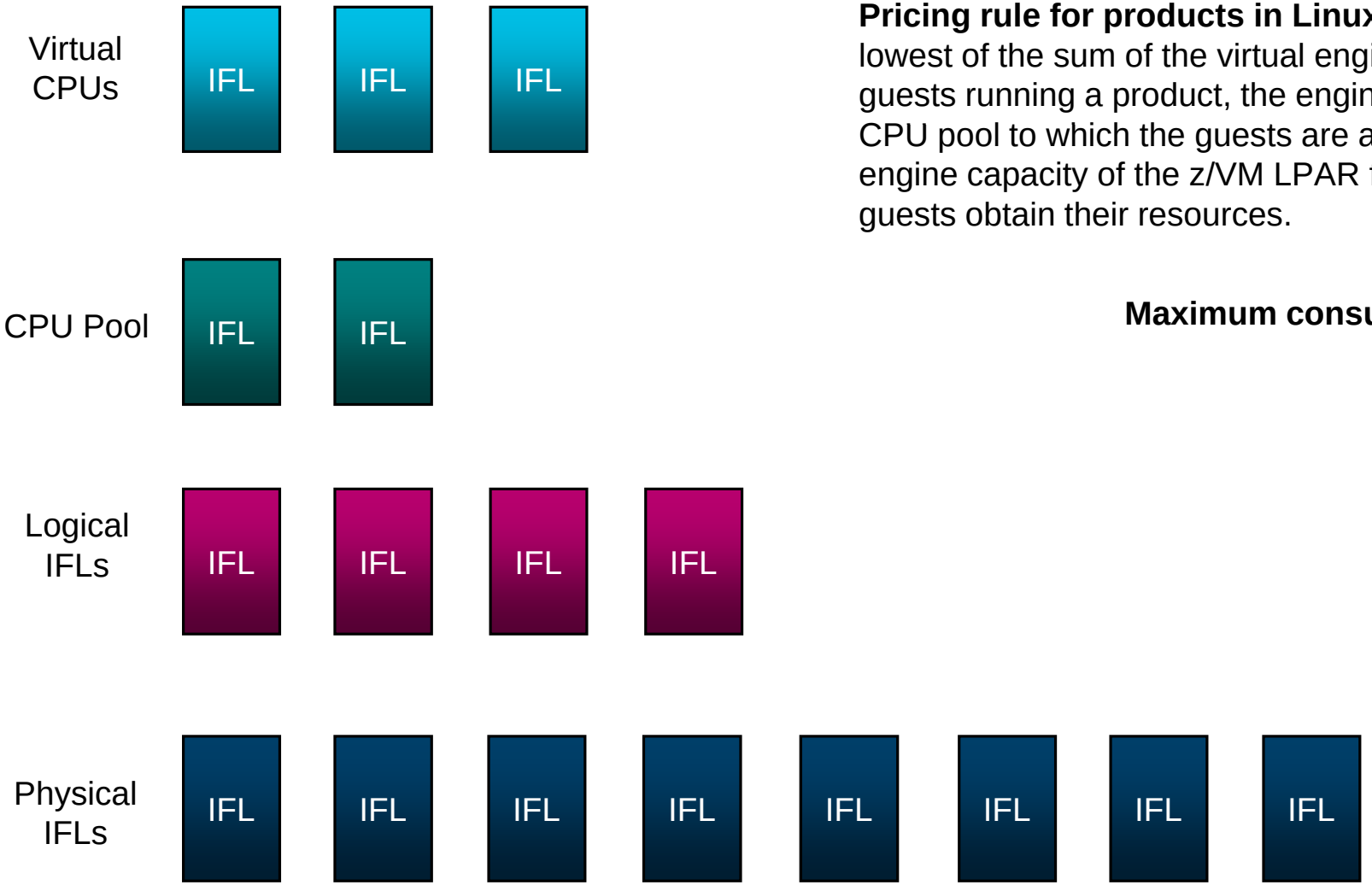
Current Linux Guest Software Pricing

Pricing rule for products in Linux guests: The lower of the sum of the virtual engines available to guests running a product or the engine capacity of the z/VM LPAR from which the guests obtain their resources.



Maximum consumption: 2 IFLs

Linux Guest Software Pricing With CPU Pooling



Pricing rule for products in Linux guests: The lowest of the sum of the virtual engines available to guests running a product, the engine capacity of the CPU pool to which the guests are assigned, or the engine capacity of the z/VM LPAR from which the guests obtain their resources.

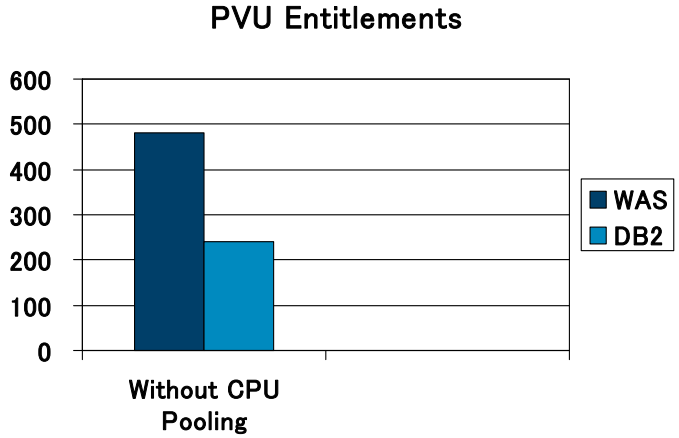
Maximum consumption: 2 IFLs

Use cases for CPU Pooling

- Department budgeting
  - Assign each department's guests to CPU pool with contracted capacity
- Grow workloads without affecting the budget
  - Add New Workload
  - Add Capacity
  - Combine LPARs
  - Handle fractional workload requirements
- Prevent resource over-consumption
  - Limit aggressive workloads

Add New Workload Without CPU Pooling

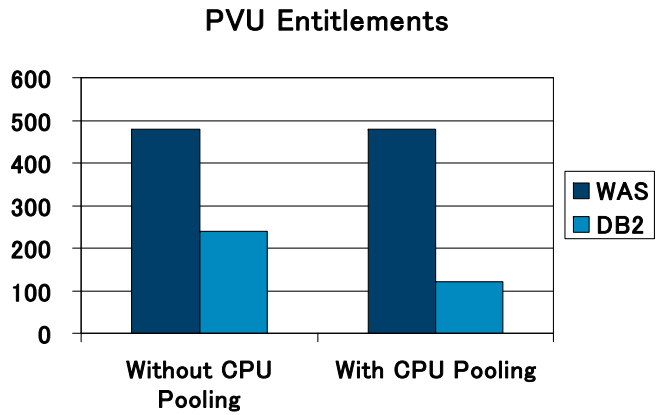
- 4 WAS production guests
  - Requires 4-engine WAS entitlement
- Add 2 DB2 production guests
  - Requires 2-engine DB2 entitlement

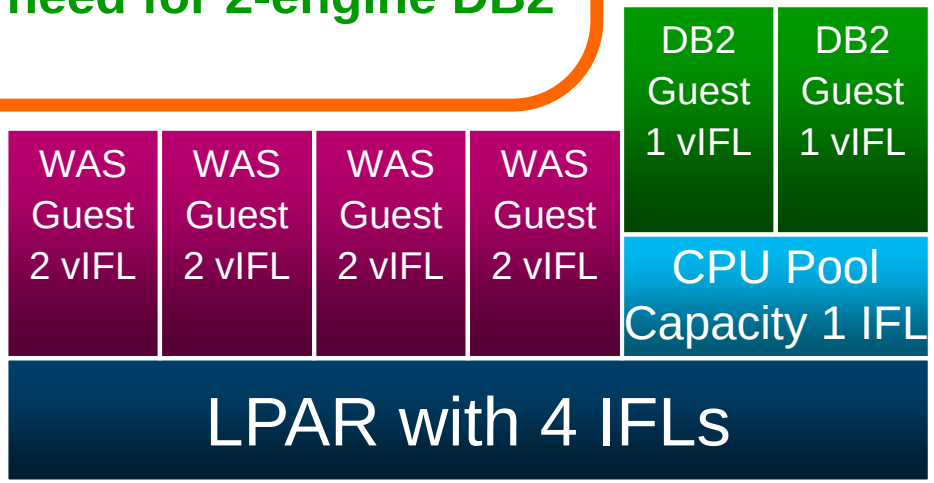


Note: All PVU Entitlement examples based on zEC12 (120 PVU per IFL) – will look proportionally the same on zBC12 (100 PVU per IFL)

Add New Workload With CPU Pooling

- 4 WAS production guests
  - Requires 4-engine WAS entitlement
- Create a 1-IFL pool
- Put the 2 DB2 production guests in pool
  - Requires 1-engine DB2 entitlement (avoiding the need for 2-engine DB2 entitlement)



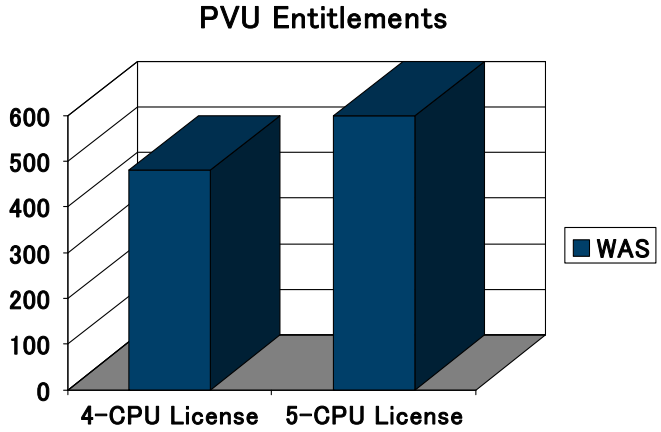


- Allows new workloads to be added cost effectively
- Encourages additional workload consolidation after initial success

Note: All PVU Entitlement examples based on zEC12 (120 PVU per IFL) – will look proportionally the same on zBC12 (100 PVU per IFL)

Add Capacity Without CPU Pooling

- **4 WAS production guests**
  - **Requires 4-engine WAS entitlement**
- **Add another IFL to the LPAR**
  - **Requires increase to 5-engine WAS entitlement**



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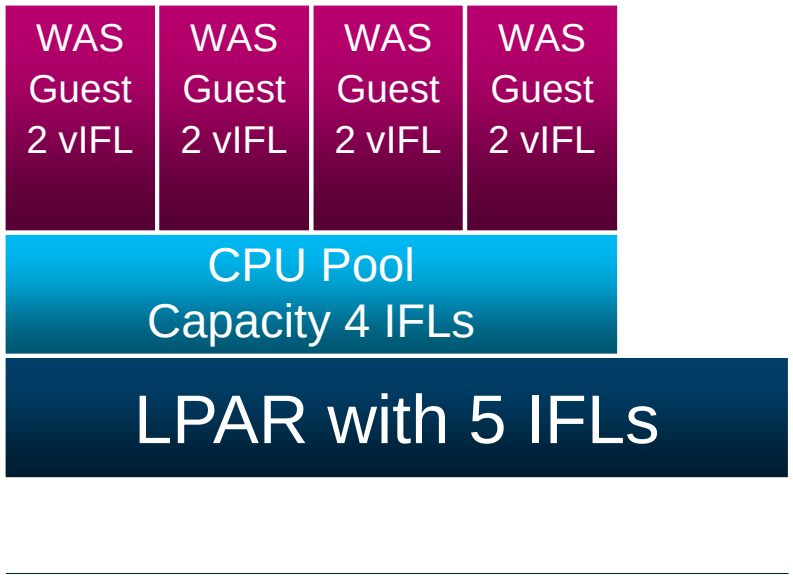
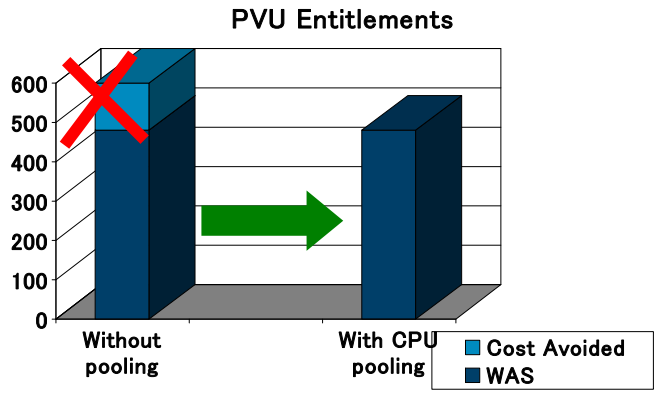
Add Capacity With CPU Pooling

- LPAR with 4 IFLs
- Set up CPU Pooling for 4 IFLs
  - 4 WAS production guests require 4-engine WAS entitlement
- Add another IFL to the LPAR
- Avoids an incremental WAS entitlement license – allows capacity to be added without increasing software license charges
- Encourages adding capacity for other workloads (e.g., open source applications)





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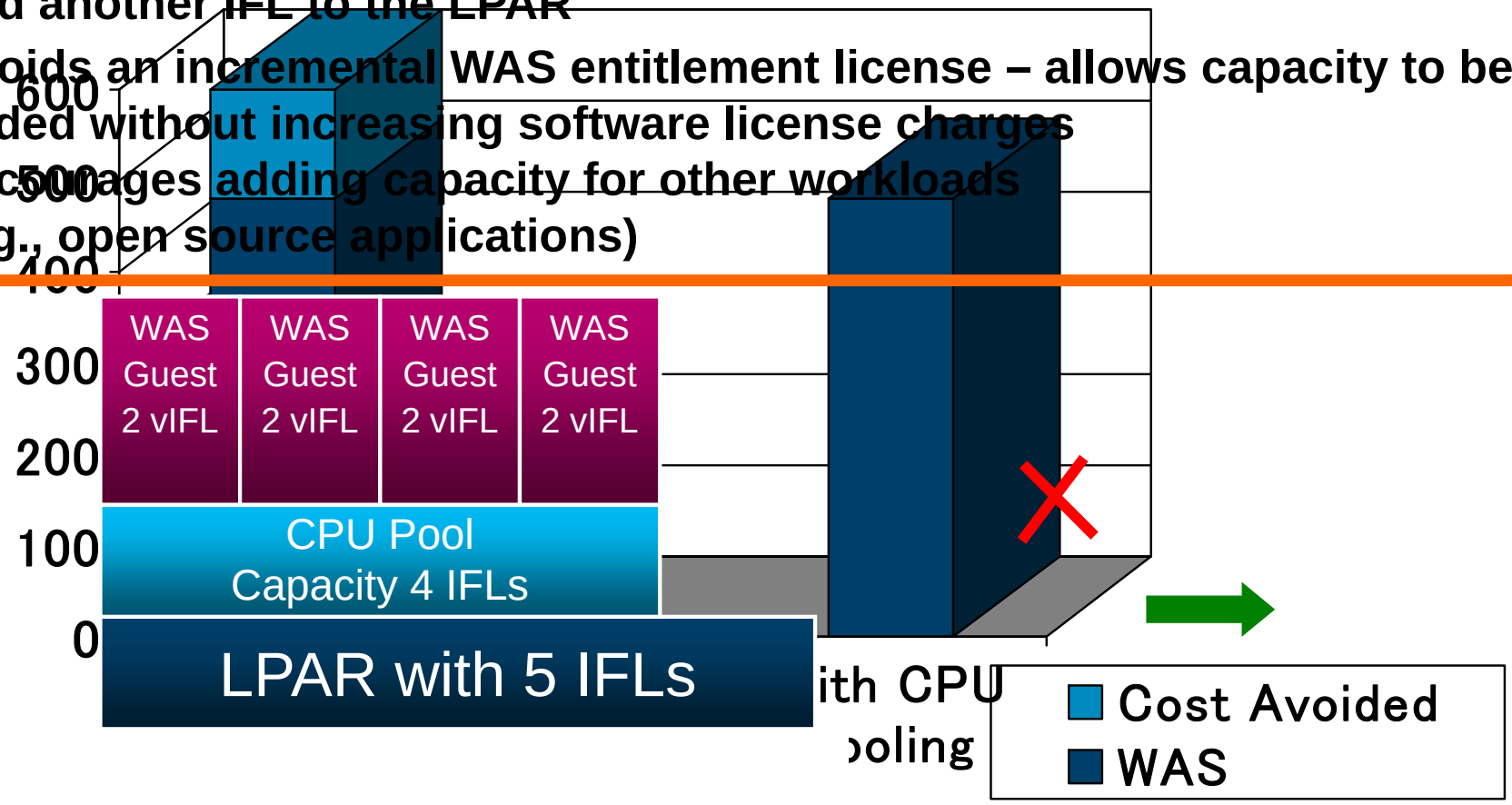

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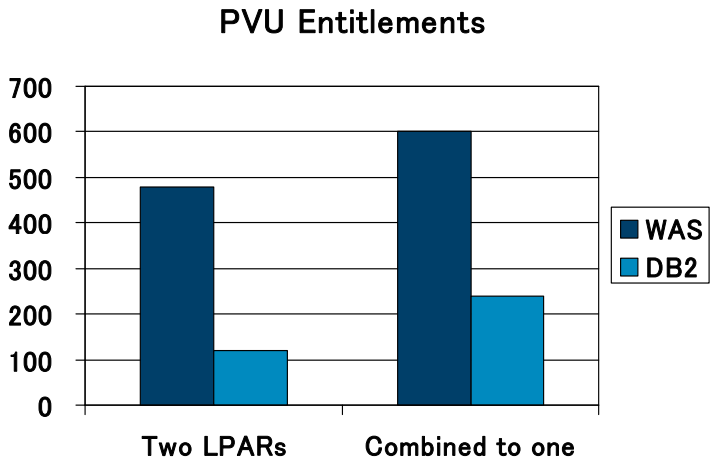
Combine LPARs Without CPU Pooling

- **LPAR with 4 IFLs and 4 WAS production guests**
  - **Requires 4-engine WAS entitlement**
- **LPAR with 1 IFL and 2 DB2 production guests**
  - **Requires 1-engine DB2 entitlement**

Note: All PVU Entitlement examples based on zEC12 (120 PVU per IFL) – will look proportionally the same on zBC12 (100 PVU per IFL)

Combine LPARs Without CPU Pooling

- LPAR with 4 IFLs and 4 WAS production guests
  - Requires 4-engine WAS entitlement
- LPAR with 1 IFL and 2 DB2 production guests
  - Requires 1-engine DB2 entitlement
- LPARs merge to one LPAR with 5 IFLs
  - Requires increase to 5-engine WAS entitlement
  - Requires increase to 2-engine DB2 entitlement



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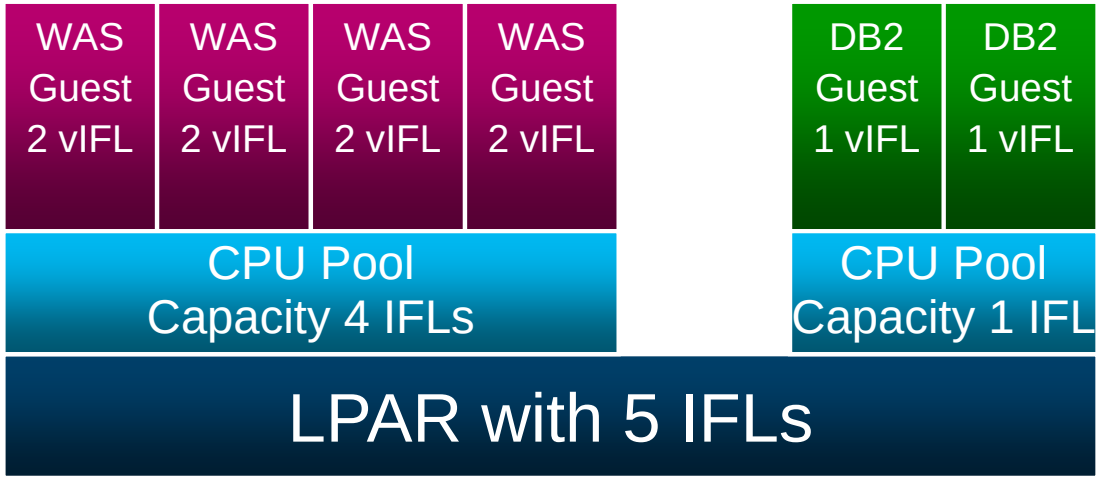
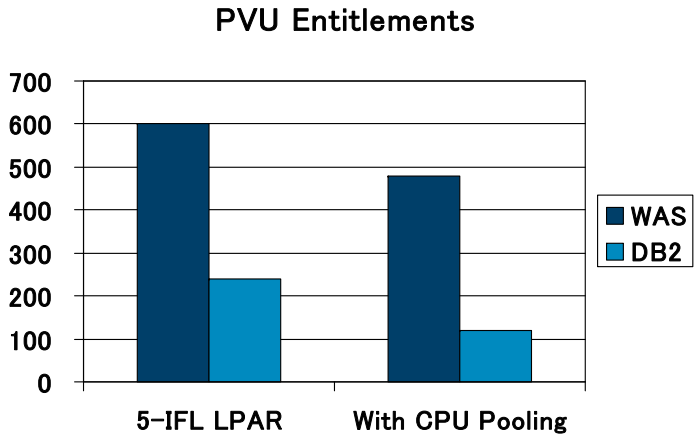
Combine LPARs With CPU Pooling

- LPAR with 5 IFLs
- Create 2 Pools – one with 4-IFLs and one with 1-IFL
- Place the four WAS guests in the 4-IFL pool and the two DB2 guests in the 1-IFL pool
  - Requires 4-engine WAS entitlement
  - Requires 1-engine DB2 entitlement



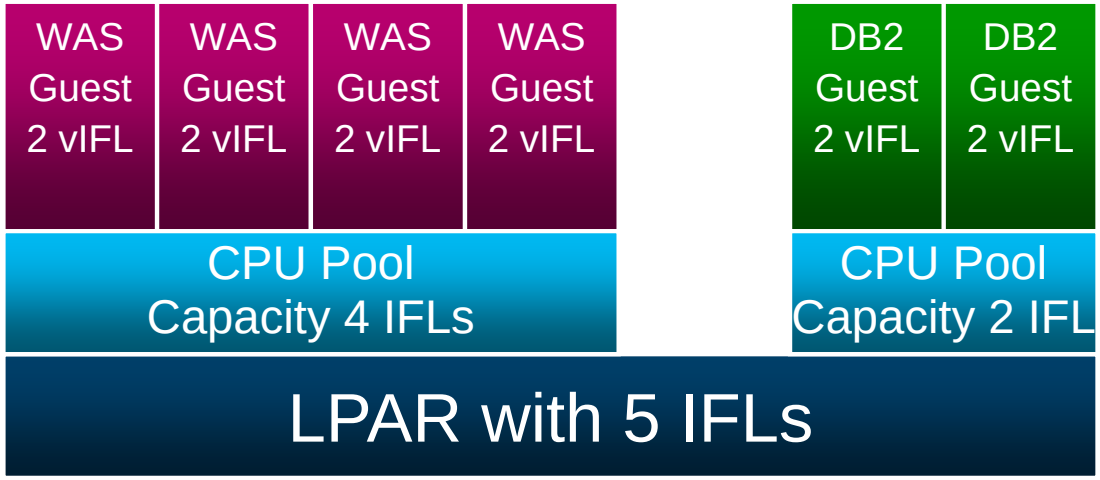


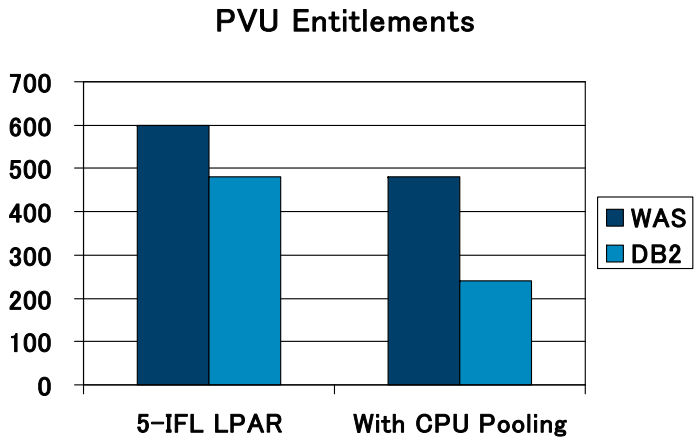
- Avoids increase in software license requirements (and costs)
- Reduces z/VM system management and maintenance workload
- Consolidates resources (memory, paging, network) for greater efficiency

Note: All PVU Entitlement examples based on zEC12 (120 PVU per IFL) – will look proportionally the same on zBC12 (100 PVU per IFL)

CPU Pools that Overcommit

- LPAR with 5 IFLs
- Create 2 Pools – one with 4-IFLs and one with 2-IFLs
- Place the four WAS guests in the 4-IFL pool and the two DB2 guests in the 2-IFL pool
  - Requires 4-engine WAS entitlement
  - Requires 2-engine DB2 entitlement



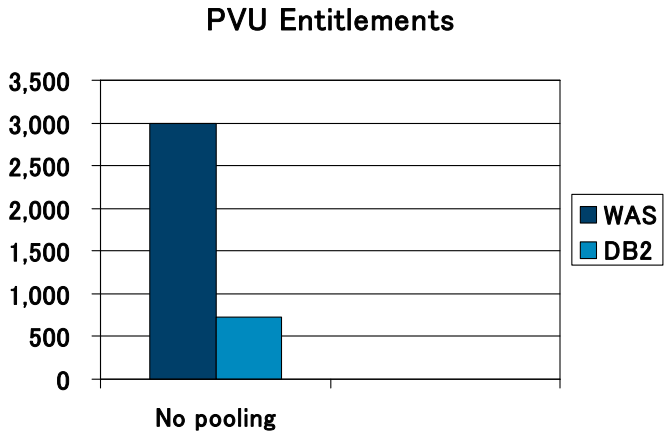


- Avoids increase in software license requirements (and costs)
- Reduces z/VM system management and maintenance workload

Note: All PVU Entitlement examples based on zEC12 (120 PVU per IFL) – will look proportionally the same on zBC12 (100 PVU per IFL)

Large system with virtual machines that require fractional IFL capacity

- **LPAR with 25 IFLs**
- **2 DB2 production guests**
  - **Requires 6-engine DB2 entitlement**
- **3 WAS production guests and 12 small WAS test guests**
  - **Requires 25-engine WAS entitlement**



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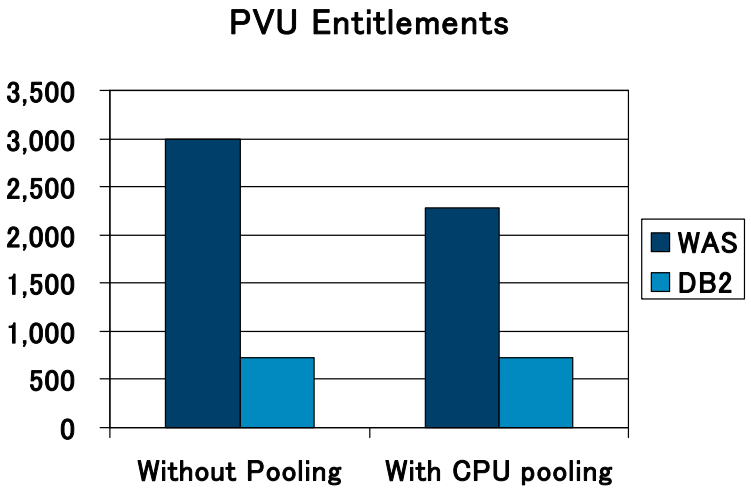
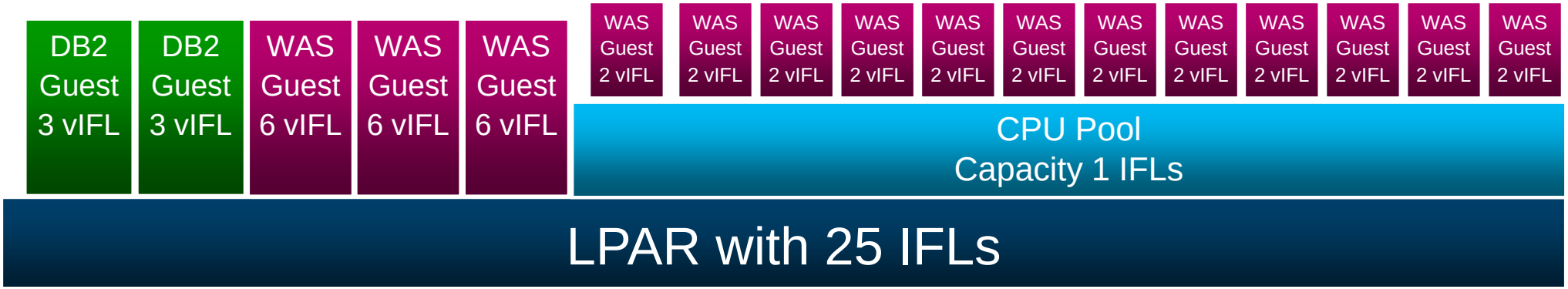
Align fractional capacity virtual machines to small CPU pools

- LPAR with 25-IFLs
- Set up a 1-IFL pool
- 2 DB2 production guests
  - Requires 6-engine DB2 entitlement
- 3 WAS production guests and 12 small WAS test guests in IFL pool
  - Requires 19-engine WAS entitlement

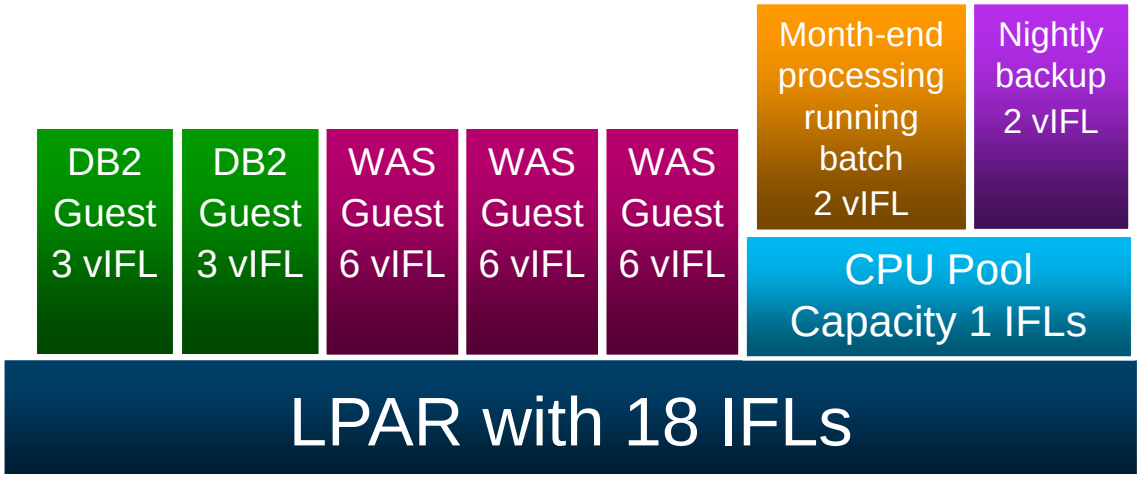




Note: All PVU Entitlement examples based on zEC12 (120 PVU per IFL) – will look proportionally the same on zBC12 (100 PVU per IFL)

Contain workloads that take too many resources

- **LPAR with 18-IFLs**
- **2 DB2 production guests and 3 WAS production guests are sharing the 18-IFLs**
- **Month-end processing or nightly backup uses any available capacity – could take from production guests**
- **Set up a 1 IFL CPU pool for running these tasks**



Note: All PVU Entitlement examples based on zEC12 (120 PVU per IFL) – will look proportionally the same on zBC12 (100 PVU per IFL)

Summary

- CPU Pooling offers greater control over resource allocation
  - By workload
  - By department
  - By software product

- With ILMT 9.0.1, can limit software license costs, particularly where multiple software products are run in the same z/VM system
  - Enables organic growth of individual workloads
  - Avoids paying for capacity not used for a software product
  - Broadens options for workload consolidation, lowering overhead and administrative costs

More Information

More information

- Passport Advantage Sub-Capacity FAQ:
  - http://www.ibm.com/software/passportadvantage/subcapfaqov.html
- Virtualization Capacity License Counting Rules
  - http://www.ibm.com/software/passportadvantage/Counting_Software_licenses_using_specific_virtualization_technologies.html

Thanks!

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