



z/OS Capacity Provisioning Introduction and Update for z/OS V2.1

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z/OS Workload Management

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Agenda

- *Capacity Provisioning Overview*
- **Capacity Provisioning Introduction and Concepts**
 - *Processing Modes*
 - *CPM Configuration*
 - *Reports, Logs, Audit Trails*
 - *Documentation*
- **New z/OS V2.1 Enhancements**
 - *Management of defined and group capacity*
 - *Takeover of manually activated capacity*



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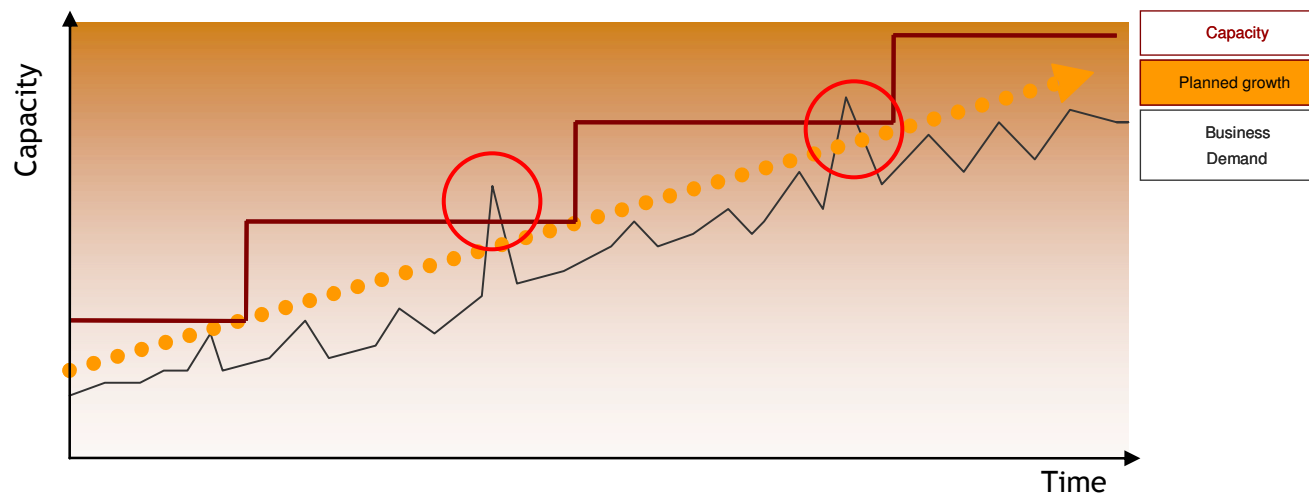
Today's challenges to managing capacity

- Unexpected events and workload spikes can afford higher processing capacity
- Manual capacity management can be time-consuming and error prone
- Capacity provisioning decisions must be made without sound data



IBM z/OS Capacity Provisioning Basics

- **Contained in z/OS base component free of charge**
 - Requires a monitoring component, such as z/OS RMF, or equivalent
 - Base element since z/OS V1.9
- **Exploits on System z On/Off Capacity on Demand Feature**
 - IBM zEnterprise System z10 or later
 - If On/Off CoD is not used CPM “analysis” mode may be used for monitoring and alerts
- **Exploits Defined Capacity and Group Capacity**
 - Defined Capacity with IBM System z10 or later
 - Group Capacity with IBM zEnterprise z196 or later



Capacity Provisioning Capabilities Overview

- The Capacity Provisioning Manager (CPM) can control *additional capacity* on IBM zEC12, z196, or z10
 - Temporary general purpose capacity
 - Considers different capacity levels (i.e. effective processor speeds) for subcapacity processors (general purpose capacity)
 - Number of temporary zAAPs or zIIPs
 - Defined capacity and group capacity limits
 - Can advise on logical processors
 - Can control one or more IBM zEnterprise or System z10 servers
 - Including multiple Sysplexes
 - Provides commands to control z196 and later static power save mode
 - Provides commands to control temporary IFLs



CPM allows for different types of provisioning requests:

- Manually at the z/OS console through Capacity Provisioning Manager commands
- Via user defined policy at specified schedules
- Via user defined policy by observing workload performance on z/OS

Manual capacity upgrades – How it could look like

1.	Workload increases	0 min
2.	Operator realizes bottleneck	5-10 min
3.	Operator informs system programmers and manager	2 min
4.	Discussion	10 min
5.	Logon to HMC, activate record or increase limits	5 min

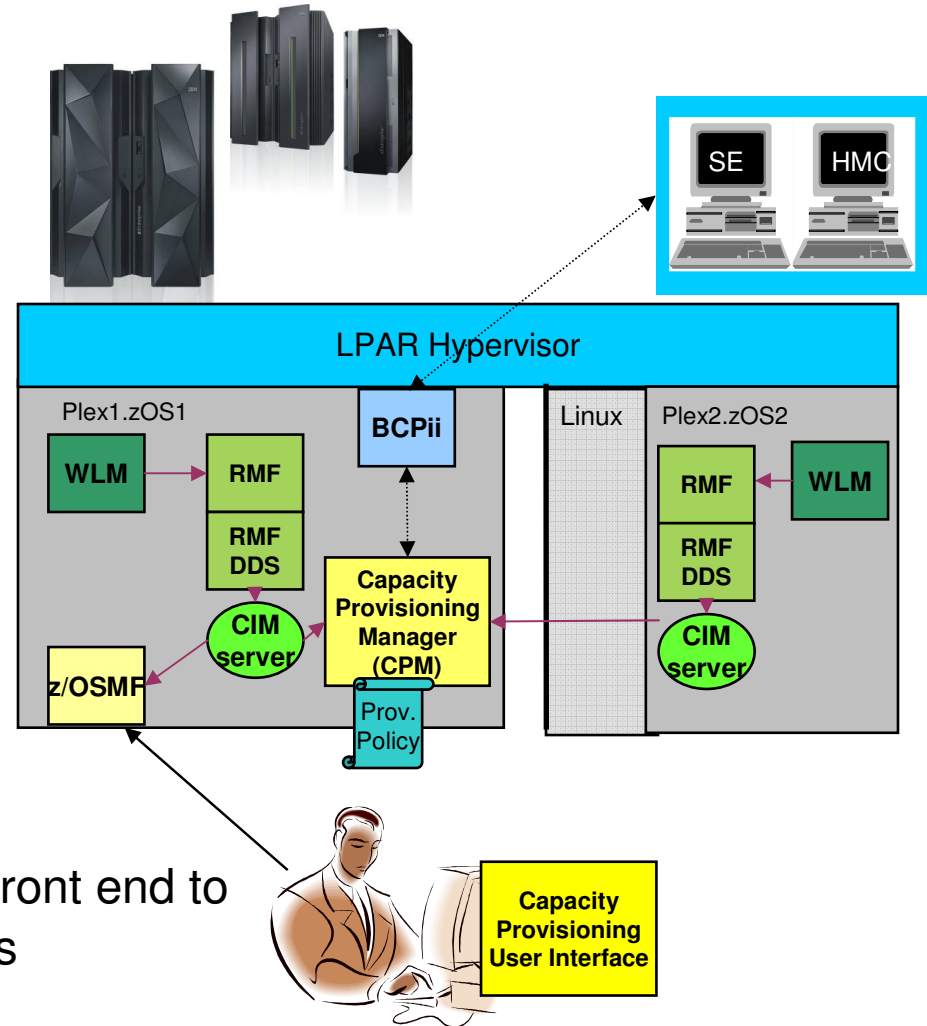
... meanwhile, so much workload may have queued up that one additional processor would be insufficient to decrease the queued workload

→ Much more capacity needs to be added

CPM can react faster and reduce cost

Capacity Provisioning – Infrastructure in a Nutshell

- z/OS WLM manages workloads to goals and business importance
- WLM indicators available through monitoring product
 - E.g. z/OS Resource Measurement Facility (RMF)
 - One RMF gatherer per z/OS system
 - RMF Distributed Data Server (DDS) per Sysplex
- Capacity Provisioning Manager (CPM) retrieves critical metrics through CIM
- CPM communicates to support elements or HMC, via BCPii.
- Capacity Provisioning User Interface is front end to administer Capacity Provisioning policies
 - A Control Center in earlier versions
 - z/OSMF Capacity Provisioning task



Main Components of Capacity Provisioning

- **The Capacity Provisioning Manager (CPM)**

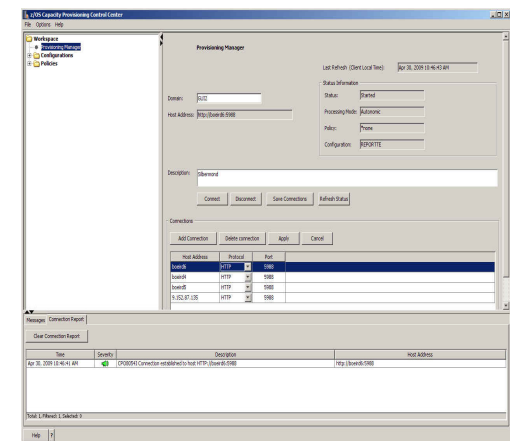
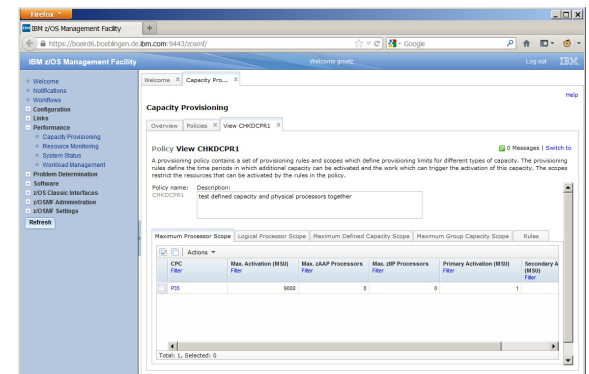
 - is the server program that monitors the defined systems and CPCs and takes actions as appropriate and authorized by the policies.

- **User interface:** The z/OSMF Capacity Provisioning task is used to interact with the CPM

 - Is the browser-based user interface to administer provisioning policies and domain configurations and interact with the Capacity Provisioning Manager.

 - Requires z/OS V1.13 or higher

 - Up to z/OS V1.13, you can use the Capacity Provisioning Control Center (CPCC) to work with provisioning policies and domain configurations. The CPCC is installed and used on a Windows™ workstation. It is not required for regular operation of CPM.



Processing Modes

Capacity Provisioning Manager can operate in one of four modes that allow for different degrees of automation

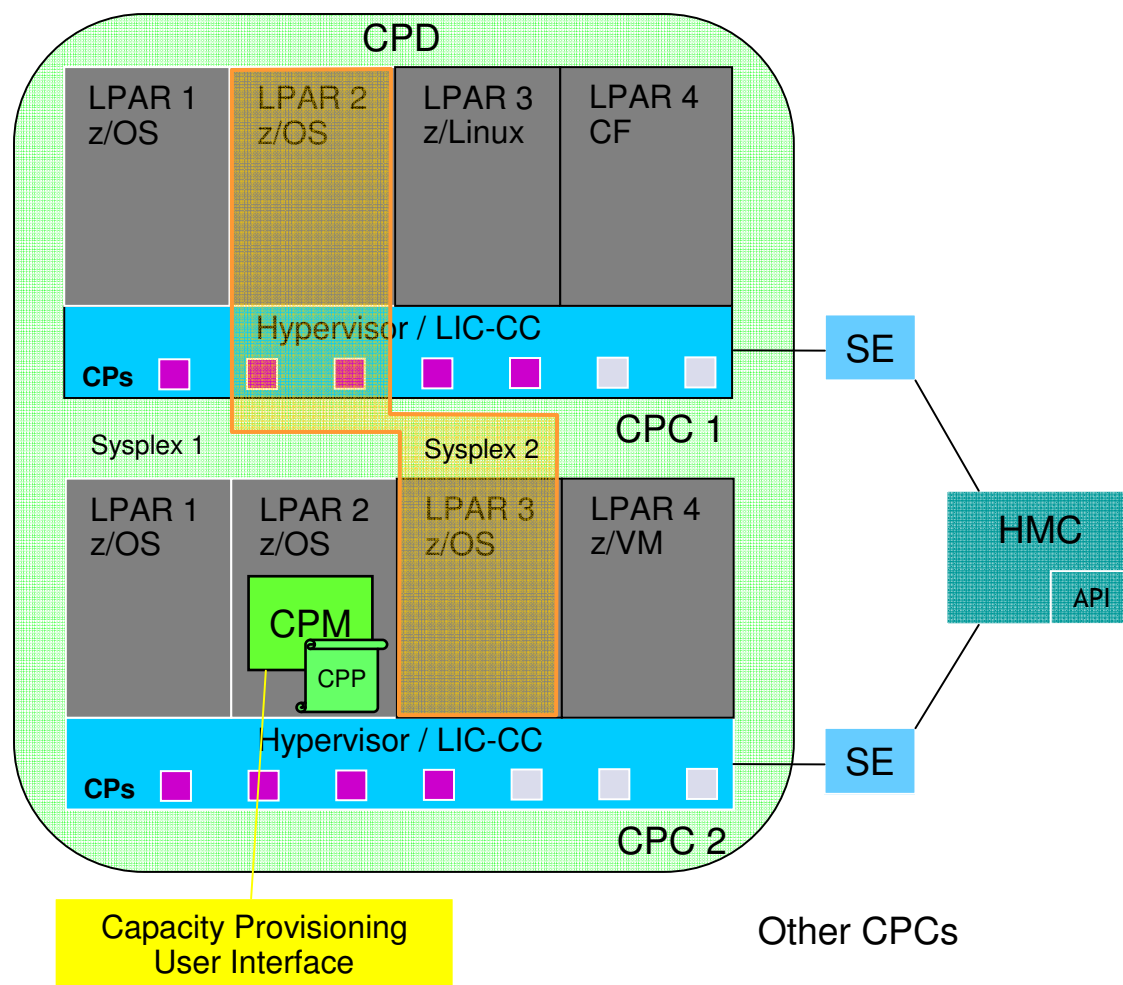
- **Manual mode**
 - Server capacities can be controlled via CPM commands
 - Command driven mode where no CPM policy is active
- **Analysis mode**
 - CPM processes capacity provisioning policy and informs the operator when a provisioning / deprovisioning action would be due according to criteria specified in the policy.
 - It is up to the operator either to ignore that information or to perform the up-/downgrade manually (using the HMC/SE or the available CPM commands)
- **Confirmation mode**
 - CPM processes the policy and interrogates the On/Off CoD record to be used for capacity provisioning.
Every provisioning action needs to be authorized (confirmed) by the operator.
- **Autonomic mode**
 - Similar to the confirmation mode, except that no human (operator) intervention is required.

Various reports are available with information about workload and provisioning status, and the rationale for provisioning recommendations

CPM Policies and Processing Parameters

- CPM server uses three types of input:
 - **Domain configuration** defines the topology and connections, such as the CPCs and z/OS systems that are to be managed by the server
 - **Policy** contains the information as to
 - which work is provisioning eligible,
under which conditions and during which timeframes
 - how much capacity may be activated when the work suffers due to insufficient processing capacity
 - **PARM** data set contains setup instructions such as UNIX environment variables, and various processing options that may be set by an installation.

Domain Configuration



- The *domain configuration* defines the CPCs and z/OS systems that are controlled by an instance of the CPM
- One or more CPCs, sysplexes and z/OS systems can be defined into a domain
- Sysplexes and CPCs do not have to be completely contained in a domain but must not belong to more than one Capacity Provisioning domain
- One active Capacity Provisioning policy per domain
- Multiple Sysplexes and hence multiple WLM service definitions may be involved

Policy Approach

The Capacity Provisioning policy defines the circumstances under which additional capacity may be provisioned:

- Three “dimensions” of criteria considered:
 - **When** is provisioning allowed
 - **Which** work qualifies for provisioning
 - **How much** additional capacity may be activated
- These criteria are specified as “rules” in the policy:

```
If  
{ in the specified time interval  
  the specified work “suffers”  
}  
Then up to  
{ - the defined additional capacity  
  may be activated  
}
```

- The specified rules and conditions are named and may be activated or deactivated selectively by operator commands

Policy Overview

Capacity Provisioning Policy

Maximum Provisioning Scope

Processor Limits

Defined Capacity Limits

Rule

Provisioning Condition

Time Condition

Workload Condition

Provisioning Scope

Processor Limits

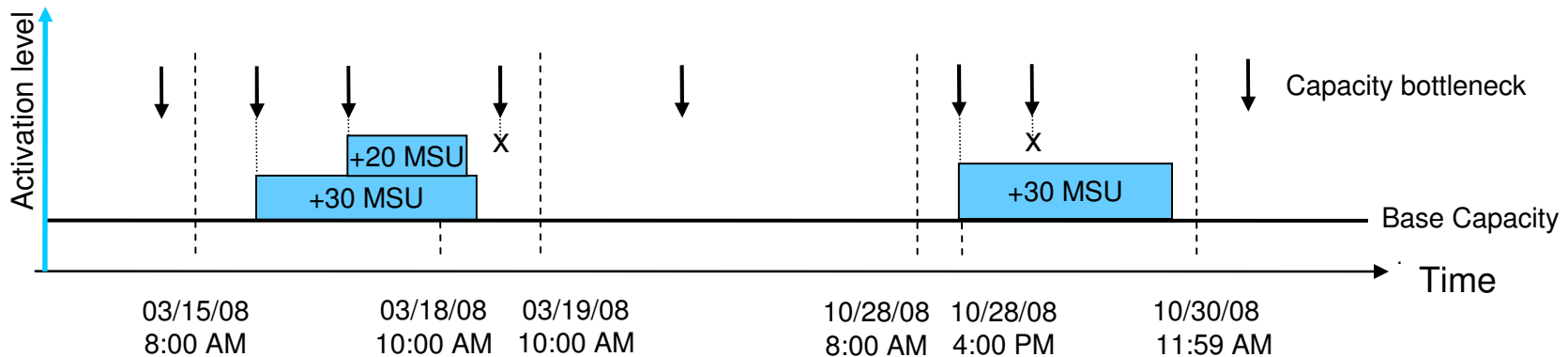
Defined Capacity Limits

- The „Maximum Provisioning Scope“ defines the maximum additional capacity that may be activated, by all the contained rules
- „Provisioning Condition“ is simply a combination of Time and Workload Conditions that can be referred to via its name
- “Provisioning Scope” defines the maximum capacity that may be activated based on the rule
 - Specified as number of zAAP/zIIP processors
 - MSU for general purpose capacity
 - MSU for Defined Capacity
 - MSU for Group Capacity

Rules: Provisioning Conditions - Time

- Time condition defines when temporary capacity may be activated.
 - Non-recurring time conditions specify
 - Start Time: provisioning of additional capacity allowed
 - Deadline: provisioning of additional capacity no longer allowed
 - End Time: deactivation of additional capacity should begin

Name	Start Time	Deadline	End Time
TC1	03/15/08 08:00 AM	03/18/08 10:00 AM	03/19/08 10:00 AM
TC2	10/28/08 08:00 AM	10/28/08 04:00 PM	10/30/08 11:59 AM



Rules: Provisioning Conditions - Workload

- Identifies the work that may trigger the activation of additional capacity,
 - When that work does not achieve its goal due to insufficient capacity and additional capacity would help
 - Expressed as one or more WLM service class periods

Workload Condition WL1 ✔ 0 Messages

A workload condition specifies the work that is eligible to cause activation of additional capacity and the conditions under which that work can trigger this action.

Name: WL1 Description:

System: IRD6 Sysplex: IRD4PLEX

	Service Definition Filter	Service Policy Filter	Service Class Filter	Period Filter	Provisioning PI Filter	Provisioning Duration (Minutes) Filter	Deprovisioning PI Filter	Deprovisioning Duration (Minutes) Filter	PI Scope Filter
<input type="checkbox"/>	Any service definitio	Any service policy	CPULOW	1	1.5	5	1.3	5	System

Workload Condition Parameters

■ Parameters:

- Sysplex/Systems: The z/OS systems that may run eligible work
- Workload specification:
 - Importance Filter:
Eligible service class periods, identified by WLM importance
 - Included Service Classes: Eligible service class periods
Extends the set of Service Class periods with qualified work
(extends the default set of default eligible service classes)
and may specify different PI criteria
 - Excluded Service Classes: Identifies service class periods, that
should not be considered

Workload Condition Parameters cont.

- PI (Performance Index) criteria:

- Activation threshold:

PI of service class periods must exceed the activation threshold for a specified duration before the work is considered to require help.

- Deactivation threshold:

PI of service class periods must fall below the deactivation threshold for a specified duration the work is considered to no longer require help.

- If no workload condition is specified a scheduled activation and deactivation will be performed:

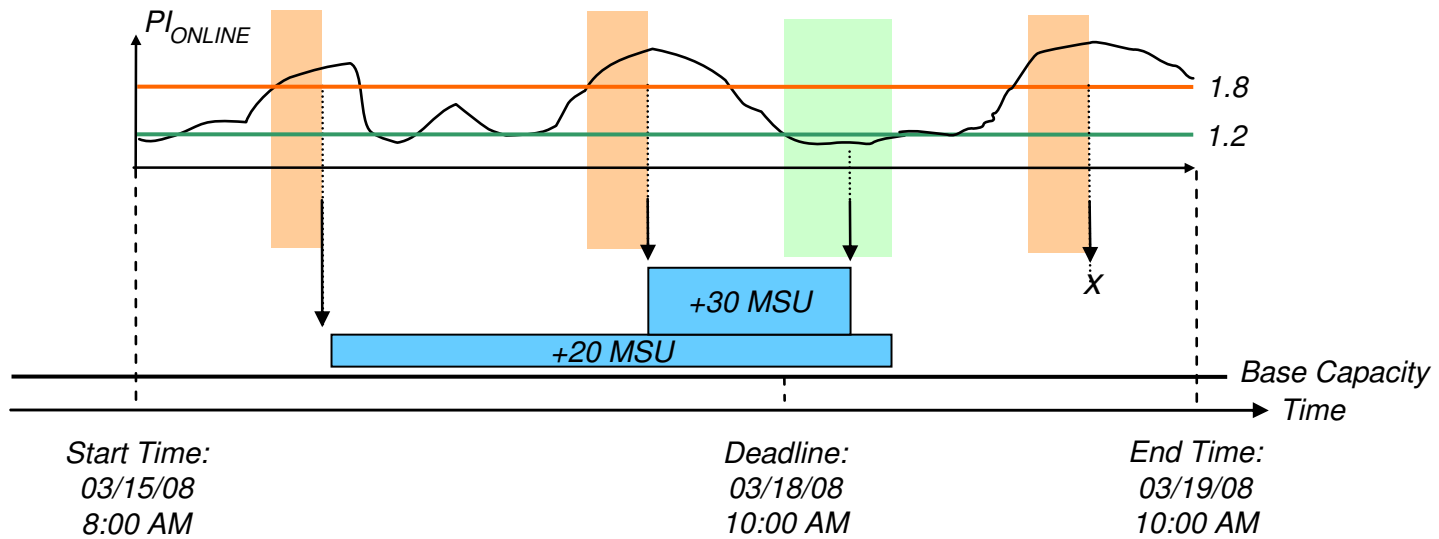
- Full capacity as specified in the rule scope
- Unconditionally at the start and end times of the time condition

Sample Workload Condition

Sample definition:

Name: PT1
Sysplex: PLEX1
System: SYSA
Included Service Class Periods:
ONLINE in WLMSD with $PI \geq 1.8$ for 10 min until $PI \leq 1.2$ for 10 min
Excluded Service Class Periods:
BACKUP in WLMSD

Monitor Service Class PI's:



Rule: Provisioning Scope – Processor Limits

- CPC within provisioning domain for which activation of resources is allowed
- Max number of additional MSU/zAAPs/zIIPs that may be activated
 - ✧ Only the required delta capacity will be activated by the CPM
- Provisioning scope exists in two flavors:
 - Maximum provisioning scope defines an upper limit of resources that may be activated in total for all the contained rules at any point in time. Additionally, capacity increments can be defined. Increments are defined in MSU for general purpose capacity and number of processors for zIIP and zAAP processors.
 - Provisioning scope on the „rule“ level defines an upper limit of resources that may be activated for the single rule at any point in time
 - Allows for definitions like „I authorize 300 MSU for workload 1 and 200 MSU for workload 2, but at no point in time more than 400 MSU.“

<i>CPC</i>	<i>Max MSU</i>	<i>Max zAAPs</i>	<i>Max zIIPs</i>
CPC1	400	3	5
CPC2	800	0	0

Rule: Provisioning Scope – Defined Capacity Limits

- System within provisioning domain for which to increase defined capacity limit
- Max number of increased MSU capacity
 - ✧ Only the required delta capacity will be activated by the CPM
- Provisioning scope exists in two flavors:
 - Maximum provisioning scope defines an upper limit of MSU that may be increased in total for all the contained rules at any point in time. Additionally, capacity increments can be defined. Increments are defined in MSU.
 - Provisioning scope on the „rule“ level defines an upper limit of MSU that may be increased for the single rule at any point in time
 - Allows for definitions like „I authorize 30 MSU for workload 1 and 40 MSU for workload 2, but at no point in time more than 40 MSU.“

<i>System</i>	<i>Sysplex</i>	<i>Max. Increase (MSU)</i>
SYS1	PLEX1	15
SYS2	PLEX1	40

Rule: Provisioning Scope – Group Capacity Limits

- Capacity group of a CPC within provisioning domain for which activation of resources is allowed
- Max number of increased MSU
 - ✧ Only the required delta capacity will be activated by the CPM
- Provisioning scope exists in two flavors:
 - **Maximum provisioning scope** defines an upper limit of MSU that may be increased in total for all the contained rules at any point in time. Additionally, capacity increments can be defined. Increments are defined in MSU.
 - **Provisioning scope on the „rule“ level** defines an upper limit of resources that may be activated for that single rule at any point in time
 - Allows for definitions like „I authorize 30 MSU for rule 1 and 20 MSU for rule 2, but at no point in time more than 40 MSU.“

<i>Group</i>	<i>CPC</i>	<i>Max. Increase (MSU)</i>
GROUP1	CPC1	90
GROUP2	CPC2	150

Additional CPM Processing and Directives

- For workload-based provisioning it is a necessary condition that the performance index exceeds the specified provisioning PI
 - However, it is **not a sufficient condition**
 - The underlying CPM processing examines many metrics and parameters to ensure that
 - the observed performance bottleneck is caused by a processor capacity shortage of the respective processor type, and
 - that additional capacity could actually be consumed by the workload that incurred the capacity demand
- Deprovisioning is under control of additional parameters
 - The “minimum activation time” specifies for how long any added capacity must remain active *at a minimum*.
 - Specified in the PARM member
- For many aspects of the CPM processing additional directives may be specified in the PARM member
 - Refer to documentation for full list

Overview on Observed Metrics

CPC Metrics

- Per processor type
 - Shared physical utilization
 - Total logical processors
 - Total weights
 - Physical processors
- Group capacity

LPAR/System Metrics

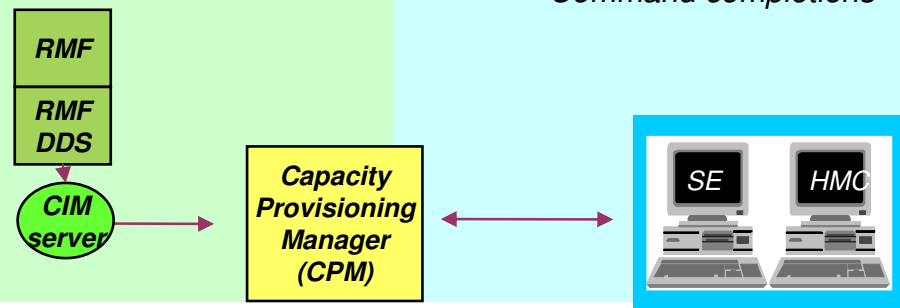
- WLM Service definition, policy, service classes Shared/dedicated
- Initial capping
- Defined capacity
- Capping & time-to-cap
- 4h Rolling Average
- Dispatchable units (InR Queue)
- IRD weight & vary CPU mgmt
- Per processor type
 - Online CPs, zAAPs, zIIPs
 - Reserved processors
 - LPAR weight
 - MVS utilization
 - LPAR utilization

Service Class Period Metrics

- Local PI
- Sysplex PI
- %Capped
- Delays
- Per processor type
 - Processor delays
 - TCB, SRB

Support Element

- H/W model
- Spare processors
- Installed OOCOD records including Activation limits, validity, current activation level
- Current S/W model
- Current number of processors
- Power save (z196 and later)
- Event subscriptions
 - Capacity and accounting change
 - Command completions



Reports, Logs, Audit Trails

- History of actual workload and system activity available with CPM reports
 - Especially REPORT ACTIVITY, REPORT WORKLOAD
 - Available at the z/OS console, at the CPCC, and in the z/OSMF Capacity Provisioning task (starting with z/OS V1.13)
 - Reports can be directed to files and archived
- History of capacity changes available via CPM logging
 - Metrics, decisions and other data can be logged to file system
 - Binary format
- Other information available:
 - RMF Mon III data sets
 - Model and capacity changes recorded outside CPM
 - SMF22
 - RMF 70.1, 72
 - Current capacity information also available via STSI instruction, and related MVS programming interfaces

New with z/OS V2.1: Capacity Provisioning supports defined capacity and group capacity

- Analogously to temporary physical capacity management CPM supports management of defined and group capacity:
 - CPM commands to modify defined capacity and group capacity with the CPM domain
 - Scheduled increases of defined capacity and group capacity
 - Workload-based management of defined capacity and group capacity
 - Reports for defined capacity and group capacity setting
- If the active policy does **not** allow managing defined capacity and group capacity the processing is the same as prior to z/OS V2.1:
 - Capacity bottlenecks caused by defined capacity are recognized. Activation of physical capacity is not initiated because physical capacity is not the bottleneck

New with z/OS V2.1: Defined and group capacity management

- When managing defined capacity the CPM interrogates defined and group capacity settings and listens to changes to them
- Also for defined capacity the CPM distinguishes between
 - *Managed capacity*, i.e. the capacity it “owns” (i.e. was activated by CPM policy)
 - Only managed capacity will be deactivated by CPM
 - *Management base*, i.e., capacity found active initially plus/minus any capacity that was (de)activated externally (HMC, API, or through CPM commands)
 - Unlike physical capacity there is no “permanent” or base model.
Therefore, it is even more relevant to identify current management base
- CPM is aware of system vs. LPAR and group topology and allows commands to targeted against either by Sysplex and system name or CPC and LPAR name

CPM Commands: Adding Defined Capacity

- Command to manually increase the defined capacity limit for an LPAR:

```
▶▶ ACTIVATE DEFINEDCAPACITY [PLEX=name SYS=name] MSU=limit  
A DC [CPC=name LPAR=name]
```

DEACTIVATE DEFINEDCAPACITY is used to decrease the limit

- Example:
 - First 3 messages issued when observation begins. Changes to management base are reported by messages and identified in reports

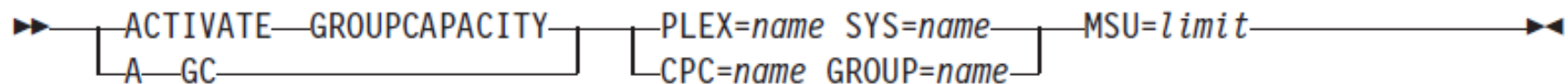
```
CPO3027I Defined capacity information for CPC CPC1 is available  
CPO3986I Defined capacity observed. Current capacity is 50 MSU  
for LPAR LP1 of CPC CPC1 with system PROD1 in sysplex PRODPLEX  
CPO3960I Defined capacity base is 50 MSU for LPAR LP1 of CPC CPC1  
with system PROD1 in sysplex PRODPLEX
```

...

```
MODIFY CPOSERV,APPL=A DC LPAR=SYS4 CPC=EC12 MSU=55  
CPO1289I Defined capacity limit for LPAR SYS4 on CPC EC12  
increased to 55 MSU
```

CPM Commands: Adding Group Capacity

- Command to manually increase/decrease the capacity limit for a capacity group:



DEACTIVATE GROUPOCAPACITY is used to decrease the limit

- Example:

```
CP03027I Defined capacity information for CPC CPC1 is available
...
MODIFY CPOSERV,APPL=A GC GROUP=GROUP1 CPC=CPC1 MSU=1000
CP01298I Group capacity limit for group GROUP1 on CPC CPC1
increased to 1000 MSU
```

- Also for capacity groups the management base is reported

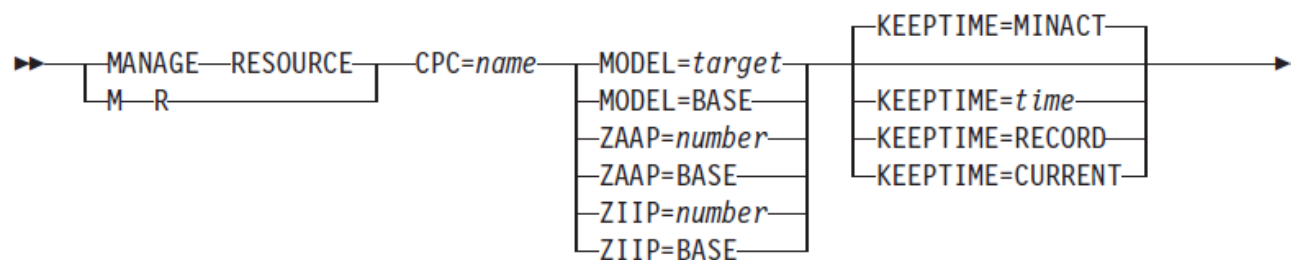
CPM Commands: Reporting on Defined Capacity

- Defined capacity settings can be queried via CPM commands
- Reports on current settings, time-to cap, as well as CPM's management base
 - Equivalent report exists for group capacity
- Example:

```
CP01095I Defined capacity report generated at 12/22/2012 08:45:10
Defined capacity for LPAR SAMPLPAR on CPC SAMPCPC
CPC.LPAR:                                SAMPCPC.SAMPLPAR
Sysplex.System:                          SYSPLEX.SYSTEM1
Management state:                         increased, decrease blocked until
                                           12/22/2012 08:55:05
Policy limit:                             50 additional MSU
Management base:                          100 MSU
Managed capacity:                        30 additional MSU
Current capacity:                         130 MSU
Remaining time until capping:             3 minutes
4 hour rolling average consumption:       122 MSU
```

“Takeover” of manually activated capacity

- Usually the CPM does not include manually activated capacity in its management scope
- However, it can be desired to pass on the responsibility for deactivating capacity to CPM
 - Usually the case when reactive CPM management is not sufficient and capacity needs to be activated proactively (“market open”)
- New MANAGE RESOURCE commands allow transferring temporary capacity to CPM’s managed capacity
 - Additional options to control when capacity may be activated
 - including an option “until end of current 24h H/W activation interval”
 - Only physical capacity can be taken over



New REPORT RECORD command

```

CP04430I Record report generated at 12/22/2012 08:45:10
Record Id:                A0123456 (On/Off CoD)
CPC name:                 G14
Management state:        provisioned
Active resources:         145 MSU, 0 zAAPs, 0 zIIPs
                          0 IFLs, 0 ICFs, 0 SAPs
Managed resources:       1 CPs, 0 CLIs, 0 zAAPs, 0 zIIPs
Activation time:          01/16/2006 16:58:49
Activation limits:        3 zAAPs, 3 zIIPs
                          3 IFLs, 3 ICFs, 3 SAPs
Residual capacity:        150 MSU days,4 zAAP days, 5 zIIP days
                          1 IFL days, 1 ICF days, 1 SAP days

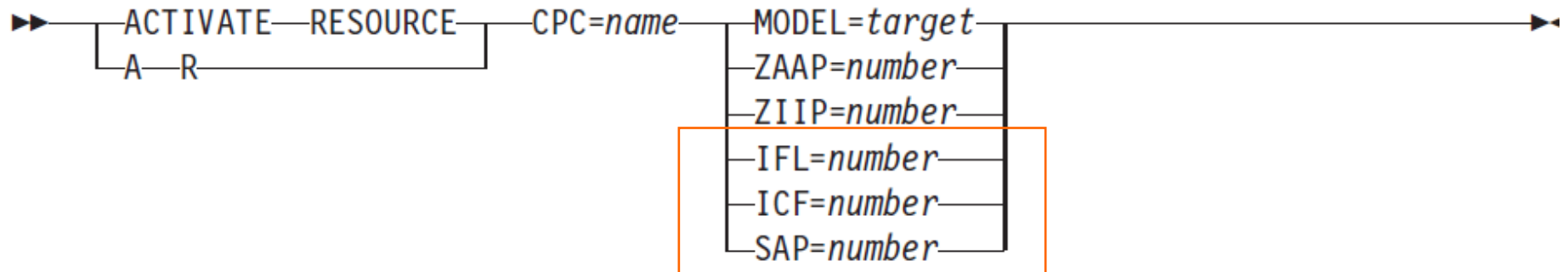
```

- REPORT RECORD reports on current On/Off CoD record, CPM-managed capacity, residual capacity and the allowable target models from the current model.

Allowed models:

Model	CP	CLI	MSU original	MSU absolute	MSU relative	MSU managed	Activation type	
505	0	0	0	240	-145	--	MAN	← Permanent model
506	1	0	39	279	-106	--	MAN	
605	0	1	52	292	-93	--	MAN	
507	2	0	77	317	-68	--	MAN	
606	1	1	99	339	-46	0	MAN	
705	0	2	123	363	-22	--	MAN	
607	2	1	145	385	0	46	PM	← Current model
706	1	2	182	422	37	--	--	← Max model as allowed by record
707	2	2	239	479	94	--	--	

Additional processor types supported for commands



- In addition to general purpose capacity, zAAP and zIIP processors the (DE)ACTIVATE RESOURCE commands now support:
 - IFL processors
 - ICF processors
 - SAP processors
- These additional processor types can only be used with the above commands. There is no policy-based management of these processor types.

New Function Overview – Provisioning Manager

<i>z/OS (CPM) release</i> Function	<i>V2.1</i>	<i>V1.13</i>	<i>V1.12</i>
<i>Capacity increments Recurring time conditions</i>	+	+	OA35284
<i>Static Power Save Mode</i>	+	+	OA30433
<i>Management of Defined Capacity and Group Capacity</i>	+		
<i>Coexistence Support for z/OS V2.1</i>	n/a	OA37450 OA42911	OA37450 OA42911
<i>Commands for IFLs, ICFs, Takeover (Manage Resource)</i>	+		

+: Support integrated into release base

New Function Overview – User Interface

<i>z/OS and z/OSMF release</i> <i>Function</i>	V2.1	V1.13	V1.12
<i>CPCC Windows Vista support</i>		+	+
<i>CPCC Windows 7 support</i>		+	
<i>z/OSMF CPM status monitoring</i>	+	+	
<i>z/OSMF CPM policy management</i>	+	PM74519	

+: Support integrated into release base

Documentation

- For more information contact: IBMCPM@de.ibm.com
- Website <http://www.ibm.com/systems/z/os/zos/features/cpm>
- z/OS MVS Capacity Provisioning User's Guide, SC33-8299, at <http://publibz.boulder.ibm.com/epubs/pdf/iea2u141.pdf>
- IBM DEMOzone Demonstration of Capacity Provisioning
<http://www14.software.ibm.com/webapp/download/demo.jsp?id=IBM+z%2FOS+Capacity+Provisioning+Jan09>
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