



# **Introduction to IBM Java Workload Engine**

## **zAAP**

### **(zSeries Application Assist Processor)**

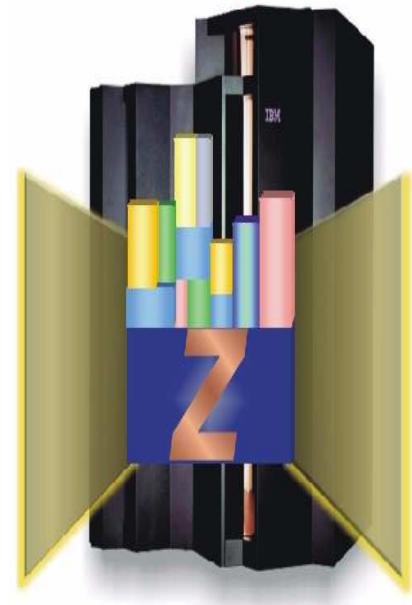
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# Understanding zAAP

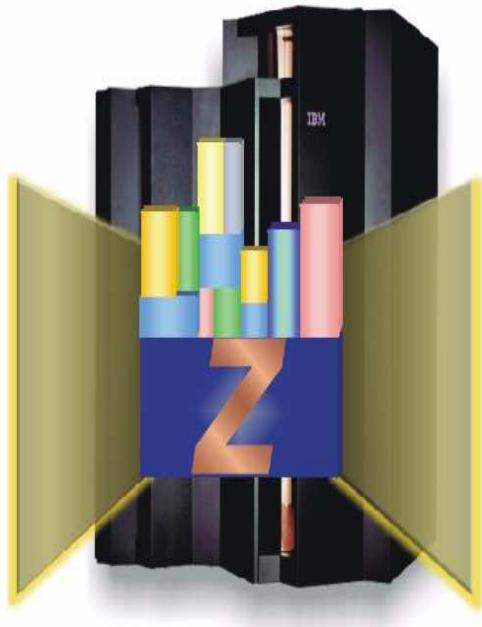
- ❖ What is zAAP?
- ❖ Exploitation Requirements
- ❖ zAAP Architecture and Characteristics
- ❖ zAAP Configuration & Execution Options
- ❖ Projecting zAAP Eligibility
  - SMF/RMF Reporting metrics
  - zAAP Eligibility Projection Tool and Excel Workbook
- ❖ Reference Summary and Wrap-Up

## zSeries Application Assist Processor (aka IFA)

- ❖ A special-purpose processor on z890, z990, z9-109 hardware supporting z/OS Java workloads
- ❖ A specialized z/OS and z/OS.e Java execution environment for Java-based applications
  - With no anticipated modifications to Java application
- ❖ zAAP are attractively priced zSeries processors limited to execute z/OS Java workloads
- ❖ The processor capacity of the zAAP engines are not included when determine capacity-based software license charges from IBM software
  - The amount of savings will vary based on the amount of Java code actually executed by zAAPs



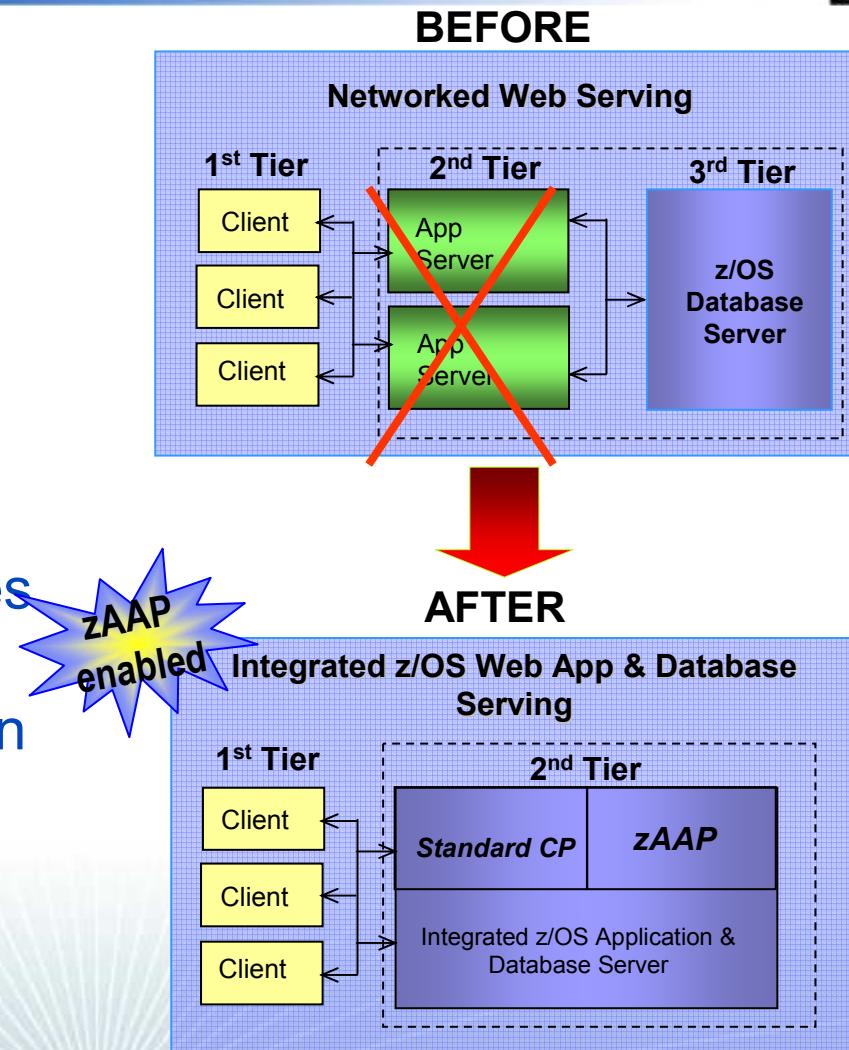
# Requirements for zAAP Exploitation



- ❖ **Prerequisites:**
  - z990 GA3 or z890 or z9-109
  - z/OS V1R6 or z/OS.e V1R6
  - IBM SDK for z/OS, Java 2 Technology Edition, V1.4 with APAR PQ86689
  - Middleware and Applications that are using SDK 1.4
    - WAS V5.1 +
    - CICS® /TS 2.3
    - DB2 V8
    - IMS™ V8
    - WebSphere WBI/SF for z/OS
- ❖ **Processor Resource/Systems Manager™**
  - PR/SM must be enabled
  - zAAPs *must be jointly configured* with the General CPs
  - Using normal PR/SM™ Logical Partition Image Profile
- ❖ **zAAP GA on 9/24/04 with z/OS V1R6**
- ❖ **zAAP operation enhancements**
  - APAR **OA14131** and **OA13953**

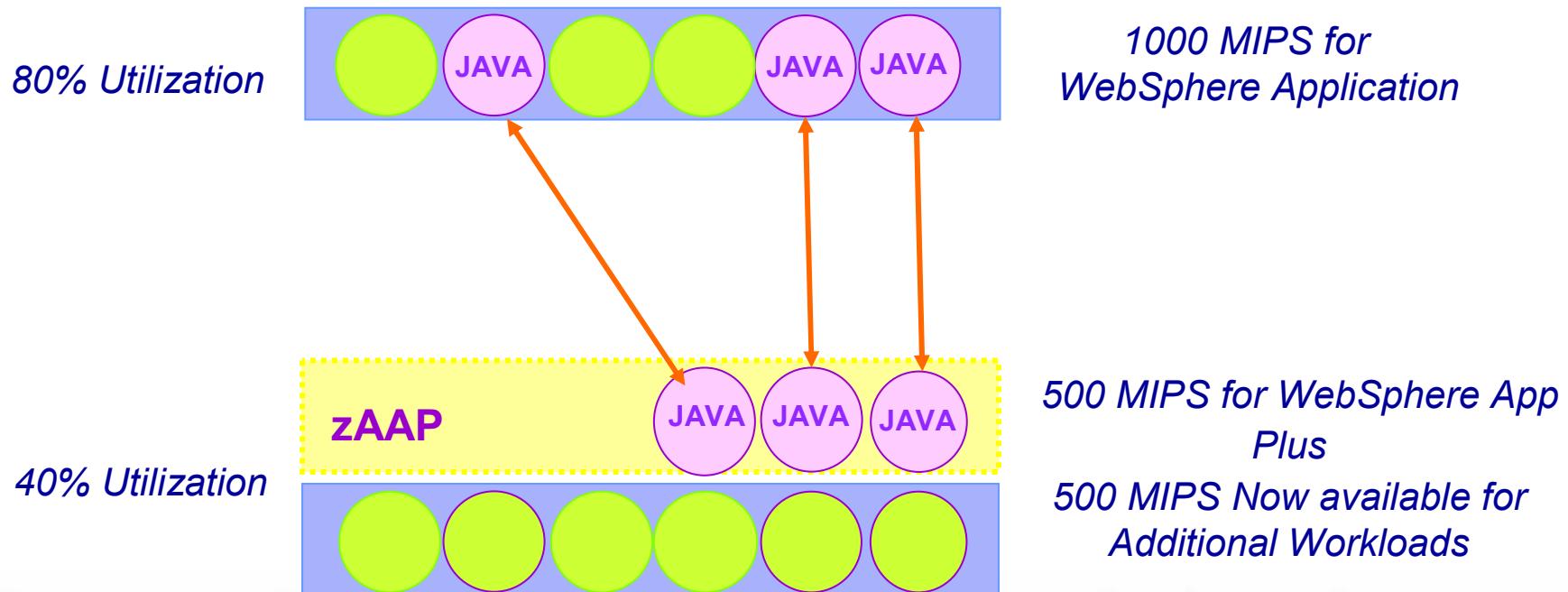
# zAAP Objectives

- ❖ Help simplify and reduce server infrastructures and improve operational efficiencies
- ❖ Help improve standard CP and system productivity
- ❖ Leverage on a single zSeries tier vs multi-tier front and backend data server solution
- ❖ **zAAPs can deliver significant TCA savings**



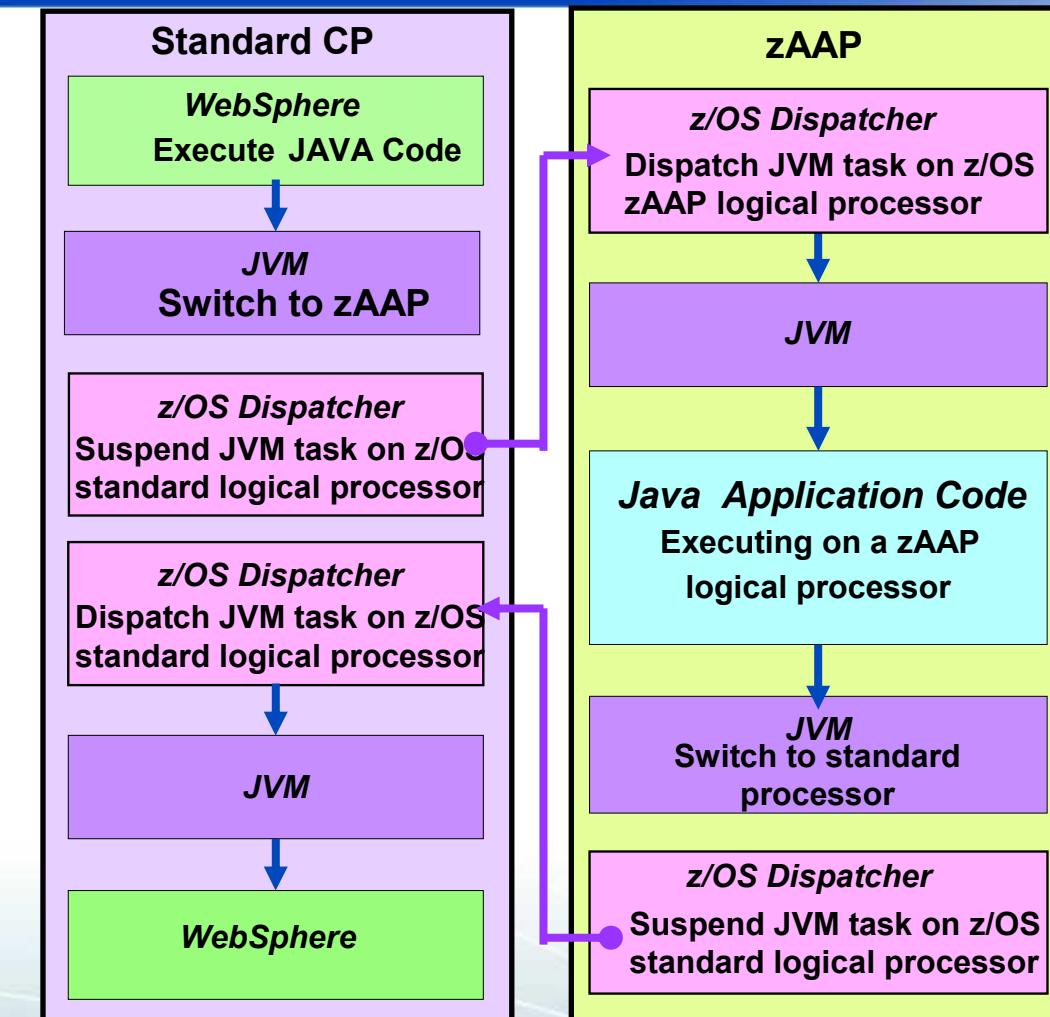
# zAAP Objectives: A Simplified Example

Consider a WebSphere Application that is transactional in nature and requires 1000 MIPS



*With the zAAP engines, we can reduce the standard CP capacity requirement for the Application to 500 MIPS or at a 50% reduction.*

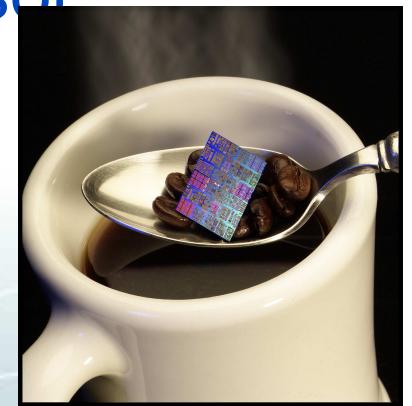
# zAAP Architecture and Process Flow



- ❖ IBM JVM, LE runtime, z/OS Supervisor, WLM, SMF/RMF components are being updated in support of the *zAAP feature*
- ❖ When Java is to be executed, the work unit is "eligible" to be dispatched on a *zAAP*
- ❖ A *Switch Service* is in place to work with the *z/OS Dispatcher*, managing the dispatching of zAAP eligible work between the standard CPs and the *zAAP Engines*

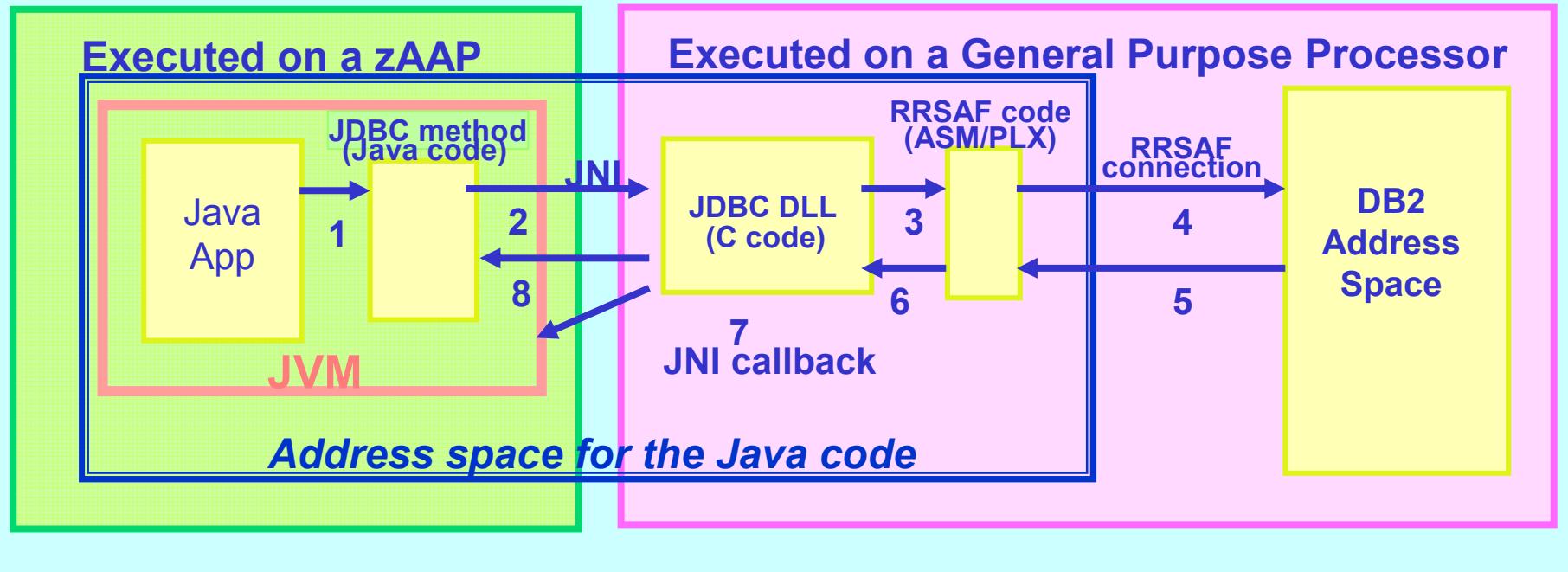
## zAAP Characteristics

- ❖ Can not be IPLed
- ❖ Only executes z/Architecture™ mode instructions
- ❖ Do not support all manual operator controls
  - PSW Restart, LOAD or LOAD derivates (from file, CDROM, Server)
- ❖ Does not respond to SIGP requests unless enabled by z/OS that supports zAAPs
- ❖ The z/OS design accommodates processor differences
  - No I/O interrupts
  - No Clock Comparator interrupts
  - No affinity scheduling



# zAAP Eligibility

## *z/OS Logical Partition*



- ❖ Java application uses a JNI to request a z/OS DB2 database access are outside of JVM, therefore, execute only on the General Purpose Processor

# PR/SM LPAR Configuration Panel



Customize Image Profiles: TC4Q04

Logical processor assignment

Dedicated central processors

Dedicated central processors and integrated facility for applications

Not dedicated central processors

Not dedicated central processors and integrated facility for applications

Not dedicated central processor details

Initial processing weight  1 to 999  Initial capping

Enable WorkLoad Manager

Minimum processing weight

Maximum processing weight

“Not dedicated” zAAP weight equals CP weight, but share calculation is based on ICF+IFL+zAAP weights.

Number of processors – Initial  Reserved

Number of integrated facility for application – Initial  Reserved

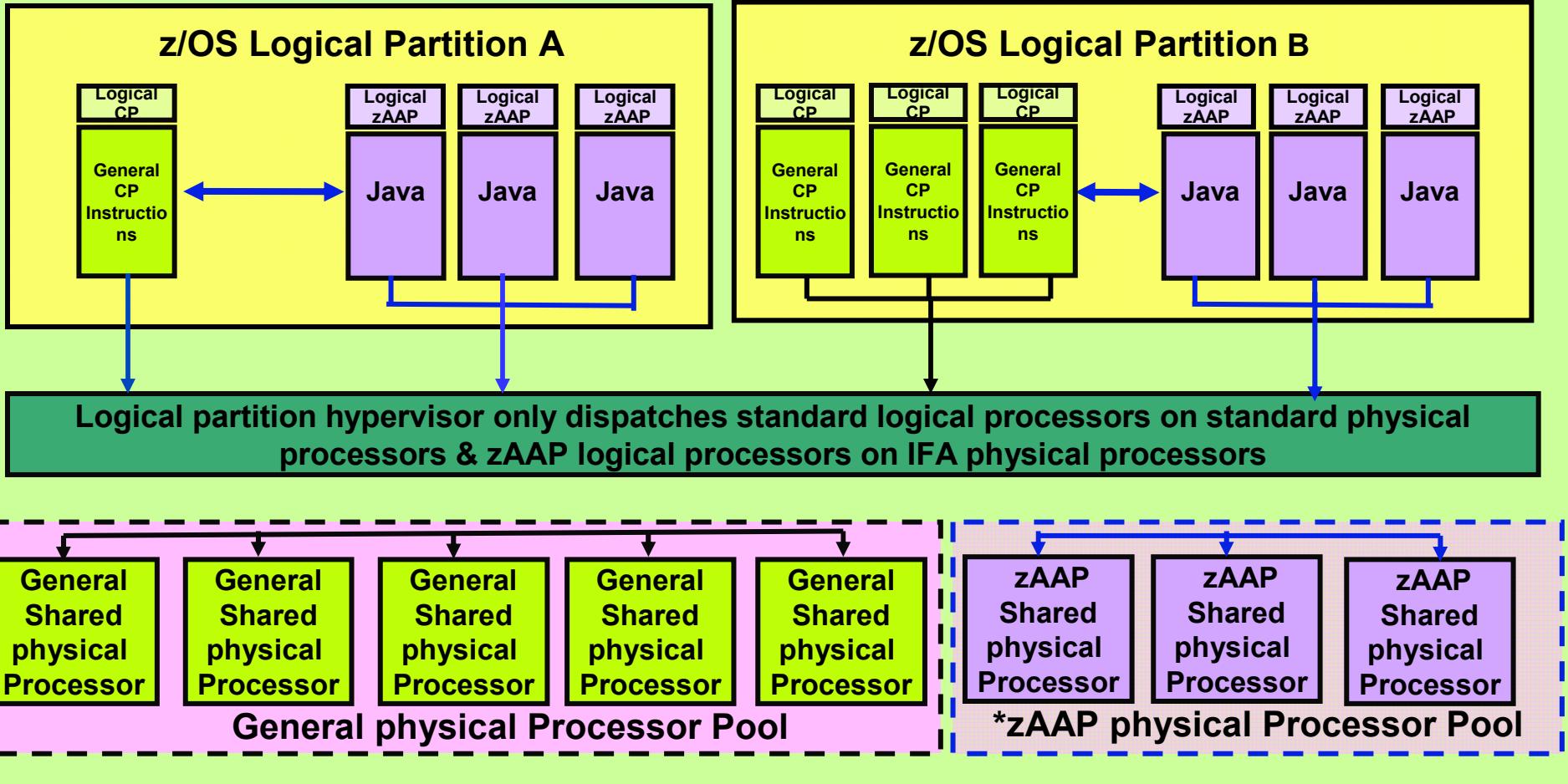
Note: zAAP called “integrated Facility for Applications” (IFA)

General Processor Security Storage Options Load PCI Crypto

Save Copy notebook Paste notebook Assign profile Cancel Help

## zAAP Technical View: Two *zAAP Partitions*

**Note: zAAP = IFA in PRSM panel**



**Note: You cannot install more physical zAAPs than physical CPs but you can assign more logical zAAPs than logical CPs to an LPAR**

# Single Shared ICF Pool Considerations

- ❖ zAAPs, CFs, and Linux partitions all use ICF CPs which are managed out of a single pool of capacity
  - Managed independently from the General CP pool
- ❖ zAAPs will acquire their characteristics from the z/OS partitions using the zAAPs
  - If z/OS uses dedicated CPs, the zAAPs defined to the partition will be dedicated
  - If z/OS uses shared CPs, the zAAPs defined to the partition will use shared CPs and the weight given to the zAPPs will be equal to the z/OS partitions weight

**Important:** The ICF pool's partition weights need to be updated to reflect the introduction of the zAAP

# Managing zAAP Eligible Work (updated with **FLASH10432**)

## New parameters in IEAOPTxx of SYS1.PARMLIB

### ❖ **IFACrossover=Yes**

- zAAP-eligible work can be executed on the standard CPs
  - When the processor entered a wait state
  - Processed at a lower priority than standard discretionary work

### ❖ **IFAHonorPriority=Yes (the default, recommended)**

- Standard CPs may execute both zAAP-eligible and non-eligible work in priority order
  - If zAAP processors are unable to execute all zAAP-eligible

### ❖ **IFAHonorPriority=No**

- zAAP-eligible work can run on standard CPs but at a lower priority than the non-zAAP work

### ❖ **IFACrossover=No**

- Standard CPs will not execute zAAP-eligible work
- ❖ Can be dynamically changed by the SET OPT command

# zAAP Operand Supporting Matrix

Crossover	Honor Priority	General Purpose Processors Behavior
No	No	No zAAP work on General Purpose Processors
No	Yes	zAAP work on General Purpose Processors only when help is needed
Yes	No	zAAP work on General Purpose Processors only when no non-zAAP work is ready
Yes	Yes	zAAP work on General Purpose Processors when help is needed and when no non-zAAP work ready

Note: In the event the last zAAP processor becomes unavailable to process zAAP work, the settings of the IFACROSSOVER and IFAHONORPRIORITY parameters are ignored as if no zAAP processors had been defined to the LPAR  
 The zAAP work is run in priority order with all other work by the GPPs

Reference: FLASH10432

# zAAP Operator Interface

## ❖ D M=CPU

```
IEE174I 17.43.46 DISPLAY M
PROCESSOR STATUS
ID  CPU          SERIAL
00  +
01  +A          136A3A2084
02  +A          136A3A2084
.   .
.   .
.   .
ASSIST PROCESSOR
```

## ❖ CF CPU(nn),OFFLINE | ONLINE

- ❖ zAAPs are not WLM (IRD) managed, so there is no +AW or -AW status
- ❖ SDSF DA reflects zAAP usage (APAR PQ93310)
  - DA panel shows the address space service time on the CP, IFA and IFA service time on the CP

# JVM Startup Options for zAAPs

<code>-Xifa:on</code>	Enables Java workloads to be run on the zAAP processors, if its available. (default setting)
<code>-Xifa:off</code>	Disable the use of zAAP processors
<code>-Xifa:force</code>	Forces Java attempting to use zAAP processors, even if there are none available (Valid on z/OS V1.6 or later)
<code>-Xifa:projectn</code>	Tracks projected zAAP CPU usage and made available to SMF/RMF reporting (Valid on z/OS V1.2, V1.3, V1.4 and V1.5)

- ❖ **`-Xifa:force`** option allow the customers to use SMF 72 records for capacity planning to figure out how many IFAs they would need for their Java workloads
- ❖ **`-Xifa:projectn`** option will help customers to track the "Would- have-been" IFA CPU time (where n is interval length, default value is 15)

**Important:** JVM startup options which are only processed at JVM startup time

# RMF™ Reporting

- ❖ RMF supports zAAP processors by extending the
  - Postprocessor *CPU activity report*
  - Postprocessor *Workload report*
  - Monitor III *Enclave report* (*pop-up panel for IFA Using and Delay samples*)
- ❖ The Internals
  - Distinguishes between standard CP and zAAP processors where necessary
  - Collects and reports about *zAAP service times*
  - Collects and reports about *zAAP using and delay states* for service and report class periods
- ❖ zAAP support is shipped as SPE APAR OA05371
- ❖ PTFs will be available for z/OS V1.5 RMF
  - UA90081 (Base)
  - UA90082 (Kanji)

# zAAP Workload Reporting Samples

## The Resource Consumption Section of the WLMGL report

TRANSACTIONS		TRANS.-TIME	HHH.MM.SS.TTT	--DASD I/O--		----SERVICE----		--SERVICE TIMES--		PAGE-IN	RATES	---
<b>STORAGE----</b>												
AVG	4.42	ACTUAL		8.142	SSCHRT	6.5	IOC	56040	TCB	271.3	SINGLE	0.0
298.08												AVG
MPL	4.39	EXECUTION		8.142	RESP	53.6	CPU	1680K	SRB	9.2	BLOCK	0.0
1309.04												TOTAL
ENDED	1879	QUEUED		0	CONN	20.0	MSO	2938K	RCT	4.4	SHARED	0.0
1309.04												CENTRAL
END/SEC	1.04	R/S AFFINITY		0	DISC	3.2	SRB	56695	IIT	2.0	HSP	0.0
0.00												EXPAND
#SWAPS	3154	INELIGIBLE		0	Q+PEND	25.7	TOT	4731K	HST	3.4	HSP MISS	0.0
EXCTD	0	CONVERSION		0	IOSQ	4.7	/SEC	2626	IFA	20.1	EXP SNGL	0.0
SHARED	0.00											
AVG ENC	0.32	STD DEV		8.431					APPL% CP	15.0	EXP BLK	0.0
REM ENC	0.12						ABSRPTN	598	APPL% IFACP	0.2	EXP SHR	0.0
MS ENC	0.01						TRX SERV	594	APPL% IFA	1.1		

IFA	IFA Service Time (in seconds)
APPL% CP	% of CPU time used by transactions running on regular CPs
APPL% IFACP	% of CPU time used by IFA transactions executed on regular CPs
APPL% IFA	% of CPU time on IFA processors used by IFA transactions

**Note:** If no IFAs/zAAPs configured, N/A is shown for the new fields.

# zAAP CPU Activity Report Samples

CPU 2084 MODEL 316							
---CPU---		ONLINE TIME	LPAR BUSY	MVS BUSY	CPU SERIAL	I/O TOTAL	% I/O INTERRUPTS
NUM	TYPE	PERCENTAGE	TIME PERC	TIME PERC	NUMBER	INTERRUPT RATE	HANDLED VIA TPI
0	CP	100.00	69.41	69.41	011511	58.67	0.00
1	CP	100.00	70.75	70.75	111511	233.6	0.00
2	CP	100.00	68.40	68.40	211511	254.2	0.00
3	CP	100.00	63.64	63.64	311511	63.49	0.00
4	CP	100.00	67.74	67.74	411511	1380	0.01
CP TOTAL/AVERAGE		67.99	67.99		1990	0.01	
8	IFA	100.00	39.41	39.41	811511		
9	IFA	100.00	40.75	40.75	911511		
IFA AVERAGE		40.08	40.08				

- ❖ A new **TYPE** column indicates whether the processor belongs to the pool of regular CPs or IFAs
- ❖ The last two columns are only available for regular CPs
- ❖ A TOTAL/AVERAGE line is printed per pool

# RMF Partition Data Report Sample

MVS PARTITION NAME LP1  
 IMAGE CAPACITY 167  
 NUMBER OF CONFIGURED PARTITIONS 6  
 WAIT COMPLETION NO  
 DISPATCH INTERVAL DYNAMIC

NUMBER OF PHYSICAL PROCESSORS 16  
 CP 8  
 ICF 8

----- PARTITION DATA -----				-- LOGICAL PARTITION PROCESSOR DATA --						-- AVERAGE PROCESSOR UTILIZA			
-----MSU-----				-CAPPING--		PROCESSOR-		----DISPATCH TIME DATA----		LOGICAL PROCESSORS		--- PHYS	
NAME	S	WGT	DEF	ACT	DEF	WLM%	NUM	TYPE	EFFECTIVE	TOTAL	EFFECTIVE	TOTAL	LPAR MGM
LP1	A	50	0	167	NO	0.0	5	CP	00.29.26.356	00.29.27.505	99.94	100.0	0.02
LP2	A	50	0	33	NO	0.0	1	CP	00.05.53.443	00.05.53.501	99.98	100.0	0.00
LP4	A	50	0	268	NO	0.0	8	CP	00.47.08.000	00.47.08.008	100.0	100.0	0.00
*PHYSICAL*													
TOTAL				-----						-----			
ICF2	A	75					8	ICF	00.04.53.443	00.04.53.501	99.98	100.0	0.00
IFL4	A	25					3	ICF	00.24.08.000	00.24.08.008	100.0	100.0	0.00
LP1	A	50					6	ICF	00.09.26.356	00.09.27.505	99.94	100.0	0.02
*PHYSICAL*													
TOTAL				-----						-----			
The ICF block contains logical processors of type ICF, IFL, IFLA, IFLA													

## Do I Need zAAP?

- ❖ Do you have considerable Java workload
- ❖ Anticipate growth in Java workloads
- ❖ Need more capacity
- ❖ Consolidating Java workloads
- ❖ Need to lower the cost of running Java workloads

# How Many zAAPs Do I Need?

## Projecting zAAP eligibility for my Java workload

- ❖ z/OS V1R6 with SDK 1.4.2 (SR2A)
  - SMF Type 30 and 72 records
  - JVM property option `-Xifa:force option`
    - *Plus the Excel workbook*
- ❖ Prior to z/OS V1R6 with SDK 1.3.1
  - Instrumented SDK 1.3.1 SR24 and the Excel workbook
    - Must be at PTF UQ94379
  - ~~Instrumented SDK 1.3.1 SR22 with zAAP Projection Tool and the Excel workbook~~
    - Must be at PTF UQ84703 level
    - Must enable the Projection Tool for each address space

**WP100431 - Obtaining the zAAP Usage Estimation Information in WebSphere for z/OS Version 5**  
**WP100417 - z/OS Performance: Capacity Planning Considerations for zAAP Processors**

# Not All Java Applications Are Created Equal

- ❖ Some are good candidates
  - Heavy Java
- ❖ Some aren't good candidates
  - Light weigh Java
- ❖ The cost of dispatching between zAAP and Standard CPs
  - It costs more to get there than being there
  - Look at the “Switch Rate” and “zAAP eligible microseconds per switch” under Excel workbook

# zAAP Projection Tool

- ❖ SDK 1.3.1 SR22
  - ~~Must be at PTF UQ84703 level~~
- ❖ SDK 1.3.1 SR24: Projection Tool is integrated
  - **SR24 is recommended for zAAP eligibility projection exercise**
- ❖ Integrated as part of SDK 1.4 product
- ❖ Writes Output Message every 5 minutes
  - The information on processor time is provided as messages in standard out for the SDK which is available in the z/OS JOBLOG file
- ❖ A spreadsheet summarization tool is available to assist in the analysis of the zAAP Projection
  - zAAP projection tool workbook.xls (reads from JOBLOG)  
<https://www6.software.ibm.com/dl/zosjava2/zosjava2-p>

# Excel Worksheet Example

SMF name	Instance or Group	RMF interval start	zAAP	CP	Space	%Time zAAP eligible	zAAP% engine eligible	Other Java% engine	Appl% engine	zAAP% w/capt ratio	ZAAPs w/wait
Service Class				newwork				all LPARS			
SYSD	test1	18:31:00	99	102	209	48%	33%	34%	70%	39%	52%
SYSD	test1	18:36:00	104	107	219	48%	35%	36%	73%	41%	55%
SYSD	test1	18:41:00	112	114	234	48%	37%	38%	78%	44%	58%
SYSD	test1	18:46:00	103	105	216	48%	34%	35%	72%	40%	54%

- ❖ Seconds of zAAP eligible processing, non zAAP-eligible (standard CP) processing, and total address space time for the JAVA space(s).
- ❖ Combines data from multiple address spaces (JVMs), service classes and LPARs
- ❖ Combines the data and aligns to intervals such as the RMF interval used.
- ❖ Ability to adjust zAAP utilization factoring in z/OS capture ratios
- ❖ zAAP and standard CP time expressed as a percent of the engine (single CP) that the data was collected on. This can be used as input to the projected number of zAAPs needed factoring in a target maximum utilization to ensure workload responsiveness

# Things You Should Know . . .

- ❖ zAAP capability can be exploited by any Java application using the IBM JVM
- ❖ Number of zAAPs may not exceed the number of permanently purchased CPs (including z990 unassigned CPs or z890 Downgrade – Record Only CPs) on a given machine model
- ❖ All Java applications runs under z/OS are eligible to execute on zAAP engines
  - Java workloads for zLinux are not eligible to run on zAAP engines
- ❖ RMF will use the term IFA (Integrated Facility for Applications) in all reports and panels. The term IFA will also be seen in PR/SM™ Logical Partition Image Profile
- ❖ zPCR support for zAAP capacity planning available since **01/05**
- ❖ IBM does not impose or impact software charges on zAAP capacity for the IBM WebSphere Application Server
- ❖ Although the zAAP engines do not contribute to the rated MSU capacity of a system, provision is made for the customer to do capacity planning, performance management and chargeback related to zAAP processor utilization
- ❖ You should contact your ISVs directly to determine if their charges will be affected by zAAP
- ❖ Don't plan 100% busy time for zAAP engines as you would with the standard CPs

# zAAP Enablement Resources Summary

- ❖ Performance White Paper
  - <http://www-1.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP100417>
- ❖ Techdoc WP100431 Installing zAAP Projection too
  - <http://www-1.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP100431>
- ❖ Techdoc WP100489 Mission: zAAP your costs Running WebSphere and Java on the zSeries Application Assist Processor
  - <http://www-1.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP100489>
- ❖ IBM Redbook on zAAP: SG24-6386
- ❖ IBM zAAP site
  - [ibm.com/zseries/zaap](http://ibm.com/zseries/zaap)
  - Frequently Asked Questions
  - Customer Brochure
- ❖ z990 Latest Enhancements [Announcement Letter \(104-118\)](#).
- ❖ z890 [Announcement Letter \(104-117\)](#).

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Thank  
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