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.
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
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

Note: zAAP called "integrated Facility for Applications" (IFA)

"Not dedicated" zAAP weight equals CP weight, but share calculation is based on ICF+IFL+zAAP weights.
zAAP Technical View: Two zAAP Partitions

Logical partition hypervisor only dispatches standard logical processors on standard physical processors & zAAP logical processors on IFA physical processors

General CP Instructions
Logical CP
Logical zAAP
Java
Java
Java
zAAP Shared physical Processor
General Shared physical Processor
General Shared physical Processor
General Shared physical Processor
General Shared physical Processor
General physical Processor Pool

Logical CP
Logical CP
Logical CP
Logical zAAP
Java
Java
Java
zAAP Shared physical Processor
General Shared physical Processor
General Shared physical Processor
General Shared physical Processor
General Shared physical Processor
General physical Processor Pool

*zAAP physical Processor Pool

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 zAAPs 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 IEALOPTxx 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 executed 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

<table>
<thead>
<tr>
<th>Crossover</th>
<th>Honor Priority</th>
<th>General Purpose Processors Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>No zAAP work on General Purpose Processors</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>zAAP work on General Purpose Processors only when help is needed</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>zAAP work on General Purpose Processors only when no non-zAAP work is ready</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>zAAP work on General Purpose Processors when help is need and when non non-zAAP work ready</td>
</tr>
</tbody>
</table>

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   +      136A3A2084
  01   +A     136A3A2084
  02   +A     136A3A2084
  . . .
  . . .
  A   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

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Xifa:on</td>
<td>Enables Java workloads to be run on the zAAP processors, if its available. (default setting)</td>
</tr>
<tr>
<td>-Xifa:off</td>
<td>Disable the use of zAAP processors</td>
</tr>
<tr>
<td>-Xifa:force</td>
<td>Forces Java attempting to use zAAP processors, even if there are none available (Valid on z/OS V1.6 or later)</td>
</tr>
<tr>
<td>-Xifa:projectn</td>
<td>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)</td>
</tr>
</tbody>
</table>

- **-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)
The Resource Consumption Section of the WLMGL report

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

IFA Service Time (in seconds)

<table>
<thead>
<tr>
<th>IFA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>APPL% CP</td>
<td>% of CPU time used by transactions running on regular CPs</td>
</tr>
<tr>
<td>APPL% IFACP</td>
<td>% of CPU time used by IFA transactions executed on regular CPs</td>
</tr>
<tr>
<td>APPL% IFA</td>
<td>% of CPU time on IFA processors used by IFA transactions</td>
</tr>
</tbody>
</table>

Note: If no IFAs/zAAPs configured, N/A is shown for the new fields.
### zAAP CPU Activity Report Samples

<table>
<thead>
<tr>
<th>CPU 2084 MODEL 316</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>NUM</th>
<th>TYPE</th>
<th>PERCENTAGE</th>
<th>TIME PERC</th>
<th>TIME PERC</th>
<th>NUMBER</th>
<th>I/O TOTAL</th>
<th>% I/O INTERRUPTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>CP</td>
<td>100.00</td>
<td>69.41</td>
<td>69.41</td>
<td>011511</td>
<td>58.67</td>
<td>0.00</td>
</tr>
<tr>
<td>1</td>
<td>CP</td>
<td>100.00</td>
<td>70.75</td>
<td>70.75</td>
<td>111511</td>
<td>233.6</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>CP</td>
<td>100.00</td>
<td>68.40</td>
<td>68.40</td>
<td>211511</td>
<td>254.2</td>
<td>0.00</td>
</tr>
<tr>
<td>3</td>
<td>CP</td>
<td>100.00</td>
<td>63.64</td>
<td>63.64</td>
<td>311511</td>
<td>63.49</td>
<td>0.00</td>
</tr>
<tr>
<td>4</td>
<td>CP</td>
<td>100.00</td>
<td>67.74</td>
<td>67.74</td>
<td>411511</td>
<td>1380</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>CP TOTAL/AVERAGE</td>
<td></td>
<td>67.99</td>
<td>67.99</td>
<td></td>
<td>1990</td>
<td>0.01</td>
</tr>
<tr>
<td>8</td>
<td>IFA</td>
<td>100.00</td>
<td>39.41</td>
<td>39.41</td>
<td>811511</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>IFA</td>
<td>100.00</td>
<td>40.75</td>
<td>40.75</td>
<td>911511</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IFA AVERAGE</td>
<td></td>
<td>40.08</td>
<td>40.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 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

<table>
<thead>
<tr>
<th>MVS PARTITION NAME</th>
<th>LP1</th>
<th>NUMBER OF PHYSICAL PROCESSORS</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMAGE CAPACITY</td>
<td>167</td>
<td>CP</td>
<td>8</td>
</tr>
<tr>
<td>NUMBER OF CONFIGURED PARTITIONS</td>
<td>6</td>
<td>ICF</td>
<td>8</td>
</tr>
<tr>
<td>WAIT COMPLETION</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DISPATCH INTERVAL</td>
<td>DYNAMIC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PARTITION DATA</th>
<th>Logistical PROCESSOR DATA</th>
<th>AVERAGE PROCESSOR UTILIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>S WGT DEF</td>
<td>ACT DEF WLM% NUM</td>
</tr>
<tr>
<td>LP1</td>
<td>A 50 0</td>
<td>167 NO 0 5 CP</td>
</tr>
<tr>
<td>LP2</td>
<td>A 50 0</td>
<td>33 NO 0 1 CP</td>
</tr>
<tr>
<td>LP4</td>
<td>A 50 0</td>
<td>268 NO 0 8 CP</td>
</tr>
<tr>
<td>ICF2</td>
<td>A 75</td>
<td>8 ICF</td>
</tr>
<tr>
<td>IFL4</td>
<td>A 25</td>
<td>3 ICF</td>
</tr>
<tr>
<td>LP1</td>
<td>A 50</td>
<td><em>PHYSICAL</em></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Partition Name & Weight match indicates IFA(s)

The ICF block contains logical processors of type ICF, IFL, IFA
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)
Excel Worksheet Example

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

- 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**

- **Techdoc WP100431 Installing zAAP Projection too**

- **Techdoc WP100489 Mission: zAAP your costs Running WebSphere and Java on the zSeries Application Assist Processor**

- **IBM Redbook on zAAP: SG24-6386**

- **IBM zAAP site**
  - [ibm.com/zseries/zaap](http://ibm.com/zseries/zaap)
  - Frequently Asked Questions
  - Customer Brochure


*W3.ibm.com to learn more on zAAP, Please …Search on “zAAP”*
Thank You