

**zAAPs, zIIPs and Other Specialty Processors**  
**NaSPA**  
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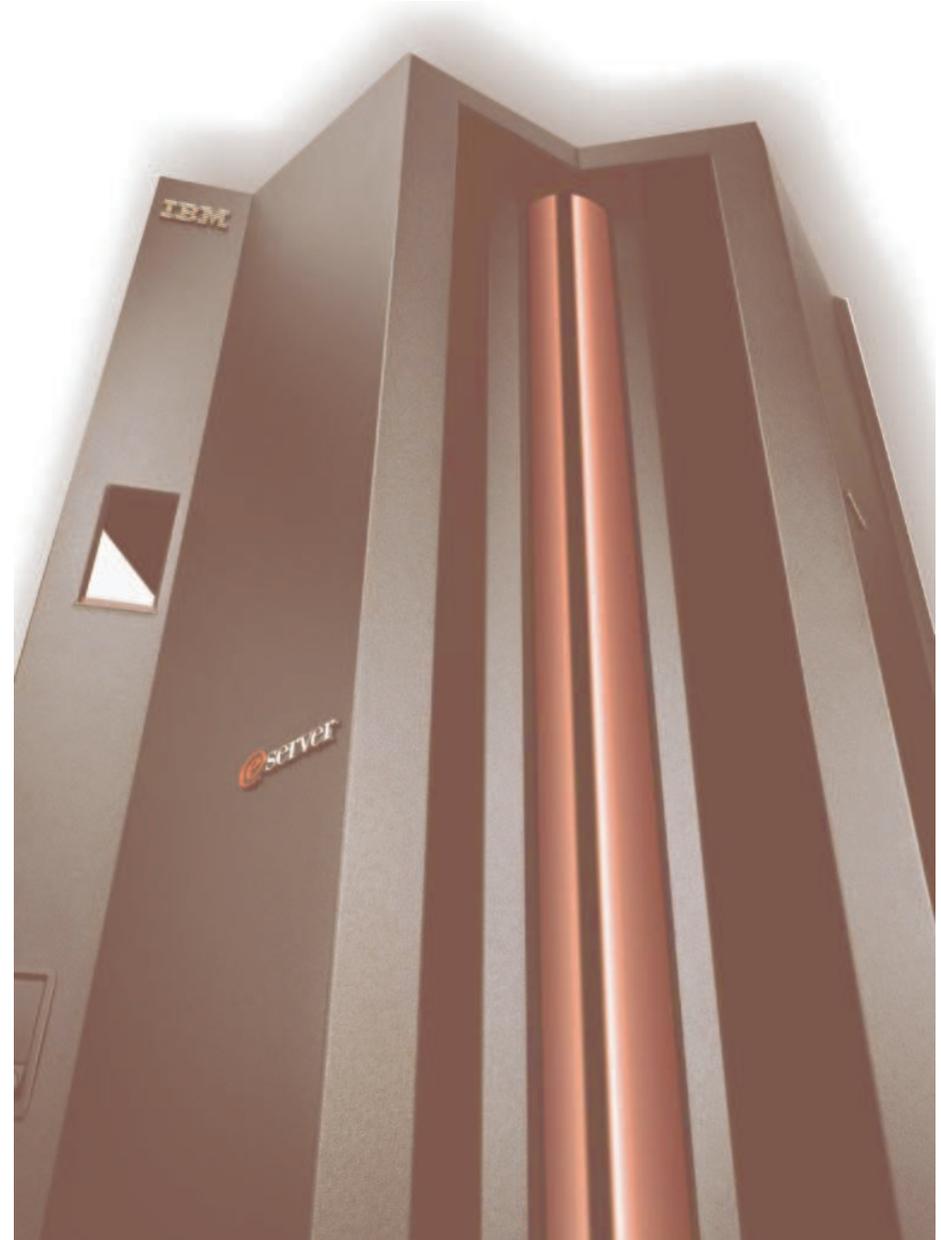
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- **DB2 Connect**
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# Agenda

- **First was the SAP**
- **Integrating the Coupling Facility**
- **Facilitating Linux**
- **Adding the zAAP**
- **and now the zIIP**



# Specialized Mainframe Processors

- **On IBM bipolar mainframe systems, ancillary processing was done on specifically designed processors.**
  - ▶ **I/O processing was at times done on CPUs from a previous generation**
    - **The 3033 used a 158 processor as an "I/O director" which communicated with the I/O channels.**
- **Later, small RISC processors were used for this type of processing to offload from expensive bipolar hardware to less expensive CMOS hardware**
  - ▶ **The ES/9000 had a RISC I/O Processor (IOP)**
  - ▶ **Also implemented the asynchronous data mover facility (ADMF)**
  - ▶ **Other offloaded functions were predicted (database, sort, etc.)**

# The System Assist Processor (SAP)

- **The System Assist Processor (SAP) was introduced in 1994 with first 9672 processors**
- **Implemented on the same chip as customer CPs**
- **Performed a number of functions**
  - ▶ **I/O processing - communication with channel cards**
  - ▶ **Asynchronous Data Mover Facility (this function was dropped on zSeries processors)**
  - ▶ **Communication to the Service Element and Hardware Management Console**
  - ▶ **Only runs Licensed Internal Code (LIC)**

## Specialized Mainframe Processors

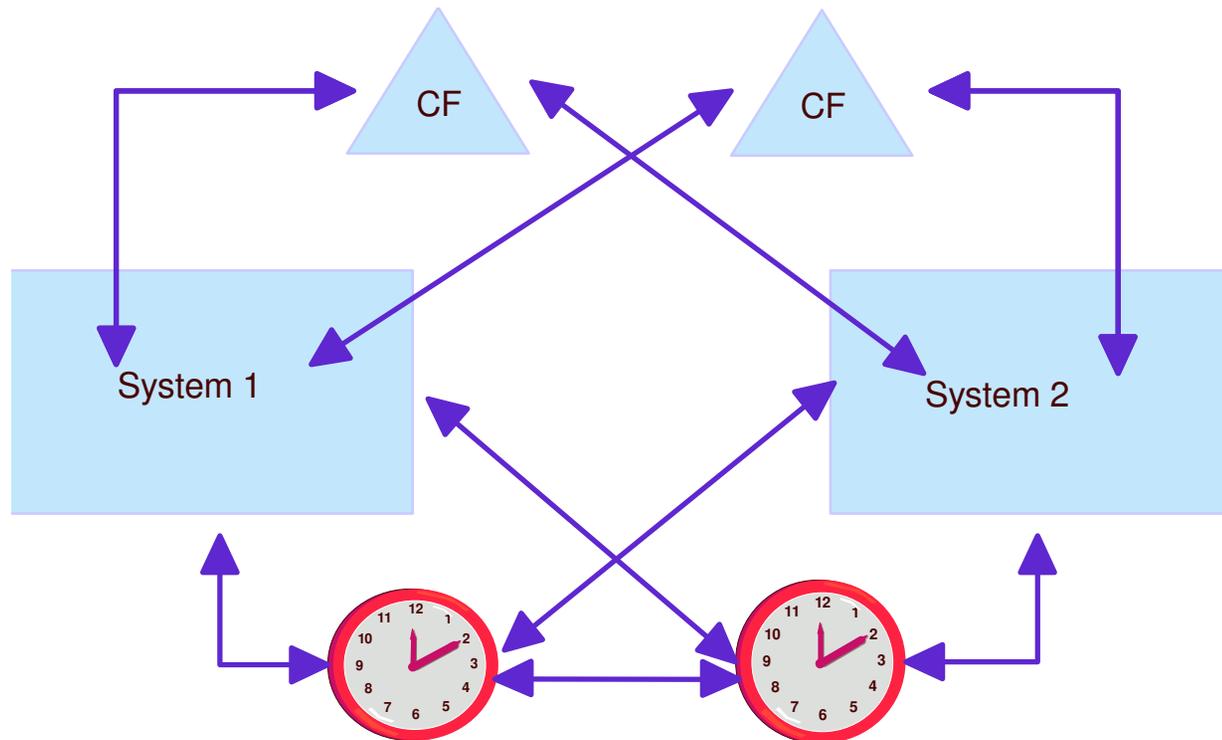
- **With the introduction of the IBM 9672 CMOS mainframes in 1994, things changed:**
  - ▶ **less incentive to offload functions from CMOS engines to specialized CMOS processors.**
  - ▶ **there are design and manufacturing efficiencies if specially designed processors are not required for I/O processing, etc.**
  - ▶ **it became economically reasonable to use the same CMOS processor chips that run customer applications for specialized activities.**

# The System Assist Processor (SAP)

- **The SAPs are not visible to the operating system and are not seen by it in the hardware configuration**
- **The SAP set the precedent for IBM not charging any IBM software license charges for the capacity contributed to the system by specialty engines.**
- **Because it is implemented on the same CP chip, a spare CP, or even an active CP if there are no spares, can be used for recovery if the last SAP fails.**
  - ▶ **Provides enhanced availability without additional cost**
- **Normally the system comes with a predefined number of SAPs which are priced with the system.**
  - ▶ **an RPQ can be requested if more are needed (e.g. for TPF)**

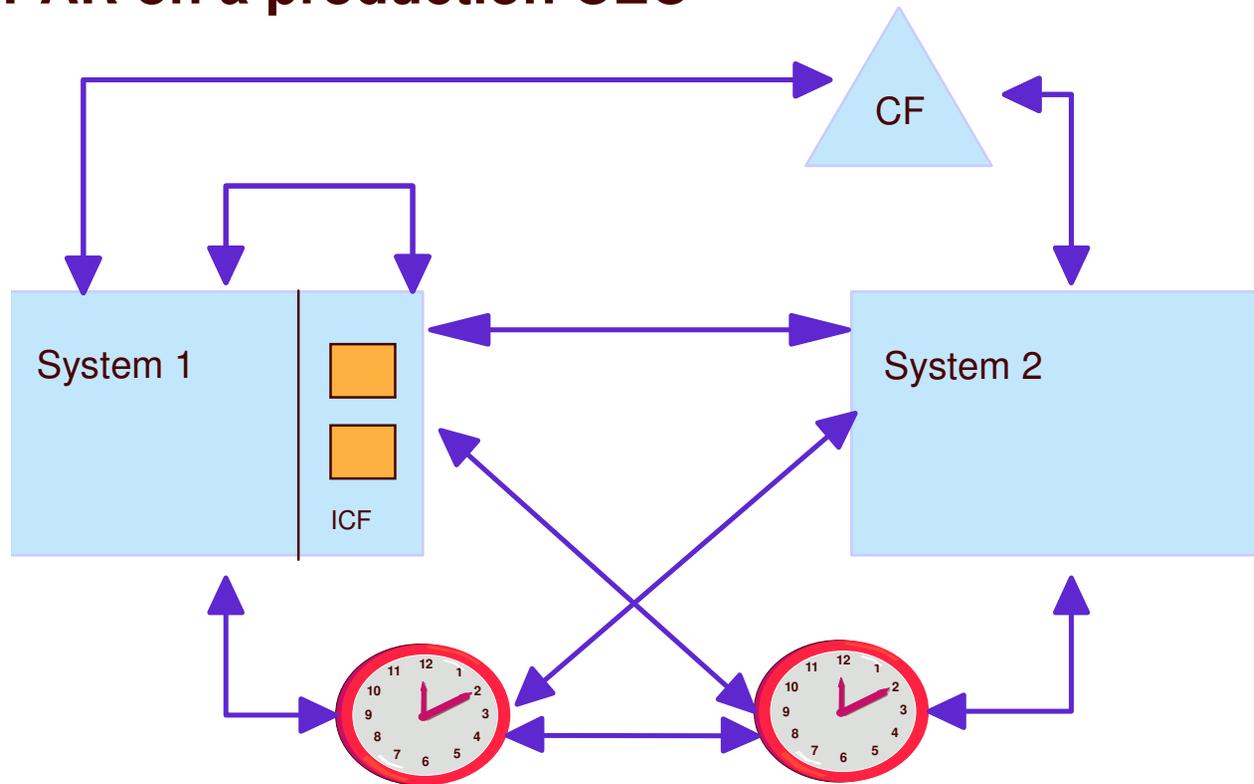
# External Coupling Facilities

- **Initial Parallel Sysplex implementation required external CFs in separate boxes**
  - ▶ actually two, to avoid a single point of failure.
  - ▶ but, the implementation used 9672 processor chips



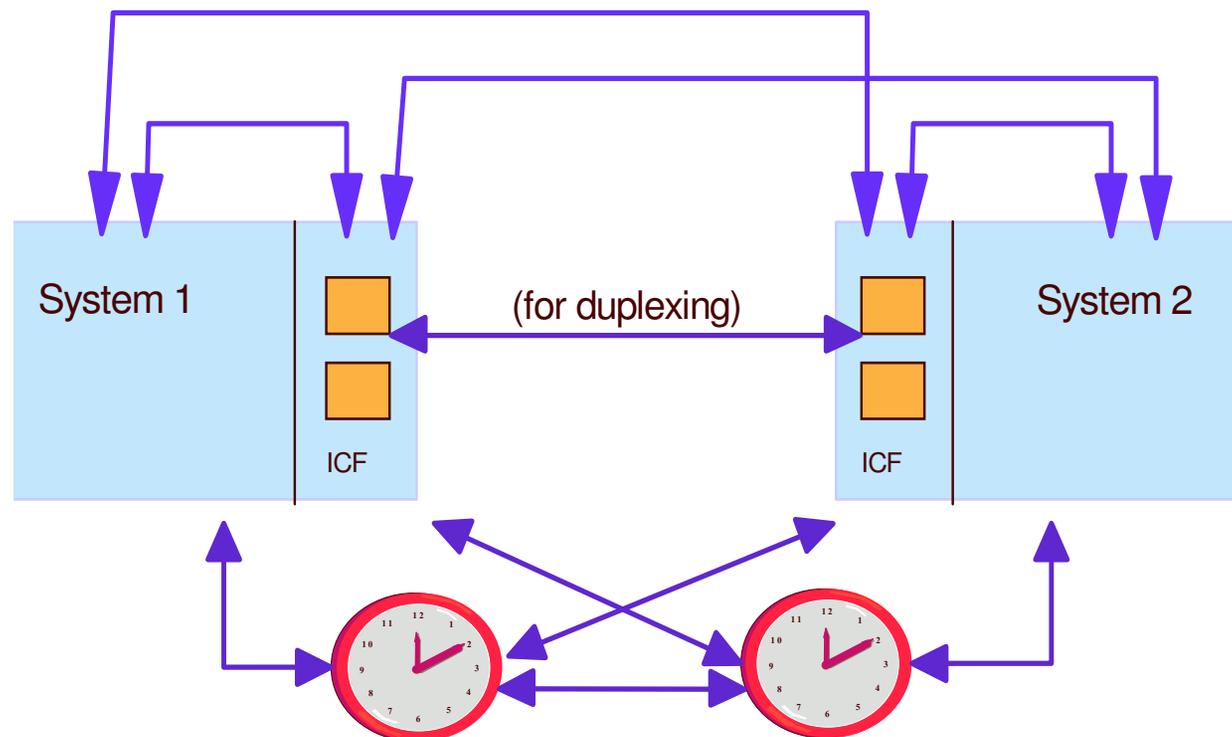
## Internal Coupling Facilities

- Since the CF was implemented using 9672 CP chips, it was possible to implement "internal CFs".
  - ▶ The introduction of ICFs in 1997 allowed the backup CF to be an LPAR on a production CEC



# Internal Coupling Facilities

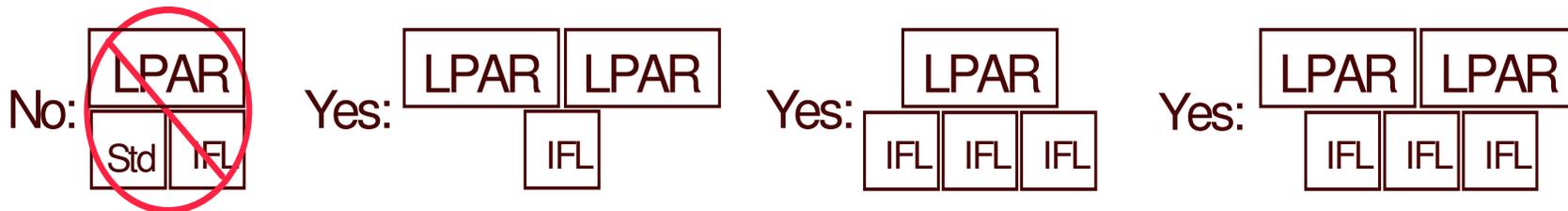
- **With the introduction of CF duplexing, it becomes possible to use internal CFs on both CECs**
  - ▶ Helped improved price/performance
  - ▶ CFs are not a single point of failure



# zSeries Integrated Facility for Linux (IFL)



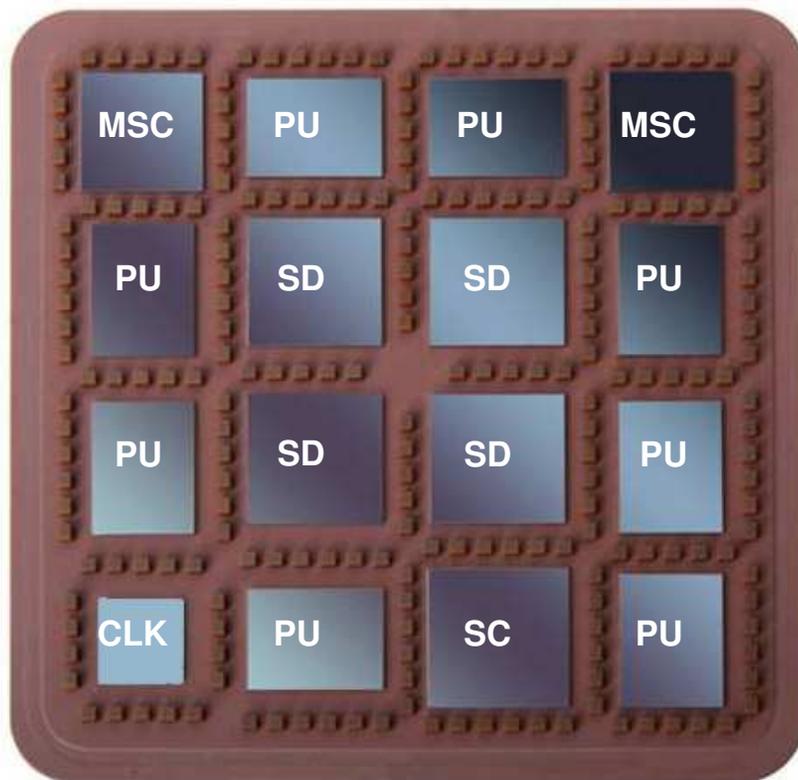
- **IFLs are processors dedicated to Linux-only workloads**
  - ▶ Allocated from the set of spare processors
  - ▶ Less expensive than standard processors
  - ▶ Will not support traditional mainframe operating systems
  - ▶ Only usable in LPAR mode
  - ▶ IFLs cannot be mixed with standard processors in a partition
  
- **Available with System z9 and zSeries servers**
  - ▶ Fully configured standard engine servers do not have spare processors available for IFLs
  
- **Adding IFLs does not change a server's model designation**
  - ▶ No increase in fees for IBM software installed on standard processors



## z9 EC multi-chip module (MCM)

- Advanced 95mm x 95mm MCM

- ▶ 102 Glass Ceramic layers
- ▶ 16 chip sites, 217 capacitors
- ▶ 540 m of internal wiring



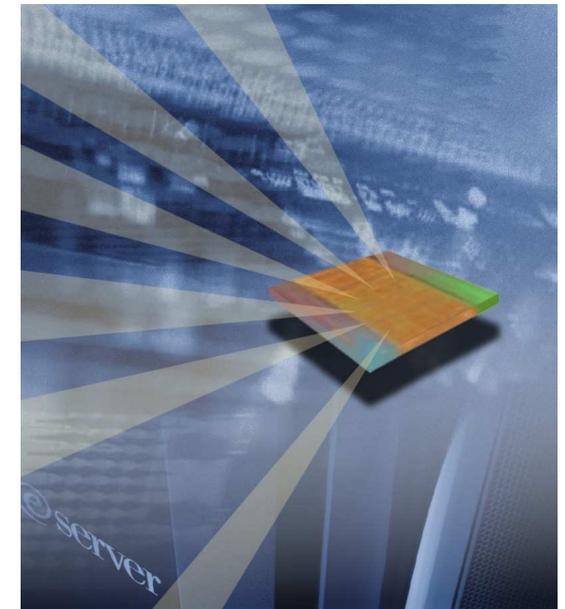
- CMOS 10K chip Technology

- ▶ PU, SC, SD and MSC chips
- ▶ Copper interconnections, 10 copper layers
- ▶ 8 PU chips/MCM
  - 15.78 mm x 11.84 mm
  - 121 million transistors/chip
  - L1 cache/PU
    - 256 KB I-cache
    - 256 KB D-cache
  - 0.58 ns Cycle Time
- ▶ 4 System Data (SD) cache chips/MCM
  - 15.66 mm x 15.40mm
  - 660 million transistors/chip
  - L2 cache per Book: 40 MB
- ▶ One Storage Control (SC) chip
  - 16.41mm x 16.41mm
  - 162 million transistors
  - L2 cache crosspoint switch
  - L2 access rings to/from other MCMs
- ▶ Two Memory Storage Control (MSC) chips
  - 14.31 mm x 14.31 mm
  - 24 million transistors/chip
  - Memory cards (L3) interface to L2
  - L2 access to/from MBAs (off MCM)
- ▶ One Clock (CLK) chip - CMOS 8S
  - ▶ Clock and ETR Receiver

# The zSeries Application Assist Processor (zAAP)

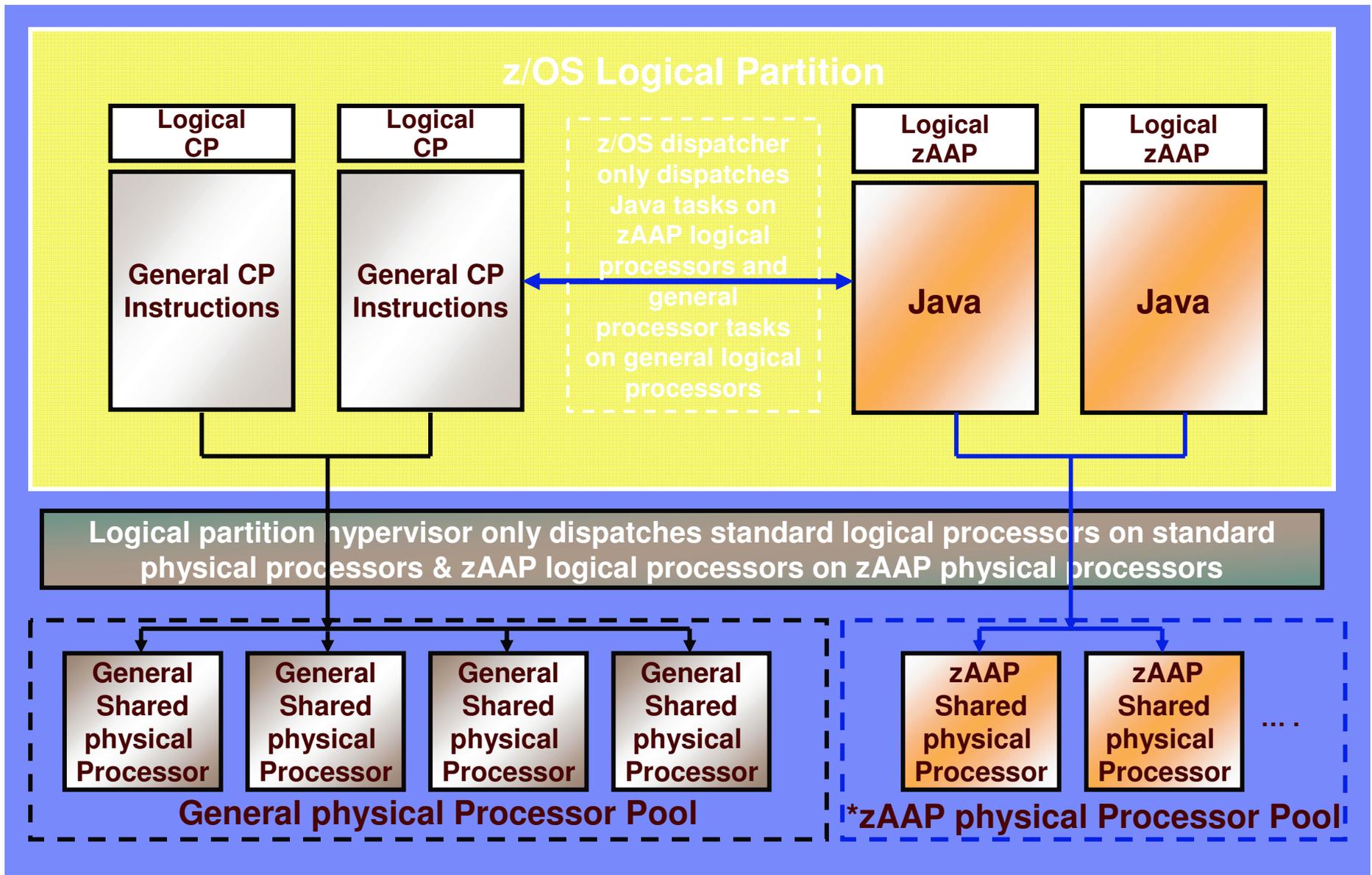
***New specialty assist processor dedicated exclusively to execution of Java workloads under z/OS® – e.g. WebSphere®***

- ▶ **zAAP - zSeries Application Assist Processor**
- ▶ **A processor type on the z990, z890, System z9 EC and System z9 BC**
- ▶ **A special-purpose processor that is used for the IBM Java Virtual Machine on z/OS to support Java workloads**
- ▶ **A specialized z/OS Java execution environment for Java-based applications**
- ▶ **With no anticipated modifications to Java applications**
- ▶ **The processor capacity of the zAAP engines are not included when determining capacity-based software license charges from IBM software**



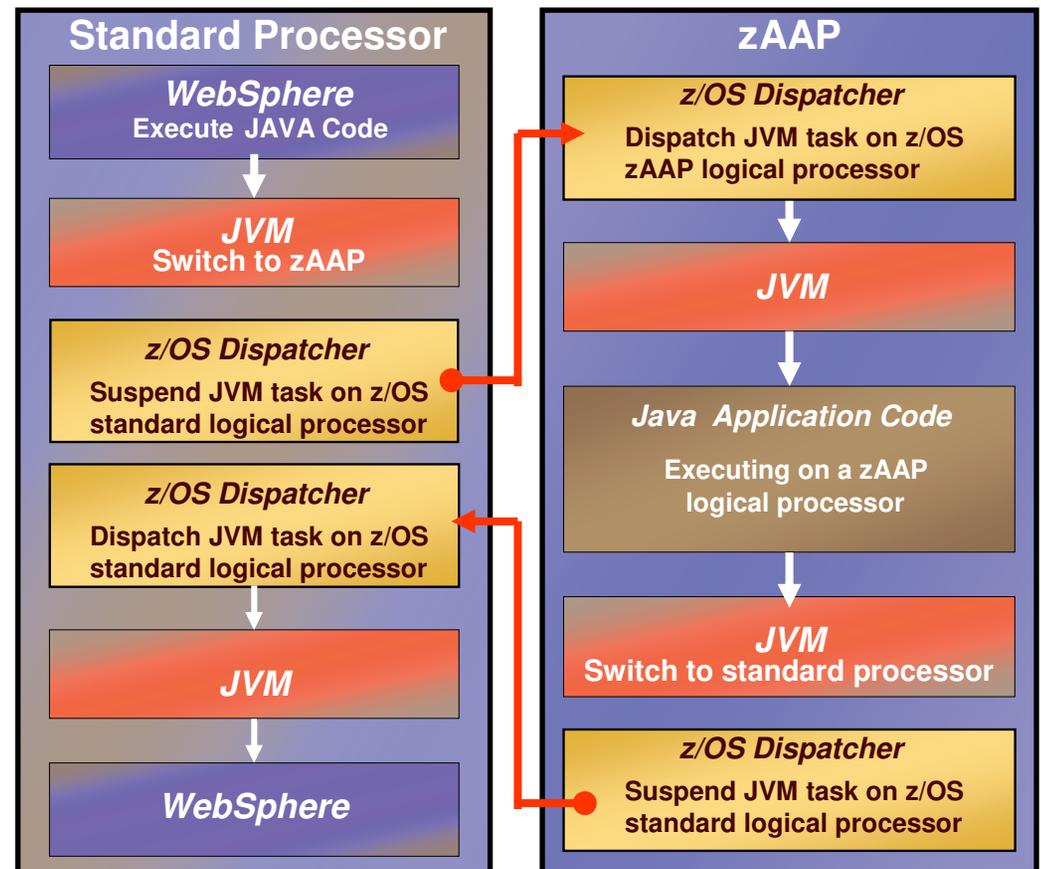
***Objective: Enable integration of new Java based Web applications with core z/OS backend database environment for high performance, reliability, availability, security, and lower total cost of ownership***

# zAAP Technical Overview: z/OS zAAP Partition



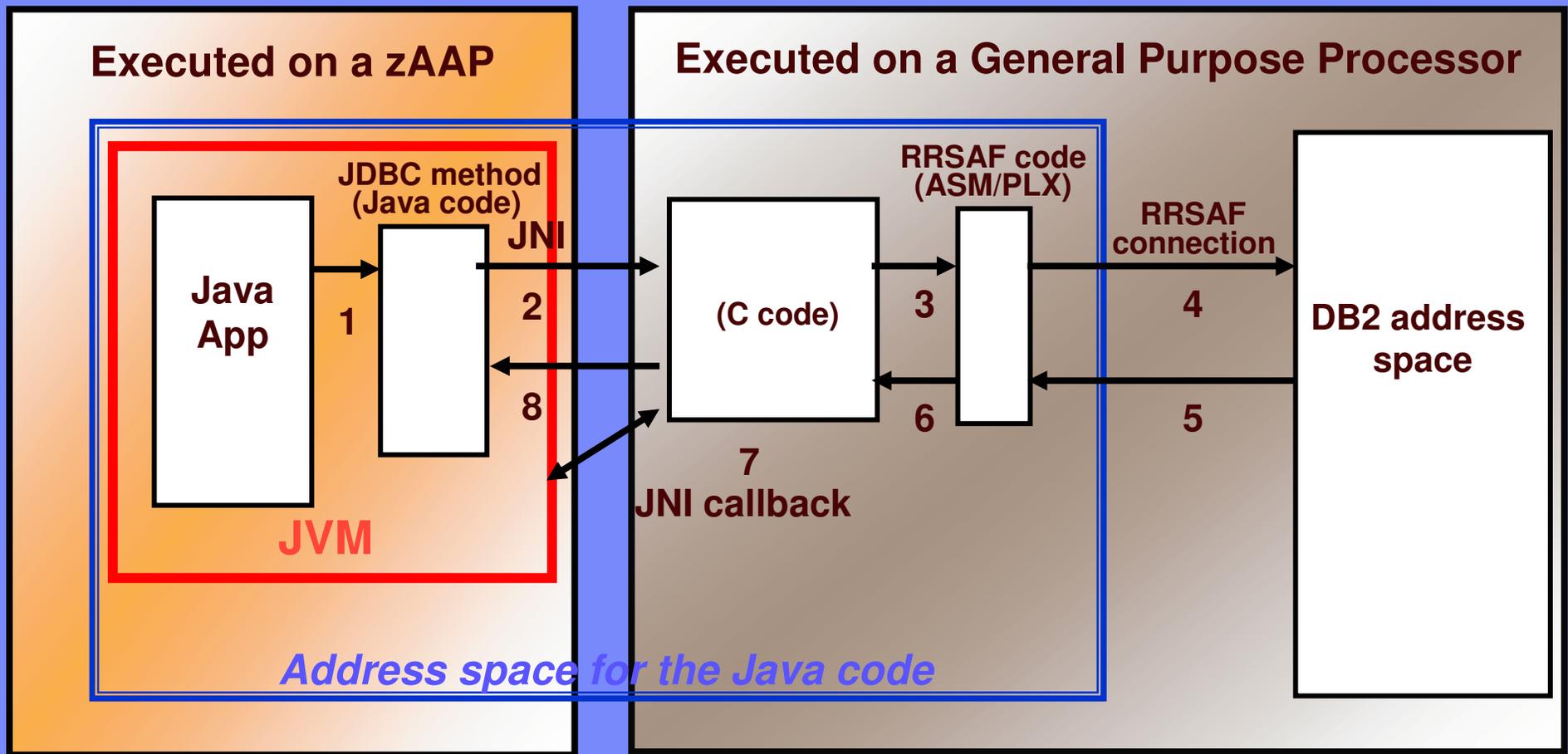
# zAAP Architecture and Workflow: Executing Java under IBM JVM control

- IBM JVM, parts of LE runtime, and z/OS Supervisor needed to support JVM execution can operate on zAAPs
- IBM JVM communicates to z/OS dispatcher when Java code is to be executed
- When Java is to be executed, the work unit is "eligible" to be dispatched on a zAAP
- zAAP ineligible work only dispatched on standard processors
- There is an installation control to limit the use of standard processors to execute zAAP eligible work



# zAAP Integration at Work: Java App calling DB2

## z/OS Logical Partition



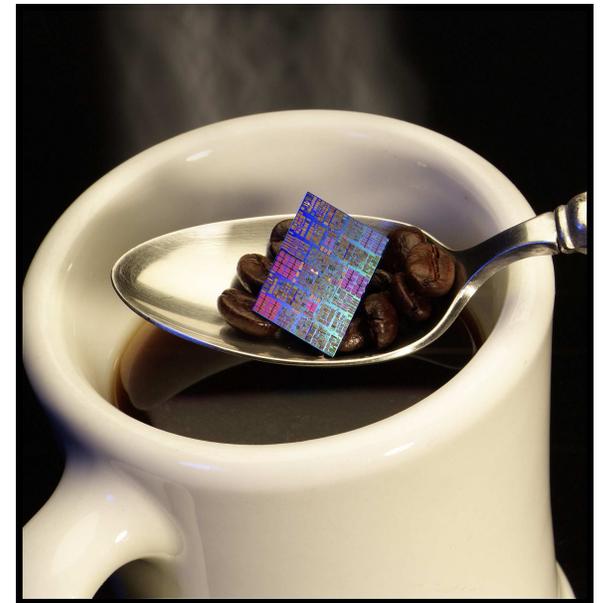
# How zAAPs Differ from General Purpose Processors

## ■ Some zAAPs Limitations

- ▶ zAAPs cannot be IPLed
- ▶ zAAPs only executes z/Architecture™ mode instructions
- ▶ zAAPs do not support all manual operator controls
  - No: PSW Restart, LOAD or LOAD derivatives (load from file, CDROM, Server)
- ▶ zAAPs don't respond to SIGP requests unless enabled by a z/OS that supports zAAPs

## ■ The z/OS design accommodates processor differences for zAAPs:

- ▶ No I/O interrupts
- ▶ No Clock Comparator interrupts
- ▶ No affinity scheduling



# Requirements for zAAP Exploitation

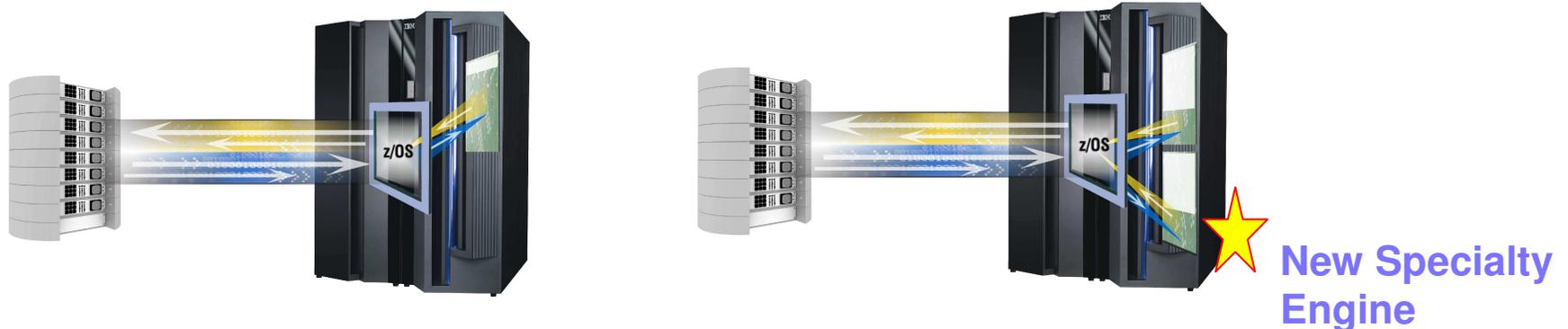
- Available on z990, z890, System z9 EC and System z9 BC models only
- Prerequisites:
  - ▶ z/OS 1.6 (or z/OS.e 1.6)
  - ▶ IBM SDK for z/OS, Java 2 Technology Edition, V1.4 with PTF for APAR PQ86689
  - ▶ Processor Resource/Systems Manager (PR/SM) must be enabled.
- Subsystems and Apps using SDK 1.4 exploit zAAPs automatically:
  - ▶ WAS 5.1
  - ▶ CICS® /TS 2.3
  - ▶ DB2 V7, DB2 V8
  - ▶ IMS™ V7, IMS™ V8, IMS™ V9
  - ▶ WebSphere WBI for z/OS
- zAAPs must be jointly configured with general purpose processors within z/OS LPARs
  - ▶ 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.

## IBM System z9 Integrated Information Processor (zIIP)

- **The new zIIP is introduced to run various low-level system and subsystem code.**
  - ▶ **The zIIP is designed so that an authorized program can work with z/OS to have all or a portion of its enclave Service Request Block (SRB) work directed to the zIIP.**
  - ▶ **Once given directions from the program that creates the enclave and schedules the SRBs into it, the z/OS dispatcher manages the redirection of the work to zIIPs.**

# DB2 V8 exploitation of IBM zIIP can add value to database workloads

- Portions of the following DB2 for z/OS V8 workloads may benefit from zIIP
  1. ERP, CRM, Business Intelligence or other enterprise applications
    - Via DRDA<sup>®</sup> over a TCP/IP connection



2. Data warehousing applications
  - Requests that result in long running parallel queries
3. DB2 for z/OS V8 utilities
  - Internal DB2 utility functions used to maintain index maintenance structures

## How does the zIIP work .....

The zIIP is designed so that a program can work with z/OS to have all or a portion of its enclave Service Request Block (SRB) work directed to the zIIP. The types of DB2 V8 work listed below are those executing in enclave SRBs, portions of which can be sent to the zIIP.

### Example 1 = Distributed SQL requests (DRDA)

Queries that access DB2 for z/OS V8 via DRDA over a TCP/IP connection are dispatched within z/OS in enclave SRBs. z/OS directs a portion of this work to the zIIP.

### Example 2 = Complex parallel query (BI)

Long running parallel queries will now use enclave SRBs. z/OS directs a portion of this work to the zIIP.

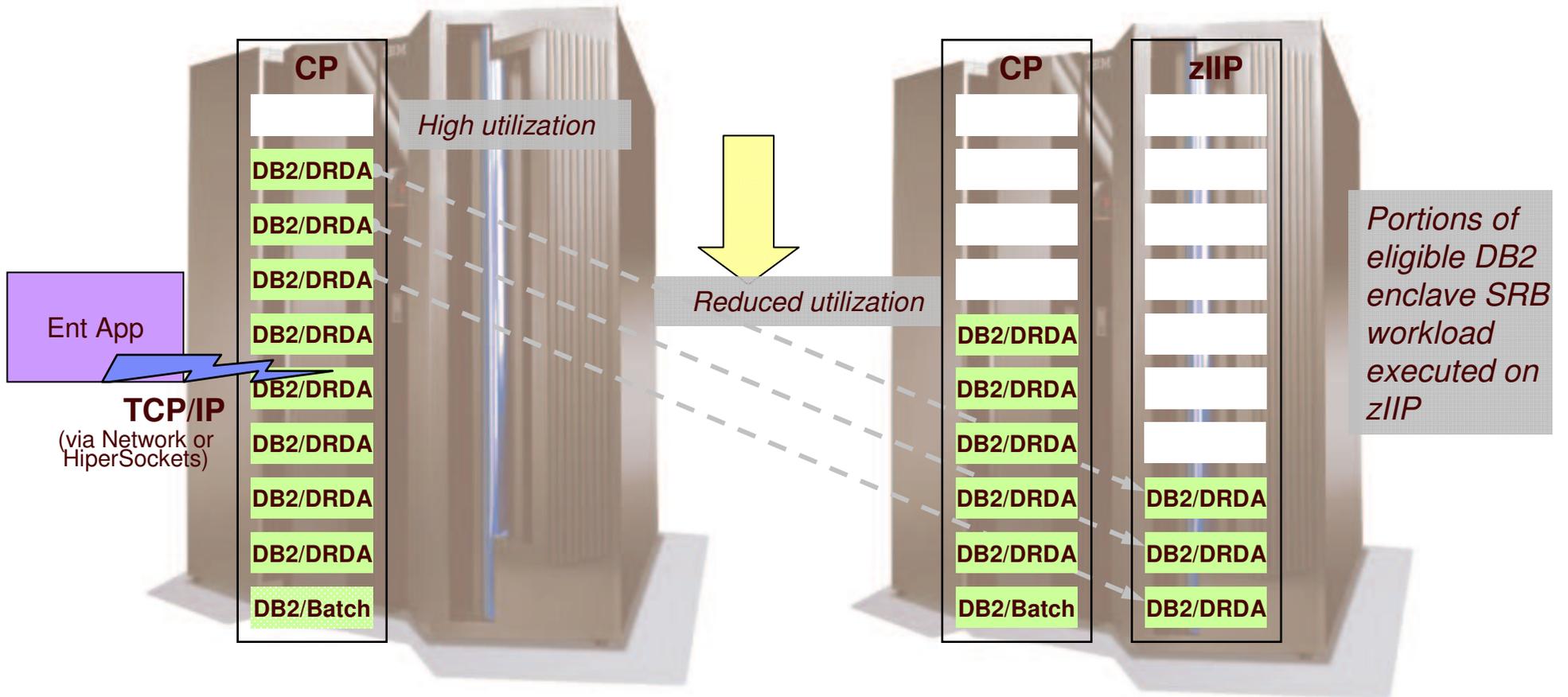
### Example 3 = DB2 utilities for index maintenance

DB2 utilities LOAD, REORG, and REBUILD will now use enclave SRBs for the portion of the processing that is related to index maintenance. z/OS directs a portion of this work to the zIIP.



# Example 1: Enterprise Applications

Enterprise Applications that access DB2 for z/OS V8 via DRDA over a TCP/IP connection will have portions of these SQL requests directed to the zIIP

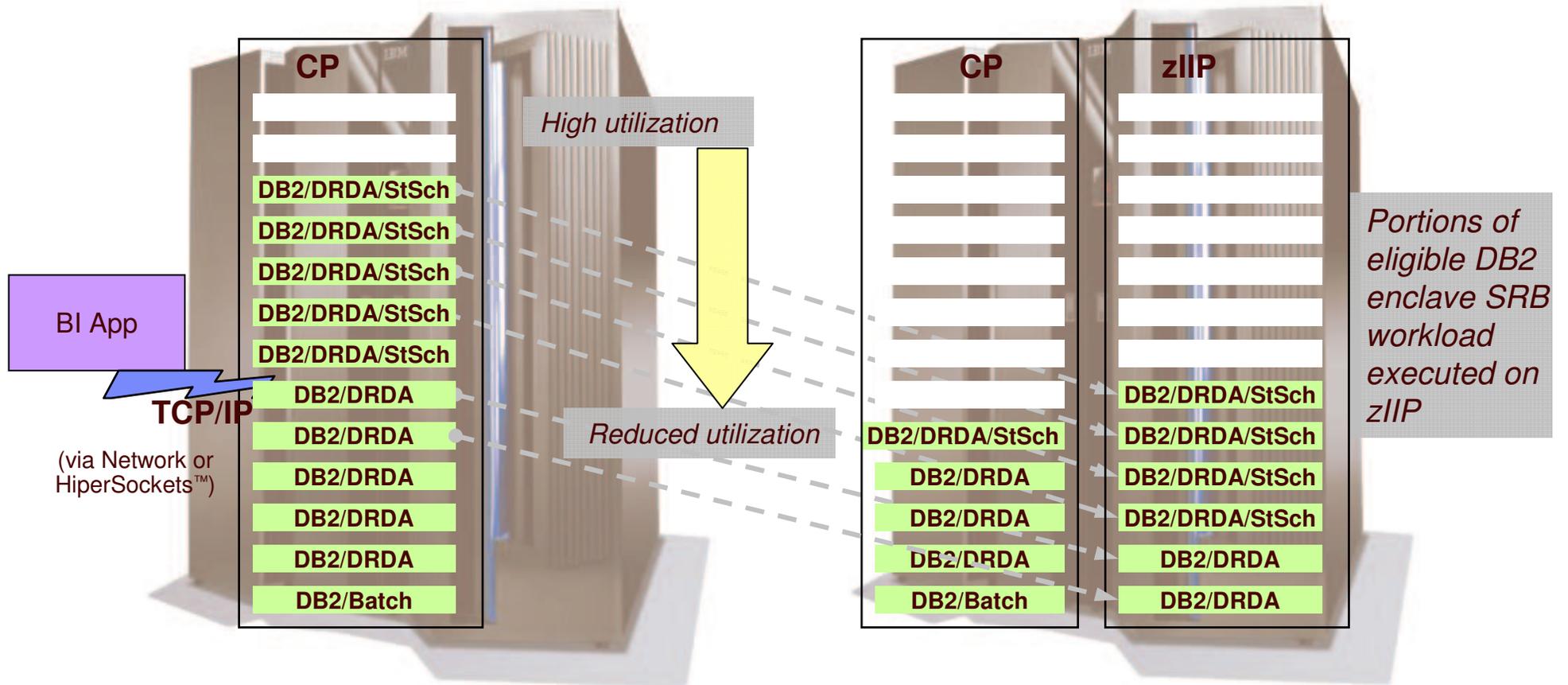


For illustrative purposes only  
Actual workload redirects may vary



# Example 2.0: Business Intelligence Applications

Complex parallel queries via DRDA over a TCP/IP connection will have portions of this work directed to the zIIP



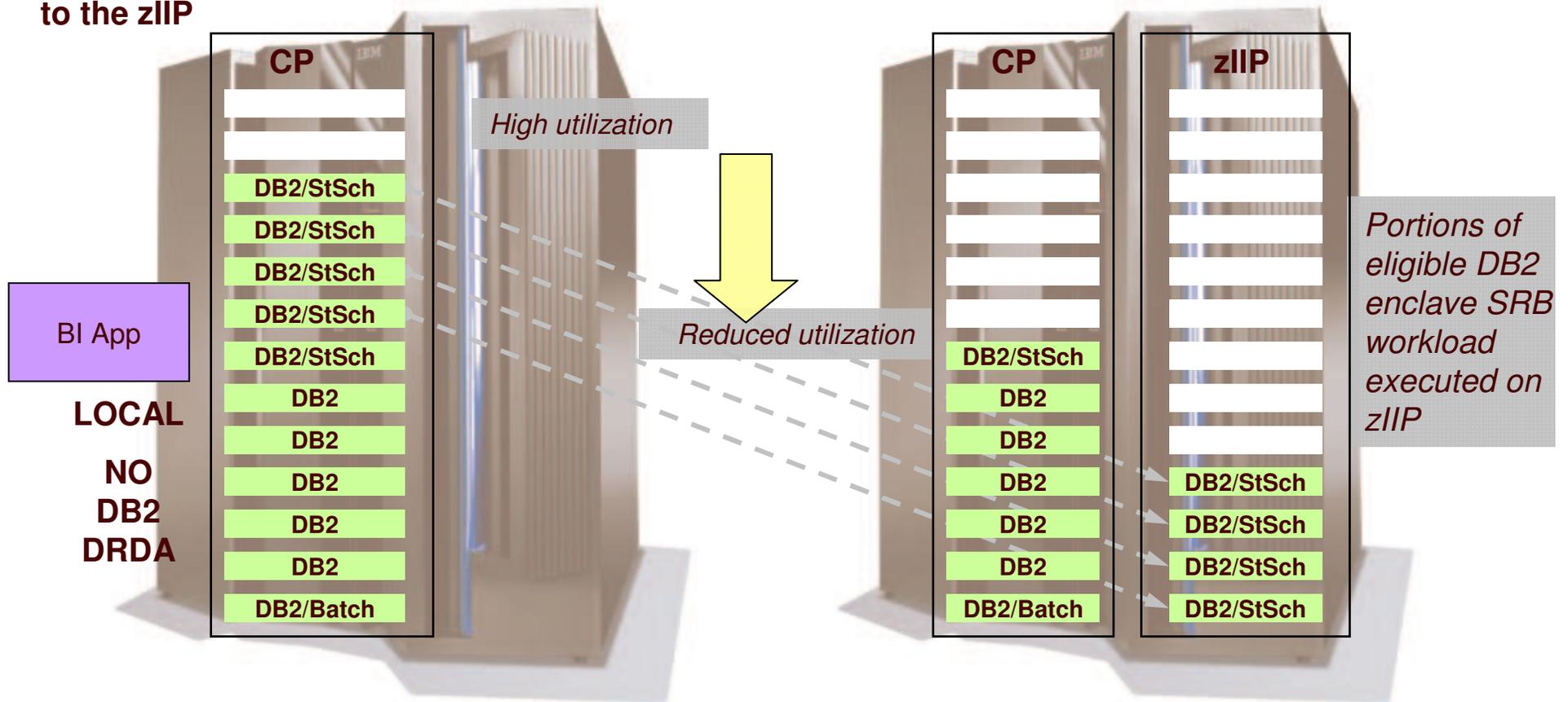
For illustrative purposes only

Actual workload redirects may vary depending on how long the queries run, how much parallelism is used, and the number of zIIPs and CPs employed



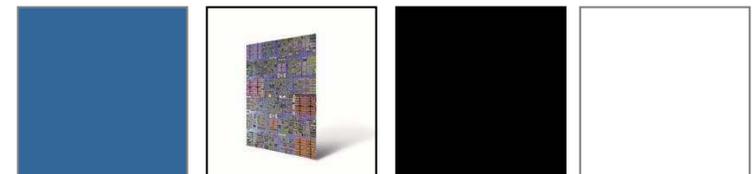
# Example 2.5: Business Intelligence Applications (local - no DRDA)

Long running parallel queries via LOCAL connection will have portions of this work directed to the zIIP



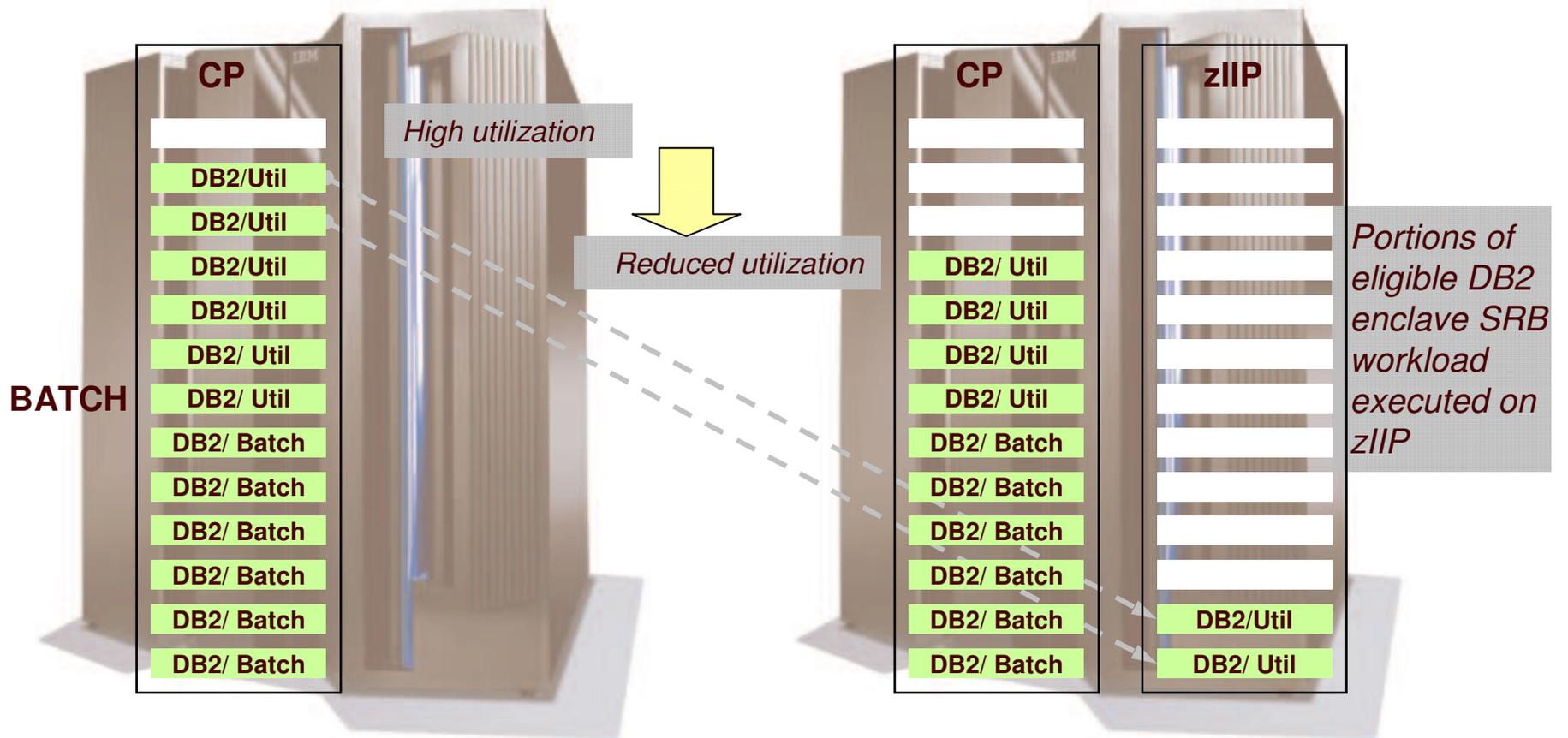
For illustrative purposes only

Actual workload redirects may vary depending on how long the queries run and how much parallelism is used



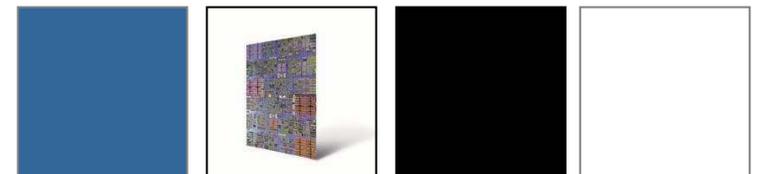
# Example 3: DB2 for z/OS utilities

DB2 for z/OS utilities used to maintain index structures

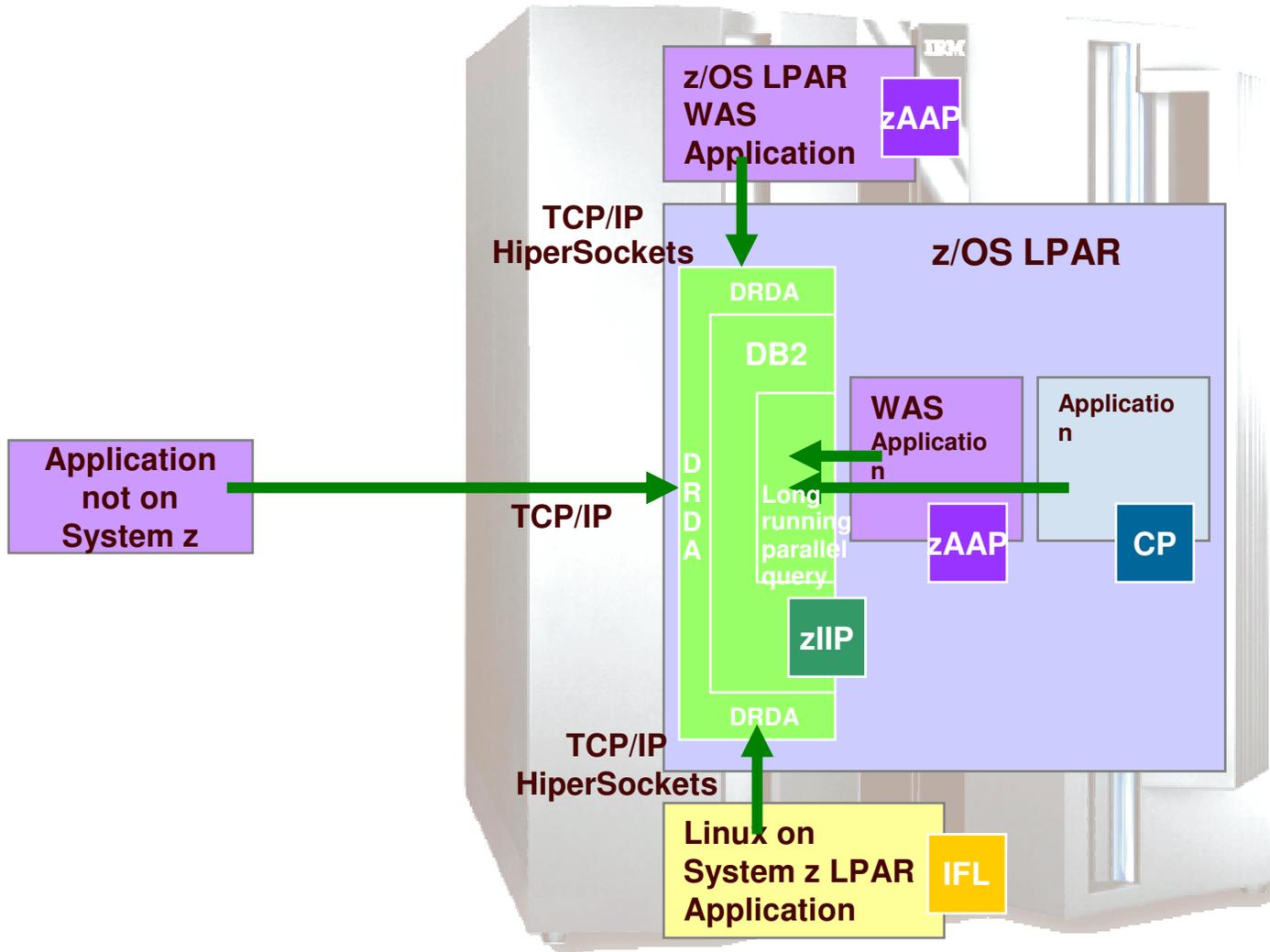


For illustrative purposes only, actual workload redirects may vary.

Only the portion of the DB2 utilities used to maintain index structures (within LOAD, REORG, and REBUILD) is redirected.



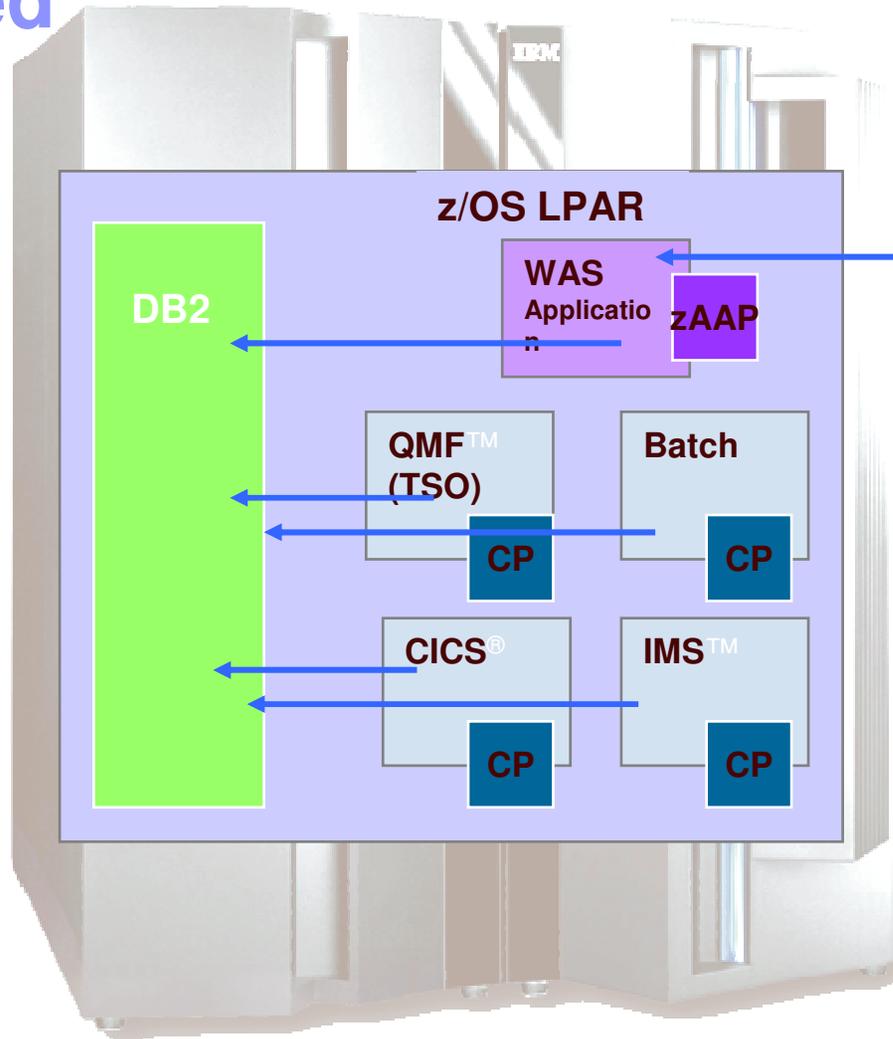
# Specialty engines



The IBM System z9 specialty engines can operate on the same machine together

(shown at left, instances where zIIP can be employed)

# Some instances where zIIP would not be exploited



WAS applications may access with a local Type2 JDBC access. For performance reasons, this is the recommended scenario as the WAS code was optimized for this configuration. No zIIP would be needed here.

# Requirements for zIIP Exploitation

- **Available on System z9 EC and System z9 BC and follow-on models only**
- **z/OS and z/OS.e exclusive**
- **Prerequisites:**
  - ▶ **z/OS 1.6 or z/OS.e 1.6 (with PTF)**
  - ▶ **Processor Resource/Systems Manager (PR/SM) must be enabled.**
- **Subsystems exploiting zIIPs:**
  - ▶ **DB2 for z/OS Version 8 (with PTF)**
- **zIIPs must be jointly configured with general purpose processors within z/OS LPARs**
  - ▶ **Number of zIIPs may not exceed the number of permanently purchased CPs on a given machine model.**

# Specialty Engine Summary

- **IBM System z9 Integrated Information Processor (zIIP)**
  - ▶ Designed to improve resource optimization
  - ▶ Can help lower cost of computing for eligible workloads
  - ▶ First IBM exploiter is DB2 for z/OS V8
- **System z9 Application Assist Processor (zAAP)**
  - ▶ zAAPs support Java code execution
    - z/OS Java Virtual Machines (JVMs) assist with the execution of code from standard processors to zAAPs
    - JVM executes the Java code on the zAAP
  - ▶ Designed to provide a Single Tier integrated application and database serving environment
- **Integrated Facility for Linux (IFL)**
  - ▶ Provides additional processing capacity exclusively for Linux workloads
  - ▶ Runs Linux native or as a guest of z/VM® V4 and V5
- **Internal Coupling Facility (ICF)**
  - ▶ Provides additional processing capacity used for coupling to other processors
- **System Assist Processor (SAP)**
  - ▶ Created to perform low-level system function like communication with I/O channels