Parallel Sysplex Clustering Technology

Guide Share France z/OS
Montpellier Juin 2003
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MQSeries*
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Parallel Sysplex*
PR/SM
RMF
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MAINFRAME:

"An obsolete device still used by thousands of obsolete companies serving billions of obsolete customers and making huge obsolete profits for their obsolete shareholders"

- And this year's run twice as fast as last year's
Parallel Sysplex Technology Highlights
z/OS 1.1 through z/OS 1.4

- Ease of Use
  - msys for Operations
  - HealthChecker for z/OS® and Parallel Sysplex® Clustering
  - System Automation for OS/390®
  - New White Papers
  - WLM Goal Mode Migration Aid
  - CF Sizer

- z/OS
  - Intelligent Resource Director
  - System-Managed CF Structure Duplexing
  - CFRM Performance
  - Heuristic CF Access
  - WLM Enhancements
  - System Logger Enhancements
  - Continued TCP/IP Exploitation

- IBM™ zSeries® 800 (z800), 900 (z900), 990 (z990) servers
  - Dynamic links
  - Peer Mode links
  - New ICB-4 Peer Mode links
  - Expanded number of CF links
Easy to Install, Easy to Use
User Centered Design

- Managed System Infrastructure
  - msys for Setup
  - msys for Operations
  - HealthChecker
- Intelligent Resource Director
  - CPU Management
  - CPU Management for Linux
  - Channel Subsystem Priority Queuing
  - Dynamic CHPID Management
- System Management
  - System Automation for OS/390 V2.2
  - System Managed CF Structure Duplexing
  - WLM Improvements
Easy to Install, Easy to Use ...

- Self-Configuring
  - Parallel Sysplex Configuration Assistant
  - Base Sysplex Configuration Assistant
  - z/OS msys for Operations Customization Wizard
  - z/OS Intelligent Resource Director Planning Wizard
  - CF Structure Sizer
  - SDSF Configuration Assistant
  - HFS Shared Files
  - WLM Goal Mode Migration Aid tool

ibm.com/servers/eserver/zseries/zos/wizards/
z/OS Managed System Infrastructure for Operations (msys for Operations)

- z/OS base element
  - Available on OS/390 R10
- Increase availability of systems and applications
  - Improve system recoverability
  - Reduce outages due to operations errors
- Decrease total cost of ownership
  - Reduce operations complexity
  - Greater operational awareness
- Manage
  - Systems in a Parallel Sysplex cluster
  - Coupling facilities, couple data sets and structures
- Automate
  - WTO(R) buffer shortage
  - System log problems
  - Resolve ENQ contention
  - Resolve Auxiliary Storage shortage (z/OS R3)
  - Clear "pending" conditions of CF Structures (z/OS R3)
msys for Operations
z/OS 1.2 Functions

- Systems - Panel Display / Issue Commands
- Consoles - Panel Display / Consolidated Info
- Coupling Facility Management
- Couple Data Set Management
- Alternate Couple Data Set Allocation
- WTO/WTOR Buffer Shortage Recovery
- Log Stream Data Set Directory Shortage Recovery
- Check Log Stream Data Set 'SHAREOPTIONS'
- System Log Recovery
msys for Operations
z/OS 1.3 Functions

- HMC/SE Interaction - Programmatic HW Control
- Capture IPL Statistics - What’s running or changed?
- CF Enable/Drain - Linemode & LPAR Act/Deact
- Active ECA - Elimination of Long ENQs
- Add Local Page Data Sets - ASM Recovery
- Automation of IXC102A - Isolate Failed System
- SVCDUMP / DUMP Options / SLIPs
- Rebuild STRs after CFRM Policy Switch
- Support for Starting/Stopping Duplex Process
- Physical/Logical Control of CF Sender Path

More improvements coming...
msys for Operations
z/OS 1.4 Function

- HealthChecker Integration
- Hardware Validation
- Hung Command Recovery
  - Detect and recover from command hangs
    - Prevent console lockouts
    - VARYDEV and CHNGDEV latches
  - Similar to Active ECA Recovery
- Automation of IXC402D
  - Unresponsive system in a Sysplex
  - Assists partitioning a system from a Parallel Sysplex cluster

Advanced Availability through Automation
IBM HealthChecker for z/OS and Sysplex

- Identify potential problems before they impact your availability
- Addresses implementation of best practices:
  - Reflects best practice values from multiple IBM sources
  - Reports on your configuration’s active settings compared to IBM's suggestions, simplifying administration and operations
  - Reports on your configuration’s active settings specific to any customer-specified preferences that can be used to override IBM values
  - Provides a mechanism for IBM to distribute updates to either best practice values or to provide additional checks in a manner that is easily integrated into your environment
- This tool will be updated periodically with additional function and runs on all z/OS releases and on OS/390 V2R10.

- Available at the z/OS Download site: ibm.com/servers/eserver/zseries/zos/downloads/
HealthChecker Concepts

- Significant number of outages can be avoided by implementing 'best practices'
  - Many sources of best practice information
    - Scattered, Static and Overwhelming
- Provide a way to more easily & effectively assist installations to implement "best practices"
  - Environment HealthChecker
    - Scan for values that can lead to outages and poor performance
  - Leverage msys/Ops foreground & background infrastructure
- Health Validation
  - Check various settings active on the system
    - Active changes - not a PARMLIB Scan
    - Check against known best practices
    - Notify when exceptions are found
    - Ability to revalidate checks at various intervals
SODs, EoS  May 2003 Announcement

- IBM Sysplex Timer 9037-001 EOS has been announced
  - Effective December 2003

- Customers should start planning to migrate to 9037-002
  - IBM 9037-002 is the only replacement available
  - Refer to Redpaper REDP3666, Migration Planning for the 9037 Model 2 Sysplex Timer, for migration procedures

- IBM intends to deliver new function that will reduce the duration of an outage associated with certain Coupling Facility Control Code (CFCC) LIC upgrades or changes. In the future, CFCC LIC changes will be designed to never require that the entire server be down to apply a patch or upgrade. Only the LPAR running the CFCC LIC being upgraded will need to be restarted, and then only if the patch is "disruptive." This availability enhancement will be especially important to customers who run their Parallel Sysplex environment using Internal Coupling Facilities (ICFs) and who may have multiple ICFs on the same server.

- The z990 will be the last zSeries server to support Parallel Sysplex connectivity using ICB-2 links. These links provide connection between two 9672 G5/G6 servers and z990 servers.
What is CF duplexing?

- User Managed CF structure duplexing
  - Available now for DB2 GBPs
  - User (DB2)
    - asks for primary/secondary structures
    - writes updates to both
    - synchronizes via already held locks

- System Managed CF structure duplexing
  - Future function
  - Installation selects duplexing option
    - for specific exploiters/structures
  - System
    - creates primary/secondary structures
    - writes updates to both
    - synchronizes via 2 CF-to-CF ops
Why CF duplexing?

- Faster recovery from CF failures
  - much, much faster compared to log recovery
  - faster compared to rebuild
- Provides failure isolation
  - fully exploit ICFs
- Some potential exploiters
  - JES2, WLM, system logger
  - IRLM
  - MQ Series
  - DB2
  - VTAM
  - IMS
  - CICS

- Prerequisites
  - Hardware 9672 G5/G6 or zSeries
  - CFCC Support - CFCC Level 11 (9672 Coupling Facility) or Level 12 (zSeries Coupling Facility)
  - CF-to-CF Links
  - OW41617 enables the format utility to process the SMDUPLEX keyword
  - OW45976 supports Sender links on the Coupling Facilities
  - Required Software
  - All systems must be at z/OS V1R2 or greater
  - Exploiter Support by subsystems
What is the cost of CF duplexing?

- Duplexed pair of ops versus simplex op
  - CF storage - no change (what was "white space" is now "in-use")
  - User Managed costs
    - Host CPU, CF CPU, CF link all 2x
    - (synchronization already paid through locking)
  - Preliminary estimates of System Managed costs
    - Host CPU cost: 3x to 4x
    - CF CPU cost: 4x to 5x (but may need less "white space")
    - CF link cost: 6x to 8x (but may need less "white space")
- % of structure activity to be duplexed (thus pay above costs)
  - cache (e.g., GBP): 1% to 100% (typically 20%)
  - lock: 100%
  - list: near 100%
- Duplexing is selectable by structure
  - each structure should be evaluated for value versus cost
### Example Duplexing Cost Estimates

<table>
<thead>
<tr>
<th>Host CPU capacity</th>
<th>simplex</th>
<th>impact</th>
<th>duplex</th>
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<tbody>
<tr>
<td>UM GBPs</td>
<td>5%</td>
<td>20%@2x</td>
<td>6%</td>
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<tr>
<td>SM lock</td>
<td>2%</td>
<td>100%@4x</td>
<td>8%</td>
</tr>
<tr>
<td>SM list</td>
<td>1%</td>
<td>100%@3x</td>
<td>3%</td>
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<tr>
<td>not duplexed</td>
<td>2%</td>
<td>NA</td>
<td>2%</td>
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<td><strong>TOTAL</strong></td>
<td><strong>10%</strong></td>
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<td><strong>19%</strong></td>
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<table>
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<tr>
<td>UM GBPs</td>
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<td>18%</td>
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<tr>
<td>SM lock</td>
<td>5%</td>
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<tr>
<td>not duplexed</td>
<td>6%</td>
<td>NA</td>
<td>6%</td>
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<td><strong>TOTAL</strong></td>
<td><strong>30%</strong></td>
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<td><strong>65%</strong></td>
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<table>
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<th>impact</th>
<th>duplex</th>
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<tr>
<td>UM GBPs</td>
<td>5%</td>
<td>20%@2x</td>
<td>6%</td>
</tr>
<tr>
<td>SM lock</td>
<td>2%</td>
<td>100%@8x</td>
<td>16%</td>
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<tr>
<td>SM list</td>
<td>1%</td>
<td>100%@6x</td>
<td>6%</td>
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<tr>
<td>not duplexed</td>
<td>3%</td>
<td>NA</td>
<td>3%</td>
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<td><strong>TOTAL</strong></td>
<td><strong>11%</strong></td>
<td></td>
<td><strong>31%</strong></td>
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System-Managed Coupling Facility (CF) Structure Duplexing

- Improves availability by:
  - Providing a robust failure recovery capability via the redundancy of duplexing
  - Enhancing the ease of use of Parallel Sysplex clustering by providing a consistent recovery mechanism
  - Basic recovery for structures that have no other means to recover data
  - Faster recovery of structures by having the data already in the second CF
  - May eliminate the need for standalone CF
  - Technical paper (GM13-0103-03) available at ibm.com/server/eserver/zSeries/pso

A robust failure recovery capability
System-Managed Coupling Facility (CF) Structure
Duplexing Exploiters

- z/OS
  - HSM Common Recall Queue
  - JES2 Checkpoint
  - System Logger
  - VSAM RLS lock
  - VTAM®
    - G/R
    - MNPS
    - Sysplex-Wide Security Associations (1.4)
    - SYSPLEXPORTS (1.4)
  - WLM
    - Shared enclaves
    - LPAR clusters

- Program Products
  - BatchPipes® (PQ49953)
  - CICS TS V2.2
    - Shared TS
    - CF data tables
    - Named Counter
  - DB2 V7 SCA
  - IMS V7
    - EMH (PQ47642)
    - SMQ (PQ47642)
    - VSO (PQ50661)
  - IRLM lock (PQ48823)
    - DB2 (Above + PQ48996)
    - IMS
  - MQSeries® Shared Queues
    - Non-Persistant (5.2) Persistant (5.3)
All ICF Configuration

Provides complete failure-isolation from all structure connectors
z/OS 1.2 - Change To Path Busy

- z/OS matches subchannels to links to avoid busy conditions, but if links are shared then path busys occur
- Prior to z/OS 1.2, SYNC requests retried immediately and ASYNC requeued
- z/OS 1.2 - All requests are retried immediately
- In all cases Path Busy retry time included in service time
Subchannel Tuning - OW54796

- Shifts point of queuing from path busy to subchannel busy
  - Improves efficiency in link constrained environments
    - Keeps path busy in the 10-20% range
  - Allocates/deallocates subchannels

4 Images sharing 3 ICBs and 2 ISCs
Sync to Async Heuristic Algorithm

- Long running Synchronous CF requests use more CPU on sender
- Prior to z/OS 1.2, XES changed some LIST/CACHE Sync requests to async based on preset rules
  - Factors included
    - Request type
    - Sender and receiver processor type
    - Amount of data being sent
- In z/OS 1.2, CF response time for SYNC requests is monitored for every request type (LIST/LOCK/CACHE) and compared to thresholds so long-running requests are converted
  - Thresholds are normalized by processor type
  - Thresholds are not externally adjustable
    - APAR OW51813 for the latest threshold adjustments
Heuristic CF Access Sync to Async Conversion

- Performance Improvements
  - Dynamically determines optimal CF access type
  - Self Optimizing to reduce CF Overhead
  - Most benefit when service time is long:
    - Overloaded links or CF utilization
    - Distance between the CF and an attached z/OS system exceeds a small number of kilometers
      - GDPS environment
    - Mismatch between the z/OS and CF uniprocessor speed
    - CF Configured with Shared Processors or Dynamic CF Dispatching
- Based on type of request and amount of data transferred
Sync to Async Heuristic Algorithm . . .

- Requests that are changed from SYNC to ASYNC based on the Heuristic Algorithm are counted as ASYNC
  - Not included in the CHNGD counts

The decision is continuously reevaluated by allowing every $n^{th}$ SYNC request to be issued unchanged and comparing it with the thresholds.
SNTP Daemon
z/OS 1.4

- SNTP Daemon (z/OS 1.4)
  - SNTP is a simplified version of Network Time Protocol and can interoperate with it
  - Used to synchronize clocks across a WAN or LAN
  - SNTPD, a new TCP/IP daemon, enables synchronization of time between various platforms using the Sysplex Timer® in the client / server network
  - Use z/OS as the time source of a network
  - Enable use of the zSeries clock as the source clock
  - SNTP allows for a precision of about 200 pico seconds
Message Time Ordering

- A Coupling Facility configured as an ICF on any 2xx model z900 or later, requires connectivity to the same 9037 Sysplex Timer that the systems in its Parallel Sysplex cluster are using for time synchronization.

- TOD clocks of CPC must be synchronized within the signaling time between CPCs

- Worst Case TOD synchronization times have to meet best case CF access time
CF Request Time Ordering - Solution

- Time stamps will be added to each message (CF request) that is sent to the CF and received from the CF
- Any message that appears to be out of order with the local TOD will be delayed
  - Slow the CF access time when necessary to ensure that the accuracy of the TOD synchronization is maintained

CF Requirements
- Message Time Ordering may be enabled for z900 GA3 or z800
- Message Time Ordering will be required for future processors
  - CFs must be connected to same Sysplex Timer® as the other systems in the Parallel Sysplex
  - CFs must be connected to z/OS systems with message-based Time Ordering hardware support installed

z/OS Requirements
- Running on a processor with MTO hardware support installed
- OS/390® Version 2.8 up through z/OS V1.4
  - XCF/XES Apar OW53831
IBM z900 CF Request Time Ordering

IBM z900 (2C1-216) with ICF and non-Parallel Sysplex LPARs

Non-Sysplex LPARs

CF01
ICF

IBM

z900

Sysplex LPARs

z/OS

ICB-3 / ISC-3

ICB-3 or ISC-3

Sysplex Timer® Connectivity to Coupling Facilities
IBM z900 CF Request Time Ordering

RESPONSE=SYSA
IXL150I  13.44.42  DISPLAY CF 211
COUPLING FACILITY 002064.IBM.02.000000010B2E
  PARTITION: 5  CPCID: 00
  CONTROL UNIT ID: FFFD
NAMED CF1
COUPLING FACILITY SPACE UTILIZATION

<table>
<thead>
<tr>
<th>ALLOCATED SPACE</th>
<th>DUMP SPACE UTILIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRUCTURES: 351744 K</td>
<td>STRUCTURE DUMP TABLES: 0 K</td>
</tr>
<tr>
<td>DUMP SPACE: 10240 K</td>
<td>TABLE COUNT: 0</td>
</tr>
<tr>
<td>FREE SPACE: 1671680 K</td>
<td>FREE DUMP SPACE: 10240 K</td>
</tr>
<tr>
<td>TOTAL SPACE: 2033664 K</td>
<td>TOTAL DUMP SPACE: 10240 K</td>
</tr>
<tr>
<td>MAX REQUESTED DUMP SPACE: 0 K</td>
<td></td>
</tr>
</tbody>
</table>

VOLATILE: NO
STORAGE INCREMENT SIZE: 256 K

CFLEVEL: 12
CFCC RELEASE 12.00, SERVICE LEVEL 04.08
BUILT ON 06/27/2002 AT 11:51:00

CF REQUEST TIME ORDERING: REQUIRED AND ENABLED
CF REQUEST TIME ORDERING: NOT-REQUIRED AND ENABLED

COUPLING FACILITY SPACE CONFIGURATION

<table>
<thead>
<tr>
<th></th>
<th>IN USE</th>
<th>FREE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL SPACE:</td>
<td>361984 K</td>
<td>1671680 K</td>
<td>2033664 K</td>
</tr>
<tr>
<td>NON-CONTROL SPACE:</td>
<td>0 K</td>
<td>0 K</td>
<td>0 K</td>
</tr>
</tbody>
</table>
IBM z900 CF Request Time Ordering

RESPONSE=SYSA
IXC357I 15.49.48 DISPLAY XCF 073
SYSTEM SYSA DATA

<table>
<thead>
<tr>
<th>INTERVAL</th>
<th>OPNOTIFY</th>
<th>MAXMSG</th>
<th>CLEANUP</th>
<th>RETRY</th>
<th>CLASSLEN</th>
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<tbody>
<tr>
<td>85</td>
<td>88</td>
<td>1500</td>
<td>60</td>
<td>10</td>
<td>956</td>
</tr>
</tbody>
</table>

SSUM ACTION SSUM INTERVAL WEIGHT
ISOLATE 10 90

MAX SUPPORTED CFLEVEL: 12
MAX SUPPORTED SYSTEM-MANAGED PROCESS LEVEL: 12

CF REQUEST TIME ORDERING FUNCTION: INSTALLED
CF REQUEST TIME ORDERING FUNCTION: NOT-INSTALLED

SYSTEM NODE DESCRIPTOR: 002064.IBM.02.000000010B2E
PARTITION: 1 CPCID: 00

SYSTEM IDENTIFIER: 0B2E2064 010001EA

COUPLEXX PARMLIB MEMBER USED AT IPL: COUPLEZ4

SYSPLEX COUPLE DATA SETS
PRIMARY DSN: SYS1.XCFCD3.PRI
VOLSER: XCFCD1 DEVN: 700F
FORMAT TOD MAXSYSTEM MAXGROUP (PEAK) MAXMEMBER (PEAK)
03/12/2001 14:35:25 4 80 (37) 351 (17)
CFRM Performance
z/OS R1.4

- Coupling Facility Resource Manager Performance Enhancements - Stage 1
  - Elapsed time of CF structure rebuilds can be reduced over 30%
  - Improved Parallel Sysplex availability by speeding up CFRM processes such as rebuilds

- Improved CFRM performance during recovery operations is designed to improve Parallel Sysplex availability
  - Recovery actions (CEC failure, CF failure, Structure rebuild) may result in large records requiring large I/O bandwidth
    - Originally: 64 structures with 32 connectors
    - Currently: 512 structures with 255 connectors
  - Up to 30% CFRM CDS I/O performance improvement
    - Reduces possibility of I/O bottleneck on CFRM CDS
More Sysplex Enhancements

- **Automatic Tape Switching (z/OS R1.2)**
  - New design using Global Resource Serialization (GRS)
  - Replaces IEFAUTOS CF structure
  - Easier to configure, improved performance
  - Fast, in GRS Star mode

- **Global Resource Serialization (GRS) RNLs (z/OS R1.2)**
  - Support wildcard characters ("**" and "?"") within resource names
  - RNL exit now allows the modification of resource QNAME, RNAME, SCOPE, or UCB address or the bypassing of RNL processing entirely
  - Improved system management
  - More reliable, robust, and serviceable

- **Multi-System Cascaded Transactions (z/OS R1.2)**
  - Coordinate distributed transactions across sysplex
  - Without overhead of APPC or 2-phase commit protocols
  - Improved availability and performance; reduced complexity
## Coupling Facility CF Level of Support

<table>
<thead>
<tr>
<th>CF Level</th>
<th>Function</th>
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<tbody>
<tr>
<td>1</td>
<td>Dynamic Alter support</td>
</tr>
<tr>
<td>2</td>
<td>DB2 performance</td>
</tr>
<tr>
<td>3</td>
<td>IMS shared message queue base</td>
</tr>
<tr>
<td>4</td>
<td>Performance optimization for IMS &amp; VSAM RLS</td>
</tr>
<tr>
<td>5</td>
<td>DB2 cache structure duplexing</td>
</tr>
<tr>
<td>6</td>
<td>ICB &amp; IC TPF support</td>
</tr>
<tr>
<td>7</td>
<td>Shared ICF partitions on server models</td>
</tr>
<tr>
<td>8</td>
<td>Dynamic ICF Expansion into shared ICF pool Systems-Managed Rebuild</td>
</tr>
<tr>
<td>9</td>
<td>Intelligent Resource Director IC3 / ISC3 / ICB3 peer mode MQSeries Shared Queues WLM Multi-System Enclaves</td>
</tr>
<tr>
<td>10</td>
<td>z900 GA2 Level</td>
</tr>
<tr>
<td>11</td>
<td>SM Duplexing support for 9672 G5/G6/R06 Toleration for LPAR id &gt;15 on z9xx</td>
</tr>
<tr>
<td>12</td>
<td>64-bit CFCC addressability Message Time Ordering DB2 Performance SM Duplexing support for zSeries CFs Toleration for LPAR id &gt;15 on z9xx</td>
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<tr>
<th></th>
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<th>G4</th>
<th>G5</th>
<th>G6</th>
<th>z800</th>
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<td>6</td>
<td></td>
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<tr>
<td>7</td>
<td></td>
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<td>8</td>
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<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Detailed information regarding CF levels can be found in “Coupling Facility Level (CFLevel) Consideration” at URL: [ibm.com/servers/eserver/zseries/pso/cftable.html](http://ibm.com/servers/eserver/zseries/pso/cftable.html)
IBM™ zSeries™ 900 (z900) and IBM zSeries 800 (z800) Coupling Technology

- 64-bit Architecture
- Dedicated or shared ICFs
- Up to fifteen logical partitions
- Up to 32GB storage
- Peer-Mode Links
  - ISC-3
  - ICB-3
- Compatibility-Mode Links
  - ISC-2
  - ICB-2
- Dynamic CF Dispatch (DCFD)
- Dynamic ICF Expansion

- Up to 9 ICFs
- 16 ICB-3, 32 ISC-3
- Upgrade to z900
- Upgrade from R06

- Up to 4 ICFs
- 6 ICB-3, 24 ISC-3
- Upgrade to z900
zSeries 900 Model 100 Coupling Facility

- 64-bit Architecture
- Up to 32 GB of storage
- z900 Peer to Peer Channels
- z900 to z900
  - InterSystem Channels-3 (ISC3)
  - Integrated Cluster Bus-3 (ICB3)
- z900 Compatibility Channels
- z900 to 9672
  - InterSystem Channels (ISC)
  - Integrated Cluster Bus (ICB)

- Processor Assignments
  - Dedicated and/or Shared ICFs
  - Up to 9 ICFs with 15 LPs
- Dynamic CF Dispatch
- Dynamic CF (ICF) Expansion

- Upgradeable from 9672 R06
- Upgradeable to z900 models
Merging of Sender and Receiver Peer Mode Links

- Multi-Server Environment with System Managed CF Duplexing
  - Only one IC link per CF is normally needed within 9672
- Multi-server environment
  - ICB-3 Links 1 Gbyte/sec ~7 Meters
  - ISC-3 Links 2 Gbits/sec ~10-20 km
  - IC Links Internal
  - 7 Link Buffers in Peer Mode

Single Server Environment
Parallel Sysplex Scalability Enhancements

- Up to 48 concurrent internal tasks for improved multiprocessing
- 64-bit addressing to support larger structure sizes
  - Support provided by CFCC Level 12 (zSeries)
  - Elimination of 2 GB "control store" line

```
COUPLING FACILITY SPACE UTILIZATION

ALLOCATED SPACE                      DUMP SPACE UTILIZATION
STRUCTURES: 343808 K                  STRUCTURE DUMP TABLES: 0 K
DUMP SPACE: 10240 K                   TABLE COUNT: 0
FREE SPACE: 1679616 K                 FREE DUMP SPACE: 10240 K
TOTAL SPACE: 2033664 K                TOTAL DUMP SPACE: 10240 K
MAX REQUESTED DUMP SPACE: 0 K
VOLATILE: NO                         STORAGE INCREMENT SIZE: 256 K
CFLEVEL: 12
CFCC RELEASE 12.00, SERVICE LEVEL 06.01
BUILT ON 09/12/2002 AT 09:27:00

CF REQUEST TIME ORDERING: REQUIRED AND ENABLED

COUPLING FACILITY SPACE CONFIGURATION

                     IN USE          FREE           TOTAL
CONTROL SPACE: 354048 K                1679616 K     2033664 K
NON-CONTROL SPACE: 0 K                  0 K           0 K
```
z900 Model 100 CP Assignment

- z900 Model 100 CFs can be defined with Dedicated and/or Shared ICFs
- Dedicated and Shared ICFs can be defined on the same z900 Model 100
- Up to 9 ICF engines running up to 15 CF LPs
- z900 Server ICFs can be defined with Dedicated and/or Shared CPs
z900 Dynamic ICF Expansion

- Expands into pool of shared CPs
  - L-shaped partitions
- Dynamic adjustment of CF processor resources
  - Peaks
  - Failures

- Configuration Flexibility
- Availability
- Low Cost
- Ideal for Backup
zSeries 990 Model 300 Coupling Facility

- 64-bit Architecture
- Up to 64 GB of storage per book
- z990 to z990
  - InterSystem Channels-3 (ISC3)
  - Integrated Cluster Bus-4 (ICB4)
- z990 to z900/z800
  - InterSystem Channels-3 (ISC3)
  - Integrated Cluster Bus-3 (ICB3)
  - NOT ICB
- z990 to 9672
  - InterSystem Channels (ISC)
  - Integrated Cluster Bus (ICB)

- Processor Assignments
  - Dedicated and/or Shared ICFs
  - Up to 32 ICFs with 32 LPs
- Dynamic CF Dispatch
- Dynamic CF (ICF) Expansion

NOT directly Upgradeable from z900-100

Upgradeable to z990 models
### z900 CF Link Speeds

<table>
<thead>
<tr>
<th>Model</th>
<th>IC</th>
<th>ICB-4</th>
<th>ICB-3</th>
<th>ICB</th>
<th>ISC-3</th>
<th>ISC</th>
</tr>
</thead>
<tbody>
<tr>
<td>9672 G5/G6</td>
<td>700 MB/sec</td>
<td>n/a</td>
<td>333* MB/sec</td>
<td>n/a</td>
<td>100 MB/sec</td>
<td></td>
</tr>
<tr>
<td>z900</td>
<td>1250 MB/sec</td>
<td>1000* MB/sec</td>
<td>333* MB/sec</td>
<td>✓ 200 MB/sec ✓ 100 MB/sec beyond 10 km ✓ 100 MB/sec Comp Mode</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>z800</td>
<td>1125 MB/sec</td>
<td>1000* MB/sec</td>
<td>n/a</td>
<td>(same as z900)</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>z990</td>
<td>(tbd)</td>
<td>2000* MB/sec</td>
<td>1000* MB/sec</td>
<td>333* MB/sec</td>
<td>(same as z900)</td>
<td>n/a</td>
</tr>
</tbody>
</table>

- Peer mode supports
  - Improved throughput, increasing coupling efficiency and improving response times
  - Merging of Sender and Receiver links, reducing number of links required
  - Increase from 2 to 7 subchannels per buffer sets, reducing number of links required
  - Larger data buffers and improved protocols improving long distance performance
- zSeries connected to 9672 must use compatibility mode
- z990 connected to z990 can use ICB-4 and ISC-3

*maximum rate*
## G5/G6/zSeries CF connectivity to z990

<table>
<thead>
<tr>
<th>CF on one of the following processors</th>
<th>Connected to z990 with LPAR ID &lt;= 15</th>
<th>Connected to z990 with LPAR ID &gt;15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-G5</td>
<td>Not supported</td>
<td>Not supported</td>
</tr>
<tr>
<td>G5, G6</td>
<td>CFLEVEL 11 (CFLEVEL 9 out of support)</td>
<td>CFLEVEL 11 with Compatibility patch</td>
</tr>
<tr>
<td>z800, z900</td>
<td>CFLEVEL 12 (CFLEVEL 10 out of support)</td>
<td>CFLEVEL 12 with Compatibility patch</td>
</tr>
</tbody>
</table>

- **Connection can be:**
  - z990 OS image connecting to G5/G6/z900 CF
  - z990 CF duplexing with G5/G6/z900 CF

CFRM Policy changes for z990

- CFRM Policy utility changed to accept 2-digit *PARTITION* value
  - Restriction: must have Compatibility or Exploitation feature installed on *all* systems in the sysplex to use 2-digit partition values
- All XCF/XES messages that display logical partition numbers, will now use 2 hex digits

- Meaning of *PARTITION*:
  - Non-z990 - Partition number assigned to CF partition when you define partition to HCD or IOCP
  - z990 - LPAR identifier specified for CF partition in the LPAR image profile
  - Applicable to both Compatibility and Exploitation systems
z990 Parallel Sysplex Migration

- CFRM Policy utility changed to accept 2-digit PARTITION value
  - Restriction: must have Compatibility or Exploitation feature installed on all systems in the sysplex to use 2-digit partition values
- Meaning of PARTITION:
  - Non-z990 - Partition number assigned to CF partition when you define partition to HCD or IOCP
  - z990 - LPAR identifier specified for CF partition in the LPAR image profile
- All XCF/XES messages that display logical partition numbers, will now use 2 hex digits
  - May require change to automation routines
- z/OS V1.1 does not support being in the same (base) Sysplex as a z990
  - Compatibility Feature not available on z/OS V1.1.
z990 Coupling Facility Links

- **ISC-3**
  - Connect to z990, z900, z800, G5/G6
  - Requires new connector if migrating from G5/G6
  - Connection to G3/G4 *not supported*
  - Up to 20 km with Extended distance RPQ, longer distance with RPQ and DWDM

- **ICB-2**
  - Connects to G5/G6 *only*
  - New STI-2 card with two ICB-2 ports (requires I/O slot)
  - SOD: z990 last CPU to support ICB-2

- **ICB-3**
  - Connects to ICB3 on z800, z900, z990
  - New STI-3 card with two ICB-3 ports (requires I/O slot)
  - (ICB-4 performs better when connecting to other z990s)

- **IC**
  - Memory to memory within z990
  - Supports Spanning (GA2)

- **New! ICB-4**
  - Connect to another z990
  - 7 meter distance between connected boxes
  - *Recommended connection for z990 to z990 at short distance and for System-Managed CF Structure Duplexing*

---

CF Link connectivity between z990 and G3/G4 *not supported!*

SOD: z990 last zSeries server to support ICB-2!

ICB-3, ICB-4 and IC are *Peer Mode only!*
z990 Parallel Sysplex Migration...

z990 ICB-2s do not connect to z800s, z900s, z990s

- Example A: z/OS on a z990 is connected by ICB-2 to a CF on a 9672-R06. R06 is upgraded to a z900
  1. Connect the z/OS to the CF with an ISC link
  2. Make the processor upgrade
  3. Upgrade the ISC to an ISC3 (definition change only) or to an ICB3

- Example B: z/OS on a z900 is connected by ICB-2 to a CF on a z900-100. z/OS server is upgraded to z990
  1. Connect two z900s by ICB-3s
  2. Make the processor upgrade

z990 ICB-3s not recommended to z990s
   (ICB-4s have better performance)
## Configuring CF Links

<table>
<thead>
<tr>
<th>Max. # Links</th>
<th>IC</th>
<th>ICB-4</th>
<th>ICB-3</th>
<th>ICB</th>
<th>ISC-3</th>
<th>Max. # Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>9672 - R06</td>
<td>32</td>
<td></td>
<td>24</td>
<td>32</td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>z900 - 100 CF</td>
<td>32</td>
<td>16</td>
<td>16</td>
<td>✓ 32</td>
<td>✓ 42</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓ 8</td>
<td>✓ 12/16 w/ RPQ</td>
<td></td>
</tr>
<tr>
<td>z900 Server</td>
<td>32</td>
<td>16</td>
<td>✓ 8</td>
<td>16</td>
<td>32</td>
<td>32 External + 32 IC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓ 12/16 w/ RPQ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>z800 - 0CF</td>
<td>32</td>
<td>6</td>
<td>24</td>
<td></td>
<td></td>
<td>24 ISC-3s (w/ no ICB-3s) + 32 IC</td>
</tr>
<tr>
<td>z800 Server</td>
<td>32</td>
<td>5</td>
<td>-</td>
<td>24</td>
<td></td>
<td>(same as 0CF)</td>
</tr>
<tr>
<td>z990-A08</td>
<td>32</td>
<td>16</td>
<td>16</td>
<td>8</td>
<td>32</td>
<td>32 External + 32 IC</td>
</tr>
</tbody>
</table>
## Connectivity Matrix

<table>
<thead>
<tr>
<th>Model</th>
<th>Link Type</th>
<th>z990</th>
<th>z900 z100*</th>
<th>z800 0CF</th>
<th>9672 R06*</th>
<th>9672 C05</th>
</tr>
</thead>
<tbody>
<tr>
<td>z990</td>
<td>ICB-4</td>
<td>P</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>ICB-3</td>
<td>P</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>ICB-2</td>
<td>C</td>
<td>No</td>
<td>No</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>ISC-3</td>
<td>P</td>
<td>No</td>
<td>No</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>z900</td>
<td>ICB-3</td>
<td>P</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>ICB</td>
<td>C</td>
<td>No</td>
<td>No</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>ISC-3</td>
<td>P</td>
<td>No</td>
<td>No</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>z800</td>
<td>ICB-3</td>
<td>P</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>ISC-3</td>
<td>P</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>9672 G5 / G6</td>
<td>ICB</td>
<td>P</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>ISC</td>
<td>P</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* 9672 G5/G6, z800, and z900 requires toleration microcode to connect to z990 with more than 15 LPARs

P = Peer Mode  C = Compatibility Mode
sm = Single-Mode (100 MB/Sec) links and HiPerLinks
mm = Multi-Mode (50 MB/Sec) links
### zSeries Coupling Efficiency Projections

**Coupling Overhead (%) - "Average" Production Datasharing Workload**

**OS/390 or z/OS Sender**

<table>
<thead>
<tr>
<th>Host CF</th>
<th>G3</th>
<th>G4</th>
<th>G5</th>
<th>G6</th>
<th>z800 1xx</th>
<th>z900 2xx</th>
<th>z900 3xx</th>
</tr>
</thead>
<tbody>
<tr>
<td>C04 - SM</td>
<td>10%</td>
<td>11%</td>
<td>16%</td>
<td>19%</td>
<td>21%</td>
<td>22%</td>
<td>25%</td>
</tr>
<tr>
<td>C05/HiPerLinks</td>
<td>9%</td>
<td>10%</td>
<td>14%</td>
<td>16%</td>
<td>18%</td>
<td>19%</td>
<td>22%</td>
</tr>
<tr>
<td>R06- HL</td>
<td>9%</td>
<td>9%</td>
<td>12%</td>
<td>14%</td>
<td>16%</td>
<td>17%</td>
<td>19%</td>
</tr>
<tr>
<td>R06 - ICB</td>
<td>---</td>
<td>---</td>
<td>9%</td>
<td>10%</td>
<td>---</td>
<td>13%</td>
<td>14%</td>
</tr>
<tr>
<td>G5/G6 - IC</td>
<td>---</td>
<td>---</td>
<td>8%</td>
<td>8%</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>z800 - ISC</td>
<td>9%</td>
<td>9%</td>
<td>11%</td>
<td>12%</td>
<td>11% Peer</td>
<td>12% Peer</td>
<td>13% Peer</td>
</tr>
<tr>
<td>z800 - ICB/IC</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>9% Peer</td>
<td>10% Peer</td>
<td>11% Peer</td>
</tr>
<tr>
<td>z900 - ISC</td>
<td>8%</td>
<td>9%</td>
<td>11%</td>
<td>12%</td>
<td>10% Peer</td>
<td>11% Peer</td>
<td>12% Peer</td>
</tr>
<tr>
<td>z900 - ICB / IC</td>
<td>---</td>
<td>---</td>
<td>8%</td>
<td>9%</td>
<td>8% Peer</td>
<td>9% Peer</td>
<td>10% Peer</td>
</tr>
<tr>
<td>z990 - ISC</td>
<td>7%</td>
<td>8%</td>
<td>8%</td>
<td>9%</td>
<td>9% Peer</td>
<td>10% Peer</td>
<td>11% Peer</td>
</tr>
<tr>
<td>z990 - ICB / IC</td>
<td>---</td>
<td>---</td>
<td>8%</td>
<td>8%</td>
<td>7% Peer</td>
<td>8% Peer</td>
<td>8% Peer</td>
</tr>
</tbody>
</table>

**Host effect with primary application involved with datasharing**
Console Restructure

- Console requirements
  - Improve message delivery
    - Storage and XCF utilization
  - Improve Console State Information
    - Data replicated on every system in the sysplex
    - State changes, systems join/leave causing flurries of activity
  - Eliminate Limit of 99 consoles in a sysplex
    - Installation constraint
Console Restructure
Console Enhancements Feature of z/OS 1.4

- Improved Availability in sysplex and non-sysplex environments
  - Robust management of WTO message storage improves system availability
  - Multiple-line messages not queued until completed
  - Emphasis placed on maintaining overall health of the system and sysplex in stressed environments

- More efficient message broadcast and deletion
  - Use of XCF ordered delivery to ensure that messages and message deletion requests arrive in the order that they were sent
  - Simplified message routing decision making
    - Decision made at target, not source system
Parallel Sysplex White Papers / References

- [ibm.com/servers/eserver/zseries/ps0](ibm.com/servers/eserver/zseries/ps0)
  - zSeries Parallel Sysplex Cluster: What is it and what can it do for you?
    - Business Value Overview
  - System-Managed CF Structure Duplexing (GM13-0103)
  - Configuring consoles for maximum availability
  - Availability Checklist
  - CF Configuration Options
  - Leveraging z/OS TCP/IP Dynamic VIPAs and Sysplex Distributor for Higher Availability
More Information

- storage.ibm.com/software/sms/index.html
- ibm.com/eserver/zseries/zos/wizards/
- z/OS Web site:
  - ibm.com/servers/eserver/zseries/zos/
- General Q & A:
  - ibm.com/servers/eserver/zseries/faq/
- z/OS V1R3 Hot Topics Newsletter GA22-7501
Parallel Sysplex Evolution - Hardware
Less parts and more performance

Delivers on Availability
Parallel Sysplex Evolution Software

- Traditional Environment Complete
  - DB2 - Business Intelligence
  - DB2 GBP Duplexing
  - Batch Management
  - Intelligent Data Miner
  - SAP
  - Transactional VSAM
  - MQSeries for OS/390

- Traditional Environments
  - Workload Manager
  - Resource Sharing
  - IMS DB
  - IMS TM/DB
  - DB2
  - CICS/VSAM
  - ISVs

- e-business/Objects Enabled
- Disaster Recovery Solutions
  - Resource sharing
  - Intelligent Resource Director
  - Systems Management Improvements
  - Geographically Dispersed Parallel Sysplex™ (GDPS)
  - GDPS XRC support
  - GDPS VTS support
  - GDPS CBU
  - Parallel Web server
  - WebSphere for OS/390
  - SecureWay® for OS/390
  - TCP/IP improvements

- Easier to Use
- Self-Configuration
  - Intelligent Resource Director
  - z/OS msys for Setup
  - z/OS msys for Operations
  - ICF Enhancements
  - Hierarchical Files
  - Configuration Assistance for Shared HFS
  - Optical Data
  - System Automation for OS/390
  - Auto Alter
  - Enhanced Contention Analysis
  - CF Sizer
  - CF Configuration Assistant
  - SDSF Configuration Assistant
  - ARM Wrapper
  - Goal Mode Migration Aid
  - System-Managed CF Duplexing

Delivers on Promises
Backup Charts
zSeries Technology Integration

- **How do I manage the explosion of users/servers?**
  - z900 Upgrades
  - Model 100 CF
  - msys for Setup
  - msys for Operations
  - Cloning / Symbolics
  - Single System Image

- **How do I manage the LPARs?**
  - LPAR CPU Mgmt
    - Linux CPU Mgmt
  - Dynamic CHPID Mgmt
  - Channel Subsystem Priority Queuing

- **How can I obtain consistent response time?**
  - WLM Goal Mode
  - IRD
  - Dynamic Workload Balancing

- **How do I manage the network?**
  - DNS/WLM
  - Interactive Network Dispatcher
  - MNLB
  - Dynamic XCF Addressing
  - VIPA Takeback
  - Sysplex Sockets
  - VTAM G/R
  - Multi-Node Persistent Sessions

- **What about the cost?**
  - Workload License Charge
  - Parallel Sysplex License Charge

- **How do I ensure continuous service?**
  - SM CF Duplexing
  - Sysplex Distributor
  - VIPA Takeback

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