Note
Before using this information and the product it supports, be sure to read the safety information under "Safety and Environmental Notices" on page xiii and the general information under Appendix C, "Notices," on page C-1.

Fourth Edition (October 2006)
This edition, SA22-6832-03, applies to the IBM® @server zSeries™ 890 processors and replaces SA22-6832-02. A technical change to the text or illustration is indicated by a vertical bar to the left of the change.

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Safety and Environmental Notices

Safety Notices

Safety notices may be printed throughout this guide. **DANGER** notices warn you of conditions or procedures that can result in death or severe personal injury. **CAUTION** notices warn you of conditions or procedures that can cause personal injury that is neither lethal nor extremely hazardous. **Attention** notices warn you of conditions or procedures that can cause damage to machines, equipment, or programs.

There are no **DANGER** notices in this guide.

World Trade Safety Information

Several countries require the safety information contained in product publications to be presented in their national languages. If this requirement applies to your country, a safety information booklet is included in the publications package shipped with the product. The booklet contains the safety information in your national language with references to the US English source. Before using a US English publication to install, operate, or service this IBM product, you must first become familiar with the related safety information in the booklet. You should also refer to the booklet any time you do not clearly understand any safety information in the US English publications.

Laser Safety Information

All System z models can use I/O cards such as PCI adapters, ESCON, FICON, Open Systems Adapter (OSA), InterSystem Coupling-3 (ISC-3), or other I/O features which are fiber optic based and utilize lasers or LEDs.

Laser Compliance

All lasers are certified in the U.S. to conform to the requirements of DHHS 21 CFR Subchapter J for class 1 laser products. Outside the U.S., they are certified to be in compliance with IEC 60825 as a class 1 laser product. Consult the label on each part for laser certification numbers and approval information.

**CAUTION:**
Data processing environments can contain equipment transmitting on system links with laser modules that operate at greater than Class 1 power levels. For this reason, never look into the end of an optical fiber cable or open receptacle. (C027)

**CAUTION:**
This product contains a Class 1M laser. Do not view directly with optical instruments. (C028)

Environmental Notices

Product Recycling and Disposal

This unit must be recycled or discarded according to applicable local and national regulations. IBM encourages owners of information technology (IT) equipment to responsibly recycle their equipment when it is no longer needed. IBM offers a variety of product return programs and services in several countries to assist

Esta unidad debe reciclarse o desecharse de acuerdo con lo establecido en la normativa nacional o local aplicable. IBM a los propietarios de equipos de tecnología de la información (TI) que reciclen responsablemente sus equipos cuando éstos comiencen ya no les sean útiles. IBM dispone de una serie de programas y servicios de devolución de productos en varios países, a fin de ayudar a los propietarios de equipos a reciclar sus productos de TI. Se puede encontrar información sobre las ofertas de reciclado de productos de IBM en el sitio web de IBM [http://www.ibm.com/ibm/environment/products/prp.shtml](http://www.ibm.com/ibm/environment/products/prp.shtml).

**Notice:** This mark applies only to countries within the European Union (EU) and Norway.

Appliances are labeled in accordance with European Directive 2002/96/EC concerning waste electrical and electronic equipment (WEEE). The Directive determines the framework for the return and recycling of used appliances as applicable throughout the European Union. This label is applied to various products to indicate that the product is not to be thrown away, but rather reclaimed upon end of life per this Directive.

In accordance with the European WEEE Directive, electrical and electronic equipment (EEE) is to be collected separately and to be reused, recycled, or recovered at end of life. Users of EEE with the WEEE marking per Annex IV of the WEEE Directive, as shown above, must not dispose of end of life EEE as unsorted municipal waste, but use the collection framework available to customers for the return, recycling, and recovery of WEEE. Customer participation is important to minimize any potential effects of EEE on the environment and human health due to the potential presence of hazardous substances in EEE. For proper collection and treatment, contact your local IBM representative.

注意：このマークはEU 諸国およびノルウェーにおいてのみ適用されます。
この機器は、EU 諸国に対する廃電気電子機器指令 2002/96/EC(WEEE) のラベルが貼られています。この指令は、EU 諸国に適用する使用済み設備の回収とリサイクルの骨子を定めていま
す。このラベルは、使用済みになった時に指令に従って適正な処理をする必要があることを
知らせるために種々の製品に貼られています。

Remarque : Cette marque s'applique uniquement aux pays de l'Union Européenne et à la Norvège.

L'étiquette du système respecte la Directive européenne 2002/96/EC en matière de Déchets des Equipements Electriques et Electroniques (DEEE), qui détermine les dispositions de retour et de recyclage applicables aux systèmes utilisés à travers l’Union européenne. Conformément à la directive, ladite étiquette précise que le produit sur lequel elle est apposée ne doit pas être jeté mais être récupéré en fin de vie.
Battery Return Program

This product may contain sealed lead acid, nickel cadmium, nickel metal hydride, lithium, or lithium ion battery(s). Consult your user manual or service manual for specific battery information. The battery must be recycled or disposed of properly. Recycling facilities may not be available in your area. For information on disposal of batteries outside the United States, go to [http://www.ibm.com/ibm/environment/products/batteryrecycle.shtml](http://www.ibm.com/ibm/environment/products/batteryrecycle.shtml) or contact your local waste disposal facility.

In the United States, IBM has established a return process for reuse, recycling, or proper disposal of used IBM sealed lead acid, nickel cadmium, nickel metal hydride, and other battery packs from IBM Equipment. For information on proper disposal of these batteries, contact IBM at 1-800-426-4333. Please have the IBM part number listed on the battery available prior to your call.

In Taiwan, the following applies:

Please recycle batteries 廢電池請回收

For the European Union:

For California:

Perchlorate Material - special handling may apply. See [http://www.dtsc.ca.gov/hazardouswaste/perchlorate](http://www.dtsc.ca.gov/hazardouswaste/perchlorate).

The foregoing notice is provided in accordance with California Code of Regulations Title 22, Division 4.5, Chapter 33. Best Management Practices for perchlorate Materials. This product, part, or both may include a lithium manganese dioxide battery which contains a perchlorate substance.

IBM Cryptographic Coprocessor Card Return Program

The following information applies only for systems originally sold prior to July 1, 2006:

This machine may contain an optional feature, the cryptographic coprocessor card, which includes a polyurethane material that contains mercury. Please follow Local Ordinances or regulations for disposal of this card. IBM has established a return program for certain IBM Cryptographic Coprocessor Cards. More information can be found at [http://www.ibm.com/ibm/environment/products/prp.shtml](http://www.ibm.com/ibm/environment/products/prp.shtml).
IBM Cryptographic Coprocessor

برنامج ارجاع كرت

هذه الماكينة قد تحتوي على خاصية اختيارية، وهي كارت Cryptographic Coprocessor
والتي تحتوي على مادة بوليوريثين التي تحتوي على الزئبق 
وتجهاز اتباع القوانين أو المعلومات المحلية للتخلص من هذا الكارت .
IBM Cryptographic Coprocessor

قامت شركة IBM بإعداد برنامج لارجاع بعض كروت Coprocessor

لمزيد من المعلومات، راجع زيارة الموقع
About this Publication

This publication describes the design, components, functions, features, and capabilities of the IBM @server zSeries® 890 (z890) models. It is intended for executives, data processing managers, data processing technical staff, consultants, and vendors who wish to exploit z890 advantages.

You should be familiar with the various publications listed in "Prerequisite Publications" and "Related Publications." A "Glossary" on page D-1 and an Index are provided at the back of this publication.

What is Included in this Publication

This publication contains the following chapters and appendices:

- Chapter 1, "Introduction," on page 1-1
- Chapter 2, "Hardware Characteristics," on page 2-1
- Chapter 3, "Software Support," on page 3-1
- Chapter 4, "Channel Subsystem Structure," on page 4-1
- Chapter 5, "I/O Connectivity," on page 5-1
- Chapter 6, "Sysplex Functions," on page 6-1
- Chapter 7, "Cryptography," on page 7-1
- Chapter 8, "Cabling," on page 8-1
- Chapter 9, "Hardware Management Console and Support Element," on page 9-1
- Chapter 10, "Reliability, Availability, and Serviceability (RAS)," on page 10-1
- Appendix A, "Resource Link," on page A-1

Prerequisite Publications

Before reading this publication you should be familiar with IBM z/Architecture™, IBM S/390®, and IBM Enterprise Systems Architecture/390® (ESA/390) as described in the following publications:

- z/Architecture Principles of Operation, SA22-7832

Related Publications

Important
Please ensure that you are using the most recent version of all related documentation.

Other IBM publications that you will find helpful and that you should use along with this publication are in the following list. You can access these books from Resource Link under the Library section.

- zSeries Application Programming Interfaces, SB10-7030
- zSeries ESCON and FICON Channel-to-Channel Reference, SB10-7034
- Hardware Management Console Operations Guide, SC28-6830
Parallel Sysplex Publications

A Parallel Sysplex system consists of two or more servers coupled by intersystem channels so as to present a single image to the user. A Parallel Sysplex uses a coupling facility to provide data sharing among the systems participating in the Parallel Sysplex. The following publications provide additional information to help you understand and prepare for a Parallel Sysplex that uses coupling facility for data sharing purposes.

- **OS/390 Parallel Sysplex Hardware and Software Migration**, GC28-1862, provides hardware and software planning information to help you migrate to a Parallel Sysplex with a coupling facility.
- **OS/390 Parallel Sysplex Overview: Introducing Data Sharing and Parallelism in a Sysplex**, GC28-1860, provides an overview of the Parallel Sysplex environment and coupling facility data sharing.
- **OS/390 Parallel Sysplex Systems Management**, GC28-1861, provides planning considerations for Parallel Sysplex systems management.
- **z/OS Parallel Sysplex Application Migration**, SA22-7662, provides planning considerations for defining CICS/ESA® and IMS/ESA® applications to run in a Parallel Sysplex environment.
- **z/OS Parallel Sysplex Overview: Introducing Data Sharing and Parallelism in a Sysplex**, SA22-7661, provides an overview of the sysplex and coupling facility data sharing and describes basic concepts and values of the sysplex to your business.
OSA Publications
The following publication provides additional information for planning and using the OSA-Express features:

Cryptographic Publications
The following publications provide additional information about the Cryptographic Coprocessor feature:
- *z/OS ICSF Trusted Key Workstation User’s Guide 2000*, SA22-7524
- *z/OS Integrated Cryptographic Service Facility Administrator’s Guide*, SA22-7521
- *z/OS Integrated Cryptographic Service Facility Messages*, SA22-7523
- *z/OS Integrated Cryptographic Service Facility Overview*, SA22-7519
- *OS/390 Integrated Cryptographic Service Facility Messages*, SC23-3977
- *OS/390 Integrated Cryptographic Service Facility Overview*, GC23-3972
- *Cryptographic Subsystem Concepts and Facilities*, GC22-9063
- *Data Security Through Cryptography*, GC22-9062

Miscellaneous Publications
The following publications provide additional miscellaneous information:
- *IBM 3390 Direct Access Storage Introduction*, GC26-4573
- *IBM TotalStorage Enterprise Storage Server Introduction and Planning Guide*, GC26-7294
- *Technical Introduction IBM z890*, SG24-6310

Related Web Sites
The following web sites provide additional z890 information:
- [Resource Link](http://www.ibm.com/servers/resourcelink) - *Resource Link* is a key element in supporting the z890 product life cycle. Some of the main areas include:
  - *Education*
- Planning
- Library
- CHPID Mapping Tool
- Fiber Cabling
- Customer Initiated Upgrade (CIU).


Additional Online Information

Online information is available about the z890 system to define tasks and to aid in completing tasks. The following information is available under the Books icon on the Hardware Management Console:

- Application Programming Interfaces (API)
- Programming Interfaces for Java™
- Coupling Facility Control Code Commands
- Hardware Management Console Operations Guide
- Support Element Operations Guide.

Help is available for panels, panel options, and fields on panels.

Engineering Change (EC) Level Considerations

Future enhancements available for z890 may be dependent on the EC level of the Central Processor Complex (CPC) and/or Hardware Management Console (HMC). Additionally, some enhancements may further be dependent on the Microcode Load (MCL) level of the EC on the CPC and/or Hardware Management Console. The required MCL level will be available to the IBM field representative.


How to Send Your Comments

Your feedback is important in helping to provide the most accurate and high-quality information. Send your comments by using Resource Link at http://www.ibm.com/servers/resourcelink Select Feedback on the Navigation bar on the left. Be sure to include the name of the book, the form number of the book, the version of the book, if applicable, and the specific location of the text you are commenting on (for example, a page number or table number).
Summary of changes

Summary of changes for the zSeries 890 System Overview, SA22-6832.

Table 1. Summary of Changes

<table>
<thead>
<tr>
<th>Release Level</th>
<th>Date</th>
<th>Changes in Level</th>
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| 00a           | 05/04| This revision contains editorial changes and the following technical change:  
|               |      | • HSA size for small and large system I/O configuration. |
| 01            | 10/04| This revision contains editorial changes and the following technical changes:  
|               |      | • GDPS supports z/VM® V5.1 HyperSwap™  
|               |      | • Crypto Express2, combines PCICA and PCIXCC (Available 1Q05)  
|               |      | • 19 digit PANs supported on PCIXCC (Available 4Q04  
|               |      | • Preview of FCP Logical Unit Number (LUN) Access Control  
|               |      | • FICON purge path extended  
|               |      | • OSA-Express2 for networks (Available 1Q05)  
|               |      | • Layer 2 (Link Layer) transport mode support for OSA-Express and OSA-Express2  
|               |      | • CFCC level 14  
|               |      | • On/Off CoD no charge test  
|               |      | • Extended staging of CIU Express and On/Off CoD orders  
|               |      | • TKE 4.2 code with Smart Card Reader support. |
| 02            | 01/05| This revision contains editorial changes and the following technical changes:  
|               |      | • Addition of FICON Express2  
|               |      | • GDPS/PPRC enhancements. |
| 03            | 10/06| This revision contains editorial changes and the following technical changes:  
|               |      | • Addition of Server Time Protocol (STP) support. |
Chapter 1. Introduction

The IBM @server zSeries 890 (z890) represents the continuation of the new generation of scalable servers introduced with the IBM @server zSeries 990 (z990). Using z/Architecture and zSeries latest building blocks and virtualization technology, the z890 extends zSeries key platform characteristics of reliability, availability, scalability, clustering, and quality of service to respond to the ever changing business climate with a processor that delivers extensive growth options and excellent price/performance if you are requiring a lower capacity entry point than offered with the z990.

The IBM eServer™ z890 is designed to help enable your business to be resilient in the unpredictable on demand world. It has the ability to meet mission critical requirements that include unexpected demands, high numbers of transactions, a heterogenous application environment, and the ability to consolidate a number of servers. This helps you with your workloads by adding capacity, bandwidth, number of channels, and Logical Partitions (LPARs) giving you the ability to reduce costs and positioning yourself for future expansion.

![IBM eServer™ zSeries 890](image)

Figure 1-1. IBM @server zSeries 890

With a single model and a wide range of capacity settings, the newest member of the zSeries family delivers significantly improved granularity and enriched functions over it’s predecessor the z800:

- Almost twice the processing power
- Over two times the total system capacity
- Significantly increased I/O capacity.

The z890 supports double the number of LPARs that were supported in z800, facilitates horizontal growth with the Logical Channel Subsystem (LCSS) feature introduced in z990, and introduces a new eServer zSeries Application Assist Processor (zAAP) which provides an attractively priced Java execution environment.
To address the growing complexity of fiber optic connectivity in the Information Technology (IT) infrastructure, IBM Networking Services continues to offer scalable fiber optic cabling services to satisfy e-business infrastructure requirements at both the product-level and the enterprise-level. Refer to Chapter 8, “Cabling,” on page 8-1 for more information. You can also access Resource Link at http://www.ibm.com/servers/resourcelink and click Services on the navigation bar for the network cabling services.

**Important Note**

When the term FICON is used, it refers to FICON Express and FICON Express2.
When the term OSA is used, it refers to OSA-Express and OSA-Express2.
When the term crypto is used, it refers to Crypto Express2, PCIXCC, and PCICA.

### z890 Highlights

The design of z890 includes the following new or improved features over the previous zSeries 800 machine:
- Provides increased scalability over two times the total capacity of the largest z800
- Introduces a lower capacity entry point into the zSeries family
- Crypto Express2 combines PCICA and PCIXCC into a single feature
- Offers enhanced incremental growth options with 28 levels of capacity
- Doubles the number of supported channels
- Doubles the number of logical partitions (LPARs) over z800 (except on the smallest sub-uniprocessor equipped capacity setting)
- Quadruples the number of HiperSockets™ (internal LANs)
- OSA-Express2 Gigabit Ethernet and 10 Gigabit Ethernet features
- Layer 2 (Link Layer) transport mode support for OSA (QDIO ethernet only)
- 640 TCP/IP stacks for OSA-Express2
- 160 IP stacks for OSA-Express OSD (QDIO) CHIPDs
- Offers performance assists for Linux and z/VM
- Introduces OSA-Express enhancements including the new Integrated Console Controller (ICC)
- Internal Coupling (IC), HiperSockets, FICON, Integrated Cluster Bus (ICB), InterSystem Channel-3 (ISC-3), and OSA spanned channels
- Increases channel maximums for ESCON®, FICON, ISC-3, and OSA over z800 (except on the smallest sub-uniprocessor equipped capacity setting)
- Offers enhancements to fiber optic cabling services from IBM Networking Services (this is not available in Canada)
- Extends IBM’s zSeries world class SSL performance
- Introduces the IBM eServer zSeries Application Assist Processor (zAAP)
- Offers an Internal Battery Feature (IBF)
- Extends GDPS®/PPRC distance to up to 100 km
- Increases ISC-3 links in peer mode up to 48 (only 32 can be defined in compatibility mode)
- Coupling Facility Control Code Level 14 with CFCC Dispatcher Modifications includes the Level 13 support for CFCC enhanced patch apply and DB2® performance for cast-out processing.
- Ability to dynamically add meaningful logical partition names.
- On/Off Capacity on Demand (On/Off CoD) test at no charge
- Extended staging of CIU Express and On/Off CoD orders
- GDPS supports z/VM V5.1 HyperSwap
- GDPS/PPRC enhancements
- Server Time Protocol feature provides:
  - Improved time synchronization for z9 EC, z9 BC, z990, and z890 servers
  - Increased multisite sysplex distance to 100 km
  - Coexistence with an ETR network
  - Concurrent migration from an ETR network.
- Preview of Fibre Channel Protocol (FCP) Logical Unit Number (LUN) Access Control
- TKE with Smart Card Reader support
- Large send for offloading
- FICON Express2 doubles channel capacity and increases performance over FICON Express on a z890.

**Scalability**

z890 contains a new superscalar microprocessor architecture exploiting the copper and Silicon-on-insulator (SOI) technology and improving uniprocessor performance. z890 is an air-cooled, single-frame, single-book variant of the z990 platform. The capability for a significant capacity increase versus z800 has been achieved with the availability of the following on z890:

- **Up to 32 GigaBytes of memory** - 8GB, 16GB, 24GB, and 32GB
- **Up to 16 GigaBytes per second of bandwidth** for data communication between I/O and memory by using up to 8 Self-Timed Interconnect (STI) host buses.
  
  Connection of the Input/Output (I/O) subsystem to the Central Processor Complex (CPC) subsystem is done by using 8 Self-Timed Interconnect (STI) links each having a capacity of 2 Gigabytes per second (GBps).
- **One I/O cage** with 28 I/O slots (16 on the smallest sub-uniprocessor equipped capacity setting).
- **A new Channel Subsystem (CSS)** where two Logical Channel Subsystems (LCSSs) can exist for horizontal growth, supporting up to 256 CHPIDs per LCSS for a total of 512 channels per system. Refer to Chapter 4, “Channel Subsystem Structure,” on page 4-1 for more information.
- **Double the number of Logical Partitions (LPARs)** up to 30 LPARs (15 on the smallest sub-uniprocessor equipped capacity setting).
- **Increased channel maximums for ESCON, FICON, and OSA** (except on the smallest sub-uniprocessor equipped capacity setting)

There is an increased number of FICON cards allowing a larger number of simultaneous I/O connections available for the FICON features. The z890 system allows 20 FICON features to be plugged. FICON Express allows a total of 40 available channels. The z800 allowed 32 total available channels. For more information, refer to “FICON Express Channels” on page 5-2. FICON Express2 allows a maximum of 80 channels. For more information, refer to “FICON Express2” on page 5-1.

OSA offers a maximum of 20 features per system compared to 12 for z800. You have 40 ports of LAN connectivity and you can choose any combination of OSA features: 1000BASE-T Ethernet over copper, 10 GbE, Gigabit Ethernet (GbE), Fast Ethernet, or Token Ring. All features contain 2 ports per feature except 10GbE which has only one port per feature providing only 24 ports of LAN connectivity. Refer to “OSA-Express Channels” on page 5-34 for more information.

The ESCON feature has 16 ports, 15 of which can be activated for normal use. One port is always reserved as a spare, in the event of a failure of one of the...
other ports. You can define up to a maximum of 420 ESCON channels and a maximum of 28 features. Refer to “ESCON Channels” on page 5-21 for more information.

- **Quadruple the number of HiperSockets**
  HiperSockets support 16 internal Local Area Network (LANs) that can be configured. A HiperSockets channel must be spanned in order to communicate between LPARs in different LCSSs. Refer to “Spanned Channels” on page 4-12 for more information.

- **Cryptographic options** which include: CP Assist for Cryptographic Function (CPACF) which delivers cryptographic support on every PU for data encryption/decryption, a PCIX Cryptographic Coprocessor (PCIXCC) feature which supports secure key cryptographic functions, encrypted key values, and User Defined extensions (UDX), a PCI Cryptographic Accelerator (PCICA) feature for leading edge performance, and Crypto-Express2 which supports the Federal Information Processing Standard (FIPS) and replaces PCICA and PCIXCC.

- **Integrated Cluster Bus-4 (ICB-4)** is used to connect z890 to z890 and z990 and is two times faster than an ICB-3.

- **Integrated Cluster Bus-3 (ICB-3)** is a coupling link connecting z890 to z800 and z900 with a maximum of 16 links where as z800 is limited to six links.

- **ISC-3 links** are doubling to provide additional horizontal growth opportunities for parallel sysplex environments. z890 supports 48 links, 12 features (four links per feature). The z800 supports 24 links.

- **Coupling Facility Control Code (CFCC) Level 14** with dispatcher modifications supports CF Duplexing. The CFCC dispatcher and internal serialization mechanisms have been modified to improve the management of coupled workloads from all environments under certain circumstances.

- **Coupling Facility Control Code (CFCC) Level 13** provides availability and performance enhancements and supports:
  - CFCC enhanced patch apply
  - DB2 performance for cast-out processing.

- **IBM eServer zSeries Application Assist Processor (zAAP)** is a specialized processor unit which provides an attractively priced Java execution environment if you desire the traditional qualities of service and the integration advantages of the zSeries platform.

**Note:** The zAAP is a specific example of an assist processor that is known generically as an Integrated Facility for Applications (IFA). The generic term IFA often appears in panels, messages, and other online information relating to the zAAP.

- **Internal Battery Feature (IBF)** used for emergency backup power.

- **Five Processor Units (PUs)**
  - One model
  - 28 unique capacity settings, offering increased granularity
  - Up to four Central Processors (CPs) and one mandatory System Assist Processor (SAP). Refer to Table 1-1 on page 1-6

A Processor Unit (PU) is the generic term for the z/Architecture processor on the Multichip Module (MCM) that can be characterized as a:
  - Central Processor (CP) to be used by the operating system
  - Internal Coupling Facility (ICF) to be used by the CFCC
  - Integrated Facility for Linux (IFL)
  - IBM eServer zSeries Application Assist Processor (zAAP).
With z890 at least one CP, ICF, or IFL must be purchased and activated. For each zAAP engine installed there must be a corresponding CP engine permanently purchased and installed. (Refer to Table 1-1 on page 1-6). PUs can be purchased in single-PU increments and are orderable by feature code.

Server Consolidation
With the expanded capacity of z890 over z800, and its new Channel Subsystem, there is a significant increase in server scalability, facilitating consolidation of multiple servers into one z890.

With the z/OS® V1R4 z990 Exploitation Support feature, you can install more operating system images and up to a total of 512 channels (up to 256 CHPIDs maximum per operating system), allowing each z890 (except on the smallest sub-uniprocessor equipped capacity setting) to access more channels, coupling links, and LANs:
- ESCON (up to 420 channels)
- FICON (up to 80 channels)
- ISC-3 (up to 48 links)
- OSA (up to 40 ports).

z890 Functions and Features
The zSeries 890 offers the following functions and features:
- Consists of one model (A04) and 28 capacity settings.
- All configurations of z890 contain the same number of physical Processor Units (five), however, you are only licensed to use the Licensed Internal Code (LIC) to support the amount of CPs and capacity actually purchased.
- Each configuration has one mandatory SAP and must contain at least one CP, IFL, or ICF engine. For each zAAP engine installed there must be a corresponding CP engine permanently purchased and installed.
- Can be configured with all IFL or ICF engines.
- Any remaining PUs (subject to configuration rules and execution of appropriate terms and conditions, as applicable) may be assigned to optional functions such as ICFs, IFLs, zAAPs, On/Off Capacity on Demand (On/Off CoD), or Capacity Backup Upgrade (CBU) or they may be assigned as spares.
- The total number of CP, ICF, IFL, zAAP, spare, On/Off CoD engine, or CBU engine cannot exceed four (plus one mandatory SAP for a total of five PUs).
- CBU applies to whole zSeries CP engine additions only and only to the largest capacity configuration (full engine).
- CBU does not apply to changes in capacity setting and does not apply to IFLs, ICFs, SAPs, zAAPs, or memory.
- CBU is always a temporary capacity upgrade.
- On/Off CoD is a Licensed Internal Code (LIC) enabled temporary capacity upgrade with a prerequisite of enablement feature codes 9896 and 9898. Downgrades from this temporary capacity are to the original capacity setting only.
- With On/Off CoD, while capacity upgrades to the processor itself are concurrent, some operating system software may not be able to take advantage of changes in capacity without performing an Initial Program Load (IPL).
- On/Off CoD activation is mutually exclusive with CBU activation. Both On/Off CoD and CBU can reside on the server, but only one can be activated at a time.
- On/Off CoD can be activated and the CBU feature is not removed.
Table 1-1 displays the content of the z890 Model A04, including the number of PUs, SAPs, CPs, optional ICFs, optional IFLs, optional zAAPs, spare PUs, available engines for On/Off CoD, and available engines for CBU.

Table 1-1. z890 Model A04

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<tr>
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<th>PUs</th>
<th>SAPs</th>
<th>CPs</th>
<th>ICFs Max</th>
<th>IFLs Max</th>
<th>zAAPs Max</th>
<th>Spares Max</th>
<th>On/Off CoD Engines Max</th>
<th>CBU Engines Max</th>
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<td>Note: Some of these configuration options are mutually exclusive.</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Non-traditional Engines (with minimum/maximum amounts specified)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6516</td>
<td>5</td>
<td>1</td>
<td>0/0</td>
<td>N/A</td>
<td>1/4</td>
<td>N/A</td>
<td>0/3</td>
<td>0/2</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Table 1-1. z890 Model A04 (continued)

<table>
<thead>
<tr>
<th>Feature Code</th>
<th>PUs</th>
<th>SAPs</th>
<th>CPs Max</th>
<th>ICFs Max</th>
<th>IFLs Max</th>
<th>zAAPs Max</th>
<th>Spares Max</th>
<th>On/Off CoD Engines Max</th>
<th>CBU Engines Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>6518</td>
<td>5</td>
<td>1</td>
<td>0/0</td>
<td>1/4</td>
<td>N/A</td>
<td>N/A</td>
<td>0/3</td>
<td>0/2</td>
<td>N/A</td>
</tr>
<tr>
<td>6520</td>
<td>5</td>
<td>1</td>
<td>1/3²</td>
<td>N/A</td>
<td>N/A</td>
<td>1/2</td>
<td>0/2</td>
<td>0/2⁴</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Notes:
1. Traditional Engines: Additional engines are not available, but capacity can be changed by changing capacity setting
2. Traditional Engines: Requires a traditional engine feature code
3. Traditional Engines: The smallest sub-uniprocessor equipped capacity setting
4. Non-traditional Engines: CP and/or zAAP.

CP Models
The Central Processor model indicates the number of CPs defined. Since there is only one z890 model A04, each of the 28 capacity settings will have a four digit associated feature code.
- Position one = fixed value of 6 (can be ignored)
- Position two = number of CPs (1-4)
- Position three = capacity setting (1-7, one being the smallest subcapacity setting and seven being a full processor)
- Position four = engine identifier (0=CP, 1=On/Off CoD Use Day, 2=downgrade record).

The following table lists the CP feature codes for the 28 capacity setting models.

Table 1-2. z890 CP Feature Codes

<table>
<thead>
<tr>
<th>1-way (Uni)</th>
<th>2-way (Dyadic)</th>
<th>3-way (Triadic)</th>
<th>4-way (Quadratic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP</td>
<td>On/Off CoD</td>
<td>CP</td>
<td>On/Off CoD</td>
</tr>
<tr>
<td>6110</td>
<td>N/A</td>
<td>6210</td>
<td>6211</td>
</tr>
<tr>
<td>6120</td>
<td>6121</td>
<td>6220</td>
<td>6221</td>
</tr>
<tr>
<td>6130</td>
<td>6131</td>
<td>6230</td>
<td>6231</td>
</tr>
<tr>
<td>6140</td>
<td>6141</td>
<td>6240</td>
<td>6241</td>
</tr>
<tr>
<td>6150</td>
<td>6151</td>
<td>6250</td>
<td>6251</td>
</tr>
<tr>
<td>6160</td>
<td>6161</td>
<td>6260</td>
<td>6261</td>
</tr>
<tr>
<td>6170</td>
<td>6171</td>
<td>6270</td>
<td>6271</td>
</tr>
</tbody>
</table>

Resource Link
Resource Link is a key component in getting your zSeries server up and running and maintained. Key areas of improvement include the Customized planning aids, CHPID mapping tool, Customer Initiated Upgrades (CIU), Fiber Cabling Service, and additional Education courses. Refer to Appendix A, “Resource Link,” on page A-1 for detailed information about Resource Link and all the functions that it can assist you with for your zSeries processor.

Fiber Optic Cabling
IBM Networking Services provides a comprehensive set of services for your products and enterprises. These services help you gain an Information Technology
(IT) advantage by providing you with the tools you need to gain market share in this fast paced e-business economy. It relieves you of the stress and complexity of selecting the appropriate connectors and cables to support your servers, devices, LANs, and Storage Area Networks.

The zSeries fiber cabling services and enterprise fiber cabling services, offered by IBM Networking Services, are designed to help you keep pace and provide you with the optimum reliability, availability, and serviceability, as well as the scalability you need to grow your system. Refer to Chapter 8, “Cabling,” on page 8-1 for additional information or you can access Fiber Cabling on Resource Link.

**z/Architecture**

The zSeries is based on z/Architecture which is 64-bit addressing that eliminates bottlenecks associated with lack of addressable memory by making the addressing capability virtually unlimited (up to 16 Exabytes compared to the prior capability of 2 Gbytes in S/390 systems.) As an application's single systems image increases in size and demands a linear increase in server capacity, the requirement for greater addressability actually increases geometrically. As addressability begins to be constrained, the lack of real storage increases overhead and ultimately constrains system growth. This situation exacerbates critical situations in which explosive systems growth has been a result of successful eBusiness implementation.

IBM’s z/Architecture has the following enhancements that are supported on z890:
- List-Directed Initial Program Load (IPL)
- Hexadecimal-Floating-Point (HFP) Multiply-and-Add/Subtract facility (ESA/390 and z/Architecture modes)
- Message-Security Assist (ESA/390 and z/Architecture modes)
- Long-Displacement facility (z/Architecture mode)
- Extended-I/O-Measurement-Block facility (ESA/390 and z/Architecture modes)
- Extended-I/O-Measurement-Word facility (ESA/390 and z/Architecture modes).

For more detailed information on these enhancements, refer to “z/Architecture” on page 2-19 and the z/Architecture Principles of Operation.

IBM’s z/Architecture also supports the following functions:
- Enables optimal use of memory resources.
- Provides for migration flexibility.
- Uses a single level of OS/390® or z/OS operating system across an entire enterprise.
- Allows non-disruptive test and migration and provides for ease of transition for systems support staff.
- Ensures maximum transparency to the operating system and complete transparency to system applications.
- Offers a doubleword Indirect Data Address Word (IDAW) which allows all programs to designate 64-bit data addresses for I/O. Use of 64-bit operands and general registers for all I/O instructions is added.
- Gigabit Ethernet architecture is expanded to allow 64-bit Queued I/O queuing structures, in addition to the doubleword Indirect Data Address Word for data addresses for I/O.
- IEEE Floating-Point architecture has twelve instructions for 64-bit integer conversion.
- Coupling Facility Control Code (CFCC) LEVEL 13, which ships with z890, supports 64-bit addressing for the CFCC image.
- Use of 64-bit operands and general registers for all PCICA and PCIXCC instructions.

### Upgrade Progression

The following upgrades can take place:

- Only z800 models 002 and 004 can be upgraded to z890
- Any z890 model can be upgraded to any z890 model
- There will be limited upgrade paths from z890 Model A04 to z990 model A08 (for details contact your IBM representative or IBM Business Partner)
- There are no upgrades from machine types 9672, 2003, and 7060.

### Unsupported Features/Functions

This section lists the features/functions that are **not** supported on z890 and a recommended alternative, if applicable.

**Basic mode**

Only LPAR mode is available.

**SNA Auto Ops**

With the industry move to TCP/IP networks, Systems Network Architecture (SNA) Operations Management commands will no longer be supported on z890 servers. These commands were previously used by the System Automation for OS/390 product as well as directly from NetView® by the customer. To transition the removal of this function, customers should now use the Simple Network Management Protocol (SNMP) Application Programming Interfaces (APIs) for their automation needs.

1. If customers previously used the System Automation for OS/390 product, they must now use Version 2.2 or higher. This will allow them to define an automation policy for SNMP APIs rather than a policy for SNA Operations Management commands.
2. If customers directly used the SNA Operations Management commands on NetView, they must now use the SNMP APIs for systems automation management.

For detailed information on the SNMP APIs commands and environment requirements, refer to [*zSeries Application Programming Interfaces*](#). For more information on the SNA Operations Management command support that was removed on z890, refer to [*Managing Your Processors*](#), GC38-0452. Both publications are available on [Resource Link](#).

**Parallel channels (FC 2304)**

You can use:

- A parallel channel converter box such as the IBM 9034, which is available through IBM Global Services, or
- A parallel converter box from Optica, Optica 34600 FXBT.

**OSA-Express Asynchronous Transfer Mode (ATM) features (FC 2362, 2363)**

If ATM connectivity is still desired, you can use multiprotocol switch or router with appropriate network interface (such as 1000BASE-T Ethernet or Gigabit Ethernet).

**Notes:**

1. Not offered as a new build option
2. Not offered on an upgrade from z800.
**OSA-2 Ethernet/Token Ring (ENTR) cards (FC 5201)**
These cards should be migrated to the new OSA-Express 1000BASE-T Ethernet card or to the OSA-Express Token Ring card. This feature is not offered on z890.

**4-Port ESCON cards (FC 2313)**
These cards must be replaced with 16-port ESCON cards.

**FICON cards (FC 2315, 2318)**
These cards must be replaced with FICON Express2 cards.

**Default CHPID assignment**
There are no default CHPID numbers assigned. These assignments are made by using the HCD/IOCP definitions. The CHPID Mapping Tool, found on Resource Link, may be used to aid with the definitions. Refer to Chapter 4, “Channel Subsystem Structure,” on page 4-1 for more information.
Chapter 2. Hardware Characteristics

This chapter describes the hardware features and functions for the z890 Model A04 (machine type 2086).


System Frame Configuration

The z890 single-frame system is an enclosure built to Electronic Industry Association (EIA) standards. The 'A' frame makes up the frame configuration. The following figure displays the frame configuration.

![Figure 2-1. z890 Frame Configuration](image)

The 'A' frame consists of:

- Processor Cage (or Central Processor Complex (CPC)) which consists of:
  - One processor book (model A04), which provides:
    - Four PUs (CP, IFL, ICF, zAAP, or spare)
    - One mandatory SAP
    - One memory card (physical card sizes are 8GB, 16GB, and 32GB),
- Input/Output (I/O) cage for channel attachment capability
- Two internal Support Elements (SEs)
- System Power Supply
Optional Internal Battery Feature (IBF) - A pair of batteries that are installed in the top of the 'A' frame for emergency backup power. Refer to "Internal Battery Feature" on page 2-18 for more information.

Central Processor Complex (CPC)

The Central Processor Complex (CPC) is comprised of a single book.

The CPC cage basically consists of:
- One book containing:
  - One Multichip Module (MCM)
  - One memory card
  - Two Memory Bus Adapters (MBAs) (four STIs per MBA).
- Distributed Converter Assembly (DCA) cards
- Two Oscillator (OSC) cards
- Two optional External Time Reference (ETR) cards.

Book

A book plugs into a slot in the CPC cage of the z890. A book is a physical package containing memory, an MCM, and the MBAs. The single book is referred to as BOOK 0 and is also known as the Basic Infrastructure Controller (BIC) book. If the BIC book fails, the entire system fails. Figure 2-2 displays the book position in the CPC cage.

![Book Position](image)

Figure 2-2. Book Position

Multichip Module (MCM)

The z890 model utilizes a five processing unit MCM of which four are available for PU characterization. The remaining PU is reserved by IBM as a standard SAP. There are no designated standard spares.

Processor Unit (PU)

The z890 model contains five physical Processor Units (PUs) as shown in Table 1-1 on page 1-6. For z890, you must select at least one CP, IFL, or ICF as shown in Table 1-1 on page 1-6. Any remaining PUs (subject to configuration rules and execution of appropriate terms and conditions, as applicable) may be assigned to
optional functions such as ICFs, IFLs, CPs, zAAPs, On/Off CoD, or CBU engines or they may be assigned as spares. The total number of CPs, SAPs, spares, ICFs, IFLs, zAAPs, On/Off CoD, and CBU engines activated may not exceed five, the total number of PUs available.

**Central Processor (CP):** A Central Processor (CP) is a PU that has the z/Architecture and ESA/390 instruction sets. It can run z/VM, z/OS, z/OS.e, Linux, and TPF operating systems and the Coupling Facility Control Code (CFCC). z890 processors operate only in LPAR mode; consequently all CPs are dedicated to a partition or shared between partitions. Reserved CPs can also be defined to a logical partition, to allow for nondisruptive image upgrades.

All CPs within a configuration are grouped into a CP pool. Any z/VM, z/OS, and TPF operating systems can run on CPs that were assigned from the CP pool. Within the capacity of the z890 book, CPs can be concurrently added to an existing configuration permanently by using CIU, CUoD, or temporarily by using On/Off CoD or CBU.

**Internal Coupling Facility (ICF):** An ICF provides additional processing capability exclusively for the execution of the Coupling Facility Control Code (CFCC) in a coupling facility LPAR. Optional ICF may be ordered. ICFs can only be used in coupling facility logical partitions, but can be shared or dedicated, since only CFCC runs on these PUs. Software Licensing charges are not affected by the addition of ICFs. For more information, refer to “Coupling Facility” on page 6-6.

**Integrated Facility for Linux (IFL):** An IFL provides additional processing capacity exclusively for Linux workloads. Optional IFL features may be ordered. These IFLs can only be used in Linux or z/VM logical partitions, but those IFLs can be shared or dedicated, since only Linux software runs on these CPs. Software licensing charges are not affected by the addition of IFLs. For more information on Software licensing, contact your IBM Representative.

**zSeries Application Assist Processor (zAAP):** This specialized processor unit provides an economical Java execution environment if you desire the traditional Qualities of Service and the integration advantages of the zSeries platform.

When configured with CPs within logical partitions (LPARs) running z/OS or z/OS.e, zAAPs may help increase CP productivity and may contribute to lowering the overall cost of computing for z/OS and z/OS.e Java technology-based applications. zAAPs are designed to operate asynchronously with the CPs to execute Java programming under control of the IBM Java Virtual Machine (JVM). This can help reduce the demands and capacity requirements on CPs which may then be available for reallocation to other zSeries workloads.

The IBM JVM processing cycles can be executed on the configured zAAPs with no anticipated modifications to the Java application. Execution of the JVM processing cycles on a zAAP is a function of the Software Developer’s Kit (SDK) 1.4.1 for zSeries, z/OS and z/OS.e V1R6, and Processor Resource/Systems Manager™ (PR/SM™).

**Note:** The zAAP is a specific example of an assist processor that is known generically as an Integrated Facility for Applications (IFA). The generic term IFA often appears in panels, messages, and other online information relating to the zAAP.
**System Assist Processor (SAP):** A SAP is a PU that runs the channel subsystem Licensed Internal Code (LIC) to control I/O operations. The SAP performs I/O operations for all logical partitions.

**Memory**

Each CPC has its own processor memory resources. CPC processor memory can consist of both **central** and **expanded** storage.

**Central Storage (CS)**

Central storage consists of main storage, addressable by programs, and storage not directly addressable by programs. Non-addressable storage includes the Hardware System Area (HSA). Central storage provides:

- Data storage and retrieval for the Processor Units (PUs) and I/O
- Communication with PUs and I/O
- Communication with and control of optional expanded storage
- Error checking and correction.

Part of central storage is allocated as a variable-sized Hardware System Area (HSA) which is not addressable by application programs. Factors affecting size are described in "Hardware System Area (HSA)" on page 2-5.

In z/Architecture, storage addressing is 64 bits, allowing for an addressing range up to 16 Exabytes. Consequently, all central storage in a z890 (up to 32GB) can be used for central storage.

**Key-controlled storage protection** provides both store and fetch protection. It prevents the unauthorized reading or changing of information in central storage.

Each 4KB block of storage is protected by a 7-bit storage key. For processor-initiated store operations, access key bits 0 – 3 from the active program status word (PSW) are compared with bits 0 – 3 from the storage key associated with the pertinent 4KB of storage to be accessed. If the keys do not match, the central processor is notified of a protection violation, the data is not stored, and a program interruption occurs. The same protection is active for fetch operations if bit 4 of the storage key (the fetch protection bit) is on. Refer to **zSeries 890 and 990 Processor Resource/Systems Manager Planning Guide** for more information on central storage.

**Expanded Storage (ES)**

Expanded storage can optionally be defined on z890 servers. It is controlled by the control program, which can transfer 4KB pages between expanded storage and central storage. The control program can use expanded storage to reduce the paging and swapping load to channel-attached paging devices in a storage-constrained environment and a heavy-paging environment.

The z890 offers a flexible storage configuration which streamlines the planning effort by providing a single storage pool layout at IML time. The storage is placed into a single pool which can be dynamically converted to ES and back to CS as needed. Logical partitions are still specified to have CS and optional ES as before. Activation of logical partitions as well as dynamic storage reconfigurations will cause LPAR to convert the storage to the type needed.

No new software support is required to take advantage of this function.

The control program initiates the movement of data between main storage (the addressable part of central storage) and expanded storage. No data can be
transferred to expanded storage without passing through main storage. A dedicated move page engine assists in efficiently transferring data between main and expanded storage. Refer to zSeries 890 and 990 Processor Resource/Systems Manager Planning Guide for more information on expanded storage.

**CF LPAR Considerations:** You cannot define expanded storage for CF LPARs defined on a z890.

**Memory Card**
A memory card resides on the processor board within the book. The physical card capacity is 8GB, 16GB, and 32GB. The following table displays the characteristics of the memory card.

**Note:** The sum of enabled memory on each card is the amount available for use in the system.

Table 2-1. Memory Card Characteristics

<table>
<thead>
<tr>
<th>Memory Card</th>
<th>Feature Code</th>
<th>GB Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>8GB</td>
<td>2008</td>
<td>8GB</td>
</tr>
<tr>
<td>16GB</td>
<td>2016</td>
<td>16GB</td>
</tr>
<tr>
<td>32GB</td>
<td>2032</td>
<td>24GB, 32GB</td>
</tr>
</tbody>
</table>

The following list contains some general rules for memory.

- Memory cards are Field Replaceable Units (FRUs), separate from the book.
- Larger capacity cards may be used for sparing and manufacturing substitution. LIC CC will dial down to ordered size.
- Memory downgrades are not supported.
- Minimum memory orderable is 8GB. Maximum memory orderable is 32GB.
- Upgrades are orderable in 8GB increments, i.e. 8, 16, 24, 32.
- Changing an installed physical memory card is a disruptive action.
- LIC CC dialing is utilized to offer concurrent memory upgrades within the physical memory card installed.
- The Memory LIC CC record is combined with the PU LIC CC record for the book. Both memory and PU LIC CC are shipped on a single diskette.

For stocking and service flexibility, larger capacity memory cards may be used to replace smaller capacity cards. With the proper code they are made into logical equivalents. z890 will logically make larger capacity cards the equivalent of smaller capacity cards.

**Hardware System Area (HSA)**
The HSA contains the CPC Licensed Internal Code (LIC) and configuration dependent control blocks. HSA is not available for program use.

The HSA size varies according to:

- Size and complexity of the system I/O configuration
- Whether or not dynamic I/O configuration is enabled
- Whether or not concurrent code changes are authorized.
Note: z890 supports 63K subchannels per logical channel subsystem. The subchannel capabilities affect HSA storage requirements to accommodate the associated configuration tables. The machine no longer has a unique HSA subchannel limit.

The HSA Estimation Tool is available to estimate HSA size. A Hardware Management Console panel is provided for the input of configuration parameters to the tool which estimates the HSA size without requiring a Power-on Reset (POR).

The HSA allocation can vary according to the I/O configuration. The following system I/O configurations require the given HSA size.

- Small system I/O configuration: 768MB
  - 1 LCSS
  - 2 logical partitions
  - 96 physical control units
  - 4096 devices
  - Concurrent code change not authorized
  - 64 channels
  - Dynamic I/O not enabled.

- Large system I/O configuration: 1664MB
  - 2 LCSSs
  - 30 logical partitions (15 logical partitions in each LCSS)
  - 64512 devices per LCSS
  - Concurrent code change authorized
  - Dynamic I/O enabled.

Your HSA size includes 5MB to 25MB for coupling facility depending on the number of logical partitions defined and on the installed storage. The HSA size required for concurrent code patch is approximately 100MB. The HSA Granularity is fixed at 64 MB. The number of cache and list vectors per logical partition is increased to 1024 for each type of vector.

If future additions of I/O are planned (concurrent conditioning), be sure to provide enough HSA for additional devices by specifying a large enough number of total devices in HCD or IOCP (dynamic I/O configurations only), or by overdefining your IOCDS to define anticipated additions (both dynamic I/O and non-dynamic I/O configurations).

Error Checking and Correction (ECC)
Data paths between central storage and expanded storage (if configured), and between central storage and the central processors and channels are checked using either parity or Error Checking and Correction (ECC). Parity bits are included in each command or data word. ECC bits are stored with data in central storage. ECC codes apply to data stored in and fetched from central storage. Memory ECC detects and corrects single bit errors. Also, because of the memory structure design, errors due to a single memory chip failure are corrected. Unrecoverable errors are flagged for follow-on action. ECC on z890 is performed on the memory data bus as well as memory cards.

Memory Bus Adapters (MBAs)
z890 machines have a single book installed in the CPC. The book includes two MBAs. Each MBA supports four 2.0 GigaBytes per second (GBps) Self-Timed Interconnect (STI) connections. The z890 is designed to contain up to a maximum of 8 total STI connections. For more information on STI connections, refer to “Availability Guidelines for the z890” on page 4-4.
Distributed Converter Assembly-XP (DCA-XP) Cards

The Distributed Converter Assembly-XP (DCA-XP) cards are DC-to-DC converter cards in the CPC cage that convert −350 volts DC to logic voltages. There are two DCA-XP cards in the CPC.

Oscillator (OSC) Card

On the z890, two quarter high Oscillator (OSC) cards are standard. These cards provide the main oscillator, including the STI, reference, and MBA clocks.

External Time Reference (ETR) Card

On the z890, two (quarter high) External Time Reference (ETR) cards are optional features (FC 6154). These cards provide attachment to the Sysplex Timer. Each ETR card connects to a different 9037 Sysplex Timer in an Expanded Availability configuration. Each feature has a single port supporting an MT-RJ fiber optic connector to provide the capability to attach to a Sysplex Timer Unit. The 9037 Sysplex Timer Unit has an optical transceiver that supports an ESCON Duplex connector.

Note: The z890 server ETR feature does not support a multimode fiber optic cable terminated with an ESCON Duplex connector. However, 62.5 micron multimode ESCON Duplex jumper cables can be reused to connect to the ETR feature. This is done by installing an MT-RJ/ESCON Conversion kit between the ETR feature MT-RJ port and the ESCON Duplex jumper cable.

Sysplex Timer Attachment

The 9037 Sysplex Timer is a centralized time source that sets the Time-of-Day (TOD) clocks in all attached servers to maintain synchronization. The Sysplex Timer can provide the stepping signal that ensures that all TOD clocks in a multisystem environment increment in unison to permit full read/write data sharing with integrity. The IBM 9037 Sysplex Timer is a hardware requirement for a Parallel Sysplex consisting of more than one System z9 (z9 BC/z9 EC non-STP capable) or zSeries (z890/z990 non-STP capable) or S/390 G5/G6 servers. It is a key component of an IBM Parallel Sysplex environment and a Geographically Dispersed Parallel Sysplex® (GDPS) e-business availability solution. For more information on the parallel sysplex environment, refer to Chapter 6, “Sysplex Functions,” on page 6-1.

A function of the z890 server is being implemented in the server’s Support Element microcode. It requires the ETR Network ID of the attached Sysplex Timer Network to be manually set in the Support Element at installation time. This function checks that the ETR Network ID being received in the timing signals via each of the server’s two ETR ports matches the ETR Network ID manually set in the server’s Support Element. This function provides greater checking, helping eliminate cabling errors where either server ETR port may be incorrectly connected to Sysplex Timer Units of an incorrect Sysplex Timer ETR Network. If the ETR Network ID received on one or both server ETR ports does not match the value set in the server’s Support Element, that ETR port state is made semi-operational by the server. Timing signals are still received from the semi-operational ETR port, but are not used for stepping the server TOD clock. This has some important operational considerations at sysplex system IPL time as well as for running sysplex systems. Another important value of this function is it allows verification of cabling connectivity from the Sysplex Timer to the z890 server prior to IPLing z/OS or OS/390.
I/O Cage

There is an I/O cage in the bottom of the 'A' frame. An I/O cage is included even if no I/O cards are in the configuration.

The I/O cages support ESCON, FICON, ISC-3, STI-3, OSA and Crypto features. An I/O cage allows you to add channels up to the amount supported by a particular I/O cage and the CPC.

Figure 4-1 on page 4-5 is an example of the I/O cage layout for z890.

I/O Features

The I/O cards that are supported in the I/O cage are shown in Table 2-2 on page 2-9. There is a total of 28 slots in the I/O cage. You can also refer to Chapter 5, "I/O Connectivity," on page 5-1 for more detailed information on the I/O channels and adapters.

Notes:
1. Crypto features utilize I/O slots. The cryptographic cards are either accelerator cards or coprocessors that do not have ports and do not use fiber optic cables. They are not defined in the IOCDS and therefore do not receive CHPID numbers, however, they are assigned PCI cryptographic numbers. After Crypto Express2 is available, PCICA and PCIXCC will no longer be orderable.
2. ICB, specifically ICB-3 (connects z890 to z890, z990, z900 or z800), has a special distribution card (referred to as STI-3) occupying I/O slots. ICB-4 (connects z890 to z890 or z990) does not require distribution cards.
### Table 2-2. I/O Channels Summary per System

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Feature Code</th>
<th>Minimum Features</th>
<th>Maximum I/O slots used by Features</th>
<th>Maximum Connections</th>
<th>Ports/Channels/Increments per Feature</th>
<th>Purchase Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESCON, 16-port</td>
<td>2323</td>
<td>0&lt;sup&gt;1&lt;/sup&gt;</td>
<td>28</td>
<td>420 channels&lt;sup&gt;11&lt;/sup&gt;</td>
<td>16 channels&lt;sup&gt;2&lt;/sup&gt;</td>
<td>4 channels&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>FICON Express&lt;sup&gt;4&lt;/sup&gt;</td>
<td>2319 2320</td>
<td>0&lt;sup&gt;1&lt;/sup&gt;</td>
<td>20</td>
<td>40 channels&lt;sup&gt;11&lt;/sup&gt;</td>
<td>2 channels</td>
<td>1 feature</td>
</tr>
<tr>
<td>FICON Express2&lt;sup&gt;4&lt;/sup&gt;</td>
<td>3319 3320</td>
<td>0&lt;sup&gt;1&lt;/sup&gt;</td>
<td>20</td>
<td>80 channels&lt;sup&gt;11&lt;/sup&gt;</td>
<td>4 channels</td>
<td>1 feature</td>
</tr>
<tr>
<td>OSA-Express&lt;sup&gt;4&lt;/sup&gt;</td>
<td>1364 1365 1366 2364 2365 2366 2367</td>
<td>0</td>
<td>20</td>
<td>40 ports&lt;sup&gt;11&lt;/sup&gt;</td>
<td>2 ports</td>
<td>1 feature</td>
</tr>
<tr>
<td>OSA-Express2&lt;sup&gt;4&lt;/sup&gt;</td>
<td>3364 3365 3368</td>
<td>0</td>
<td>20</td>
<td>40 ports</td>
<td>2 ports</td>
<td>1 feature</td>
</tr>
<tr>
<td>STI-3&lt;sup&gt;5&lt;/sup&gt;</td>
<td>3993 0993</td>
<td>0&lt;sup&gt;1&lt;/sup&gt;</td>
<td>N/A</td>
<td>N/A</td>
<td>2 outputs</td>
<td>N/A</td>
</tr>
<tr>
<td>ICB-3 link</td>
<td>3393 0993</td>
<td>0&lt;sup&gt;1&lt;/sup&gt;</td>
<td>N/A</td>
<td>N/A</td>
<td>2 outputs</td>
<td>N/A</td>
</tr>
<tr>
<td>ICB-4 link</td>
<td>3393 0993</td>
<td>0&lt;sup&gt;1&lt;/sup&gt;</td>
<td>N/A</td>
<td>N/A</td>
<td>2 outputs</td>
<td>N/A</td>
</tr>
<tr>
<td>ISC-3&lt;sup&gt;6&lt;/sup&gt;</td>
<td>0219</td>
<td>0&lt;sup&gt;1&lt;/sup&gt;</td>
<td>12</td>
<td>48 links&lt;sup&gt;6&lt;/sup&gt;</td>
<td>4 links</td>
<td>1 link&lt;sup&gt;9&lt;/sup&gt;</td>
</tr>
<tr>
<td>PCICA&lt;sup&gt;4&lt;/sup&gt;</td>
<td>0862</td>
<td>0</td>
<td>2</td>
<td>4 accelerator cards</td>
<td>2 accelerator cards</td>
<td>1 feature</td>
</tr>
<tr>
<td>PCIXCC&lt;sup&gt;4&lt;/sup&gt;</td>
<td>0868</td>
<td>0&lt;sup&gt;10&lt;/sup&gt;</td>
<td>4</td>
<td>4 coprocessors</td>
<td>1 coprocessor</td>
<td>1 feature&lt;sup&gt;10&lt;/sup&gt;</td>
</tr>
<tr>
<td>Crypto Express2</td>
<td>0863</td>
<td>0 or 2</td>
<td>8&lt;sup&gt;12&lt;/sup&gt;</td>
<td>16 coprocessors</td>
<td>2 coprocessors</td>
<td>1 feature</td>
</tr>
</tbody>
</table>
Table 2-2. I/O Channels Summary per System (continued)

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Feature Code</th>
<th>Minimum Features</th>
<th>Maximum I/O slots used by Features</th>
<th>Maximum Connections</th>
<th>Ports/Channels/Increments per Feature</th>
<th>Purchase Increments</th>
</tr>
</thead>
</table>

Notes:
1. A minimum of one I/O feature (ESCON, FICON) or Coupling Link (ICB, ISC-3) is required.
2. Each ESCON feature has 16 channels of which 15 channels may be activated. One channel is always reserved as a spare.
3. ESCON channels are purchased in increments of four and are activated via Licensed Internal Code Configuration Control (LIC CC). Channels are activated equally across all installed 16-port ESCON features for high availability.
4. The maximum quantity of FICON, OSA, and crypto in combination cannot exceed 20 features per server.
5. The STI-3 distribution card which supports the ICB-3s resides in the I/O cage, occupying one I/O slot. Thus, it is listed in this table.
6. The maximum number of Coupling Links combined (ICs, ICB-3s, ICB-4s, and active ISC-3 links) cannot exceed 64 per server.
7. ICB-4s do not require connectivity to a card in the I/O cage. ICB-4s are not included in the maximum feature count for I/O slots.
8. A maximum of 48 ISC-3s can be defined in peer mode (operating at a link data rate of 2 Gbps) and a maximum of 32 ISC-3s can be defined in compatibility mode (operating at 1 Gbps, instead of 2 Gbps).
9. It is recommended that an initial order for ISC-3 include two links. ISC-3 is offered in one link increments. When two links are purchased, two ISC-3 features are shipped and activated links are balanced across ISC-3 features for high availability.
10. PCIXCC feature increments are 0, 2, 3, or 4.
11. Except on the smallest sub-uniprocessor equipped capacity setting (ESCON=240 channels, FICON Express=32 channels, and OSA-Express=24 ports).
12. The total number of crypto features cannot exceed eight per server.

Distributed Converter Assembly-CX (DCA-CX) Cards

The Distributed Converter Assembly-CX (DCA-CX) cards are DC-to-DC converter cards in the I/O cage that convert −350 volts DC to logic voltages. There are two DCA-CX cards in the I/O cage.

PSC24V Card

The PSC24V card is a Power Sequence Control (PSC) card used to turn on/off specific control units from the CPC. The PSC24V card in the I/O cage provides the physical interface between the cage controller and the PSC boxes, located outside the I/O cage in the system frame. You can only have one PSC24V card.

Note: The PSC24V card is not hot pluggable.

For more information on PSC, refer to "Power Sequence Control" on page 2-19.

HiperSockets

HiperSockets employs the Queued Direct Input/Output (QDIO) architecture for high speed internal TCP/IP communication ("network within the box" - an independent internal LAN) between programs running on z/OS, z/OS.e, z/VM, z/VSE™, VSE/ESA, or Linux on zSeries, or as guests under z/VM, whether in the same or in
different LPARs on the same server. A synchronous data mover function transfers data at memory access speed with very low latency. Refer to “HiperSockets” on page 5-37 for more information.

System Power Supply

The System Power Supply located in the top of the ‘A’ frame provides the control structure to support the power requirements for the CPC cage and the I/O cage.

The power subsystem’s basic components include:

- Bulk Power Assembly (BPA) - provides the prime power conversion and high voltage DC distribution
- Base Power Interface (BPI) - main power controller and cage controller for the BPA
- Base Power Distribution (BPD) - distributes -350 VDC, Ethernet, and RS422 communications to logic cage power Field Replaceable Units (FRUs)
- Bulk Power Fan (BPF) - cooling device
- Bulk Power Regulator (BPR) - main front end power supply which converts line voltage to regulated -350 VDC
- Bulk Power Enclosure (BPE) - metal enclosure which contains the back plane
- Distributed Converter Assemblies (DCAs)
- Supporting software.

The BPI is the principal control node for the z890 diagnostic/service and power/cooling system. It is the cage controller for the BPA cage and connects to both Ethernet service networks. It provides the Ethernet connection to the Support Element and also the DCAs.

Channel Subsystem (CSS)

A Channel Subsystem (CSS) structure for z890 expands beyond 256 channels. The z890 server provides 512 channels since channels are grouped into sets called Logical Channel Subsystems (LCSSs) and each LCSS can contain 256 channels. The z890 supports two logical channel subsystems. Refer to Chapter 4, “Channel Subsystem Structure,” on page 4-1 for more information.

Logically Partitioned (LPAR) Mode

LPAR mode is the mode of operation for the z890. It allows you to:

- Define ESA/390, ESA/390 TPF, coupling facility, and Linux-only logical partitions
- Define and use up to 32GB (minus HSA) in a single LPAR.
- Dynamically reconfigure storage between logical partitions.

You can define and activate up to 30 logical partitions (15 on the smallest sub-uniprocessor equipped capacity setting) for each CPC.

After you define and activate an ESA/390 or ESA/390 TPF logical partition, you can load a supporting operating system into that logical partition.

Processor Resource/Systems Manager (PR/SM) enables logical partitioning of the CPC.

Resources for each logical partition include:

- Processor Units (CPs, ICFs, IFLs, or zAAPs)
Storage (central storage and expanded storage)
Channels.

Processor Units

On z890, PUs can be used within a logical partition as Central Processors (CPs), Internal Coupling Facilities (ICFs), Integrated Facilities for Linux (IFLs), or zSeries Application Assist Processors (zAAPs). The initial allocation of CPs, ICFs, IFLs, and zAAPs to a logical partition is made when the logical partition is activated.

Within a logical partition on z890, PUs may be used as follows:

- CPs can be dedicated to a single logical partition or shared among multiple logical partitions. The use of CP resources shared between logical partitions can be limited and modified by operator commands while the logical partitions are active. CPs that are dedicated to a logical partition are available only to that logical partition. A maximum of 4 CPs can be defined per logical partition.
- ICFs, IFLs, and zAAPs are available as orderable features on z890 for use in a logical partition. ICFs are available as a feature for use in a Coupling Facility (CF) logical partition (refer to "Internal Coupling Facility (ICF)" on page 2-3 for additional information). IFLs are available as a feature for running Linux (refer to "Integrated Facility for Linux (IFL)" on page 3-4 for additional information). zAAPs are available as a feature for providing special purpose assists that execute JAVA programming under control of the IBM Java Virtual Machine (JVM) (refer to "zSeries Application Assist Processor (zAAP)" on page 2-3 for additional information).

Dynamic ICF Expansion is a function that allows an ICF logical partition defined with dedicated ICFs to acquire additional processing power from the LPAR pool of shared CPs or shared ICFs being used to execute production and/or test work on the system. Dynamic ICF Expansion is standard on z890 that has at least one ICF. Refer to "Dynamic ICF Expansion" on page 10-3 and the zSeries 890 and 990 Processor Resource/Systems Manager Planning Guide for additional details of this function.

Storage

Before you can activate logical partitions, you must define central storage and optional expanded storage to the logical partitions. Refer to "Central Storage (CS)" on page 2-4 and "Expanded Storage (ES)" on page 2-4 for more information.

All installed storage is initially configured as central storage. Each individual logical partition is limited to a maximum of 2 GB (in ESA/390 mode) or 32 GB (in z/Architecture mode) of central storage. When a logical partition is activated, the storage resources are allocated in contiguous blocks.

The z890 model has a fixed physical storage granularity (64MB). You can dynamically reallocate storage resources for z/Architecture and ESA/390 architecture logical partitions using Dynamic Storage Reconfiguration. Dynamic storage reconfiguration allows both central and expanded storage allocated to a logical partition to be changed while the logical partition is active. It provides the capability to reassign storage from one logical partition to another without the need to POR the CPC or IPL the recipient logical partition. For more information, refer to zSeries 890 and 990 Processor Resource/Systems Manager Planning Guide.

Note: You cannot share allocated central storage or expanded storage among multiple logical partitions.
Expanded storage granularity for logical partitions is fixed at 64 MB.

Channels

You can allocate channels to logical partitions as follows:

• **Dedicated channels**
  Dedicated channels are unshared channels and can only be used by one logical partition. All channel types supported by the model can be allocated as dedicated channels.

• **Reconfigurable channels**
  Reconfigurable channels are unshared channels that can be moved among logical partitions within an LCSS but can only belong to one logical partition at a given time. All channel types supported by the model can be allocated as reconfigurable channels.

• **Shared channels**
  The Multiple Image Facility (MIF) allows channels to be shared among multiple logical partitions in a Logical Channel Subsystem (LCSS). Shared channels are configured to a logical partition giving the logical partition a channel image of the shared channel that it can use. Each channel image allows a logical partition to independently access and control the shared channel as if it were a physical channel assigned to the logical partition. For more information, refer to “Multiple Image Facility (MIF)” on page 4-11.

  You can define the channels, shown in Table 4-2 on page 4-2, as shared among multiple logical partitions within an LCSS so that the shared channels can be accessed by more than one logical partition in an LCSS at the same time.

  On z890 with coupling facility logical partitions, CFP, CBP, ICP, and CFS channels may be shared by many ESA logical partitions and one Coupling Facility logical partition.

• **Spanned channels**
  Spanned channels are channels that are configured to multiple Logical Channel Subsystems (LCSSs) and are transparently shared by any or all of the configured LPARs without regard to the LCSS to which the LPAR is configured.

• **Device Sharing**
  You can share a device among logical partitions by:
  – Using a separate channel for each logical partition
  – Using a shared channel
  – Using a spanned channel.

  **Note:** While multiple operating systems can concurrently access the same remote Fibre Channel port using a single FCP channel, Fibre Channel devices (identified by their LUNs) can only be serially re-used when they are explicitly configured for read-only LUN sharing using the Configuration Utility for FCP LUN Access Control.

  In order for two or more unique operating system instances to share concurrent read-write access to a single Fibre Channel or SCSI device Logical Unit Number (LUN), each of these operating systems will have to access this device through a different zSeries FCP channel.

Logical Partition Time Offset Support

Logical Partition Time Offset support provides for the optional specification of a fixed time offset (specified in days, hours, and quarter hours) for each logical partition activation profile. The offset, if specified, will be applied to the time that a
logical partition will receive from connected Sysplex Timers or from the Current Time Server (CTS) in a Coordinated Timing Network (CTN).

This support can be used to address the customer environment that includes multiple local time zones with a single Sysplex Timer, two Sysplex Timers in an Expanded Availability configuration, or a Current Time Server (CTS) in a CTN.

It is sometimes necessary to run multiple Parallel Sysplexes with different local times and run with the time set to GMT=LOCAL. This causes the results returned in the store clock (STCK) instruction to reflect local time. With logical partition time offset support, logical partitions on each z890 CPC in a Parallel Sysplex that need to do this can specify an identical time offset that will shift time in the logical partition sysplex members to the desired local time. Remaining logical partitions on the z890 CPCs can continue to participate in current date production Parallel Sysplexes utilizing the same Sysplex Timer(s) or CTS with the time provided by the Sysplex Timer(s) or CTS.

This function is supported by all in service releases of OS/390 and z/OS.

For more information on logical partitions, refer to the zSeries 890 and 990 Processor Resource/Systems Manager Planning Guide and to the zSeries z890 and z990 Input/Output Configuration Program User’s Guide.

**Server Time Protocol (STP)**

Server Time Protocol (STP) (FC 1021) provides the means for multiple System z9, z890, and z990 servers to maintain time synchronization with each other without using a Sysplex Timer. STP is designed to synchronize servers configured in a Parallel Sysplex or a sysplex without a coupling facility, as well as servers that are not in a sysplex.

STP uses a message-based protocol to transmit timekeeping information over externally defined Coupling Links between servers. Unlike the Sysplex Timer, which distributes time to multiple servers in a star pattern, STP distributes time messages in layers (called strata). The timekeeping information is needed to determine the Coordinated Server Time (CST) at each server. The Coupling Links used to transport STP messages include ISC-3 links configured in peer mode, ICB-3 links, and ICB-4 links. These links can be the same links already being used in a Parallel Sysplex for Coupling Facility communications.

For more details about Server Time Protocol, refer to “Server Time Protocol (STP)” on page 6-9

**Requirements and Prerequisites to Enable STP**

To use the Server Time Protocol function, the following requirements and prerequisites must be satisfied:

**Hardware Requirements:**

- Upgraded 9037 Sysplex Timer Model 2 Licensed Internal Code (LIC) to support using STP in a Mixed Coordinated Timing Network (CTN)
- Version 2.9.1 LIC of Hardware Management Console (HMC) application or a previously installed HMC with upgrades for V2.9.1 LIC.
- Required STP LIC for the server with all required maintenance. After the MCLs are installed, the server becomes an STP-capable server.
STP feature code for enablement (FC 1021) installed on each server and
Coupling Facility you want enabled. This is a chargeable feature. (The
enablement code is loaded using the server's Support Element and is loaded
without disruption to current operations.)

Software Requirements:

- z/OS Prerequisites:
  - z/OS or z/OS.e Version 1.7 or above (with maintenance)
  - z/OS or z/OS.e Version 1.4 through 1.6 (with toleration code)

Refer to the 2086DEVICE PSP bucket for STP related maintenance.

- If Coupling Facility links are not already configured for communication within a
  Parallel Sysplex, then Timing-only links are required for the configuration, which
  requires additional PTFs.

Refer to the 2086DEVICE PSP bucket for STP related maintenance.

- z/OS and z/OS.e V1.4 through z/OS and z/OS.e V1.6 systems (with toleration
code installed) can coexist in a Sysplex or a Parallel Sysplex multisystem Mixed
  Coordinated Timing Network (CTN) configuration.

For further details on hardware and software requirements, refer to the STP Web

Support Element

There are two identical Support Elements (SE) on the z890: primary and alternate.
The SEs are ThinkPads which are positioned one on top of the other and located in
the front of the ‘A’ frame. The Support Elements communicate with the CPC and
with each other through the service network. The second Support Element, the
alternate SE, is standard on the z890 and is configured the same as, and serves as
an alternate to, the primary SE. Refer to Figure 2-1 on page 2-1 to see the location
of the SEs on z890.

The SE provides the interface between the Hardware Management Console and the
CPC. The SE sends hardware operations and management controls to the
Hardware Management Console for the CPC and allows for independent and
parallel operational control of a CPC from the Hardware Management Console.
NetView applications (for example: System Automation for OS/390 Processor
Operations Component (SA OS/390 ProcOps)) and other System Management
Products) can also send commands to the SE.

During normal operation, the primary SE monitors CPC operation, collecting and
sending CPC status, hardware messages, and operating system messages to the
Hardware Management Console for consolidation and exception processing. The
internal SE can also send SNA alerts and operating system messages to Netview
applications.

The SE contains the following:

- Licensed Internal Code for the CPC.
- Hardware system definitions for the CPC (contained in the reset, image, and load
  profiles for the CPC and IOCDs).
- Battery-powered clock used to set the CPC time-of-day (TOD) clock at power-on
  reset. In ETR timing mode, CPC attachment to a Sysplex Timer causes the CPC
  TOD clock to take its time setting from the Sysplex Timer. In STP timing mode,
  the CPC TOD clock is initialized to Coordinated Server Time (CST).
Two 10/100 Mbps Ethernet LAN adapters to connect the SE to the Hardware Management Console via an external Ethernet switch (hub), or a mixture of Token Ring and Ethernet LAN adapters for SE/Hardware Management Console connection via the Multistation Access Unit (MAU).

An Ethernet mini-PCI LAN adapter or LAN on Board to connect the SE to the CPC through the power service network.

For more detailed information on the Support Element, refer to the Chapter 9, “Hardware Management Console and Support Element,” on page 9-1 or to the zSeries 890 and 990 Support Element Operations Guide.

Support Element Attachment to HMC

The following attachments are used by the Support Element:

- Support Element with Token Ring and Ethernet (FC 0086)
  This provides support for the z890 performing functions such as diagnostics, test, and system bring up. The SE is connected to the HMC either via a Token Ring and/or Ethernet LAN. This is only offered as part of the initial order. By default, a Multi-Station Access Unit (MAU) is shipped with this feature.

- Support Element with Dual Ethernet (FC 0087)
  This provides support for the z890 performing functions such as diagnostics, test, and system bring up. The SE has two Ethernet cards to connect to the HMC via an Ethernet LAN. This is offered as part of the initial order and/or as a Manufacturing Engineering Specification (MES). An Ethernet switch/hub (FC 0089) is shipped automatically on every order unless you deselected FC 0089.

Ethernet Switch/Hub

If an Ethernet adapter is selected for the second LAN adapter on the Support Element, an Ethernet switch/hub is required to provide an Ethernet attachment between the Hardware Management Console and the internal SEs. The IBM supplied Ethernet switch/hub must be capable of 10 Mbps or 100 Mbps link data rates.

Hardware Management Console

On z890, the Hardware Management Console provides a hardware management platform that can control and monitor status for multiple zSeries Central Processor Complexes (CPCs), and S/390 9672, 9674, 2003, 3000, and 7060 CPCs providing a single point of control and single system image for those CPCs defined to it.

The Hardware Management Console can also control and monitor status for multiple CPCs configured to it providing a single point of control and single system image. One Hardware Management Console can control 100 Support Elements. One Support Element can be controlled by 32 Hardware Management Consoles.

The Hardware Management Console is a PCI bus PC (Pentium® Processor) running OS/2® Warp Server for e-business, SecureWay® Communications Server for OS/2, a remote control systems management product, and the Hardware Management Console Application (HWMCA). It also contains configuration information about its own configuration and about the internal Support Elements (SEs) defined to it.

The Hardware Management Console hardware configuration also includes new build hardware requirement minimums for FC 0074, FC 0075, FC 0076, FC 0077, and FC 0078 shown in the following tables.
### Table 2-3. New Build Hardware Management Console FC 0074 Hardware Minimum Requirements

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Optional display monitor</td>
</tr>
<tr>
<td></td>
<td>Keyboard</td>
</tr>
<tr>
<td></td>
<td>Mouse</td>
</tr>
<tr>
<td></td>
<td>Parallel printer port</td>
</tr>
<tr>
<td>Processor</td>
<td>2 GHz Pentium 4</td>
</tr>
<tr>
<td>Hard drive</td>
<td>40 GB</td>
</tr>
<tr>
<td>Memory</td>
<td>1 GB ECC</td>
</tr>
<tr>
<td>Video</td>
<td>nVidea Vanta 16 mb 4X AGP</td>
</tr>
<tr>
<td>LAN</td>
<td>Integrated Ethernet 10/100 Mb</td>
</tr>
<tr>
<td></td>
<td>16/4 Token Ring PCI Adapter</td>
</tr>
<tr>
<td>Removable Storage</td>
<td>Panasonic DVD-RAM</td>
</tr>
</tbody>
</table>

### Table 2-4. New Build Hardware Management Console FC 0075 Hardware Minimum Requirements

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Optional display monitor</td>
</tr>
<tr>
<td></td>
<td>Keyboard</td>
</tr>
<tr>
<td></td>
<td>Mouse</td>
</tr>
<tr>
<td></td>
<td>Parallel printer port</td>
</tr>
<tr>
<td>Processor</td>
<td>2.4 GHz Pentium 4</td>
</tr>
<tr>
<td>Hard drive</td>
<td>40 GB</td>
</tr>
<tr>
<td>Memory</td>
<td>512 MB</td>
</tr>
<tr>
<td>Video</td>
<td>Integrated Intel® 845</td>
</tr>
<tr>
<td>LAN</td>
<td>Ethernet 10/100 Mb</td>
</tr>
<tr>
<td></td>
<td>16/4 Token Ring PCI Adapter</td>
</tr>
<tr>
<td>Removable Storage</td>
<td>Hitachi DVD-RAM</td>
</tr>
</tbody>
</table>

### Table 2-5. New Build Hardware Management Console FC 0076 Hardware Minimum Requirements

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
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<tr>
<td></td>
<td>Keyboard</td>
</tr>
<tr>
<td></td>
<td>Mouse</td>
</tr>
<tr>
<td></td>
<td>Parallel printer port</td>
</tr>
<tr>
<td>Processor</td>
<td>2.4 GHz Pentium 4</td>
</tr>
<tr>
<td>Hard drive</td>
<td>40 GB</td>
</tr>
<tr>
<td>Memory</td>
<td>512 MB</td>
</tr>
<tr>
<td>Video</td>
<td>Integrated Intel® 845</td>
</tr>
<tr>
<td>LAN</td>
<td>Ethernet 10/100/1000 Mb</td>
</tr>
<tr>
<td></td>
<td>Ethernet 10/100 Adapter</td>
</tr>
<tr>
<td>Removable Storage</td>
<td>Hitachi DVD-RAM</td>
</tr>
</tbody>
</table>

**Note:** This will only be available if you are running on FC 0075.
Table 2-6. New Build Hardware Management Console FC 0077 Hardware Minimum Requirements

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Optional display monitor</td>
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<td></td>
<td>Keyboard</td>
</tr>
<tr>
<td></td>
<td>Mouse</td>
</tr>
<tr>
<td></td>
<td>Parallel printer port</td>
</tr>
<tr>
<td>Processor</td>
<td>3.0 GHz Pentium 4</td>
</tr>
<tr>
<td>Hard drive</td>
<td>40 GB</td>
</tr>
<tr>
<td>Memory</td>
<td>512 GB</td>
</tr>
<tr>
<td>Video</td>
<td>Integrated Intel 845</td>
</tr>
<tr>
<td>LAN</td>
<td>Ethernet 10/100/1000 Mb</td>
</tr>
<tr>
<td></td>
<td>Ethernet 10/100 Adapter</td>
</tr>
<tr>
<td>Removable Storage</td>
<td>Hitachi DVD-RAM</td>
</tr>
</tbody>
</table>

Table 2-7. New Build Hardware Management Console FC 0078 Hardware Minimum Requirements

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Optional display monitor</td>
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<td></td>
<td>Keyboard</td>
</tr>
<tr>
<td></td>
<td>Mouse</td>
</tr>
<tr>
<td></td>
<td>Parallel printer port</td>
</tr>
<tr>
<td>Processor</td>
<td>3.0 GHz Pentium 4</td>
</tr>
<tr>
<td>Hard drive</td>
<td>40 GB</td>
</tr>
<tr>
<td>Memory</td>
<td>512 GB</td>
</tr>
<tr>
<td>Video</td>
<td>Integrated Intel 845</td>
</tr>
<tr>
<td>LAN</td>
<td>Ethernet 10/100 Mb</td>
</tr>
<tr>
<td></td>
<td>16/4 Token Ring PCI Adapter</td>
</tr>
<tr>
<td>Removable Storage</td>
<td>Hitachi DVD-RAM</td>
</tr>
</tbody>
</table>

The physical location of the Hardware Management Console hardware features (standard and/or optional) are dictated by the specific PC. Some features may be mutually exclusive with other features depending on the PC model. Each CPC must be connected to at least one Hardware Management Console on the same network as the SEs of the CPC.

For more detailed information on the Hardware Management Console, refer to Chapter 9, “Hardware Management Console and Support Element,” on page 9-1 or to the Hardware Management Console Operations Guide.

Internal Battery Feature

The optional Internal Battery Feature (IBF) (FC 3210) provides the function of a local Uninterruptible Power source. It has continuous self-testing capability for battery backup which has been fully integrated into the diagnostics, including Remote Service Facility (RSF) support.

The IBF provides battery power to preserve processor data in case of a loss of power on both of the AC supplies from the utility company. The IBF can hold power briefly over a 'brownout' or for an orderly shutdown in case of a longer outage.
In the event of input power interruption to the system, the IBF provides sustained system operation for the times listed in the following table.

**Table 2-8. System IBF Hold-up Times**

<table>
<thead>
<tr>
<th>Hold-up time (minutes) for general purpose processor with 1 I/O cage</th>
<th>Hold-up time (minutes) for dedicated CF, ICB only</th>
<th>Hold-up time (minutes) for dedicated CF, ISC-3 only</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-11</td>
<td>24</td>
<td>20</td>
</tr>
</tbody>
</table>

**Notes:**
1. The numbers shown are approximate for 70° C, batteries no older than 3 years, and full N+1 power (both power supplies in operation).
2. Hold-up times are influenced by temperature, battery age, and fault conditions within the system.
3. Assumes maximum supported configuration (maximum I/O adapters installed). Actual hold-up times will be longer for less-than-maximum configurations.

The IBF is fully integrated into the server power control/diagnostic system which provides full battery charge, and test and repair diagnostics. For more information on the IBF, refer to *zSeries 890 Installation Manual for Physical Planning*.

### Power Sequence Control

The optional Power Sequence Controller (PSC) is available on z890. The PSC feature provides the ability to turn on/off specific control units from the CPC. The PSC feature consists of two PSC boxes, a PSC24V card, and PSC cables. The boxes are mounted on the front and rear frame extensions. For more information on the PSC24V card, refer to [“PSC24V Card” on page 2-10](#).

### Additional Features/Functions Supported

The z890 model, compared to the z800, provides high performance and flexibility due to an improved design and use of technology advances. In addition to the standard and optional features previously listed, the design also supports the features/functions discussed in this section.

### z/Architecture

This section discusses the enhancements to z/Architecture that z890 supports in addition to the functions already discussed in [“z/Architecture” on page 1-8](#). Refer to [“z/Architecture Principles of Operation”](#) for more detailed information on z/Architecture.

### List-Directed IPL

**Note:** The List-directed IPL implementation is the z990 SCSI IPL feature discussed in this publication. Refer to [“SCSI Initial Program Load (IPL)” on page 5-16](#) for more information.

List-directed IPL supports the use of I/O devices which are not accessed by CCWs. List-directed IPL may be provided for a logical partition or virtual machine, depending on the model and the amount of memory available to the logical partition or virtual machine.
Hexadecimal-Floating-Point (HFP) Multiply-and-Add/Subtract Facility
The HFP-multiply-add/subtract facility provides instructions for improved processing of hexadecimal floating-point numbers. The MULTIPLY and ADD (or SUBTRACT) instruction is intended to be used in place of MULTIPLY followed by ADD (or SUBTRACT) NORMALIZED.

Message-Security Assist (MSA)
The Message-Security assist (MSA) may be available on a model implementing z/Architecture. The MSA basic facility includes the following instructions:
- CIPHER MESSAGE
- CIPHER MESSAGE WITH CHAINING
- COMPUTE INTERMEDIATE MESSAGE DIGEST
- COMPUTE LAST MESSAGE DIGEST
- COMPUTE MESSAGE AUTHENTICATION CODE.

Also included are five query functions and two functions for generating a message digest based on the secure-hash algorithm (SHA-1). The five query functions, one for each instruction, are used to determine the additional installed MSA facilities, which may include the MSA Data-Encryption-Algorithm (DEA) facility.

The MSA Data-Encryption-Algorithm (DEA) facility consists of nine functions for ciphering messages, with or without chaining, and for generating a message-authentication code (MAC) using a 56-bit, 112-bit, or 168-bit cryptographic key. All of these functions are based on the DEA algorithm.

Long-Displacement Facility
The long-displacement facility provides a 20-bit signed-displacement field in 69 previously existing instructions (by using a previously unused byte in the instructions) and 44 new instructions. A 20-bit signed displacement allows relative addressing of up to 524,287 bytes beyond the location designated by a base register or base-and-index-register pair and up to 524,288 bytes before that location. The enhanced previously existing instructions generally are ones that handle 64-bit binary integers. The new instructions generally are new versions of instructions for 32-bit binary integers. The new instructions also include a LOAD BYTE instruction that sign-extends a byte from storage to form a 32-bit or 64-bit result in a general register and new floating-point LOAD and STORE instructions. The long-displacement facility provides register-constraint relief by reducing the need for base registers, code size reduction by allowing fewer instructions to be used, and additional improved performance through removal of possible address-generation interlocks.

Extended-I/O-Measurement-Block Facility
The extended-I/O-measurement-block facility may be available on models implementing z/Architecture. The facility includes the following features:
- A new format of the channel-measurement block. The new measurement block, termed a format-1 channel-measurement block, is expanded to 64 bytes and is addressed using a separate measurement-block address for each subchannel. The new measurement-block format provides additional measurement information and the flexibility to store the measurement blocks in non-contiguous, real storage.
- The previously existing channel-measurement block is termed a format-0 channel-measurement block. A device-busy-time-field is added to the format-0 channel-measurement block.
Extended-I/O-Measurement-Word Facility

The extended-I/O-measurement-word facility may be available on models implementing z/Architecture. The extended-measurement-word (EMW) is an extension to the interruption-response block (IRB) and allows channel-measurement data to be provided on an I/O operation basis. This reduces program overhead by alleviating the previous requirement that the program fetch the measurement block before and after an operation and calculate the difference between the respective measurement data values.

ESA/390 Architecture

ESA/390 architecture provides:

- 31-bit addressing with a virtual address range of 2GB.
- ESCON, FICON, ISC-3, ICB (ICB-4 and ICB-3), IC channel, OSA channels, and HiperSockets.
- Channel path selection and I/O-busy-condition management as hardware functions (rather than control program functions) that provide:
  - As many as eight channel paths available to each I/O device.
  - Increased I/O device accessibility by allowing each central processor to initiate operations with any of the I/O devices and to handle any I/O interruption conditions.
- A significantly extended addressability through access to multiple address spaces and data spaces while maintaining compatibility with existing 24-bit and 31-bit subsystems and user applications. Each address space can contain as many as 2GB of programs and data. Each data space can contain as many as 2GB of data.

Floating-Point Operations

z/Architecture and ESA/390 architecture floating-point supports sixteen 64-bit floating-point registers, a 32-bit floating-point-control register, and 175 instructions operating on floating-point data in either the hexadecimal or binary floating-point format. Extensions are grouped into four areas:

- Basic floating-point extensions
- Binary floating-point (BFP) facility
- Hexadecimal floating-point (HFP) extensions
- Floating-point-support (FPS) extensions.

The HFP and BFP instructions operate on data in the HFP and BFP formats, respectively; while the FPS instructions operate on floating-point data independent of the format or convert it from one format to the other.

Basic Floating-Point Extensions

The basic floating-point extensions provides the following:

- 16 floating-point registers.
  Floating-point registers 0, 2, 4, and 6, are available on the z890 machine. The remaining 12 floating-point registers (1, 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, and 15) are called the additional-floating-point (AFP) registers. The AFP registers can be used only if the AFP-register-control bit is one. All floating-point instructions (FPS, HFP, and BFP) use the same floating-point registers. The floating-point registers are identified by the numbers 0-15 and are designated by a four-bit R field in floating-point instructions. Each floating-point register is 64 bits long and can contain either a short (32-bit) or a long (64-bit) floating-point operand. Pairs of floating-point registers can be used for extended (128-bit) operands.
- A 32-bit floating-point-control (FPC) register.
The floating-point-control (FPC) register is a 32-bit register, which contains mask bits, flag bits, data exception code, and rounding mode bits.

- An AFP-register-control bit, (bit 13 of control register 0) which controls whether the new registers and the BFP instructions can be used.

Bit 13 of control register 0 is the AFP-register-control bit. The AFP registers and the BFP instructions can be used only when the AFP-register-control bit is one. The AFP-register-control bit permits optimum dispatching of old programs which do not use the AFP registers and also provides for compatible operation for the case of an old operating system running on new hardware and the old operating system does not save and restore the new registers.

- Extension to the program interruption for data exception to store a data-exception code (DXC).
- In ESA/390, a signal processor (SIGP) order, store-extended-status-at-address is provided to allow programs to logout the new floating point registers. In z/Architecture, this function is provided by the store-status-at-address order.

**Binary Floating-Point (BFP) Extensions**

The BFP facility defines 32-bit, 64-bit, and 128-bit binary-floating-point (BFP) data formats, and provides 87 additional instructions in ESA/390 and 93 additional instructions in z/Architecture, to operate on data in these formats.

Except for binary-decimal conversion, which must be provided in software, the BFP formats and operations provide everything necessary to conform to ANSI/IEEE Std 754-1985, IEEE Standard for Binary Floating-Point Arithmetic, dated August 12, 1985.

**Hexadecimal Floating-Point (HFP) Extensions**

HFP extensions includes 26 additional instructions in ESA/390, and 32 additional instructions in z/Architecture, to operate on data in the HFP format.

All of these are counterparts to additional instructions provided by the BFP facility, including conversion between floating-point and fixed-point formats, and a more complete set of operations on the extended format.

**Floating-Point-Support (FPS) Extensions**

FPS extensions provides eight additional instructions, including four to convert data between the HFP and BFP formats.

**Data Representation**

The basic addressable data unit is an 8-bit byte that can be used as one character, 2 hexadecimal digits, or 8 binary bits. The z890 CPC provides the following data representation features:

- Efficient use of storage and effective I/O rates for decimal data.
- Variable-length fields.
- Broad and flexible code conversion.
- Decimal arithmetic.
- Fixed-point and floating-point arithmetic.
- 32-bit words, 64-bit doublewords, and 128-bit extended words (for floating-point arithmetic) in ESA/390 architecture.
- 64-bit words, 128-bit doublewords, and 256-bit extended words (for floating-point arithmetic) in z/Architecture.
- Instructions for functions such as translate, edit, convert, move, and compare.
Data Compression

The z890 CPC supports hardware-assisted data compression for DB2, IMS™, DFSMS/MVS, OS/390, and z/OS.

Hardware facilities allow the compression and expansion of data which can provide significant reductions in the total cost of computing by significantly reducing:

- DASD and tape storage requirements.
- The number of communication lines or required line speeds for network data transmission.
- Central processor (CP) cycles needed to perform data compression and expansion (when compared to software-only data compression).

Data compression, along with the increased data rate of ESCON and FICON channels and sequential data striping, may provide further enhancements to the effective bandwidth of general purpose models. When combined, these attributes may improve channel utilization and enhance system level performance in situations where I/O bandwidth has been a limiting factor.

This feature requires a software corequisite.

Dynamic I/O Configuration

Dynamic I/O configuration allows you to modify the I/O configuration without performing:

- Power-on Reset (POR) of the CPC, or
- Initial Program Load (IPL) of the System Control Program (SCP).

Dynamic I/O configuration allows you to add, delete, or modify the I/O definitions of channel paths, control units, and I/O devices in the CPC. You can also name previously reserved logical partitions and it allows you to save the changes you made to the I/O configuration definitions and apply them to the active I/O Configuration Data Set (IOCDS).

Dynamic I/O configuration requires z/OS, OS/390, or z/VM. z/VSE, Linux, VSE/ESA™, and TPF do not provide Dynamic I/O configuration support.

Support for dynamic I/O configuration, with z/OS V1R4 z990 Exploitation Support and z/VM V4.4, has been extended to allow channel paths, control units, and devices to be dynamically added, changed, and deleted in multiple LCSSs.

z/VM provided compatibility support for V3.1, V4.2, and V4.3 and limited exploitation of two LCSSs when running on a z890 server. Dynamic I/O configuration is supported when only LCSS 0 is defined. z/VM uses I/O resources in LCSS 0 and LCSS 1. Refer to Chapter 3, “Software Support,” on page 3-1 for more information.

When z/VM is controlling the I/O configuration, z/VM’s dynamic I/O support is designed to handle all of the elements of the multiple Channel Subsystem facility for dynamic I/O configuration changes. To dynamically change the I/O configuration, one of two techniques can be employed:

- z/VM Control Program (CP) suite of interactive dynamic I/O commands
- HCM/HCD - configuration management tools.

Dynamic I/O support for adding and deleting logical partition names is provided in z/OS V1R6.
Subspace Group Facility Support

The z890 CPC provides support for the subspace group facility which can enhance the data integrity and reliability of application server subsystems like Customer Information Control System Transaction Server (CICS® TS), reducing application failures, service outages, and incorrect modification of critical business data.

Application server subsystems like CICS TS use a single application server program to provide common function to multiple application programs all running within a single address space. The subspace group facility allows the application server program to assign address space private storage to each application program running in the address space.

This prevents one application program from accidentally overwriting the code and data of another application program running in the same address space. Preventing accidental overwrites reduces application failures, service outages, and incorrect modification of critical business data. (This storage isolation feature was first implemented for CICS/ESA, but it is exploited by CICS TS.)

Additionally, there should be little or no modification required of existing application programs because you implement storage isolation and protection through the subsystem application server program.

CICS TS Use of the Subspace Group Facility

CICS TS uses the subspace group facility to implement transaction isolation to prevent one application program from accidentally overwriting the storage of another application program running in the same address space. Transaction isolation extends the subsystem storage protection capability which protects CICS TS system storage from being accidentally overwritten by user-written application programs.

Additionally, transaction isolation use of the subspace group facility enhances application development and maintenance for the subsystem. When an application attempts to access the address space private storage of another application, CICS abends the program making it easy to identify the failing application that could cause a data integrity problem.

This feature requires a software corequisite.

Dedicated Move Page Engine

A dedicated move page engine assists in efficiently transferring data between central and expanded storage, or between two main storage locations.

Fast Sync/Data Mover Facility

Asynchronous Data Mover Facility (ADMF) was invented to improve storage-to-storage movement of large blocks of data. The continued evolution of CMOS processor and memory technology in z890 has improved synchronous data movement using the Move Page instruction to the point where its performance is on par with ADMF.

The Fast Sync/Data Mover facility is implemented on z890 and future processors as an indicator to DB2 that Move Page should be used in place of ADMF. A PTF released for DB2 checks this indicator and uses Move Page instead of ADMF. DB2 will continue to use ADMF on pre-G5 machines. ADMF is not available on z890.
Immediate and Relative Instruction Facility

The Immediate and Relative Instruction facility reduces the need to use general registers to address branch targets. As a result, the general registers and access registers can be allocated more efficiently in programs that require many registers.

Perform Locked Operation (PLO) Facility

This facility consists of the unprivileged Perform Locked Operation instruction, which appears to provide concurrent interlocked-update references to multiple storage locations.

Logical String Assist

The logical string assist provides instructions that more efficiently process string data types. These instructions are of particular value to large, complex C-programming language applications that rely heavily on null-character-terminated string manipulation functions. This feature requires software corequisites.

The logical string assist provides the following architected instructions:

- **COMPARE LOGICAL STRING**
  Compare Logical String compares bytes between two strings until it either finds an inequality or a specified ending character.

- **MOVE STRING**
  Move String moves a string until it finds a specified ending character.

- **SEARCH STRING**
  Search String searches a string of a specified length for a specified character.

The first two instructions, COMPARE LOGICAL STRING and MOVE STRING, are particularly useful to the C-programming language that normally delimits strings by a null ending character. For more information, refer to the Enterprise System Architecture/390 Principles of Operation.
Chapter 3. Software Support

This chapter describes the software support for the z890. The following table displays a summary of the supported operating systems.

Table 3-1. Supported Operating Systems

<table>
<thead>
<tr>
<th>Operating System</th>
<th>ESA/390 (31-bit)</th>
<th>z/Arch (64-bit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>z/OS Version 1 Releases 4, 5, 6, 7, and 8</td>
<td>No(^1,, 2)</td>
<td>Yes</td>
</tr>
<tr>
<td>z/OS.e Version 1 Releases 4, 5, 6, 7, and 8</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>z/OS.e</strong> is unique for z890 and z800. It is a specially priced offering of z/OS, providing the z/OS qualities of service to help you deploy new applications. z/OS.e has the same migration, fallback, and coexistence as z/OS, allowing you to leverage existing skills and investments. z/OS.e must execute in z/Architecture (64-bit) mode.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linux for zSeries: SUSE SLES 7, SUSE SLES 8, RedHat RHEL 3.0, Turbolinux TLES 8, Conectiva CLEE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Linux for S/390: SUSE SLES 7, SUSE SLES 8, RedHat RHEL 3.0, Turbolinux TLES 8, Conectiva CLEE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>z/VM Version 5 Release 1</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>z/VM Version 4 Releases 3 and 4</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>z/VM Version 3 Release 1</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>VSE/ESA Version 2 Releases 6 and 7</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>z/VSE Version 3 Release 1(^3) (Preview)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>TPF Version 4 Release 1 (ESA mode only)</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Notes:**
1. ESA/390 mode permitted for migration purposes only.
2. IBM Bimodal Accommodation offering is available for z/OS z/OS V1R3, and z/OS V1R4 (not available for z/OS V1R5).
3. The z/VSE operating system can execute in 31-bit mode only. It does not implement z/Architecture, and specifically does not implement 64-bit mode capabilities. The z/VSE operating system is designed to exploit select features of IBM eServer zSeries hardware.
4. With applicable PTFs.

**Note:** The z890 CPC does NOT support S/370™ architecture in operation in a logical partition or as a guest of VM.

This information applies to the z890 CPC running in an LPAR mode.

Any program written for z/Architecture or ESA/390 architecture mode can operate on a CPC operating in the architecture mode for which the program was written, provided that the program:

- Is not time-dependent.
- Does not depend on the presence of system facilities (such as storage capacity, I/O equipment, or optional features) when the facilities are not included in the configuration.
• Does not depend on the absence of system facilities when the facilities are included in the configuration.
• Does not depend on results or functions that are defined as unpredictable or model dependent in the z/Architecture Principles of Operation, or in the Enterprise System Architecture/390 Principles of Operation.
• Does not depend on results or functions that are defined in this publication (or, for logically partitioned operation, in the zSeries 890 and 990 Processor Resource/System Manager Planning Guide) as being differences or deviations from the appropriate Principles of Operation publication.
• Does not depend on the contents of instruction parameter fields B and C on interception of the SIE instruction.

Any problem-state program written for ESA/390 architecture mode can operate in z/Architecture mode provided that the program complies with the limitations for operating in ESA/390 mode and is not dependent on privileged facilities which are unavailable on the system.

Previously, z/OS had to run in 64-bit z/Architecture mode on a z/Architecture server. The z/OS Bimodal Accommodation offering is your alternative to running in 64-bit mode when you first migrate to z/OS V1R3, or z/OS V1R4 on a z/Architecture server. It gives you the security of knowing you can return to 31-bit mode if there are any 64-bit issues during your migration. For more information, you can refer to http://www.ibm.com/servers/eserver/zseries/zos/installation/bimodal.html

For z/OS to operate as a guest of z/VM on a z890, z/OS and z/VM must be operating in 64-bit mode, refer to Table 3-2.

Table 3-2. Running z/OS as a Guest of z/VM

<table>
<thead>
<tr>
<th></th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>z890</td>
<td>z890</td>
</tr>
<tr>
<td>z/VM</td>
<td>z/VM</td>
<td>z/VM</td>
</tr>
<tr>
<td>z/VM mode</td>
<td>31-bit</td>
<td>64-bit</td>
</tr>
<tr>
<td>z/OS</td>
<td>z/OS</td>
<td>z/OS</td>
</tr>
<tr>
<td>z/OS mode</td>
<td>31-bit</td>
<td>64-bit</td>
</tr>
<tr>
<td>Supported</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

z/OS

This section describes the z/OS software support available for z890. Refer to the z/OS subset of the 2086DEVICE Preventive Service Planning (PSP) bucket prior to installing a z890 server. For the minimum cryptographic software requirements, refer to Chapter 7, “Cryptography,” on page 7-1.

Because of the similarities between the z890 and z990 servers, the software deliverables that support the z990 server also apply to the z890 server. That is, the features and web deliverables that are required for the z990 server are also required for the z890 server, even though "z890" is not in the name of most of the features and web deliverables. Also, PTF service alone does not provide z890 software support.

z/OS and z/OS.e V1R8

z/OS and z/OS.e V1R8 is the current version associated with the z890 platform.
z/OS and z/OS.e V1R7

z/OS V1R7 (with maintenance) is required for STP support.

z/OS and z/OS.e V1R6

z/OS and z/OS.e V1R6 is required for support of zSeries Application Assist Processors (zAAPs) and supports the dynamic naming of logical partitions.

z/OS and z/OS.e V1R5

z/OS and z/OS.e V1R5 includes the exploitation function from the prior z/OS release.

z/OS V1R4

The following support for z/OS V1R4 includes these features:

• z/OS V1R4 z990 Exploitation Support Feature
  This unpriced optional feature allows z/OS V1R4 to take advantage of new functions provided by the z990 and z890 servers. This feature also provides the compatibility support that was in the z/OS V1R4 z990 Compatibility Support feature, which this feature replaces. Any z/OS V1R4 customer who does not already have the compatibility support but requires it, must now order the z/OS V1R4 z990 Exploitation Support feature. This feature can be required on coexisting non-z990 and non-z890 systems.

z/OS.e V1R4

The following support for z/OS.e V1R4 includes:

• z/OS.e V1R4 z990 Coexistence Update Feature
  This feature allows you to maintain a consistent code base for z/OS and z/OS.e and provides compatibility and exploitation support for two Logical Channel Subsystems and 30 LPARs. It is required on all z/OS.e V1R4 servers in a Parallel Sysplex when a z/OS or CF image in that same Parallel Sysplex is running on a z890 or z990 and the LPAR identifier of the operating system or CF is greater than 15 ('XF').

z/VM

The z890 is supported by the z/VM levels, features, and web deliverables discussed in this section.

z/VM provides compatibility support for z/VM V3.1 and V4.3 with limited exploitation for two LCSSs when running on a z890 server and supports both internal (IC and HiperSocket) and external (ICB, ISC-3, FICON, and OSA) spanned channels. Dynamic I/O configuration is supported only within LCSS 0. Refer to the z/VM subset of the 2086DEVICE Preventive Service Planning (PSP) bucket prior to installing a z890.

z/VM V4.4 provides additional exploitation support for the following functions:

• SCSI IPL for guests
• Two LCSSs
• Adapter interruptions for OSA and FCP channels
• OSA-Express Integrated Console Controller (OSA-ICC) with PTFs
• Performance Assist for V=V guests in z/VM environment
• 30 LPARs
• Dynamic I/O support for LCSS 0 and LCSS 1
- FCP LUN Access Control for guests with PTFs.

z/VM V5.1 will support the following functions in addition to those supported by z/VM V4.4:
- SCSI IPL system support for z/VM and guests
- Crypto shared-queue and dedicated-queue support for Linux for zSeries guests and z/OS guests
- Internet Protocol Version 6 (IPv6).
- GDPS HyperSwap
- FCP LUN Access Control for VM system owned LUNs with PTFs.

VSE/ESA

VSE/ESA compatibility is provided on the following releases:
- VSE/ESA V2R6
- VSE/ESA V2R7.

For the latest information on compatibility support requirements, refer to the VSE subset of the 2086DEVICE Preventive Service Planning (PSP) bucket prior to installing the z890 server.

VSE/ESA V2R6 and later releases provide further exploitation support for the following functions:
- 30 LPARs
- Two logical channel subsystems
- OSA-Express Integrated Console Controller (OSA-ICC)
- HiperSockets (IQD) spanned channels (VSE/ESA V2R7 and later releases)
- Adapter interruptions for OSA (CHPID type OSD) and FICON (CHPID type FCP) (VSE/ESA V2R7 and later releases).

Linux Support

You can run Linux natively in a logical partition or as a guest under z/VM. You can also isolate your Linux on a z890 in its own workspace, using the Integrated Facility for Linux (IFL). IFL is a hardware option for capacity dedicated to Linux workload.

Integrated Facility for Linux (IFL)

This optional feature, available on z890, enables you to purchase additional processing capacity exclusively for Linux workload, with no effect on the z890 model designation. Executing Linux workload on the IFL will not result in any increased IBM software charges for traditional z/OS, z/VM, VSE/ESA, or TPF operating systems/applications.

Only Linux applications or Linux operating in conjunction with z/VM are supported by the IFL. Up to four IFL features may be ordered for z890.

The IFL is managed by Processor Resource/Systems Manager (PR/SM). A logical partition which is defined as a Linux logical partition, can run Linux or z/VM Version 4 and Version 5. These Linux-mode logical partitions can be defined to use the IFLs in either a dedicated or shared processor configuration. IFLs cannot be defined for use in non-Linux-mode logical partitions. Implementation of this feature will require a logical partition definition, followed by a normal logical partition activation procedure.
As with any change in the logical partition configuration of a processor, the introduction of additional resources to manage may have an impact on the capacity of the existing partitions and workloads running on the server. The size of the impact is dependent on the quantity of added resources and the type of applications being introduced. Also, one should carefully evaluate the value of sharing resources (like CHPIDs and devices) across partitions to assure the desired balance of performance, security, and isolation has been achieved.

**Benefits**
The IFL enables you to:

- Add processing capacity dedicated to running Linux on the z890 server.
- Run multiple Linux images independently of the traditional z/Architecture or ESA/390 workload, with associated savings of IBM z/Architecture and S/390 software charges.
- Define many virtual Linux images on fewer real z890 resources.
Chapter 4. Channel Subsystem Structure

The Channel Subsystem structure in the z890 is designed to “break the barrier” of 256 channels. With the introduction of this system structure and all of its scalability benefits, it is essential that the Channel Subsystem (CSS) also be scalable and permit “horizontal” growth. This is facilitated by allowing more than one Logical Channel Subsystem (LCSS) on a single z890. Consistent with this premise, IBM is introducing increased connectivity by offering the following channel/port maximums. These new maximums are contrasted with z800.

Table 4-1. Channel Maximums (z890 compared to z800)

<table>
<thead>
<tr>
<th>Channel Type</th>
<th>z890 Maximum</th>
<th>z800 Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESCON</td>
<td>420 (240 on smallest sub-uni)</td>
<td>240</td>
</tr>
<tr>
<td>FICON Express</td>
<td>40 (32 on smallest sub-uni)</td>
<td>32</td>
</tr>
<tr>
<td>FICON Express2</td>
<td>80 (64 on smallest sub-uni)</td>
<td>Not available</td>
</tr>
<tr>
<td>OSA-Express and OSA-Express2</td>
<td>40 (24 on smallest sub-uni)</td>
<td>24</td>
</tr>
<tr>
<td>IC link</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>ISC-3 link</td>
<td>48</td>
<td>24</td>
</tr>
<tr>
<td>ICB-4 link</td>
<td>8</td>
<td>Not available</td>
</tr>
<tr>
<td>ICB-3 link</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>PCICA</td>
<td>2 (4 accelerator engines)</td>
<td>6</td>
</tr>
<tr>
<td>PCIXCC</td>
<td>4 (1 coprocessor per card)</td>
<td>Not available</td>
</tr>
<tr>
<td>Crypto Express2</td>
<td>16 coprocessors</td>
<td>Not available</td>
</tr>
</tbody>
</table>

Note: The maximum number of coupling links (any combination of ICB-4s, ICB-3s, ICs, and ISC-3 links) is 64.

The Channel Subsystem Structure offers the following:

- Two Logical Channel Subsystems (LCSSs)
  - Each LCSS can have up to 256 CHPIDs defined
  - Each LCSS can be configured with one to 15 Logical Partitions (LPARs), cannot exceed 30 LPARs per server (15 LPARs on the smallest sub-uniprocessor equipped capacity setting).
- Spanned channels are shared among LPARs across LCSSs. For more information on spanned channels, refer to Table 4-2 on page 4-2 and to “Spanned Channels” on page 4-12.

Note: There is no change to the operating system maximums. One operating system image continues to support up to a maximum of 256 Channel Path Identifiers (CHPIDs).

Support for dynamic I/O configuration, with z/OS V1R4 with the z/OS V1R4 z990 Exploitation Support feature and z/VM V4.4 and later, allows channel paths, control units, and devices to be dynamically added, changed, and deleted in multiple LCSSs.

z/OS V1R4 z990 Exploitation Support feature is required for z/OS to run more than a single LCSS. Without z/OS V1R4 z990 Exploitation Support feature, z/OS may only execute in LCSS 0. z/VM V3.1, V4.3 and later, may execute in LCSS 0 and
LCSS 1. However, when using z/VM V3.1 and V4.3 compatibility support, dynamic I/O configuration is supported in LCSS 0 only.

When z/VM is controlling the I/O configuration, z/VM’s dynamic I/O support is designed to handle all of the new elements of the multiple Channel Subsystem facility for dynamic I/O configuration changes. To dynamically change the I/O configuration, one of two techniques can be employed:
- z/VM Control Program (CP) suite of interactive dynamic I/O commands
- HCM/HCD - configuration management tools.

The I/O Subsystem (IOSS) continues to be viewed as a single Input/Output Configuration Data Set (IOCDS) across the entire system with up to two LCSSs. Only one Hardware System Area (HSA) is used for the multiple LCSSs.

Previously, a two-digit identifier, a CHPID, was associated with a physical I/O connection. Now a three-digit Physical Channel Identifier (PCHID) is being used to accommodate the mapping of 512 channels to two LCSSs with up to 256 CHPIDs each. CHPIDs continue to exist and will be associated with PCHIDs.

A new CHPID Mapping Tool (CMT) is being introduced and the CHPID report from the IBM Configurator for e-business (eConfig) is replaced by a PCHID report. CMT is available from Resource Link, [http://www.ibm.com/servers/resourcelink](http://www.ibm.com/servers/resourcelink) as a standalone PC-based program. For more information on the CHPID Mapping Tool, CHPIDs, or PCHIDs refer to zSeries 890 and 990 CHPID Mapping Tool User’s Guide.

### IOCP Channel Definitions

The following table lists the channel types as defined in an IOCDS that are used with z890 systems.

**Table 4-2. I/O Channels with CHPID Type**

<table>
<thead>
<tr>
<th>Channels</th>
<th>CHPID Type</th>
<th>May be defined as Shared</th>
<th>May be defined as Spanned</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESCON channels:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connection Channel (ESCON architecture)</td>
<td>CNC</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Channel-to-Channel (connects to CNC)</td>
<td>CTC</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>ESCON channels connected to converter:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conversion Channel (ESCON to Parallel Block Multiplexer (BL))</td>
<td>CVC</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Conversion Channel (ESCON to Parallel Byte Multiplexer (BY))</td>
<td>CBY</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>FICON bridge channels that attach ESCON devices through an ESCON Director 9032 Model 006 with the FICON Bridge feature</td>
<td>FCV</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>FICON native channels that attach to FICON directors or directly to FICON control units</td>
<td>FC</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>FICON channels that attach to Fibre channel switches, directors, hubs, or Fibre-Channel-to-SCSI bridges</td>
<td>FCP</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>ISC-3 peer mode channels (connects to another CFP)</td>
<td>CFP</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>ISC-3 compatibility mode sender channels (connects to CFR)</td>
<td>CFS</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>ISC-3 compatibility mode receiver channels (connects to CFS)</td>
<td>CFR</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>ICB-4 peer channels (connects to another ICB-4)</td>
<td>CBP</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>ICB-3 peer channels (connects to another ICB-3)</td>
<td>CBP</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>IC peer channels (connects to another ICP)</td>
<td>ICP</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>
Table 4-2. I/O Channels with CHPID Type  (continued)

<table>
<thead>
<tr>
<th>Channels</th>
<th>CHPID Type</th>
<th>May be defined as Shared</th>
<th>May be defined as Spanned</th>
</tr>
</thead>
<tbody>
<tr>
<td>HiperSocket (iQDIO) channels</td>
<td>IQD</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>OSA channels using QDIO architecture</td>
<td>OSD</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>OSA-Express channels using non-QDIO architecture</td>
<td>OSE</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>OSA-Express 1000BASE-T channels for OSA-ICC</td>
<td>OSC</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Each of these channel types requires that a CHPID be defined, even if it is an internal channel and no physical hardware (channel card) exists. Each channel, whether a ‘real’ channel or a virtual (such as HiperSocket) must be assigned a unique CHPID within the LCSS. You can arbitrarily assign a number within the X'00' to X'FF' range. Real channels require a PCHID value to be defined. Most of these channel types can be shared and used concurrently among multiple LPARs within the same LCSS. Refer to "Multiple Image Facility (MIF)" on page 4-11 for more information on shared channels.

**Coupling Link Peer Channels**

You may define an ISC-3 feature as CFP and an ICB-4 and ICB-3 feature must be defined as CBP. Any available/unused CHPID may be defined as ICP.

You can configure a CFP, CBP, or ICP channel path as:

- An unshared dedicated channel path to a single logical partition.
- An unshared reconfigurable channel path that can be configured to only one logical partition at a time but which can be dynamically moved to another logical partition by channel path reconfiguration commands. Reconfigurable support for CFP, CBP, and ICP is limited to two coupling facility logical partitions total. One coupling facility logical partition in the initial access list and one other coupling facility partition in the candidate list.
- A shared or spanned channel path that can be concurrently used by the logical partitions to which it is configured. A peer channel cannot be configured to more than one coupling facility logical partition at a time, although it can be configured to multiple z/Architecture or ESA/390 logical partitions in addition to the single coupling facility logical partition.
- Timing-only links. These are coupling links that allow two servers to be synchronized using Server Time Protocol (STP) messages when a Coupling Facility does not exist at either end of the coupling link.

Each ICP channel path must specify which ICP channel path it is logically connected to.

The z890 supports dynamic I/O configuration for all peer channel path types.

**Coupling Link Sender Channels**

You can define an ISC-3 feature as CFS.

You can configure a CFS channel path as:

- An unshared dedicated channel path to a single logical partition.
An unshared reconfigurable channel path that can be configured to only one logical partition at a time but which can be dynamically moved to another logical partition by channel path reconfiguration commands.

A shared or spanned channel path that can be concurrently used by the logical partitions to which it is configured.

The z890 supports dynamic I/O configuration for all sender channel path types.

Note: A maximum of 32 ISC-3 links may be defined as CFS or CFR.

**Coupling Link Receiver Channels**

You can define an ISC-3 feature as CFR.

You can configure a CFR channel path as:

- An unshared dedicated channel path to a single coupling facility logical partition.
- An unshared reconfigurable channel path that can be configured to only one logical partition at a time but which can be dynamically moved to another logical partition by channel path reconfiguration commands. Reconfigurable support for CBR is limited to two logical partitions total. One logical partition in the initial access list and one other logical partition in the candidate list.

The z890 supports dynamic I/O configuration for all receiver channel path types.

Note: A maximum of 32 ISC-3 links may be defined as CFS or CFR.

**Subchannel Connectivity**

With two Logical Channel Subsystems comes more subchannels. There is a maximum of 63K subchannels per LCSS. With two Logical Channel Subsystems, each LCSS can have its own set of 63K subchannels and each logical partition in each LCSS can have access to the 63K subchannels.

With two Logical Channel Subsystems you can have:

- Up to a maximum of 63K devices/subchannels per LCSS
- Up to a maximum of 126K devices for two LCSSs (two LCSSs times 63K subchannels for each LCSS).

Each LPAR can access the 63K devices in its assigned LCSS.

This capability relieves the I/O device configuration constraints experienced by large system configurations.

**Availability Guidelines for the z890**

When configuring devices with multiple paths to the same CPC, select any of the channel paths from any I/O card shown in Figure 4-1 on page 4-5 that:

- Are available on the CPC you are defining
- Are the correct type (FICON, ESCON, etc.) to meet the control unit, coupling facility, or network attachment requirements
- Satisfy the rules regarding the mixing of channel types to a control unit.
However, for maximum availability of the device, OSA network, or coupling facility on z890, you should consider the following guidelines:

- **For systems with multiple STIs**, distribute paths across the STIs.

  **Note:** We also recommend this for optimum performance of your most heavily-used I/O devices.

  When choosing the STIs to use, try to use STIs from different MBAs on the book. Refer to your PCHID Report (or Table 4-3 on page 4-6) to determine which STI links belong to which MBAs on the book. If you have multiple paths to the device and multiple domains available that have the correct channel type, spreading the paths across both MBAs is also advisable.
Connecting your critical devices this way ensures access to those devices while running in a degraded mode. In the unlikely event of an MBA failure, you may be able to take advantage of running degraded until the repair.

When configuring ICB or coupling CHPIDs for the same target CPC or coupling facility, use a combination of STIs from different MBAs. This allows for continued connectivity if you have to run degraded after an MBA failure.

When configuring ICB-3 channel paths for the same target CPC or coupling facility, use links that originate from different STI cards in the I/O cage. This eliminates the STI card as a single-point-of-failure.

- **If you define multiple paths from the same STI**, distribute paths across different channel cards. Also, if you define multiple Coupling Facility (CF) channels to the same coupling facility or the same ESA image, distribute paths across different coupling facility channel adapter cards or different CF daughter cards.

The following table illustrates the relationship between the book jack numbers and the MBA that supports those STIs.

<table>
<thead>
<tr>
<th>Book Jack Numbers</th>
<th>MBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>J00, J01, J02, J03</td>
<td>MBA-0</td>
</tr>
<tr>
<td>J08, J09, J10, J11</td>
<td>MBA-2</td>
</tr>
</tbody>
</table>

**STI Configurations**

A z890 has one book installed, with two MBAs. Each MBA has four STI links attached to them, therefore, eight STIs, operating at 2.0 GBps.

**Note:** When configuring the machine to exploit the best RAS characteristics, you want to use STIs equally from each MBA in the book.

ICB-4s and I/O cages are supported with the 2.0 GBps STIs directly from the CPC cage. Figure 4-2 on page 4-7 depicts the STI connections for ICBs. The STI cable is 10 meters (33 feet) in length, of which 3 meters are reserved for intraserver connection.
Planning for Channel Subsystem

This section contains information to aid in the planning for maximum channel subsystem availability on z890 models. It addresses ESCON, FICON, OSA, ISC-3, ICB (ICB-4 and ICB-3) and IC channels, and HiperSockets. The information shows the major components of the channel subsystem and suggests ways to configure the CSS for maximum availability.

This information is in the PCHID report or CFReport provided by the IBM account team for your machine.

The following references, available on Resource Link can assist you with your channel subsystem planning:

- CHPID Mapping Tool
- zSeries 890 and 990 CHPID Mapping Tool User’s Guide.

CHPID and PCHID Assignments

Note: For z890, there are no default CHPIDs assigned. CHPID assignment is provided in the IOCDS using IOCP or HCD. The CHPID Mapping Tool may be used to help define the PCHID to CHPID assignment.

The overall process of assigning CHPIDs and PCHIDs begins when you order the z890 or an MES to an existing machine. After placing the order, the e.config configurator prepares a report detailing the physical location for each channel in the machine. For the z890, this report shows PCHID assignments.
Physical PCHIDs must be assigned to logical CHPID numbers. Do this assignment in either HCD or IOCP using the PCHID report from the account team. The CHPID Mapping Tool may be used to help with these assignments. You will use the data in the CFRReport (provided by your account team) or the hardware configuration file (available from Resource Link) and IOCP input for assigning PCHID values using the CHPID Mapping Tool.

The PCHID number identifies a physical location. A PCHID relates directly to a jack location in a specific slot in the cage. Table 4-4 lists the PCHID assignments for slots in the I/O cage. Only the active ports on an installed card are actually assigned a PCHID, the remainder are unused.

Table 4-4. I/O Cage PCHIDs

<table>
<thead>
<tr>
<th>Cargo Slot</th>
<th>PCHID Range -- Cage 1/Bottom 'A'</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100 - 10F</td>
</tr>
<tr>
<td>2</td>
<td>110 - 11F</td>
</tr>
<tr>
<td>3</td>
<td>120 - 12F</td>
</tr>
<tr>
<td>4</td>
<td>130 - 13F</td>
</tr>
<tr>
<td>6</td>
<td>140 - 14F</td>
</tr>
<tr>
<td>7</td>
<td>150 - 15F</td>
</tr>
<tr>
<td>8</td>
<td>160 - 16F</td>
</tr>
<tr>
<td>9</td>
<td>170 - 17F</td>
</tr>
<tr>
<td>10</td>
<td>180 - 18F</td>
</tr>
<tr>
<td>11</td>
<td>190 - 19F</td>
</tr>
<tr>
<td>12</td>
<td>1A0 - 1AF</td>
</tr>
<tr>
<td>13</td>
<td>1B0 - 1BF</td>
</tr>
<tr>
<td>15</td>
<td>1C0 - 1CF</td>
</tr>
<tr>
<td>16</td>
<td>1D0 - 1DF</td>
</tr>
<tr>
<td>17</td>
<td>1E0 - 1EF</td>
</tr>
<tr>
<td>18</td>
<td>1F0 - 1FF</td>
</tr>
<tr>
<td>19</td>
<td>200 - 20F</td>
</tr>
<tr>
<td>20</td>
<td>210 - 21F</td>
</tr>
<tr>
<td>21</td>
<td>220 - 22F</td>
</tr>
<tr>
<td>22</td>
<td>230 - 23F</td>
</tr>
<tr>
<td>24</td>
<td>240 - 24F</td>
</tr>
<tr>
<td>25</td>
<td>250 - 25F</td>
</tr>
<tr>
<td>26</td>
<td>260 - 26F</td>
</tr>
<tr>
<td>27</td>
<td>270 - 27F</td>
</tr>
<tr>
<td>29</td>
<td>280 - 28F</td>
</tr>
<tr>
<td>30</td>
<td>290 - 29F</td>
</tr>
<tr>
<td>31</td>
<td>2A0 - 2AF</td>
</tr>
<tr>
<td>32</td>
<td>2B0 - 2BF</td>
</tr>
</tbody>
</table>

Direct (z890 to z890 and z990) book connections (to STI ports) are used for ICB-4 channels. (These channels are used for connections to Coupling Facilities.) There are eight STI ports on a book, and a PCHID number is assigned to each one, as
shown in the following table.

*Table 4-5. Book PCHIDs*

<table>
<thead>
<tr>
<th>Book</th>
<th>PCHIDs</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>010 - 013</td>
</tr>
<tr>
<td></td>
<td>018 - 01B</td>
</tr>
</tbody>
</table>

*Note:* These PCHIDs and connections do not involve the I/O cage.

**PCHID Report**

When planning an I/O configuration, using the PCHID Report from the Order Process Configurator is a valuable aid. Use the following information to relate this report to the availability guidelines presented in "Availability Guidelines for the z890" on page 4-4. An example of a PCHID report is on page 4-10.

**Book/Jack/MBA**
- Displays the Book number (0), Jack number (J.xx), and MBA number (0 or 2) that the STI and channel card are serviced by.

**Cage**
- Displays the location of the I/O cage and CPC cage containing I/O (CPC cages are shown only if ICB-4s are part of the configuration).

**Slot**
- Displays the slot that the channel card is plugged into.

**F/C**
- Displays the feature code for the I/O type (ESCON, FICON) installed in that location.

**PCHID/Ports**
- Displays the PCHID assignment and the physical port (jack number) on the card in the slot with that assignment.

*Note:* If you use the CHPID Mapping Tool, available from Resource Link, to aid you in assigning PCHIDs to CHPIDs, the tool provides you with a new report with your CHPID assignment in addition to the PCHID values.
<table>
<thead>
<tr>
<th>Book/Jack/MBA</th>
<th>Cage</th>
<th>Slot</th>
<th>F/C</th>
<th>PCHID/Ports</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/J.03/0</td>
<td>A19B</td>
<td>06</td>
<td>3393</td>
<td>013/J03</td>
<td></td>
</tr>
<tr>
<td>0/J.11/2</td>
<td>A19B</td>
<td>06</td>
<td>3393</td>
<td>01B/J11</td>
<td></td>
</tr>
<tr>
<td>0/J.00/0</td>
<td>A01B</td>
<td>D101</td>
<td>0218</td>
<td>109/J00 101/J01</td>
<td></td>
</tr>
<tr>
<td>0/J.00/0</td>
<td>A01B</td>
<td>D201</td>
<td>0218</td>
<td>108/J00 109/J01</td>
<td></td>
</tr>
<tr>
<td>0/J.08/2</td>
<td>A01B</td>
<td>D102</td>
<td>0218</td>
<td>110/J00 111/J01</td>
<td></td>
</tr>
<tr>
<td>0/J.08/2</td>
<td>A01B</td>
<td>D202</td>
<td>0218</td>
<td>118/J00</td>
<td></td>
</tr>
<tr>
<td>0/J.00/0</td>
<td>A01B</td>
<td>03</td>
<td>0868</td>
<td>120/P00</td>
<td></td>
</tr>
<tr>
<td>0/J.08/2</td>
<td>A01B</td>
<td>04</td>
<td>0862</td>
<td>130/P00 131/P01</td>
<td></td>
</tr>
<tr>
<td>0/J.06/0</td>
<td>A01B</td>
<td>06</td>
<td>2319</td>
<td>140/J00 141/J01</td>
<td></td>
</tr>
<tr>
<td>0/J.08/2</td>
<td>A01B</td>
<td>07</td>
<td>2319</td>
<td>150/J00 151/J01</td>
<td></td>
</tr>
<tr>
<td>0/J.00/0</td>
<td>A01B</td>
<td>08</td>
<td>2320</td>
<td>160/J00 161/J01</td>
<td></td>
</tr>
<tr>
<td>0/J.08/2</td>
<td>A01B</td>
<td>09</td>
<td>2323</td>
<td>170/J00 171/J01 172/J02 173/J03</td>
<td>174/J04 175/J05 176/J06 177/J07 178/J08 179/J09 17A/J10 17B/J11 17C/J12 17D/J13 17E/J14</td>
</tr>
<tr>
<td>0/J.01/0</td>
<td>A01B</td>
<td>D110</td>
<td>0218</td>
<td>180/J00 181/J01</td>
<td></td>
</tr>
<tr>
<td>0/J.01/0</td>
<td>A01B</td>
<td>D210</td>
<td>0218</td>
<td>188/J00</td>
<td></td>
</tr>
<tr>
<td>0/J.09/2</td>
<td>A01B</td>
<td>11</td>
<td>0868</td>
<td>190/P00</td>
<td></td>
</tr>
<tr>
<td>0/J.01/0</td>
<td>A01B</td>
<td>12</td>
<td>1364</td>
<td>1A0/J00 1A1/J01</td>
<td></td>
</tr>
<tr>
<td>0/J.09/2</td>
<td>A01B</td>
<td>13</td>
<td>1366</td>
<td>180/J00 181/J01</td>
<td></td>
</tr>
<tr>
<td>0/J.01/0</td>
<td>A01B</td>
<td>15</td>
<td>2320</td>
<td>1C0/J00 1C1/J01</td>
<td></td>
</tr>
<tr>
<td>0/J.09/2</td>
<td>A01B</td>
<td>16</td>
<td>2320</td>
<td>1D0/J00 1D1/J01</td>
<td></td>
</tr>
<tr>
<td>0/J.01/0</td>
<td>A01B</td>
<td>17</td>
<td>2323</td>
<td>1E0/J00 1E1/J01 1E2/J02 1E3/J03</td>
<td>1E4/J04 1E5/J05 1E6/J06 1E7/J07 1EB/J08 1EB/J09 1E9/J10 1EB/J11 1EC/J12 1ED/J13 1EE/J14</td>
</tr>
<tr>
<td>0/J.09/2</td>
<td>A01B</td>
<td>18</td>
<td>2323</td>
<td>1F0/J00 1F1/J01 1F2/J02 1F3/J03</td>
<td>1F4/J04 1F5/J05 1F6/J06 1F7/J07 1FB/J08 1FB/J09 1FA/J10 1FB/J11 1FC/J12 1FD/J13</td>
</tr>
<tr>
<td>0/J.02/0</td>
<td>A01B</td>
<td>31</td>
<td>0993</td>
<td>2A0/J01</td>
<td></td>
</tr>
<tr>
<td>0/J.10/2</td>
<td>A01B</td>
<td>32</td>
<td>0993</td>
<td>2B0/J01 2B1/J02</td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- A19B  Top of A frame
- A01B  Bottom of A frame
- D1xx  Half high card in top of slot xx
- D2xx  Half high card in bottom of slot xx
- 0218  ISC D <10KM
CHPID Mapping Tool

The CHPID Mapping Tool is a Java-based standalone application available from IBM [Resource Link] and must be downloaded to your personal computer for use. Once downloaded, you can make PCHID assignments without further internet connections. You can make changes, save them (in your machine), and load them at a later time. You need a CFReport, or hardware configuration file and you import an IOCP file, assign PCHIDs to defined CHPIDs, and export a new IOCP file.

The intent of the CHPID Mapping Tool is to ease installation of new zSeries processors and for making changes to an already installed processor either to make slight changes to the mapping or as part of an MES action to add or remove channel features on the processor.

The zSeries 890 and 990 servers do not have default CHPIDs assigned to ports as part of the initial configuration process. It is your responsibility to perform these assignments by using the HCD/IOCP definitions and optionally the CHPID Mapping Tool. The result of using the tool is an IOCP deck that will map the defined CHPIDs to the corresponding PCHIDs for your processor. However, there is no requirement to use the mapping tool. You can assign PCHIDs to CHPIDs directly in IOCP decks or through HCD but it is much easier to use the tool to do the channel mapping and the tool can help make PCHID to CHPID assignments for availability.

For more information on the CHPID Mapping tool refer to one of the following:
- zSeries 890 and 990 CHPID Mapping Tool User’s Guide
- CHPID Mapping Tool on Resource Link.

Multiple Image Facility (MIF)

The Multiple Image Facility (MIF) allows channel sharing among multiple logical partitions and optionally shares any associated I/O devices configured to these shared channels. MIF also provides a way to limit the logical partitions that can access a reconfigurable channel, spanned channel, or a shared channel to enhance security.

With multiple LCSSs, the CSS provides an independent set of I/O controls for each logical channel subsystem called a CSS image. Each logical partition is configured to a separate CSS image in order to allow the I/O activity associated with each logical partition to be processed independently as if each logical partition had a separate CSS. For example, each CSS image provides a separate channel image and associated channel path controls for each shared channel and separate subchannel images for each shared device that is configured to a shared channel.

With MIF, you can configure channels as follows:
- ESCON (TYPE=CNC or TYPE=CTC), FICON (TYPE=FCV, TYPE=FC, or TYPE=FCP), ISC-3 peer (TYPE=CFP), ISC-3 compatibility mode sender
You can configure a channel path as:
- An unshared dedicated channel path to a single logical partition.
- An unshared reconfigurable channel path that can be configured to only one logical partition at a time it can be moved to another logical partition within the same LCSS.
- A shared channel path that can be concurrently used by the ESA/390 images or CF logical partitions within the same LCSS to which it is configured.

- **FICON (TYPE=FC or TYPE=FCP), ISC-3 peer (TYPE=CFP), ISC-3 compatibility mode sender (TYPE=CFS), ICB-4/ICB-3 peer (TYPE=CBP), IC peer (TYPE=ICP), HiperSockets (TYPE=IQD), and OSA (TYPE=OSC, TYPE=OSD, or TYPE=OSE)**
  You can configure these CHPID types for spanning. They can be shared by logical partitions in different logical channel subsystems.

- **ESCON (TYPE=CVC and TYPE=CBY) and ISC-3 compatibility mode receiver (TYPE=CFR).**
  You can configure a channel path as:
  - An unshared dedicated channel path to a single logical partition.
  - An unshared reconfigurable channel path that can be configured to only one logical partition at a time but which can be moved to another logical partition in the same LCSS by channel path reconfiguration commands.

Neither ESCON (TYPE=CVC or TYPE=CBY) nor ISC-3 compatibility mode receiver (TYPE=CFR) can be configured as shared channels.

With MIF and multiple channel subsystems, shared and spanned channel paths can provide extensive control unit and I/O device sharing. MIF allows all, some, or none of the control units attached to channels to be shared by multiple logical partitions and multiple CSSs. Sharing can be limited by the access and candidate list controls at the CHPID level and then can be further limited by controls at the I/O device level.

For example, if a control unit allows attachment to multiple channels (as is possible with a 3990 control unit), then it can be shared by multiple logical partitions using one or more common shared channels or unique unshared channel paths.

### Spanned Channels

With multiple LCSSs, transparent sharing of internal (ICs and HiperSockets) and external (FICON, ICB-3, ICB-4, ISC-3, and OSA channels across LCSSs is introduced, extending Multiple Image Facility (MIF). MIF allows sharing of channel resources across logical partitions. ICs, HiperSockets, FICON, ICB-3s, ICB-4s, ISC-3s, OSA features (except when defined as FCV or CFR channels) can all be configured as MIF spanning channels.

Spanning channels is the ability for the channels to be configured to multiple LCSSs, and be transparently shared by any or all of the configured logical partitions without regard to the Logical Channel Subsystem to which the partition is configured. For more information on MIF, refer to "Multiple Image Facility (MIF)" on page 4-11. For information on the channel CHPID types and spanning capabilities, refer to Table 4-2 on page 4-2.
### Internal Coupling and HiperSockets Channels

Internal Coupling (IC) channels and HiperSockets are virtual attachments and, as such, require no real hardware. However, they do require CHPID numbers and they do need to be defined in the IOCDS. The CHPID type for IC channels is ICP; the CHPID type for HiperSockets is IQD.

1. It is suggested that you define a minimum number of ICP CHPIDs for Internal Coupling. For most customers, IBM suggests defining just one ICP for each Coupling Facility (CF) logical partition in your configuration. For instance, if your z890 configuration has several ESA LPARs and one CF LP, you would define one pair of connected ICP CHPIDs shared by all the logical partitions in your configuration. If your configuration has several ESA LPARs and two CF logical partitions, you still would define one connected pair of ICP CHPIDs, but one ICP should be defined as shared by the ESA images and one of the CF LPARs, while the other ICP is defined as shared by the ESA LPARs and the other CF LPAR. Refer to zSeries 890 and 990 Processor Resource/Systems Manager Planning Guide for more information. Both of these examples best exploit the peer capabilities of these coupling channels by using the "sending" and "receiving" buffers of both channels. If your ESA images and CF images are in different CSSs and you want to exploit the optimal use of ICP then your ICP CHPIDs must be defined as spanned.

2. Each IQD CHPID represents one internal LAN. If you have no requirement to separate LAN traffic between your applications, only one IQD CHPID needs to be defined in the configuration. If the partitions sharing the LAN are in different LCSSs your IQD CHPID must be defined as spanned.

### IOCP Considerations

ICP IOCP supports the z890 model CPC and multiple LCSSs. Refer to zSeries z890 and z990 Input/Output Configuration Program User’s Guide for ICP IOCP for more information.

Enhancements to IOCP allow you to define controls for multiple channel subsystems. These changes include changes to the way you define logical partitions, channel paths, and I/O devices.

### Logical Partition Definition

You must specify the required RESOURCE statement. Use the RESOURCE statement to define LCSSs and the logical partitions in each LCSS. You can also assign a MIF image ID to each logical partition. If you do not specify a MIF image ID using the RESOURCE statement, ICP IOCP assigns them. You can also define reserved logical partitions which can be configured later with dynamic I/O.

### Channel Path Definition

You can define shared channel paths in addition to dedicated and reconfigurable channel paths. The CHPID statement has an additional SHARED keyword to accomplish this. You can also define spanned channel paths using the PATH keyword. You can define:

- All channel paths as dedicated or reconfigurable.
- Only CNC, CTC, FCV, FC, FCP, CFP, CFS, CBP, ICP, IQD, OSC, OSD, or OSE channel paths as shared.
- Only FC, FCP, CFP, CFS, CBP, ICP, IQD, OSC, OSD, and OSE channel paths as spanned.
ICP IOCP provides access controls for spanned, shared or reconfigurable channel paths. Parameters on the PART I PARTITION or NOTPART keyword on the CHPID statement allow you to specify an access list and a candidate list for spanned, shared and reconfigurable channel paths.

The access list parameter specifies the logical partition or logical partitions that will have the channel path configured online at logical partition activation following the initial power-on reset of an LPAR IOCDS. For exceptions, refer to zSeries 890 and 990 Processor Resource/Systems Manager Planning Guide.

The candidate list parameter specifies the logical partitions that can configure the channel path on-line. It also provides security control by limiting the logical partitions that can access shared or reconfigurable channel paths.

**Note:** PR/SM LPAR manages the channel path configuration across POR. Refer to zSeries 890 and 990 Processor Resource/Systems Manager Planning Guide.

**I/O Device Definition**

You can specify either the optional PART I PARTITION keyword or the optional NOTPART keyword on the IODEVICE statement to limit device access by logical partitions for devices assigned to shared ESCON, FICON, or OSA channels, or HiperSockets. (The IODEVICE candidate list is not supported for shared CFP, CBP, CFS, or ICP CHPIDs.)

By limiting access to a subset of logical partitions, you can:
- Provide partitioning at the device level.
- Provide security at the device level.
- Better manage the establishment of logical paths.

**Hardware Configuration Definition (HCD) Considerations**

z890 HCD support is available beginning with z/VM V4.4 and is available on all OS/390 and z/OS levels. HCD provides the capability to make both dynamic hardware and software I/O configuration changes.

**Note:** Support in MVS™ for multiple logical channel subsystems in HCD is only available on OS/390 V2R10 and z/OS V1R2 and later.

HCD also provides:
- An online, interactive way to more usably manage the I/O configuration than IOCP.
- The capability to define the I/O configuration for dynamic or non-dynamic I/O configuration purposes.

HCD allows you to define LPAR controls for defining logical partitions, channel paths, and I/O devices. The following HCD panels (or corresponding HCM dialogs) support these controls.

**Add Partition**
- Allows explicit definition of logical partitions and associated logical partition numbers.

**Define Access List**
- Allows definition of initial access list for channel path access control of shared and reconfigurable channel paths.
Define Candidate List (for channel paths)
Allows definition of candidate list for channel path access control of shared and reconfigurable channel paths.

Define Candidate List (for devices)
Allows definition of candidate list for device access control for devices assigned to shared channels.

Add Processor
Allows you to determine the capabilities of a CPC.

Add Channel Path
Operation mode field allows definition of a channel path as dedicated, reconfigurable, or shared.

Define Device / Processor
Additional field to specify candidate list.
Chapter 5. I/O Connectivity

This chapter discusses the channels associated with I/O connectivity. You can also refer to Table 2-2 on page 2-9 for a summary of the I/O channel characteristics.

FICON Express2

The FICON Express2 feature conforms to the Fibre Connection (FICON) architecture and the Fibre Channel (FC) architecture, providing connectivity between any combination of servers, directors, switches, and devices in a Storage Area Network (SAN). FICON Express2 supports cascading to concentrate and minimize the number of cross-site connections and reduce implementation costs for disaster recovery applications, Graphically Dispersed Parallel Sysplex (GDPS), and remote copy.

FICON Express2 features, exclusive to z890 and z990, double the channel capacity and increase performance. FICON Express2 SX and LX, with four channels per feature, provides up to 80 channels in the same amount of physical space. The maximum number of any combination of FICON Express2 and FICON Express features per server remains at 20 for z890. FICON Express2 SX and LX features can be added to an existing z890 concurrently.

FICON Express2 has two CHPID types, FC and FCP.

The connectivity options for each channel are defined as:
- Auto-negotiated as 1 or 2 Gbps
- Shared among LPARs
- Defined as a spanned channel
- Intermixed, FC and FCP, in the same director
- Cascaded.

FICON Express2 features include:
1. **FICON Express2 LX - long wavelength (FC 3319)**
   The FICON Express2 long wavelength feature provides connectivity between any combination of servers, directors, switches, and devices in a Storage Area Network (SAN). Each of the four independent ports/channels is capable of 1 gigabit per second (Gbps) or 2 Gbps depending upon the capability of the attached switch or device. The link speed is auto-negotiated, point-to-point, and is transparent to users and applications.

2. **FICON Express2 SX - short wavelength (FC 3320)**
   The FICON Express2 short wavelength feature occupies a single I/O slot, using one CHPID per channel, four CHPIDs per feature, while continuing to support 1 Gbps and 2 Gbps link data rates. The link speed is auto-negotiated, point-to-point, and is transparent to users and applications.

The two modes of operation supported by FICON Express2 SX and LX features are configured on a channel-by-channel basis with each of the four channels configured in either of the two supported modes. The two modes are:

1. **Fibre Channel (CHPID type FC)** which is native FICON in addition to FICON Channel-to-Channel (server-to-server).
2. Fibre Channel Protocol (CHPID type FCP) which supports attachment to SCSI devices through Fibre Channel switches and directors in z/VM and Linux on zSeries environments.

FICON Express2 replaces the FICON Express card for support of FC, including CTC, and FCP channel types. Channel type FCV and FICON Bridge are not supported by the FICON Express2 feature. For existing infrastructures using FCV, FICON Express will continue to be supported on the z890.

Note: IBM ESCON Director Model 5 (9032-005), including FICON to ESCON Bridge are no longer orderable.

Purge Path Extended

For additional information about purge path extended, refer to Purge Path Extended on page 5-6.

Software Support

Following are the minimum software requirements for FICON Express2 for each CHPID type:

- **FC** including Channel-to-Channel (CTC):
  - z/OS and z/OS.e V1.3, and later
  - z/VM V3.1, V4.3, V4.4, V5.1, and later
  - VSE/ESA V2.6, and later
  - TPF V4.1 at PUT 16 and later
  - Linux on zSeries - the currently available distributions, SUSE SLES 8 and SLES 9, Red Hat RHEL3.

- **FCP** for support of SCSI disks:
  - z/VM V5.1 (for z/VM install, IPL, and operation from SCSI disks)
  - z/VM V4.4, V5.1, and later for:
    - Performance Assist for Adapter Interruptions
    - Performance Assist for V=V Guests
    - Guest IPL from SCSI devices
    - FCP LUN Access Control - APAR VM63328 is required.
  - z/VM V4.3, V4.4, V5.1 and later for Linux as a guest under a/VM
  - Linux on zSeries - the currently available distributions, SUSE SLES 8 and SLES 9, Red Hat RHEL 3.

FICON Express Channels

The FICON Express channel uses the industry standard Fibre Channel Standard as a base. It is an upper layer protocol that maps the channel architecture on the general transport vehicle used throughout the industry for such other upper layer protocols as SCSI, IPI, and IP, among others. This transport vehicle includes the physical definition, the transmission protocol, and signalling protocol that is the same for all of the other upper layer protocols.

There are three FICON CHPID types specified via IOCP or HCD:

- **FICON native (FC).**
  Native FICON devices can be attached to servers via the FC CHPID type either directly or through a Fibre Channel Director. FC also supports Channel-to-Channel (CTC) communication (Server-to-Server or LPAR-to-LPAR).
• FICON bridge (FCV).
  ESCON devices can be attached only through a 9032 model 5 via the FICON bridge card (FCV CHPID type).
• Fibre Channel Protocol (FCP).
  Storage controllers and devices with an FCP interface can be attached to the zSeries system using Fibre Channel switches or directors in z/VM and Linux on zSeries environments.

FICON builds upon the strengths of ESCON. The maximum link data rate is increased from 20 MBps to 200 MBps. The FICON implementation enables full duplex data transfer. So data travels both directions simultaneously, rather than the ESCON half duplex data transfer. Furthermore, concurrent I/Os can occur on a single FICON channel, a fundamental difference between FICON and ESCON. The data rate droop is minimal with FICON even at distances up to 100 km.

Native FICON supports up to 32 concurrent I/O operations per second. ESCON supports one I/O operation at a time. FICON Bridge supports up to eight I/O operations at a time to different control units.

FICON Express Features

There are two FICON Express features.
• FICON Express LX (FC 2319) has two independent ports and is an optional feature which supports the Fibre CONnection (FICON) architecture and the Fibre Channel architecture providing connectivity between any combination of servers, directors, switches, and devices (control units, disk, tape, printers) in a storage area network. Each of the two independent ports/channels is capable of 1 Gbps or 2 Gbps depending upon the capability of the attached device. The link speed is auto-negotiated, point-to-point, between server and device and is transparent to users and applications. FICON Express LX (CHPID types FC or FCP only) can be defined as a spanned channel and can be shared among LPARs within and across LCSSs.
  The FICON Express LX feature also supports cascading (the connection of two FICON Directors in succession) to concentrate and minimize the number of cross-site connections and reduce implementation costs for disaster recovery applications, Geographically Dispersed Parallel Sysplex (GDPS), and remote copy.
  There are three modes of operation supported by each port, independently.
  – FCV
  – FC
  – FCP.
  The FICON Express LX feature supports an LC Duplex connector versus the SC Duplex connector used with the prior generations of FICON features.
  Each FICON Express LX port supports attachment to an ESCON Director Model 5 with a FICON LX Bridge feature, to a Fibre Channel Director with a Fibre Channel/FICON LX feature, or to a control unit with a Fibre Channel/FICON LX feature. FICON Express LX communicates with any LX feature supporting FICON. The FICON Express LX feature utilizes a long wavelength (LX) laser as the optical transceiver and supports use of a 9/125-micrometer single mode fiber optic cable terminated with an LC Duplex connector.
• FICON Express SX (FC 2320) feature has two independent ports and is an optional feature which supports the Fibre CONnection (FICON) architecture and the Fibre Channel architecture providing connectivity between any combination of servers, directors, switches, and devices (control units, disk, tape, printers) in a
storage area network. Each of the two independent ports/channels is capable of 1 Gbps or 2 Gbps depending upon the capability of the attached device. The link speed is auto-negotiated, point-to-point, between server and device and is transparent to users and applications. FICON Express SX (CHPID type FC or FCP) can be defined as a spanned channel and can be shared among LPARs within and across LCSSs.

The FICON Express SX feature also supports cascading (the connection of two FICON Directors in succession) to concentrate and minimize the number of cross-site connections and reduce implementation costs for disaster recovery applications, Geographically Dispersed Parallel Sysplex (GDPS), and remote copy.

There are two modes of operation supported by each port, independently.

– FC
– FCP.

The FICON Express SX feature supports an LC Duplex connector versus the SC Duplex connector used with the prior generations of FICON features.

Each FICON Express SX port supports attachment to a Fibre Channel Director with a Fibre Channel/FICON SX feature, or to a control unit with a Fibre Channel/FICON SX feature. FICON Express SX communicates with any SX feature supporting FICON. The FICON Express SX feature utilizes a short wavelength (SX) laser as the optical transceiver, and supports use of a 50/125-micrometer multimode fiber optic cable or a 62.5/125-micrometer multimode fiber optic cable terminated with an LC Duplex connector.

The two channels residing on a single FICON Express card can be configured individually, and can be of a different channel type.

**Note:** Conversion kits may be required if the connecting devices do not support use of LC Duplex connectors.

**FICON Channel Considerations**

You can define a maximum of 40 FICON channels on your z890 (32 on the smallest sub-uniprocessor equipped capacity setting), up to a maximum of 20 features per system (16 on the smallest sub-uniprocessor equipped capacity setting). The FICON Express features support 1 Gbps or 2 Gbps link data rate, auto-negotiating the speed, point-to-point, without application, or end-user intervention.

Each FICON Express Bridge channel can support up to 3000 start I/O’s per second with a 50% channel utilization. Each native FICON Express 2 Gbps channel can support up to 4150 start I/O’s per second with a 50% channel utilization. These figures represent an average and a 4K block size.

FICON is supported by MIF, so that multiple logical partitions on a server can share a FICON channel.

The FICON Express channel cards can be plugged nondisruptively into the z890.

**FICON Express Features Support 2 Gbps Link Data Rate**

The zSeries FICON Express features configured as native FICON or Fibre Channel Protocol channel support two Gigabits per second (Gbps) link data rates. These features are capable of auto-negotiation with the attached device to operate at 1 or 2 Gbps. These faster link speeds result in faster data transfer times and increased data throughput across links for those applications that transfer large amounts of data sequentially. For example, it takes 20 microseconds to transfer 2 KB of data...
across a 1 Gbps link. With a 2 Gbps link, this transfer takes place in 10 microseconds - half the transfer time of a 1 Gbps link. This is noticeable for applications with highly sequential large data transfers of all reads or all writes.

In order to benefit from 2 Gbps link data rates, the infrastructure needs to be positioned to take advantage of this higher data rate capability. For full 2 Gbps link capability, each FICON/Fibre Channel port and each FICON/Fibre Channel device must be capable of 2 Gbps, for a 2 Gbps end-to-end data path.

In the event where zSeries and the director negotiate a 2 Gbps link data rate and that same director and a storage device negotiate a 1 Gbps link data rate, care should be taken that the overall system throughput is balanced. The total throughput for that channel connection both in and out of the director should be examined and the number of channels adjusted. For example, a customer might have to double the number of links and host adapters to the storage device to avoid loading the capability of a 1 Gbps control unit port due to the higher bandwidth capability of the 2 Gbps FICON Express channel port.

We recommend you engage IBM Networking Services to assist with the planning and installation of the fiber infrastructure and to assure that possible bandwidth constraints are identified, particularly where there is a mix of 1 Gbps and 2 Gbps devices.

If only part of your I/O infrastructure is 2 Gbps capable then the link speed will be auto-negotiated to 1 Gbps (100 MBps). When the zSeries and ESS are 2 Gbps capable, but the rest of the I/O infrastructure is not, then the zSeries and ESS will communicate at 1 Gbps (100 MBps) link speeds. Also, when the switches and fiber infrastructure are 2 Gbps capable but the zSeries and ESS are not, then in the case of FICON cascading and/or FCP fabrics, the switches will auto-negotiate between each other 2 Gbps link speeds and the zSeries and ESS will auto-negotiate with the switches 1 Gbps (100 MBps) link speeds.

Table 5-1 contrasts the unrepeated distances when using single mode or multimode fiber at 1 Gbps and 2 Gbps.

<table>
<thead>
<tr>
<th>Fiber Type in Microns (µ)</th>
<th>Light Source</th>
<th>1 Gbps link</th>
<th>2 Gbps link</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 µ single mode</td>
<td>LX laser</td>
<td>10 km</td>
<td>10 km</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.2 miles</td>
<td>6.2 miles</td>
</tr>
<tr>
<td>50 µ multi-mode</td>
<td>SX laser</td>
<td>500 meters</td>
<td>300 meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1640 feet</td>
<td>984 feet</td>
</tr>
<tr>
<td>62.5 µ multi-mode</td>
<td>SX laser</td>
<td>250 meters</td>
<td>120 meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>820 feet</td>
<td>394 feet</td>
</tr>
</tbody>
</table>

Note: These numbers reflect the Fibre Channel Physical Interface specification. The link budget above is derived from combining the channel insertion loss budget with the unallocated link margin budget. The link budget numbers have been rounded to the nearest tenth.

You need to ensure that the tactical as well as the strategic requirements for your data center, Storage Area Network (SAN), and Network Attached Storage (NAS) infrastructures are taken into consideration as you employ 2 Gbps and beyond link data rates.
Note: Mode Conditioning Patch (MCP) cables are not supported at the 2 Gbps link data rate.

**Purge Path Extended**
The purge path extended function provides enhanced capability for FICON problem determination. The FICON purge path error-recovery function is extended to transfer error-related data and statistics between the channel and entry switch, and from the control unit and its entry switch to the host operating system.

FICON purge path extended is exclusive to z890 and z990, and is supported by z/OS and z/OS.e. FICON purge path extended applies to the FICON features when configured as a native FICON channel.

**Maximum ESCON Channel Equivalency Using FCV CHPID Type**
The following tables show how to get total ESCON channel equivalency.

Note: The tables show some representative configurations, not all that are possible.

<table>
<thead>
<tr>
<th>FICON Express Cards/Channels Installed</th>
<th>ESCON Cards/Channels Installed</th>
<th>ESCON Channel Equivalency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/0</td>
<td>18/256</td>
<td>0 + 256 = 256</td>
</tr>
<tr>
<td>1/2</td>
<td>18/254</td>
<td>16 + 254 = 270</td>
</tr>
<tr>
<td>6/12</td>
<td>18/244</td>
<td>96 + 244 = 340</td>
</tr>
<tr>
<td>12/24</td>
<td>16/232</td>
<td>192 + 232 = 424</td>
</tr>
<tr>
<td>14/28</td>
<td>14/208</td>
<td>224 + 208 = 432</td>
</tr>
<tr>
<td>16/32</td>
<td>12/180</td>
<td>256 + 180 = 436</td>
</tr>
</tbody>
</table>

The assumptions for this table are that there is an 8-to-1 ESCON to FICON channel ratio.

**FICON Exploitation of Existing ESCON Cabling Infrastructure**
FICON can also reuse existing single-mode or multimode fiber.

The single mode fiber infrastructure, utilizes a 9 micron single mode fiber supported for 10 km links with 7db loss. Long wave transceivers are required in the channels, switches and devices that are connected via a single mode fiber optic infrastructure.

There are two ways to support a multimode fiber optic infrastructure:
- Use of short wavelength transceivers with 50 or 62.5 multimode fiber optic cables, or
- Use of long wavelength transceivers with Mode Conditioning Patch (MCP) cables at each end of the link and your existing multimode fiber optic infrastructure in between.

When using a FICON Bridge feature, which supports long wavelength (LX) transceivers, only MCP cables can be used with the existing multimode fiber optic infrastructure. The length of the conditioning jumper is two meters. The maximum end-to-end distance when using MCP cables is 550 meters (1804 feet). For the FC...
path type, short wave optical transceivers are required in the channels, switches, and devices that are connected via a multimode infrastructure.

FICON Bridge in the IBM ESCON Director Model 5
The FICON Bridge card enables existing ESCON control units to exploit the FICON channel providing investment protection for currently installed ESCON control units.

FICON and FICON Comparison

ESCON and FICON Comparison

ESCON Frame Process
The following diagram illustrates multiple ESCON control units attached through an ESCON Director to a single channel on a server. This implementation is sometimes referred to as logical daisy chaining. In the ESCON environment data transfer is half duplex. That is, data can only be traveling in one direction at a time. The data transfer rate is limited to 17 MBps, depending upon the capabilities of the control
In the logical daisy chain environment, only one controller can be performing an I/O operation at a time. So, the controllers have to take turns.

**FICON Frame Process**

With the FICON channel, the frame process is considerably different. As shown in the following diagram, in the same environment with multiple control units connected to a single channel, you actually have multiple, concurrent I/Os.

These I/Os can travel in both directions. FICON is full duplex, so controllers A, B, C, and D can all be transferring data frames simultaneously. Some could be receiving, some could be sending.

With FICON, a data rate of up to 200 MBps can be achieved. Under certain conditions, with Native FICON, it is possible to exceed 200 MBps with a mixture of reads and writes which exploits the full duplex capabilities of the FICON link.

**FICON Bridge:** When the FICON channel, CHPID type FCV, is used to connect to ESCON control units, it is accomplished by connecting the FICON channel to the ESCON Director via the FICON Bridge feature. This feature converts the FICON protocol into ESCON protocol and enables the FICON channel to communicate with up to 8 ESCON control units concurrently.

For example, a system which has eight ESCON channels with two control units attached to each of those eight channels, logically daisy chained through an ESCON director, has a total of 16 control units to eight channels. Only one of each pair of control units in the ESCON environment could be doing a data transfer at a time.

Taking that configuration, and combining all eight ESCON channels onto one FICON channel through a FICON Bridge card, you now have 16 ESCON control units connected to one FICON channel. With the FICON Bridge configuration, any eight of those 16 ESCON control units can be performing I/O simultaneously across a single FICON channel.

**Native FICON:** Native FICON channels, CHPID type FC, can connect to FICON control units either directly or through a Fibre Channel switch. FICON control units have the advantage of communicating at full FICON bandwidth and the channels of executing up to a maximum of 32 operations concurrently.
**FICON CTC:** The native fibre channel path can function as both a channel and a channel-to-channel at the same time. It provides auto configuration and load balancing of the CTC function among FICON channel paths, including proper configuration when the target channel does not have an integrated CTC. The customer simply specifies a CTC control unit (TYPE=FCTC) at each end of the connection and auto-configuration performs load balancing automatically.

FICON CTC acts as a dual-sided control unit, providing control unit function for both the local inboard channel and an outboard channel on the other side of the fibre channel network. CTC function does not access storage or any system facilities.

You can achieve FICON channel-to-channel connections between z990 general purpose model CPCs and other IBM CPCs with FICON channels if the FICON channels are defined to operate in channel-to-channel mode and one is capable of doing so. To define a FICON (TYPE=FC) channel to operate as a CTC, you must define a control unit on the channel as a FCTC type (UNIT=FCTC). At least one end of any connection must be a z990 to be capable of providing the CTC control unit function.

**FICON Cascaded Directors:** Native FICON (FC) channels support cascaded directors. This support is for a two-switch configuration only. With cascading, a native FICON channel operating as a channel or a Channel-to-Channel (CTC) can connect a server to a device or other server with two FICON directors between them. This cascaded director support (cascaded switching) is for single-vendor fabrics only. There cannot be a mix of OEM directors in the same fabric. Figure 5-5 on page 5-10 displays an overview of FICON cascaded directors.
Cascaded support is important for disaster recovery and business continuity solutions. It provides high availability connectivity as well as the potential for fiber infrastructure cost savings for extended storage networks. FICON two-director cascaded technology allows for shared links and therefore improved utilization of intersite-connected resources and infrastructure. Solutions such as Geographically Dispersed Parallel Sysplex (GDPS) can benefit from the reduced intersite-configuration complexity that native FICON cascaded directors provide. In most cases, customers who have data centers separated between two sites may reduce the number of cross site connections by using cascaded directors.

FICON cascaded directors also have the ability to provide high integrity data paths. The high integrity function is an integral component of the FICON architecture when configuring FICON channel paths through a cascaded fabric.

End-to-end data integrity is maintained through the cascaded director fabric. Data integrity ensures that any changes to the customer’s data streams are always detected, and the data frames (data streams) are delivered to the correct end point (FICON channel port or a FICON Control Unit port). For FICON channels, Cyclical Redundancy Checking (CRC) and Longitudinal Redundancy Checking (LRC) are bit patterns added to the customer data streams to allow for detection of any bit changes in the data stream. With FICON cascaded switching, new integrity features are introduced within the FICON channel and the FICON cascaded switch fabric to ensure the detection and reporting of any miscabling actions occurring within the fabric during operational use that may cause a frame to be delivered to the wrong end point.
A FICON channel, when configured to operate with a cascaded-switch-fabric, requires that the switch-fabric supports high integrity. During initialization, the FICON channel will query the switch-fabric to determine that it supports high integrity, and if it does, then the channel will complete the initialization process allowing the channel to operate with the fabric. OEM switches in a FICON cascaded switch fabric may require mandatory features to support the high integrity fabric. If this is in question, consult the OEM.

Once a FICON switch-fabric has been customized to support FICON cascaded switching and the required switches have been customized in the fabric switch list, the fabric will ensure that its Interswitch Links (ISLs) are installed to the correct switches before they are made operational. Once the ISLs are operational, any changes to the ISL connections will be checked by switches within the fabric before they can be used (the connected switches must be in the switch fabric list). With this checking, if an ISL is incorrectly installed, the fabric is designed to stop using the links for customer data streams thereby preventing frames from being delivered to the wrong end points.

**Note:** Before configuring a FICON channel to operate with a cascaded-switch-fabric, ensure your applications and operating system have any needed updates to support cascading.


**Topology Comparison**
The following diagram illustrates a migration from an ESCON environment with 32 ESCON channels (four channels to each of eight control units), to a FICON environment with only a total of four channels, but with the same pathing configuration.

![Topology Comparison Diagram](image)

*Figure 5-6. FICON Bridge and ESCON Comparison*

By moving to the FICON environment, you go from many connections to far fewer connections, which means fewer channels, ports, fiber optic cables and patch panel ports, etc., greatly reducing the complexity of your installation.

A 17 MBps link rate half duplex, increases to 200 MBps link rate full duplex. The number of I/Os per second per channel (operating at 50% of channel capacity) increases from perhaps 600 to as many as 4150.

Some of the addressing limits of ESCON have been removed. Instead of a limit of only 1K unit addresses per ESCON channel, it is increased to 16K unit address per FICON channel.
The technology has improved as well with FICON enabling performance improvements over great distances. With ESCON, the performance starts to degrade at 9km. With the FICON, there is negligible data rate droop even up to 100km (with repeaters).

**Distance Comparison**
The following diagram illustrates the distance and performance implications of FICON over ESCON.
In the ESCON environment, with both vaulting and Geographically Dispersed Parallel Sysplex Cluster solutions, some sort of repeater is required at each site. This repeater is usually an ESCON Director at each site. Then, between the two

Figure 5-7: FICON Bridge and ESCON Comparison - Distance
sites, as you go across the link, you start to experience the data rate droop at about
nine kilometers. At nine kilometers the data rate starts dropping to 17.6 MBps and
drops steadily after that.

In the FICON environment, with both the vaulting and the Geographically Dispersed
Parallel Sysplex Cluster solutions, an ESCON or FICON director is required only at
one site. Because of the FICON implementation, you do not experience the data
rate droop that was experienced with ESCON. It is negligible at 10 km, with no
repeaters, and if you use repeaters you can get negligible data rate droop all the
way out to 100 km.

**FICON Bridge Card Coexistence with ESCON**

The FICON Bridge card was designed to coexist well with ESCON and be exploited
by your existing ESCON control units.

As the following diagram illustrates, the FICON Bridge paths can be mixed in any
combination with ESCON paths even within a single image. In fact, on the same
9032-5 ESCON Director, you can have a FICON channel bridge path dynamically
connected to the same ESCON Director port of a control unit as an ESCON path.
FICON Bridge paths, directly attached ESCON paths, ESCON paths through
9032-5s, ESCON paths through previous generation IBM ESCON Directors, MIFed
or non-MIFed (ESCON and or FICON), can all be intermixed to a single control unit,
even within a single image. All paths, ESCON or FICON, from a processor must be
shared or unshared. It is feasible to install FICON channels within one z890 with
bridge cards in 9032-5s in a shared I/O environment that includes previous
generations of S/390 servers and previous generations of ESCON Directors.

**FICON Bridge Hardware and Software Support**

In terms of hardware, the FICON channels are available on the z890 and the
FICON Bridge will only be implemented in the 9032 ESCON Director Model 5.

To install the FICON Bridge cards, a FICON enablement feature will be required.
This is a no charge feature which can be installed nondisruptively with currently
available redundant components installed. On z890 FICON Bridge (CHPID type
FCV), the minimum software requirements are z/OS V1R2 and later, z/OS.e V1R3 and later, OS/390 V2R10, z/VM V3.1 and V4.3 and later, VSE/ESA V2.6 and later, and TPF V4.1 at PUT 16.

Helpful migration utilities are incorporated with the Hardware Configuration Manager (HCM) product. HCM is a documentation/definition tool available from IBM. It pulls in your IODF and creates accurate documentation automatically. Utilities included within HCM to simplify the migration to FICON, including aggregation of multiple ESCON CHPIDs onto a single FICON CHPID, and making the appropriate ESCON Director port number changes. HCM can be obtained as an optional priced feature of OS/390, z/OS, or z/OS.e and simplifies the migration process to FICON.

System Automation for OS/390 (SA/OS390) is a powerful management tool for the entire server enterprise, and is enhanced to support FICON with Release 2 or greater. SA/OS390 is an optional product which can be used to control connectivity of complex environments, assist in problem determination, provide automated operations capabilities, and permit remote control of IBM processors.

### Fibre Channel Protocol for SCSI (FCP) Devices

Fibre Channel (FC) is a computer communications protocol that attempts to combine the benefits of both channel and network technologies. Fibre Channel made the biggest impact in the storage arena, specifically, using Small Computer System Interface (SCSI) as an upper layer protocol.

Fibre Channel is broken down into five layers: FC-0, FC-1, FC-2, FC-3, and FC-4. The layers define the following functions:
- **FC-0** defines the physical characteristics
- **FC-1** defines the character encoding and link maintenance
- **FC-2** defines the frame format, flow control, classes of service
- **FC-3** defines the common services

FICON and FCP implement those layers, unchanged.

- **FC-4** defines the upper layer protocol mapping which includes SCSI as well as Fibre Channel - Single Byte-2 (FC-SB-2), which is FICON.

The Fibre Channel Protocol (FCP) capability, supporting attachment to Small Computer Systems Interface (SCSI) is based on the Fibre Channel (FC) standards defined by the INCITS, and published as ANSI standards. SCSI devices in Linux on zSeries environments is based on the Fibre Channel. FC is an upper layer fibre channel mapping of SCSI on a common stack of Fibre Channel physical and logical communication layers. HIPPI, IPI, IP, and FICON (FC-SB-2) are other examples of upper layer protocols.

SCSI is an industry-standard protocol which is supported by a wide range of controllers and devices which complement the classical zSeries storage attachment capability through FICON and ESCON channels. FCP channels on zSeries systems are provided to enable operating systems on zSeries to access industry-standard SCSI storage controllers and devices.

The zSeries FCP function can facilitate the consolidation of UNIX® server farms onto zSeries, protecting investments in SCSI-based storage.

FC is the base for open industry-standard Fibre Channel networks or Storage Area Networks (SANs).
Fibre Channel networks consist of processors and storage controllers and devices as end nodes, interconnected by Fibre Channel switches, directors, and hubs. While switches and directors are used to build Fibre Channel networks or fabrics, Fibre Channel loops can be constructed using Fibre Channel hubs. In addition, different types of bridges and routers may be used to connect devices with different interfaces (like parallel SCSI). All of these interconnects may be combined in the same network.

For information about the configurations supported by the zSeries FCP channel, refer to “Configurations” on page 5-18.

An FCP channel is defined in the IOCP as channel type FCP and is available on FICON features.

FCP channels also support 2 Gbps link data rates (refer to “FICON Express Features Support 2 Gbps Link Data Rate” on page 5-4) and full-fabric support. The FCP full-fabric support means that multiple numbers of directors/switches can be placed between the server and FCP/SCSI device, thereby allowing many hops through a storage network for I/O connectivity.

**Note:** Full-fabric connectivity is for homogeneous, single-switch-vendor-fabrics only.

In addition, for FCP channels, a high integrity fabric solution is not required but is recommended. If an FCP Interswitch Link (ISL) is moved, data could potentially be sent to the wrong destination without notification.

**SCSI Initial Program Load (IPL)**

This function allows you to IPL an operating system from an FCP-channel-attached disk, to execute either in a logical partition or as a guest operating system under z/VM. In particular, SCSI IPL can directly IPL a zSeries operating system which has previously been installed on an SCSI disk. Thus, there is no need for a classical channel (ESCON or FICON) attached device, such as an ECKD™ disk control unit, in order to install and IPL a zSeries operating system. The IPL device is identified by its Storage Area Network (SAN) address, consisting of the worldwide port number (WWPN) of the disk controller, and the Logical Unit Number (LUN) of the IPL device.

You can also IPL a standalone-dump program from an FCP channel attached SCSI disk. The standalone-dump program can also store the generated dump data on such a disk.

To use this function with an FCP channel, a no-charge orderable platform feature (FC 9904) is required.

Support of SCSI IPL in z/VM V4.4 and later, allows Linux and other guest operating systems that support SCSI IPL to be IPLed from FCP-attached SCSI disk, when z/VM is running on a z890 or equivalent server equipped with the SCSI IPL function. Therefore, Linux guests may be started and run completely from FCP channel attached disk in your hardware configuration. z/VM V4.4 and earlier, continue to require ESCON-attached or FICON-attached disk or tape for their own IPL and other functions.

z/VM V5.1 provides the capability to install z/VM from a DVD to an Enterprise Storage Server® (ESS) SCSI disk emulated as a Fixed Block Architecture (FBA) disk as well as from a DVD to a 3390 disk. Thus, z/VM and its Linux guests may be
started and run completely from FCP disks on your hardware configuration. Refer to z/VM subset of the 2086DEVICE Preventive Service Planning (PSP) bucket for any service required for z/VM support for SCSI IPL.

z/VM V5.1 supports SCSI-attached disks to be used for installation, IPL, and operations such as storing dumps, and other functions, while continuing to provide support for ESCON-attached of FICON-attached disk or tape.

z/VM V5.1 SCSI support can allow a Linux server farm to be deployed on z/VM in a configuration that includes only SCSI disks.

For Linux on zSeries support for SCSI IPL refer to this web site: http://www10.ibm.software.com/developerworks/opensource/linux390

For additional information on:
- How to use the SCSI IPL feature for a logical partition, refer to the zSeries 890 and 990 Support Element Operations Guide or to the Hardware Management Console Operations Guide
- Messages that can show up on the operating systems console on the SE or Hardware Management Console, refer to zSeries Small Computer Systems (SCSI) IPL - Machine Loader Messages
- How to use the SCSI IPL feature for a z/VM guest, refer to [http://www.vm.ibm.com/pubs](http://www.vm.ibm.com/pubs) for appropriate z/VM publications

Software Support
Following are the minimum software requirements for:
- SCSI IPL for FCP:
  - z/VM V5.1 (enables z/VM IPL from SCSI disks)
  - z/VM V4.4 and later (for Linux as a guest under z/VM)
  - Linux on zSeries - the currently available distributions SUSE SLES 8, Turbolinux TLES 8, and Conectiva CLEE contain the tools to support IPL from SCSI disk.
- FICON Express (CHPID type FCP), for support of SCSI disk:
  - z/VM V5.1 (for z/VM install, IPL, and operation from SCSI disk)
  - z/VM V4.4 and later for:
    - Performance Assist for Adapter Interruptions on V=V guests (refer to 2086 PSP bucket.
    - z/VM V4.3 and later (for Linux as a guest under z/VM)
  - Linux on zSeries - the currently available distributions, SUSE SLES 8, Red Hat RHEL 3.0, Turbolinux TLES 8, and Conectiva CLEE.

FCP Channel

The FICON features, when defined as FCP CHPID type in the IOPCP, support storage controllers and devices with an FCP interface in z/VM and Linux on zSeries environments. The total number of FICON channels, whether FCV, FC, or FCP cannot exceed 80 channels per system.

Each port on a single FICON card can be configured individually, and can be of a different CHPID type.
For a description of the FICON Express cards and their capabilities, refer to "FICON Express Features" on page 5-3.

Software Support
SCSI controllers and devices can be accessed for Linux on zSeries with the appropriate I/O support. Linux may run either natively in a logical partition, or as a guest operating system under z/VM.

z/VM Version 4 Release 3 or later is required to support Linux FCP under z/VM.

z/VM V5.1.0 provides support for the installation, IPL, and system operation of z/VM on IBM ESS SCSI disks. SCSI disks are emulated under z/VM as 9336 model 20 FBA DASD to allow VM guests, applications, and system functions that support FBA operations to run under z/VM without charge. z/VM V5.1.0 continues to support dedicated FCP subchannels for use by VM guests that support SCSI, such as z/Linux. This support allows z/VM and guests running under z/VM that support FBA DASD or dedicated FCP subchannels to run in a SCSI only disk environment.

For the availability of the FCP channel support in Linux on zSeries and for appropriate support in z/VM in order to let a guest operating system access an FCP channel, refer to [http://www10.software.ibm.com/developerworks/opensource/linux390/index.shtml](http://www10.software.ibm.com/developerworks/opensource/linux390/index.shtml).

Configurations
Direct attachment of SCSI devices to a zSeries system is not supported.

Storage controllers and devices with an FCP interface can be attached to the zSeries system via Fibre Channel switches or directors. A storage controller or device with an appropriate FCP interface may be attached to each port of a Fibre Channel switch or director.

In addition, the following devices and controllers can be attached to each port on a Fibre Channel switch or director:

- **FC-AL controllers or devices, and FC-AL hubs.**
  - If the switch or director supports the Fibre Channel Arbitrated Loop (FC-AL) protocol, devices implementing this protocol may be attached to that port and accessed from the zSeries system. Devices typically implementing the FC-AL protocol are tape units and libraries, and low-end disk controllers.
  - If the switch or director does not support the FC-AL protocol, you can also install a FC-AL bridge between the switch or director and the FC-AL controller or device.
  - If more than one FC-AL controller or device should be attached to a FC-AL switch port, it is convenient to use a Fibre Channel hub, where multiple devices with a FC-AL interface can be directly attached to that hub.

- **Fibre-Channel-to-SCSI bridges.**
  - Fibre-Channel-to-SCSI bridges can be used to attach storage controllers and devices implementing the electrical, parallel SCSI interface. Different types of Fibre-Channel-to-SCSI bridges may support different variants of the parallel SCSI interface, such as Low Voltage Differential (LVD), High Voltage Differential (HVD), Single Ended, wide (16-bit) versus narrow (8-bit) interfaces, and different link speeds.

Each zSeries FCP channel (CHPID) can support up to 480 subchannels, where each subchannel represents a communication path between software and the FCP channel. Refer to "Channel and Device Sharing" on page 5-20 for more information.
Host operating systems sharing access to a zSeries FCP channel can establish in
total up to 2048 concurrent connections to up to 510 different remote Fibre Channel
ports associated with Fibre Channel controllers.

The total number of concurrent connections to end devices, identified by logical unit
numbers (LUNs), must not exceed 4096.

I/O Devices
The FCP channel implements the FCP standard as defined by the INCITS Fibre
Channel Protocol for SCSI (FCP), and Fibre Channel Protocol for SCSI, Second
Version (FCP-2), as well as the relevant protocols for the SCSI-2 and SCSI-3
protocol suites. Theoretically, each device conforming to these interfaces should
work when attached to a zSeries FCP channel as previously defined. However,
experience tells us that there are small deviations in the implementations of these
protocols. Therefore, it is advisable to do appropriate conformance and
interoperability testing to verify that a particular storage controller or device can be
attached to an FCP channel in a particular configuration (i.e. attached via a
particular type of Fibre Channel switch, director, hub, or Fibre-Channel-to-SCSI
bridge).

Also, for certain types of FCP and SCSI controllers and devices, specific drivers in
the operating system may be required in order to exploit all the capabilities of the
controller or device, or to cope with unique characteristics or deficiencies of the
device.

For a list of storage controllers and devices that have been verified to work in a
Fibre Channel network attached to a zSeries FCP channel, and for specific software
requirements to support FCP and SCSI controllers or devices, refer to

Addressing
FCP channels use the Queued Direct Input/Output (QDIO) architecture for
communication with the operating system. IOCP is only used to define the QDIO
data devices. The QDIO architecture for FCP channels, derived from the QDIO
architecture that had been defined for communications via an OSA card, defines
data devices that represent QDIO queue pairs, consisting of a request queue and a
response queue. Each queue pair represents a communication path between an
operating system and the FCP channel. It allows an operating system to send FCP
requests to the FCP channel via the request queue. The FCP channel uses the
response queue to pass completion indications and unsolicited status indications to
the operating system.

IOCP is not used to define the actual Fibre Channel storage controllers and
devices, nor the Fibre Channel interconnect units such as switches, directors, or
bridges. IOCP is only used to define the QDIO data devices. The Fibre Channel
devices (end nodes) in a Fibre Channel network are addressed using World Wide
Names (WWNs), Fibre Channel Identifiers (IDs), and Logical Unit Numbers (LUNs).
These addresses are configured on an operating system level, and passed to the
FCP channel together with the corresponding Fibre Channel I/O or service request
via a logical QDIO device (queue).

Preview of FCP Logical Unit Number (LUN) Access Control: Fibre Channel
Protocol (FCP) Logical Unit Number (LUN) Access Control is designed to provide
host-based control of access to storage controllers and their devices as identified by
their logical unit numbers (LUNs). It will allow read-only sharing of FCP SCSI
devices among multiple operating systems.
When available, FCP LUN Access Control will be supported by FICON Express features when configured as CHPID type FCP. It is exclusive to z890 and z990 with planned availability in the z/VM and Linux on zSeries environments.

**Channel and Device Sharing**

An FCP channel can be shared between multiple operating systems, running in a logical partition or as a guest operating system under z/VM. Under z/VM V5.1, multiple z/VM, CMS, Linux, and VSE guests are able to share SCSI channels and devices using z/VM Fixed Block Architecture (FBA) emulation. To access the FCP channel directly, each operating system needs its own QDIO queue pair, defined as a data device on an FCP channel directly in the IOCPLC.

Each FCP channel can support up to 480 QDIO queue pairs. This allows each FCP channel to be shared among 480 operating system instances.

While multiple operating systems can concurrently access the same remote Fibre Channel port through a single FCP channel. Fibre channel, Fibre Channel devices, identified by their LUNs, can only be serially re-used when explicitly configured for read-only LUN sharing using the Configuration Tool for LUN Access Control.

Attempting to share a single Fibre Channel or SCSI device (LUN) over the same zSeries FCP channel without adequate support in the FCP Channel and the operation system might lead to unpredictable results such as timeouts or other problems.

In order for two or more unique operating system instances to share concurrent access to a single Fibre Channel or SCSI device (LUN), in read-write mode, each of these operating systems needs to access this device through a different zSeries FCP channel.

Without a valid access control table established in the FCP channel, devices can only be serially re-used. In order for two or more unique operating system instances to share concurrent access to a single Fibre Channel or SCSI device Logical Unit Number (LUN), each of these operating systems will have to access this device through a different zSeries FCP channel.

In case a valid access control table has been established, rules within the access control table define:
- Whether an operating system is allowed to access a device exclusively
- Or a device can be serially re-used
- Or a device can be accessed shared read-only mode (note, that this mode is supported for disk devices only).

If an operating system instance tries to access a LUN that can only be serially re-used and is currently owned by another instance over the same FCP channel, a LUN conflict will occur when both instances use identical 8 byte Logical Unit Numbers.

A LUN conflict will also occur, when none of the rules within an Access Control table grants access for an operating system to a device (identified by its LUN).

**Note:** Some devices only regard a subset of the LUN as the device address. For example, only four high-order hexadecimal digits are recognized and the remaining digits are ignored. Therefore, different eight byte LUN addresses which have the same four high-order hexadecimal digits would lead to
access of the same device. It is strongly recommended to never use different LUN addresses for the same device in such a case. Otherwise, shared access to a device may happen without being detected, and unpredictable results can occur.

Secure Channel Sharing
An access control table can be configured for an FCP Channel. Based upon this table, the Channel polices each access from an operating system to a target device. If multiple operating systems share access to a SAN through the same Fibre Channel, this function is complementing SAN functions such as LUN masking and/or zoning.

Positioning
FCP and SCSI are industry-standard protocols, which have been implemented by many vendors in a large number of different types of storage controllers and devices. These controllers and devices have been widely accepted in the marketplace, and proven to be adequate to meet the requirements regarding Reliability, Availability, and Serviceability (RAS) in many environments.

However, it must be noted that there are some advanced, unique RAS characteristics of zSeries storage attachments based on ESCON and FICON attachments, using zSeries channel programs (and the Extended Count Key Data (ECKD) protocol in the case of disk control units) which may not be readily available in such an FCP or SCSI based world. Therefore, whenever there are very stringent requirements regarding isolation, reliability, availability, and serviceability, a conscious decision must be made whether FCP attached storage controllers and devices or classical zSeries FICON or ESCON attached control units should be used. Customers requiring the more robust RAS characteristics should choose FICON or ESCON channels.

ESCON Channels
The ESCON Channel provides a high-speed connection between host and control units for I/O devices. It is a channel that uses fiber optic cabling, which is thinner and weighs less than copper cabling. Fiber optic cabling also reduces electromagnetic emissions, which provides for improved security.

The ESCON Channel provides a light-emitting diode (LED) light source for fiber optic cables. It can extend up to 3 kilometers (1.86 U.S. miles), a range that can be further extended to 6 or 9 kilometers (km) by retransmission through one or two ESCON directors.

You can define a maximum of 420 ESCON channels on your z890 (240 on the smallest sub-uniprocessor equipped capacity setting), up to a maximum of 28 features per system (16 on the smallest sub-uniprocessor equipped capacity setting). This can facilitate server consolidation. The maximum number of configurable CHPIDs is 256 per LCSS and per operating system image. The high density ESCON feature has 16 ports, 15 of which can be activated for your use. One port is always reserved as a spare, in the event of a failure of one of the other ports. When four ports are ordered, two 16-port ESCON features are installed and two ports are activated on each feature. After the first pair, ESCON features are installed in increments of one. ESCON channels continue to be ordered in increments of four.

ESCON supports these operating system environments: OS/390, z/OS, z/OS.e, z/VM, z/VSE, VSE/ESA, TPF, and Linux on zSeries.
With the ESCON Channel, 'channel attached' achieves a new meaning. Devices directly attached to the processor no longer need to be in close range. With fiber links, the channel-to-channel and channel-to-control-unit distances can be up to 3 kilometers. With the signal repeated through ESCON directors, the channel-to-channel distances can be up to 26 kilometers. Display users within a 26 kilometer range can be connected through a channel link instead of a telecommunications link. The IBM 3490/3490E Tape range can extend up to 23 kilometers, and IBM 3990 or 9343 DASD Storage Controllers can be located up to 9 kilometers away. In some cases, longer distances can be achieved with repeaters.

The use of the ESCON Channel in combination with ESCON directors saves space and relocation costs - less space is required to house cabling for any distance; the same cabling can be shared by multiple channels and control units interconnected with an ESCON director; the total length of cabling will be considerably reduced; lighter and more easily installed fiber optic cabling is easier to relocate if necessary.

You can also use ESCON Channel hardware and cabling, in combination with an ESCON converter. This capability allows you to mix your current data processing environment with the ESCON environment. You can continue to use existing control units and copper cables while you evolve to fiber optic cables and ESCON control units as your requirements for enterprise growth increase.

ESCON channels affect the performance of the channel subsystem. Maximizing channel subsystem performance is an important consideration in configuring I/O devices to a z990 general purpose model CPC. Channel subsystem performance depends on the factors described in this chapter.

For an explanation of basic ESCON channel concepts, refer to Introducing Enterprise Systems Connection. For detailed information about synchronous and nonsynchronous I/O operation, refer to Storage Subsystem Library Introduction to Nonsynchronous Direct Access Storage Subsystems.

**ESCON Converter Operation**

You can configure ESCON converter channels (attached to a parallel converter - the IBM 9034 or the Optica 34600 FXBT) for block and byte multiplexer mode of operation.

As many as eight channel paths are available to attach to any I/O device. During any I/O operation, one of the available channel paths is selected. Channel path selection is a hardware function rather than a function of the system control program.

At the start of an I/O operation, a central processor signals the channel subsystem that an I/O operation is needed. An I/O request is posted to a queue; meanwhile, instruction execution in the central processor continues.

**Channel Multiplexing Modes**

The data mode of operation is determined by the multiplexer mode (byte or block). This is selected for specific channels when either the CPC or a logical partition is initialized.

**Block Multiplexer Mode of Operation:** In block multiplexer mode of operation, a device stays connected to a channel continuously during the transfer of a full block of data.
Block multiplexer mode of operation allows a control unit to present 'channel end' and to disconnect from a channel at the completion of a specified operation. 'Device End' is presented at a later point. During the interval between 'channel end' and 'device end' another device attached to the same channel can be started or can complete an operation that is ready. However, if the second device does connect to the same channel during this interval, the first device may find the channel busy when it tries to reconnect, and then the first device must wait for service.

ESCON can be configured for block multiplexer mode of operation. In block multiplexer mode of operation, ESCON channels configured as CVC channel paths can operate in either interlock (high-speed transfer) mode or in data-streaming mode. They can also be attached to control units that operate in high-speed transfer or in data-streaming mode. Data rates can be as high 4.5 MBps for ESCON CVC channel paths.

**Byte Multiplexer Mode of Operation:** Byte interleave mode of operation allows the execution of multiple I/O operations concurrently. Byte multiplexer mode permits several relatively slow-speed I/O devices to operate at the same time. Each addressed device requesting service is selected for transfer of a byte or a group of bytes to or from main storage. Bytes from multiple devices are interleaved on the channel and routed to or from the desired locations in main storage.

The load that a byte multiplexer channel can sustain is variable. It is governed by I/O device performance factors such as the data transfer rate, device buffers, number of bytes per data burst on the channel, channel program requirements, synchronized mechanical motion, and priority sequence position on the I/O interface.

ESCON converter channels (defined as CBY) can be configured for byte multiplexer mode of operation. In byte multiplexer mode of operation, ESCON channels configured as CBY channel paths can operate in either byte multiplexer mode or in burst mode. CBY channels require a 9034 ESCON converter. Byte multiplexer mode permits several relatively slow-speed I/O devices to operate at the same time.

Refer to the 2086IO subset id in the 2086DEVICE upgrade ID of the Preventive Service Planning (PSP) bucket for prerequisite 9034 EC level information.

**Byte Multiplexer Mode and Burst Mode:** A byte multiplexer channel can be monopolized by one I/O device (burst mode) or shared by many I/O devices (byte multiplexer mode). The number of bytes transferred at a time in byte multiplexer mode can be one (single byte transfers) or more than one (multibyte transfers). Most control units that operate in byte multiplexer mode can also operate in burst mode. A manually set switch at the control unit determines whether the control unit operates in burst mode or byte multiplexer mode.

Some devices offer a choice of how many bytes are transferred during a single data transfer sequence in byte multiplexer mode.

Because most of the time spent in a data-transfer control sequence is for control, increasing the burst size (the number of bytes transferred per sequence) results in a relatively small increase in the total channel busy time for the sequence. Also, increasing the burst size reduces the number of data transfer sequences required. The net effect is a significant improvement in channel efficiency and a higher allowable data rate.
Burst mode, although most effective in the use of channel resources, can cause another device on the byte multiplexer channel to exceed its critical time. From the perspective of the control unit, burst mode occurs when the time contributed by the control unit in a transfer sequence is more than 32 microseconds. (Refer to the Enterprise System Architecture/390 System 360 and System 370 I/O Interface Channel to Control Unit OEMI.)

If the device configuration guidelines are followed for byte multiplexer channels on a general purpose model CPC, deferred accesses are minimized and data transfer sequences exceeding 32 microseconds are acceptable when large burst sizes are specified.

Most class-2 and class-3 devices that can operate in burst mode should be attached to block multiplexer channels for better performance.

**I/O Operations Control**

ESA/390 I/O operations are performed by executing a channel program that consists of one or more chained Channel Command Words (CCWs). Each CCW contains a command and other information that is used by both the channel and control unit in executing the I/O operation.

Channel commands are segmented into six basic categories with many variations based on control unit type. A channel program is initiated and controlled by executing one or more of the ESA/390 I/O instructions described below. I/O interruptions may result during the execution of a channel program to notify the CP of progress or completion.

**Channel Commands**
The six basic channel commands are:

- **Write** Initiates the transfer of data from main storage to an I/O device.
- **Read** Initiates the transfer of data from an I/O device to main storage.
- **Read Backward** Initiates the transfer of data from an I/O device to main storage, storing data bytes in reverse order.
- **Control** Specifies operations such as set tape density, rewind tape, advance paper in a printer, or sound an audible alarm.
- **Sense** Requests information from a control unit. The information contains unusual conditions detected during the last I/O operation and detailed device status.
- **Transfer in Channel (TIC)** Specifies the location in main storage where the next CCW in the channel program is to be fetched. The TIC command provides branching between CCWs in noncontiguous storage areas. A TIC command cannot specify a CCW containing another TIC command.

**ESA/390 Mode I/O Instructions**

In ESA/390 mode, any CP can initiate I/O operations with any I/O device and can handle I/O interruptions from any I/O device. Each I/O device is assigned a unique device number, and is associated with one subchannel.

The CPs communicate with devices by specifying the appropriate subchannel. The subchannel uses the assigned device address to communicate with the device over
one or more channel paths. The device number provides a path-independent means to refer to a device for use in operator messages or at the time of IPL.

For descriptions of these instructions, refer to Enterprise System Architecture/390 Principles of Operation.

The I/O instructions for operation in ESA/390 mode are:

- **Start Subchannel (SSCH).**
- **Test Subchannel (TSCCH).**
- **Clear Subchannel (CSCH).**
- **Halt Subchannel (HSCH).**
- **Resume Subchannel (RSCH).**
- **Store Subchannel (STSCH).**
- **Modify Subchannel (MSCH).**
- **Test Pending Interruption (TPI).**
- **Reset Channel Path (RCHP).**
- **Set Channel Monitor (SCHM).**
- **Store Channel Report Word (STCRW).**
- **Cancel I/O (XSCH).**

The SSCH instruction specifies an operation request block, which designates the channel program.

**Chaining Operations**

Following the transfer of information over a channel designated by a Channel Command Word (CCW), an operation initiated by the Start Subchannel (SSCH) instruction can be continued by fetching a new CCW. Fetching a new CCW immediately following the completion of the previous CCW is called chaining. Chaining is described in more detail in the Enterprise System Architecture/390 Principles of Operation.

CCWs located in contiguous areas of central storage (successive doubleword locations) can be chained. Chains of CCWs located in noncontiguous storage areas can be coupled for chaining purposes by using a Transfer in Channel command. All CCWs in a chain refer to the I/O device specified in the original instruction.

The type of chaining (data or command) is specified by chain-data and chain-command flag bits in the CCW.

**Data Chaining**

When the data transfer specified by the current CCW is finished, data chaining causes the operation to continue by fetching a new CCW and using the storage area defined by the new CCW. Execution of the operation at the I/O device is not affected.

**Command Chaining**

Each time a new CCW is fetched during command chaining, a new I/O operation is specified. The new operation is initiated when the device end signal for the current operation is received, unless suspension is specified in the new CCW. When command chaining takes place, the completion of the current operation does not cause an I/O interruption.

**I/O Interruptions**

I/O interruptions report the completion of I/O operations to the CPs, error and time-out conditions, and progress.
Ending status information about the operation is available to the control program at the end of the I/O operation. When an I/O operation is completed, an I/O interruption request is sent to a central processor. When the request is honored, an I/O interruption occurs and places the central processor under control of the I/O new program status word (PSW). Until an I/O interruption condition is honored, it is called a pending I/O interruption.

Errors detected by the channel subsystem are reported to the CPs as I/O interruptions or machine-check interruptions. I/O interruptions report the following hardware-related conditions:
- Interface Control Check (IFCC); for example, interface tag errors and time-outs.
- Channel Control Check (CCC); for example, parity, decode, or control errors.
- Channel Data Check (CDC); for example, a parity error detected in central storage.

Machine-check interruptions include the following:
- Unrecoverable errors (retry is unsuccessful).
- Persistent errors (retry can be attempted, but the error threshold is exceeded).
- Serious channel element errors that require immediate reporting or cannot be reported as an IFCC or CCC with an I/O interruption.

Resets
An I/O system reset is issued to all channels, and the channels signal a system reset to all attached I/O devices. An I/O system reset:
- Stops all subchannel operations.
- Resets interruptions and status in all subchannels.

An I/O system reset occurs as part of:
- Channel subsystem power-on reset.
- Initial program load.
- System reset.

A channel issues a selective reset to a specific I/O device in response to an IFCC, CCC, or as part of execution of the clear subchannel instruction. The status of the specific device is reset.

I/O Interface Protocol
The I/O interface protocol is determined by the interface sequencing operations selected for specific control units and their associated devices that are attached to the channel.

Channel-to-Channel Connection
The Channel-to-Channel (CTC) function simulates an I/O device that can be used by one system control program to communicate with another system control program. It provides the data path and synchronization for data transfer between two channels. When the CTC option is used to connect two channels that are associated with different system, a loosely coupled multiprocessing system is established. The CTC connection, as viewed by either of the channels it connects, has the appearance of an unshared I/O device.

The CTC is selected and responds in the same manner as any I/O device. It differs from other I/O devices in that it uses commands to open a path between the two channels it connects, and then synchronizes the operations performed between the two channels.
**ESCON CTC Support:** The parallel I/O CTC architecture defines two operating modes for CTC communication: basic mode and extended mode. ESCON CTC support for both of these modes is available.

**ESCON Channels (Using Link-level and Device-level Protocols):** You can achieve ESCON channel-to-channel connections between CPCs with ESCON or FICON Express channels if one of the ESCON channels is defined to operate in channel-to-channel (CTC) mode.

ESCON CTC type channels can talk with FICON Express FCV type channels through a FICON bridge only, not with FICON FC type channels.

ESCON channels that operate in CTC mode (extended mode or basic mode) can be defined as shared ESCON channels. For more information, refer to “Multiple Image Facility (MIF)” on page 4-11.

For detailed information about the ESCON channel-to-channel adapter, refer to *Enterprise Systems Architecture/390 ESCON Channel-to-Channel Adapter.*

**Channel Time-out Functions**
The optional time-out function described here applies only to ESCON channels that attach to a 9034 ESCON converter channel.

Each channel path has I/O interface time-out functions that time the control unit delays in completing the following I/O interface sequences:

- A 6-second time-out for all selection and status presentation sequences. A time-out occurs if the sequence is not complete within 6 seconds.
- A 30-second time-out for data transfer. A time-out occurs if a byte of data is not transferred within 30 seconds.

If a time-out occurs, the channel terminates the I/O request to the control unit and generates an IFCC interruption.

The time-out function detects malfunctions in control units and I/O devices that can cause the channel path to be unusable to other control units and I/O devices. The time-out function is specified as active or inactive for a device by IOCP when the IOCDS is created.

**Control Unit (CU) Priority on an I/O Interface**
CU priority on an I/O interface applies only to ESCON channels attached to a 9034 ES Connection Converter channel.

CU priority on the I/O interface of a channel depends on the order in which they were attached. If the CUs are connected to the 'select out' line, the first CU has the highest priority. If the CUs are attached to the 'select in' line, the priority sequence is reversed. CUs attached to the 'select out' line have priority over CUs attached to the 'select in' line.
Dynamic Reconnection
In ESA/390 mode, the channel subsystem permits dynamic reconnection of I/O devices that have the dynamic-reconnection feature installed and that are set up to operate in a multipath mode, such as the IBM 3390 Direct Access Storage Model A14 or A22. Dynamic reconnection allows the device to reconnect and continue a chain of I/O operations using the first available channel path (one of as many as eight possible channel paths defined in an IOCP parameter). The selected path is not necessarily the one used initially in the I/O operation.

ESCON Channel Performance
Channel subsystem performance can be examined by observing two measurements:
• Response time (the amount of time taken to complete an I/O operation).
• Throughput (the number of I/O operations an I/O subsystem can complete in a given amount of time).
Channel subsystem response time and throughput can be divided into four major components:

- **Queuing and setup time**
  - The time taken for a channel path, control unit, and device to become available.
  - The time taken for a channel to send the I/O operation commands to the control unit.

- **Control unit and device time**
  The time required by the control unit and device to prepare for the transfer of data for the I/O operation. For example, a non-cached DASD control unit may have to wait for the DASD’s seek and latency times before being ready to accept or send data.

- **Data transfer time**
  The time it takes to transfer the data for the I/O operation.

- **Completion time**
  The time it takes for the channel and control unit to post the status of and end the I/O operation.

These major components of channel performance are affected by:

- Type of operation (nonsynchronous versus synchronous)
- Data transfer rate
  - Distance.
- Attached device characteristics
- Workload characteristics.

**Factors Affecting the Components of ESCON Channel Performance**

Factors that affect the various components of performance include:

- Synchronous or nonsynchronous type of operation
- Data transfer rate
  - Distance.
- Attached device characteristics
- Channel subsystem workload characteristics.

**Synchronous and Nonsynchronous I/O Operation:** For detailed information about concepts described in this section, refer to *Storage Subsystem Library Introduction to Nonsynchronous Direct Access Storage Subsystems.*

**Synchronous operation**

Most DASD devices in a parallel environment transfer data synchronously. Synchronous operation requires that the channel, control unit, and device be active at the same time.

All work involved in ending an operation and advancing to the next operation must be completed before the DASD head reaches the next record (commonly referred to as the inter-record gap). If this does not occur, a rotational positional sensing/sensor (RPS) miss or an overrun is generated and the operation must wait for one DASD revolution before continuing.

**Nonsynchronous operation**
Nonsynchronous operation removes the requirements of synchronous operation. During nonsynchronous operation, the channel, control unit, and device do not have to be active at the same time to perform an I/O operation; thereby:

- Increasing DASD storage potential (by reducing inter-record gap).
- Allowing the channel and control units to be separated by longer distances.
- Eliminating command overruns.
- Reducing response time (by reducing RPS misses).
- Permitting the channel to perform other operations during the time it would normally wait for the device (this increases the throughput of the system).

Extended count key data (ECKD) channel programs are required to gain the benefits of nonsynchronous I/O operations. Count key data (CKD) channel programs are supported, but without the benefit of nonsynchronous operation. CKD channel-program performance could be degraded relative to ECKD channel programs in a nonsynchronous environment.

**Data Transfer Rate:** One of the factors that affects channel performance is the data transfer rate. The I/O subsystem data rate is the data transfer rate between processor storage and the device during an I/O operation.

The I/O subsystem data rate is made up of three components:

- **Channel data rate**
  The rate that the channel transfers data between the transmission link and processor storage during an I/O operation. For ESCON channels, the link speed is 20 MBps and the channel data rate is 17 MBps at 0 distance. The data rate increases with distance as indicated in Figure 5-7 on page 5-13.

- **Control unit data rate**
  The rate that the control unit transfers data between the control unit and the transmission link during an I/O operation.

- **Device data rate**
  The rate of data transfer between the control unit and the device. This rate depends on the control unit and device you use.

The **I/O subsystem data rate** is the lowest of the channel data rate, the control unit data rate, and the device data rate. In cases where the data comes from the control unit or is stored on the control unit and not directly to the device (for example, a cache read), the I/O subsystem data rate is the lower of the two: channel data rate or the control unit data rate.

The I/O subsystem data rate affects only the data transfer portion of the response time for an I/O operation. Response time and throughput both improve (response time decreases and throughput increases).

**I/O Device Characteristics:** The characteristics of devices attached to a channel subsystem can have a substantial effect on performance. Device characteristics such as caches, buffers, and data transfer rates all affect response time and throughput.

**Channel Subsystem Workload Characteristics:** The performance of a specific I/O configuration varies based on the workload characteristics of that configuration.
Two significant factors that determine workload characteristics and affect response time and throughput are channel program characteristics and cache-hit rates.

Channel program characteristics

Channel program characteristics affect channel subsystem performance. ESCON channel subsystems using link-level and device-level protocols perform nonsynchronous data transfers, and should use extended count key data (ECKD) channel programs.

Count key data (CKD) channel programs run in an ESCON environment, but may increase response times and reduce throughput due to lost DASD rotations.

Channel programs that contain indirect data address words (IDAWs), Transfer in Channel commands (TICs), and chained data commands, or that have poorly-aligned data boundaries, cause longer storage-response and increase channel subsystem response times.

Chained data commands increase response time due to an additional interlocked exchange between the channel and control unit. Refer to “ESCON Performance Characteristics” for more information.

The amount of data to be transferred per I/O operation affects throughput. As the amount of data transferred per I/O operation increases (the ratio of data transferred to overhead improves), throughput improves.

Cache-hit rates

For control units which implement caches, cache-hit rates affect the channel subsystem performance. As the cache-hit rate increases, response time and throughput improve. The cache-hit rate is the percentage of times when data needed for a read operation is in the control unit's cache. For example, a cache-hit rate of 70% means that the required data is in the cache for 7 out of 10 read operations.

The cache-hit rate is significant because data is transferred out of the cache at the control unit's maximum data transfer rate, while data from the device is transferred at lower device speeds. This means that the higher the cache-hit rate, the better the response time and the better the throughput.

ESCON Performance Characteristics

This section describes the performance characteristics of ESCON channels and ESCON channels attached to a 9034.

All ESCON Channels: With ESCON channels you need to consider the distance between the channel and the control unit since this affects the setup and completion times of an I/O operation. As the distance between the channel and the control unit increases, the response time increases and the throughput decreases. Channel and control unit utilization also increases as distance between the channel and control unit increases.

The speed of data transfer through fiber optic cable is subject to the Propagation delay time is determined by two factors: the speed of light through the optical fiber (which is fixed), and the length of the fiber optic link. Propagation delay time increases as the distance between elements in a fiber optic environment increase.

Interlocked exchange affects response time. Interlocked exchange requires that the channel (or control unit) wait for a response from the control unit (or channel)
before proceeding with the next step of an I/O operation. As distance increases, the
interlocked-exchange response time increases because of longer propagation delay
times.

The throughput and response time for a shared ESCON channel are comparable to
that of an unshared ESCON channel with comparable workload.

**ESCON Channels Attached to 9034:** This section describes channel performance
concepts for ESCON channels (attached to a 9034).

Performance-related factors that should be considered in configuring ESCON
channels (attached to a 9034) include:

**Elapsed time**
The elapsed time to complete service for an I/O device connected to a
channel includes the device tag time, the cable propagation time, the
channel busy time to service the requested control sequence, and the wait
time for channel resources.

**Critical time**
The time that an I/O device can wait for channel service without a negative
impact on the performance of the device is called critical time. Each I/O
device has limits on the elapsed times of various sequences between the
device and the channel. When these time limits are not satisfied, device
performance may be reduced.

For devices operating on block multiplexer channels, the control sequences
that have the most significant critical-time constraints are those related to
chaining operations. For devices operating on byte multiplexer channels,
the time for connecting and disconnecting of the device to the channel for
each byte or burst of data sent is the most critical sequence.

In some cases, the time limit is related to synchronized motion (for
example, the time between columns on a card moving through an IBM 2501
Card Reader, or the time between the end of a Search ID Equal and the
beginning of a Read or Write at an IBM 3380 Direct Access Storage). In
each case, a control sequence must be completed within a time limit that
relates directly to the physical motion of the device to sustain maximum I/O
performance.

The critical time of a device can be exceeded because of other traffic on
the channel or other traffic in the channel subsystem. Central storage
loading can also contribute to the elapsed time, but not significantly. If the
elapsed time is greater than the critical time, some performance
degradation occurs. The result of exceeding critical time is described under
Deferred access on page 5-32 and "Device Class" on page 5-33.

**Deferred access**
A data deferred access is caused by the inability of the channel to transmit
or accept data at the rate requested or transmitted by an I/O device.

A data deferred access is much less likely to occur on buffered devices
than on unbuffered devices because buffered devices can wait for channel
service. Unbuffered devices (such as start-stop terminals) may have data
deferred accesses when the time required for an error-recovery system
logout exceeds the critical time.
Data-chaining operations involving the transfer of one or more blocks of data increase the probability of data deferred accesses with devices that do not respond to 'suppress out'.

A chaining check is an error detected in a channel when a channel accepts more data (in an input operation) than was specified by the count in the CCW. The check occurs when an I/O data rate is too high to be handled by the channel and storage.

A command deferred access is the inability of the channel to present the next command within the critical command-chaining time of a control unit. Degradation (a loss in performance) can result from a deferred access. A deferred access that requires operator intervention can create significant degradation. In most cases, a deferred access that is handled automatically by retry does not significantly affect throughput.

Depending on the device and the type of deferred access, the operation may be halted when the need for a deferred access occurs, or it may continue transferring data until the end of the block is reached. A deferred access may cause a unit check to be presented to the channel. Any chaining is suppressed and an I/O interruption request is generated at the end of the operation. Certain control units, however, may initiate a command retry sequence without generating an I/O interruption request. Refer to "I/O Interruptions" on page 5-25 for additional information.

**Operation in Byte Multiplexer Mode**

ESCON converter (CBY channel path) can operate in byte multiplexer mode.

**Note:** z890 CPC is able to define and use CBY channel paths to connect to 3720, 3725, and 3745 control units requiring byte multiplexer channel path attachment. Connection is through a 9034 ESCON Converter Model 1.

Refer to the 2086IO subset ID in the 2086DEVICE upgrade ID of the Preventive Service Planning (PSP) bucket for prerequisite 9034 EC level information.

**Device Class:** Devices that can operate in byte multiplexer mode of operation are classified by what happens when the device is not serviced within the critical time for the requested control sequence for that device. Depending on how overall channel performance is impacted by the critical time for the device being exceeded, a device falls into one of three classes:

**Device Class 1**

When the critical time is exceeded, a deferred access occurs and the data is not transferred successfully. The consequent error indication causes an I/O interruption request, and program recovery action is required.

**Device Class 2**

When the critical time is exceeded, the device must be resynchronized. The additional delay results in performance degradation. The device performance is degraded by the combined delay of waiting for the channel and resynchronization.

**Device Class 3**

When the critical time is exceeded, the device waits for channel service and causes performance degradation (the delay of waiting for the channel service).
**Operation in Block Multiplexer Mode**

The ESCON Architecture provides two protocols for block multiplexer mode of operation on the I/O interface for the serial transmission of data:

- Link-level protocols
- Device-level protocols.

Block multiplexer mode of operation using link-level and device-level protocols can sustain a maximum data rate of 17 MBps.

I/O operations for the serial transmission and reception of data have link-level and device-level protocols present in both the channel and the control unit.

The channel subsystem provides two modes for block multiplexer mode of operation on the I/O interface in a parallel environment:

- Interlocked.
  
  Data transfer performance using the interlocked mode depends on overall tag timings (including channel subsystem service), cable length, and control unit service. Block multiplexer mode of operation using the interlocked protocol can sustain a maximum data of 1.5 MBps.

- Data streaming.
  
  The data-streaming protocol does not require interlocking of data transfer signals between the channel and the control unit; once data transfer is established over the interface, it continues at a rate governed by the control unit. Block multiplexer mode of operation using the data-streaming protocol can sustain a maximum data rate of 4.5 MBps.

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**OSA-Express Channels**

**Note:** Refer to *zSeries Open Systems Adapter-Express Customer’s Guide and Reference* to assist you in determining the minimum software requirements to support OSA-Express.

The Open Systems Adapter-Express (OSA-Express) is an integrated hardware feature that provides direct connection to clients on Local Area Networks (LANs). The OSA-Express feature plugs into an I/O slot just like a channel card. Up to 20 OSA-Express features (12 features on the smallest sub-uniprocessor equipped capacity setting) can be installed in a z890, allowing you 40 ports of LAN connectivity (24 ports on the smallest sub-uniprocessor equipped capacity setting).

You can choose any combination of z890 OSA-Express features:

- Gigabit Ethernet (GbE) LX (FC 1364) - Cannot be ordered after OSA-Express2 GbE features are available.
- Gigabit Ethernet (GbE) SX (FC 1365) - Cannot be ordered after OSA-Express2 GbE features are available.
- 1000BASE-T Ethernet (FC 1366)
- Token Ring (FC 2367).

You can also carry forward on an upgrade from z800:

- Gigabit Ethernet (GbE) LX (FC 2364)
- Gigabit Ethernet (GbE) SX (FC 2365)
- Fast Ethernet (FC 2366)
- Token Ring (FC 2367).
All of these OSA-Express features can use IBM’s Queued Direct Input/Output (QDIO) architecture to eliminate the need for Channel Control Words (CCWs) and host interrupts, resulting in accelerated TCP/IP data packet transmission. While in QDIO mode all the OSA-Express features support z/OS Communications Server Intrusion Detection Services (IDS). IDS helps detect attacks on the TCP/IP stack that can potentially harm its ability to function normally and cause a misuse of system resources.

Each OSA-Express feature has two separate channels for direct LAN attachment. If you install the maximum of 20 OSA-Express features, you will use 40 CHPIDs. OSA-Express channels (CHPID types OSC, OSD, OSE) can be defined as spanned channels and can be shared among LPARs within and across LCSSs. This is referred to as the Multiple Image Facility (MIF), sharing of channels across logical partitions.

For more detailed information on OSA-Express, refer to zSeries Open Systems Adapter-Express Customer’s Guide and Reference.

**Supported Operating Modes**

OSA-Express supports two different modes of operation: QDIO and non-QDIO. If an OSA-Express feature is running in QDIO mode the channel type is OSD and if it is running in non-QDIO mode the channel type is OSE. Gigabit Ethernet only supports channel type OSD.

The 1000BASE-T Ethernet feature supports an additional operating mode: OSA-Express Integrated Console Controller (OSA-ICC), with a channel type of OSC, supporting TN3270E (RFC 2355) emulation. 3270 emulation for console session connections is integrated in the z890. This is supported at any of the feature settings (10/100/1000 Mbps - half or full duplex). For more information on OSA-ICC, refer to the zSeries Open Systems Adapter-Express Integrated Console Controller User’s Guide.

For more detailed information on these operating modes, refer to zSeries Open Systems Adapter-Express Customer’s Guide and Reference.

**OSA/SF**

The Open Systems Adapter Support Facility (OSA/SF) is a host-based tool to support and manage the OSA features operating in QDIO or non-QDIO mode. The OSA/SF is used primarily to manage all OSA ports, configure all OSA non-QDIO ports, and configure local MACs.

One OSA/SF application can communicate with all OSA features in a hardware complex. OSA/SF communicates with an OSA feature through a device predefined on the OSA feature. The device type is OSAD.

A new version of OSA/SF is being introduced and includes a Java-based Graphical User Interface (GUI) in support of the client application. The Java GUI is independent of any operating system/server (transparent to operating system), and is expected to operate wherever the Java 1.4 runtimes are available.

Interoperability testing has been performed for Windows 2000, Windows XP, and Linux on zSeries. In the past, workstation support was downloaded to a client supporting Windows NT®, Windows 95, or OS/2.
Use of the GUI is optional; a REXX command interface is also included with OSA/SF. OSA/SF is not required to set up the OSA features in QDIO mode (CHPID type OSD). However, it can be used to set up MAC addresses and set adapter speed. OSA/SF has been, and continues to be, integrated in z/OS, z/OS.e, OS/390, z/VM, and VSE/ESA and runs as a host application. For OSA/SF, Java GUI communication is supported via TCP/IP only. In the past, communication was supported via EHLAPI (3270), APPC, and TCP/IP.

This new integrated version of OSA/SF is a complete replacement for the currently integrated versions in z/OS, z/OS.e, OS/390, z/VM, z/VSE, and VSE/ESA and is not being offered as a separately orderable program product.

For more detailed information on OSA/SF, refer to zSeries Open Systems Adapter-Express Customer’s Guide and Reference.

**OSA-Express2**

OSA-Express2, a new generation of zSeries LAN adapters, helps to ensure you have a balanced system to satisfy the bandwidth demands of your applications. The OSA-Express2 features are hot-pluggable, support the Multiple Image Facility (MIF) which shares channels across logical partitions (LPARs), and can be defined as spanned channel to be shared among LPARs within and across LCSSs. The maximum combined number of OSA features supported on the z890 server is 20.

Both OSA-Express2 Gigabit Ethernet (GbE) and 10 Gigabit Ethernet (10 GbE) support the Queued Direct Input/Out (QDIO) mode, carrying TCP/IP traffic only. QDIO continues to be the preferred architecture on zSeries for high-speed communication, helping to reduce host interruptions and improve response time.

OSA-Express2 Gigabit Ethernet includes support for 640 TCP/IP stacks per CHPID, TCP Segmentation Offload or large send, and concurrent LIC update.

OSA-Express2 features include:
- Gigabit Ethernet (GbE) LX (FC3364)
- Gigabit Ethernet (GbE) SX (FC 3365)
- 10 Gigabit Ethernet LR (FC 3368).

**OSA-Express2 Gigabit Ethernet LX and SX**

OSA-Express2 Gigabit Ethernet (GbE) continues to operate in QDIO mode only (CHPID type OSD), supports full duplex operation, and jumbo 8992 byte-frame size. GbE features continue to be dual-port, occupying a single I/O slot and using one CHPID per port, two CHPIDs per feature.

**OSA-Express2 10 Gigabit Ethernet LR**

The introduction of OSA-Express2 10 Gigabit Ethernet Long Reach (Feature Code 3368) LAN adapter, is used as the enterprise backbone, between campuses, to connect server farms to, and consolidate file servers on, your z890 server. OSA-Express2 10 Gigabit Ethernet (GbE) is a one port feature that operates in QDIO mode only providing 24 ports of LAN connectivity.

**Layer 2 (Link Layer) Support**

OSA features can support two transport modes: Layer 2 (Link Layer) as well as Layer 3, the Network or IP Layer. Layer 2 support can help facilitate server
consolidation and will allow applications that do not use IP or SNA protocols to run on the z890 server. Layer 2 is also supported on some levels of OSA-Express.

640 TCP/IP Stacks
Increasing the TCP/IP stacks allows you to host more Linux images. OSA-Express2 supports 640 TCP/IP stacks or connections per dedicated CHPID, or 640 total stacks across multiple LPARs using a shared or spanned CHPID when priority specification is disabled. When priority specification is enabled, 160 TCP/IP stacks are supported just as they are in OSA-Express.

Large Send
Large send improves performance by offloading TCP packet processing from the host to the OSA-Express2 features. Offloading allows the host to send IP datagrams up to 60K in size. The IP datagram size is controlled by the host TCP/IP stack. Sending larger data blocks reduces host processor utilization while increasing network efficiencies.

Concurrent LIC Update
The increased memory of OSA-Express2 features facilitates concurrent application of LIC updates without requiring a configuration off/on, thereby minimizing the disruption of network traffic during the update.

HiperSockets
HiperSockets "network within the box" functionality allows high speed any-to-any connectivity among OS images within the z890 server without requiring any physical cabling. This concept minimizes network latency and maximizes bandwidth capabilities between z/VM, Linux on zSeries, VSE/ESA, and z/OS images (or combinations of these) to enable optimized e-business and ERP solutions within a single server. These images can be first level (i.e. directly under LPAR), or second level images (i.e. under z/VM). Up to 16 separate internal LANs can be configured within a server thereby allowing OS images to be grouped according to the function they provide. These groupings are independent of sysplex affiliation. If you want the internal LANs shared between partitions in different LCSSs then the channel must be spanned. For more information on spanned channels, refer to "Spanned Channels" on page 4-12.

Separate HiperSocket LANs are mainly required if some logical partitions need to be isolated from other logical partitions. Each LAN is configured as an IQD CHPID.

VLAN Support for Linux
Virtual Local Area Networks (VLANs), IEEE standard 802.1q, is being offered for HiperSockets in a Linux on zSeries environment. VLANs can reduce overhead by allowing networks to be organized for more optimum traffic flow. The network is organized by traffic patterns rather than physical location. This allows traffic to flow on a VLAN connection both over HiperSockets and between HiperSockets and an OSA GbE, 10 GbE, 1000BASE-T Ethernet, or Fast Ethernet feature.

Broadcast Support
Internet Protocol Version 4 (IPv4) broadcast packets are now supported over HiperSockets internal LANs. TCP/IP applications that support IPv4 broadcast, such as OMPROUTE when running Routing Information Protocol Version 1 (RIPv1), can send and receive broadcast packets over HiperSockets interfaces. z/OS V1R5 and
later, z/VM V4.4 and later, and Linux on zSeries provide broadcast support for HiperSockets. Refer to [http://www10.software.ibm.com/developerworks](http://www10.software.ibm.com/developerworks) for more information on Linux on zSeries support.

**Network Concentrator**

HiperSockets Network Concentrator simplifies network addressing between HiperSockets and OSA allowing seamless integration of HiperSockets-connected operating systems into external networks, without requiring intervening network routing overhead, thus helping to increase performance and simplify configuration.

Chapter 6. Sysplex Functions

This chapter describes the following z890 sysplex functions:
- "Parallel Sysplex"
- "Coupling Facility" on page 6-6
- "System-Managed CF Structure Duplexing" on page 6-10
- "Geographically Dispersed Parallel Sysplex (GDPS)" on page 6-11
- "Intelligent Resource Director (IRD)" on page 6-13.

Parallel Sysplex

The Parallel Sysplex makes use of a broad range of hardware and software products to process, in parallel, a transaction processing workload across multiple z/OS or OS/390 images running in a Parallel Sysplex and sharing data in a coupling facility.

The Parallel Sysplex allows you to manage a transaction processing workload, balanced across multiple OS/390 or z/OS images running on multiple Central Processor Complexes (CPCs), as a single data management system. It also offers workload availability and workload growth advantages.

The Parallel Sysplex enhances the capability to continue workload processing across scheduled and unscheduled outages of individual CPCs participating in a Parallel Sysplex using a coupling facility by making it possible to dynamically reapportion the workload across the remaining active Parallel Sysplex participants. Additionally, you can dynamically add processing capacity (CPCs or LPs) during peak processing without disrupting ongoing workload processing.

CPC support for the Parallel Sysplex consists of having the capability to do any or all of the following:
- If connecting to zSeries models:
  - Install ISC-3 channels and define them as type CFP.
  - Install ICB-4 (connects z890 to z890 and z990) or ICB-3 (connects z890 and z990 to z900 and z800) channels and define them as type CBP.
  - Define IC-3 channels and define them as type ICP for internal connections within the CPC.
  - Define, as a logical partition, a portion or all of the CPC hardware resources (CPs, ICFs, storage, and coupling connections) for use as a coupling facility that connects to z/OS or other operating system images for data sharing purposes.
  - Connect to a coupling facility to share data.
- If connecting to S/390 G5 or G6 servers:
  - Install ISC-3 channels and define them as type CFR or CFS.
  - Define, as a logical partition, a portion or all of the CPC hardware resources (CPs, ICFs, storage, and coupling connections) for use as a coupling facility that connects to OS/390 or other operating system images for data sharing purposes.
  - Connect to a coupling facility to share data.

The z890 provides the following support for the Parallel Sysplex:
- Consists of supporting coupling facilities on z890, supporting attachment to remote coupling facilities via various type of coupling links, supporting Server
Time Protocol (STP) or attachment to a Sysplex Timer for purposes of sysplex-consistent time, and supporting various ancillary CPC functions used by parallel sysplex support.

**Note:** If you want to implement a parallel sysplex between two sites, the fiber distance has been increased to 100 km. Refer to page 6-11 for more information.

- Internal Coupling links can be used to connect either z/OS images to Coupling Facilities (CFs) or CF images to other CF images within a z890 CPC to provide CF duplexing between LPARs in the same CPC.

These various interconnect formats provide the connectivity for data sharing between a coupling facility and the CPCs or logical partitions (LPs) directly attached to it.

### Parallel Sysplex Coupling Link Connectivity

z890 supports IC, ICB, and ISC-3 for passing information back and forth over high speed links in a Parallel Sysplex environment. These technologies are all members of the family of Coupling connectivity options available on z890. With Server Time Protocol (STP), Coupling links can also be used to exchange timing information. Refer to **Server Time Protocol (STP)** on page 6-9 for more information about Server Time Protocol. Refer to Table 6-1 for a summary of the coupling link options.

<table>
<thead>
<tr>
<th>Link Type</th>
<th>Name</th>
<th>Communication Use</th>
<th>Maximum Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC</td>
<td>Internal Coupling channel</td>
<td>Internal between CFs and z/OS LPARs</td>
<td>32</td>
</tr>
<tr>
<td>ICB-3</td>
<td>Integrated Cluster Bus-3</td>
<td>Server-to-server z890 to z800, z900</td>
<td>16</td>
</tr>
<tr>
<td>ICB-4</td>
<td>Integrated Cluster Bus-4</td>
<td>Server-to-server z890 to z900</td>
<td>8</td>
</tr>
<tr>
<td>ISC-3</td>
<td>InterSystem Channel-3</td>
<td>Server-to-server</td>
<td>48</td>
</tr>
</tbody>
</table>

**Notes:**
1. The maximum number of coupling links combined (ICs, ICB-3s, ICB-4s, and active ISC-3 links) cannot exceed 64 per server.
2. A maximum of 48 ISC-3s can be defined in peer mode (operating at a link data rate of 2 Gbps) and a maximum of 32 ISC-3s can be defined in compatibility mode (operating at 1 Gbps, instead of 2 Gbps).
3. An ISC-3 feature on a z890 can be connected to another zSeries server in peer mode (CHPID type CFP) operating at 2 Gbps or to a Hiperlink (ISC-2) on a G5/G6 in compatibility mode (CHPID type CFS/CFR - sender/receiver) operating at 1 Gbps.

ICs are for internal communication between Coupling Facilities defined in LPARs and z/OS images on the same server. ICBs are used for server-to-server communication over short distances. The newest ICB member, ICB-4 (connects z890 to z890 and z990) supports a link data rate of 2 GigaBytes per second (GBps), compared to ICB-3 (connects z890 and z990 to z900 and z800) which supports a link data rate of 1 GBps. ICBs carry traffic over 10 meter (33 feet) copper cables, of which three meters are reserved for intraserver connection.
The ISC-3 is another member of the family of Coupling Link options available on z890. ISC-3s support a link data rate of 1 or 2 Gbps and carry traffic over 9 micron single mode fiber optic cables.

In addition, to optimize z890 performance, either between zSeries servers or between zSeries servers and S/390 Parallel Enterprise servers, two modes (peer and compatibility) of ISC-3 operation (defined using HCD/IOCP) are allowed. For ICB features, peer mode is supported for ICB-4 and ICB-3.

Notes:
1. ISC-3, ICB-4, and ICB-3 channels require a point-to-point connection (direct channel attach between a CPC and a coupling facility).
2. ISC-3, ICB-4, and ICB-3 channels can be redundantly configured (two or more ISC-3, ICB-4, or ICB-3 channels from each CPC involved in coupling facility data sharing) to enhance availability and avoid extended recovery time.
3. A coupling facility logical partition may have any combination of sender, receiver, or peer paths defined to it. An ESA/390 partition may have a combination of sender and peer paths defined to it. But all paths from an ESA image to a given coupling facility logical partition must be either all peer or all sender paths.

Peer Mode

Peer mode applies to ICBs (ICB-4 to ICB-4 and ICB-3 to ICB-3) and ISCs (ISC-3 to ISC-3). When in peer mode, ICB-4 operates at 2 Gbps, ICB-3 operates at 1 Gbps, and ISC-3 operates at 2 Gbps. It provides both sender and receiver capability on the same link. Peer links provide up to seven expanded buffer sets (compared to two buffers with send or receiver links). With these design improvements, the peer mode coupling facility links transmit faster than older links as follows:
- ICB-4 vs ICB-3: 2x faster
- ISC-3 vs ISC: 2x faster
- IC-3 vs IC: 1.75x faster.

ISC-3 links operating in peer mode, perform at up to 200 Mbps for distances less than 10 km, and, in compatibility mode, 100 Mbps for distances up to 10 km. ICB-3 links operating in peer mode can perform at a peak capacity of 1000 Mbps and ICB-4 links can perform at a peak capacity of 2000 Mbps. IC links operating in peer mode can perform at up to 1250 Mbps.

When coupling within a z890 server, the IC channel can be shared among several ESA logical partitions and one coupling facility logical partition.

Peer mode is recommended for all zSeries connections.

Note: Only ISC-3, operating in peer mode, and ICB-4 are the recommended connections between z890 and z990 models.

Compatibility Mode

Compatibility mode applies to coupling prior coupling architectures (zSeries to S/390 G5/G6 servers).

ISC-3 links defined in compatibility mode (defined as sender/receiver CHPID types) have a maximum link rating of 1 Gbps.

Only ISC-3 links defined in compatibility mode (defined as sender/receiver CHPID types) can operate in compatibility mode.
Compatibility mode is only recommended for connections to S/390 G5/G6.

Note: A maximum of 32 ISC-3s can be defined in compatibility mode, operating at 1 GBps, instead of 2 GBps.

ISC-3 Links

The ISC-3 feature, with a link data rate of 2 Gbps, is a member of the family of Coupling Link options. It has four ports and represents the third generation of coupling technology. The ISC-3 feature is used by coupled systems to pass information back and forth over high speed links in a Parallel Sysplex environment. When STP is enabled, ISC-3 links can be used to transmit STP timekeeping information and can also be defined as Timing-only links to other z9 EC, z9 BC, z990, and z890 servers. The z890 ISC-3 feature is compatible with ISC-3 features on z800, z900, and z990 systems. ISC-3 (CHPID types CFS or CFP) can be defined as a spanned channel and can be shared among LPARs within and across LCSSs.

To continue to provide “horizontal growth” opportunities for Parallel Sysplex solutions, z890 is doubling the number of ISC-3s that were allowed in z800. z890 supports 48 links, 12 features (four links per feature).

The ISC-3 feature is composed of:
- One Mother card (ISC-M), FC 0217
- Two Daughter cards (ISC-D), FC 0218.

Each daughter card has two ports or links, for a total of four links per feature. Each link is activated by using the Licensed Internal Code Configuration Control (LIC CC) and can only be ordered in increments of one. The ISC-D is not orderable. Extra ISC-M cards can be ordered, up to a maximum of 12 or the number of ISC-D cards, whichever is less. When the quantity of ISC links (FC 0219) is selected, the appropriate number of ISC-Ms and ISC-Ds is selected by the configuration tool.

Each of the four links is capable of 1 Gbps or 2 Gbps depending upon the mode of operation selected in the Hardware Configuration Definition (HCD) tool or IOCP. If the link is connected to another zSeries server and defined as a peer (CFP) mode channel, the port operates in peer mode, and the link is capable of 2 Gbps. The peer mode is used between zSeries servers only. If the port is connected to a coupling-capable server which is not a zSeries and is defined as a sender/receiver (CFS/CFR) channel, the port operates in compatibility mode, and the link is capable of 1 Gbps. The compatibility mode is used between a zSeries server and S/390 9672/9674 and G5/G6 coupling capable servers.

Each port utilizes a Long Wavelength (LX) laser as the optical transceiver, and supports use of a 9/125-micrometer single mode fiber optic cable terminated with an industry standard small form factor LC Duplex connector. The ISC-3 feature accommodates reuse (at reduced distances) of 50/125-micrometer multimode fiber optic cables when the link data rate does not exceed 1 Gbps. A pair of Mode Conditioning Patch cables are required, one for each end of the link.

ICB Links

The Integrated Cluster Bus (ICB-4, ICB-3, and ICB-2) uses the Self-Timed Interconnect (STI) cables to perform the coupling communication. When STP is enabled, ICB-3 and ICB-4 links can be used to transmit STP timekeeping...
ICB cables are ordered to match the quantity of ICBs on order. The quantity of ICB cables can be reduced, but cannot exceed the quantity of ICB functions on order.

**ICB-4 Link (FC 3393)**
The ICB-4 link, with a link data rate of 2 GBps and each end of the link has to be a z890 or z990, is a member of the family of Coupling Link options available on z890. ICB-4 is a "native" connection used between z890s or between z890s and z990s. This is the recommended connection between z890s and z990s. ICB-4s (CHPID type CBP) can be defined as a spanned channel and can be shared among LPARs within and across LCSSs. An ICB-4 connection consists of one link that attaches directly to an STI port in the system, does not require connectivity to a card in the I/O cage, and provides one output port to support ICB-4 to ICB-4 connectivity. One ICB-4 connection is required for each end of the link.

The ICB-4 cable (FC 0228) is 10 meters, of which three meters are reserved for intraserver connection. Only one cable is required for each pair of ICB features.

ICB-4 channel paths are defined as CHPID type CBP. ICB-4 channel paths allow a single channel to perform both send and receive functions on the same channel.

**ICB-3 Link (FC 0993)**
The Integrated Cluster Bus-3 (ICB-3) link, with a link data rate of 1 GBps, is a member of the family of Coupling Link options available on z890. It is used by coupled systems to pass information back and forth over high speed links in a Parallel Sysplex environment. ICB-3 links are used to connect z800 and z900 servers (2066/2064) to z890 servers and can only be ordered in increments of one. Even though ICB-3 is supported for connection to z890 and z990, the recommended ICB connection to these servers is ICB-4. ICB-3s (CHPID type CBP) can be defined as a spanned channel and can be shared among LPARs within and across LCSSs. There is an **STI-3 card** which resides in the I/O cage to support the ICB-3 connections. The STI-3 card converts the 2 GBps input into two 1 GBps links. One ICB-3 feature is required for each end of the link. If the ICB-3 feature already exists on the other server, it does not need to be reordered.

The ICB-3 cable (FC 0227) is 10 meters of which three meters are reserved for intraserver connection. Existing ICB-3 cables can be reused. Only one cable is required for each pair of ICB features.

ICB-3 channel paths are defined as CHPID type CBP (Cluster Bus Peer). ICB-3 channel paths allow a single channel to perform both send and receive functions on the same channel.

**IC Links**
The Internal Coupling (IC) channel emulates the coupling facility link functions in LIC between images within a single system. IC channel implementation is totally logical requiring no channel or cable hardware. However, a pair of CHPID numbers must be defined in the IOCDS for each IC connection. IC channels cannot be used for coupling connections to images in external systems.
IC channels will have channel path CHPID type of ICP (Internal Coupling Peer). The rules that apply to the ICP CHPID type are the same as those which apply to CFP (InterSystem Coupling Peer) CHPID type, with the exception that the following functions are not supported:

- Service On/Off
- Reset I/O Interface
- Reset Error Thresholds
- Swap Channel Path
- Channel Diagnostic Monitor
- R/V
- Configuration Manager Vital Product Data (VPD).

IC channels have improved coupling performance over ICB-4 and ISC-3 channels. IC channels also improve the reliability while reducing coupling cost. Up to 32 IC channels can be defined on the z890 but it is unusual to require more than one link (two IC CHPIDs).

Refer to "Internal Coupling and HiperSockets Channels" on page 4-13 for recommendations on CHPID usage.

### Timing-only Links

If you are configuring a timing network using STP, time synchronization may be required in configurations other than a Parallel Sysplex. For a server that is not part of a Parallel Sysplex, but required to be in the same Coordinated Timing Network (CTN), additional Coupling links must be configured in order for the server to be configured in the CTN. These Coupling links are called Timing-only links. Use HCD to define Timing-only links and generate an STP control unit.

### Coupling Facility

The coupling facility provides shared storage and shared storage management functions for the sysplex (for example, high speed caching, list processing, and locking functions). Applications running on z/OS and OS/390 images in the sysplex define the shared structures used in the coupling facility.

PR/SM LPAR allows you to define the coupling facility, which is a special logical partition that runs Coupling Facility Control Code (CFCC). Coupling Facility Control Code is Licensed Internal Code (LIC). There are two versions of CFCC:

- ESA architecture (31-bit)
- z/Architecture (64-bit).

When the CFCC is loaded by using the LPAR coupling facility logical partition activation, the z/Architecture CFCC is always loaded. However, when CFCC is loaded into a Coupling Facility guest of z/VM, the ESA architecture or z/Architecture CFCC version is loaded based on how that guest is running.

At LPAR activation, Coupling Facility Control Code automatically loads into the coupling facility LPAR from the Support Element hard disk. No Initial Program Load (IPL) of an operating system is necessary or supported in the coupling facility LPAR.

Coupling Facility Control Code runs in the coupling facility logical partition with minimal operator intervention. Operator activity is confined to the Operating System Messages task. PR/SM LPAR limits the hardware operator controls usually
available for logical partitions to avoid unnecessary operator activity. For more information, refer to _zSeries 890 and 990 Processor Resource/Systems Manager Planning Guide_.

Coupling facility channel hardware provides the connectivity required for data sharing between the coupling facility and the CPCs directly attached to it. Coupling facility channels are point-to-point connections that require a unique channel definition at each end of the channel.

**Note:** CFCC compatibility code must be installed on other coupling facility images in the sysplex in order for them to be able to connect to coupling facilities on z890 processors with large numbers of LPARs (i.e. more than 15) defined on them.

### Coupling Facility Control Code (CFCC) Considerations

To support migration from one coupling level to the next, you can run different levels of the coupling facility (CF) concurrently in different CF LPARs on the same or different CPCs. Refer to “CFCC Enhanced Patch Apply” for a description of how a CF patch or a new CF code level can be applied to one CF LPAR in a CPC while not affecting the code level of other CF LPARs in the same CPC.

When migrating CF levels, lock, list, and cache structure sizes increase to support new functions. This adjustment can have an impact when the system allocates structures or copies structures from one Coupling Facility to another at different CFCC levels.

For any CFCC level upgrade, you should always run the CFSIZER tool which takes into account the amount of space needed for the current CFCC levels. The CFSIZER tool is available at the Parallel Sysplex web site, [http://www.ibm.com/eserver/zseries/ps](http://www.ibm.com/eserver/zseries/ps).

#### CFCC Enhanced Patch Apply

The CFCC patch apply process is enhanced to eliminate the need for a Power On Reset (POR) of the z890 to apply a disruptive CFCC patch. This enhancement provides you the ability to:

- Selectively apply the new patch to one of possibly several CFs running on a z890. For example, if you have a CF that supports a test parallel sysplex and a CF that supports a production parallel sysplex on the same z890, you now have the ability to apply a disruptive patch to only the test CF without affecting the production CF. After you have completed testing of the patch, it can be applied to the production CF as identified in the example.
- Allow all other LPARs on the z890 where a disruptive CFCC patch will be applied to continue to run without being impacted by the application of the disruptive CFCC patch.

This enhancement does not change the characteristics of a concurrent CFCC patch, but does significantly enhance the availability characteristics of a disruptive CFCC patch by making it much less disruptive.

#### CFCC Level 14

CFCC Level 14 with dispatcher enhancements supports CF Duplexing. The CFCC dispatcher and internal serialization mechanisms have been modified to improve the management of coupled workloads from all environments under certain circumstances.
CFCC Level 14 support is exclusive to z890 and z990. CFCC Level 14 includes the support introduced with CFCC Level 13.

**CFCC Level 13**

CFCC level 13 provides parallel sysplex availability and performance enhancements. It provides changes that affect different software environments that run within a parallel sysplex. For example, DB2 data sharing is expected to see a performance improvement, especially for cast-out processing against very large DB2 group buffer pool structures.

CFCC Level 13 also includes support for:

- 64-bit addressing supporting larger structure sizes and eliminating the 2 GB 'control store' line in the Coupling Facility. With this support, the distinction between 'control store' and 'non-control store' (data storage) in the Coupling Facility is eliminated, and large central storage can be used for all Coupling Facility control and data objects.
- Up to 48 internal tasks for improved multiprocessing of coupling facility requests.
- System-Managed CF Structured Duplexing (CF Duplexing)
  Refer to "System-Managed CF Structure Duplexing" on page 6-10 for more information
- Message Time Ordering
  Refer to "Message Time Ordering" on page 6-10 for more information.

**Coupling Connection Considerations**

There are several limits regarding coupling connections to be aware of when ordering and configuring these resources:

- There is a combined maximum of 64 ISC, ICB, and IC links on a system.
- Refer to Table 6-1 on page 6-2 for information on the individual link limits.

IOCP issues caution messages and HCD issues errors for the following:

- ICP greater than 32.
- Compatibility mode ISC-3 (CFS/CFR) is greater than 32.

**I/O Configuration Considerations**

ICP IOCP supports ISC-3, ICB-4, ICB-3, and IC channel path definitions on z890 CPCs.

For z890, with OS/390 V2R10 or z/OS V1R2 or later, HCD provides the following enhancements to support coupling facility definition:

- Controls for defining coupling facility channels. HCD also automatically generates the control unit and device definitions associated with CFS, CFP, CBP, and ICP channel paths, when they are connected to their respective peer or receiver channel paths. All IC channels paths must be connected.
- Controls for defining a logical partition as either a coupling facility or an operating system logical partition. HCD also allows the definition of the logical partition as both so its usage does not have to be pre-specified. This allows the flexibility of usage to be determined at logical partition activation. This way, if a partition is used one day as a Coupling Facility and the next day as an OS/390 image logical partition, the I/O definitions do not need to change. Additionally, you must use these controls when defining a new logical partition in HCD.

IBM recommends that if you know a logical partition is used exclusively for ESA or exclusively for a coupling facility that you define it that way. This supplies the best
HCD rule checking. They also recommend that you use the HCD when possible, to define the coupling facility channel configuration to the channel subsystem.

**Server Time Protocol (STP)**

Server Time Protocol (STP) provides the means for multiple System z9, z890, and z990 servers to maintain time synchronization with each other without using a Sysplex Timer. STP is designed to synchronize servers configured in a Parallel Sysplex or a sysplex without a coupling facility, as well as servers that are not in a sysplex.

Server Time Protocol is a server-wide facility that is implemented in the Licensed Internal Code (LIC) of z890 server and CFs and presents a single view of time to Processor Resource/Systems Manager (PR/SM). STP uses a message-based protocol to transmit timekeeping information over externally defined Coupling Links between servers. The Coupling Links used to transport STP messages include ISC-3 links configured in peer mode, ICB-3 links, and ICB-4 links. These links can be the same links already being used in a Parallel Sysplex for Coupling Facility communications.

By using the same links to exchange timekeeping information and Coupling Facility messages in a Parallel Sysplex, STP can scale with distance. Servers exchanging messages over short distance links, such as ICB-3 and ICB-4 links, are designed to meet more stringent synchronization requirements than servers exchanging messages over long distance links, such as ISC-3 (distances up to 100 km), where the synchronization requirements are less stringent.

The STP design introduces a concept called Coordinated Timing Network (CTN). A Coordinated Timing Network (CTN) is a collection of servers and Coupling Facilities that are time synchronized to a time value called Coordinated Server Time. The concept of a Coordinated Timing Network fulfills two key goals:

- Concurrent migration from an existing External Time Reference (ETR) network to a time network using STP
- Capability of servers that cannot support STP to be synchronized in the same network as servers that support STP (z9 EC, z9 BC, z990, and z890).

A CTN can be configured in two ways:

- **Mixed CTN** - Allows the coexistence of non-STP capable servers (z800 and z900 servers) in an External Time Reference (ETR) timing network with STP capable servers. In a Mixed CTN, the IBM 9037 Sysplex Timer provides the timekeeping for the network. z800 and z900 servers are the only non-capable servers that can coexist in a Mixed CTN.

- **STP-only CTN** - Each server must be configured with same CTN ID. The HMC or Support Element provides the user interface for all time related functions, such as time initialization, time adjustment, and offset adjustment. The HMC or Support Element must also be used to initialize or modify the CTN ID and network configuration.

STP supports the following functions:

- Initialize the time manually or by dialing out to a time service, so that Coordinated Server Time can be set to within 100 milliseconds of an international time standard, such as UTC
- Schedule periodic dial outs to a time service so that Coordinated Server Time may be gradually steered to an international time standard
- Initialize Time Zone offset, Daylight Saving Time (DST) offset, and Leap seconds offset
- Schedule changes to Time Zone offset, Daylight Saving Time (DST) offset, and Leap Seconds offset. STP can automatically schedule Daylight Saving Time, based on the selected Time Zone
- Adjust Coordinated Server Time by up to +/- 60 seconds.

The benefits of STP include:
- Allowing clock synchronization without requiring the Sysplex Timer and dedicated timer links. This reduces costs by eliminating Sysplex Timer maintenance costs, power costs, space requirements, and fiber optic infrastructure requirements.
- Supporting a multisite timing network of up to 100 km over fiber optic cabling, thus allowing a sysplex to span these distances. This overcomes the limitation of timer to timer links being supported only up to 40 km.
- Potentially reducing the cross-site connectivity required for a multisite Parallel Sysplex. Dedicated links are no longer required to transport timing information because STP and Coupling Facility messages may be transmitted over the same links.

**Message Time Ordering**

As server and Coupling Facility link technologies have improved over the years, the synchronization tolerance between servers in a Parallel Sysplex has become more rigorous. In order to ensure that any exchanges of time-stamped information between servers in a Parallel Sysplex involving the Coupling Facility observe the correct time ordering, time-stamps are now included in the message-transfer protocol between the servers and the Coupling Facility. This is known as Message Time Ordering.

Therefore, when a Sysplex Timer exists and a Coupling Facility is configured as an ICF on a z890, the Coupling Facility requires connectivity to the same Sysplex Timer that the other servers in its Parallel Sysplex are using for the time synchronization. If the ICF is on the same server as a member of its Parallel Sysplex, no additional Sysplex Timer connectivity is required, since the server already has connectivity to the Sysplex Timer. However, when an ICF is configured on a z890 which does not host any systems in the same Parallel Sysplex, it is necessary to attach the server to the Sysplex Timer.

If you have an STP Mixed CTN, the only servers and Coupling Facilities that do not support STP but can coexist in the same timing network are servers that support MTOF. The z900 and z800 servers and CFs satisfy this requirement. They must also be connected to the Sysplex Timer.

**System-Managed CF Structure Duplexing**

z890 fully supports System-Managed Coupling Facility Structure Duplexing (CF Duplexing). This is a set of architectural extensions to Parallel Sysplex in support of duplexing of coupling facility structures for high availability. All three structure types (cache structures, list structures, and locking structures) can be duplexed using this architecture.

In e-business, two important objectives for survival are systems designed to provide continuous availability and near transparent disaster recovery (DR). Systems that are designed to deliver continuous availability combine the characteristics of high availability and near continuous operations to deliver high levels of service - targeted at 24 x 7.

To attain high levels of continuous availability and near-transparent disaster recovery, the solution should be based on geographical clusters and data mirroring. These technologies are the backbone of the GDPS solution. GDPS offers three different solutions based on the underlying mirroring technology:

- The GDPS solution, based on Peer-to-Peer Remote Copy (PPRC, recently renamed to IBM TotalStorage® Metro Mirror), is referred to as GDPS/PPRC.
- The GDPS solution based on Extended Remote Copy (XRC, recently renamed to IBM TotalStorage z/OS Global Mirror), is referred to as GDPS/XRC.
- The GDPS solution based on IBM TotalStorage Global Mirror is referred to as GDPS/Global Mirror.

GDPS is an integrated, automated application and data availability solution designed to provide the capability to manage the remote copy configuration and storage subsystem(s), automate Parallel Sysplex operational tasks, and perform failure recovery from a single point of control, thereby helping to improve application availability. GDPS is independent of the transaction manager (e.g., CICS TS, IMS, WebSphere®) or database manager (e.g., DB2, IMS, and VSAM) being used, and is enabled by means of key IBM technologies and architectures.

**GDPS/PPRC**

GDPS/PPRC is designed to manage and protect IT services by handling planned and unplanned exception conditions, and maintain data integrity across multiple volumes and storage subsystems. By managing both planned and unplanned exception conditions, GDPS/PPRC can help to maximize application availability and provide business continuity.

GDPS/PPRC is capable of the following attributes:

- Near continuous Availability solution
- Near transparent D/R solution
- Recovery Time Objective (RTO) less than an hour
- Recovery Point Objective (RPO) of zero (optional)
- Protects against localized area disasters (distance between sites limited to 100 km fiber)

Server Time Protocol (STP) allows you to have a GDPS/PPRC configuration across two sites up to 100 km apart. STP overcomes the limitations of the Sysplex Timer to Sysplex Timer links being supported only up to 40 km. STP is designed to eliminate the need for a third site to locate the second Sysplex Timer for installations where the multisite sysplex spans a distance greater than 40 km but less than 100 km.

**GDPS/XRC**

Extended Remote Copy (XRC, recently renamed to IBM TotalStorage z/OS Global Mirror) is a combined hardware and z/OS software asynchronous remote copy solution. GDPS/XRC includes automation to manage remote copy pairs and
automates the process of recovering the production environment with limited manual intervention, including invocation of CBU. This provides the ability to perform a controlled site switch for a planned or unplanned site outage and gives significant value in reducing the duration of the recovery window and requiring less operator interaction.

GDPS/XRC is capable of the following attributes:
- Disaster recovery solution
- RTO between an hour to two hours
- RPO less than one minute
- Protects against localized as well as regional disasters (distance between sites is unlimited)
- Minimal remote copy performance impact.

**GDPS/Global Mirror**

Global Mirror enables a two-site disaster recovery and backup solution for z/OS and open systems environments. Using asynchronous technology, Global Mirror is designed to maintain a consistent and restartable copy of data at a remote site that can be located at virtually unlimited distances from the local site.

GDPS/Global Mirror is capable of the following attributes:
- Disaster recovery solution
- RTO between an hour to two hours
- RPO less than one minute
- Protects against regional disasters (distance between sites is unlimited)
- Minimal remote copy performance impact
- Support for z/OS and open data.

**Enhancements in GDPS V3.3**

IBM Global Services continues to enhance GDPS with:
- *Extended HyperSwap functionality with IOS timing trigger.* This is designed to allow HyperSwap to be invoked automatically when user-defined I/O timing thresholds are exceeded.
- *Improved availability with enhanced recovery support in a CF structure duplexing environment.* This is designed to ensure that the secondary PPRC volumes and the CF structures are time consistent, thereby helping to provide consistent application restart times without any special recovery procedures.
- *Performance improvements for System Logger in a z/OS Global Mirror* (previously known as XRC) environment. XRC+ provides the option for asynchronous writes to staging data sets for logstreams. Previously, all writes had to be synchronous. This limited the throughput for high-volume logging applications such as WebSphere, CICS, and IMS. The ability to do asynchronous writes can allow the use of z/OS Global Mirror (XRC) for some applications for which it was not previously practical.
- Scalability improvements for XRC. This includes support for > 14 SDMs, improved parallelism of XRC commands, and support for Write Pacing to simplify XRC tuning.

For a detailed description of the functions and capabilities of each of the above GDPS solutions, visit the GDPS web site at: http://www-03.ibm.com/systems/z/gdps/
Intelligent Resource Director (IRD)

Intelligent Resource Director (IRD) is a function which optimizes your workload’s resource utilization of the z890 across multiple logical partitions.

This extension combines the strengths of key z890 and S/390 platform leadership technologies, including z/OS Workload Manager, Processor Resource/Systems Manager (PR/SM) (logical partitioning hardware technology) and Parallel Sysplex Clustering technology. This powerful combination provides the ability to dynamically manage workloads within multiple logical operating system images executing on a single z990 server, as a single large-scale computer resource, with dynamic workload management and physical resource balancing built into the native operating system and underlying hardware.

With IRD, z/OS Workload Manager (WLM) exploits Parallel Sysplex technologies to monitor performance of workloads on multiple images against those workload goals. z/OS WLM will then interact with the PR/SM hypervisor, directing PR/SM to dynamically adjust the physical CPU and I/O resource allocation of the hardware across the multiple operating system instances, without requiring Parallel Sysplex data-sharing to achieve these benefits, and totally transparent to customer workload applications.

IRD not only combines PR/SM, z/OS WLM, and Parallel Sysplex for LPAR CPU management, but it also includes two additional z890 exclusives: Dynamic Channel Path Management (DCM), and I/O (Channel) Subsystem Priority to increase business productivity.

Through IRD technology extensions, the Parallel Sysplex will be able to dynamically change system image weights, reconfigure channels on the fly, and vary logical processors on and off-line dynamically to maximize overall throughput across all of the system images to enable the most critical business application of highest priority to get the resources (CPU and I/O) it needs.

LPAR CPU Management (Clustering)

An LPAR cluster is the subset of the systems in a parallel sysplex that are running as logical partitions on the same server.

LPAR CPU management allows dynamic adjustment of processor resources across partitions in the same LPAR cluster. Through the z/OS WLM policy, installations specify the business importance and goals for their workloads. WLM will then manage these sets of logical partitions to provide the processor resources needed for the work to meet its goals based on business importance.

LPAR CPU management requires z/OS WLM goal mode and a coupling facility structure which contains critical status information enabling cross-partition management of CP and I/O resources. These functions are delivered as a part of z/OS and CFCC Level 13 on the z890 machine.

Note: The structure requires CFCC Level 9, although Level 13 comes in the z890 machine. For example, a 9672 R06 with CFCC Level 9 can hold the IRD/WLM structures.

LPAR cluster support is also provided for Linux in the CP management area.
I/O Priority Queuing (IOPQ)

Priority queuing is not a new concept to enterprise operating systems. It has been available within a single OS/390 image for years. I/O Priority Queuing (IOPQ) was recently introduced into the control unit with the IBM Enterprise Storage Server. I/O Subsystem Priority Queuing extends the classic strengths of I/O priority queuing by addressing other challenges that are not currently handled by existing I/O priority schemes.

For example, prior to I/O Subsystem Priority Queuing, discretionary work in one partition could dominate channels shared with business critical work in another partition. With this new function, z/OS WLM and the Hardware Management Console set priorities that will be used to give the business-critical work higher priority access to the channels. This in turn may allow customers that do not exploit MIF, in order to prevent such problems, to be able to do so now and may lead to reduced overall channel requirements. These new capabilities will help provide optimal workload management.

The range of I/O weights for each logical partition is set within the Hardware Management Console. WLM adjusts the I/O weights within this range. It can be a fixed range, in which WLM would play no part.

Dynamic Channel Path Management (DCM)

This portion of IRD is a combination of hardware strengths and software flexibility. Paths can now be managed between the processor and the control units in the system. Dynamic Channel Path Management (DCM) enables the system to respond to ever changing channel requirements by moving channels from lesser used control units to more heavily used control units as needed. DCM can manage control units connected to ESCON channels.

When used with z/OS Workload Manager (z/OS WLM) in Goal Mode, z/OS WLM is able to direct Dynamic Channel Path Management to move channels to help business critical work achieve its goals. This also helps reduce the requirement for greater than 256 channels.

I/O Priority Queuing and Dynamic Channel Path Management (DCM) benefit the Parallel Sysplex environment, with increased benefit in a multi-image environment (Parallel Sysplex). Although Parallel Sysplex data sharing is not required for IRD, the benefits of combining the two are unsurpassed.

I/O Priority Queuing has no value in a single-system environment.

Table 6-2. IOPQ in a Single-System Environment

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LPAR CPU Mgmt</td>
<td>Yes</td>
<td>Yes</td>
<td>Little (Vary Logical CP)</td>
</tr>
<tr>
<td>DCM</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>IOPQ</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Note: Both DCM and IOPQ do have more value with Goal Mode.

Workload Manager (WLM)

Workload Manager (WLM) provides industry leading partitioning and workload management. Maximum utilization of all system resources is enabled through
dynamic, automatic allocation of processor, memory, and I/O resources across partitions based on real time workload demand and customer policy.

Workload Manager provides end-to-end management of transactions, from the web-browser to data storage then back to the web-browser. Workload Manager can exploit Cisco routers and facilitate dynamic and automatic self-management of data based on business priorities.

Using IBM's Discrete Server Technology with the z890 and z/OS, installations may take advantage of Workload Based Pricing to further reduce the cost of computing as applications continue to grow by using:

- Software pricing based on what you define, not what capacity has been installed.
- Common pricing for many cross-platform products.
- License Manager, which simplifies and centralizes via a standard licensing certificate to control software usage billing.

Workload Based Pricing is adopted by many tools vendors, and provides for 'rigid' management within a flexible system.
Chapter 7. Cryptography

The Cryptographic support for z890 provides cryptographic function on every Processor Unit (PU). To achieve the required throughput and implement new functions while maintaining balanced usage of system resources, integrated hardware is important. zSeries introduces the Message Security Assist Architecture (MSA) along with the CP Assist for Cryptographic Function (CPACF) delivering cryptographic support on every PU with DES and TDES data encryption/decryption and Secure Hash Algorithm-1 (SHA-1) hashing.

The following cryptographic features available on z890 servers include:
- Optional PCI Cryptographic Accelerator (PCICA) - FC 0862 - (Cannot be ordered after Crypto Express2 becomes available)
- Optional PCIX Cryptographic Coprocessor (PCIXCC) - FC 0868 - (Cannot be ordered after Crypto Express2 becomes available)
- Optional Crypto Express2 - FC 0863

These features provide high-speed hardware-based cryptographic functions for:
- Data privacy
- Data integrity
- Cryptographic key installation, generation, and distribution
- Digital signature generation and verification.

Support for CPACF and PCICA is also available via the Integrated Cryptographic Service Facility (ICSF) in z/OS V1R5, z/OS.e V1R5, z/OS V1R4 and z/OS V1R4 z990 Exploitation Support feature, z/OS.e V1R4 with z/OS.e V1R4 z990 Coexistence Update feature, and z990 Cryptographic Support web deliverable for z/OS V1R3 and z/OS.e V1R3. Support for CPACF, PCICA, and PCIXCC is available through z890 and z990 Enhancements to Cryptographic Support web deliverable for z/OS V1R5, z/OS V1R4, z/OS V1R3, z/OS V1R2, z/OS.e V1R5, z/OS.e V1R4, z/OS.e V1R3, and OS/390 V2R10.

Products that include any of the cryptographic feature codes contain cryptographic functions which are subject to special export licensing requirements by the U.S. Department of Commerce. It is your responsibility to understand and adhere to these regulations whenever moving, selling, or transferring these products.

The cryptographic features are eligible for export under License Exception ENC as retail items to all end users in all countries except the embargoed, subject to the usual customer screening. The dormant cards themselves, without the enabling software, are also eligible for export an NLR (No License Required) to all customers in all countries except the embargoed, subject to the usual screening.

CP Assist for Cryptographic Function

The CP Assist for Cryptographic Function (CPACF) is available on the z890 server. ICSF requires the enablement feature (FC 3863) to be installed in order to utilize the PCICA, PCIXCC, and Crypto Express2 features. The CPACF provides a set of symmetric cryptographic functions that focus on the encryption/decryption function of SSL, Virtual Private Network (VPN), and data storing applications not requiring FIPS 140-2 level 4 security.

The CPACF for Data Encryption Standard (DES) and Triple Data Encryption Standard (TDES) functions require enablement of the CPACF function (FC 3863)
for export control. The DES and TDES functions also use clear key values. The CPACF is shipped with the SHA-1 hash function enabled.

For IBM and customer written programs the CPACF for DES, TDES, and SHA-1 functions can be invoked by five new problem state instructions as defined by an extension of the zSeries architecture. Refer to “z/Architecture” on page 1-8, for more information on the instructions.

The following minimum software requirements for ICSF support of CPACF includes:

**Note:** The z/OS and OS/390 cryptographic support requirements are all web deliverables and can be downloaded at [http://www.ibm.com/eserver/zseries/zos/downloads](http://www.ibm.com/eserver/zseries/zos/downloads)

- z/OS V1R2 and later, with z990 and z890 Enhancements to Cryptographic Support
- z/OS.e V1R3 and later, with z990 and z890 Enhancements to Cryptographic Support
- OS/390 V2R10 with z990 and z890 Enhancements to Cryptographic Support
- z/VM V3.1 and V4.3 and later

**PCI Cryptographic Accelerator (PCICA)**

**Note:** PCICA is no longer orderable. Refer to “Crypto Express2” on page 7-5

The Peripheral Component Interconnect Cryptographic Accelerator (PCICA) feature (FC 0862) has two accelerator cards per feature (with a maximum of two features) and is an optional feature for the z890 server. The PCICA is a very fast cryptographic processor designed to provide leading edge performance of the complex Rivest-Shamir-Adleman algorithm (RSA) (an Internet encryption and authentication system) cryptographic operations used with the Secure Sockets Layer (SSL) protocol supporting e-business, clear key, DES, TDES, and SHA-1. It is specifically designed for maximum speed SSL acceleration. ICSF, with the enablement feature (FC 3863), requires the CPACF to be installed in order to utilize the PCICA and PCIXCC features.

The SSL and Transport Layer Security (TLS) protocols are essential and widely used protocols to support secure e-business applications. Compute-intensive public key cryptographic processes that use SSL/TLS, can be offloaded from the host to the PCICA feature to reduce CP usage and to increase system throughput.

The PCICA feature is designed for maximum speed Secure Sockets Layer (SSL) acceleration rather than for specialized financial application for secure, long-term storage of keys or secrets. Each PCICA feature is built around two accelerators embedded in an adapter package for installing within the z890. The following table displays the support of partitions for PCICA.
<table>
<thead>
<tr>
<th>Feature</th>
<th>Max number of features supported per server</th>
<th>Number of accelerators per feature</th>
<th>Max number of accelerators supported per server</th>
<th>Number of domains supported per accelerator</th>
<th>Number of active LPARs per server</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCICA</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>16</td>
<td>30</td>
</tr>
</tbody>
</table>

The total quantity of FICON, OSA, and crypto cannot exceed 20 features per server.

Each PCICA feature is assigned two PCHIDs. It does not use CHPID numbers, however, they are assigned PCI cryptographic numbers. The PCICA card plugs into an I/O slot in the I/O cage.

The following minimum software requirements for the PCICA includes:

**Note:** The z/OS and OS/390 cryptographic support requirements are all web deliverables and can be downloaded at [http://www.ibm.com/eserver/zseries/zos/downloads](http://www.ibm.com/eserver/zseries/zos/downloads)

- z/OS V1R2 and later, with z990 and z890 Enhancements to Cryptographic Support
- z/OS.e V1R3 and later, with z990 and z890 Enhancements to Cryptographic Support
- OS/390 V2R10 with z990 and z890 Enhancements to Cryptographic Support
- z/VM V5.1 (for z/OS and Linux guests)
- z/VM V4.3 and later releases (for Linux Guests)
- VSE/ESA V2.7 and IBM TCP/IP for VSE/ESA V1.5
- Linux on zSeries includes the currently available distributions of SUSE SLES 7, SUSE SLES 8, Red Hat RHEL 3.0, TurboLinux TLES 8, or Conectiva CLEE.

**PCIX Cryptographic Coprocessor (PCIXCC)**

**Note:** PCIXCC is no longer orderable. Refer to [Crypto Express2](#) on page 7-5

The Peripheral Component Interconnect Express Cryptographic Coprocessor (PCIXCC) feature (FC 0868) has one coprocessor per feature (with a maximum of four features) and is an optional feature for the z890 server. The PCIXCC feature supports:

- Secure key cryptographic functions
- Use of secure encrypted key values
- User Defined Extensions (UDX).

ICSF, with the enablement feature (FC 3863), requires the CPACF to be installed in order to utilize the PCICA and PCIXCC features.

The PCIXCC is a replacement for the PCI Cryptographic Coprocessor (PCICC) and the CMOS Cryptographic Coprocessor Facility (CCF). All critical CCF and all PCICC functions have been implemented on the PCIXCC feature. The following table displays the support of partitions for PCIXCC.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Max number of features supported per server</th>
<th>Number of coprocessors per feature</th>
<th>Max number of coprocessors supported per server</th>
<th>Number of domains supported per coprocessor</th>
<th>Number of active LPARs per server</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCIXCC</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>16</td>
<td>30</td>
</tr>
</tbody>
</table>
The total quantity of FICON, OSA, and crypto cannot exceed 20 features per server.

PCIXCC features may be installed in increments of 0, 2, 3, or 4. Each PCIXCC feature is assigned one PCHID. It does not use CHPID numbers, however, they are assigned PCI cryptographic numbers. The PCIXCC card plugs into an I/O slot in the I/O cage.

The following minimum software requirements for the PCIXCC includes:

**Note:** The z/OS and OS/390 cryptographic support requirements are all web deliverables and can be downloaded at [http://www.ibm.com/eserver/zseries/zos/downloads](http://www.ibm.com/eserver/zseries/zos/downloads).

- z/OS V1R2 and later, with z990 and z890 Enhancements to Cryptographic Support
- z/OS.e V1R3 and later, with z990 and z890 Enhancements to Cryptographic Support
- OS/390 V2R10 with z990 and z890 Enhancements to Cryptographic Support
- z/VM V5.1 (for z/OS and Linux guests)

**Note:** The PCIXCC card can take an extended amount of time to initialize after being configured online. Refer to the PCI Cryptographic Configuration panel on the SE for more information.

### User-Defined Extensions

User-Defined Extensions to the Common Cryptographic Architecture (CCA) support program that executes within the PCIXCC will be supported by an IBM Service Offering. For unique customer applications, the PCIXCC will support the loading of customized cryptographic functions on z890. Support is available via ICSF and the z990 and z890 Enhancements to Cryptographic Support web deliverable. Under a special contract with IBM, as a PCIXCC customer you gain the flexibility to define and load custom cryptographic functions yourself. This service offering can be requested by referring to the IBM 'Cryptocards' web site, [http://www.ibm.com/security/cryptocards](http://www.ibm.com/security/cryptocards) then selecting the **Custom Programming** option.

The following is required for UDX support:

- One or more PCIXCC features
- A Hardware Management Console
- A TKE workstation at 4.0 or 4.1 code level, if the UDX requires access control point
- z/OS V1R4
- z990 and z890 Enhancements to Cryptographic Support, a web deliverable.

### Derived Unique Key Per Transaction (DUKPT)

Derived Unique Key Per Transaction (DUKPT) for double length keys allows you to write applications that implement the DUKPT algorithm as defined by the ANSI X9.24 standard, providing added security for point of sale transactions that are prevalent in the retail industry.
EMV 2000 Standard

Europay Mastercard and Visa (EMV) support allows you to write applications that comply with EMV 2000 standard, which is used for financial transactions among heterogeneous hardware and software.

Crypto Express2

The Crypto Express2 (CEX2C) feature (FC 0863), is designed for Federal Information Processing Standard (FIPS) 140-2 Level 4 Certification and has two coprocessors. The Crypto Express2 feature supports:

- Consolidation and simplification using a single cryptographic coprocessor
- Up to a maximum of eight features per server
- Public key cryptographic functions
- Hardware acceleration for Secure Sockets Layer (SSL) and Transport Layer Security (TLS) protocols
- User Defined Extension (UDX)
- 2048-bit key RSA management capability.

The Crypto Express2 feature replaces the PCI Cryptographic Accelerator (PCICA) and PCIX Cryptographic Coprocessor (PCIXCC) features. It is exclusive to the z890 and z990 and is supported by z/OS, z/OS.e, z/VM, VSE/ESA, and Linux on zSeries.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Max number of features supported per server</th>
<th>Number of coprocessors per feature</th>
<th>Max number of coprocessors supported per server</th>
<th>Number of domains supported per coprocessor</th>
<th>Number of active LPARs per server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crypto Express2</td>
<td>8</td>
<td>2</td>
<td>16</td>
<td>16</td>
<td>30</td>
</tr>
</tbody>
</table>

The total quantity of FICON, OSA, and crypto features cannot exceed 20 features per server.

All logical partitions (LPARs) in all Logical Channel Subsystems (LCSSs) have access to the Crypto Express2 feature, up to 30 LPARs per feature. Although the feature occupies an I/O slot, it does not use Channel Path Identifiers (CHPIDs).

The following minimum software requirements for Crypto Express2 include:

- z/OS V1.2, and later, with z990 Cryptographic Support, or z990 and z890 Enhancements to Cryptographic Support
- z/OS.e V1.3, and later, with z990 Cryptographic Support, or z990 and z890 Enhancements to Cryptographic Support
- z/VM V5.1 for z/OS and Linux guests
- VSE/ESA V2.7 and IBM TCP/IP for VSE/ESA V1.5

Note: VSE/ESA, and Linux on zSeries offer support for clear key SSL transactions only.

Trusted Key Entry (TKE) Workstation

The TKE 4.1 code level workstation is an optional feature that provides a basic key management system, master and operational key entry support. The key management system allows an authorized person a method for key identification, exchange, separation, update, backup, and management. The TKE feature is a
combination of workstation hardware and software networked-connected to z890. The TKE workstation and 4.1 code level are designed to provide a security-rich, remote, and flexible method of providing master key entry, and to locally and remotely manage cryptographic coprocessor features. To use the TKE function on a z890, the PCIXCC feature, the TKE 4.0 or 4.1 code level, and CPACF must be installed. The TKE workstations capable of running TKE 4.0 or 4.1 code include:

- TKE with token Ring (FC 0866)
- TKE with Ethernet (FC 0869)
- TKE with Token Ring (FC 0876)
- TKE with Ethernet (FC 0879)
- TKE with Token Ring (FC 0886)
- TKE with Ethernet (FC 0889)
- TKE with Token Ring (FC 0896)
- TKE with Ethernet (FC 0899).

**Trusted Key Entry (TKE) with Smart Card Reader**

The Trusted Key Entry (TKE) workstation with the 4.2 level of Licensed Internal Code is an optional feature that provides a secure key management system allowing authorized persons a method of key identification, exchange, separation, update, and management.

Support for an optional Smart Card Reader attached to the TKE 4.2 workstation allows the use of smart cards. Smart Cards, similar in size and shape to a credit card, contain an embedded microprocessor and associated memory for data storage. Access to and use of confidential data on the smart card is protected by a user-defined personal identification number (PIN).

The following optional features are associated with the TKE 4.2 workstation Smart Card Reader support:

- TKE 4.2 code (FC 0853)
- TKE 4.2 Smart Card Reader (FC 0887)
- TKE 4.2 additional Smart Cards (FC 0888)

**RMF™ Monitoring**

The Cryptographic Hardware Activity report provides information about the activities in the Cryptographic Coprocessor (PCIXCC), Crypto Express2 (CEX2C), and the Cryptographic Accelerator (PCICA).

For PCIXCC and CEX2C, the request rate is reported per daughter card which is the number of requests per second. In addition, the utilization (how much of the interval the feature is busy) and the average execution time of all operations is reported.

For the PCICA, rate, execution time, and utilization percent is reported for all operations, for 1024-bit ME format RSA operations, for 2048-bit ME format RSA operations, for 1024-bit CRT format RSA operations, and 2048-bit CRT format RSA operations.
Certification

FIPS Certification
The PCIX Cryptographic Coprocessor, and the Crypto Express2 feature are
designed for Federal Information Processisng Standard (FIPS) 140-2 Level 4
certification.

LPAR Security
It is IBM's intention to certify the logical partitioning for the new IBM eServer
zSeries 890 at a Common Criteria EAL5 certification level (Evaluation Assurance
Level 5).
Chapter 8. Cabling

Today's marketplace is seeing the adoption of new Small Form Factor (SFF) fiber optic connectors, short wavelength (SX) and long wavelength (LX) laser transceivers, and increasing link speeds from 1 Gb per second to 10 Gb per second. New industry standard SFF fiber optic connectors and transceivers are utilized on the z890 ESCON, FICON, and OSA features and must coexist with the current infrastructure that utilizes a different “family” of fiber optic connectors and transceivers.

The IBM Network Integration and Deployment Services delivers to you a contracted service to meet the needs of your system configuration whether it is small, medium, or large. Included in this service is the following:

- Survey of the customer's data center site by an IBM specialist to determine the current fiber infrastructure.
- Analysis of the hardware configuration and feature codes ordered for the z890.
- Review of current connectivity requirements and future plans for optical fiber connectivity.
- Customer Proposal with a jumper cable configuration and a structured cabling solution for the physical connectivity of the z890 and its attaching devices.
- Bill of Materials for the jumper cables and conversion cables required to connect the z890 to the existing cabling infrastructure and its associated equipment.
- Order placement for all jumper cables included in Connectivity Readiness Service and, if required and for a fee, any additional jumper cables needed to complete the installation.
- Delivery of cabling products to meet z890 delivery and installation scheduling requirements.
- Project Management of the cabling installation, including physical routing and connection.
- End-of-Engagement review.

IBM connectivity experts will help you select the option that is best suited to achieve your business goals to simplify your z890 deployment with effective on-site fiber optic cabling planning and installation support.

For additional information on cabling, you can refer to any of the following:

- zSeries 890 Installation Manual for Physical Planning
- Fiber Cabling module on Resource Link (under Services from the navigation bar).

zSeries Fiber Cabling Services

IBM is offering the IBM Network Integration and Deployment Services for zSeries fiber cabling (zSeries Fiber Cabling Service) for the z890. This may be the ideal time to invest in the zSeries Fiber Cabling Service if:

- You do not have the skills required to perform fiber optic planning and migration.
- Your system environment includes multiple generations of products.
- You do not have dedicated personnel that are trained to address changing fiber optic technologies.

The zSeries Fiber Cabling Service can help to ensure you have the ability to manage your company's open-systems e-business environment.
The zSeries Fiber Cabling Service is designed to provide you with:

- Fiber optic connectivity expertise; personnel trained to deploy a proven fiber optic cabling methodology.
- Scalable, flexible, personalized services to effectively plan and install the fiber optic cabling to interoperate with the current infrastructure while planning for future needs.
- Reliable cabling components that meet IBM physical interface specifications.

The zSeries Fiber Cabling Services offers three fiber cabling options that can provide you with the appropriate level of connectivity. Individual fiber optic jumper cables (vs. trunk cables) are the foundation of these services along with appropriate documentation. The zSeries Fiber Cabling Services options include:

- **Fiber optic jumper cabling**
  IBM makes the planning, new cable, and installation decisions for you.

- **Fiber optic jumper cable migration and reuse for a zSeries upgrade**
  IBM sorts your existing cables, makes planning and reuse decisions. You are not offered new cables with this option.

- **Fiber optic jumper cables and installation**
  You make the planning, new cable, and installation decisions and relate that information to IBM Network Integration and Deployment Services. Europe (EMEA) does not use this option.

### Enterprise Fiber Cabling Services

The Enterprise Fiber Cabling Services offers two fiber cabling options that allow you to either connect a zSeries server into an already-structured environment or to provide a structured environment for an entire data center. The fiber optic trunk cables, harnesses, and patch panel boxes are the foundation of these services along with appropriate documentation. The Enterprise Fiber Cabling Services options include:

- **zSeries fiber optic trunk cabling**
  IBM reduces the data center cable clutter and makes decisions pertaining to planning, fiber optic trunk commodities, and installation.

- **Enterprise fiber cabling service** - previously known as Fiber Transport Services (FTS)
  IBM organizes the entire enterprise which consists of planning, new cables, fiber optic trunking commodities, and installation.

### Fiber Quick Connect (FQC) ESCON Cabling

Fiber Quick Connect (FQC) ESCON harness cabling, harness brackets, and mounting hardware are ordered with the z890 server as feature codes and are ordered in conjunction with an Enterprise Fiber Cabling Services structured (trunk) solution. This feature enables trunk cables to connect to ESCON channels using under-the-cover attachment harnesses. These harnesses are installed when your system is built, and your z890 arrives ready to connect the trunk cables at your site.

### Cable Ordering

Fiber optic cables for the z890 may be ordered by using the IBM Network Integration and Deployment Services for zSeries Fiber Cabling (zSeries Fiber Cabling Service) offered by IBM Global Services (IGS).
This service delivers a convenient, packaged solution to reduce the complexity of planning, ordering, installing, and documenting fiber optic cables. The following table lists the connectors and cabling supported for each of the features available for ordering on the z890. The features brought forward on an upgrade from z800 are also listed.

<table>
<thead>
<tr>
<th>Feature Code</th>
<th>Feature Name</th>
<th>Connector Type</th>
<th>Cable Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0219</td>
<td>ISC-3 link</td>
<td>LC Duplex</td>
<td>9 micron SM</td>
</tr>
<tr>
<td>6154</td>
<td>ETR</td>
<td>MTRJ</td>
<td>62.5 micron MM</td>
</tr>
<tr>
<td>2324</td>
<td>16-port ESCON channel</td>
<td>MTRJ</td>
<td>62.5 micron MM</td>
</tr>
<tr>
<td>2319</td>
<td>FICON Express LX</td>
<td>LC Duplex</td>
<td>9 micron SM</td>
</tr>
<tr>
<td>2320</td>
<td>FICON Express SX</td>
<td>LC Duplex</td>
<td>50, 62.5 micron MM</td>
</tr>
<tr>
<td>3319</td>
<td>FICON Express2 LX</td>
<td>LC Duplex</td>
<td>9 micron SM</td>
</tr>
<tr>
<td>3320</td>
<td>FICON Express2 SX</td>
<td>LC Duplex</td>
<td>50, 62.5 micron MM</td>
</tr>
<tr>
<td>3368</td>
<td>OSA-2 GbE LX (2)</td>
<td>SC Duplex</td>
<td>9 micron SM</td>
</tr>
<tr>
<td>3364</td>
<td>OSA-2 GbE SX</td>
<td>LC Duplex</td>
<td>9 micron SM</td>
</tr>
<tr>
<td>1364</td>
<td>OSA-2 GbE SX</td>
<td>LC Duplex</td>
<td>9 micron SM</td>
</tr>
<tr>
<td>2364</td>
<td>OSA-2 GbE SX</td>
<td>SC Duplex</td>
<td>9 micron SM</td>
</tr>
<tr>
<td>3365</td>
<td>OSA-2 GbE SX</td>
<td>LC Duplex</td>
<td>50, 62.5 micron MM</td>
</tr>
<tr>
<td>1365</td>
<td>OSA-2 GbE SX</td>
<td>LC Duplex</td>
<td>50, 62.5 micron MM</td>
</tr>
<tr>
<td>2365</td>
<td>OSA-2 GbE SX</td>
<td>SC Duplex</td>
<td>50, 62.5 micron MM</td>
</tr>
<tr>
<td>1366</td>
<td>OSA-2 1000BASE-T</td>
<td>RJ-45</td>
<td>Category 5 UTP</td>
</tr>
<tr>
<td>2366</td>
<td>OSA-2 Fast Ethernet</td>
<td>RJ-45</td>
<td>Category 5 UTP</td>
</tr>
<tr>
<td>2367</td>
<td>OSA-2 Token Ring</td>
<td>RJ-45</td>
<td>UTP or STP</td>
</tr>
</tbody>
</table>

Notes:
1. MM - Multimode fiber
2. SM - Single mode fiber
3. OSA-E - OSA-Express
4. Brought forward to z890 on an upgrade from z800
5. The OSA-Express GbE features brought forward from z800 have a different connector (SC Duplex) than the new OSA-E GbE features (LC Duplex)
6. 1000BASE-T - Ethernet feature
7. UTP - Unshielded Twisted Pair
8. STP - Shielded Twisted Pair
9. OSA-E2 - OSA-Express2

Refer to the Services section of Resource Link for further information.

Cabling Responsibilities

Cabling is a customer responsibility. The following tasks are required to be performed by the customer prior to machine installation:

- All fiber optic cable planning.
- All purchasing of correct, qualified, fiber cables.
- All installation of any required Mode Conditioning Patch (MCP) cables.
- All installation of any required Conversion Kits.
• All routing of fiber optic cables to correct floor cutouts for proper installation to server.
  – Use the Physical Channel Identifier (PCHID) report or the report from the Channel Path Identifier (CHPID) Mapping Tool to accurately route all cables.
• All labeling of fiber optic cables with PCHID numbers for proper installation to server.
  – Use the PCHID report or the report from the CHPID Mapping Tool to accurately label all cables.

Additional service charges may be incurred during the machine installation if the preceding cabling tasks are not accomplished as required.

**Cabling Report**

When the Fiber Quick Connect feature is ordered, a second part of the PCHID Report is provided to document the connections between the ESCON ports and the MTP couplers. Figure 8-1 shows a brief example of the cabling portion of the report.

<table>
<thead>
<tr>
<th>Cage</th>
<th>Slot</th>
<th>F/C</th>
<th>Brkt</th>
<th>PCHID/Harn-Leg</th>
</tr>
</thead>
<tbody>
<tr>
<td>A01B</td>
<td>17</td>
<td>2323</td>
<td>2F(6.10)R</td>
<td>1E0/6-1 1E1/6-2 1E2/6-3 1E3/6-4 1E4/6-5 1E5/6-5 1E6/7-1 1E7/7-2 1E8/7-3 1E9/7-4 1EA/7-5 1EB/7-6 1EC/8-1 1ED/8-2 1EE/8-3</td>
</tr>
</tbody>
</table>

Legend:
- A19B - Top of 'A' frame
- A01B - Bottom of 'A' frame
- 2323 - ESCON Channel 16 Ports

*Figure 8-1. Cabling Section of the PCHID Report Sample*

The columns in this part of the report represent the following data:

**Cage** Displays the cage installed and the location of the I/O and CPC cage containing I/O.

**Slot** Displays the I/O slot where the harness is plugged.

**F/C** Displays the feature code of the channel card where the harness is plugged.

**Brkt** Displays the MTP bracket that the harness plugs into (F is the bracket in the front of the frame, B is the bracket in the back of the frame, R is the bracket to the right of the frame, L is the bracket to the left of the frame).

**PCHID/Harn-Leg** Displays the PCHID number port harness is plugged into, the harness number based on the MTP coupler the harness is plugged to, the harness leg that is plugged into the port.
Chapter 9. Hardware Management Console and Support Element

The z890 includes a Hardware Management Console and two internal Support Elements (SEs) located on the 'A' frame. The second Support Element, the alternate SE, is standard on z890 and is configured the same as, and serves as an alternate to, the primary SE.

The Hardware Management Console user interface is designed to provide the functions you need through an object-oriented design. Through this design, you can directly manipulate the objects that are defined to the Hardware Management Console, and be aware of changes to object status as they are detected.

The Hardware Management Console communicates with each CPC through the CPC's Support Element. When tasks are performed at the Hardware Management Console, the commands are sent to one or more SEs which then issue commands to their CPCs. Commands can be sent to as many as all of the CPCs defined to the Hardware Management Console. One Hardware Management Console can control up to 100 CPCs and one CPC can be controlled by 32 Hardware Management Consoles. Refer to Figure 9-1 for an example of a typical Hardware Management Console configuration.

Figure 9-1. Hardware Management Console Configuration

On the z890, CPCs configured to a Hardware Management Console are those CPCs whose internal SEs are:
• Attached by local area network (LAN) to the Hardware Management Console
• Defined to have the same domain name and domain password as the Hardware Management Console
• Defined in the Defined CPCs group at the Hardware Management Console.

The internal SEs for each CPC allows the Hardware Management Console to monitor the CPC by providing status information. Each internal SE provides the Hardware Management Console with operator controls for its associated CPC so that you can target operations:
• In parallel to multiple or all CPCs
Hardware Management Console Enhancements for Version Code 1.8.2

This section highlights the significant changes and enhancements for the z890 Version Code 1.8.2. For more detailed information on these enhancements, refer to the Hardware Management Console Operations Guide. You can also refer to the education module on Resource link, How to Use the Hardware Management Console.

Integrated 3270 Console

The new Hardware Management Console icon provides a 3270 console that can be used with a host operating system without the need for any special connectivity or additional hardware, such as control units or network connections. The Integrated 3270 Console uses the already existing network connection between the Hardware Management Console and the support element, and the connection between the support element and the CPC to connect with the host operating system. One 3270 console is available for each CPC image.

The Integrated 3270 Console is exploited by z/VM V4.4 and later and removes the need for a dedicated z/VM system console and associated 2074 control unit. This feature is exploited by z/VM, the z/VM Standalone Program Loader, and the standalone DASD Dump-Restore program. It can only be used for one console session per z/VM logical partition at a time. Multiple Hardware Management Consoles cannot each simultaneously establish a console session with the same z/VM LPAR.

z/OS currently does not support the Integrated 3270 Console. It cannot be used by system console functions or by VTAM®.

Integrated ASCII Console

This feature allows a Linux logical partition to establish an ASCII console session on the Hardware Management Console and should simplify Linux installation and initial operation. It can only be used for one console session per Linux logical partition at a time. Multiple Hardware Management Consoles cannot each establish a console session with the same Linux guest.

Optional Strict Password Rules

This new feature enforces strict password rules defined in the User Profiles task if logged on in Access Administrator mode. Strict password rules include creating a password which will expire in 1 to 180 days, at least six characters in length, and consisting of both letters and numbers. For more information on creating passwords, see “User Profiles” in the Hardware Management Console Operations Guide.

Customizable Data Replication

This service provides the ability to configure a set of Hardware Management Consoles to automatically replicate any changes to certain types of data so that the configured set of Hardware Management Consoles automatically keep this data synchronized without manual intervention. For additional information on this service, see “Appendix F. Customizable Replication” in the Hardware Management Console Operations Guide.
Extended Console Logging

The View Console Tasks Performed log size has now been increased to show the last 500 actions. Previously, this log only showed the last 100 events.

Operating System Messages

The Operating System Messages display has been enhanced to display the command line on the first page. A check-box has been added to indicate a “Reply to Priority Message”.

Hardware Management Console Application (HWMCA)

The Hardware Management Console Application (HWMCA) is a licensed software application installed on the Hardware Management Console. The application provides an easy-to-use object-oriented Graphical User Interface (GUI) you use to monitor and operate your CPCs. Starting the application makes the user interface available. You can directly manipulate objects displayed in the Hardware Management Console or Support Element Workplace using a mouse or key combinations. The application begins whenever the console is powered-on or rebooted. For more detail about the Hardware Management Console and SE workplace, refer to the Hardware Management Console Operations Guide and to the zSeries 890 and 990 Support Element Operations Guide. You can also take an education course on Resource Link on How to Use the Hardware Management Console.

Customization

You can use the Hardware Management Console Workplace or Support Element Workplace Settings task to customize the presentation characteristics of the Hardware Management Console or Support Element. These customized settings can be saved to a diskette and used on other Hardware Management Consoles or Support Elements if desired. The Settings task allows you to:

- Modify the default colors or use grey patterns instead of colors.
- Associate a color or pattern with any unacceptable status value you define to distinguish between types of exceptions.
- Change the background color of the Views Area used to indicate exception and non-exception situations.
- Modify the default color associated with pending hardware or operating system messages.
- Enter the Hardware Management Console or Support Element SNA and TCP/IP addresses and domain name.

Status Reporting

Each internal SE monitors the operation of its associated CPC and any CPC images running on the CPC and sends status to the Hardware Management Console for consolidation and exception processing.

Exception processing surfaces only those hardware status items you define as unacceptable to the running of your systems. You can define the conditions for exception processing at the Hardware Management Console or Support Element using the CPC Details panel associated with each CPC or CPC image. The Hardware Management Console and Support Element use customizable panel colors to indicate hardware status requiring attention.
The Hardware Management Console Workplace and Support Element Workplace display hardware status by using color (or grey patterns) to indicate acceptable or unacceptable status for objects. Objects include CPCs, CPC Images, CPs, and CHPIDs. Unacceptable status results in an exception situation that causes the color to change for the:

- Entire Views Area background.
- Object background in the Work Area for the object with the unacceptable status.
- Group object background in the Work Area for any group that the object with the unacceptable status is part of.

The default color change is from green (acceptable status) to red (unacceptable status). You can customize these colors (or patterns) using the Hardware Management Console Workplace or Support Element Workplace Settings task.

**Hardware Messages**

The Hardware Management Console allows you to monitor the hardware messages from any CPC, CPC Images, or any group of CPCs or CPC Images configured to it. The Support Element allows you to monitor the hardware messages from its CPC or any CPC Images configured to it.

The Hardware Management Console Workplace and Support Element Workplace use color (or grey patterns) and flashing icons to indicate when hardware messages are pending for CPCs or CPC Images.

Hardware messages present information about problems that are detected, suggest actions where possible, and aid in requesting service when appropriate. When a message has been handled, it is deleted from all the Hardware Management Console(s) and SE(s).

When hardware messages are pending for a hardware object or group of hardware objects:

- The background of the object and its associated group turns blue (the default)
- The Hardware Messages icon turns blue and flashes.

**Service Required State**

The 'Service Required' state indicates that the spare hardware shipped with the CPC has been depleted. When a part fails causing the use of the last redundant parts of that type, you now have just the required number of parts to keep the CPC running. This message is a reminder to you and the service representative that repairs should be made at the earliest possible time before addition.

The following conditions can cause a Service Required state:

- Loss of bulk power assembly (BPA)
- Primary SE loss of communications with the Alternate SE
- A PU is needed for sparing and none is available
- Insufficient spare PUs to support Capacity BackUp (CBU) or Disaster Recovery Assurance (if either feature is installed)
- Memory Sparing Threshold is reached
- High humidity is sensed inside the machine
- IML will cause CPC to go down or to an unacceptable condition
- Alternate SE is fenced due to automatic switchover.
Degrade Indicator

The text 'Degraded' indicates that, although the CPC is still operating, some hardware is not working. It displays on an object in the CPC group on the remote console, the Hardware Management Console, and on the SEs when:

- Loss of channels due to CPC hardware failure
- Loss of memory
- One or more books are no longer functioning
- The ring connecting the books is open
- Capacity BackUp (CBU) resources have expired
- Processor cycle time reduced due to temperature problem
- CPC was IMLed during cycle time reduction.

Operating System Messages

Local operating systems and coupling facility control code running in a coupling facility logical partition can use the console integration facility of the hardware to send operator messages to be displayed by the Hardware Management Console or Support Element. The Hardware Management Console and Support Element allow you to monitor and respond to the operating system messages from any CPC Image, coupling facility, or any group of CPC Images configured to it.

The Hardware Management Console Workplace and Support Element Workplace use color (or patterns) and flashing icons to indicate when important operating system messages are pending for CPC(s) or CPC Images.

When important operating system messages are pending for a hardware object or group of hardware objects:

- The background of the object and its associated group turns cyan (the default)
- The Operating System Messages icon turns cyan and flashes.

For a coupling facility logical partition, coupling facility control code uses the console integration facility to display coupling facility messages and to accept coupling facility control code commands. The console integration facility, through the Operating System Messages task, provides the only interface for entering commands to an operating coupling facility logical partition.

Problem Analysis and Reporting

Each primary SE monitors and analyzes problems detected on the associated CPC. For problems that are isolated to a single CPC, the results are reported to the Hardware Management Console as a hardware message. For those problems that potentially involve multiple CPCs, that problem data is sent to the Hardware Management Console, where data from multiple CPCs is analyzed and reported. The Hardware Management Console configured as a problem analysis focal point can perform:

- Problem analysis for ESCON, coupling facility, and Sysplex Timer link faults encountered by the CPCs configured to it.
- Service calls for all CPCs configured to it. Enabling the Hardware Management Console as a phone server identifies the Hardware Management Console as having a modem that all CPCs configured to it can use for placing service calls.

Virtual RETAIN®

The Virtual RETAIN function provides a way to capture problem data when a problem is to be called into IBM service and RETAIN is not available. If RETAIN is not available, the problem data is put into Virtual RETAIN on the Support Element.
hard disk, and a Hardware Message is displayed for the Hardware Management Console, SE, and/or remote console user to instruct the customer to contact IBM Service to gather the problem data.

Licensed Internal Code (LIC)

Each Hardware Management Console and each SE has Licensed Internal Code (LIC) and is subject to periodic updates from IBM.

On systems with multiple Hardware Management Consoles, one of the Hardware Management Consoles should be configured as a LIC change management focal point. The Hardware Management Console configured can:

- Retrieve and distribute Licensed Internal Code updates for the Hardware Management Consoles remotely from IBM.
- Retrieve and distribute SE LIC updates to all the SEs of all the CPCs configured to the Hardware Management Console.

Remote I/O Configuration and IOCDS Management

Each CPC requires a definition of the I/O attached to it. The Hardware Configuration Definition (HCD) is an OS/390 and z/OS application that aids in the definition of all the I/O and aids in the distribution of the appropriate I/O definitions to the appropriate CPC(s).

The Hardware Management Console configured as a change management focal point assists HCD in finding the names of all defined CPCs. A single HCD then distributes the appropriate IOCDS and IPL parameters to the various SEs of the CPCs defined to the same Hardware Management Console with change management capability.

Scheduled Operations

The Hardware Management Console and Support Element provide support for scheduling the times and dates for automatic Licensed Internal Code (LIC) updates and backup of critical hard disk data for the CPC(s) configured to the Hardware Management Console or Support Element. You can accomplish this by using the Scheduled Operations task available from the CPC Operational Customization Tasks list.

On the Hardware Management Console the Scheduled Operations task allows you to schedule the following LIC-related operations:

- Single Step code changes retrieve and apply
- Backup critical hard disk information
- Accept internal code changes
- Retrieve internal code changes for defined CPCs
- Retrieve concurrent code changes
- Install internal code changes/Activate
- Transmit electronic service agent
- Transmit system availability data
- Remove internal code changes/Activate.

On the SE the Scheduled Operations task allows you to schedule the following LIC-related operations:

- Single step code changes retrieve and apply
- Backup critical hard disk information
- Accept internal code changes
- Install concurrent code changes/Activate
Remote Support Facility (RSF)

The Hardware Management Console provides Remote Support Facility (RSF) to aid in the service and maintenance of your system. RSF provides:
- Automatic or customer initiated call for service
- Automatic or customer down-loading of the latest LIC change levels.

IBM Service Support System support of Hardware Management Console-attached processors will be switched (TCP/IP or SNA depending on the installation) by links on the Hardware Management Console to an IBM Service Support System.

Automation and API Support

Application Programming Interfaces (APIs) on the Hardware Management Console and Support Element provide an end-user with the ability to view and manipulate managed objects, and support of the SNMP protocol for development and use by remote management applications.

These APIs contain the ability to get/set a Hardware Management Console or Support Elements managed object's attributes, issue commands to be performed on a managed object from a local or remote application, and receive asynchronous event notifications. These APIs provide a mechanism to IBM, independent system management vendors, and an enterprise, to integrate with the Hardware Management Console Application (HWMCA). For more detailed information on the APIs, refer to zSeries Application Programming Interfaces.

Activation

Activating a CPC is an intelligent (LIC controlled) process that takes the CPC from its current state to a fully operational state. The activation may involve a power-on, power-on reset, and IPL, as necessary.

To activate a CPC, you must specify system activation information for each CPC configured to the Hardware Management Console.

You specify the CPC system activation information using activation profiles. Activation profiles allow you to define multiple power-on reset (POR) configurations for the same CPC. These profiles allow you to tailor the CPC resources (central processors, storage, and channels) to meet varying business and workload needs.

You use activation profiles to define PR/SM LPAR mode configurations. Activation profiles are stored on the SE hard disk so that they are available for future activate requests.

You can modify default activation profiles that are provided with the CPC and use them as templates to produce customized profiles to fit your processing needs.

There are three types of activation profiles you can produce:
- Reset - Used during power-on reset processing
Load - Used to load an operating system
Image - Used to define a logical partition.

For PR/SM LPAR mode, you must define a Reset profile and one Image profile for each logical partition.

Hardware Management Console and Support Element Wiring Options

A local Hardware Management Console must be connected to its Support Elements via a Local Area Network (LAN) wiring. z890 provides both Token Ring and Ethernet options for the LAN wiring between the Hardware Management Console and the Support Elements. The necessary LAN adapters for the Support Elements and the Hardware Management Console may be specified as features on the system order.

For the Support Element you have a choice of Support Element options on the system order. You can choose from either a Dual Ethernet Support Element (FC0087) or a Token Ring and Ethernet Support Element (FC 0086).

For the Hardware Management Console you have a choice of Hardware Management Console options on the system order. You can choose from either a Dual Ethernet Hardware Management Console (FC 0077) or a Token Ring and Ethernet Hardware Management Console (FC 0078).

This combination of adapter options leads to four possible LAN attachment scenarios:
- Token Ring only
- Ethernet only - one path
- Ethernet only - two paths
- Token Ring and Ethernet.

For more detailed information on these four wiring options, refer to zSeries 890 Installation Manual for Physical Planning.

Security Considerations

Since multiple Hardware Management Consoles and internal SEs require connection via a LAN, and remote connections are possible, it is important to understand the use and capabilities enabled for each Hardware Management Console.

Hardware Management Consoles operate as peers with equal access to the CPCs configured to them. The SE for each CPC serializes command requests from Hardware Management Console Applications on a first come, first served basis. There is no guarantee of exclusive control across a sequence of commands sent from a single Hardware Management Console.

You should consider these security recommendations:
- Following installation of the CPC(s), Hardware Management Console(s), and SE(s) in your configuration, the access administrator should change the default logon passwords at the Hardware Management Console(s) and SE(s).
- Define the Hardware Management Console(s), all SE(s), all CPC(s), and all attaching control unit(s) to a private LAN.

Using a private LAN for your configuration offers several security, availability, and performance advantages as follows:
– Direct access to the LAN is limited to the Hardware Management Console(s), SE(s), CPC(s), and control unit(s) attached to it. Outsiders cannot connect to it.

– Traffic disruption due to temporary outages on the LAN is reduced, including disruptions caused by plugging in and powering on new devices on the LAN (minor) to LAN adapters being run at the wrong speed (catastrophic).

– LAN traffic is minimized reducing the possibility of delays at the Hardware Management Console/SE user interface.

Additionally, Hardware Management Console and SE activity, if included on a non-private LAN, could potentially disrupt other LAN activity.

• If using a private LAN is not practical, isolate the LAN used by the Hardware Management Console(s), SE(s), CPC(s), and control unit(s) by providing a LAN bridge or router between the isolated LAN and the backbone LAN to provide an intermediate level of isolation.

Important: If the LAN bridge exists between a Hardware Management Console and the SE(s), the LAN bridge must allow SNA, TCP/IP, and NetBios traffic to flow across the bridge for automatic discovery of SEs by the Hardware Management Consoles. Refer to “Remote Operations” on page 9-11 for remote operation information.

• Assign a unique domain name that includes all the CPCs controlled from one or more Hardware Management Consoles.

• Install one or more Hardware Management Consoles that have all of the CPCs you want to control defined to it.

Place at least one of these Hardware Management Consoles in the machine room near the CPCs that form its domain.

The following ‘enable/disable’ controls are provided to help you control access and provide focal point capabilities:
– Licensed Internal Code (LIC) update (change management focal point)
– Remote service support
– Remote customer access
– Remote service access
– Auto-answer of the modem.

• Physically secure the Hardware Management Console (keep it in a locked room).

• If a remote console is used for remote operations access, assign a secure logon password.

• Logoff each Hardware Management Console when it is not in use. The Hardware Management Console provide a status bar capable of displaying status colors (or grey patterns) to alert you when operator activity is needed, even when no one is logged on.

• Use the OS/2 lockup function to lock the Hardware Management Console keyboard(s) after a predetermined period of keyboard inactivity has expired (if this does not disrupt your site's operating habits).

• Customize the Hardware Management Console’s secure desktop setting to control whether console users have access to other applications and objects on the console's OS/2 desktop.

• Establish a limited list of objects and actions available to the operator.

Change Management Considerations

If you want to limit the number of Hardware Management Consoles that have change management capability (for example, LIC update control and I/O definition and remote IOCDS management capability using HCD), only enable the LIC update capability for those Hardware Management Consoles to be used as change
Remote Access Considerations

If you want to allow remote access to Hardware Management Consoles, only enable auto-answer of the modem for the Hardware Management Consoles you want to be able to control from a remote console. Remote access is then funneled through the Hardware Management Consoles you designate.

I/O Configuration

When installing the z890 CPC, you must define the I/O configuration to the channel subsystem (CSS) of the CPC. The CSS for a CPC controls the communication between the CPC (or the logical partitions on the CPC), its channels, and any control units and devices attached to the channels.

To do this, you must create the source necessary to build an input/output configuration data set (IOCDS) that contains the appropriate I/O configuration information for the CPC.

Recommended Approach

If you are upgrading an existing CPC, you may be able to write an IOCDS to your current CPC in preparation for the upgrade using the batch version of IOCP or by using HCD. The batch version of IOCP is available on the following operating systems: OS/390, z/OS, z/OS.e, z/VM, and VSE/ESA. The Hardware Configuration Definition (HCD) tool is available on OS/390, z/OS, z/OS.e, and z/VM. Refer to the zSeries z890 and z990 Input/Output Configuration Program User’s Guide for ICP IOCP to determine which CPCs can write an IOCDS in preparation for an upgrade and which CPCs can have an IOCDS written to them by IOCP. If you can write an IOCDS to your current CPC in preparation for upgrading it to a new CPC, do so and inform the service representative which IOCDS should be used.

If you are not upgrading or cannot write an IOCDS in preparation for the upgrade, stand-alone IOCP must be used to define the initial IOCDS for your CPC. It is your responsibility to supply the service representative who installs the CPC with an I/O Configuration Source (IOCS) file, consisting of IOCP card-image input statements. HCD users should use HCD to define the I/O configuration and then build the IOCP input data set (i.e. the IOCS). The IOCS contains specific data about the I/O configuration. An IOCS file must contain ASCII data. It must either be in DOS file format or have been compressed (e.g. using a zip compatible program). If the file is compressed, it must contain a single IOCS file. The IOCS file name must have a maximum of eight characters and the file extension must have a maximum of three characters. Either give the service representative a diskette containing the IOCS file or, if the Hardware Management Console is not being upgraded, copy the IOCS file to the Hardware Management Console hard drive and inform the representative of its location. Refer to the zSeries 890 and 990 Stand-Alone Input/Output Configuration Program User’s Guide for more information.

Coupling Facility Continuous Availability

You can use z/OS HCD running on a z890 model CPC to remotely write an IOCDS to z900 or z800 coupling facility model, to a 9674 coupling facility, to another z890 model, to a z990, z900, or z800 server, to an S/390 G6, G5, G4, or G3 Enterprise Server, or to an IBM Enterprise Server CPC that is running a coupling facility logical...
partition as long as both CPCs are configured to the same Hardware Management Console with change management capability.

**Note:** The following information applies to a Coupling Facility-only model or a CPC with only ICF PUs.

The IOCDS can then be used during activation of the CPC serving as a coupling facility. However, you cannot use HCD to dynamically add or delete channel paths defined in the coupling facility channel configuration.

This can be a problem if you want to add CPCs or logical partitions to a Parallel Sysplex configuration to increase its processing capacity. In this case, you need to define and, possibly install, additional coupling links (ISC-3 or ICB) to connect from the coupling facility to the newly added CPCs or LPARs.

Defining additional coupling links to the coupling facility I/O configuration requires you to update or create a new IOCDS to include the additional coupling link definitions, deactivate the coupling facility, then re-POR and reactivate the coupling facility using the updated or new IOCDS.

In either case, you could cause a partial or complete disruption of data sharing capacity characteristics of the coupling facilities in the Parallel Sysplex configuration. To avoid this situation and to enhance the continuous availability of the Parallel Sysplex configuration, you should consider doing the following:

- Pre-define a maximum number of coupling links in the coupling facility IOCDS whether they are installed or not. The extra links that you configured will show up as non-operational. (This is not a practical choice unless you know previously where the new hardware will be plugged into your machine.)

This will eliminate the need to create or modify an IOCDS and re-POR the coupling facility to add the coupling links to the I/O configuration when additional CPCs are added to the Parallel Sysplex configuration. However, you must know if the new links will be for peer (e.g. CFP) or for compatibility mode (e.g. CFR).

**Non-Dedicated Coupling Facility Configurations:** If the coupling facility is not the only logical partition running on the CPC you can use dynamic I/O from your non-CF (z/OS or z/VM) LPARs to add the new coupling hardware to the configuration definition and CFCC configuration commands to vary the new hardware into the CF logical partition.

### Remote Operations

The z890 hardware systems management products support remote operations in a variety of ways over a variety of communications connections. In each case, the objective is to enable a human or programmed operator to monitor or control a remote system in essentially the same manner as if the operator were at the same site as the remote system.

Remote operations become increasingly important as:

- Data center operations and staff consolidate, with operations centers separate from those data centers.
- Companies and their DP staffs merge.
- World-wide operations become more common.

Remote operations capability becomes a significant factor in determining overall system requirements.
The ability to monitor or control a system from a central or remote location creates a powerful tool for problem determination and diagnosis and operations assistance. This remote capability can save time and money and increase the productivity of support staff. Technical expertise can be centralized, reducing the need for highly skilled personnel at remote locations.

When considering ‘remote’ operation of zSeries processors, there are several options available. You may use one or more of these options, based on your needs and configuration.

The first set of options deal with manual interaction and provide various methods of allowing a person to interact with the user interface. Manual control allows an operator to monitor and control the hardware components of the system using:

- Hardware Management Console
- Web browser
- Remote control program management product.

A second set of options deal with machine interaction and provide methods of allowing a computer to interact with the consoles through an Application Program Interface (API). These Automated interfaces allow a program to monitor and control the hardware components of the system. The automated interfaces are used by various automated products, including:

Figure 9-2. Remote Operation Example Configuration
Manual Remote Operations

Manual remote operations are designed for human interaction. A Graphical User Interface (GUI) is used providing a state-of-the-art user interaction technique. This interface allows an operator to monitor and control the hardware components of the system from anywhere when you have the appropriate connectivity between the remote control device and the Support Element.

Using a Hardware Management Console

If you need continuous monitoring of the remote system and you have LAN connectivity between the sites, the best choice for remote control is the use of a remote Hardware Management Console. Remote versus local operation of a system is a function of the communication path and supported protocols, not the physical distance between the system and its controlling Hardware Management Console.

A remote Hardware Management Console gives the most complete set of functions because it is a complete Hardware Management Console; only the connection configuration is different from a local Hardware Management Console. It also provides the same interface as is used locally so no additional operator training is required.

A remote Hardware Management Console may be connected using either Token Ring or Ethernet wiring and either TCP/IP or SNA protocols. Using a Hardware Management Console allows multiple control points for the systems and allows multiple sites to be controlled from a single Hardware Management Console assuming that appropriate connectivity exists.

Performance (that is, time to perform an operation) associated with remote Hardware Management Console to SE communication is very good due to the concise nature of the messages. However, single object operation can be highly sensitive to transfer rates and network traffic. Availability of the status information and access to the control functions are highly dependent on the reliability, availability and responsiveness of the customer network that interconnects the remote Hardware Management Console with the Support Elements.

A remote Hardware Management Console monitors the connections to each SE and attempts to recover any lost connections and reports those that cannot be recovered.

Security for a remote Hardware Management Console is provided by the Hardware Management Console user logon procedures, the secure transmissions between the Hardware Management Console and SEs, and domain security controls.

Using a Web Browser

A second 'remote operation' option that can be considered is the use of a Web Browser to monitor and control a local Hardware Management Console and its configured SEs.

A Web Browser would be a good choice when occasional monitoring and control of SEs connected to a single local Hardware Management Console is desired. An example of use of the Web Browser might be an off-hours monitor from home by an operator or system programmer.
Each current Hardware Management Console has a 'Web Server' built in. When enabled and properly configured, a Hardware Management Console can provide a representation of the Hardware Management Console user interface to a Web Browser connected through the customer provided LAN (either Ethernet or Token Ring) or an asynchronous SLIP (Serial Line Internet Protocol) dial connection, using TCP/IP protocols. The browser interface is selected from the Hardware Management Console home page. Refer to the Hardware Management Console Operations Guide for a description of browser support.

The functions available through the browser interface are limited to:

- Monitoring system activity
- Monitoring of status, monitoring and responding to operating system messages and hardware messages
- Performing activate, deactivate, load, reset, PSW restart, system activity, configure channel path on/off tasks
- LPAR controls for partitioning weights and capping
- Customizing activation profiles
- Changing the TOD (on Hardware Management Console only) to support daylight savings time changes
- Reassigning CHPIDs between logical partitions.

Because any connection to a Hardware Management Console from the Web Browser can potentially affect the operation and/or availability of the Hardware Management Console and the CPCs that it controls, it is important that security be given adequate consideration.

For LAN based communication, the Hardware Management Console must be connected through a Token Ring LAN or an Ethernet LAN and must be connected to the enterprise Intranet via the appropriate router or bridge.

For SLIP connections, the Hardware Management Console must be enabled to accept incoming calls via a locally attached modem.

Performance associated with browser traffic is normally very good. Reliability of the status information and the availability of the control functions is dependent on the reliability, availability, and throughput of the interconnecting network.

Security for a browser connection is provided by the Hardware Management Console enablement functions, Hardware Management Console user logon controls, and customer network access controls. Encryption of the browser data may be added by selecting the 'Enable Secure only' selection.

Refer to the Hardware Management Console Operations Guide for Web Browser requirements and information on getting ready to configure and use the Web Server and things to consider during your Web session.

**Using Remote Control Program Management Products**

Remote control of a Hardware Management Console can be best achieved through the Web Browser interface using TCP/IP protocols. If this is not possible or acceptable, there are program products that provide similar functionality using SNA protocols.

If you need only occasional or short duration monitoring and control of the remote system using SNA, then a program product (such as DCAF, NetOp for OS/2, or
Remote Services Management) that can provide remote control of a local Hardware Management Console user interface may be an acceptable solution. An example of this use might be an emergency switched connection backup to a remote Hardware Management Console.

Even though the DCAF product has been withdrawn from marketing by IBM, the Hardware Management Console will continue to support its use. Each current Hardware Management Console has the ‘target’ portion of DCAF built in. When enabled and properly configured, a Hardware Management Console can present the Hardware Management Console user interface to a DCAF controller connected through customer provided LAN (either Ethernet or Token Ring) using TCP/IP or SNA protocols or a switched connection using either TCP/IP or SNA protocols. One way to connect using DCAF to a remote Hardware Management Console is via TCP/IP through a SLIP.

All local Hardware Management Console functions are available through this type of interface. Single object operation is available through this interface.

Performance of this class of remote operation is generally slower than other options and in particular, switched connections should be considered for emergency use only as they are usually very slow.

Availability of the status information and the access to the control functions is dependent on the reliability, availability and throughput of the interconnecting network.

Security is provided by the Hardware Management Console enablement functions, Hardware Management Console user logon controls, and customer network access controls.

**Manual Remote Operations Control Characteristics**

When planning for manual remote operations, there are a number of control characteristics which should be considered. Following is a list of details which should be included in those considerations:

- **Security:**
  - User Authentication
  - User access to specific tasks
  - Connectivity and activity logs
  - User network access controls.

- **Connectivity Options:**
  - Ethernet
  - Token Ring
  - Switched Synchronous Link.

- **Protocol Options:**
  - TCP/IP
  - SNA, switched and non-switched.

- **Platform Options:**
  - Windows® NT, 2000, XP Professional
  - Linux
  - OS/2.

- **Ease of Installation**
- **Configuration Requirements.**

Table 9-1 on page 9-16 displays remote control characteristics.
Table 9-1. Remote Control Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>For the Hardware Management Console</th>
<th>For the Web browser</th>
<th>For Remote Control Program Management Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connectivity</td>
<td>Ethernet and/or TR</td>
<td>Ethernet and/or TR</td>
<td>Ethernet and/or TR, Switched</td>
</tr>
<tr>
<td>Protocol</td>
<td>TCP/IP or SNA</td>
<td>TCP/IP</td>
<td>TCP/IP, SNA</td>
</tr>
<tr>
<td>Platform</td>
<td>Hardware Management Console</td>
<td>Windows (NT, 2000, XP Professional), Linux, OS/2</td>
<td>Product Dependent</td>
</tr>
<tr>
<td>Easy Installation and Setup</td>
<td>Yes (Preconfigured by IBM)</td>
<td>Yes</td>
<td>Product Dependent</td>
</tr>
<tr>
<td>Minimum Configuration</td>
<td>Full Hardware Management Console</td>
<td>PC Platform + browser</td>
<td>PC Platform + remote control program mgmt product + communication program</td>
</tr>
<tr>
<td>Security</td>
<td>Logon Controls</td>
<td>Logon Controls</td>
<td>Logon Controls</td>
</tr>
<tr>
<td></td>
<td>Function Access Controls</td>
<td>Function Access Controls</td>
<td>Function Access Controls</td>
</tr>
<tr>
<td></td>
<td>SNA LU-LU Security</td>
<td>User network access controls</td>
<td>User network access controls</td>
</tr>
<tr>
<td></td>
<td>User network access controls</td>
<td>SSL data encryption optional</td>
<td>SSL data encryption optional</td>
</tr>
<tr>
<td></td>
<td>Hardware Management Console Domain Security</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Advantages and Disadvantages of Manual Remote Operations

The following table displays the advantages and disadvantages of manual remote operations.

Table 9-2. Advantages and Disadvantages of Manual Remote Operations Control

<table>
<thead>
<tr>
<th>Manual Control</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| Hardware Management Console  | • IBM Product, integral part of product.  
• Supports choice of TCP/IP or SNA protocol.  
• Supports Ethernet and/or TR connectivity.  
• Performance good on Ethernet and TR.  
• Full functionality.  
• Shares control with other Hardware Management Consoles.  
• Same installation as other Hardware Management Consoles.  
• Security good - uses SNA LU-LU security. | • Minimum configuration requires purchase of Hardware Management Console.  
• Each Hardware Management Console requires LIC maintenance. |
| Web Browser                   | • Performs well across Ethernet or TR.  
• Supports TCP/IP protocol.  
• Can connect to multiple Hardware Management Consoles in separate windows.  
• Can be integrated with user Windows applications or OS/2.  
• Supports Windows (NT, 2000, XP Professional), OS/2, and Linux.  
• Provides full functionality.  
• Easy install and setup. | • Does not support SNA only configurations. |

9-16  z890 System Overview
Table 9-2. Advantages and Disadvantages of Manual Remote Operations Control (continued)

<table>
<thead>
<tr>
<th>Manual Control</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote Control Program Mgmt Product</td>
<td>• Performs well across Ethernet and TR.</td>
<td>• May be difficult to install and setup.</td>
</tr>
<tr>
<td></td>
<td>• Reliable using SNA.</td>
<td>• Transmission not secure.</td>
</tr>
<tr>
<td></td>
<td>• Provides full functionality.</td>
<td>• Performance very slow across switched links.</td>
</tr>
<tr>
<td></td>
<td>• Supports TCP/IP, SNA protocols.</td>
<td>• Does not allow shared control.</td>
</tr>
<tr>
<td></td>
<td>• Can connect to multiple Hardware Management Consoles, in separate windows.</td>
<td>• Not offered as IBM product.</td>
</tr>
<tr>
<td></td>
<td>• Can be integrated with user applications.</td>
<td></td>
</tr>
</tbody>
</table>

Automated Remote Operations

The following interface is available for automation:

- The Hardware Management Console APIs provide monitoring and control functions via TCP/IP SNMP to a Hardware Management Console. These APIs provide the ability to get/set managed object's attributes, issue commands, receive asynchronous notifications, and generate SNMP traps.

Controls Available for Automated Remote Operations

Following is a list of controls available for automated remote operations in the Hardware Management Consoles and Support Elements:

- Based on TCP/IP SNMP
- Provide SNMP traps for state change and problem notification
- Supports 'console integration' interface to the operating system.
Chapter 10. Reliability, Availability, and Serviceability (RAS)

The z890 reduces downtime by using standard features that provide high levels of Reliability, Availability, and Serviceability (RAS). The features for z890 include:

- Processor Unit (PU) sparing
- CFCC enhanced patch apply
- Concurrent upgrade
- Sparing for storage protect keys
- Failure containment for the Memory Bus Adapter (MBA)
- Firmware Simulation.

Reliability

The features that provide a high level of reliability include the following:

- High-reliability technology components
- Parts integration to reduce the number of parts in the machine
- MCM System Run-In Test in manufacturing to reduce very early life fails.

Availability

The features that provide a high level of availability include those that are discussed in this section.

Processor Unit (PU) Sparing

In the rare case of a PU failure, the failed PUs characterization is dynamically and transparently reassigned to a spare PU. PUs not purchased by or reserved for a client will be available for transparent sparing and no repair action will be initiated as a result. Reserved, but currently unused, PUs will be available for sparing but will generate a repair action. Where there are no available PUs, a failure will cause you to run degraded by one processor until a repair action can be completed.

CFCC Enhanced Patch Apply

The CFCC patch apply process has been enhanced to eliminate the need for a Power On Reset (POR) of the z890 to apply a “disruptive” CFCC patch. For more information, refer to "CFCC Enhanced Patch Apply" on page 6-7.

Concurrent Upgrade

A z890 can be upgraded via the concurrent addition of additional Processor Units (PUs) and I/O and limited memory upgrades (24GB to 32GB increment) with no disruption to current operations. However, while capacity upgrades to the processor itself are concurrent, your software may not be able to take advantage of the increased capacity without performing an Initial Program Load (IPL).

Sparing for Storage Protect Keys

The robust configuration of the Storage Protect Keys has chip sparing. Already a triple-array with parity protection and voting, the Key structure for z890 has sparing, similar to Main Memory chip sparing, to enhance the availability of this critical function.
Failure Containment for the Memory Bus Adapter (MBA)

Memory Bus Adapters are designed to provide the critical link between the z890 Processor Units and the I/O subsystem. The Model A04 has two MBAs. In the unlikely event of a catastrophic failure of an MBA chip, the z890 is designed to isolate the failure of that chip such that the remaining MBA chip continues to operate. This helps minimize the impact of a failure and allows for scheduling maintenance.

Firmware Simulation

The z890 process for design, development, and test of Licensed Internal Code (LIC) used firmware simulation to improve quality. Virtually every action/reaction of the code can be tested with the simulated hardware/code of the rest of the server. The result is to discover and correct design errors earlier in the process.

Processor Design

Each Processor Unit (PU) contains dual instruction and execution units that are used to verify internal operation and which operate simultaneously. Results are compared, and in the event of a miscompare, Instruction Retry is invoked. This design simplifies checking, and virtually eliminates PU failures due to soft errors.

Support Element (SE)

The z890 has two Support Elements (SEs). In the event of failure on the primary SE, the switchover to the alternate is usually handled automatically.

Hardware Management Console

One Hardware Management Console is required for system monitoring and operation of the CPC(s) configured to it. For high availability applications, it is recommended that you have at least two Hardware Management Consoles for your configuration to guarantee that the Hardware Management Console functions are available when needed.

The Hardware Management Console is concurrently maintainable with the operation of the CPCs configured to it. Having more than one Hardware Management Console provides continuous availability of Hardware Management Console functions, including the following:

- Hardware operator controls, hardware status monitoring, and hardware and operating system messages for all configured CPCs
- Capability to call for service
- Remote operations control
- Problem Analysis.

Hardware Management Console Pager

The Hardware Management Console Pager is available on the z890. The Message and State Monitor facilities of the Hardware Management Console can be enabled to send text notification to a personal paging device whenever a specific message is received from either the hardware subsystem or an operating system, or when a CPC (hardware object) or a CPC Image (Operating system object) changes from one ‘state’ to another ‘state’. The ‘state’ of an object represents its current condition and functional capability, so a state change represents a change in functional capability that may require attention. Hardware and operating system messages are intended to keep the operator informed of conditions that may require attention. However, not all messages and not all state changes are important; only specific ones require attention and notification of a responsible person.
Application Preservation

Application Preservation is used in the case where a CP fails and there are no spares. The state of the failing CP is passed to another active CP where the operating system (z/OS...) uses it to successfully resume the task in most cases without customer intervention.

Dynamic ICF Expansion

Dynamic ICF Expansion is a function that allows an ICF logical partition with dedicated ICF processors to acquire additional processing power from the logical partition pool of shared CPs or shared ICFs being used to execute production and/or test work on the system. This function is very useful when the CF logical partition in some general purpose models backs up another CF logical partition. In the event of a failure and backup to this CF logical partition, the backup CF logical partition, using Dynamic ICF Expansion, can acquire additional processing capacity to handle the full CF logical partition workload. Also, Dynamic ICF Expansion can be used to handle a peak workload situation when the CF logical partition is being used as the primary coupling facility. This feature adds considerable flexibility to the configurability of the CF logical partitions in general purpose models and optimizes the use of the processing power in the system.

The Dynamic ICF Expansion feature is available to every CF logical partition with dedicated ICF processors using coupling facility links. Each ICF coupling facility partition has its own ability to specify the number of ICF features that are dedicated to that partition and the amount of additional capability it can acquire. The trade off between using ICF features and the CPs in the logical partition shared pool is the exemption from software license fees. Dynamic ICF Expansion is available on general purpose models that have at least one ICF.

Dynamic Coupling Facility Dispatching

The dynamic Coupling Facility (CF) dispatching function helps enable continuous computing in the event of a coupling facility failure without requiring a standalone backup coupling facility. Enhanced dispatching algorithms enable you to define a backup coupling facility in a logical partition on your system. While this logical partition is in backup mode, although it is sharing resources with other logical partitions running other active workload, it uses very little processor resource. When the backup CF becomes active, only the resource necessary to provide coupling is allocated.

Error Checking and Correction (ECC)

Memory error checking and correction code detects and corrects single bit errors. Also, because of the memory structure design, errors due to a single memory chip failure are corrected.

Memory Sparing

The z890 does not contain spare memory DIMMs. Instead it has redundant memory distributed throughout its operational memory and these are used to bypass failing memory. Replacing memory cards requires power-off of the book and this is disruptive. The extensive use of redundant elements in the operational memory greatly minimizes the possibility of a failure that requires memory card replacement.

Memory Scrubbing

Storage background scrubbing provides continuous monitoring of storage for the correction of detected faults before the storage is used.
LPAR Dynamic Storage Reconfiguration
PR/SM LPAR storage reconfigurations can occur allowing nondisruptive add or removal to any partition with a cooperating guest. This capability removes the restriction of storage reconfigurations only being possible from an adjacent and above logical partition.

Subsystem Storage Protect
Subsystem storage protection and subspace group facility support, for use with CICS/ESA, prevents application software from overwriting CICS system software, control blocks, and address spaces.

Dynamic I/O Configuration
Dynamic I/O configuration enhances system availability by supporting the dynamic addition, removal, or modification of channel paths, control units, I/O devices, and I/O configuration definitions to both hardware and software without requiring a planned outage.

ESCON Port Sparing
ESCON 16-port I/O card includes one unused port dedicated for sparing in the event of a port failure on that card. Other unused ports are available for growth of ESCON channels without requiring new hardware.

FICON Cascaded Directors
FICON cascaded directors allow a native FICON (FC) channel or a FICON Channel-to-Channel (CTC) to connect a server to a device or other server with two native FICON directors between them. This is only for a two-switch configuration.

FCP Full-fabric Connectivity
The FCP full-fabric connectivity supports multiple numbers of directors/switches that can be placed between the server and the FCP/SCSI device, thereby allowing many hops through a storage network for I/O connectivity.

Maintenance/Upgrade for Coupling
The z890 provides concurrent maintenance for the ISC-3 adapter card. Also, ISC-3 coupling links may now be added concurrently. This eliminates the need for scheduled downtime in the demanding sysplex environment.

Concurrent Channel Upgrade
It is possible to concurrently add ESCON, FICON, ISC-3, and OSA channels to an I/O cage provided there are unused channel positions in the I/O cage. In addition, ICBs and their associated STI cables can be added provided there are unused cable jack positions. This capability may help eliminate an outage to upgrade the channel configuration.

Dual Power Feeds
The power system offers dual primary (AC) power feeds. Each feed is electrically isolated and enables redundant power paths to each server. To take full advantage of the redundant power paths built into the z890, it is necessary to provide dual electrical service to the server to minimize any outage due to a single-path power interruption.
Redundant Power and Thermal Subsystems

The DC power and thermal subsystems are designed with N +1 redundancy. Failure of a power or thermal component does not cause a system outage.

Redundant Flexible Service Processors

The z890 Power and Service Control Network features redundant cage controllers for logic and power control. This design enables non-disruptive service to the controllers and eliminates customer scheduled outage.

Oscillator (OSC) and External Timer Reference (ETR) cards

There are two standard OSC cards and two optional ETR cards on z890. An ETR card failure will automatically switch to the other ETR card; the effectiveness of this action depends on the proper planning of the external ETR connections. An OSC card failure will stop the server. A subsequent IML will cause a switch to the alternate OSC card and the failed card can be replaced without additional disruption.

Preferred Time Server and Backup Time Server

In an STP-only CTN configuration, it is required that at least one server is defined as the Preferred Time Server. It is also required that a Current Time Server is assigned. The Current Time Server (the Stratum 1 server) has the highest level of hierarchy in the STP-only CTN and has connectivity to the servers designated as Stratum 2 servers. If only a Preferred Time Server is defined in an STP-only CTN, it is assigned as the Current Time Server.

If there is a failure in the Preferred Time Server, synchronization fails if a backup configuration is not established. Therefore, it is highly recommended that a Backup Time Server is defined in an STP-only CTN. The Backup Time Server is normally a Stratum 2 server that has connectivity to the Preferred Time Server, as well as to all other Stratum 2 servers that are connected to the Preferred Time Server. By providing this connectivity, the Backup Server can easily take over as the Current Time Server if there is a failure with the Preferred Time Server or if a reconfiguration is planned. Therefore, the servers in the STP-only CTN can maintain synchronization.

Concurrent Hardware Maintenance

Concurrent maintenance enables the replacement of failed units concurrently with system operation. This enhances the processor availability by eliminating the need for system outage to effect the repair. Concurrent maintenance capability exists for the following elements:

- Power
- Thermal
- ESCON cards
- FICON cards
- OSA feature cards
- PCI Cryptographic Coprocessor feature
- PCI Cryptographic Accelerator feature
- ISC-3 feature card
- ICB (ICB-4 and ICB-3) STI cable
- OSC card
- ETR card
- Crypto
- Hardware Management Console
Concurrent Licensed Internal Code (LIC) Patch

Concurrent Code Patch allows the activation of a patch concurrent with system operation thereby increasing the availability of the processor by reducing scheduled outage for LIC maintenance. This capability exists for code for the following elements:

- CP
- SAP
- Cage Controllers
- LP
- CFCC
- Power
- Thermal
- ESCON channels
- FICON channels
- FCP channels
- OSA channels
- PCIXCC
- PCICA
- ISC-3 channels
- ICB channels
- IC channels
- HiperSockets
- Hardware Management Console
- Support Element
- Crypto.

Notes:
1. OSA-Express channels always require CHPID vary off/vary on cycle to activate LIC patches.
2. Concurrent patch support is available for OSA-Express2 features.

Electronic Service Agent™ (Service Director™)

Electronic Service Agent (Service Director) will have I/O error data collected by a component integral to the operating system, forwarded from the operating system to a Problem Analysis focal point application in a z890 Hardware Management Console, and then to an eService server in IBM. eService provides the analysis of the data and provides various users access to the data on the eService server through a web browser interface.

Internal Battery Feature (IBF)

The Internal Battery Feature (IBF) provides backup input power. The feature is packaged internal to the machine. It can be used with a UPS to provide additional protection.

Redundant Coupling Links

Redundant Coupling Links and ICBs can be configured between a processor and the Coupling Facility. This potentially removes a single point of failure for the processor’s data sharing capability in the Parallel Sysplex environment.
System-Managed CF Structure Duplexing (CF Duplexing)

A set of architectural extensions to the Parallel Sysplex is provided for the support of System Managed CF Structure Duplexing (CF duplexing) of coupling facility structures for high availability.

Installing this software and microcode, and enabling this function is designed to:

- Provide the necessary base for highly available coupling facility structure data through the redundancy of duplexing.
- Enhance Parallel Sysplex ease of use by reducing the complexity of CF structure recover.
- Enable some installations to eliminate the requirement for standalone CFs in their Parallel Sysplex configuration.

On/Off Capacity on Demand (On/Off CoD)

When your business needs short term additional capacity, On/Off Capacity on Demand (On/Off CoD) is designed to deliver it. On/Off CoD is designed to temporarily turn on uncharacterized Processor Units (PUs) available within the current machine, as CPs, Integrated Coupling Facilities (ICFs), IFLs, and zSeries Application Assist Processors (zAAPs).

Activation of this capability is mutually exclusive with Capacity Backup Upgrade (CBU) activation. Both On/Off CoD and CBU can reside on the server, but only one can be activated at a time. On/Off CoD is delivered through the function of Customer Initiated Upgrade (CIU). To participate in this offering, you must have installed CIU Enablement (FC 9898), and On/Off CoD Enablement (FC 9896). Subsequently, you may concurrently install temporary capacity by ordering On/Off CoD Use Days (one of FC 6121 through FC 6471), On/Off CoD Active IFLs (FC 9888), On/Off Active ICFs (FC 9889), or On/Off CoD Active zAAP (FC 9893) up to the current capacity setting or the number of IFLs, ICFs, and zAAPs, respectively, and use the additional capacity for an indeterminate time.

On/Off Capacity on Demand (On/Off CoD) No-Charge Test

The On/Off Capacity on Demand (On/Off CoD) test can be used to validate the processes to download, activate, and deactivate On/Off CoD capacity non-disruptively. Each On/Off CoD-enabled server is entitled to one no-charge test. The test may run for a maximum duration of 24 hours beginning with the download and activation of an On/Off CoD order. In addition to validating the On/Off CoD function, you can use this test as a training session for personnel who are authorized to activate On/Off CoD.

Capacity Upgrade on Demand (CUoD)

Capacity Upgrade on Demand provides the capability to add CPs, ICFs, IFLs, zAAPs, memory, and channels non-disruptively, eliminating the need for a scheduled outage. Installations who take advantage of the CUoD option may invoke the additional capacity non-disruptively. Refer to "Capacity Upgrade on Demand (CUoD)" on page B-1 for more information.

Capacity Backup Upgrade (CBU)

The z890 Capacity Backup Upgrade capability (temporary upgrade) enables enterprises to provide flexible, cost-effective Disaster Recovery on z890. Refer to "Capacity Backup Upgrade" on page B-5 for more information.
Geographically Dispersed Parallel Sysplex (GDPS)

GDPS is a multisite solution that is designed to provide the capability to manage the remote copy configuration and storage subsystems, automate parallel sysplex operational tasks, and perform failure recovery from a single point of control, thereby helping to improve application availability.

GDPS/PPRC Hyperswap Function

This function is designed to broaden the continuous availability attributes of GDPS/PPRC by extending the parallel sysplex redundancy to disk subsystems.

Concurrent Undo CBU

A prerequisite to executing this feature is that the customer or z/OS application must configure offline the processors that are being removed. So the best rule to follow is, "Configure offline the same logical processors that were configured online following the CBU activation". The Concurrent Undo CBU will require the following actions to configure the processors offline based on how it will be invoked:

- GDPS invoked Hardware Management Console/SE API.
- Customer program invoked Hardware Management Console/SE API.

Notes:

1. As the user (or z/OS automation) deconfigures logical CPs, there is no guarantee that the logical CPs will remain in sequential numbering.
2. The SE panel will give no directions as to which CPs, ICFs, or IFLs to configure offline.

Fiber Cabling Services

IBM Networking Services offers a comprehensive set of services for products and enterprises. This helps you gain an Information Technology (IT) advantage by providing you with tools you need to gain market share in this e-business economy. It relieves you of the stress and complexity of selecting the appropriate connectors and cables to support your servers, devices, LANs, and Storage Area Networks. This service is designed to help you keep pace, and to provide you with the optimum reliability, availability, and serviceability as well as the scalability you need when you grow.

CHPID Mapping Tool

This tool provides a convenient interface to map hardware I/O ports on order to your CHPID definitions. An availability option automatically assigns PCHIDs to your CHPID definitions to minimize connecting critical paths to a single points of failure. This is recommended for all new z890 hardware builds or for upgrades from a z800 processor to a z890, as well as for making changes to an already installed machine after hardware upgrades that change or increase the number of channels.

Serviceability

The features that provide a high level of serviceability include the following:

- Automatic error detection and fault isolation concurrent with system operation.
- Automatic remote support capability.
- High degree of concurrent maintenance capability in hardware and code.
- Multiple Channel Swap - an enhancement for channel problem determination allowing up to 16 channels to be swapped.
- Status Panel showing status of N+1 power system.
Appendix A. Resource Link

Resource Link is a customized Web-based solution that provides everything you need to plan for, install, and maintain IBM @server zSeries and IBM S/390 servers and associated software.


Resource Link content areas include:

- **Personal Folders**
  Organize site content according to your personal interests by creating folders for shortcuts to subscriptions. Subscribing to pages or individual documents means you will be notified of updates and changes.

- **Planning**
  Interactive planning provides a streamlined plan for the installation of a system using online planning information tailored for your system.

- **Education**
  Web-based multimedia education provides product courses that can be used for training or refreshing skills.

- **Library**
  Product documentation that can be viewed, printed, or downloaded.

- **Forums**
  Forums and the additional function called work rooms are used for group discussions and to collaborate with fellow product owners.

- **Fixes**
  Interactive tools allow you to request, receive, and install system upgrades.

- **Problem Solving**
  Resources to help you investigate and solve specific hardware and software problems.

- **Services**
  Support for services such as installation, migration, networking, planning and relocating servers, Fiber Cabling, and links to IBM software support.

- **Tools**
  Information about tools such as machine information, CHPID mapping, Coupling Facility structure sizer, and links to software tools.

- **Customer Initiated Upgrade (CIU)**
  A web-based application that allows you to download licensed internal code (LIC) to upgrade processors and memory.

Resource Link Functions

Resource Link contains the following additional functions:

- **Customized Planning Aids** - Prepares you for the arrival and installation of your new zSeries hardware. To use Customized Planning Aids you need a valid order number and a Configuration Control Number (CCN), both available from your IBM Sales Representative.

- **Customer Initiated Upgrade (CIU)** - A web-based solution that enables you to order and download licensed internal code (LIC) to upgrade processors and memory.
- **CHPID Mapping Tool** - Downloadable from Resource Link, this tool allows you to map hardware I/O ports on order to your IOCP CHPID definitions. An availability option automatically maps hardware I/O ports to CHPIDs minimizing single points of failure.

- **Fiber Cabling Service** - Provides the cabling connectivity necessary for installing your z890 processor.
Appendix B. Capacity Upgrades

The z890 processors have the capability of concurrent upgrades, providing additional capacity with no server outage. In most cases, with prior planning and operating system support, a concurrent upgrade can also be non-disruptive, meaning with no system outage.

The Licensed Internal Code Configuration Control (LIC CC) provides for processor upgrade with no hardware changes by enabling the activation of additional installed capacity. Concurrent upgrades by using LIC CC can be done for:
- CPs, SAPs, ICFs, IFLs, and zAAPs - requires available unused PUs in the book
- Memory - requires available capacity on already installed memory cards
- Channel cards (ESCON channels and ISC-3 links) - requires available ports on channel cards.

I/O configuration upgrades can also be concurrent by installing, nondisruptively, additional channel cards.

Planned upgrades can be done by the Capacity Upgrade on Demand (CUoD) or the Customer Initiated Upgrade (CIU) functions. Unplanned upgrades can be done by the Capacity Backup Upgrade (CBU) for emergency or disaster/recovery situations.

On/Off Capacity on Demand (On/Off CoD) is used to temporarily upgrade capacity for CPs, IFLs, ICFs, and zAAPs. For more information, refer to "On/Off Capacity on Demand" on page B-3.

Capacity Backup Upgrade (CBU) is a non-disruptive temporary addition of CPs due to an emergency situation. For more information, refer to "Capacity Backup Upgrade" on page B-5.

**Important Note**

Concurrent activation of CBU and On/Off CoD is not allowed and the Geographically Dispersed Parallel Sysplex (GDPS) use of CBU will fail if On/Off CoD is active.

---

**Capacity Upgrade on Demand (CUoD)**

Capacity Upgrade on Demand (CUoD) allows for the non-disruptive addition of additional Central Processors (CPs) capacity, Internal Coupling Facilities (ICFs), Integrated Facilities for Linux (IFLs), and zSeries Application Assist Processors (zAAPs). CUoD can quickly add processor capacity up to the maximum number of available inactive engines. This provides you with the capacity for much needed dynamic growth in an unpredictable e-business world. The CUoD function, combined with Parallel Sysplex technology, enables virtually unlimited capacity upgrade capability.

The CUoD functions are:
- Non-disruptive CP, ICF, IFL, and zAAP upgrades within minutes
- Dynamic upgrade of all I/O cards in the I/O cage
- Dynamic upgrade of spare installed memory (24 - 32 GB only)
- Plan Ahead and Concurrent Conditioning.
Concurrent Conditioning configures a system for hot plugging of I/O based on a future specified target configuration. Concurrent Conditioning of the z-Series I/O is minimized by the fact that all I/O cards plugging into the zSeries I/O cage are hot pluggable. Migration to FICON or additional OSA networking is exceptionally easy and non-disruptive.

The z890 supports concurrent memory upgrade. This capability allows a processor's memory to be increased without disrupting the processor operation. To take advantage of this capability, a customer should not plan processor storage on the 8 or 16 GB increments. A Model A04 with 24 GB of storage will be able to concurrently upgrade to 32 GB as there is spare memory capacity on the card. However, if you have 8 or 16 GB of memory installed to get to the next increment would be disruptive.

- 8 GB → 16 GB (Disruptive card change)
- 16 GB → 24 GB (Disruptive card change)
- 24 GB → 32 GB (Concurrent LIC CC upgrade)

The Plan Ahead process can easily identify your configuration that is required to meet future needs. The result of concurrent conditioning is a flexible IT infrastructure that can accommodate unpredictable growth in a low risk, non-disruptive way.

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**Customer Initiated Upgrade (CIU)**

Customer Initiated Upgrade (CIU) is designed to allow you to respond to sudden increased capacity requirements by downloading and applying an IBM eServer zSeries Processor Unit (PU) and/or memory upgrade through the Web, using IBM Resource Link and the Remote Support Facility (RSF). It is a faster process for upgrading your server. With the Express option on CIU, an upgrade may be installed within a few hours after order submission.

**Permanent Upgrades**

Orders (MESs) of Processor Units (PUs) and memory for IBM eServer zSeries systems that can be delivered by LIC CC are eligible for CIU delivery. This includes the upgrade of PUs for z800, z900, z890, and z990 as well as memory for z900 and z990, and limited memory upgrades for z890 (24GB to 32GB) and z990 systems up to the maximum available on the installed system.

While capacity upgrades to the processor itself are concurrent, your software may not be able to take advantage of the increased capacity without performing an Initial Program Load (IPL).

**CIU Process**

The major components in the CIU process are ordering and activation. Use the following steps to help you through the CIU process:

1. You order the CIU enablement feature, 9898, and sign the IBM Customer Agreement Supplement for Customer Initiated Upgrade and IBM eServer On/Off Capacity on Demand II. To use CIU, you need to have the following:
   - A Resource Link user ID
   - A secondary approver Resource Link user ID, if applicable
   - A Customer Number
   - The Machine Type and Serial Number of the purchased machine
   - An RSF link to IBM.
2. A CIU Administrator creates a Machine Profile from the information supplied in the Supplement.
3. You establish upgrade pricing for the machine with the Sales Representative.
4. CIU notifies you that the enablement feature is available.
5. Using Resource Link, you create a CIU order for processors and/or memory.
6. If a secondary approval is required, a notice is sent to the secondary approver.
7. The order is staged for download. The code is available for 30 days.
8. You download the code to the Support Element (SE) through the Hardware Management Console using the Single Object Operations task.
9. Billing is automatically initiated when the memory or processor upgrade is downloaded.
10. You install the code at your convenience.

Once all the prerequisites are in place, the whole process from ordering to activation of the upgrade is performed by the customer. As a CIU customer, you must make sure that your machine is set to call home a minimum of once every 14 days.

Creating an Order
When you are ready to create an order, using your Resource Link user ID, log on to Resource Link at [http://www.ibm.com/servers/resourcelink](http://www.ibm.com/servers/resourcelink) and click Customer Initiated Upgrade from the left navigation bar. A list of your machine profiles is displayed. Select the machine profile you want to upgrade and click Create Order. Complete the CIU panels as presented, then click Submit. The Using Customer Initiated Upgrade and On/Off Capacity on Demand education module on Resource Link shows you the complete ordering process.

A CIU order can be cancelled at any time during the order process. By downloading the code you are accepting the charge and the option to cancel is no longer available.

Downloading an Upgrade
You receive notification when the upgrade you have requested is available for downloading. Using SYSPROG mode, access the SE through the Hardware Management Console. In the CPC Work Area select the CPC being upgraded. Click the Single Object Operations task icon and continue the procedure for downloading the update. The Using Customer Initiated Upgrade and On/Off Capacity on Demand education module on Resource Link shows the download process.

Installing an Upgrade
The CIU panel option offers you the ability to retrieve and apply upgrade data immediately or to retrieve it with the option to apply it later. All upgrades will be applied concurrently unless system conditions prevent it. If the CIU upgrade cannot be applied concurrently an informational panel will be displayed to give you the option to continue with the disruptive upgrade or to cancel and apply the disruptive upgrade at a later time.

On/Off Capacity on Demand
On/Off Capacity on Demand (On/Off CoD) is used when you need short term additional capacity. On/Off CoD is designed to temporarily turn on previously uncharacterized Processor Units (PUs), or any unassigned Integrated Facilities for Linux (IFLs) that are available within the current machine, as CPs, Integrated Coupling Facilities (ICFs), IFLs, and zSeries Application Assist Processors (zAAPs).
The following table displays the On/Off CoD zAAP offering.

<table>
<thead>
<tr>
<th>Base Capacity Setting</th>
<th>On/Off CoD CPC</th>
<th>Base zAAPs</th>
<th>Maximum On/Off CoD zAAPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1X0</td>
<td>On/Off CoD CP Capacity is not active</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1X0</td>
<td>On/Off CoD CP Capacity is not active</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1X0</td>
<td>2X0</td>
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<tr>
<td>1X0</td>
<td>2X0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2X0</td>
<td>On/Off CoD CP Capacity is not active</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2X0</td>
<td>On/Off CoD CP Capacity is not active</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2X0</td>
<td>On/Off CoD CP Capacity is not active</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2X0</td>
<td>3X0</td>
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<td>On/Off CoD CP Capacity is not active</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3X0</td>
<td>On/Off CoD CP Capacity is not active</td>
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<td>No PUs available</td>
</tr>
<tr>
<td>3X0</td>
<td>4X0</td>
<td>0</td>
<td>No PUs available</td>
</tr>
</tbody>
</table>

Notes:
1. On/Off CoD capacity setting is restricted to the base capacity. For example, capacity setting 110 is eligible for On/Off CoD upgrades to only capacity settings 120 and 210. All other target capacity settings would result in more than two times the base capacity.
2. The maximum number of On/Off CoD zAAPs available for z890 cannot exceed the number of zAAPs, with the additional restriction that the sum of zAAPs and On/Off CoD zAAPs cannot exceed the number of CPs.

Activation of this capability is mutually exclusive with Capacity Backup Upgrade (CBU) activation. Both On/Off CoD and CBU can reside on the server, but only one can be activated at a time. On/Off CoD is delivered through the function of Customer Initiated Upgrade (CIU) and is automatically activated when downloaded. To participate in this offering, you must have installed CIU Enablement, and On/Off CoD Enablement. Subsequently, you may concurrently install temporary capacity by ordering On/Off CoD Use Days, On/Off CoD Active IFLs, On/Off Active ICFs, or On/Off CoD Active zAAPs up to the current capacity or the number of IFLs, ICFs, and zAAPs, respectively, and use the additional capacity for an indeterminate time.

You will be billed for each On/Off CoD capacity turned on in any given 24-hour period continuing until such On/Off CoD capacity is turned off. Each month your bill will be calculated for the sum of all orders installed within the prior month. Monitoring will occur through the server call home facility and a bill will be generated if the capacity has been enabled for any portion of a calendar month. You will continue to be billed for use of temporary capacity until you return the server to the original state. After concurrently returning to the original state, you may choose to activate a new On/Off CoD upgrade which can be different from the previous upgrade. When you dispose of the server, or decide that you want to disable future temporary upgrades, you are required to remove the enablement feature, On/Off CoD Enablement (FC 9896).
Capacity Backup Upgrade

The z890 Capacity Backup Upgrade (CBU) capability is the non-disruptive temporary addition of Central Processors (CPs) on servers with the CBU feature installed. It enables enterprises to provide flexible, cost-effective Disaster Recovery on the z890. The CBU feature provides the ability to concurrently increment the capacity of your processor, using LIC CC, in the event of an unforeseen loss of substantial zSeries computing capability at one or more of your eligible sites.

A Special Bid Contract for CBU must be approved before the CBU features can be ordered. The feature identifies how many CPs are in the Capacity Backup to IBM’s vital product data base for the customer system.

This contract is required and the model must be configured for the system when additional capacity is invoked. I/O cage channel requirements must be planned in advance and should already be in the configuration prior to the test or CBU being invoked.

CBU is done concurrently with system operations and performs the following:

- **Activating CBU via Password Panel**
  There are five, 10 day test allowed per CBU feature record and a REAL (90 day) CBU upgrade.
  If not already done, the CBU feature must be added by using the Add Capacity Backup (CBU) feature task. During activation, an access panel displays for authorization to activate the CBU feature. You must contact IBM for the correct password based on the Processor Unit (PU) data displayed. There are five 10 ten day tests allowed per CBU feature prior to executing a REAL CBU upgrade. After 3 unsuccessful attempts to enter the password, the CBU feature will no longer be available to the system. You must contact IBM for a new CBU record and its password. After a CBU record has been installed, the same record cannot be reinstalled.

- **CBU Automatic Activation using the IBM Service Support System**
  z890 will call home by using RSF, verify authorization, and automatically unlock the increased server capacity.

- **Viewing CBU Feature Information Panel**
  A View CBU Feature Information panel is available which displays the following information/status:
  - If CBU is installed
  - If CBU is Active
  - The date CBU was activated
  - The date CBU will expire
  - How many CBU Tests are remaining
  - Whether the activated CBU is a Test CBU or Temporary Upgrade CBU
  - If the system is enabled for CBU and the IBM Service Support option
  - The additional resources for installing the CBU feature
  - The system model that CBU will activate is indicated by the Model Capacity Identifier.

- **Automatic Enablement of CBU for the GDPS**
  GDPS, upon detection of a site failure or planned disaster test, will 'call home', by using RSF, verify authorization, and automatically unlock the increased server capacity.

- **CBU Smart Reactivation**
CBU Smart Reactivation reduces outage duration, during a disaster event, if an MCM needs to be changed (while CBU is activated).

- **Concurrent Undo CBU**
  A prerequisite to executing this feature is that the customer or z/OS application must configure offline the processors that are being removed. So the best rule to follow is, “Configure offline the same logical processors that were configured online following the CBU activation”. The Concurrent Undo CBU will require the following actions to configure the processors offline based on how it will be invoked:
  - GDPS invoked Hardware Management Console/SE API.
  - Customer program invoked Hardware Management Console/SE API.

**Notes:**
1. As the user (or z/OS automation) deconfigures logical CPs, there is no guarantee that the logical CPs will remain in sequential numbering.
2. The SE panel will give no directions as to which CPs, ICFs, IFLs, or zAAPs to configure offline.

For more information on CBU, refer to *zSeries 890 and 990 Capacity Backup User’s Guide*.

---

**Reserved CP Support in LPAR Mode**

With Reserved CP Support in LPAR mode, a logical partition may be defined with the number of logical CP’s greater than the number of physical CP’s. Additional CPs can be specified for the logical partition definition beyond the number of physical CPs currently installed on the model. Therefore, an enterprise planning to do a non-disruptive upgrade (with an logical partition defined of logical CPs equal to the number of physical CPs available on the installed hardware) does not need to deactivate, redefine, then reactivate in order to take advantage of the new CPs that have been activated. The enterprise simply needs to have defined additional CPs for the logical partition in advance. This insures that any planned logical partition can be as large as the possible physical machine configuration, non-disruptively.

For more information, refer to *zSeries 890 and 990 Processor Resource/Systems Manager Planning Guide*.

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**Non-disruptive Upgrades**

z890’s Plan-Ahead process links the use of Capacity Upgrade on Demand with planning performed between IBM's Account team and IBM's customer. Planning ahead enables customers to determine a future server configuration. IBM will also support its customers planning effort via capacity planning tools, IBM’s order processing configurative and team sessions, with the objective of non-disruptive growth to satisfy essential capacity demand.

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**Processor Capacity Downgrades**

You are allowed to downgrade your machine via CIU, CUoD, or MES. The primary benefit to downgrading is a reduction in software charges based on a lower reported machine capacity. The downgrade can be vertical (capacity setting), horizontal (number of CPs), or diagonal (capacity setting and the number of CPs).

Some additional considerations should be noted when downgrading:
- Downgrades are done by “unassigning” either CP capacity or IFLs.
- There may be a charge to unassign and then reactivate capacity.
- Unassigned capacity is still owned by the customer.
- Unassigning unused capacity can reduce software charges since many software products are priced based on the capacity.
- Unassigned capacity can be reactivated by CIU, CUoD, or MES.
- Unassigned capacity may be temporarily activated using On/Off CoD. When used as temporary capacity, unassigned capacity can be used as any of the supported capacity (thus an unassigned IFL can be activated as a CP).
- Unassigning capacity and later reactivation is concurrent.
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update: 2004/12/07

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Glossary

This glossary includes terms and definitions from:

- The Information Technology Vocabulary, developed by Subcommittee 1, Joint Technical Committee 1, of the International Organization for Standardization and the International Electrotechnical Commission (ISO/IEC JTC1/SC1). Definitions of published parts of this vocabulary are identified by the symbol (I) after the definition; definitions taken from draft international standards, committee drafts, and working papers being developed by ISO/IEC JTC1/SC1 are identified by the symbol (T) after the definition, indicating that final agreement has not yet been reached among the participating National Bodies of SC1.

The following cross-references are used in this glossary:

- **Contrast with.** This refers to a term that has an opposed or substantively different meaning.
- **See.** This refers the reader to multiple-word terms in which this term appears.
- **See also.** This refers the reader to terms that have a related, but not synonymous, meaning.
- **Synonym for.** This indicates that the term has the same meaning as a preferred term, which is defined in the glossary.

**A**

abend. Abnormal end of task

abnormal end of task (abend). Ending a task before its completion because of an error condition that cannot be resolved by recovery facilities while the task is being executed.

action. One of the defined tasks that an application performs. Actions modify the properties of an object or manipulate the object in some way.

activate logical partition. An operator-initiated procedure that performs a system reset to a logical partition and assigns the previously defined hardware to that partition. It causes an automatic IPL of the system control program to occur in the partition unless the operator performs the IPL manually. Contrast with deactivate logical partition.

active configuration. In an ESCON environment, the ESCON Director configuration determined by the status of the current set of connectivity attributes. Contrast with saved configuration.

active subchannel. A subchannel that is locked and either busy or has a pending interrupt, and is indicated by subchannel status word (SCSW) bit 24 equals 1. The control information resides in the channel subsystem because it is necessary for the current operation. Contrast with inactive subchannel. See also busy subchannel.

Note: An active subchannel can also reside in the local working storage of an IOP or channel.

active window. The window that users are currently interacting with. This is the window that receives keyboard input.

address. (1) A value that identifies a register, a particular part of storage, data source, or a data sink. The value is represented by one or more characters. (T) (2) To refer to a device or an item of data by its address. (I) (A) (3) The location in the storage of a computer where data is stored. (4) In data communication, the unique code assigned to each device or workstation connected to a network. (5) The identifier of a location, source, or destination.

address translation. (1) A value that identifies a register, a particular part of storage, a data source, or a data sink. The value is represented by one or more characters. (T) (2) In virtual storage systems, the process of changing the address of an item of data or an instruction from its virtual storage address to its real storage address. See also dynamic address translation.

ADMF. Asynchronous Data Mover Facility.

alert. (1) A unit of information, usually indicating the loss of a system resource, passed from one machine or
allocate. To assign a resource, such as a disk or a diskette file to perform a task. Contrast with deallocate.

American National Standard Code for Information Interchange (ASCII). The standard code, using a coded character set consisting of 7-bit coded characters (8 bits including parity), used for information interchange among data processing systems, data communication systems, and associated equipment. The ASCII set consists of control characters and graphics characters. (A)

Note: IBM has defined an extension to ASCII code (characters 128 - 255).

ANSI. American National Standards Institute.

APAR. Authorized program analysis report.

API. application programming interface

application. (1) The use to which an information processing system is put, for example, a payroll application, an airline reservation application, a network application. (2) A collection of software components used to perform specific types of work on a computer.

Application Assist Processor (AAP). A special processor configured for running Java applications on z890 and z990 class machines.

application program. (1) A program that is specific to the solution of an application problem. (T) (2) A program written for or by a user that applies to the user’s work, such as a program that does inventory control or payroll. (3) A program used to connect and communicate with stations in a network, enabling users to perform application-oriented activities.


ARP. Address Resolution Protocol


asynchronous. (1) Pertaining to two or more processes that do not depend upon the occurrence of specific events such as common timing signals. (T) (2) Without regular time relationship; unexpected or unpredictable with respect to the execution of program instructions. Contrast with synchronous.

ATM. Asynchronous Transfer Mode

authorized program analysis report (APAR). A request for correction of a problem caused by a defect in a current release of a program unaltered by the user.

auto-answer. In data communication, the ability of a station to respond automatically to a call that it receives over a switched line.

auto-call. In data communication, the ability of a station to initiate a call automatically over a switched line.

B

basic mode. A central processor mode that does not use logical partitioning. Contrast with logically partitioned (LPAR) mode.

batch. (1) An accumulation of data to be processed. (2) A group of records or data processing jobs brought together for processing or transmission. (3) Pertaining to activity involving little or no user action. Contrast with interactive.

BBU. Battery Back-up Unit

block. A string of data elements recorded or transmitted as a unit. The element may be characters, words, or physical records. (T)

block multiplexer channel. A multiplexer channel that interleaves blocks of data. Contrast with selector channel. See also byte multiplexer channel

BPA. Bulk Power Assembly

buffer. (1) A routine or storage used to compensate for a difference in rate of flow of data, or time of occurrence of events, when transferring data from one device to another. (A) (2) To allocate and schedule the use of buffers. (A) (3) A portion of storage used to hold input or output data temporarily. See fiber buffer.

burst. In data communication, a sequence of signals counted as one unit in accordance with some specific criterion or measure. (A)

bus. (1) A facility for transferring data between several devices located between two end points, only one device being able to transmit at a given moment. (T) (2) A network configuration in which nodes are interconnected through a bidirectional transmission medium. (3) One or more conductors used for transmitting signals or power. (A)

byte. (1) A string that consists of a number of bits, treated as a unit, and representing a character. (T) (2) A binary character operated upon as a unit and usually shorter than a computer word. (A) (3) A string that consists of a particular number of bits, usually eight, that is treated as a unit, and that represents a character. (4) A group of eight adjacent binary digits that represent one extended binary-coded decimal interchange code (EBCDIC) character.
byte multiplexer channel.  A multiplexer channel that interleaves bytes of data. Contrast with selector channel. See also block multiplexer channel.

C

CA.  channel adapter (card).
cache.  (1) A special purpose buffer storage, smaller and faster than main storage, used to hold a copy of the instructions and data obtained from main storage and likely to be needed next by the processor. (2) A buffer storage that contains frequently accessed instructions and data; it is used to reduce access time.
cache structure.  A coupling facility structure that enables high-performance sharing of cached data by multisystem applications in a Parallel Sysplex. Applications can use a cache structure to implement several different types of caching systems, including a store-through or a store-in cache.

CAP.  Crypto Asynchronous Processor
CAW.  channel address word.
CBU.  Capacity Backup Upgrade
CBY.  ESCON byte multiplexer channel.
CCC.  Channel control check.
CCW.  Channel command word.

central processor (CP).  The part of the computer that contains the sequencing and processing facilities for instruction execution, initial program load, and other machine operations.

central processor complex (CPC).  The boundaries of a system, exclusive of I/O control units and devices, that can be controlled by a single operating system. A CPC consists of main storage, one or more central processor units, time-of-day clocks, and channels, which are or can be placed in a single configuration. A CPC also includes channel subsystems, service processors, and expanded storage where installed.

central storage.  Storage that is an integral part of the processor and includes both main storage and the hardware system area.

CF.  coupling facility (CF).
CFS.  coupling facility sender channel.
CFR.  coupling facility receiver channel.
CFRM.  coupling facility resource management (policy).

change.  An alteration (addition, deletion, or modification) of one or more information system components, of one of the following types: hardware (may include internal code), or software (system or application). The term change also refers to an SNA/File Services data object containing internal code, internal code customizing data, software, software customizing data, applications data, procedures, or documentation.

CH.  Channel Card

change management.  The management discipline that defines the process of planning (for example, scheduling) and controlling (for example, distributing, installing, and tracking) changes in an SNA network.

channel.  (1) A path along which signals can be sent, for example, input/output channel. (2) The system element that controls one channel path, whose mode of operation depends on the type of hardware to which it is attached.

channel adapter.  (1) A communication controller hardware unit used to attach the controller to a data channel. (2) Hardware that attaches a group of channels to the secondary data stager and prioritizes and stages data between the channels and the channel control element.

channel address.  In S/370 mode, the 8 leftmost bits of an input/output address that identify the channel. See also device address and input/output address.

channel address word (CAW).  An area in storage that specifies the location in main storage at which a channel program begins.

channel-attached.  (1) Pertaining to attachment of devices directly by data channels (I/O channels) to a computer. (2) Pertaining to devices attached to a controlling unit by cables rather than by telecommunication lines. Contrast with link-attached.

channel command word (CCW).  A doubleword at the location in main storage specified by the channel address word. One or more CCWs make up the channel program that directs data channel operations.

channel control check.  A category of I/O errors affecting channel controls and sensed by the channel to which a device is attached. See also channel data check.

channel data check.  A category of I/O errors, indicating a machine error in transferring data to or from storage and sensed by the channel to which a device is attached. See also channel control check.

channel data rate.  The rate at which a channel can move data between a transmission link and processor storage during the data transfer portion of an I/O operation.
channel Licensed Internal Code. That part of the channel subsystem Licensed Internal Code used to start, maintain, and end all operations on the I/O interface. See also IOP Licensed Internal Code.

channel path (CHP). A single interface between a central processor and one or more control units along which signals and data can be sent to perform I/O requests.

channel path configuration. In an ESCON environment, the connection between a channel and a control unit or between a channel, an ESCON Director, and one or more control units. See also link, point-to-point channel path configuration, and switched point-to-point channel path configuration.

channel path identifier (CHPID). In a channel subsystem, a value assigned to each installed channel path of the system that uniquely identifies that path to the system.

channel status word (CSW). An area in storage that provides information about the termination of input/output operations.

channel subsystem (CSS). A collection of subchannels that directs the flow of information between I/O devices and main storage, relieves the processor of communication tasks, and performs path management functions.

channel subsystem (CSS) Licensed Internal Code. Code that consists of the IOP Licensed Internal Code and the channel Licensed Internal Code.

channel-to-channel (CTC). Refers to the communication (transfer of data) between programs on opposite sides of a channel-to-channel adapter (CTCA).

channel-to-channel adapter (CTCA). An input/output device that is used by a program in one system to communicate with a program in another system.

check stop. The state that occurs when an error makes it impossible or undesirable to continue the operation in progress.

CHD. channel driver (card).

CHN. Channel.

choice. An item that users may select. Choices appear in the selection fields, action bars, and pull-down menus.

CHP. Channel path.

CHPID. See channel path identifier.

Cl. console integration.

CICS. Customer Information Control System.

CICS/ESA. Customer Information Control System/Enterprise Systems Architecture.

CIU. Customer Initiated Upgrade

CKD. count key data.

click. To press and release a mouse button without moving the mouse pointer off the choice.

CLIST (command list). A data set in which commands and possibly subcommands and data are stored for subsequent execution.

CMOS. Complementary metal-oxide semiconductor.

CNC. Mnemonic for an ESCON channel attached to an ESCON-capable device.

command. (1) A character string from a source external to a system that represents a request for system action. (2) A request from a terminal for performance of an operation or execution of a program. (3) A value sent on an I/O interface from a channel to a control unit that specifies the operation to be performed.

command chaining. The fetching of a new channel command word (CCW) immediately following the completion of the previous CCW.

command entry field. An entry field in which a user types commands.

command list. See CLIST.

command retry. A channel and control unit procedure that causes a command to be retried without requiring an I/O interrupt.

communication control unit. A communication device that controls transmission of data over lines in a network.

communication controller. (1) A device that directs the transmission of data over the data links of a network; its operation can be controlled by a program executed in a processor to which the controller is connected or it may be controlled by a program executed within the device. (T) (2) A type of communication control unit whose operations are controlled by one or more programs stored and executed in the unit. It manages the details of line control and the routing of data through a network.

complementary metal-oxide semiconductor (CMOS). A technology that combines the electrical properties of positive and negative voltage requirements to use considerably less power than other types of semiconductors.

concurrent maintenance. Hardware maintenance actions performed by a service representative while
configuration. (1) The arrangement of a computer system or network as defined by the nature, number, and the chief characteristics of its functional units. More specifically, the term configuration may refer to a hardware configuration or a software configuration. (I) (A) (2) In an ESCON Director, the physical connection capability determined by a set of attributes. The attribute values specify the connectivity control status and identifiers associated with the ESCD and its ports. See also active configuration, configuration matrix, connectivity attribute, and saved configuration.

configure. To describe to the system the devices and optional features installed on the system.

connectivity. A term used to describe the physical interconnections of multiple devices/computers/networks employing similar or different technology or architecture together to accomplish effective communication between and among connected members involving data exchange or resource sharing.

console. A logical device used for communication between the user and the system. (A) See display station, monitor console, operator console, program mode console, programming support console, service console, and system console.

console integration (CI). The hardware and software facilities used to bring operating systems management and hardware systems management under a single control point.

control program. A computer program designed to schedule and to supervise the execution of programs of a computer system. (I) (A)

control unit. A hardware unit that controls the reading, writing, or displaying of data at one or more input/output units.

control unit data rate. The rate at which a control unit can move data between itself and a transmission link during the data transfer portion of an I/O operation.

controller. A unit that controls input/output operations for one or more devices.

conversational monitor system (CMS). A virtual machine operating system that provides general interactive time sharing, problem solving, and program development capabilities, and operates only under the z/VM control program.

Coordinated Server Time (CST). Represents the time in a CTN. Timekeeping messages carried over the coupling links determine the CST at each server.

Coordinated Timing Network (CTN). A collection of servers that are time synchronized to Coordinated Server Time (CST). All STP-configured servers in a CTN must have the same CTN ID.

coupling facility. A special logical partition that provides high-speed caching, list processing, and locking functions in a Parallel Sysplex.

coupling facility channel. A high bandwidth fiber optic channel that provides the high-speed connectivity required for data sharing between a coupling facility and the central processor complexes directly attached to it.

CP. (1) Control program. (2) Central processor.

CPC. Central processor complex.

CPCID. CPC identifier.

CPC Image. The set of CPC resources that support a single control program.

CPU. central processor unit.

CPUID. CPU identifier.

critical resource. A resource required for system operation. See also system resource.

CRW. Channel report word.

CS. (1) Central storage. (2) Channel set. (3) Control storage.

CSS. Channel subsystem.

CT. Coordinated Server Time.

CTC. (1) Channel-to-channel. (2) Mnemonic for an ESCON or FICON channel attached to another ESCON or FICON channel respectively.

CTCA. channel-to-channel adapter.

CTN. Coordinated Timing Network

CU. Control unit.

CUA. Control unit address.

CUADD. Control unit logical address.

CuOD. Capacity Upgrade on Demand

cursor. (1) A movable, visible mark used to indicate the position at which the next operation will occur on a display screen. (A) (2) A visual cue that shows the user where keyboard input will appear on the screen.

Customer Information Control System (CICS). An IBM licensed program that enables transactions entered at remote terminals to be processed concurrently by
user-written application programs. It includes facilities for building, using, and maintaining data bases.

**customize.** To change a data processing installation or network to meet the needs of particular users. Definition

**CVC.** Mnemonic for an ESCON channel attached to a 9034.

**D**

**DASD.** See direct access storage device.

**DASD subsystem.** A storage control and its attached direct access storage devices.

**DAT.** Dynamic address translation.

**data processing (DP).** The systematic performance of operations upon data; for example, arithmetic or logic operations upon data, merging or sorting of data, assembling or compiling of programs. (T)

**data rate.** See channel data rate, control unit data rate, device data rate, effective data rate, and input/output subsystem data rate. See also link rate.

**data sharing.** The ability of concurrent subsystems (such as DB2 or IMS DB) or application programs to directly access and change the same data while maintaining data integrity.

**data streaming.** In an I/O interface, a mode of operation that provides a method of data transfer at up to 4.5 MB per second. Data streaming is not interlocked between the sender and the receiver. Once data transfer begins, the sender does not wait for acknowledgment from the receiver before sending the next byte. The control unit determines the data transfer rate.

**data transfer.** (1) The result of the transmission of data signals from any data source to a data receiver. (2) The movement, or copying, of data from one location and the storage of the data at another location.

**data transfer mode.** The method of information exchange used on an I/O interface. See data streaming.

**DB2.** DATABASE 2.

**DCA.** Distributed Converter Assembly

**DCAF.** distributed console access facility.

**deactivate logical partition.** An operator-initiated procedure that releases the hardware assigned to a logical partition, making it available to other partitions. Contrast with activate logical partition.

**Note:** The operator should first deactivate the system control program, if possible or necessary, and then reactivate the partition, which could provide a reset to that partition, if required.

**deallocate.** To release a resource assigned to a task. Contrast with allocate.

**DES.** Data Encryption Standard

**device.** A mechanical, electrical, or electronic contrivance with a specific purpose.

**device address.** In S/370 mode, the 8 rightmost bits of an I/O address that identify a particular I/O device and a control unit on the designated channel. See channel address, device-level addressing, and input/output address.

**DFSMS.** Data Facility Storage Management Subsystem.

**DH.** Diffie Hellman

**direct access storage.** A storage device that provides direct access to data. (I) (A) See also random access memory.

**direct access storage device (DASD).** (1) A storage device in which the location of each data record can be directly addressed. (2) A device in which the access time is effectively independent of the location of the data. (Restriction: Does not refer to diskette drive.)

**DP.** data processing.

**DSS.** Digital Signature Standard

**dynamic address translation (DAT).** In virtual storage systems, the change of a virtual storage address to a real storage address during execution of an instruction. See also address translation.

**dynamic reconfiguration management.** In MVS, the ability to modify the I/O configuration definition without needing to perform a power-on reset (POR) of the hardware or an initial program load (IPL).

**dynamic storage reconfiguration.** A PR/SM LPAR function that allows central or expanded storage to be added or removed from a logical partition without disrupting the system control program operating in the logical partition.

**E**

**EC.** engineering change.

**ECC.** error checking and correction.

**ECKD.** extended count key data.

**EEPROM.** electrically erasable programmable read only memory.

**EIA.** Electronics Industries Association. One EIA unit is 1.75 inches or 44.45mm.

Enterprise Systems Connection (ESCON). A set of products and services that provides a dynamically connected environment using optical cables as a transmission medium.

EPO. Emergency power off.

error checking and correction (ECC). In a processor, the detection and correction of all single-bit errors, plus the detection of double-bit and some multiple-bit errors.

ESA. (1) Enterprise Systems Architecture. (2) Expanded storage array.


ESCD. Enterprise Systems Connection (ESCON) Director.

ESCM. Enterprise Systems Connection Manager.

ESCON. Enterprise Systems Connection.

ESCON channel. A channel having an Enterprise Systems Connection channel-to-control-unit I/O interface that uses optical cables as a transmission medium. Contrast with parallel channel.

ESCON Director (ESCD). A device that provides connectivity capability and control for attaching any two links to each other.

ESCON environment. The data processing environment having an Enterprise Systems Connection channel-to-control-unit I/O interface that uses optical cables as a transmission medium.

ESCON Manager (ESCM). A licensed program that provides host control and intersystem communication capability for ESCON Director connectivity operations.

Ethernet Definition. A communication network (USA, Xerox 1975).

ETR. External Time Reference

event. (1) An occurrence or happening. (2) An occurrence of significance to a task; for example, the completion of an asynchronous operation, such as an input/output operation.

expanded storage. Optional high-speed storage that transfers 4KB pages to and from central storage.

F

facility. (1) An operational capability, or the means for providing such a capability. (2) A service provided by an operating system for a particular purpose; for example, the checkpoint/restart facility.

FCP. Fibre Channel Protocol for SCSI

FDDI. Fiber Distributed Data Interface (100Mbits/second fiber optic LAN).

fiber. See optical fiber.

FICON. Fiber CONnection channel card

frame. (1) For a zSeries 990 microprocessor cluster, a frame contains one or two central processor complexes (CPCs), Support Elements, and AC power distribution. (2) A housing for machine elements. (3) The hardware support structure, covers, and all electrical parts mounted there in that are packaged as one entity for shipping. (4) A formatted display. See display frame and transmission frame.

FRU. Field-replaceable unit.

ft. Foot.

G

Gb. Gigabit

GB. Gigabyte.

GbE. Gigabit Ethernet.

gigabit (Gb). A unit of measure for storage size. One gigabit equals one billion bits.

Gigabit Ethernet. An OSA channel (type OSD)

gigabyte (GB). (1) A unit of measure for storage size. One gigabyte equals 1,073,741,824 bytes. (2) Loosely, one billion bytes.

GMT. Greenwich mean time.

H

Hardware Management Console. A console used to monitor and control hardware such as the zSeries z990 microprocessors.

hardware system area (HSA). A logical area of central storage, not addressable by application programs, used to store Licensed Internal Code and control information.

HCD. hardware configuration definition.

HDD. HDD

HSA. hardware system area.

HMCA. Hardware Management Console Application.
input/output configuration data set (IOCDS). The data set that contains an I/O configuration definition built by the I/O configuration program (IOCP).

input/output configuration program (IOCP). A program that defines to a system all the available I/O devices and the channel paths.

input/output configuration source. The file used as input to the IOCP when an IOCDS is created. It is an 80-column card-image, and is initially provided in EBCDIC form on a system tape, or in ASCII form on a 3.5-inch diskette.

interrupt. (1) A suspension of a process, such as execution of a computer program caused by an external event, and performed in such a way that the process can be resumed. (A) (2) To stop a process in such a way that it can be resumed. (3) In data communication, to take an action at a receiving station that causes the sending station to end a transmission. (4) To temporarily stop a process.

I/O. See input/output.

IOCDS. I/O configuration data set.

IOCP. I/O configuration program.

IODF. input/output definition file.

IPL. See initial program load.

IPv6. Internet Protocol Version 6

ISDN. Integrated-Services Digital Network

K

KB. kilobyte.

kilobyte. (1) A unit of measure for storage size. (2) Loosely, one thousand bytes.

km. kilometer

L

LAN. See local area network.

laser. A device that produces optical radiation using a population inversion to provide light amplification by stimulated emission of radiation and (generally) an optical resonant cavity to provide positive feedback. Laser radiation can be highly coherent temporally, or spatially, or both. (E)

LCSS. logical channel subsystem.

LED. Light-emitting diode.
**LIC.** Licensed Internal Code.

**Licensed Internal Code (LIC).** Software provided for use on specific IBM machines and licensed to customers under the terms of IBM's Customer Agreement. Microcode can be Licensed Internal Code and licensed as such.

**light-emitting diode (LED).** A semiconductor chip that gives off visible or infrared light when activated.

**local area network (LAN).** A computer network located on a user's premises within a limited geographical area. Communication within a local area network is not subject to external regulations; however, communication across the LAN boundary can be subject to some form of regulation.

**Logical address.** The address found in the instruction address portion of the program status word (PSW). If translation is off, the logical address is the real address. If translation is on, the logical address is the virtual address. See also absolute address, physical address, real address, and virtual address.

**logical control unit.** A group of contiguous words in the hardware system area that provides all of the information necessary to control I/O operations through a group of paths that are defined in the IOCDS. Logical control units represent to the channel subsystem a set of control units that attach common I/O devices.

**logical partition (LP).** A subset of the processor hardware that is defined to support the operation of a system control program (SCP). See also logically partitioned (LPAR) mode.

**logical processor.** In LPAR mode, central processor resources defined to operate in a logical partition like a physical central processor.

**logical unit (LU).** In SNA, a port to the network through which an end user accesses the SNA network and the functions provided by system services control points (SSCPs). An LU can support at least two sessions - one with an SSCP and one with another LU - and may be capable of supporting many sessions with other LUs.

**logically partitioned (LPAR) mode.** A central processor complex (CPC) power-on reset mode that enables use of the PR/SM feature and allows an operator to allocate CPC hardware resources (including central processors, central storage, expanded storage, and channel paths) among logical partitions. Contrast with basic mode.

**LUPS.** Local Uninterruptible Power Supply

**M**

**MAC.** Message Authentication Code

**main storage.** A logical entity that represents the program addressable portion of central storage. See central storage.

**main storage.** (1) Program-addressable storage from which instructions and other data can be loaded directly into registers for subsequent processing. (2) That part of internal storage into which instructions and other data must be loaded for subsequent execution or processing. (3) The part of a processor unit where programs are run. See central storage.

**Notes:**
1. Main storage refers to the whole program-addressable execution space and can include one or more storage devices.
2. The term main storage is generally used in large and intermediate computers. The term memory is primarily used in microcomputers, calculators, and some minicomputers.

**maintenance change level (MCL).** A change to correct a single licensed internal code design defect. Higher quality than a patch, and intended for broad distribution. Considered functionally equivalent to a software PTF.

**MAU.** multistation access unit.

**Mb.** Megabit

**MB.** Megabyte.

**MBA.** memory bus adapter.

**MCCU.** multisystem channel communication unit.

**MCL.** See maintenance change level.

**megabit (Mb).** A unit of measure for storage size. One megabit equals 1,000,000 bits.

**megabyte (MB).** (1) A unit of measure for storage size. One megabyte equals 1,048,576 bytes. (2) Loosely, one million bytes.

**menu bar.** The area at the top of the primary window that contains keywords that give users access to actions available in that window. After users select a choice in the action bar, a pull-down menu appears from the action bar.

**MIF.** Multiple Image Facility.

**modem (modulator/demodulator).** A device that converts digital data from a computer to an analog
signal that can be transmitted on a telecommunication line, and converts the analog signal received to data for the computer.

**mouse.** In computer graphics, a pointing device operated by moving it on a surface.

**Multiple Image Facility (MIF).** A facility that allows channels to be shared among PR/SM logical partitions in an ESCON or FICON environment.

**multiplexer channel.** A channel designed to operate with a number of I/O devices simultaneously. Several I/O devices can transfer records at the same time by interleaving items of data. See block multiplexer channel and the multiplexer channel.

**MVS.** Multiple Virtual Storage.

**MVS image.** A single occurrence of the MVS/ESA™ operating system that has the ability to process work.

**MVS system.** An MVS image together with its associated hardware, which collectively are often referred to simply as a system, or MVS system.

**N**

**NetBIOS.** local area network basic input/output system.

**NetView.** An IBM licensed program used to monitor a network, manage it, and diagnose its problems.

**network.** (1) An arrangement of nodes and connecting branches. (T) (2) A configuration of data processing devices and software connected for information exchange.

**NIC.** numerically intensive computing.

**O**

**operate.** To do a defined action, such as adding or comparing, performed on one or more data items.

**operating system (OS).** Software that controls the execution of programs and that may provide services such as resource allocation, scheduling, input/output control, and data management. Although operating systems are predominantly software, partial hardware implementations are possible. (T)

**operator console.** (1) A functional unit containing devices that are used for communications between a computer operator and a computer. (T) (2) A display used for communication between the operator and the system, used primarily to specify information concerning application programs and I/O operations and to monitor system operation.

**optical cable.** A fiber, multiple fibers, or a fiber bundle in a structure built to meet optical, mechanical, and environmental specifications. (E) See also jumper cable, optical cable assembly, and trunk cable.

**optical fiber.** Any filament made of dielectric materials that guides light, regardless of its ability to send signals. (E) See also fiber optics and optical waveguide.

**OS.** Operating system.

**OSA.** Open Systems Adapter (OSA-Express, OSA-Express2, and OSA-2). The OSA is an integrated hardware feature that provides direct connection to clients on local area networks (LANs).

**OSA/SF.** Open Systems Adapter/Support Facility

**OS/2.** Operating system/2.

**P**

**parallel channel.** (1) A channel having an S/360™ and S/370 channel-to-control-unit I/O interface that uses bus-and-tag cables as a transmission medium. Contrast with ESCON channel. (2) A data path along which a group of signals representing a character or any other entity of data can be sent simultaneously.

**PIN.** Personal Identification Number

**PKA.** Public-Key-Algorithm

**PKSC.** Public-Key Secure Cable

**point-to-point channel path configuration.** In an I/O interface, a configuration that consists of a single link between a channel and one control unit. Contrast with switched point-to-point channel path configuration.

**point-to-point connection.** A connection established between two data stations for data transmission. Contrast with multipoint connection.

**Note:** The connection may include switching facilities.

**POR.** Power-on reset.

**power-on reset.** A function that re-initializes all the hardware in the system and loads the internal code that enables the machine to load and run an operating system. This function is intended as a recovery function.

**power-on reset state.** The condition after a machine power-on sequence and before an IPL of the control program.

**problem analysis.** The process of identifying the source of a problem; for example, a program component, a machine failure, telecommunication facilities, user or contractor-installed programs or equipment, an environment failure such as a power loss, or a user error.
**problem determination (PD).** The process of determining the source of a problem; for example, a program component, machine failure, telecommunication facilities, user or contractor-installed programs or equipment, environmental failure such as a power loss, or user error.

**problem management.** The management discipline that handles a problem from its detection through its final resolution. Problem management is composed of the following:
- Problem determination
- Problem diagnosis
- Problem bypass and recovery
- Problem resolution
- Problem tracking and control.

**processor.** (1) In a computer, a functional unit that interprets and executes instructions. A processor consists of at least an instruction control unit and an arithmetic and logic unit. (T) (2) The functional unit that interprets and executes instructions. (3) The boundaries of a system, exclusive of I/O control units and devices, that can be controlled by a single operating system. A processor consists of main storage, one or more central processors, time-of-day clocks, and channels, which are, or can be, placed in a single configuration. A processor also includes channel subsystems, and expanded storage where installed.

**processor complex.** A system configuration that consists of all the machines required for operation; for example, a processor unit, a processor controller, a system display, a service support display, and a power and coolant distribution unit.

**processor console.** The workstation from which an operator can control and observe system hardware operation. See also system console.

**Processor Resource/Systems Manager (PR/SM) facility.** The feature that allows the processor to use several system control programs (SCPs) simultaneously, provides logical partitioning capability for the real machine, and provides support for multiple preferred guests.

**profile.** (1) A description of the characteristics of an entity to which access is controlled. (2) Data that describes the significant characteristics of a user, a group of users, or one or more computer resources.

**program.** Sequence of instructions for a computer. A program interacts and relies on either the hardware or other programs.

**program status word (PSW).** An area in storage used to indicate the sequence in which instructions are executed, and to hold and indicate the status of the computer system.

**program temporary fix (PTF).** A temporary solution or bypass of a problem diagnosed by IBM as resulting from a defect in a current, unaltered release of the program.

**PR/SM.** Processor Resource/Systems Manager.

**PSC.** Power Sequence Controller

**PSP.** preventive service planning.

**PSW.** Program status word.

**PTF.** Program temporary fix.

**R**

**RAS.** reliability, availability, serviceability.

**reconfiguration.** (1) A change made to a given configuration in a computer system; for example, isolating and bypassing a defective functional unit or connecting two functional units by an alternative path. Reconfiguration is effected automatically or manually and can be used to maintain system integrity. (T) (2) The process of placing a processor unit, main storage, and channels offline for maintenance, and adding or removing components. (3) Contrast with nondisruptive installation and nondisruptive removal.

**recovery.** To maintain or regain system operation after a failure occurs. Generally, to recover from a failure is to identify the failed hardware, to deconfigure the failed hardware, and to continue or restart processing.

**remote service facility (RSF).** (1) A control program plus associated communication equipment that allows local personnel to connect to an IBM service center, and allows remote personnel to operate the remote system or send new internal code fixes to it, if properly authorized. (2) A system facility invoked by Licensed Internal Code that provides procedures for problem determination and error detection.

**Remote Technical Assistance and Information Network (REAIN).** A database, accessible to service representatives, of information relating to IBM-installed products.

**REAIN.** Remote Technical Assistance and Information Network.

**REXX.** restructured extended executor language.

**ring network.** A network configuration in which devices are connected by unidirectional transmission links to form a closed path.

**Note:** A ring of an IBM Token-Ring Network is referred to as a LAN segment or as a Token-Ring Network segment.

**RMF.** Resource Measurement Facility.
RPQ. Request for Price Quotation.
RPS. rotational positional sensing/sensor.
RSA. Rivest-Shamir-Adelman
RSF. Remote Support Facility.

SAD. system activity display.
SAP. system assist processor
SCP. system control program.

scroll. To move a display image vertically or horizontally to display data that cannot be observed within the boundaries of the display frame.

scroll bar. A window component associated with a scrollable area that provides users a visual cue that more information is available and that the unseen information can be manipulated into view using the mouse. Users scroll the information in the window by interacting with the scroll bar.

SCSI. Small Computer System Interface
SDLC. See synchronous data link control.
SE. Support Element.

Server Time Protocol (STP). A message based protocol designed to enable multiple servers to maintain time synchronization with each other. The timekeeping information is passed over data links (externally defined coupling links) between servers. It provides time synchronization for the z9 EC, z9 BC, z900, and z890 servers and CFs without requiring the Sysplex Timer.

service representative. A person who performs maintenance services for IBM hardware products or systems. See also IBM program support representative.
SIE. Start Interpretive Execution

single point of control. The characteristic a Parallel Sysplex displays when you can accomplish a given set of tasks from a single workstation, even if you need multiple IBM and vendor products to accomplish that particular set of tasks.

single system image. The characteristic a product displays when multiple images of the product can be viewed and managed as one image.

SNA. See systems network architecture.

SNA/Management Services (SNA/MS). Functions distributed among network components to operate, manage, and control the network.

SNA/MS. SNA/Management Services.

SNA network. The part of a user-application network that conforms to the formats and protocols of Systems Network Architecture. It enables reliable transfer of data among end-users and provides protocols for controlling the resources of various network configurations. The SNA network consists of network addressable units (NAUs), boundary function components, and the path control network.

SNMP. simple network management protocol.
STI. Self-Timed Interconnect

STP. Server Time Protocol.
storage. (1) A functional unit into which data can be placed, in which they can be retained, and from which they can be retrieved. (T) (2) The action of placing data into a storage device. (I)

structure. A construct used by MVS to map and manage storage on a coupling facility. See cache structure, list structure, and lock structure.

subchannel. In 370-XA, ESA/390 modes, and z/Architecture modes, the facility that provides all of the information necessary to start, control, and complete an I/O operation.

subchannel number. A system-unique 16-bit value used to address a subchannel. See also channel path identifier, device identifier, and device number.

subsystem. A secondary or subordinate system, or programming support, usually capable of operating independently of or asynchronously with a controlling system. (T) See DASD subsystem and storage subsystem.

subsystem storage. Synonym for cache.

Support Element (SE). (1) an internal control element of a processor that assists in many of the processor operational functions. (2) A hardware unit that provides communications, monitoring, and diagnostic functions to a central processor complex (CPC).

synchronous data link control (SDLC). A form of communication line control that uses commands to control data transfer over a communication line.

Sysplex Timer. An IBM unit that synchronizes the time-of-day (TOD) clocks in multiple processors or processor sides. External Time Reference (ETR) is the MVS generic name for the IBM Sysplex Timer (9037).

system. Comprises the processor complex and all attached and configured I/O and communication devices.

system area. A logical area of central storage used to store Licensed Internal Code and control information (not addressable by application programs).
Systems Network Architecture (SNA). The description of the logical structure, formats, protocols, and operational sequences for transmitting information units through, and controlling the configuration and operation of, networks.

S/370. IBM System/370™
S/390. IBM System/390®.

T

target logical partition. In LPAR mode, the target logical partition is the logical partition that is selected on the System Monitor panel. It is the current or immediate logical partition; the logical partition that the operator is working with or looking at.

target processor. The processor that controls execution during a program restart, instruction trace, stand-alone dump, or IPL, and whose ID is identified by highlighting on the status line.


TDES. Triple Data Encryption Standard

time-of-day (TOD) clock. A system hardware feature that is incremented once every microsecond, and provides a consistent measure of elapsed time suitable for indicating date and time. The TOD clock runs regardless of whether the processor is in a running, wait, or stopped state.

TKE. Trusted Key Entry

TOD. Time of day.

token. A sequence of bits passed from one device to another on the token-ring network that signifies permission to transmit over the network. It consists of a starting delimiter, an access control field, and an end delimiter. The access control field contains a bit that indicates to a receiving device that the token is ready to accept information. If a device has data to send along the network, it appends the data to the token. When data is appended, the token then becomes a frame.

token-ring network. (1) A ring network that allows unidirectional data transmission between data stations, by a token passing procedure, such that the transmitted data return to the transmitting station. (T) (2) A network that uses ring topology, in which tokens are passed in a circuit from node to node. A node that is ready to send can capture the token and insert data for transmission.

Note: The IBM Token-Ring Network is a baseband LAN with a star-wired ring topology that passes tokens from network adapter to network adapter.

TPF. Transaction processing facility.

transaction processing. In batch or remote batch processing, the processing of a job or job step. In interactive processing, an exchange between a terminal and another device that does a particular action; for example, the entry of a customer’s deposit and the updating of the customer’s balance.

TSCF. target system control facility.

U

UCW. unit control word.

UPC. universal power controller.

UPS. uninterruptible power supply.

user interface. Hardware, software, or both that allows a user to interact with and perform operations on a system, program, or device.

V

VLAN. Virtual Local Area Network

VSE. virtual storage extended.

VTAM. virtual telecommunications access method.

W

WAC. Wide Area Connector (card)

window. (1) An area of the screen with visible boundaries through which information is displayed. A window can be smaller than or equal in size to the screen. Windows can overlap on the screen and give the appearance of one window being on top of another. (2) A choice in the action bar of some applications. Users select it to arrange the display of several windows or to change the active window. (3) A choice in the action bar of multiple-document interface applications. (4) A choice in an action bar that allows the user to arrange the display of all open windows and to change the active window. (5) A choice in an action bar of multiple-document interface applications that allows a user to arrange the display of all open windows and to change the active window.

workstation. (1) A functional unit at which a user works. A workstation often has some processing capability. (T) (2) A terminal or microcomputer, usually one that is connected to a mainframe or network, at which a user can perform applications. (3) See also display station and terminal.

Z

zAAP. @server zSeries Application Assist Processor. See Application Assist Processor (AAP).
z800.  @server zSeries 800
z890.  @server zSeries 890
z900.  @server zSeries 900
z990.  @server zSeries 990

**Numerics**

370-XA.  IBM System/370 extended architecture
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