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Abstract

This document describes the IBM 9672 R2 and R3 models announced on June 13, 1995. It provides an overview of the IBM 9672 R2 and R3 models system hardware.

This document was written for IBM Large Systems specialist, as well as for customer management, systems programmers, and systems operations staff. Some knowledge of ESA/390 architecture is assumed.
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Preface

This document describes the IBM 9672 R2 and R3 models models announced on June 13, 1995. It provides an overview of the IBM 9672 R2 and R3 models system hardware.

This document was written for IBM Large Systems specialist, as well as for customer management, systems programmers, and systems operations staff.

This publication is intended to help the reader obtain an understanding of the IBM 9672 R2 and R3 models hardware. Some knowledge of ESA/390 architecture is assumed.

Related Publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this document.

- System/360, System/370, and System/390 I/O Interface Channel to Controlunit Original Equipment Manufacturers’ Information, GA22-6974
- Enterprise Systems Architecture/390: ESCON I/O Interface, SA22-7202
- Introducing Enterprise Systems Connection, GA23-0383
- Enterprise Systems Connection: Planning for Migration, GG66-3181
- PR/SM Planning Guide, GA22-7123
- Hardware Management Console Guide, GC38-0453
- Operations Guide, GC38-0454
- Stand-Alone IOCP User’s Guide, GC38-0455
- Sysplex Hardware and Software Migration, GC28-1210
- System/390 Microprocessor Installation Manual - Physical Planning, GC22-7101

International Technical Support Organization Publications

- MVS/ESA 5.1 Sysplex Migration Guide, GG24-4368

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The authors of this document are:

Gene Pate International Technical Support Organization, Poughkeepsie
Keith George IBM United Kingdom
Yuhsuke Ikeda IBM Japan
Dick Jorna IBM The Netherlands

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Johannes Appel IBM System/390 Division, Boeblingen
Vijay Dalal IBM System/390 Division, Poughkeepsie
Ralf Fischer IBM System/390 Division, Boeblingen
Joerg Gschwendtner IBM System/390 Division, Boeblingen
Juergen Haess IBM System/390 Division, Boeblingen
Wilhelm Haller IBM System/390 Division, Boeblingen
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Klaus Hoffmann IBM System/390 Division, Boeblingen
Jeff Kubala IBM System/390 Division, Poughkeepsie
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Charles Shapley IBM System/390 Division, Poughkeepsie
Wilfred Struck IBM System/390 Division, Boeblingen
Manfred Teckhaus IBM System/390 Division, Boeblingen
Werner Weichert IBM System/390 Division, Boeblingen

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The IBM 9672 R2 and R3 models are the continuation of a series of S/390 Enterprise Server processors, based on CMOS technology microprocessors.

Each CPC operates under its own operating system, but they can be coupled together to create an MVS Systems Complex (Sysplex), either as a separate entity or as part of a Sysplex that includes previous 9672 E, P, and R models, ES/9000 9021 711-based processors, and ES/9000 9121 511-based processors.
Chapter 1. Overview

This section provides a brief description of the IBM 9672 R2 and R3 models followed by an overview of available features. It also describes the components of the IBM 9672 R2 and R3 models.
Over-2 Topics

This foil provides a list of topics to be presented.

- **System Highlights** - Provides an overview of the IBM 9672 R2 and R3 models and features.
- **System Structure** - Describes the overall structure of the IBM 9672 R2 and R3 models and the layout of each Central Processor Complex (CPC) within the IBM 9672 R2 and R3 models.
- **Processing Unit (PU)** - Describes the Processing Units within the CPC.
- **Processor Storage (PS)** - Describes the CPC’s Processor Storage.
- **Channel Configurations** - Describes the possible channel configurations within each CPC.
- **Support Element (SE)** - Describes the Support Element within each CPC.
- **System Operation** - Describes the operation of IBM 9672 R2 and R3 models using the Hardware Management Console (HMC).
- **Coupling Configurations** - Describes the IBM 9674 C02 and C03 models.
- **System Configurations and Upgrades** - Provides tables on the configurations and upgrades available and their availability dates.
- **Function Matrix** - Provides tables comparing the functions available on the IBM 9672 R2 and R3 models with previous S/390 systems.
The packaging used in the IBM 9672 R2 and R3 models is comparable to that of the IBM 9672 R1 models. The IBM 9672 R1 models A frame may contain up to two cages, a cage either being a CPC cage or an expansion cage for additional I/O capability. A third cage type, the OSA cage, also may be added.

While the packaging used may be comparable to the of the IBM 9672 R1 models, there are differences in implementation. In addition the packaging of the IBM 9672 R2 models differs from the packaging used for the IBM 9672 R3 models. The packaging technology for the IBM 9672 R2 models is comparable with the packaging currently used for the IBM 9672 “E,” “P,” and “R1” models, where processor, storage and channels are packaged together in a CPC cage, with the ability to extend the I/O capability by adding an expansion cage. The IBM 9672 R2 models implementation allows for the addition of one expansion cage if the configuration requires.

The IBM 9672 R3 models introduce a new type of CPC packaging. The CPC cage contains processors and storage, but does not provide I/O capabilities. I/O capabilities are made available by adding one to three I/O cages to the configuration. Also the CPC is implemented differently on the IBM 9672 R3 models. Instead of mounting the processing units on a processor card that is plugged into the CPC cage as any other card, this implementation uses up to two multi-chip modules (MCMs) that are directly attached to the planar board of the CPC cage. Each of these MCMs contain 4, 5, or 6 processing units.
There are twelve models of IBM 9672 R2 and R3 Models:

- RA2 - 1 CPU and 1 SAP in the CPC
- R12 - 1 CPU and 1 SAP in the CPC
- R22 - 2 CPUs and 1 SAP in the CPC
- R32 - 3 CPUs and 1 SAP in the CPC
- R42 - 4 CPUs and 1 SAP in the CPC
- R52 - 5 CPUs and 1 SAP in the CPC
- R72 - 7 CPUs and 1 SAP in the CPC
- R53 - 5 CPUs and 1 SAP in the CPC on one MCM
- R63 - 6 CPUs and 2 SAPs in the CPC on two MCMs
- R73 - 7 CPUs and 2 SAPs in the CPC on two MCMs
- R83 - 8 CPUs and 2 SAPs in the CPC on two MCMs
- RX3 - 10 CPUs and 2 SAPs in the CPC on two MCMs

The IBM 9674 Model C02 can be configured as a CPC with 1, 2, 3, 4, 5, or 7 CPUs.

The IBM 9674 Model C03 can be configured as a CPC with 5, 6, 7, 8, or 10 CPUs.

All models must have a minimum of either one Parallel or one ESCON channel card installed. They may be configured with either all Parallel, all ESCON, or a mix of both Parallel and ESCON channels. Parallel channels are connected via 78D cables that are connected to the Parallel channel card and then to the regular Bus-and-Tag channel cables under the raised floor.

The “C0x” models do not support Parallel or ESCON channels.

Upgrades of IBM 9672 R2 models to IBM 9672 R3 models are available as well as upgrades within each model range. In addition, upgrades from IBM 9672 E01, P01, and Rx1 models to IBM 9672 R2 models, or IBM 9672 R3 models are also available.

The Hardware Management Console (HMC) provides the operator interface to control multiple CPCs from one system console without the need for a console for each CPC. When tasks are performed at the HMC, commands are sent to one or more CPCs. The HMC is an IBM PS/2 operating under OS/2 that provides the functions required through an object-oriented user interface.
Over-4 IBM 9672 R2 models - Characteristics

The highlights of the IBM 9672 R2 Model CPC include:

• Use of state-of-the-art CMOS technology provides high density chips that have low power consumption and heat generation characteristics.

• Processor Storage for each IBM 9672 R2 Model CPC can be configured from a minimum of 256MB up to a maximum of 2GB and can be assigned as either central storage or expanded storage. The exception is the processor storage for a Model RA2 that can be configured from a minimum of 128MB up to a maximum of 1GB.

• The size of central storage for an IBM 9672 R2 Model CPC can be defined at Power-On-Reset (POR) time. Minimum central storage size is 64MB, and it can be assigned in 16MB increments up to a maximum equal to the size of processor storage installed. It follows that expanded storage can be defined as a minimum of 0MB up to a maximum of the size of processor storage installed less 64MB in increments of 16MB.

• Dual power feeds are provided for the IBM 9672 R2 Models. Additional cages are powered from the dual power feeds in such a way that if one power source fails, or if one cage drops from the power ring, the remaining cages continue to operate.

• In the IBM 9672 R2 Models, from 2 to 8 Processing Units (PU) are installed on the processor card. From 1 to 7 of the PUs act as CPUs. The remaining PU is used as I/O processor (SAP).

• In the CPC cage of the IBM 9672 R2 Models there are 16 I/O slots available that can be used to install ESCON, Parallel, OSA, or Coupling Facility (CF) channels. ESCON channel cards for the IBM 9672 R2 models contain four ESCON channels, while Parallel channel cards contain three Parallel channels and can be defined to operate in either byte multiplexer or block multiplexer.
mode. Coupling Facility channel cards contain a maximum of two coupling channels. An OSA 2 card occupies one I/O slot, either providing two Token-Ring/Ethernet ports or one FDDI port. If an OSA 1 cage is part of the configuration, BIE cards are used to connect to the OSA 1 cage. One BIE card occupies one I/O slot and serves up to three OSA 1 cards in an OSA 1 cage.

**Note:** The number of channels of a specific type that can be installed in the IBM 9672 Model R2 CPC cage depends on the number of other types of channels configured and also on the number of CF and OSA cards or cages configured.

- From 1 up to 12 CF channels can be installed in the IBM 9672 R2 Models. The CF channels provide a high speed (50 MB/s or 100 MB/s) link between the CPC and attached Coupling Facilities in a Sysplex configuration. CFCs are supplied in increments of one.

  **Note:** The number of CF channels that can be installed depends on the number of ESCON, Parallel, and OSA channels configured.

- In addition, a model 2020 expansion cage can be added to the IBM 9672 R2 Models (except RA2) configuration. The diagram shows the two frames that are possible with a new build IBM 9672 R2 Models (except RA2) and the possible positions of the OSA 1 and the model 2020 I/O expansion cage. Only one OSA 1 cage is supported and only one model 2020 expansion is supported. In the IBM 9672 R2 Models the model 2020 expansion cage supports up to 16 I/O slots that can be used to install ESCON, Parallel, CF, and OSA channels (the maximum number of channel slots usable by the IBM 9672 R2 Models (except RA2) is 32 - 16 for the RA2). The total number of channels on IBM 9672 R2 models may not exceed the maximum of 128 channels (64 for the IBM 9672 model RA2). The maximum number of ESCON channels is 128, the maximum number of Parallel channels is 96, and the maximum number of CF channels is 12. The maximum number of BIE cards in support of an OSA 1 cage is three, and the maximum number of OSA 2 cards is 12 per IBM 9672 Model R2. On the IBM 9674 Model C02 models up to 32 CF channels can be installed.

- An IBM 9672 Model R2 may consist of up to two frames (for the model RA2 this is one frame). The total number of frames needed depends on the configuration.

  When the IBM 9672 Model R2 is the result of an upgrade from an IBM 9672 E01, P01, or Rx1 Model, the configuration may have up to three frames in total. The RA2 is always a one frame machine.
Over-5 IBM 9672 R3 models - Characteristics

The highlights of the IBM 9672 R3 Model CPC include:

- Use of state-of-the-art CMOS technology provides high density chips that have low power consumption and heat generation characteristics.

- Processor Storage for each IBM 9672 R3 Model CPC can be configured from a minimum of 512MB up to a maximum of 4GB and can be assigned as either central storage or expanded storage.

- The size of central storage for a IBM 9672 R3 Model CPC can be defined at Power-On-Reset (POR) time. Minimum central storage size is 64MB, and it can be assigned in 16MB increments up to a maximum equal to the lesser of either 2GB or the size of processor storage installed. It follows that expanded storage can be defined as a minimum of 0MB up to a maximum of the size of processor storage installed less 64MB in increments of 16MB.

- Dual power feeds are provided for the IBM 9672 R3 Models. Additional cages are powered from the dual power feeds in such a way that if one power source fails, or if one cage drops from the power ring, the remaining cages continue to operate.

- On the R53 model one MCM contains 6 PUs of which 5 PUs act as CPUs and 1 PU acts as the I/O processor (SAP). On the R63 to RX3 models, from 8 to 12 PUs are divided among two MCMs, of which 6 to 10 PUs act as CPUs an 2 PUs act as SAPs.

- In the CPC cage of the IBM 9672 R3 models, there is no I/O capability. This means that all I/O will be present in up to three model 2020 I/O expansion cages. The expansion cages can be used to install ESCON, Parallel, OSA, or CF channels. ESCON channel cards for the IBM 9672 R3 models contain four ESCON channels, while Parallel channel cards contain three Parallel...
channels and can be defined to operate in either byte multiplexer or block multiplexer mode. Coupling Facility channel cards contain a maximum of two coupling channels. An OSA 2 card occupies one I/O slot, either providing two Token-Ring/Ethernet ports or one FDDI port. If an OSA 1 cage is part of the configuration, BIE cards are used to connect to the OSA 1 cage. One BIE card occupies one I/O slot and serves up to three OSA 1 cards in an OSA 1 cage.

**Note:** The number of channels of a specific type that can be installed in the model 2020 I/O expansion cages depends on the number of other types of channels configured and also on whether an OSA 1 cage is configured.

- From 1 up to 12 CF channels can be installed. The CF channels provide a high speed (50 MB/s or 100 MB/s) link between the CPC and attached Coupling Facilities in a Sysplex configuration. CF channels are supplied in increments of one.

  **Note:** The number of CF channels that can be installed depend on the number of ESCON, Parallel, and OSA channels configured.

- Each of the three possible model 2020 expansion cages may contain up to 22 I/O slots that can be used to install ESCON, Parallel, OSA, and CF channels (the maximum number of channel slots usable by the IBM 9672 R3 Models (except R53) is 48 - 32 for the R53). The total number of channels on IBM 9672 R3 models may not exceed the maximum of 192 channels (128 for the IBM 9672 model R53). The maximum number of ESCON channels is 192, the maximum number of Parallel channels is 96, and the maximum number of CF channels is 12. The maximum number of BIE cards in support of the OSA 1 cage is three, and the maximum number of OSA 2 cards is 12 per IBM 9672 Model R3. On the IBM 9674 Model C03 up to 32 coupling channels can be installed.

- An IBM 9672 Model R3 may consist of up to two frames. The total number of frames needed depends on the configuration.

  When the IBM 9672 Model R3 is the result of an upgrade from an IBM 9672 E01, P01, or Rx1 Model, the configuration may have four frames in total.
Over-6 Functional Capabilities

The following functional capabilities, among others, are incorporated in the CPC as standard facilities. They are consistent with those provided on ES/9000 9121 511-based processors and ES/9000 9021 711-based processors.

- PR/SM with EMIF
- Coupling Facility Control Code (CFCC)
- Integrated Coupling Migration Facility (ICMF)
- CICS Availability Enhancements
- Data Compression
- Dynamic Reconfiguration Management (DRM)
- Dynamic Storage Reconfiguration (DSR)
- Asynchronous Data Mover Facility (ADMF)
- 8-Path Dynamic Reconnect
- Asynchronous Pageout Facility
- DB2 Sort Assist
- ESA/TPF Mode

Over-6 Functional Capabilities

The following functional capabilities, among others, are incorporated in the CPC as standard facilities. They are consistent with those provided on ES/9000 9121 511-based processors and ES/9000 9021 711-based processors.

- PR/SM is standard on all IBM 9672 R2 models and IBM 9672 R3 models and supports S/370, ESA/390, and ESA/TPF modes of operation in any LPAR. ESA/370 and 370-XA are subsets of ESA/390. A CPC can be Power-On-Reset in ESA/390 or LPAR mode.
  - The facilities provided under PRSM are equivalent to those on ES/9000 9121 511-based processors, including EMIF, but with the exception of the number of partitions (10 versus 7) and the absence of PAF support for LPAR recovery.
  - ESCON Multiple Image Facility (EMIF) - Offers channel sharing among PR/SM logical partitions and can reduce the number of channels required to access ESCON capable control units and Coupling Facilities.
  - ESA/390 is the native mode of the processors. When operating in ESA/390 mode, PR/SM provides assists for VM/ESA multiple preferred guests.

When operating in LPAR mode, PR/SM provides flexible partitioning of system resources among multiple logical partitions. LPAR mode is also required to support all S/370 architecture operating systems, such as MVS/370, VSE/SP, or VM/SP HPO (they can also operate as guests under VM/ESA or VM/XA running in native ESA/390 mode).

In LPAR mode, PR/SM also provides support for a Coupling Facility to run in a special logical partition. The Coupling Facility logical partition is defined in much the same way as normal logical partitions, but the customer does not IPL anything into the Coupling Facility partition.
When a Coupling Facility partition is activated, the Support Element (SE) in the CPC loads the Coupling Facility Control Code (CFCC) into the logical partition.

- **Coupling Facility Control Code (CFCC)** - The Coupling Facility Control Code is a standard feature on the IBM 9672 R2 and R3 models hardware. It provides the Coupling Facility function and is the same as the CFCC feature on the ES/9000 9121 511-based processors and ES/9000 9021 711-based processors.

- **Integrated Coupling Migration Facility (ICMF)** - The Integrated Coupling Migration Facility is a standard feature on the IBM 9672 R2 and R3 models hardware. It provides the Coupling Facility function for MVS/ESA 5.1.0 (or higher) LPARs on the same physical CPC without requiring any physical CFCs. The ICMF is the same as the ICMF feature on the ES/9000 9121 511-based and ES/9000 9021 711-based systems.

- **CICS Availability Enhancements** - CICS/ESA, when running on a IBM 9672 R2 and R3 Models, is provided with increased isolation of CICS application programs, thus enhancing CICS application availability. The Subsystem Storage Protection hardware facility protects the CICS nucleus from applications within the same address space. CICS Subspaces hardware, in cooperation with the MVS Subspace support and CICS/ESA, also protects the applications themselves from each other.

- **Data Compression** - This hardware assist facility will allow for a reduction in the cost of computing by:
  - Reducing the amount of DASD storage
  - Reducing the number of channels
  - Reducing the number of communication lines
  while transmission of compressed data may lead to:
  - Improved response times
  - Reduced elapsed time for bulk data transfer
  and at the same time minimizing compression/decompression processing overheads. Data compression will be supported by MVS/ESA subsystems, including VTAM, DB2, IMS and DFSMS/MVS.

- **Dynamic Reconfiguration Management (DRM)** - This facility, in conjunction with MVS/ESA and a Hardware Configuration Definition (HCD), allows changes to be made to hardware and software I/O configuration definitions without requiring a Power-On-Reset of the hardware or an IPL of MVS/ESA. Scheduled system outages are reduced.

- **Dynamic Storage Reconfiguration (DSR)** - This facility, in conjunction with MVS/ESA, allows reserved central and expanded storage from one logical partition to be made available to another logical partition, while the receiving logical partition remains active. This is useful, for example, in an environment where one partition requires all the memory be defined for it during prime shift, but can release some of the memory to another partition during off-shift hours.

- **Asynchronous Data Mover Facility (ADMF)** - This function is used by subsystem software, such as DB2, to move large amounts of data between central and expanded storage. It also operates on data stored in compressed format, thus further increasing the performance benefits.

- **8-Path Dynamic Reconnect** - The IBM 9672 R2 and R3 Models I/O subsystem supports dynamic I/O reconnection on up to 8 paths. This doubles the number of paths supported on many previous systems.

- **Asynchronous Pageout Facility** - Allows IBM subsystems to move data asynchronously from central to expanded storage. This means that a program can continue processing while data is moved to expanded storage.

- **DB2 Sort Assist** - This hardware assist significantly reduces the elapsed and CPU time required to perform DB2 sorting operations.
• ESA/TPF is a superset of ESA/390, which provides additional function for the Transaction Processing Facility (TPF) operating system.

Note:

These are only some of the major functions implemented in the IBM 9672 R2 and R3 Models. A list of other functions is provided at the end of this overview section in the form of a functions matrix.
### IBM 9672 R2, R3, and C Models

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<th>9672 R2 Models</th>
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<td><strong>R72</strong> 7-way processor</td>
<td><strong>RX3</strong> 10-way processor</td>
</tr>
<tr>
<td><strong>R52</strong> 5-way processor</td>
<td><strong>R83</strong> 8-way processor</td>
</tr>
<tr>
<td><strong>R42</strong> 4-way processor</td>
<td><strong>R73</strong> 7-way processor</td>
</tr>
<tr>
<td><strong>R32</strong> 3-way processor</td>
<td><strong>R63</strong> 6-way processor</td>
</tr>
<tr>
<td><strong>R22</strong> 2-way processor</td>
<td><strong>R53</strong> 5-way processor</td>
</tr>
<tr>
<td><strong>R12</strong> 1-way processor</td>
<td></td>
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<tr>
<td><strong>RA2</strong> 1-way processor</td>
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</tbody>
</table>

#### 9674 C02 Models
- Coupling Facility
- 1, 2, 3, 4, 5, or 7-way

#### 9674 C03 Models
- Coupling Facility
- 5, 6, 7, 8, or 10-way

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**Over-7 IBM 9672 R2, R3, and C Models**

The S/390 Parallel Enterprise Server Type 9672 comes in several flavors. At first there are the IBM 9672 R1 models that became available in the second half of 1994. These models are known as the S/390 Parallel Enterprise Server Type 9672 Models R11 through R61.

On June 13th two ranges of Parallel Enterprise Servers were announced that are also known as S/390 Parallel Enterprise Servers Type 9672 Models. One range, the IBM 9672 R2 models, contain the following processor types:

- Model R72, a 7-way processor
- Model R52, a 5-way processor
- Model R42, a 4-way processor
- Model R32, a 3-way processor
- Model R22, a 2-way processor
- Model R12, a 1-way processor
- Model RA2, a 1-way processor

The other range, the IBM 9672 R3 models, contain the following processor types:

- Model RX3, a 10-way processor
- Model R83, a 8-way processor
- Model R73, a 7-way processor
- Model R63, a 6-way processor
- Model R53, a 5-way processor
in addition there are two models that serve as Coupling Facilities. The IBM 9674 Model C02 uses the packaging of the IBM 9672 R2 models and may contain 1, 2, 3, 4, 5, or 7 CPUs. The IBM 9674 Model C03 uses the packaging of the IBM 9672 R3 models and may contain 5, 6, 7, 8, or 10 CPUs.
Over-8 IBM 9672 R2 Model - Processor Cage

The frames of the IBM 9672 R2 models are equivalent to the frames already used for the IBM 9672 R1 models today, but the CPC and expansion cages differ in design, content, and size (a 24 inch cage is used). The building blocks used for the IBM 9672 R2 models are a specific CPC cage for the IBM 9672 R2 Model and an I/O cage that is common for IBM 9672 R2 and R3 Models.

The IBM 9672 R2 Model processor cage contains a triple book processor card, two double book memory cards, and two IBB domains each support 8 I/O slots. In addition, voltage regulator cards (DCAs), the ETR card, and the UPC card are present in the IBM 9672 R2 Model CPC cage.
Over-9 IBM 9672 R3 Model - Processor Cage

The frames of the IBM 9672 R3 models are equivalent to the frames already used for the IBM 9672 R1 models today. The IBM 9672 R3 uses a 19 inch CPC cage, while the accompanying I/O cages are 24 inch. The building blocks used for the IBM 9672 R3 models are a specific CPC cage for the IBM 9672 R3 Model and an I/O cage that is common for IBM 9672 R2 and R3 Models.

The IBM 9672 R3 processor cage contains the processor modules, that are directly plugged onto the board, and four memory card positions. The IBM 9672 R3 CPC cage does not have I/O support. In addition, voltage regulator cards (DCAs), the ETR card, and the UPC card are present in the IBM 9672 R3 Model CPC cage.
Over-10 IBM 9672 Models R2 and R3 - I/O Cage

The IBM 9672 R2 and R3 Models use a common 24 inch I/O cage, the Model 2020 I/O cage. For the IBM 9672 R2 new build systems, the Model 2020 I/O cage is optional and only configured when more I/O capacity than fits in the IBM 9672 R2 CPC cage is needed. The IBM 9672 R3 new build systems need at least one Model 2020 I/O cage, because the IBM 9672 R3 CPC cage does not provide I/O slots.

The Model 2020 I/O cage supports up to three IBB domains with a total of 22 I/O slots. In addition, voltage regulator cards (DCAs), and the UPC card are present in the I/O cage.
Over-11 IBM 9672 R2 - CPC Layout

This foil shows the layout of an IBM 9672 R2 CPC cage. Only one CPC cage can be installed in a frame. The second cage position may be occupied by an expansion cage or an OSA 1 cage. The IBM 9672 R2 Model new build systems allow for a maximum of one Model 2020 I/O expansion cage and one OSA 1 cage. Thus the first frame can contain the CPC cage and a Model 2020 I/O expansion cage or an OSA 1 cage, while the second frame may contain either one Model 2020 I/O expansion cage or one OSA 1 cage.

The foil shows the location of CPC components within the CPC cage. They are in four sections:

- The top of the cage contains power supply elements (the bulk power adapters or BPAs).
- The bottom of the cage houses the cooling blower unit.
- In the center of the cage is a double-sided planar board into which all circuit component cards are plugged.
- The Support Element is located in front of the CPC cage. This is a laptop computer (Thinkpad) that provides hardware operational support (system initialization, problem recording, IPL, system reconfiguration, and so forth). When in normal operation, the Thinkpad is folded away in a vertical position to allow the doors of the frame to be closed.

The planar board acts as the central power and signal distribution medium between all elements within the CPC. The processing unit, channels, channel adapters (CHAs), IBB cards, and voltage regulator cards (DCAs) are plugged into the front of the planar board. Memory, ETR, power, channel adapter, and channel cards are plugged into the rear of the planar board.
This foil shows the layout of an IBM 9672 R3 CPC cage. Only one CPC cage can be installed in a frame. The second cage position may be occupied by an expansion cage. The IBM 9672 R3 new build systems allow for a maximum of three additional cages. These may consist of a maximum of three Model 2020 I/O expansion cages or two Model 2020 I/O expansion cages and one OSA 1 cage. Thus the first frame contains the CPC cage and a Model 2020 I/O expansion cage, while the second frame may contain either one Model 2020 I/O expansion cage and one OSA 1 cage, or two Model 2020 I/O expansion cages.

The foil shows the location of CPC components within the CPC cage. They are in three sections:

- In the center of the cage is a single-sided planar board into which all circuit component cards and modules are plugged (from the front only).
- The rear of the cage is fully occupied by the cooling blower unit at the top and the power supply elements (bulk power adapters or BPAs) at the bottom.
- The Support Element is located in front of the CPC cage. This is a laptop computer (Thinkpad) that provides hardware operational support (system initialization, problem recording, IPL, system reconfiguration, and so forth). When in normal operation, the Thinkpad is folded away in a vertical position to allow the doors of the frame to be closed.

The planar board acts as the central power and signal distribution medium between all elements within the CPC.

The lower part of the board is where the processing units are located. The processing units are found on one or two Multi-Chip Modules (MCMs) that are directly plugged into the planar board.
The MCMs are equipped with a heatsink to allow proper cooling. Around the modules several Single Chip Modules (SCMs) are located that are also directly plugged in the board providing functions like the Memory Bus Adapter (MBA), redrive, clock, and the Bus Switching Network (BSN). Below each MCM is an IBB connector. Each connector provides for two IBB cables to IBB cards in the expansion cages.

The upper part of the board is the location where processor storage, voltage regulation (DCAs), ETR, and the power card are plugged into the planar board. There is no I/O capability on the board.
Over-13 IBM 9672 Model R2 - Processor Card

Highlights of the processor card used in the IBM 9672 R2 models are:

- Depending on the CPU feature selected when the CPC model was configured, the processor card is populated with from 2 to 6, or 8 processing units (PUs). At least one PU is assigned as a System Assist Processor (SAP), which performs I/O operations in an asynchronous manner, with the remaining PUs assigned as conventional ESA/390 CPUs (1 to 5, or 7 CPUs). If PORed in I/O intensive mode, two PUs (if 4 or more PUs are available) will be assigned as SAPs to support the high intensity I/O environment.

- All PUs in a CPC reside on the same physical card, and therefore, they cannot be physically partitioned. There are four positions on the processor card for mounting Multi-Chip Modules (MCM). Each MCM can contain up to two PUs, allowing for a maximum of eight PUs on the card.

- Each PU has its own 16KB L1-cache. The L1-cache is implemented on the PU chip and operates in store-through mode to the L2.

- Each PU has its own 192KB L2-cache. The L2-cache is implemented in two chips on the PU MCM and operates in store-in mode (modified data is not immediately written through to processor storage).

- Coprocessor chip in the MCM for Floating Point operations.

- The complete PU function implementation requires 4 chips (1 PU, 1 FP, and 2 L2) of which one or two sets are packaged together on one MCM.

- The cycle time of each PU within an IBM 9672 R2 Model CPU is 12 ns (15 ns for the RA2).
Over-14 IBM 9672 Model R2- Processor Card

The foil shows the layout of the IBM 9672 R2 processor card.

- Four IBB connectors (RA2 = 2 IBB connectors)
- Memory Bus Adapters (MBAs)
- Bus Switching Network (BSN)
- Up to four Processing Unit MCMs
  - RA2 and R12: 1 MCM (1 x 2 PUs)
  - R22: 2 MCMs (1 x 2 PUs + 1 PU)
  - R32: 2 MCMs (2 x 2 PUs)
  - R42: 3 MCMs (2 x 2 PUs + 1 PU)
  - R52: 3 MCMs (3 x 2 PUs)
  - R72: 4 MCMs (4 x 2 PUs)
Over-15 IBM 9672 Model R3 - Processor Board

Highlights of the processor board in an IBM 9672 R3 Model are:

- Depending on the CPU feature selected when the CPC model was configured, the processor board is populated with from 6 to 12 Processing Units (PUs). Two PUs (one on the R53) are assigned as a System Assist Processors (SAP), which performs I/O operations in an asynchronous manner, with the remaining PUs assigned as conventional ESA/390 Central Processing Units (CPUs). If PORed in I/O intensive mode, four PUs (2 PUs on the R53) will be assigned as SAPs to support the high intensity I/O environment.
- All PUs in a CPC reside on the same physical board, and therefore, they cannot be physically partitioned. On the board are two positions for the mounting of a Multi-Chip Module (MCM). Each MCM contains 4, 5, or 6 PUs, allowing for a maximum of 12 PUs on the board.
- Each PU has its own 16KB L1-cache. The L1-cache is implemented on the PU chip and operates in store-through mode to the L2.
- Each PU has its own 384KB L2-cache. The L2-cache is implemented in four chips on the PU MCM and operates in store-in mode (modified data is not immediately written through to Processor Storage).
- Coprocessor chip in the MCM for Floating Point operations.
- The complete PU function implementation requires 6 chips (1 PU, 1 FP, 4 L2) of which up to 6 sets are packaged together on one MCM.
- The cycle time of each PU within a IBM 9672 R3 Model CPC is 12 ns.

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Over-16 IBM 9672 Model R3- Processor Board

The foil shows the layout of the IBM 9672 R3 processor board.

- Four IBB connectors (R53 = 2 IBB connectors)
- Memory Bus Adapters (MBAs).
- Bus Switching Network (BSN).
- Up to two Processing Unit MCMs.
  - R53: 1 MCM (1 x 6 PUs)
  - R63: 2 MCMs (4 PUs + 4 PUs)
  - R73: 2 MCMs (5 PUs + 4 PUs)
  - R83: 2 MCMs (6 PUs + 4 PUs)
  - RX3: 2 MCMs (6 PUs + 6 PUs)

The upper side of the board is used to plug the four storage cards, the voltage regulators (DCAs), the ETR card and the power card.
Over-17 IBM 9672 R2 - Processor Storage

Regardless of installed capacity, processor storage is contained on two (double book) storage cards of equal capacity (the IBM 9672 R2 Model RA2 uses only one storage card) and is used for both central storage and expanded storage. Expanded storage is configured, if required, at Power-On Reset (POR) time through the Hardware Management Console’s icon interface.

Data interleaving between the two storage cards enhances performance. Interleaving enables more efficient retrieval of data and faster loading of L2-caches when multiple sequential cache lines are required.

All available processor storage sizes are listed on the foil. A maximum of 2048MB of processor storage can be installed.

Processor storage is based on either 4Mbit or 16Mbit storage chips. Up to 512MB, 4Mbit storage chips are used and 16Mbit chips from 1GB to 2GB. The RA2 uses 4Mbit chips up to 256MB and 16Mbit chips from 512MB to 1GB.

The Error Correction Code (ECC) bits are stored with the data in Processor Storage. All single-bit errors are detected and corrected, double-bit errors are detected and some (one soft-bit and one hard-bit error) are corrected, while multiple-bit errors are detected and flagged for further action by the operating system. With the EECC function on the IBM 9672 R2 and R3 Models it is possible to correct up to four failing bits if all four bits are from the same memory chip. Chip sparing and storage scrubbing are also employed, but will not be described in this overview presentation.
The IBM 9672 R2 Model CPC uses two high performance memory buses for data transfers between processor storage, PUs, and channels.

**Note:** The IBM 9672 R2 Model RA2 uses one memory bus only. There is no System Control Element as there is in IBM 3090, 9121 and 9021 processors.
Over-18 IBM 9672 R3 - Processor Storage

- On four equal capacity storage cards
- Data interleaving (storage to processor) enhances storage access rates
- Used for both central storage and expanded storage
- Processor storage sizes:
  - 512 MB, 1024 MB, 2048 MB, 4096 MB
- Up to 512 MB uses 4Mbit chips, above; 16 Mbit chips
- Error checking and correction (ECC)
  - Single-bit error detection and correction
  - Double-bit error detection and some correction
  - Multiple-bit error detection
  - Up to Four-bit error detection and correction (with EECC)
- Four high speed memory busses

Over-18 IBM 9672 R3- Processor Storage

Regardless of installed capacity, processor storage is contained on four storage cards of equal capacity and is used for both central storage and expanded storage. Expanded storage is configured, if required, at Power-On Reset (POR) time through the Hardware Management Console’s icon interface.

Data interleaving between the four storage cards enhances performance. Interleaving enables more efficient retrieval of data and faster loading of L2-caches when multiple sequential cache lines are required.

All available processor storage sizes are listed on the foil. A maximum of 4GB of processor storage can be installed.

Processor storage is based on either 4Mbit or 16Mbit storage chips. Up to 1GB, 4Mbit storage chips are used and 16Mbit chips from 2 GB to 4 GB.

The Error Correction Code (ECC) bits are stored with the data in processor storage. All single-bit errors are detected and corrected, double-bit errors are detected and some (one soft-bit and one hard-bit error) are corrected, while multiple-bit errors are detected and flagged for further action by the operating system. With the EECC function on the IBM 9672 R2 and R3 Models it is possible to correct up to four failing bits if all four bits are from the same memory chip. Chip sparing and storage scrubbing are also employed, but will not be described in this overview presentation.
The IBM 9672 R3 Model CPC uses four high performance memory busses for data transfers between processor storage, PUs, and channels. There is no System Control Element as there is in IBM 3090, 9121 and 9021 processors.
Central Storage

- Shared by all processing units
- Minimum size: 64 MB
- Increments: 16 MB
- Maximum size:
  - Model RA2: 1024 MB
  - All other R2 and R3 Models: 2048 MB
- Fetch and Store protect
- Data movement between I/O devices and central storage does not go through the L1/L2 caches
  - L2 cache is checked for changed / invalidated cache lines
- Contains Hardware System Area (HSA)

Over-19  Central Storage

Central storage is shared by all PUs, which access it by way of their own L2 High Speed Buffer. The size of central storage is defined in the activation profile selected at Power-On Reset (POR) time. Any remaining processor storage is automatically allocated as expanded storage. The minimum amount of central storage that can be defined is 64MB. Size increments are 16MB up to a maximum of 2048MB.

Central storage frames are fetch protected and store protected to prevent unauthorized access or modification. Each frame is also protected by a 4-bit storage protect key. The storage protect key, and the fetch-protection and store-protection bits are held in internal arrays within the Storage Controller (STC).

I/O data transfers are initiated by the operating system, controlled by the SAP, and do not pollute the PUs L1/L2 cache.

The Hardware System Area (HSA) contains I/O configuration data (created at POR time from the contents of the IOCDS) and Licensed Internal Code (LIC). In Enterprise Systems Architecture (ESA/390) mode, HSA is allocated, as needed, in 64KB segments until sufficient storage has been taken to support the required IOCDS and Licensed Internal Code. The HSA cannot be accessed by user programs.
Over-20 Expanded Storage

Expanded storage is part of processor storage just like central storage. Expanded storage is not a separate component as it is on IBM 3090 and 9021 processors; it is similar to the ES/4381, 9221 and 9121 implementations. Processor storage that is not assigned as central storage is automatically assigned as expanded storage.

At Power-On Reset (POR) time, the required amount of central storage is specified through the Hardware Management Console’s icon interface. All remaining processor storage is automatically allocated to expanded storage.

The minimum amount of expanded storage is 0MB, while the maximum on IBM 9672 R2 models can be up to 1984MB (on IBM 9672 Model RA2 it is 960MB) and for IBM 9672 R3 models it can be up to 4032MB (64MB less than the installed processor storage size). Expanded storage definition size increments are 16MB.

Data transfer to and from expanded storage is initiated by the operating system and takes place in 4KB blocks. This data movement is controlled by the Storage Controller (STC) and does not use the High Speed Buffer (HSB).

Data movement directly between expanded storage and I/O devices is not supported. All data movement to and from I/O devices is done from central storage.
## Over-21 Channel Types

**Parallel**
- 3 channels on a channel card
- 4.5 MB/s block multiplexer
- 1 MB/s byte multiplexer
- 122 m (400 feet) maximum cable length

**ESCON (LED)**
- 4 channels on a channel card
- Multi-mode fiber optic cable
- 17 MB/s data rate
- 3 km (1.8 miles) maximum cable length

**Coupling Facility Channels**
- 2 channels on a channel card
- Multi-mode or single-mode fiber optic cable
- 50 MB/s or 100 MB/s data rate
- 1 or 3 km (0.6 or 1.8 miles) maximum cable length

Parallel channels can be configured as either byte or block multiplexer (specified in IOCP definition). When running in block multiplexer mode, data rates of up to 4.5 MB/sec are supported. When running in byte multiplexer mode, data rates of up to 1 MB/sec are supported. The maximum cable length for a Parallel channel is 122 meters (400 feet) when operating in data streaming mode.

ESCON channels using fiber optic cables and a LED (Light Emitting Diode) light source support data rates of up to 17 MB/sec. The maximum unrepeated Multi-mode link distance is 3 km when using 62.5 micron fiber. When using 50 micron fiber, the maximum unrepeated Multi-mode distance is 2 km. When using ESCON directors and/or ESCON 9036 converter/repeaters, distances are I/O device dependent.

The coupling channel provides a high speed link between the CPC and a Coupling Facility using fiber optic cable containing either two (50 or 62.5 micron) multi-mode fibers (one for each direction) and a short wave laser source or two (9 or 10 micron) single-mode fibers (one for each direction) and a long wave laser source. For the shortwave coupling facility channel, the maximum data transfer rate is approximately 50 MB/sec and the maximum connection distance is 1 km (0.6 miles). For the long wave coupling facility channel the maximum data transfer rate is approximately 100 MB/sec and the maximum connection distance is 3 km (1.8 miles). A special internal transmission protocol is used in coupling channels, not the ESCON interface protocol.
Over-22 Channel Types II

The OSA 1 Bidirectional Interface Extender (BIE) takes the place of an ESCON or parallel channel card and links FDDI, Ethernet or Token-Ring cards in an OSA 1 cage to the CPC. Each BIE card supports up to three OSA 1 cage cards.

The IBM 9672 R2 and R3 Models support an OSA 2 card that does not require an OSA 1 cage. The OSA 2 card is installed like an ESCON or parallel channel card and supports either two Ethernet/Token-Ring ports, or one FDDI port.

ESCON Extended Distance Facility (XDF) is only supported on the IBM 9672 R2 and R3 Models when they are carried over from an IBM 9672 R1 Model in an upgrade situation.

ESCON Extended Distance Facility (XDF) channels using 9 or 10 micron Single-mode fiber optic cables and a laser light source support the same 17 MB/sec data rate as ESCON (LED) channels. The maximum unrepeated single-mode link distance is 20 km. When using ESCON directors and/or ESCON 9036 converter/repeaters, distances are I/O device dependent.

Note: An XDF channel cannot currently connect directly to an I/O device. Either an ESCON director or an ESCON 9036 converter/repeater is required to convert the Single-mode fiber to Multi-mode fiber.

ESCON and ESCON XDF channels can be defined as ESCON serial channels, ESCON CTCAs (channel-to-channel adapters), or ESCON conversion channels (IBM 9034 attachment). As an ESCON conversion channel, both block multiplexer mode and byte multiplexer mode are supported.
Over-23 IBM 9672 Model R2 - CPC Cage I/O

The CPC cage of the IBM 9672 R2 models has two IBB domains (IBB0 and IBB1). An IBB domain consists of an IBB card, and two Channel Adapter (CHA) cards and controls eight I/O slots.

CHAs are only required for IBB domains that contain ESCON, Parallel, OSA 1, or OSA 2 cards (ie. CF channels do not require CHA cards).

Each I/O slot may contain an ESCON card (four channels), a Parallel card (three channels), and OSA 1 BIE card (3 channels), or an OSA 2 card (1 channel).

OSA 1 BIE cards for the OSA 1 cage can only be plugged in slot positions 28, 27, or 26, starting with position 28.

Coupling facility channel cards (each card supports up to two CF channels) can only be plugged in slots 10, 21, 6, 29, 18, 34, 28, 17, and 33 following the same plugging order.

OSA 2 cards (one Ethernet/Token-ring card supports two ports and an FDDI cards support one port) can be plugged into any channel slot.
IBM 9672 R2 and R3 - I/O Cage

- Three IBB domains (IBB0, IBB1, and IBB2)
  - Only IBB0 and IBB1 domains used on R2 models
  - Each domain controls two Channel Adapter (CHA) cards
  - Double wide IBB available for IBB0/IBB1 domain on R3 models
    - Double wide IBB controls four Channel Adapter (CHA) cards
    - Double wide IBB does not support CF channel cards

- Each CHA cards controls up to four channel cards
  - IBB0 (CHA1 and CHA2) supports 8 I/O slots
  - IBB1 (CHA3 and CHA4) supports 8 I/O slots
  - IBB2 (CHA5 and CHA6) supports 6 I/O slots

- Channel Support:
  - Maximum ESCON channels (R2: 64) (R3: 88) 4 channels/card
  - Maximum Parallel channels (R2: 48) (R3: 66) 3 channels/card
  - Maximum CF channels (R2: 12) (R3: 12) 2 channels/card
  - Maximum of 3 CF channel cards per single wide IBB

Over-24 IBM 9672 R2 and R3 - I/O Cage

The I/O cage of the IBM 9672 R2 and R3 models has a maximum of three IBB domains (IBB0, IBB1, and IBB2). IBB domains 0 and 1 consist of one IBB card, and two channel adapter (CHA) cards and control eight I/O slots each. IBB domain 2 consists of one IBB card and two channel adapter cards and control six I/O slots.

CHA cards are only required for IBB domains that contain ESCON, Parallel, OSA 1, or OSA 2 cards (ie. CF channels do not require CHA cards).

IBB0 and IBB1 may be contained in a double book IBB card, using one IBB cable to the processor, thus extending the number of I/O slots supported. The double book IBB card does not support coupling channels and is not supported by the IBM 9672 R2 models.

Each I/O slot may contain an ESCON card (four channels), a Parallel card (three channels), and OSA 1 BIE card (3 channels), or an OSA 2 card (1 channel).

OSA 1 BIE card support (each card supports three OSA 1 channels) for the OSA 1 cage can only be plugged in slot positions 28, 27, or 26, starting with position 28.

Coupling facility channel cards (each card supports up to two CF channels) can only be plugged in slots 10, 21, 6, 29, 18, 34, 28, 17, and 33 following the same plugging order.

OSA 2 cards (one Ethernet/Token-ring cards supports two ports and an FDDI cards supports one port) can be plugged in any slot.
Over-25 IBM 9672 R2 and R3 - I/O Maximums

IBM 9672 R2 and R3 - I/O Maximums

- R2 Maximums per System
  - 32 max I/O slots (requires 4 single wide IBB cards)
  - 128 max channels (all ESCON and requires 1 expansion cage)
  - 96 max Parallel channels
  - 12 max CF channels (max 6 CF channels per IBB domain)

- R3 Maximums per System (except R53)
  - 48 max I/O slots (requires 2 double + 2 single wide IBB cards)
  - 192 max channels (all ESCON and requires 3 expansion cages)
  - 96 max Parallel channels
  - 12 max CF channels (max 6 CF channels per IBB domain)

- C02 / C03 Maximums per System
  - 32 max CF channels
    - Minimum of 2 CF channels in C02 and C03
    - C02 does not use an expansion cage
    - C03 uses one expansion cage, IBB0 and IBB1 domains

The maximum number of channels supported on any IBM 9672 R2 Model may never exceed 128 channels. Since the two IBB domains in the IBM 9672 Model R2 CPC cage only support a maximum of 64 channels, a Model 2020 I/O expansion cage is needed to achieve this maximum.

The maximum number of channels supported on any IBM 9672 R3 Model may never exceed 192 channels. Since the three IBB domains in the I/O cage only supports a maximum of 88 channels, three I/O cages (expansion cages) and double book IBBs are needed to achieve the maximum I/O configuration for IBM 9672 R3 models. To achieve the maximum I/O configuration for the IBM 9672 Model R2 one I/O cage is required.

The IBM 9674 Model C02 and C03 require a minimum of 2 and support a maximum of 32 CF channels.
Over-26 Upgrades from R1 to R2, or R3

When an IBM 9672 E01, P01, or Rx1 Model is upgraded to a IBM 9672 R2 or IBM 9672 R3 model, the following parts will be removed from the CPC cage.

- MAU
- Service Element
- EPO
- Tailgate (if present)
- Processing Unit
- Expansion cage (feature code #2000)
- Memory cards
- ETR
- CF channel cards from slots 18 and 20

Moved to an R2 or R3 cage:

- ETR (features #6150 and #6152)
  - feature #6150 requires feature #6153
- CF channel cards from slots 18 and 20
  - (if slots 17 and 19 in R1 cage are not available)

What remains:

- R1 CEC cage (as an I/O cage) and any model #1000 I/O cage
- ESCON, Parallel, XDF channels, the OSA cage, and
  - CF channel cards (only in slots 17 and 19)

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Over-26 Upgrades from R1 to R2, or R3

When an IBM 9672 E01, P01, or Rx1 Model is upgraded to a IBM 9672 R2 or IBM 9672 R3 model, the following parts will be removed from the CPC cage.

- MAU
- Service Element
- EPO
- Tailgate (if present)
- Processing Unit
- Expansion cage (feature code #2000)
- Memory cards
- ETR cards (feature #6150 and #6152 is moved)
- CF channel cards from slots 18 and 20

Feature #6152 is the two port ETR card and will be moved to the CPC cage of the IBM 9672 R2 or the IBM 9672 R3. ETR features #6150 is moved but requires #6153 and attachment to another #6150 card. ETR features #6151 (the slave ETR card) is removed.

The remaining parts; ESCON channels, XDF channels, and OSA channels remain in their original cage. This cage becomes an I/O cage of the IBM 9672 R2 and R3 models to which the IBM 9672 E01, P01, or Rx1 Models are upgraded.
A feature code #1000 expansion cage may be carried across to the IBM 9672 R2 and R3 models.

**Note:** All removed parts become the property of IBM.
Over-27 Upgrades from R1 to R2

When an IBM 9672 E01, P01, or Rx1 Model is upgraded to an IBM 9672 R2 Model the possible frame layouts are different from the new build IBM 9672 R2 Models. In addition to the different frame layouts the number of I/O slots is also reduced so long as the converted CPC cage or any model #1000 I/O expansion cages remain in the IBM 9672 Model R2 configuration.

The IBM 9672 R2 Model upgraded configuration also supports up to two I/O expansion cages. One or both I/O expansion cages may be model #1000 (one of the model #1000 cages would be the converted IBM 9672 E01, P01, or Rx1 Model CPC cage) I/O expansion cages. If only one model #1000 I/O expansion cage is used then a model #2020 I/O expansion cage may also be used (although only one IBB domain could be used in the model #2020 cage).

OSA 1 BIE cards for connecting the OSA 1 cage could be installed in either the IBM 9672 R2 Model CPC cage, the model #1000 I/O expansion cage, or the model #2020 I/O expansion cage. Only one OSA 1 cage can be installed in the IBM 9672 R2 Model configuration.
Over-28 Upgrades from R1 to R3

When an IBM 9672 E01, P01, or Rx1 Model is upgraded to an IBM 9672 R3 Model the possible frame layouts are different from the new build IBM 9672 R3 Models. In addition to the different frame layouts the number of I/O slots is also reduced so long as the converted CPC cage or any model #1000 I/O expansion cages remain in the IBM 9672 Model R3 configuration.

The IBM 9672 R3 Model upgraded configuration also supports up to four I/O expansion cages. One or two of the I/O expansion cages may be model #1000 I/O expansion cages (one of the model #1000 cages would be the converted IBM 9672 E01, P01, or Rx1 Model CPC cage). If only one model #1000 I/O expansion cage is used then a third model #2020 I/O expansion cage may also be used (although only one IBB domain could be used in the model #2020 cages).

OSA 1 BIE cards for connecting the OSA 1 cage could be installed in either one of the model #1000 I/O expansion cages, or one of the model #2020 I/O expansion cages. Only one OSA 1 cage can be installed in the IBM 9672 R3 Model configuration.

If the OSA 1 BIE cards are installed in one of the model #2020 I/O expansion cages then only two model #2020 expansion cages may be installed in the IBM 9672 R2 Model configuration.
Over-29 Maximum Channel Configurations

This table shows the maximum I/O configurations possible when all available I/O slots are filled with ESCON channel cards. For new machines, the following maximum values count:

- The model RA2 can only be one CPC cage, thus having the I/O capability of two IBB domains, amounting to 16 I/O slots with a maximum capability of 64 ESCON channels.

- All other IBM 9672 R2 models reach their maximum I/O capability by adding one I/O cage to the CPC cage. The CPC cage has two IBB domains (64 channels), the I/O cage has the capability of three IBB domains, however, the IBM 9672 Model R2 PU only supports a total of four IBB domains (one IBB cable per domain of 32 channels), thus a maximum of 64 ESCON channels in the I/O cage. In total 128 ESCON channels.

- The model R53 Processing Unit only has two IBB connectors. The maximum of 128 ESCON channels is reached by connecting to two double book IBB cards. A double book IBB cards supports 16 I/O slots on one IBB cable. Each IBB connects to an I/O cage, each capable of delivering 64 ESCON channels.

- All other IBM 9672 R3 models reach their maximum I/O capability by adding the maximum three I/O cages to the CPC cage. The CPC cage itself has no I/O capability. Two of the I/O cages must have double book IBB cards (good for 128 channels) and the third I/O cage has two single book IBB cards (each covering 32 channels) to a total of 192 channels.

IBM 9672 R2 and R3 Models resulting from an upgrade of an IBM 9672 E01, P01, or Rx1 Model, get one or two model #1000 I/O cages from these models. Each of the model #1000 I/O expansion cages have one IBB domain, each covering a maximum of 24 ESCON channels (8 I/O slots x 3 ESCON channels). The following maximum values count:
IBM 9672 R2 models with one model #1000 I/O expansion cage from an IBM 9672 E01, P01, or Rx1 Model upgrade (one domain, 24 channels) may populate two additional IBB domains in the CPC cage (64 ESCON channels). The fourth domain of 32 ESCON channels resides in an additional I/O cage (24 + 64 + 32 = 120).

IBM 9672 R2 models with two model #1000 I/O expansion cage from an IBM 9672 E01, P01, or Rx1 Model upgrade (two domains, 48 channels) may populate two additional IBB domains in the CPC cage (64 ESCON channels) (24 + 24 + 64 = 112).

IBM 9672 Model R53s have two IBB connectors. IBM 9672 Model R53s with one model #1000 I/O expansion cage from an IBM 9672 E01, P01, or Rx1 Model upgrade (one domain, 24 channels) may populate one additional IBB domain in the model #2020 I/O expansion cage (32 ESCON channels with a single book IBB, 64 ESCON channels with a double book IBB, 24 + 32 = 56 or 24 + 64 = 88).

IBM 9672 Model R53s with two model #1000 I/O expansion cages from an IBM 9672 E01, P01, or Rx1 Model upgrade (two domains, 48 channels) have no available IBB cables and would not connect to a model 2020 I/O expansion cage (24 + 24 = 48).

IBM 9672 R3 Models (except R53) have four IBB connectors. IBM 9672 R3 Models with one model #1000 I/O expansion cage from an IBM 9672 E01, P01, or Rx1 Model upgrade (one domain, 24 channels) may populate three additional IBB domains in the model #2020 I/O expansion cages (32 ESCON channels with a single book IBB, 24 ESCON channels with a single book IBB in the six slot IBB domain, or 64 ESCON channels with a double book IBB, 24 + 24 + 64 = 112, 24 + 24 + 64 + 64 = 176, or 24 + 32 + 64 + 64 = 184).

IBM 9672 R3 Models with two model #1000 I/O expansion cages from an IBM 9672 E01, P01, or Rx1 Model upgrade (two domains, 48 channels) may populate two additional IBB domains in the model #2020 I/O expansion cages (64 ESCON channels with a double book IBB, 24 + 24 = 48, 24 + 24 + 64 = 112, or 24 + 24 + 64 + 64 = 176).
Over-30 Support Element Structure

The IBM 9672 R2 and R3 Models service and operational support subsystem is made up of the following elements:

- An integrated Support Element (SE) in each CPC, which consists of a Thinkpad. IBM service personnel will use this equipment while servicing the CPC or the SE itself.
- A Hardware Management Console (HMC) for the CPC, which consists of a fully configured PS/2 and associated equipment.
- Each SE is connected to its CPC and to a LAN that may connect the SEs of more than one CPC with the HMC.
- A Remote Support Facility (RSF) connection into the IBM RETAIN system is provided in the HMC.

A single HMC can be used to operate all configured CPCs attached through their SEs. This reduces the systems management overhead usually associated with multiple systems consoles and greatly improves productivity. If an HMC is already installed with IBM 9672 E01, P01, or Rx1 Models it may be used to operate the new IBM 9672 R2 and R3 Models.
**Over-31 SE Functions**

The Support Element (SE) implemented within each CPC provides the following functions:

- Controlling the CPC with which it is associated, through such functions as Power-On Reset (POR), Initial Program Load (IPL), and LPAR control.
- Hardware monitoring of functional elements, such as Processing Units, power, and cooling.
- Hardware Problem Analysis (PA) and determination of Field Replaceable Units (FRUs) in case of malfunctions.
- Logging of CPC hardware errors onto the SE hard disk.
- Licensed Internal Code (LIC) is stored on the hard disk of the SE, along with I/O configurations in IOCDS data sets.
- The SE provides the system interface for IBM service personnel and is used to support such tasks as Problem Analysis, and Repair and Verify.
Over-32 Hardware Management Console Structure

The Hardware Management Console (HMC) is an IBM PS/2 operating under OS/2 with object oriented operator applications. OS/2 object drag and drop facilities are used to perform tasks such as Power-On Reset (POR), Initial Program Load (IPL), and systems management operations.

A single HMC can be used to operate all configured CPCs attached through their SEs. This reduces the systems management overhead usually associated with multiple systems consoles and greatly improves productivity.

The HMC communicates with SEs in each CPC through a Token Ring LAN. Up to four HMCs can be configured on the LAN for high availability through redundancy, or for separation of operational functions.

The HMC and the SEs operate under OS/2, and Distributed Console Access Facility (DCAF) is used to enable the HMC to control functions on the SEs.

A Remote Support Facility (RSF) connection can be made into the IBM RETAIN system for automation of service calls, remote problem analysis, and to download Licensed Internal Code (LIC) updates.

Multiple HMCs can be configured on the LAN or on separate bridged LANs if required.
Over-33 HMC Workplace

The HMC uses the OS/2 Workplace Shell to provide an object oriented interface and the ability to manipulate objects and windows. The foil shows an example of an HMC Workplace display:

- Tasks section (right hand side of the screen) provides icons of operations that can be performed on objects such as a CPC or a group of CPCs.
- Views section (top part of the screen) provides icons that represent different views of the objects within the group of CPCs. The background of the section is status sensitive, and the color of the icon background will change if there is a status change.
- Work area (center of screen) displays objects associated with a selected view.

In this example, the objects are the CPCs defined as a specific group. A task, such as “Activate,” could be performed on a single CPC, or a number of CPCs, by selecting and dragging all CPCs in the group from the work area and dropping them on the “Activate” icon in the task section.
Over-34 Performance Ratios

The foils show performance ratios. The IBM 9672 R2 Model R12 is used as the base, and has been set to 1.00.

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Coupling Configurations

S/390 Coupling Facility Type 9674 Models C02 and C03

**C02 models:** (2) 1-way, 2-way, 3-way, 4-way, 5-way, 7-way
   Available: October 31, 1995
   Upgrades from C01 to C02 available: October 31, 1995
   Upgrades from C02 to C02 available: January 31, 1996

**C03 models:** 5-way, 6-way, 7-way, 8-way, 10-way
   Available: July 31, 1995
   Upgrades from C01 to C03 available: July 31, 1995
   Upgrades from C02 to C03 available in January 31, 1996
   Upgrades from C03 to C03 available: October 31, 1995

**Minimum of 2 and a Maximum of 32 coupling channels**

Over-35 Coupling Configurations

The foil shows the most important information related to the IBM 9674 Model C02, and IBM 9674 Model C03.
Over-36 Model Groups and MSUs

The foil shows the software model groups and MSU ratings for the various IBM 9672 R2 and R3 Models.

<table>
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<tr>
<th>Model</th>
<th>Group</th>
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<td>RX3</td>
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Over-37 R2 / R3 Upgrades

This foils shows the R2 to R2, R2 to R3, and R3 to R3 upgrade options available within the family of IBM 9672 R2 and R3 Models.
Over-38 R1 to R2 / R3 Upgrades

This foils shows the R1 to R2 and R1 to R3 upgrade options available within the 9672 family of processors.
### Availability Dates - New Models

**New R3 Models**
- RX3 - Ten-way Processor
- R83 - Eight-way Processor
- R73 - Seven-way Processor
- R63 - Six-way Processor
- R53 - Five-way Processor

**Available:**
- July 31, 1995
- July 31, 1995
- July 31, 1995
- July 31, 1995
- July 31, 1995

**New R2 Models**
- R72 - Seven-way Processor
- R52 - Five-way Processor
- R42 - Four-way Processor
- R32 - Three-way Processor
- R22 - Two-way Processor
- R12 - One-way Processor
- RA2 - One-way processor

**Available:**
- October 31, 1995
- October 31, 1995
- October 31, 1995
- October 31, 1995
- October 31, 1995
- October 31, 1995
- October 31, 1995

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**Over-39 Availability Dates - New Models**

The foil shows the availability dates of the new IBM 9672 R2 and R3 models.
## Over-40 Availability - Vertical Upgrades

The foil shows the availability dates of the vertical upgrades within the family of IBM 9672 R2 and R3 models.
Over-41 Availability - Horizontal and Diagonal Upgrades

The foil shows the availability dates of the horizontal and diagonal upgrades from the “E”, “P”, and “R1” models to the IBM 9672 R2 and R3 models.
## CAPABILITY:

### I/O:

<table>
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<th>Feature</th>
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<td>ESA 2</td>
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### PR/SM:

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**Notes:**
- S = standard
- O = optional
- O@ = not supported

S* or O* on ES/3090 includes models 180, 200, 280 and above

O@ only on R2/R3 models upgraded from R1 models
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*S* = standard  
*O* = optional  
*not supported  
*S* or *O* on ES/3090 includes models 180, 200, 280 and above  
*S1* = MP models only  
*S@* Dynamic Memory replacement only performed during POR
### APAFOIL Processing Options

**APAFOIL** July 22, 1994 Release 3.2

#### Runtime values:

- **DEVICE**: 3820A
- **BIND (Odd, Even)**: 1.00i, 1.00i
- **TWOPASS**: YES
- **INDEX**: YES

**Foil Set: 1**

- **Input File (Current)**: SG244575

**Layout of Heading (FOILHD Tag or Default)**

- **FOILHD**: NULL NULL NULL
- **FRAME**: NONE

**Layout of Body (LAYOUT Tag or Default)**

- **RULE**: SOLID
- **BORDER**: NONE
- **RUBRICWT**: LIGHT

**Layout of Footing (FOILFT Tag or Default)**

- **FOILFT**: NULL NULL NULL
- **FRAME**: NONE

**Statistics:**

- **Title Page**: 1
- **Contents**: 0
- **Parts**: 1
- **Foils**: 43
- **Notes**: 0
- **Overflow**: 0
- **Total Pages**: 45

**APAFOIL Messages:**

- **Information**: 0
- **Warning**: 0
- **Error**: 0

**System Variables:**

- **SYSVAR B**: MID
- **SYSVAR N**: INCLUDE

---

### Artwork Definitions

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### Headings

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id | File   | Page | References
---|--------|------|-------------
PAGENO | SG244575 SCRIPT | 57  | (no text)

Processing Options

Runtime values:
- Document fileid: SG244575 SCRIPT
- Document type: USERDOC
- Document style: ZDOCSTYL
- Profile: EDFPRF30
- Service Level: 0029
- SCRIPT/VS Release: 4.0.0
- Date: 95.08.16
- Time: 11:57:59
- Device: 3820A
- Index: YES
- SYSVAR D: YES
- SYSVAR G: INLINE
- SYSVAR P: FINALT
- SYSVAR V: ITSCEVAL

Formatting values used:
- Annotation: NO
- Cross reference listing: YES
- Cross reference head prefix only: NO
- Dialog: LABEL
- Duplex: YES
- DVCF conditions file: (none)
- DVCF value 1: (none)
- DVCF value 2: (none)
- DVCF value 3: (none)
- DVCF value 4: (none)
- DVCF value 5: (none)
- DVCF value 6: (none)
- DVCF value 7: (none)
- DVCF value 8: (none)
- DVCF value 9: (none)
- Explode: NO
- Figure list on new page: YES
- Figure/table number separation: YES
- Folio-by-chapter: NO
- Head 0 body text: Part
- Head 1 body text: Chapter
- Head 1 appendix text: Appendix
- Hyphenation: NO
- Justification: NO
- Language: ENGL
- Layout: 1
- Leader dots: YES
- Master index: (none)
- Partial TOC (maximum level): 4
- Partial TOC (new page after): INLINE
- Print example id’s: NO
- Print cross reference page numbers: YES
- Process value: FINALT
- Punctuation move characters: 
- Read cross-reference file: (none)
- Running heading/footing rule: NONE
- Show index entries: NO
- Table of Contents (maximum level): 4
- Table list on new page: YES
- Title page (draft): RIGHT
- Write cross-reference file: (none)
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