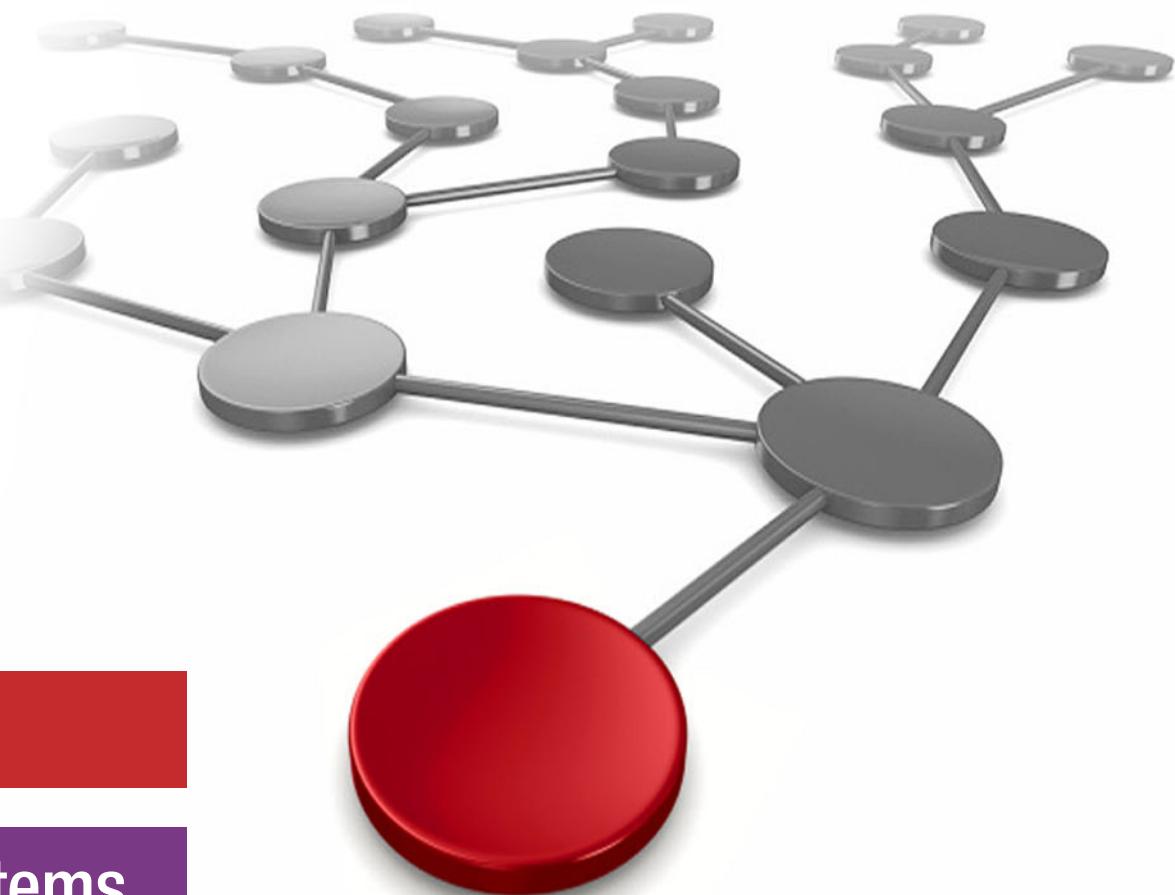


# IBM Power E1080 Technical Overview and Introduction

Tim Simon

Dean Mussari

Tsvetomir Spasov



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## **IBM Power E1080 Technical Overview and Introduction**

November 2024

**Note:** Before using this information and the product it supports, read the information in “Notices” on page vii.

## **Second Edition (November 2024)**

This edition applies to IBM Power E1080 - 9080-HEX.

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# Contents

<b>Notices .....</b>	vii
Trademarks .....	viii
<b>Preface .....</b>	ix
Authors .....	ix
Now you can become a published author, too! .....	x
Comments welcome .....	x
Stay connected to IBM Redbooks .....	xi
<b>Summary of changes .....</b>	xiii
November 2024, Second Edition .....	xiii
<b>Chapter 1. Introducing IBM Power E1080 .....</b>	1
1.1 System overview .....	2
1.1.1 System nodes, processors, and memory .....	2
1.1.2 Expansion drawers and storage enclosures .....	3
1.1.3 Hardware at-a-glance .....	3
1.1.4 System capacities and features .....	6
1.2 System nodes .....	7
1.3 System control unit .....	10
1.4 Server specifications .....	12
1.4.1 Physical dimensions .....	12
1.4.2 Electrical characteristics .....	13
1.4.3 Environment requirements and noise emission .....	13
1.5 System features .....	15
1.5.1 Minimum configuration .....	15
1.5.2 Processor features .....	17
1.5.3 Memory features .....	19
1.5.4 System node PCIe features .....	22
1.5.5 System node disk and media features .....	23
1.5.6 System node USB features .....	24
1.5.7 Power supply features .....	24
1.6 I/O drawers .....	25
1.6.1 System node PCIe interconnect features .....	25
1.6.2 I/O expansion drawers .....	26
1.6.3 Disk expansion drawers .....	28
1.6.4 IBM System Storage .....	29
1.7 System racks .....	30
1.7.1 New rack considerations .....	31
1.7.2 IBM Enterprise 42U Slim Rack 7965-S42 .....	31
1.7.3 AC power distribution unit and rack content .....	32
1.7.4 PDU connection limits .....	35
1.7.5 Rack-mounting rules .....	35
1.7.6 Useful rack additions .....	36
1.7.7 Original equipment manufacturer racks .....	38
1.8 Hardware Management Console overview .....	39
1.8.1 HMC 7063-CR2 .....	40
1.8.2 Virtual HMC .....	41
1.8.3 BMC network connectivity rules for 7063-CR2 .....	41

1.8.4	High availability HMC configuration . . . . .	42
1.8.5	HMC code level requirements for the Power E1080 . . . . .	43
1.8.6	HMC currency . . . . .	44
<b>Chapter 2. Architecture and technical overview</b>	. . . . .	45
2.1	IBM Power10 processor . . . . .	46
2.1.1	Power10 processor overview . . . . .	47
2.1.2	Power10 processor core . . . . .	50
2.1.3	Simultaneous multithreading . . . . .	53
2.1.4	Matrix Math Accelerator AI workload acceleration . . . . .	54
2.1.5	Power10 compatibility modes . . . . .	54
2.1.6	Processor Feature Codes . . . . .	55
2.1.7	On-chip L3 cache and intelligent caching . . . . .	55
2.1.8	Open memory interface . . . . .	56
2.1.9	Pervasive memory encryption . . . . .	56
2.1.10	Nest accelerator . . . . .	58
2.1.11	SMP interconnect and accelerator interface . . . . .	60
2.1.12	Power and performance management . . . . .	61
2.1.13	Comparing Power10, Power9, and Power8 processors . . . . .	65
2.2	SMP interconnection . . . . .	66
2.2.1	Two-system node drawers OP-bus connection . . . . .	67
2.2.2	SMP cable reliability, availability, and serviceability attribute . . . . .	67
2.3	Memory subsystem . . . . .	68
2.3.1	Memory bandwidth . . . . .	70
2.3.2	Memory placement rules . . . . .	71
2.4	Capacity on Demand . . . . .	72
2.4.1	New CoD features . . . . .	73
2.4.2	IBM Power Private Cloud with Shared Utility Capacity . . . . .	73
2.4.3	Static, Mobile, and Base activations . . . . .	74
2.4.4	Capacity Upgrade on Demand . . . . .	75
2.4.5	Elastic CoD (Temporary) . . . . .	77
2.4.6	IBM Power Enterprise Pools 1.0 and Mobile CoD . . . . .	77
2.4.7	Utility CoD . . . . .	79
2.4.8	Trial CoD . . . . .	79
2.4.9	Software licensing and CoD . . . . .	79
2.5	Internal I/O subsystem . . . . .	79
2.5.1	Internal PCIe Gen 5 subsystem and slot properties . . . . .	79
2.5.2	Internal NVMe storage subsystem . . . . .	84
2.5.3	USB subsystem . . . . .	87
2.5.4	PCIe slots features . . . . .	88
2.6	Supported PCIe adapters . . . . .	89
2.6.1	LAN adapters . . . . .	89
2.6.2	Fibre Channel adapters . . . . .	90
2.6.3	SAS adapters . . . . .	91
2.6.4	Crypto adapter . . . . .	92
2.6.5	USB adapter . . . . .	92
2.6.6	I/O expansion drawers . . . . .	92
2.6.7	Disk drawer . . . . .	93
2.6.8	SFP transceiver . . . . .	93
2.7	External I/O subsystems . . . . .	94
2.7.1	PCIe Gen4 I/O expansion drawer . . . . .	94
2.7.2	PCIe Gen3 I/O Expansion Drawer . . . . .	97
2.8	External disk subsystems . . . . .	106

2.8.1 NED24 NVMe Expansion Drawer . . . . .	106
2.8.2 IBM EXP24SX SAS Storage Enclosure . . . . .	112
2.9 System control and clock distribution . . . . .	115
2.10 Operating system support . . . . .	120
2.10.1 Power E1080 prerequisites . . . . .	120
2.10.2 AIX operating system . . . . .	120
2.10.3 IBM i . . . . .	121
2.10.4 Linux . . . . .	122
2.10.5 Virtual I/O Server . . . . .	125
2.10.6 Entitled System Support . . . . .	125
2.10.7 Update Access Keys . . . . .	125
2.11 Manageability . . . . .	127
2.11.1 Service user interface . . . . .	127
2.11.2 System firmware maintenance . . . . .	128
2.11.3 I/O firmware update . . . . .	132
2.12 Serviceability . . . . .	132
2.12.1 Error detection . . . . .	133
2.12.2 Diagnostics . . . . .	134
2.12.3 Reporting . . . . .	135
2.12.4 Notification . . . . .	135
2.12.5 Ease of location and service . . . . .	136
<b>Chapter 3. Enterprise solutions . . . . .</b>	<b>139</b>
3.1 PowerVM . . . . .	140
3.1.1 IBM POWER Hypervisor . . . . .	140
3.1.2 Multiple shared processor pools . . . . .	144
3.1.3 Virtual I/O Server . . . . .	145
3.1.4 Live Partition Mobility . . . . .	146
3.1.5 Active Memory Expansion . . . . .	146
3.1.6 Remote Restart . . . . .	147
3.1.7 POWER processor modes . . . . .	147
3.1.8 Single Root I/O Virtualization . . . . .	148
3.1.9 More information about virtualization features . . . . .	149
3.2 IBM PowerVC overview . . . . .	149
3.2.1 IBM PowerVC functions and advantages . . . . .	149
3.3 System automation with Ansible . . . . .	150
3.3.1 Ansible Automation Platform . . . . .	152
3.3.2 Power servers in the Ansible ecosystem . . . . .	152
3.3.3 Ansible modules for AIX . . . . .	152
3.3.4 Ansible modules for IBM i . . . . .	153
3.3.5 Ansible modules for HMC . . . . .	153
3.3.6 Ansible modules for VIOS . . . . .	153
3.4 Protect trust from core to cloud . . . . .	153
3.4.1 Crypto engines and transparent memory encryption . . . . .	154
3.4.2 Quantum-safe cryptography support . . . . .	155
3.4.3 IBM PowerSC support . . . . .	155
3.5 Running artificial intelligence where operational data is stored . . . . .	156
3.5.1 Training anywhere, and deploying on Power E1080 . . . . .	157
<b>Related publications . . . . .</b>	<b>159</b>
IBM Redbooks . . . . .	159
Online resources . . . . .	160
Help from IBM . . . . .	160

<b>Abbreviations and acronyms .....</b>	<b>161</b>
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# Preface

This IBM Redpaper publication provides a broad understanding of a new architecture of the IBM Power E1080 (also known as the Power E1080) server that supports IBM AIX®, IBM i, and selected distributions of Linux operating systems. The objective of this paper is to introduce the Power E1080, the most powerful and scalable server of the IBM Power portfolio, and its offerings and relevant functions:

- ▶ Designed to support up to four system nodes and up to 240 IBM Power10 processor cores  
The Power E1080 can be ordered as a 1-, 2-, 3-, or four-node configuration with each node providing up to 60 Power10 processor cores to a maximum 240 Power10 processor cores in a 4-node configuration.
- ▶ Designed to support up to 64 TB of memory  
The Power E1080 can be initially ordered with the total memory capacity of up to 8 TB. It supports up to 64 TB in a full combined four-system nodes server.
- ▶ Designed to support up to 32 Peripheral Component Interconnect Express (PCIe) Gen 5 slots in a full combined four-system nodes server, and up to 192 PCIe Gen 3 slots with expansion I/O drawers
- ▶ Up to over 4,000 directly attached serial-attached SCSI (SAS) disks or solid-state drives (SSDs)
- ▶ Up to 1,000 virtual machines (VMs) with logical partitions (LPARs) per system
- ▶ System control unit (SCU), providing redundant system master Flexible Service Processor (FSP)
- ▶ Supports IBM Power Private Cloud Solution with Dynamic Capacity

This publication is for professionals who want to acquire a better understanding of Power servers. The intended audience includes the following roles:

- ▶ Customers
- ▶ Sales and marketing professionals
- ▶ Technical support professionals
- ▶ IBM Business Partners
- ▶ Independent software vendors (ISVs)

This paper does not replace the current marketing materials and configuration tools. It is intended as an extra source of information that, together with existing sources, can be used to enhance your knowledge of IBM® server solutions.

## Authors

This paper was produced by a team of specialists from around the world working at IBM Redbooks, Poughkeepsie Center.

**Tim Simon** is an IBM Redbooks® Project Leader who is based in Tulsa, Oklahoma, US. He has over 40 years of experience with IBM, primarily in a technical sales role working with customers to help them create IBM solutions to solve their business problems. He holds a BS degree in Math from Towson University in Maryland. He has worked with many IBM products and has extensive experience creating customer solutions by using IBM Power, IBM Storage, and IBM Z® throughout his career.

**Dean Mussari** is an IBM Power Brand Technical Specialist in the National Market in the US. He recently came to IBM, bringing 35 years of experience working with IBM servers and storage solutions in large retail environments. His main area of expertise is Power servers with a focus on IBM i. He holds a masters degree in computer science from Loyola University of Chicago.

**Tsvetomir Spasov** is a Power Servers Hardware Product Engineer in Sofia, Bulgaria. He has 8 years of experience with IBM in RTS, SME, and PE roles. His main area of expertise is Hardware Management Console (HMC), FSP, eBMC, POWERLC, and GTMS. He holds a masters degree in Electrical Engineering from Technical University of Sofia.

Thanks to the following people for their contributions to this project:

Thanks to the authors of the previous editions of this paper.

Authors of the first edition, *IBM Power E1080 Technical Overview and Introduction*, REDP-5649, published in October 2021, were:

Scott Vetter, Giuliano Anselmi, Manish Arora, Ivaylo Bozhinov, Dinil Das, Turgut Genc, Bartlomiej Grabowski, Madison Lee, Armin Röllr

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# Summary of changes

This section describes the technical changes that were made in this edition of the paper and in previous editions. This edition might also include minor corrections and editorial changes that are not identified.

Summary of Changes for REDP-5649-01  
IBM Power E1080 Technical Overview and Introduction  
as created or updated on November 15, 2024.

## November 2024, Second Edition

This revision includes the following new and changed information.

### New information

- ▶ Added information on Double Data Rate 5 (DDR5)-based differential dual inline memory modules (DDIMMs), which provide increased memory throughput and reduced latency compared to the Double Data Rate 4 (DDR4)-based memory that originally was delivered with IBM Power10.
- ▶ Added information about the Peripheral Component Interconnect Express (PCIe) Gen 4 Expansion drawer, which replaces the previous PCIe Gen 3 Expansion drawer. This expansion drawer can hold more PCIe adapters for your system, and provides improved throughput over the previous version.
- ▶ Added information about the NED24 Non-Volatile Memory Express (NVMe) Expansion drawer. This new expansion drawer provides more NVMe slots for U2 NVMe devices. Each NED24 expansion drawer can provide up to 153 TB of capacity. Up to three NED24 drawers are supported per system node, providing up to 460 TB of capacity per drawer or over 1840 TB per system.
- ▶ This section also includes information about the multipath support in the NED24 expansion drawer.
- ▶ Added information about new adapters that are supported in the Power E1080.

### Changed information

- ▶ Noted that the PCIe Gen 3 Expansion drawer is withdrawn from marketing. The replacement is the PCIe Gen 4 expansion drawer.
- ▶ Noted that the EXP24SX serial-attached SCSI (SAS) expansion drawer is withdrawn from marketing. The recommended replacement is the NED24 expansion drawer because it generally provides better performance and often lower costs compared to equivalent SAS storage options.





# Introducing IBM Power E1080

The Power E1080 is the newest addition to the IBM Power family, the industry's best-in-class server platform for security and reliability. The Power E1080 introduces the essential enterprise hybrid cloud platform, which is uniquely designed to help you securely and efficiently scale core operational and artificial intelligence (AI) applications anywhere in a hybrid cloud.

The Power E1080 simplifies end-to-end encryption and brings AI where your data is stored for faster insights. This configuration helps enable greater workload deployment flexibility and agility while accomplishing more work.

The Power E1080 can help you to realize the following benefits:

- ▶ Protect trust from core to cloud

Protect data that is in-transit and at-rest with greatly simplified end-to-end encryption across hybrid cloud without affecting performance.

- ▶ Enjoy enterprise quality of service (QoS)

The Power E1080 can detect, isolate, and recover from soft errors automatically in the hardware without taking an outage or relying on an operating system to manage the faults.

- ▶ Drive greater efficiency with sustainable and scalable compute

The processor performance, massive system throughput, and memory capacity qualify the Power E1080 server to be the perfect workload consolidation platform. This performance leads to significant savings in floor space, energy consumption, and operational expenditure costs.

This chapter includes the following topics:

- ▶ 1.1, "System overview" on page 2
- ▶ 1.2, "System nodes" on page 7
- ▶ 1.3, "System control unit" on page 10
- ▶ 1.4, "Server specifications" on page 12
- ▶ 1.5, "System features" on page 15
- ▶ 1.6, "I/O drawers" on page 25
- ▶ 1.7, "System racks" on page 30
- ▶ 1.8, "Hardware Management Console overview" on page 39

## 1.1 System overview

The Power E1080, also referred to by its 9080-HEX machine type-model designation, represents the most powerful and scalable server in the IBM Power portfolio. It is composed of a combination of central electronic complex (CEC) enclosures that are called *nodes* (or *system nodes*) and more units and drawers.

### 1.1.1 System nodes, processors, and memory

In this section, we provide a general overview of the system nodes, processors, and memory. For more information about the system nodes, see 1.2, “System nodes” on page 7.

A *system node* is an enclosure that provides the connections and supporting electronics to connect the processor with the memory, internal disk, adapters, and the interconnects that are required for expansion. A combination of one, two, three, or four system nodes per server is supported.

Each system node provides four sockets for Power10 processor chips and 64 differential dual inline memory module (DDIMM) slots for Double Data Rate 5 (DDR5) or Double Data Rate 4 (DDR4) technology DIMMs.

Each socket holds one Power10 single-chip module (SCM). An SCM can contain 10, 12, or 15 Power10 processor cores. It also holds the extra infrastructure logic to provide electric power and data connectivity to the Power10 processor chip.

A 4-node Power E1080 server scales up to 16 processor sockets and 160, 192, or 240 cores, depending on the number of cores that is provided by the configured SCM type.

The processor configuration of a system node is defined by the selected processor feature. Each feature defines a set of four Power10 processor chips with the same core density (10, 12, or 15). All system nodes within a Power E1080 server must be configured with the same processor feature.

Each system node can support up to a maximum of 16 TB of system memory by using the largest available memory DIMM. A fully configured 4-node Power E1080 can support up to 64 TB of memory.

To provide internal boot capability, each system node enables up to four Non-Volatile Memory Express (NVMe) drive bays. More drive bays can be configured by using expansion drawers.

Each system node provides eight Peripheral Component Interconnect Express (PCIe) Gen 5 capable slots, with a maximum of 32 per Power E1080 server.

The system control unit (SCU) is required in all configurations. The SCU provides system hardware, firmware, and virtualization control through redundant Flexible Service Processors (FSPs). Only one SCU is required and supported for every Power E1080 server. For more information about the SCU, see 1.3, “System control unit” on page 10.

For more information about the environmental and physical aspects of the server, see 1.4, “Server specifications” on page 12.

## 1.1.2 Expansion drawers and storage enclosures

More PCIe slots can be added by using expansion drawers, and more disk capacity can be added to your system by using storage enclosures.

An expansion drawer provides more PCIe slots for I/O connectivity if needed. There are two versions of the PCIe expansion drawer: the original version supporting PCIe Gen 3 I/O slots<sup>1</sup>, and a newer version supporting PCIe Gen 4 I/O slots. There is no upgrade path from the Gen3 version to the Gen4 version, but you may mix the two I/O expansion drawers within a single system.

The I/O expansion drawer is a 19-inch PCIe 4U enclosure that provides up to 12 PCIe slots and connects to the system node with a pair of PCIe x16 to CXP converter cards (fanout adapters) that are housed in the system node. Each system node can support up to three Gen 4 I/O expansion drawers or four Gen 3 I/O expansion drawers, for a total of 48 PCIe Gen 3 slots or 36 PCIe Gen 4 slots. A fully configured Power E1080 can support a maximum of 16 Gen 3 I/O expansion drawers, providing a total of 192 PCIe Gen 3 slots or a maximum of 12 Gen 4 I/O expansion drawers for a total of 144 Gen 4 I/O slots.

An optional NVMe expansion capability is provided by the NED24 NVMe expansion drawer. The NED24 attaches to the system units by using the same fanout adapters that are used by the I/O expansion drawers and provides up to 24 NVMe U2 drive slots. Each NVMe drive can be individually assigned to its own partition, providing great flexibility for boot images and more data for each partition.

More serial-attached SCSI (SAS) storage can be implemented by using the EXP24SX SAS storage enclosure<sup>2</sup>, which provides twenty-four 2.5-inch small form factor (SFF) SAS bays. It supports up to 24 hot-swap hard disk drives (HDDs) or solid-state drives (SSDs) in only 2U rack units of space in a 19-inch rack. The EXP24SX is connected to the Power E1080 server by using SAS adapters that are plugged into PCIe slots either in the system nodes or in an I/O expansion drawer.

For more information about enclosures and drawers, see 1.6, “I/O drawers” on page 25.

More storage can also be allocated externally by using Storage Network Connections through the appropriate adapters that are installed in the system PCIe slots. For more information about IBM storage products, see [this web page](#).

## 1.1.3 Hardware at-a-glance

The Power E1080 server provides the following hardware components and characteristics:

- ▶ 10-, 12-, or 15-core Power10 processor chips that are packaged in an SCM per socket.
- ▶ One, two, three, or four system nodes with four Power10 processor sockets each.
- ▶ Redundant clocking in each system node.
- ▶ Up to 60 Power10 processor cores per system node and up to 240 per system.
- ▶ Up to 16 TB of memory per system node and up to 64 TB per system. Either DDR4 or DDR5 memory are supported.
- ▶ Eight PCIe Gen 5 slots per system node and a maximum of 32 PCIe Gen 5 slots per system.

---

<sup>1</sup> The PCIe Gen 3 I/O drawer was withdrawn from marketing as of January 2024.

<sup>2</sup> The EXP24SX was withdrawn from marketing, but is still supported.

- ▶ PCIe Gen 1, Gen 2, Gen 3, Gen 4, and Gen 5 adapters are supported in the system nodes.
- ▶ Up to three PCIe Gen 4 4U I/O expansion drawers per system node provide a maximum of 36 more PCIe Gen 4 slots or up to four PCIe Gen 3 expansion drawers for a maximum of 48 more PCIe Gen 3 slots.
- ▶ Up to 144 PCIe Gen 4 slots that use 12 PCI Gen 4 expansion drawers or 192 PCIe Gen 3 slots that use 16 PCIe Gen 3 I/O expansion drawers per system.
- ▶ Up to over 4,000 directly attached SAS HDDs or SSDs through EXP24SX SFF drawers.
- ▶ Up to 288 directly attached external NVMe drives that use 12 NED24 NVMe expansion drawers.
- ▶ SCU, which provides redundant FSPs and support for the operations panel, the system vital product data (VPD), and externally attached DVD.

The massive computational power, exceptional system capacity, and the unprecedented scalability of the Power E1080 server hardware are provided by unique enterprise class firmware and system software capabilities and features. The following important characteristics and features are offered by the IBM Power enterprise platform:

- ▶ Support for IBM AIX, IBM i, and Linux operating system environments, including support for Red Hat OpenShift Cloud Platform.
- ▶ An innovative dense math engine (DME) that is integrated in each Power10 processor core to accelerate AI-inferencing workloads.
- ▶ Optimized encryption units that are implemented in each Power10 processor core.
- ▶ Dedicated data compression engines that are provided by the Power10 processor technology.
- ▶ Hardware- and firmware-assisted and enforced security provide trusted boot and pervasive memory encryption support.
- ▶ Up to 1,000 virtual machines (VMs) or logical partitions (LPARs) per system.
- ▶ Dynamic LPAR (DLPAR) support to modify available processor and memory resources according to workload, without interruption of the business.
- ▶ Capacity on Demand (CoD) processor and memory options to help respond more rapidly and seamlessly to changing business requirements and growth.
- ▶ IBM Power Private Cloud Solution with Dynamic Capacity featuring Power Enterprise Pools 2.0 that supports unsurpassed enterprise flexibility for real-time workload balancing, system maintenance and operational expenditure cost management.

Table 1-1 compares important technical characteristics of the Power E1080 server with the Power E980 server, based on IBM Power9® processor-based technology.

*Table 1-1 Comparing the Power E980 and the Power E1080 server*

Features	Power E980 server	Power E1080 server
Processor	Power9	Power10
Processor package	SCM	SCM
Cores per SCM	6, 8, 10, 11, 12	10, 12, 15
Number of cores per system	Up to 192 cores	Up to 240 cores
Sockets per node	4	4
System configuration options	1-, 2-, 3-, and 4-node systems	1-, 2-, 3-, and 4-node systems

Features	Power E980 server	Power E1080 server
Maximum memory per node	16 TB	16 TB
Maximum memory per system	64 TB	64 TB
Maximum memory bandwidth per node	920 GBps	1636 GBps
Aggregated maximum memory bandwidth per system	3680 GBps	6544 GBps
Pervasive memory encryption	No	Yes
PCIe slots per node	Eight PCIe Gen 4 slots	Eight PCIe Gen 5 slots
I/O drawer expansion option	Yes	Yes
Acceleration ports	Yes CAPI 2.0 & OpenCAPI 3.0 <sup>a</sup>	Yes OpenCAPI 3.0, 3.1
PCIe hot-plug Support	Yes	Yes
I/O bandwidth per node	545 GBps	576 GBps
Integrated USB	USB 3.0	Not available
Internal storage bays per node	Four NVMe PCIe Gen 3 bays <sup>b</sup>	Four NVMe PCIe Gen 4 bays
Per lane bit rate between sockets	25 Gbps	32 Gbps
Reliability, availability, and serviceability (RAS)	Symmetric multiprocessing (SMP) <sup>c</sup> cable concurrent repair	Non-active SMP cables with concurrent maintenance capability and time domain reflectometry (TDR) <sup>d</sup> fault isolation
Secure and trusted boot	Yes	Yes

a. CAPI designates the coherent accelerator processor interface technology and OpenCAPI designates the open coherent accelerator processor interface technology. For more information about architectural specifications and the surrounding system, see [this web page](#).

b. NVMe designates the NVMe interface specification under the supervision of the NVM Express consortium: <https://nvmexpress.org>.

c. Used to build monolithic servers out of multiple processor entities.

d. Allows the server to actively detect faults in cables and locate discontinuities in a connector.

Figure 1-1 shows a 4-node Power E1080 server that is mounted in an IBM rack. Each system node is cooled by a set of five fans, which are arranged side by side in one row. The cooling assemblies show through the front door of the rack.



Figure 1-1 Power E1080 4-node server mounted in an S42 rack with a #ECRT door

#### 1.1.4 System capacities and features

With any initial orders, the Power E1080 supports up to four system nodes. The maximum memory capacity that is supported in each node is 16 TB.

The maximum number of supported PCIe Gen 3 I/O expansion drawers is four per system node, which can be mixed with PCI Gen 4 expansion drawers (a maximum of three Gen 4 drawers are supported). Each I/O expansion drawer can be populated with two Fanout Modules. Each Fanout Module is connected to a system node through one PCIe x16 to CXP Converter Card.

In August 2024, IBM announced new memory features for the Power10 server line that use DDR5 technology. New memory features are available for the DDR5-based memory. The Power E1080 supports DDR5 and DDR4 DDIMMs in the same system, but all memory in each node must be the same type. The DDR5 DDIMMs provide increased memory bandwidth, which can result in improved performance of the system.

The following features are available:

- ▶ Maximum of four #EDN1 5U system node drawers
- ▶ Maximum of 16 TB of system memory per node drawer
- ▶ Maximum of 16 #EMX0 PCIe Gen 3 I/O expansion drawers or a maximum of 12 #ENZ0 PCIe Gen 4 I/O expansion drawers
- ▶ Maximum of 32 #EMXH PCIe Gen 3 6-slot Fanout Modules for PCIe Gen 3 expansion drawers or a maximum of 24 #ENFZ Fanout Modules for PCIe Gen 4 expansion drawers
- ▶ Maximum of 32 #EJ24 PCIe x16 to CXP Converter Cards

## 1.2 System nodes

A fully operational Power E1080 includes one SCU and one, two, three, or four system nodes. The server's CEC is composed of one, two, three, or four system nodes, which are also referred to as CEC drawers.

Each system node is 5U rack units high and holds four air-cooled Power10 SCMs that are optimized for performance, scalability, and AI workloads. An SCM is constructed of one Power10 processor chip and more logic, pins, and connectors that enable plugging the SCM into the related socket on the system node system board.

The Power E1080 Power10 SCMs are available in 10-core, 12-core, or 15-core capacity. Each core can run in an eight-way simultaneous multithreading (SMT) mode, which delivers eight independent hardware threads of parallel execution power.

The 10-core SCMs are ordered in a set of four per system node through processor feature #EDP2. In this way, feature #EDP2 provide 40 cores of processing power to one system node and 160 cores of total system capacity in a 4-node Power E1080 server. The maximum frequency of the 10-core SCM is specified with 3.9 GHz, which makes this SCM suitable as a building block for entry class Power E1080 servers.

The 12-core SCMs are ordered in a set of four per system node through processor feature #EDP3. In this way, feature #EDP3 provides 48 cores capacity per system node and a maximum of 192 cores per fully configured 4-node Power E1080 server. This SCM type offers the highest processor frequency at a maximum of 4.15 GHz, which makes it a perfect choice if highest thread performance is one of the most important sizing goals.

The 15-core SCMs are ordered in a set of four per system node through processor feature #EDP4. In this way, feature #EDP4 provides 60 cores per system node and an impressive 240 cores total system capacity for a 4-node Power E1080. The 15-core SCMs run with a maximum of 4.0 GHz and meet the needs of environments with demanding thread performance and high compute capacity density requirements.

**Note:** All Power10 SCMs within a system node must be of the same type: 10-core, 12-core, or 15-core. Also, all system nodes within a specific Power E1080 server must be configured with identical processor features.

Three PowerAXON<sup>3</sup> 18-bit wide buses per Power10 processor chip are used to span a fully connected fabric within a CEC drawer. Each SCM within a system node is directly connected to every other SCM of the same drawer at 32 GBps speed. This on-system board interconnect provides 128 GBps chip-to-chip data bandwidth, which marks an increase of 33% relative to the previous Power9 processor-based on-system board interconnect implementation in Power E980 servers. The throughput can be calculated as 16 lanes with \* 32 GBps = 64 GBps per direction \* 2 directions for an aggregated rate of 128 GBps.

Each of the four Power10 processor chips in a Power E1080 CEC drawer is connected directly to a Power10 processor chip at the same position in every other CEC drawer in a multi-node system. This connection is made by using an SMP PowerAXON 18-bit wide bus per connection running at 32 Gbps speed.

<sup>3</sup> PowerAXON stands for A-bus/X-bus/OpenCAPI/Networking interfaces of the Power10 processor.

The Power10 SCM provides eight PowerAXON connectors directly on the module, of which six are used to route the SMP bus to the rear tailstock of the CEC chassis. This innovative implementation allows the use of passive SMP cables, which reduces the data transfer latency and enhances the robustness of the drawer to drawer SMP interconnect. Cable features #EFCH, #EFCE, #EFCF, and #EFCG are required to connect system node drawers to the SCU. They are required to facilitate the SMP interconnect among each drawer in a multi-node Power E1080 configuration.

The Power10 processor technology introduces a new memory connection technology that uses the open memory interface (OMI). Using the OMI provides an abstraction layer for the memory that allows the system memory to be introduced without changing the system board connections. This capability allowed the introduction of DDR5-based memory.

The 16 available high-speed OMI links are driven by eight on-chip memory controller units (MCUs) that provide a total aggregated bandwidth of up to 409 GBps per SCM. This design represents a memory bandwidth increase of 78% compared to the Power9 processor-based technology capability.

Every Power10 OMI link is directly connected to one memory buffer-based DDIMM slot. Therefore, the four sockets of one system node offer a total of 64 DDIMM slots with an aggregated maximum memory bandwidth of 1636 GBps. The DDIMM densities that are supported in Power E1080 servers are 32 GB, 128 GB, and 256 GB, all of which use either DDR5 or DDR4 technology.

The Power E1080 memory options are available as 128 GB (#EMC1), 256 GB (#EMC2), 512 GB (#EMC3), and 1024 GB (#EMC4) memory features when using DDR4 memory. For the DDR5-based memory, the options are 128 GB (#EMFM), 256 GB (#EMFN), 512 GB (#EMFP), and 1024 GB (#EMFQ). Each memory feature provides four DDIMMs.

Each system node supports a maximum of 16 memory features that cover the 64 DDIMM slots. For the Power E1080, you may mix different DIMM sizes within a socket with the new Feature Code #ECMC. This intermix is supported only when using DDR5-based DDIMMs.

Using the 1024 GB DDIMM features yields a maximum of 16 TB per node. Using the maximum of four nodes provides a maximum of 64 TB capacity. The minimum number of DDIMMs per node is eight. Activation of a minimum of 50% of the installed memory capacity is required unless you use Power Enterprise Pools 2, in which case the minimum activation is 256 GB. For more information about Power Enterprise Pools, see 2.4, “Capacity on Demand” on page 72.

The Power10 processor I/O subsystem is driven by 32 GHz differential PCIe 5.0 (PCIe Gen 5) buses that provide 32 lanes that are grouped in two sets of 16 lanes. The 32 PCIe lanes deliver an aggregate bandwidth of 576 GBps per system node and are used to support 8 half-length, low-profile (LP) (half-height) adapter slots for external connectivity and 4 NVMe mainstream SSDs of form factor U.2. for internal storage.

Six of the eight external PCIe slots can be used for PCIe Gen 4 x16 or PCIe Gen 5 x8 adapters and the remaining two offer PCIe Gen 5 x8 capability. All PCIe slots support earlier generations of the PCIe standard, such as PCIe Gen 1 (PCIe 1.0), PCIe Gen 2 (PCIe 2.0), PCIe Gen 3 (PCIe 3.0), and PCIe Gen 4 (PCIe 4.0).

For extra connectivity, up to four 19-inch PCIe Gen 3 4U high I/O expansion units (#EMX0) or up to three PCIe Gen 4 expansion drawers can be attached to one system node. Each expansion drawer contains one or two PCIe Fanout Modules with six PCIe Gen 3 full-length, full-height slots each.

A fully configured 4-node Power E1080 server offers a total of 32 internal PCIe slots and up to 192 PCIe slots through I/O expansion units.

Figure 1-2 shows the front view of a system node. The fans and power supply units (PSUs) are redundant and concurrently maintainable. Fans are n+1 redundant; therefore, the system continues to function when any one fan fails. Because the power supplies are n+2 redundant, the system continues to function, even if any two power supplies fail.



Figure 1-2 Front view of a Power E1080 system node

Figure 1-3 shows the rear view of a system node with the locations of the external ports and features.

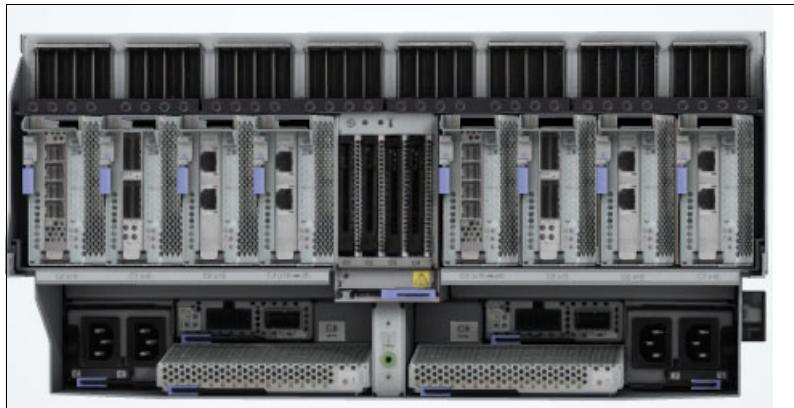


Figure 1-3 Rear view of a Power E1080 system node

Figure 1-4 shows the internal view of a system node and some of the major components like heat sinks, processor voltage regulator modules (VRMs), VRMs of other miscellaneous components, DDIMM slots, system clocks, Trusted Platform Modules (TPMs), and internal SMP cables.



Figure 1-4 Top view of a Power E1080 system node with the top cover assembly removed

## 1.3 System control unit

The SCU is implemented in a 2U high chassis and provides system hardware, firmware, and virtualization control functions through a pair of redundant FSP devices. It also contains the operator panel and the electronics module that stores the system VPD. The SCU is also prepared to facilitate USB connectivity that can be used by the Power E1080 server.

One SCU is required for each Power E1080 server (any number of system nodes), and depending on the number of system nodes, the SCU is powered according to the following rules:

- ▶ Two universal power interconnect (UPIC) cables are used to provide redundant power to the SCU.
- ▶ In a Power E1080 single system node configuration, both UPIC cables are provided from the single system node to be connected to the SCU.
- ▶ For a two, three, or four system nodes configuration, one UPIC cable is provided from the first system node and the second UPIC cable is provided from second system node to be connected to the SCU.

The set of two cables facilitate a 1+1 redundant electric power supply. If there is a failure of one cable, the remaining UPIC cable is sufficient to feed the needed power to the SCU.

Two service processor cards in SCU are ordered by using two mandatory #EDFP features. Each one provides two 1 Gb Ethernet ports for the Hardware Management Console (HMC) system management connection. One port is used as primary connection and the second port can be used for redundancy. To enhance resiliency, it is a best practice to implement a dual-HMC configuration by attaching separate HMCs to each of the cards in the SCU.

Four FSP ports per FSP card provide redundant connection from the SCU to each system node. System nodes connect to the SCU by using the cable features #EFCH, #EFCE, #EFCF, and #EFCG. Feature #EFCH connects the first system node to the SCU and it is included by default in every system node configuration. It provides FSP, UBIC, and USB cables, but no SMP cables. All the other cable features are added depending on the number of extra system nodes that are configured and includes FSP and SMP cables.

The SCU implementation also includes the following highlights:

- ▶ Elimination of clock cabling since the introduction of Power9 processor-based servers
- ▶ Front-accessible USB port
- ▶ Optimized UPIC power cabling
- ▶ Optional external DVD
- ▶ Concurrently maintainable time of day clock battery

Figure 1-5 shows the front and rear view of a SCU with the locations of the external ports and features.

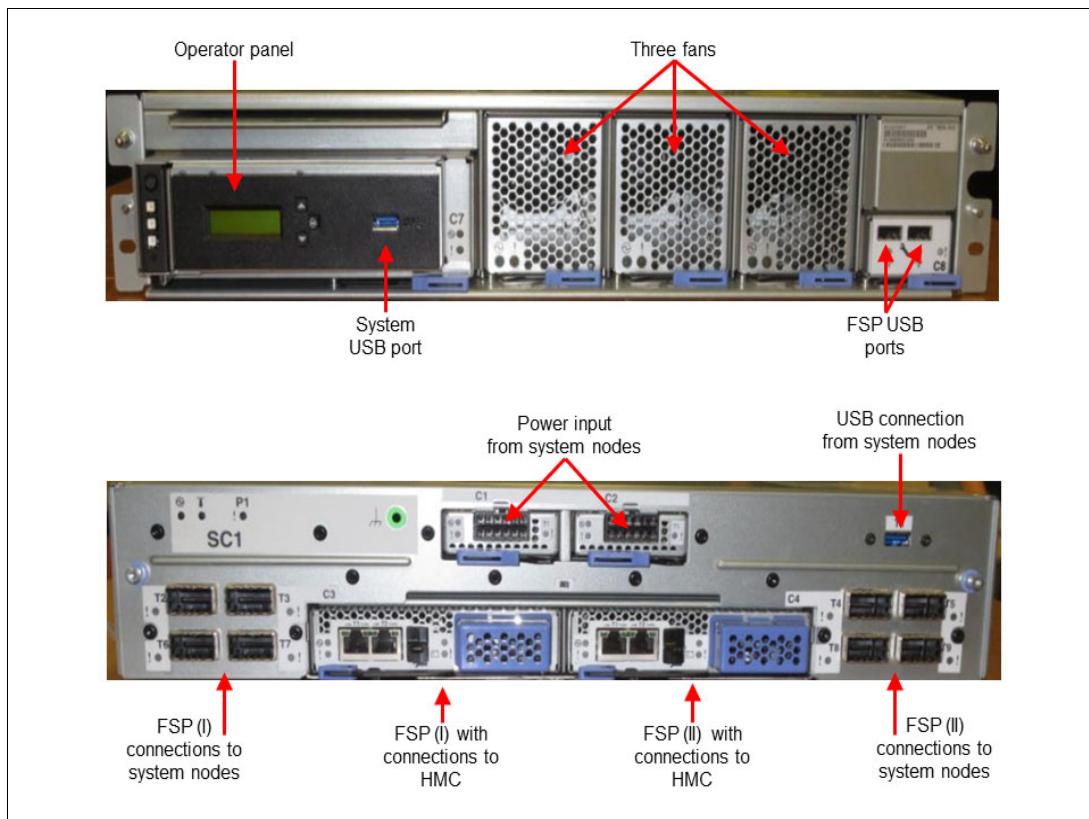


Figure 1-5 Front and rear view of the system control unit

## 1.4 Server specifications

The Power E1080 server specifications are essential to planning for your server. For a first assessment in the context of your planning effort, this section provides you with an overview that is related to the following topics:

- ▶ Physical dimensions
- ▶ Electrical characteristics
- ▶ Environment requirements and noise emission

For more information about the comprehensive Model 9080-HEX server specifications and product documentation, see [IBM Documentation](#).

### 1.4.1 Physical dimensions

The Power E1080 is a modular system that is built on a single SCU and one, two, three, or four system nodes.

Each system component must be mounted in a 19-inch industry standard rack. The SCU requires 2U rack units and each system node requires 5U rack units. Thus, a single-node system requires 7U, a two-node system requires 12U, a three-node system requires 17U, and a four-node system requires 22U rack units. More rack space must be allotted; for example, to PCIe I/O expansion drawers, an HMC, flat panel console kit, network switches, power distribution units (PDUs), and cable egress space.

Table 1-2 lists the physical dimensions of the Power E1080 server control unit and a Power E1080 system node. The component height is also given in Electronic Industries Alliance (EIA) rack units. (One EIA unit corresponds to one rack unit (U) and is defined as 1 3/4 inch or 44.45 mm respectively).

*Table 1-2 Physical dimensions of the Power E1080 server components*

Dimension	Power E1080 server control unit	Power E1080 system node
Width	445.6 mm (17.54 in)	445 mm (17.51 in)
Depth	779.7 mm (30.7 in)	866.95 mm (34.13 in)
Height	86 mm (3.39 in) / 2 EIA units	217.25 mm (8.55 in) / 5 EIA units
Weight	22.7 kg (50 lb)	81.6 kg (180 lb)

#### Lift tools

It is a best practice to have a lift tool available at each site where one or more Power E1080 servers are located to avoid any delays when servicing systems. An optional lift tool #EB2Z is available for order with a Power E1080 server. One #EB2Z lift tool can be shared among many servers and I/O drawers. The #EB2Z lift tool provides a hand crank to lift and position up to 159 kg (350 lb). The #EB2Z lift tool is 1.12 meters x 0.62 meters (44 in x 24.5 in).

**Attention:** A single system node can weigh up to 86.2 kg (190 lb). Also available are a lighter, lower-cost lift tool (#EB3Z) and wedge shelf toolkit for #EB3Z with Feature Code #EB4Z.

## 1.4.2 Electrical characteristics

Each Power E1080 system node has four 1950 W bulk power supplies. The hardware design provides N+2 redundancy for the system power supply, and any node can continue to operate at full function in nominal mode with any two of the power supplies functioning.

Depending on the specific Power E1080 configuration, the power for the SCU is provided through two UPIC cables that are connected to one or two system nodes, as described in 1.2, "System nodes" on page 7.

Table 1-3 lists the electrical characteristics per Power E1080 system node. For planning purposes, use the maximum values that are provided. However, the power draw and heat load depend on the specific processor, memory, adapter, and expansion drawer configuration and the workload characteristics.

*Table 1-3 Electrical characteristics per Power E1080 system node*

Electrical characteristics	Properties
Operating voltage	200 - 208 / 220 - 240 V AC
Operating frequency	50 Hz or 60 Hz +/- 3 Hz AC
Maximum power consumption	4500 W
Maximum power source loading	4.6 kVA
Maximum thermal output	15355 BTU/h
Phase	Single

**Note:** The Power E1080 must be installed in a rack with a rear door and side panels for electromagnetic compatibility compliance.

## 1.4.3 Environment requirements and noise emission

The environment requirements for the Power E1080 servers are classified in operating and non-operating environments. The operating environments are further segmented regarding the recommended and allowable conditions.

**Environmental assessment:** The [IBM Systems Energy Estimator tool](#) can provide more accurate information about the power consumption and thermal output of systems based on a specific configuration

The recommended operating environment designates the long-term operating environment that can result in the greatest reliability, energy efficiency, and reliability. The allowable operating environment represents where the equipment is tested to verify functions. Because the stresses that operating in the allowable envelope can place on the equipment, these envelopes must be used for short-term operation, not continuous operation.

The condition of a non-operating environment pertains to the situation when equipment is removed from the original shipping container and is installed, but is powered down. The allowable non-operating environment is provided to define the environmental range that an unpowered system can experience short term without being damaged.

Table 1-4 lists the environment requirements for the Power E1080 server regarding temperature, humidity, dew point, and altitude. It also lists the maximum noise emission level for a fully configured Power E1080 server.

*Table 1-4 Power E1080 environment requirements and noise emission*

Property	Environment		
	Operating		Non-operating
	Recommended	Allowable	
Temperature	18.0°C – 27.0°C (64.4°F – 80.6°F)	5.0°C – 40.0°C (41.0°F – 104.0°F)	5°C - 45°C (41°F - 113°F)
Low-end moisture	-9.0°C (15.8°F) dew point	-12.0°C (10.4°F) dew point and 8% relative humidity	N/A
High-end moisture	60% relative humidity and 15°C (59°F) dew point	85% relative humidity and 24.0°C (75.2°F) dew point	N/A
Relative humidity	N/A	N/A	8% to 85%
Maximum dew point	N/A	N/A	27.0°C (80.6°F)
Maximum altitude	N/A	3,050 m (10,000 ft)	N/A
Maximum noise level	10.0 B L <sub>WA,m</sub> <sup>a</sup> (heavy workload on one fully configured 16-socket four-node system, 35°C (95°F) at 500 m (1640 ft))	N/A	N/A

a. Declared level L<sub>WA,m</sub> is the upper-limit A-weighted sound power level that is measured in bel (B).

A comprehensive list of noise emission values for various different Power E1080 server configurations is provided by the Power E1080 product documentation. For more information about noise emissions, search for “Model 9080-HEX server specifications” at [IBM Documentation](#).

**Note:** IBM does not recommend operation above 27° C, but you can expect full performance up to 35° C for these systems. Above 35° C, the system can operate, but possible reductions in performance might occur to preserve the integrity of the system components. Above 40° C, there might be reliability concerns for components within the system.

**Note:** Government regulations, such as those regulations that are issued by the Occupational Safety and Health Administration (OSHA) or European Community Directives, can govern noise level exposure in the workplace and might apply to you and your server installation. The Power E1080 server is available with an optional acoustical door feature that can help reduce the noise that is emitted from this system.

The sound pressure levels in your installation depend on various factors, including the number of racks in the installation; the size, materials, and configuration of the room where you designate the racks to be installed; the noise levels from other equipment; the room ambient temperature, and employees' location in relation to the equipment.

Also, compliance with such government regulations depends on various other factors, including the duration of employees' exposure and whether employees wear hearing protection. As a best practice, consult with qualified experts in this field to determine whether you are in compliance with the applicable regulations.

## 1.5 System features

This section lists and explains the available system features on a Power E1080 server. These features describe the resources that are available on the system by default or by virtue of procurement of configurable Feature Codes.

An overview of various Feature Codes and the essential information is also presented that can help users design their system configuration with suitable features that can fulfill the application compute requirement. This information also helps with building a highly available, scalable, reliable, and flexible system around the application.

### 1.5.1 Minimum configuration

A minimum configuration enables a user to order a fully qualified and tested hardware configuration of a Power server with a minimum set of offered technical features. The modular design of a Power E1080 server enables the user to start low with a minimum configuration and scale up vertically as and when needed.

Table 1-5 lists the Power E1080 server configuration with minimal features.

*Table 1-5 Minimum configuration*

Feature	Feature Code	Feature Code description	Min quantity
Primary operating system Feature Code	► 2145 ► 2146 ► 2147	► Primary OS - IBM i ► Primary OS - AIX ► Primary OS - Linux	1
System enclosure	EDN1	5U System node Indicator drawer	1
FSP	EDFP	FSP	2

Feature	Feature Code	Feature Code description	Min quantity
Bezel	EBAB	IBM Rack-mount Drawer Bezel and Hardware	1
Processor	EDP2 EDP3 EDP4	<ul style="list-style-type: none"> <li>▶ 40-core (4x10) Typical 3.65 - 3.90 GHz (max) Power10 Processor with 5U system node drawer</li> <li>▶ 48-core (4x12) Typical 3.60 - 4.15 GHZ (max) Power10 Processor with 5U system node drawer</li> <li>▶ 60-core (4x15) Typical 3.55 - 4.00 GHz (max) Power10 Processor with 5U system node drawer</li> </ul>	1 of any Feature Code
Processor activation	EDPB EDPC EDPD	<ul style="list-style-type: none"> <li>▶ 1 core Processor Activation for #EDBB/#EDP2</li> <li>▶ 1 core Processor Activation for #EDBC/#EDP3</li> <li>▶ 1 core Processor Activation for #EDBD/#EDP4</li> </ul>	16 1 if in PEP 2.0
Memory	EMC1 EMC2 EMC3 EMC4  EMFM EMFN EMFP EMFQ	<ul style="list-style-type: none"> <li>▶ 128 GB (4x32 GB) DDIMMs, 3200 MHz, 16 Gbit DDR4 Memory</li> <li>▶ 256 GB (4x64 GB) DDIMMs, 3200 MHz, 16 Gbit DDR4 Memory</li> <li>▶ 512 GB (4x128 GB) DDIMMs, 2933 MHz, 16 Gbit DDR4</li> <li>▶ 1 TB (4x256 GB) DDIMMs, 2933 MHz,</li>   <li>▶ 128 GB (4x32 GB) DDIMMs, 4000 MHz, 16 Gbit DDR5 Memory</li> <li>▶ 256 GB (4x64 GB) DDIMMs, 4000 MHz, 16 Gbit DDR5 Memory</li> <li>▶ 512 GB (4x128 GB) DDIMMs, 4000 MHz, 16 Gbit DDR5</li> <li>▶ 1 TB (4x256 GB) DDIMMs, 4000 MHz, 16 Gbit DDR5</li> </ul>	8 features of any Feature Code
Memory activation	EMAZ	1 GB Memory activation for HEX	50% or 256 GB in PEP 2.0
DASD backplanes	EJBC	4-NVMe U.2 (7 mm) Flash drive bays	1
Data protection	0040	Mirrored System Disk Level, Specify Code	<ul style="list-style-type: none"> <li>▶ 1 if IBM i</li> <li>▶ 0 for other OS</li> </ul>
UPIC cables	EFCH	System Node to System Control Unit Cable Set for Drawer 1	1

**Note:** The minimum configuration that is generated by the IBM configurator includes more administrative and indicator features.

## 1.5.2 Processor features

Each system node in a Power E1080 server provides four sockets to accommodate Power10 SCMs. Processor features are offered in 10-core, 12-core, and 15-core density. Table 1-6 lists the available processor Feature Codes for a Power E1080 server.

*Table 1-6 Processor features.*

Feature Code	CCIN	Description	OS support
EDP2	5C6C	40-core (4x10) Typical 3.65 GHz - 3.90 GHz (max) Power10 Processor with 5U system node drawer	AIX, IBM i, and Linux
EDP3	5C6D	48-core (4x12) Typical 3.60 - 4.15 GHZ (max) Power10 Processor with 5U system node drawer	AIX, IBM i, and Linux
EDP4	5C6E	60-core (4x15) Typical 3.55 GHz - 4.00 GHz (max) Power10 Processor with 5U system node drawer	AIX, IBM i, and Linux

Each Feature Code provides four processor SCMs. The Feature Code identifies the number of processors on each SCM, and a system configuration requires either one, two, three, or four of the same processor feature, where the number of Feature Codes corresponds to the number of system nodes.

The system nodes connect to other system nodes and to the SCU through cable connect features. Table 1-7 lists the set of cable features that are required for one-, two-, three-, and four-node configurations.

*Table 1-7 Cable set features quantity*

System configuration	Qty EFCH	Qty EFCG	Qty EFCF	Qty EFCE
1-node	1	0	0	0
2-node	1	0	0	1
3-node	1	0	1	1
4-node	1	1	1	1

Every Feature Code that is listed in Table 1-6 provides the processor cores, not their activation. The processor core must be activated to be assigned an LPAR. The activations are offered through multiple permanent and temporary activation features. For more information about these options, see 2.4, “Capacity on Demand” on page 72.

Table 1-8 lists the processor Feature Codes and the associated permanent activation features. Any of these activation Feature Codes can permanently activate one core.

*Table 1-8 Processor and activation features*

Processor feature	Static activation feature	Static Linux only activation feature
EDP2	EDPB	ELCL
EDP3	EDPC	ELCQ
EDP4	EDPD	ECLM

The following types of permanent activations are available:

<b>Static</b>	These features permanently activate cores or memory resources in a system. These activations cannot be shared among multiple systems and remain associated with the system for which they were ordered.
<b>Regular</b>	A regular static activation can run any supported operating system workload.
<b>Linux-only</b>	A Linux-only static activation can run only Linux workloads and are priced less than regular static activations.
<b>Mobile</b>	These features permanently activate cores or memory resources. They are priced more than static activation features because they can be shared among multiple eligible systems that are participating in a Power Enterprise Pool. They can also be moved dynamically among the systems without IBM involvement, which brings more value to the customer than static activations.
<b>Base</b>	In a Power Enterprise Pool 2.0 (PEP 2.0) environment, systems are ordered with some initial compute capacity. This initial capacity is procured by using base activation features. These activations do not move like mobile activations in the PEP 1.0 environment, but can be shared among multiple eligible systems in a PEP 2.0 pool.
<b>Any OS base</b>	These base activations are supported on any operating system (AIX, IBM i, or Linux) in a PEP 2.0 environment.
<b>Linux only base</b>	These base activations are priced less than any OS base activation, but support only Linux workloads in a PEP 2.0 environment.

A minimum of 16 processor cores must always be activated with the static activation features, regardless of the Power E1080 configuration. Also, if the server is associated to a PEP 2.0, a minimum of one base activation is required.

For more information about other temporary activation offerings that are available for the Power E1080 server, see 2.4, “Capacity on Demand” on page 72.

Regular and PEP 2.0 associated activations for Power E1080 are listed in Table 1-9. The Order type table column includes the following designations:

<b>Initial</b>	Denotes the orderability of a feature for <i>only</i> the new purchase of the system.
<b>MES</b>	Denotes the orderability of a feature for <i>only</i> the Miscellaneous Equipment Specification (MES) upgrade purchases on the system.
<b>Both</b>	Denotes the orderability of a feature for new <i>and</i> MES upgrade purchases.
<b>Supported</b>	Denotes that a feature is not orderable, but is supported. That is, the feature can be migrated only from existing systems.

Table 1-9 Processor activation features

Feature Code	Description	Order type
EPS0	1 core Base Proc Act (Pools 2.0) for #EDP2 any OS (from Static)	MES
EPS1	1 core Base Proc Act (Pools 2.0) for #EDP3 any OS (from Static)	MES
EPS2	1 core Base Proc Act (Pools 2.0) for #EDP4 any OS (from Static)	MES

Feature Code	Description	Order type
EPS5	1 core Base Proc Act (Pools 2.0) for #EDP2 Linux (from Static)	MES
EPS6	1 core Base Proc Act (Pools 2.0) for #EDP3 Linux (from Static)	MES
EPS7	1 core Base Proc Act (Pools 2.0) for #EDP4 Linux (from Static)	MES
EPSK	1 core Base Proc Act (Pools 2.0) for #EDP2 any OS (from Prev)	MES
EPSL	1 core Base Proc Act (Pools 2.0) for #EDP3 any OS (from Prev)	MES
EPSM	1 core Base Proc Act (Pools 2.0) for #EDP4 any OS (from Prev)	MES
EDP2	40-core (4x10) Typical 3.65 GHz - 3.90 GHz (max) Power10 Processor with 5U system node drawer	Both
EDP3	48-core (4x12) Typical 3.60 to 4.15 GHZ (max) Power10 Processor with 5U system node drawer	Both
EDP4	60-core (4x15) Typical 3.55 GHz - 4.00 GHz (max) Power10 Processor with 5U system node drawer	Both
ED2Z	Single 5250 Enterprise Enablement	Both
ED30	Full 5250 Enterprise Enablement	Both
EDPB	1 core Processor Activation for #EDBB/#EDP2	Both
EDPC	1 core Processor Activation for #EDBC/#EDP3	Both
EDPD	1 core Processor Activation for #EDBD/#EDP4	Both
EDPZ	Mobile processor activation for HEX/80H	Both
EPDC	1 core Base Processor Activation (Pools 2.0) for EDP2 any OS	Both
EPDD	1 core Base Processor Activation (Pools 2.0) for EDP3 any OS	Both
EPDS	1 core Base Processor Activation (Pools 2.0) for EDP4 any OS	Both
EPDU	1 core Base Processor Activation (Pools 2.0) for EDP2 Linux only	Both
EPDW	1 core Base Processor Activation (Pools 2.0) for EDP3 Linux only	Both
EPDX	1 core Base Processor Activation (Pools 2.0) for EDP4 Linux only	Both
ELCL	PowerLinux processor activation for #EDP2	Both
ELCM	PowerLinux processor activation for #EDP4	Both
ELCQ	PowerLinux processor activation for #EDP3	Both

### 1.5.3 Memory features

This section describes the memory features that are available on a Power E1080 server. Careful selection of these features helps the user to configure their system with the correct amount of memory that can meet the demands of memory-intensive workloads. On a Power E1080 server, the memory features can be classified into the following feature categories:

- ▶ Physical memory
- ▶ Memory activation

These features are described next.

## Physical memory features

Physical memory features that are supported on Power E1080 are the next generation DDIMMs, called DDIMM (see 2.3, “Memory subsystem” on page 68). DDIMMs that are used in the E1080 are Enterprise Class 4U DDIMMs.

### ***DDR5 versus DDR4 memory***

The memory DDIMM features on the Power E1080 are available in 32 GB, 64 GB, 128 GB, or 256 GB capacity. The initial DDIMMs were based on DDR4 technology, but in August 2024, IBM announced memory DDIMMs that use DDR5 technology.

Because the DDIMMs are designed based on the OMI, it was possible to integrate new memory technology without having to replace the memory connections in the system. In addition, several enhancements were built into the DDR5-based DDIMMs that provided significant performance improvements compared to the DDR4-based DDIMMs. For example, all the DDR5-based memory runs at 4000 MHz, but when using the DDR4-based memory, the 32 GB and 64 GB DDIMMs run at 3200 MHz frequency, and the 128 GB and 256 GB DDIMMs run at 2933 MHz frequency. In addition, IBM added more connections to the DDIMMs to increase bandwidth between the system and the memory. For more information about DDR5 memory, see 2.3, “Memory subsystem” on page 68.

Each system node provides 64 DDIMM slots that support a maximum of 16 TB memory. A 4-system node E1080 can support a maximum of 64 TB memory. DDIMMs are ordered by using memory Feature Codes, which include a bundle of four DDIMMs with the same capacity.

Consider the following points regarding improved performance:

- ▶ Plugging DDIMMs of the same density provides the highest performance.
- ▶ Filling all the memory slots provides maximum memory performance.
- ▶ System performance improves when more quads of memory DDIMMs match.
- ▶ System performance also improves as the amount of memory is spread across more DDIMM slots. For example, if 1 TB of memory is required, 64 x 32 GB DDIMMs can provide better performance than 32 x 64 GB DDIMMs.

Figure 1-6 shows a DDIMM memory feature.

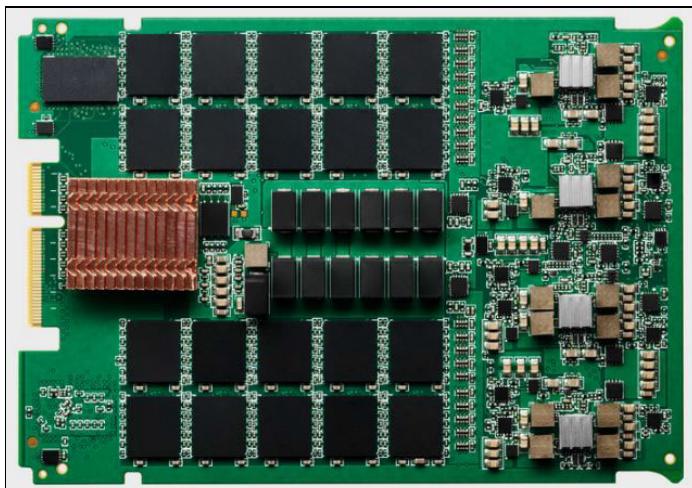


Figure 1-6 DDIMM feature

Table 1-10 lists the available memory DDIMM Feature Codes for the Power E1080.

Table 1-10 E1080 memory Feature Codes

Feature Code	Description	OS support
EMC1	128 GB (4x32 GB) DDIMMs, 3200 MHz, 16 Gbit DDR4 Memory	AIX, IBM i, and Linux
EMC2	256 GB (4x64 GB) DDIMMs, 3200 MHz, 16 Gbit DDR4 Memory	AIX, IBM i, and Linux
EMC3	512 GB (4x128 GB) DDIMMs, 2933 MHz, 16 Gbit DDR4	AIX, IBM i, and Linux
EMC4	1 TB (4x256 GB) DDIMMs, 2933 MHz, 16 Gbit DDR4	AIX, IBM i, and Linux
EMFM	128 GB (4x32 GB) DDIMMs, 4000 MHz, 16 Gbit DDR5 Memory	AIX, IBM i, and Linux
EMFN	256 GB (4x64 GB) DDIMMs, 4000 MHz, 16 Gbit DDR5 Memory	AIX, IBM i, and Linux
EMFP	512 GB (4x128 GB) DDIMMs, 4000 MHz, 16 Gbit DDR5	AIX, IBM i, and Linux
EMFQ	1 TB (4x256 GB) DDIMMs, 4000 MHz, 16 Gbit DDR5	AIX, IBM i, and Linux

### Memory activation features

To assign physical memory in the Power E1080 to LPARs, software keys are necessary for activation. These keys are provided when you order the memory activation feature and can be purchased at any point during the server's lifecycle. Users can increase memory capacity without downtime, except when more physical memory must be added and activated.

A server administrator or user cannot control which physical memory DDIMM features are activated when memory activations are used.

The amount of memory to activate is determined by the Feature Code that is ordered. For example, ordering two instances of Feature Code EDAB (100 GB DDR4 Mobile Memory Activation for HEX) activates a total of 200 GB of installed physical memory. The IBM PowerVM® hypervisor recognizes the total quantity of each type of memory that is activated on the server. Then, it manages the activation and allocation of the physical DDIMM memory to the LPARs.

Similar to processor core activation features, different types of permanent memory activation features are offered on the Power E1080 server. For more information about the available types of activations, see 1.5.2, “Processor features” on page 17.

Orders for memory activation features must consider the following rules:

- ▶ The system must have a minimum of 50% activated physical memory. It can be activated by using static or static and mobile memory activation features.
- ▶ The system must have a minimum of 25% of physical memory that is activated by using static memory activation features.
- ▶ When a Power E1080 is part of a PEP 2.0 environment, the server must have a minimum of 256 GB of base memory activations.

Consider the following examples:

- ▶ For a system with 4 TB of physical memory, at least 2 TB (50% of 4 TB) must be activated.
- ▶ When a Power E1080 is part of a PEP 1.0 environment, a server with 4 TB of physical memory and 3.5 TB of activated memory requires a minimum of 896 GB (25% of 3.5 TB) of physical memory that is activated by using static activation features.
- ▶ When a Power E1080 is part of a PEP 2.0 environment, a server with 4 TB of physical memory requires a minimum of 256 GB of memory that is activated with base activation features.

Table 1-11 lists the available memory activation Feature Codes for Power E1080. The Order type column indicates whether the Feature Code is available for an initial order only, or also with a MES upgrade on an existing server only, or both.

*Table 1-11 Memory activation features*

Feature Code	Description	Order type
EDAB	100 GB DDR4 Mobile Memory Activation for HEX	Both
EDAG	256 GB Base Memory Activation (Pools 2.0)	Both
EDAH	512 GB Base Memory Activation (Pools 2.0)	Both
EDAL	256 GB Base Memory Activation Linux only	Both
EDAM	512 GB Base Memory Activation Linux only	Both
EDAP	1 GB Base Memory activation (Pools 2.0) from Static	Both
EDAQ	100 GB Base Memory activation (Pools 2.0) from Static	Both
EDAR	512 GB Base Memory activation (Pools 2.0) from Static	Both
EDAS	500 GB Base Memory activation (Pools 2.0) from Static	Both
EDAT	1 GB Base Memory activation (Pools 2.0) MES only	Both
EDAU	100 GB Base Memory activation (Pools 2.0) MES only	Both
EDAV	100 GB Base Memory Activation (Pools 2.0) from Mobile	Both
EDAW	500 GB Base Memory Activation (Pools 2.0) from Mobile	Both
EDAX	512 GB Base Memory Activation Linux only - Conversion	Both
ELME	512 GB PowerLinux Memory Activations for HEX	Both
EMAZ	1 GB Memory activation for HEX	Both
EMBK	500 GB DDR4 Mobile Memory Activation for HEX/80H	Both
EMBZ	512 GB Memory Activations for HEX	Both
EMQZ	100 GB of #EMAZ Memory activation for HEX	Both

#### 1.5.4 System node PCIe features

Each system node provides eight PCIe Gen 5 hot-plug enabled slots; therefore, a two-system nodes server provides 16 slots, a three-system nodes server provides 24 slots, and a four-system nodes system provides 32 slots.

Table 1-12 lists all the supported PCIe adapter Feature Codes inside the Power E1080 system node drawer.

*Table 1-12 PCIe adapters that are supported on a Power E1080 system node*

Feature Code	CCIN	Description	OS support
EN1A	578F	PCIe Gen 3 32 Gb 2-port Fibre Channel Adapter	AIX, IBM i, and Linux
EN1B	578F	PCIe Gen 3 LP 32 Gb 2-port Fibre Channel Adapter	AIX, IBM i, and Linux
EN1C	578E	PCIe Gen 3 16 Gb 4-port Fibre Channel Adapter	AIX, IBM i, and Linux
EN1D	578E	PCIe Gen 3 LP 16 Gb 4-port Fibre Channel Adapter	AIX, IBM i, and Linux
EN1F	579A	PCIe Gen 3 LP 16 Gb 4-port Fibre Channel Adapter	AIX, IBM i, and Linux
EN1H	579B	PCIe Gen 3 LP 2-Port 16 Gb Fibre Channel Adapter	AIX, IBM i, and Linux
EN1K	579C	PCIe Gen 4 LP 32 Gb 2-port Optical Fibre Channel Adapter	AIX, IBM i, and Linux
EN2A	579D	PCIe Gen 3 16 Gb 2-port Fibre Channel Adapter	AIX, IBM i, and Linux
EN2B	579D	PCIe Gen 3 LP 16 Gb 2-port Fibre Channel Adapter	AIX, IBM i, and Linux
5260	576F	PCIe2 LP 4-port 1 GbE Adapter	AIX, IBM i, and Linux
5899	576F	PCIe2 4-port 1 GbE Adapter	AIX, IBM i, and Linux
EC2T	58FB	PCIe Gen 3 LP 2-Port 25/10 Gb NIC&ROCE SR/Cu Adapter <sup>a</sup>	AIX, IBM i, and Linux
EC2U	58FB	PCIe Gen 3 2-Port 25/10 Gb NIC&ROCE SR/Cu Adapter <sup>a</sup>	AIX, IBM i, and Linux
EC67	2CF3	PCIe Gen 4 LP 2-port 100 Gb ROCE EN LP adapter	AIX, IBM i, and Linux
EN0S	2CC3	PCIe2 4-Port (10 Gb+1 GbE) SR+RJ45 Adapter	AIX, IBM i, and Linux
EN0T	2CC3	PCIe2 LP 4-Port (10 Gb+1 GbE) SR+RJ45 Adapter	AIX, IBM i, and Linux
EN0X	2CC4	PCIe2 LP 2-port 10/1 GbE BaseT RJ45 Adapter	AIX, IBM i, and Linux

a. Requires Service Focal Point (SFP) to provide 10 Gb, 2 Gb, or 1 Gb BaseT connectivity.

## 1.5.5 System node disk and media features

The Power E1080 system node supports up to four 7-mm NVMe U.2 drives or up to four 15-mm NVMe U.2 drives. They are plugged into a carrier backplane in the node, which is Feature Code EJBC for the 4-drive carrier or EJBD for the 2-drive carrier. Each system node requires one backplane, even if no NVMe U.2 drives are selected.

Each NVMe U.2 drive can be independently assigned to different LPARs for hosting the operating system and to start from them or to assign more data capacity. NVMe U.2 drives are concurrently replaceable. For more information, see 2.5.2, “Internal NVMe storage subsystem” on page 84.

If more NVMe capacity is required, NVMe drives can be placed in the NED24 disk enclosure. For more information, see 2.7, “External I/O subsystems” on page 94.

### 1.5.6 System node USB features

The Power E1080 supports one stand-alone external USB drive that is associated to Feature Code EUA5. The Feature Code includes the cable that is used to the USB drive to the preferred front-accessible USB port on the SCU.

The Power E1080 system node does not offer an integrated USB port. The USB 3.0 adapter Feature Code EC6J is required to provide connectivity to an optional external USB DVD drive and requires one system node or I/O expansion drawer PCIe slot. The adapter connects to the USB port in the rear of the SCU with the cable that is associated to Feature Code EC6N. Because this cable is 1.5 m long, if there is a Power E1080 with more than one system node, the USB 3.0 adapter can be used in the first or the second system node only.

The USB 3.0 adapter Feature Code EC6J supports the assignment to an LPAR and can be migrated from an operating LPAR to another, including the connected DVD drive. This design allows it to assign the DVD drive feature to any LPAR according to the need.

Dynamic allocation of system resources such as processor, memory, and I/O is also referred to as *dynamic logical partition (DLPAR)*.

For more information about the USB subsystem, see 2.5.3, “USB subsystem” on page 87.

### 1.5.7 Power supply features

Each Power E1080 system node has four 1950 W bulk PSUs that are operating at 240 V. These PSU features are a default configuration on every Power E1080 system node. The four units per system node do not have an associated Feature Code and are always auto-selected by the IBM configurator when a new configuration task is started.

Four power cords from the PDUs drive these power supplies, which connect to four C13/C14 type receptacles on the power cord conduit in the rear of the system. The power cord conduit sources power from the rear and connects to the PSUs in the front of the system.

The system design provides N+2 redundancy for system bulk power, which allows the system to continue operation with any two of the PSUs functioning. The failed units must remain in the system until new PSUs are available for replacement.

The PSUs are hot-swappable, which allows replacement of a failed unit without system interruption. The PSUs are placed in front of the system, which makes any necessary service simpler.

Figure 1-7 on page 25 shows the PSUs and their physical locations, which are marked as E1, E2, E3, and E4 in the system.



*Figure 1-7 Power supply units*

## 1.6 I/O drawers

Each system node provides eight PCIe Gen5 hot-plug enabled slots, so a 2-node system provides 16 slots, a 3-node system provides 24 slots, and a 4-node system provides 32 slots.

If more PCIe slots beyond the system node slots are required, the Power E1080 server supports adding I/O expansion drawers. Two different I/O expansion drawers are supported: the PCIe Gen 4 and the PCIe Gen3 expansion drawers.<sup>4</sup> To connect an I/O expansion drawer, a PCIe interconnect feature (fanout module) is required. The fanout module requires a PCIe slot and connects to a 6-slot expansion module in the I/O drawer. Up to two expansion modules are supported per I/O expansion drawer. For more information about the I/O drawers, see 1.6.2, “I/O expansion drawers” on page 26.

To increase the amount of internal disk in the system, the Power E1080 supports two different disk drawers: a 24-bay SAS connected enclosure (the EXP24SX SAS storage enclosure)<sup>5</sup> and a 24-bay NVMe enclosure (the NED24 NVMe expansion drawer). The SAS enclosure uses SAS adapters in the system to connect to the enclosure. The NVMe enclosure uses the same fanout modules that are used by the I/O expansion drawers. These fanout adapters are described in 1.6.1, “System node PCIe interconnect features” on page 25. For more information about the drive enclosures, see 2.7, “External I/O subsystems” on page 94.

### 1.6.1 System node PCIe interconnect features

The I/O expansion drawers and the NED24 NVMe disk expansion drawer all require extension of the PCIe I/O buses from the node to the respective expansion drawer, but the SAS expansion drawer uses SAS adapters in the node to connect. The PCIe expansion function is enabled by using the PCIe x16 to CXP Converter Card (#EJ24). For the PCIe Gen 3 drawer, up to four I/O expansion drawers are supported per node. For the PCIe Gen 4 drawer and the Ned24 disk expansion drawer, a total of six converter cards are supported per node.

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<sup>4</sup> The PCIe Gen 3 Drawer was withdrawn from marketing in January 2024.

<sup>5</sup> The EXP24SX SAS Storage Enclosure was withdrawn from marketing in October 2023.

Table 1-13 shows the maximum number of PCIe slots that are available when using either the PCIe Gen 3 drawers or the Gen 4 drawer, and the maximum number of expansion drawers per node without any NED24 drawers being used.

*Table 1-13 PCIe slots availability for different system nodes configurations*

Number of system nodes	Number of I/O expansions	LP slots <sup>a</sup>	Full-height slots with Gen 3 drawer	Full-height slots with Gen 4 drawer
1	4	8	48	36
2	8	16	96	72
3	12	24	144	108
4	16	32	192	144

a. For the Gen 3 drawer case, all LP slots are occupied with #EJ24. For the Gen 4 case, there are two LP slots that are available in the system node.

**Important:** When using both the I/O expansion drawers and the NED24 disk expansion drawers, the combined maximum of NED24 NVMe Expansion Drawer (#ESR0), PCIe Gen4 I/O Expansion Drawer (#ENZ0), and PCIe Gen3 I/O Expansion Drawer (#EMX0) is half of the maximum of controller cards #EJ24 that are allowed per server.

Each fanout module connects to the system by using a pair of CXP cable features. Select a longer-length Feature Code for inter-rack connection between the system node and the expansion drawer. The same cable features are used to connect either the Gen 4 expansion drawer or the NED24 NVMe expansion drawer, but different cable features are used to connect the Gen 3 expansion drawer (they are not interchangeable).

Both the CXP optical cable pair and the optical cable adapter features are concurrently maintainable. Therefore, careful balancing of I/O, assigning adapters through redundant EMX0 expansion drawers, and different system nodes can help ensure high availability for I/O resources that are assigned to partitions.

**Restriction:** Only two different fanout modules are supported for use in I/O expansion drawers for Power10 servers. Feature EMXF supports the Gen 3 expansion drawer, and feature ENZF supports the Gen 4 expansion drawer. Previous versions are not supported.

For more information about internal buses and the architecture of internal and external I/O subsystems, see 2.5, “Internal I/O subsystem” on page 79.

## 1.6.2 I/O expansion drawers

At the time of writing, there are two PCIe expansion drawers that are available:

- ▶ The PCIe Gen 4 I/O expansion drawer is the replacement for the previous PCIe Gen 3 I/O expansion drawer and should be used for all new system attachments.
- ▶ The PCIe Gen 3 expansion drawer has been withdrawn from marketing effective January 2024. However, it is still supported for use with the Power E1080.

The I/O expansion drawers are 19-inch rack mounted 4U units. Each expansion drawer supports two PCIe fanout modules, which provide 12 PCIe I/O full-length, full-height slots. Each fanout module provides six PCIe slots, two of the slots are x16 slots, and the remaining four are x8 slots. PCIe Gen1, Gen2, and Gen 3 full-high adapters are supported. A maximum of three PCIe Gen 4 expansion drawers or a maximum of four PCIe Gen 3 expansion drawers can be attached to each system node. The two types of expansion drawers can be used together on the same system when migrating existing PCIe Gen 3 drawers from another system.

A PCIe CXP converter adapter and Active Optical Cables (AOCs) connect the system node to each PCIe fanout module in the I/O expansion drawer. Each expansion drawer has two power supplies.

A blind-swap cassette (BSC) houses the full-high adapters that are installed in these slots. The drawer includes a full set of BSCs, even if the BSCs are empty. Drawers can be added to a server dynamically. Concurrent repair and adding or removing expansion drawers and PCIe adapters is done through HMC-guided menus or by operating system support utilities.

Careful balancing of I/O, assigning adapters through redundant EMX0 expansion drawers, and connectivity to different system nodes can help ensure high availability for I/O resources that are assigned to LPARs.

Figure 1-8 shows a PCIe Gen 4 I/O Expansion Drawer.

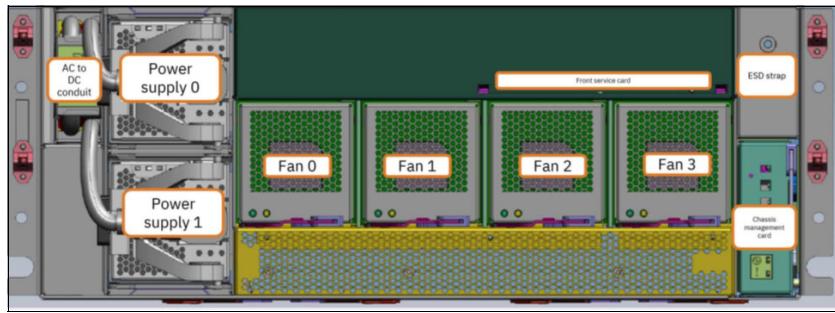


Figure 1-8 PCIe Gen 3 I/O Expansion Drawer

Figure 1-9 shows the rear view of the PCIe Gen 3 I/O Expansion Drawer with the location codes for the PCIe adapter slots in the PCIe Gen 3 6-slot Fanout Module.

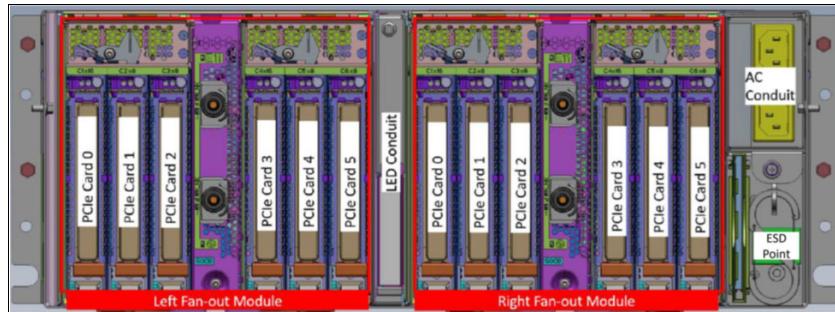


Figure 1-9 Rear view of a PCIe Gen 4 I/O Expansion Drawer

### 1.6.3 Disk expansion drawers

There are two available disk expansion drawers. As a best practice, use the NVMe connected NED24 drawer because the price of NVMe enterprise drives is lower than equivalent SAS attached drives and the performance of the NVMe drives is significantly higher. The SAS-attached drawer is still supported, but it has been withdrawn from marketing.

#### NED24 NVMe Expansion Drawer

IBM continues to provide industry-leading I/O capabilities with a PCIe direct-attached expansion drawer that supports NVMe drive attachment. The NED24 NVMe Expansion Drawer (#ESR0) is a storage expansion enclosure with 24 U.2 NVMe bays.

Each of the 24 NVMe bays in the NED24 drawer is separately addressable and can be assigned to a specific LPAR or Virtual I/O Server (VIOS) to provide native boot support for up to 24 partitions. At the time of writing, each drawer can support up to 153 TB.

Figure 1-10 is a view of the front of the NED24 NVMe Expansion Drawer.



Figure 1-10 NED24 NVMe Expansion Drawer front view

Up to 24 U.2 NVMe devices can be installed in the NED24 drawer by using 15 mm Gen3 carriers. The 15-mm carriers can accommodate either 7 mm or 15 mm NVMe devices.

The NED24 drawer is supported in the Power E1080 by using the same interconnect card that is used for the PCIe Gen 4 and PCIe Gen 3 expansion drawers. A maximum of three NED24 NVMe expansion drawers is supported per system node in the E1080. When mixing the different expansion drawers, the maximum number of drawers that are supported is based on the number of EJ24 fanout cards that are supported.

For more information about the NED24 Drawer, see 2.8.1, “NED24 NVMe Expansion Drawer” on page 106.

#### EXP24SX SAS Storage Enclosures

If you need more disks than are available with the internal disk bays, you can attach more external disk subsystems, such as an EXP24SX SAS Storage Enclosure (#ESLS). This expansion drawer has been withdrawn from marketing.

The EXP24SX drawer is a storage expansion enclosure with 24 2.5-inch SFF SAS bays. It supports up to 24 hot-plug HDDs or SSDs in only 2 EIA of space in a 19-inch rack. The EXP24SX SFF bays use SFF Gen2 (SFF-2) carriers or trays.

With AIX/Linux/VIOS, the EXP24SX can be ordered with four sets of 6 bays (mode 4), two sets of 12 bays (mode 2) or one set of 24 bays (mode 1). With IBM i one set of 24 bays (mode 1) is supported. It is possible to change the mode setting in the field by using software commands along with a documented procedure.

**Important:** When changing modes, a skilled, technically qualified person must follow the specially documented procedures. Improperly changing modes can destroy RAID sets, which prevent access to data, or allow other partitions to access another partition's data.

The attachment between the EXP24SX drawer and the PCIe Gen 3 SAS adapter is through SAS YO12 or X12 cables. The PCIe Gen 3 SAS adapters support 6 Gb throughput. The EXP24SX drawer can support up to 12 Gb throughput if future SAS adapters support that capability.

The EXP24SX drawer includes redundant AC power supplies and two power cords.

Figure 1-11 shows the EXP24SX drawer.



Figure 1-11 EXP24SX drawer

For more information about SAS cabling and cabling configurations, see [IBM Documentation](#).

**Note:** For the EXP24SX drawer, a maximum of twenty-four 2.5-inch SSDs or 2.5-inch HDDs are supported in the #ESLS 24 SAS bays. HDDs and SSDs cannot be mixed in the same mode-1 drawer. HDDs and SSDs can be mixed in a mode-2 or mode-4 drawer, but they cannot be mixed within a logical split of the drawer. For example, in a mode-2 drawer with two sets of 12 bays, one set can hold SSDs and one set can hold HDDs, but you cannot mix SSDs and HDDs in the same set of 12 bays.

## 1.6.4 IBM System Storage

The IBM System Storage Disk Systems products and offerings provide compelling storage solutions with superior value for all levels of business, from entry-level to high-end IBM Storage Systems.

IBM Storage simplifies data infrastructure by using an underlying software foundation to strengthen and streamline the storage in the hybrid cloud environment, which uses a simplified approach to containerization, management, and data protection. For more information about the various offerings, see [this web page](#).

The following section highlights a few of the offerings.

### IBM FlashSystem Family

The IBM FlashSystem® family is a portfolio of cloud-enabled Storage Systems designed to be easily deployed and quickly scaled to help optimize storage configurations, streamline issue resolution, and lower storage costs.

IBM FlashSystem is built with IBM Spectrum® Virtualize software to help deploy sophisticated hybrid cloud storage solutions, accelerate infrastructure modernization, address security needs, and maximize value by using the power of AI. The products are designed to provide enterprise-grade functions without compromising affordability or performance. They also offer the advantages of end-to-end NVMe, the innovation of IBM FlashCore® technology, and SCM for ultra-low latency. For more information, see [this web page](#).

### **IBM System Storage DS8000**

IBM DS8900F is the next generation of enterprise data systems that are built with the most advanced IBM POWER® processor technology and feature ultra-low application response times.

Designed for data-intensive and mission-critical workloads, DS8900F adds next-level performance, data protection, resiliency, and availability across hybrid cloud solutions through ultra-low latency, better than seven 9's (99.99999) availability, transparent cloud, tiering, and advanced data protection against malware and ransomware. This enterprise-class storage solution provides superior performance and higher capacity, which enables the consolidation of all mission-critical workloads in one place.

IBM DS8900F can provide 100% data encryption at-rest, in-flight and in the cloud. This flexible storage supports IBM Power, IBM Z, and IBM LinuxONE. For more information, see [this web page](#).

### **IBM SAN Volume Controller**

IBM SAN Volume Controller is an enterprise-class system that consolidates storage from over 500 IBM and third-party Storage Systems to improve efficiency, simplify management and operations, modernize storage with new capabilities, and enable a common approach to hybrid cloud regardless of storage system type.

IBM SAN Volume Controller provides a complete set of data resilience capabilities with high availability, business continuance, and data security features. Storage supports automated tiering with AI-based IBM Easy Tier® that can help improve performance at a lower cost. For more information, see [this web page](#).

## **1.7 System racks**

The Power E1080 server fits a standard 19-inch rack. The server is certified and tested in the IBM Enterprise racks (7965-S42, 7014-T42, 7014-T00, or 7965-94Y). Customers can choose to place the server in other racks if they are confident that those racks have the strength, rigidity, depth, and hole pattern characteristics that are needed. Contact IBM Support to determine whether other racks are suitable.

**Important:** As a best practice, order the Power E1080 server with an IBM 42U enterprise rack 7965-S42 feature. This rack provides a complete and higher-quality environment for IBM Manufacturing system assembly and testing, and provides a complete package.

If a system is installed in a rack or cabinet that is not from IBM, help ensure that the rack meets the requirements that are described in 1.7.7, “Original equipment manufacturer racks” on page 38.

**Important:** The customer is responsible for ensuring the installation of the drawer in the preferred rack or cabinet results in a configuration that is stable, serviceable, safe, and compatible with the drawer requirements for power, cooling, cable management, weight, and rail security.

### 1.7.1 New rack considerations

Consider the following points when racks are ordered:

- ▶ The new IBM Enterprise 42U Slim Rack 7965-S42 offers 42 EIA units (U) of space in a slim footprint.
- ▶ The 7014-T42, 7014-T00, and 7965-94Y racks are no longer available to purchase with a Power E1080 server. Installing a Power E1080 server in these racks is still supported.

**Attention:** All PDUs that are installed in a rack that contains a Power E1080 server must be installed horizontally to allow for cable routing in the sides of the rack.

### 1.7.2 IBM Enterprise 42U Slim Rack 7965-S42

The 2.0-meter (79-inch) Model 7965-S42 is compatible with past and present IBM Power servers and provides an excellent 19-inch rack enclosure for your data center. Its 600 mm (23.6 in.) width combined with its 1100 mm (43.3 in.) depth plus its 42 EIA enclosure capacity provides great footprint efficiency for your systems. It can be placed easily on standard 24-inch floor tiles.

Compared to the 7965-94Y Slim Rack, the Enterprise Slim Rack provides extra strength and shipping and installation flexibility.

The 7965-S42 rack includes space for up to four PDUs in side pockets. Extra PDUs beyond four are mounted horizontally and each uses 1U of rack space.

The Enterprise Slim Rack front door, which can be Basic Black/Flat (#ECRM) or High-End appearance (#ECRT), has perforated steel, which provides ventilation, physical security, and visibility of indicator lights in the installed equipment within.

Standard is a lock that is identical to the locks in the rear doors. The door (#ECRG) can be hinged on the left or right side.

In addition to the #ECRT door, you can order the #ECRF high-end appearance door (Figure 1-12).



Figure 1-12 The #ECRF and the #ECRT rack doors

### 1.7.3 AC power distribution unit and rack content

The Power E1080 servers that are integrated into a rack at the factory feature PDUs that are mounted horizontally in the rack. Each PDU takes 1U of space in the rack. Mounting the PDUs vertically in the side of the rack can cause cable routing issues and interfere with optimal service access.

Two possible PDU ratings are supported: 60A/63A (orderable in most countries) and 30A/32A. Consider the following points:

- ▶ The 60A/63A PDU supports four system node power supplies and one I/O expansion drawer or eight I/O expansion drawers.
- ▶ The 30A/32A PDU supports two system node power supplies and one I/O expansion drawer or four I/O expansion drawers.

Rack-integrated system orders require at least two of #7109, #7188, or #7196.

High-function PDUs provide more electrical power per PDU and offer better “PDU footprint” efficiency. In addition, they are intelligent PDUs that provide insight into power usage by receptacle and remote power on and off capability for support by individual receptacle. The new PDUs are orderable as #ECJJ, #ECJL, #ECJN, and #ECJQ.

High-function PDU FCs are listed in Table 1-14.

*Table 1-14 Available high-function PDUs*

<b>PDUs</b>	<b>1-phase or 3-phase depending on country wiring standards</b>	<b>3-phase 208 V depending on country wiring standards</b>
Nine C19 receptacles	ECJJ	ECJL
Twelve C13 receptacles	ECJN	ECJQ

In addition, the following high-function PDUs are available:

- ▶ High Function 9xC19 PDU plus (#ECJJ)

This intelligent, switched 200-240 V AC PDU includes nine C19 receptacles on the front of the PDU. The PDU is mounted on the rear of the rack, which makes the nine C19 receptacles easily accessible.

- ▶ High Function 9xC19 PDU plus 3-Phase (#ECJL)

This intelligent, switched 208 V 3-phase AC PDU includes nine C19 receptacles on the front of the PDU. The PDU is mounted on the rear of the rack, which makes the nine C19 receptacles easily accessible.

- ▶ High Function 12xC13 PDU plus (#ECJN)

This intelligent, switched 200-240 V AC PDU includes 12 C13 receptacles on the front of the PDU. The PDU is mounted on the rear of the rack, which makes the 12 C13 receptacles easily accessible.

- ▶ High Function 12xC13 PDU plus 3-Phase (#ECJQ)

This intelligent, switched 208 V 3-phase AC PDU includes 12 C13 receptacles on the front of the PDU. The PDU is mounted on the rear of the rack, which makes the 12 C13 receptacles easily accessible.

Two or more PDUs can be installed horizontally in the rear of the rack. Mounting PDUs horizontally uses 1U per PDU and reduces the space that is available for other racked components. When mounting PDUs horizontally, the preferred approach is to use fillers in the EIA units that are occupied by these PDUs to facilitate proper air-flow and ventilation in the rack.

Each PDU requires one PDU-to-wall power cord. Various power cord features are available for various countries and applications by varying the PDU-to-wall power cord, which must be ordered separately.

Each power cord provides the unique design characteristics for the specific power requirements. To match new power requirements and save previous investments, these power cords can be requested with an initial order of the rack or with a later upgrade of the rack features.

Table 1-15 lists the available wall power cord options for the #7188 and High Function PDUs and iPDU features, which must be ordered separately.

*Table 1-15 Wall power cord options for the PDU and iPDU features*

Feat code	Wall plug	Rated voltage (V AC)	Phase	Rated amperage	Geography
6653	IEC 309, 3P+N+G, 16 A	230	3	16 amps/phase	Internationally available
6489	IEC309 3P+N+G, 32 A	230	3	32 amps/phase	EMEA
6654	NEMA L6-30	200 - 208, 240	1	24 amps	US, Canada, LA, and Japan
6655	RS 3750DP (watertight)	200 - 208, 240	1	24 amps	US, Canada, LA, and Japan
6656	IEC 309, P+N+G, 32 A	230	1	24 amps	EMEA
6657	PDL	230 - 240	1	32 amps	Australia and New Zealand
6667	PDL	380 - 415	3	32 amps	Australia and New Zealand
6658	Korean plug	220	1	30 amps	North and South Korea
6492	IEC 309, 2P+G, 60 A	200 - 208, 240	1	48 amps	US, Canada, LA, and Japan
6491	IEC 309, P+N+G, 63 A	230	1	63 amps	EMEA

**Important:** Help ensure that the suitable power cord feature is configured to support the power that is being supplied. Based on the power cord that is used, the PDU can supply between 4.8 - 19.2 kVA. The power of all the drawers that are plugged into the PDU must not exceed the power cord limitation.

To better enable electrical redundancy, each CEC has four power supplies that must be connected to separate PDUs, which are not included in the base order.

For maximum availability, a preferred approach is to connect power cords from the same system to two separate PDUs in the rack, and to connect each PDU to independent power sources.

For more information about power requirements of and the power cord for the 7965-94Y rack, see [IBM Documentation](#).

## 1.7.4 PDU connection limits

Two possible PDU ratings are supported: 60/63 amps and 30/32 amps. The PDU rating is determined by the power cord that is used to connect the PDU to the electrical supply. The number of system nodes and I/O expansion drawers that are supported by each power cord are listed in Table 1-16.

Table 1-16 Maximum supported enclosures by power cord

Feature Code	Wall plug	PDU Rating	Maximum supported system nodes per PDU pair	Maximum supported I/O drawers with no system nodes
6653	IEC 309, 3P+N+G, 16 A	60 Amps	Two system nodes and 1 I/O expansion drawer	8
6489	IEC309 3P+N+G, 32 A	60 Amps	Two system nodes and 1 I/O expansion drawer	8
6654	NEMA L6-30	30 Amps	One system node and 1 I/O expansion drawer	4
6655	RS 3750DP (watertight)	30 Amps	One system node and 1 I/O expansion drawer	4
6656	IEC 309, P+N+G, 32 A	30 Amps	One system node and 1 I/O expansion drawer	4
6657	PDL	30 Amps	One system node and 1 I/O expansion drawer	4
6658	Korean plug	30 Amps	One system node and 1 I/O expansion drawer	4
6492	IEC 309, 2P+G, 60 A	60 Amps	Two system node and 1 I/O expansion drawer	4
6491	IEC 309, P+N+G, 63 A	60 Amps	Two system nodes and 1 I/O expansion drawer	8

## 1.7.5 Rack-mounting rules

Consider the following primary rules when you mount the system into a rack:

- ▶ For rack stability, start filling the rack from the bottom.
- ▶ As a best practice, use an IBM approved lift tool for the installation of systems into any IBM or non-IBM rack.
- ▶ IBM does not support installation of system nodes higher than the 29U position.
- ▶ Any remaining space in the rack can be used to install other systems or peripheral devices. Help ensure that the maximum permissible weight of the rack is not exceeded and the installation rules for these devices are followed.
- ▶ Before placing the system into the service position, follow the rack manufacturer's safety instructions regarding rack stability.

## 1.7.6 Useful rack additions

This section highlights several rack addition solutions for IBM Power rack-based systems.

### IBM System Storage 7226 Model 1U3 Multi-Media Enclosure

The IBM System Storage 7226 Model 1U3 Multi-Media Enclosure can accommodate up to two tape drives, two RDX removable disk drive docking stations, or up to four DVD-RAM drives.

The IBM System Storage 7226 Multi-Media Enclosure supports LTO Ultrium and DAT160 Tape technology, DVD-RAM, and RDX removable storage requirements on the following IBM systems:

- ▶ IBM POWER6 processor-based systems
- ▶ IBM POWER7 processor-based systems
- ▶ IBM Power8® processor-based systems
- ▶ IBM Power9 processor-based systems
- ▶ IBM Power10 processor-based systems

The IBM System Storage 7226 Multi-Media Enclosure offers an expansive list of drive feature options, as listed in Table 1-17.

*Table 1-17 Supported drive features for the 7226-1U3*

Feature Code	Description	Status
1420	DVD-RAM SAS Optical Drive	Available
1422	DVD-RAM Slim SAS Optical Drive	Available
5762	DVD-RAM USB Optical Drive	Available
5763	DVD Front USB Port Sled with DVD-RAM USB Drive	Available
5757	DVD RAM Slim USB Optical Drive	Available
8348	LTO Ultrium 6 Half High Fibre Tape Drive	Available
8341	LTO Ultrium 6 Half High SAS Tape Drive	Available
8441	LTO Ultrium 7 Half High SAS Tape Drive	Available
8546	LTO Ultrium 8 Half High Fibre Tape Drive	Available
EU03	RDX 3.0 Removable Disk Docking Station	Available

The following options are available:

- ▶ LTO Ultrium 6 Half-High 2.5 TB SAS and Fibre Channel Tape Drive: With a data transfer rate up to 320 MBps (assuming a 2.5:1 compression), the LTO Ultrium 6 drive is read/write compatible with LTO Ultrium 6 and 5 media, and read-only compatibility with LTO Ultrium 4. By using data compression, an LTO-6 cartridge can store up to 6.25 TB of data.
- ▶ The LTO Ultrium 7 drive offers a data rate of up to 300 MBps with compression. It also provides read/write compatibility with Ultrium 7 and Ultrium 6 media formats, and read-only compatibility with Ultrium 5 media formats. By using data compression, an LTO-7 cartridge can store up to 15 TB of data.
- ▶ The LTO Ultrium 8 drive offers a data rate of up to 300 MBps with compression. It also provides read/write compatibility with Ultrium 8 and Ultrium 7 media formats. It is not read or write compatible with other Ultrium media formats. By using data compression, an LTO-8 cartridge can store up to 30 TB of data.

- ▶ DVD-RAM: The 9.4 GB SAS Slim Optical Drive with an SAS and USB interface option is compatible with most standard DVD disks.
- ▶ RDX removable disk drives: The RDX USB docking station is compatible with most RDX removable disk drive cartridges when it is used in the same OS. The 7226 offers the following RDX removable drive capacity options:
  - 500 GB (#1107)
  - 1.0 TB (#EU01)
  - 2.0 TB (#EU2T)

Removable RDX drives are in a rugged cartridge that inserts into an RDX removable (USB) disk docking station (#1103 or #EU03). RDX drives are compatible with docking stations, which are installed internally in Power8, Power9, and Power10 processor-based servers, where applicable.

Figure 1-13 shows the IBM System Storage 7226 Multi-Media Enclosure.



*Figure 1-13 IBM System Storage 7226 Multi-Media Enclosure*

The IBM System Storage 7226 Multi-Media Enclosure offers a customer-replaceable unit (CRU) maintenance service to help make the installation or replacement of new drives efficient. Other 7226 components are also designed for CRU maintenance.

The IBM System Storage 7226 Multi-Media Enclosure is compatible with most Power8, Power9, and Power10 processor-based systems that offer current level AIX, IBM i, and Linux operating systems.

**Unsupported:** IBM i does not support 7226 USB devices.

For a complete list of host software versions and release levels that support the IBM System Storage 7226 Multi-Media Enclosure, see [IBM System Storage Interoperation Center \(SSIC\)](#).

**Note:** Any of the existing 7216-1U2, 7216-1U3, and 7214-1U2 multimedia drawers are also supported.

### Flat panel display options

The IBM 7316 Model TF5 is a rack-mountable flat panel console kit that can also be configured with the tray pulled forward and the monitor folded up, which provides full viewing and keying capability for the HMC operator.

The Model TF5 is a follow-on product to the Model TF4 and offers the following features:

- ▶ A slim, sleek, and lightweight monitor design that occupies only 1U (1.75 in.) in a 19-inch standard rack
- ▶ A 18.5 inch (409.8 mm x 230.4 mm) flat panel TFT monitor with truly accurate images and virtually no distortion

- ▶ The ability to mount the IBM Travel Keyboard in the 7316-TF5 rack keyboard tray
- ▶ Support for the IBM 1x8 Rack Console Switch (#4283) IBM Keyboard/Video/Mouse (KVM) switches

The #4283 is a 1x8 Console Switch that fits in the 1U space behind the TF5. It is a CAT5-based switch. It contains eight analog rack interface (ARI) ports for connecting PS/2 or USB console switch cables. It supports chaining of servers that use an IBM Conversion Options switch cable (#4269). This feature provides four cables that connect a KVM switch to a system, or can be used in a daisy-chain scenario to connect up to 128 systems to a single KVM switch. It also supports server-side USB attachments.

### 1.7.7 Original equipment manufacturer racks

The system can be installed in a suitable OEM rack if that the rack conforms to the EIA-310-D standard for 19-inch racks. This standard is published by the Electrical Industries Alliance. For more information, see [IBM Documentation](#).

The IBM Documentation provides the general rack specifications, including the following information:

- ▶ The rack or cabinet must meet the EIA Standard EIA-310-D for 19-inch racks that was published August 24, 1992. The EIA-310-D standard specifies internal dimensions, for example, the width of the rack opening (width of the chassis), the width of the module mounting flanges, and the mounting hole spacing.
- ▶ The front rack opening must be a minimum of 450 mm (17.72 in.) wide, and the rail-mounting holes must be 465 mm plus or minus 1.6 mm (18.3 in. plus or minus 0.06 in.) apart on center (horizontal width between vertical columns of holes on the two front-mounting flanges and on the two rear-mounting flanges).

Figure 1-14 is a top view showing the rack specification dimensions.

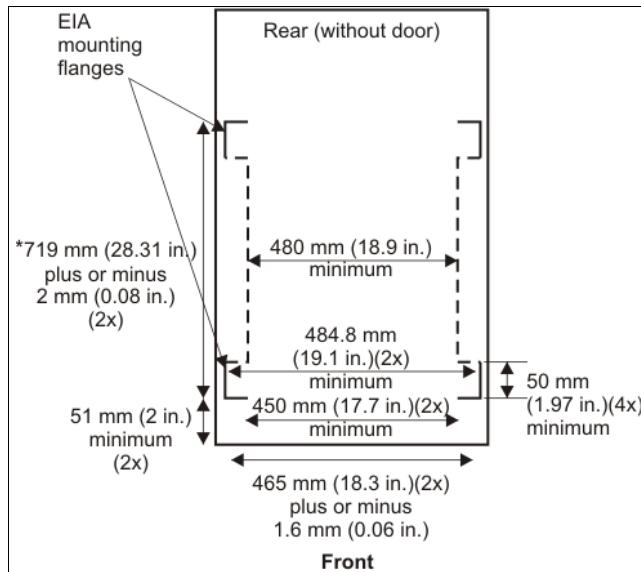


Figure 1-14 Rack specifications (top-down view)

- ▶ The vertical distance between mounting holes must consist of sets of three holes that are spaced (from bottom to top) 15.9 mm (0.625 in.), 15.9 mm (0.625 in.), and 12.7 mm (0.5 in.) on center, which makes each three-hole set of vertical hole spacing 44.45 mm (1.75 in.) apart on center.

Figure 1-15 shows the vertical distances between the mounting holes.

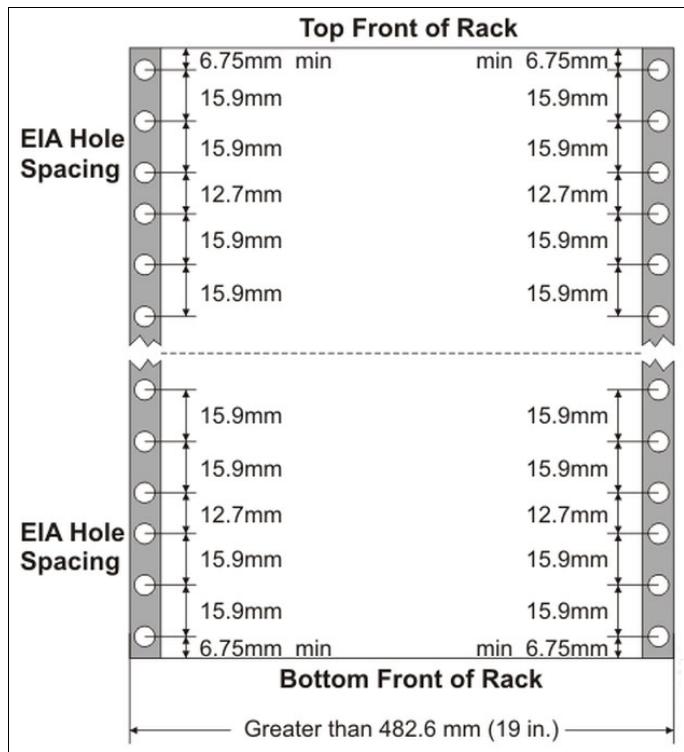


Figure 1-15 Vertical distances between mounting holes

- ▶ The following rack hole sizes are supported for racks where IBM hardware is mounted:
  - 7.1 mm (0.28 in.) plus or minus 0.1 mm (round)
  - 9.5 mm (0.37 in.) plus or minus 0.1 mm (square)

The rack or cabinet must be capable of supporting an average load of 20 kg (44 lb.) of product weight per EIA unit. For example, a four EIA drawer has a maximum drawer weight of 80 kg (176 lb.).

## 1.8 Hardware Management Console overview

The HMC can be a hardware appliance or virtual appliance that can be used to configure and manage your systems. The HMC connects to one or more managed systems and provides capabilities for following primary functions:

- ▶ Systems Management functions, such as Power Off, Power on, system settings, CoD, Enterprise Pools, shared processor pools (SPPs), Performance and Capacity Monitoring, and starting Advanced System Management Interface (ASMI) for managed systems.
- ▶ Deliver virtualization management through support for creating, managing, and deleting LPARs, Live Partition Mobility (LPM), Remote Restart, configuring SRIOV, managing Virtual IO Servers, dynamic resource allocation, and operating system terminals.

- ▶ Acts as the SFP for systems and supports service functions, including call home, dump management, guided repair and verify, concurrent firmware updates for managed systems, and around-the-clock error reporting with Electronic Service Agent (ESA) for faster support.
- ▶ Provides appliance management capabilities for configuring network, users on the HMC, and updating and upgrading the HMC

We discuss the available HMC offerings next.

### 1.8.1 HMC 7063-CR2

The 7063-CR2 IBM Power HMC (see Figure 1-16) is a second-generation Power processor-based HMC.

The CR2 model includes the following features:

- ▶ 6-core Power9 130W processor chip
- ▶ 64 GB (4x16 GB) or 128 GB (4x32 GB) of memory RAM
- ▶ 1.8 TB with RAID1 protection of internal disk capacity
- ▶ 4-port 1 Gb Ethernet (RH-45), 2-port 10 Gb Ethernet (RJ-45), two USB 3.0 ports (front side) and two USB 3.0 ports (rear side), and 1 Gb IPMI Ethernet (RJ-45)
- ▶ Two 900W PSUs
- ▶ Remote Management Service: IPMI port (OpenBMC) and Redfish application programming interface (API)
- ▶ The Base Warranty is 1 year 9x5 with available optional upgrades

A USB Smart Drive is not included.

**Note:** The recovery media for V10R1 is the same for 7063-CR2 and 7063-CR1.



Figure 1-16 HMC 7063-CR2

The 7063-CR2 is compatible with flat panel console kits 7316-TF3<sup>6</sup>, TF4<sup>6</sup>, and TF5.

## 1.8.2 Virtual HMC

Initially, the HMC was sold only as a hardware appliance, including the HMC firmware installed. However, IBM extended this offering to allow the purchase of the hardware appliance and a virtual appliance that can be deployed on ppc64le architectures and deployed on x86 platforms.

Any customer with valid contract can download it from Entitled Systems Support (ESS) site or it can be included within an initial Power E1080 order.

The virtual HMC supports the following hypervisors:

- ▶ On x86 processor-based servers:
  - Kernel-based Virtual Machine
  - Xen
  - VMware
- ▶ On Power processor-based servers: PowerVM

The following minimum requirements must be met to install the virtual HMC:

- ▶ 16 GB of memory
- ▶ Four virtual processors
- ▶ Two network interfaces (maximum 4 allowed)
- ▶ One disk drive (500 GB available disk drive)

For an initial Power E1080 order with the IBM configurator (e-config), HMC virtual appliance can be found by selecting **add software** → **Other System Offerings** (as product selections) and then:

- ▶ 5765-VHP for IBM HMC Virtual Appliance for Power V10
- ▶ 5765-VHX for IBM HMC Virtual Appliance x86 V10

For more information about an overview of the Virtual HMC, see [this web page](#).

For more information about how to install the virtual HMC appliance and all requirements, see [IBM Documentation](#).

## 1.8.3 BMC network connectivity rules for 7063-CR2

The 7063-CR2 HMC features a baseboard management controller (BMC), which is a specialized service processor that monitors the physical state of the system by using sensors. OpenBMC that is used on 7063-CR2 provides a GUI (GUI) that can be accessed from a workstation that has network connectivity to the BMC. This connection requires an Ethernet port to be configured for use by the BMC.

The 7063-CR2 provides two network interfaces (eth0 and eth1) for configuring network connectivity for BMC on the appliance.

Each interface maps to a different physical port on the system. Different management tools name the interfaces differently. The HMC task **Console Management** → **Console Settings** → **Change BMC/IPMI Network Settings** modifies only the Dedicated interface.

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<sup>6</sup> The 7316-TF3 and 7316-TF4 were withdrawn from marketing.

The BMC ports are listed see Table 1-18.

Table 1-18 BMC ports

Management tool	Logical port	Shared/Dedicated	CR2 physical port
OpenBMC UI	eth0	Shared	eth0
OpenBMC UI	eth1	Dedicated	Management port only
ipmitool	lan1	Shared	eth0
ipmitool	lan2	Dedicated	Management port only
HMC task (change BMC/IMPI Network settings)	lan2	Dedicated	Management port only

Figure 1-17 shows the BMC interfaces of the HMC.

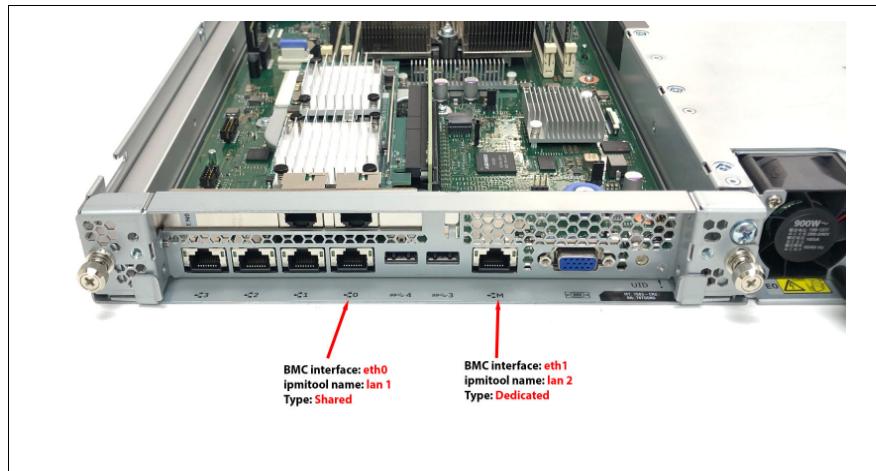


Figure 1-17 BMC interfaces

The main difference is that the shared and dedicated interface to the BMC can coexist. Each has its own LAN number and physical port. Ideally, the customer configures one port, but both can be configured. Connecting Power servers to the HMC rules remain the same as previous versions.

#### 1.8.4 High availability HMC configuration

For the best manageability and redundancy, a dual HMC configuration is suggested. This configuration can be two hardware appliances, but also one hardware appliance and one virtual appliance or two virtual appliances.

The following requirements must be met:

- ▶ Two HMCs are at the same version.
- ▶ The HMCs use different subnets to connect to the FSPs.
- ▶ The HMCs can communicate with the servers' partitions over a public network to allow for full synchronization and function.

## 1.8.5 HMC code level requirements for the Power E1080

The minimum required HMC version for the Power E1080 is V10R1. V10R1 is supported only on 7063-CR1, 7063-CR2, and Virtual HMC appliances. It is *not* supported on 7042 Machine types. HMC with V10R1 cannot manage POWER7 processor-based systems.

New features and capabilities are implemented with firmware updates, and many firmware updates require a minimum version of HMC code. Help ensure that your installed firmware and HMC levels support the features that you plan to implement.

An HMC that is running V10R1 M1010 includes the following features:

- ▶ HMC OS Secure Boot support for the 7063-CR2 appliance.
- ▶ Ability to configure login retries and suspended time and support for inactivity expiration in the password policy.
- ▶ Ability to specify HMC location and data replication for groups.
- ▶ VIOS Management Enhancements:
  - Prepare for VIOS Maintenance:
    - Validation for redundancy for the storage and network that is provided by VIOS to customer partitions
    - Switch path of redundant storage and network to start failover
    - Rollback to original configuration on failure of prepare
    - Audit various validations and prepare steps that are performed
    - Report any failures that are seen during prepare
  - Command Line and Scheduled operations support for VIOS backup or restore VIOS Configuration and SSP Configuration
  - Option to backup or restore Shared Storage Pool configuration in HMC
  - Options to import or export the backup files to external storage
  - Option to fail over all Virtual NICs from one VIOS to another VIOS
- ▶ Supports 128 MB and 256 MB LMB sizes.
- ▶ Automatically chooses the fastest network for LPM memory transfer.
- ▶ HMC user experience enhancements:
  - Usability and performance improvements
  - Enhancements to help connect global search
  - Quick view of serviceable events
  - More progress information for UI Wizards
- ▶ Allow LPM/Remote Restart when virtual optical device is assigned to partition.
- ▶ Update Access Key (UAK) support.

- Scheduled operation function: In the ESA, a new feature that allows customers to receive message alerts only if scheduled operations fail (see Figure 1-18).

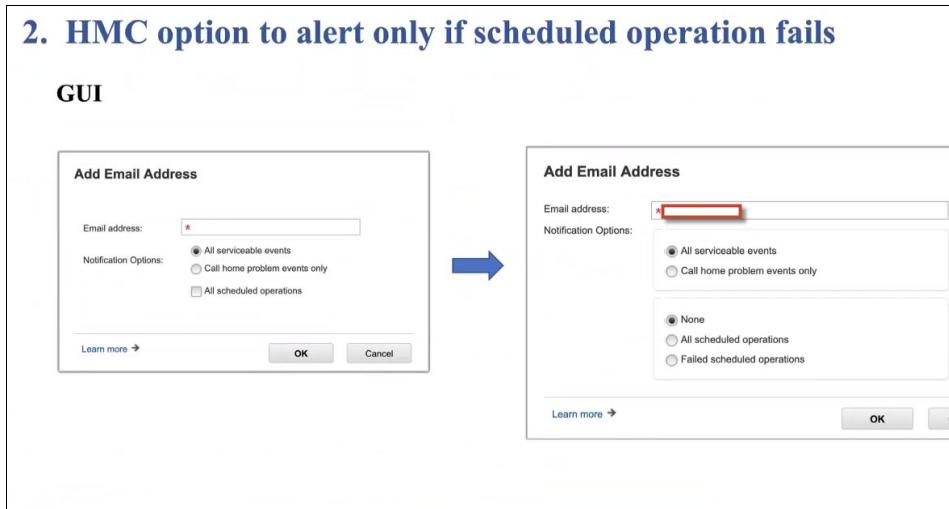


Figure 1-18 HMC alert feature

Log retention of the HMC audit trail is also increased.

### 1.8.6 HMC currency

In recent years, cybersecurity emerged as a national security issue and an increasingly critical concern for CIOs and enterprise IT managers.

The IBM Power processor-based architecture has always ranked highly in terms of end-to-end security, which is why it remains a platform of choice for mission-critical enterprise workloads.

A key aspect of maintaining a secure Power environment is helping ensure that the HMC (or virtual HMC) is current and fully supported (including hardware, software, and Power firmware updates).

Outdated or unsupported HMCs represent a technology risk that can quickly and easily be mitigated by upgrading to a current release.



# Architecture and technical overview

This chapter describes the overall system architecture for the IBM Power E1080 (9080-HEX) server. The bandwidths that are provided throughout are theoretical maximums that are used for reference. The speeds that are shown are at an individual component level. Multiple components and application implementations are key to achieving the best performance.

Always complete performance sizing at the application workload environment level and evaluate performance by using real-world performance measurements and production workloads.

This chapter includes the following topics:

- ▶ 2.1, “IBM Power10 processor” on page 46
- ▶ 2.2, “SMP interconnection” on page 66
- ▶ 2.3, “Memory subsystem” on page 68
- ▶ 2.4, “Capacity on Demand” on page 72
- ▶ 2.5, “Internal I/O subsystem” on page 79
- ▶ 2.6, “Supported PCIe adapters” on page 89
- ▶ 2.7, “External I/O subsystems” on page 94
- ▶ 2.8, “External disk subsystems” on page 106
- ▶ 2.9, “System control and clock distribution” on page 115
- ▶ 2.10, “Operating system support” on page 120
- ▶ 2.11, “Manageability” on page 127
- ▶ 2.12, “Serviceability” on page 132

## 2.1 IBM Power10 processor

Figure 2-1 shows the logical system architecture of the Power E1080 server.

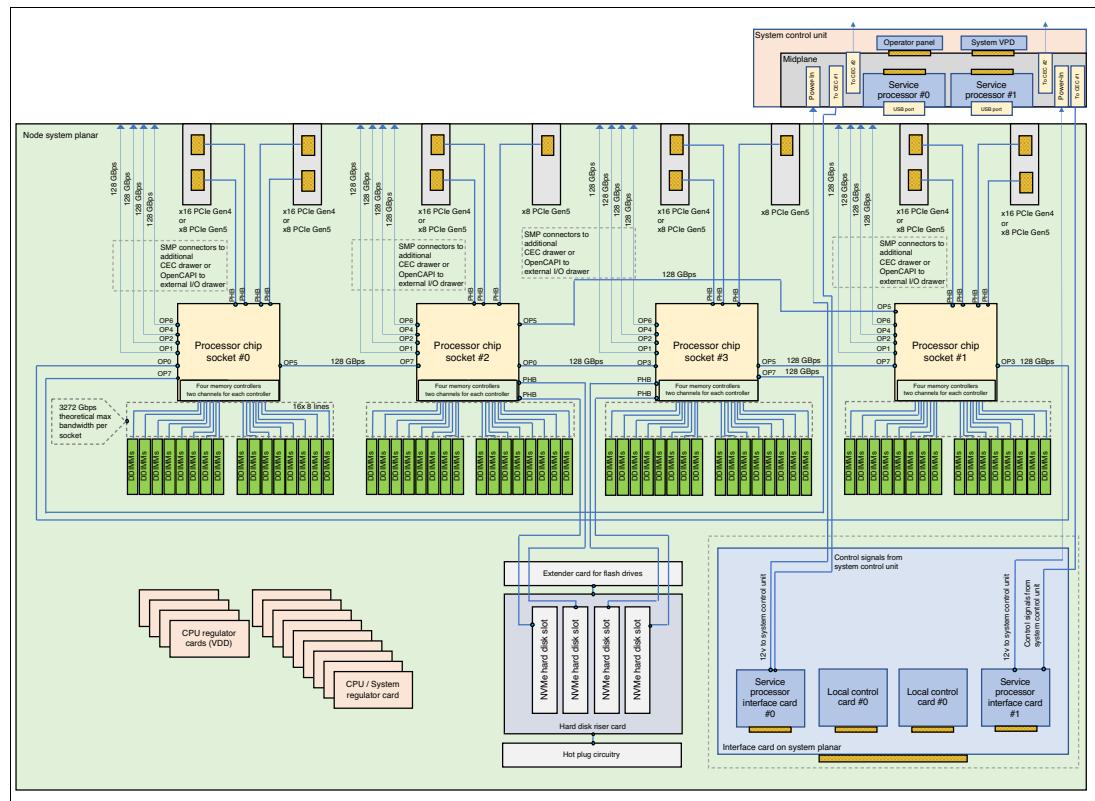


Figure 2-1 Power E1080 logical system

The IBM Power10 processor was introduced to the public on August 17, 2020 at the 32nd HOT CHIPS<sup>1</sup> semiconductor conference. At that meeting, the new capabilities and features of the latest POWER processor microarchitecture and the Power Instruction Set Architecture (ISA) v3.1B were revealed and categorized according to the following Power10 processor design priority focus areas:

- ▶ Data plane bandwidth focus area
  - Terabyte per-second signaling bandwidth on processor functional interfaces, petabyte system memory capacities, 16-socket symmetric multiprocessing (SMP) scalability, and memory clustering and memory inception capability.
- ▶ Powerful enterprise core focus area
  - New core micro-architecture, flexibility, larger caches, and reduced latencies.
- ▶ End-to-end security focus area
  - Hardware enabled security features that are co-optimized with PowerVM hypervisor support.

<sup>1</sup> Source: <https://hotchips.org/>

- ▶ Energy-efficiency focus area  
Up to threefold energy-efficiency improvement in comparison to Power9 processor technology.
- ▶ Artificial intelligence (AI)-infused core focus area  
A 10-20x matrix-math performance improvement per socket compared to the Power9 processor technology capability.

The remainder of this section provides more specific information about the Power10 processor technology as it is used in the Power E1080 scale-up enterprise class server.

The *IBM's Power10 Processor* session material as presented at the 32nd HOT CHIPS conference is available through the HC32 conference proceedings archive at [this web page](#).

### 2.1.1 Power10 processor overview

The Power10 processor is a superscalar symmetric multiprocessor that is manufactured in complimentary metal-oxide-semiconductor (CMOS) 7 nm lithography with 18 layers of metal. The processor contains up to 15 cores that support eight simultaneous multithreading (SMT8) independent execution contexts.

Each core has private access to 2 MB L2 cache and local access to 8 MB of L3 cache capacity. The local L3 cache region of a specific core is also accessible from all other cores on the processor chip. The cores of one Power10 processor share up to 120 MB of latency optimized non-uniform cache access (NUCA) L3 cache.

The processor supports the following three distinct functional interfaces, which all are capable running with a signaling rate of up to 32 giga-transfers per second (GTps):

- ▶ Open memory interface (OMI)

The Power10 processor has eight memory controller unit (MCU) channels that support one OMI port with two OMI links each<sup>2</sup>. One OMI link aggregates 8 lanes running at 32 GTps speed and connects to one memory buffer based differential dual inline memory module (DDIMM) slot to access main memory. Physically, the OMI interface is implemented in two separate die areas of 8 OMI links each. The maximum theoretical full-duplex bandwidth aggregated over all 128 OMI lanes is 1 TBps.

- ▶ SMP fabric interconnect (PowerAXON)

A total of 144 lanes are available in the Power10 processor to facilitate the connectivity to other processors in an SMP architecture configuration. Each SMP connection requires 18 lanes, eight data lanes plus one spare lane per direction (2 x(8+1)). In this way the processor can support a maximum of eight SMP connections with a total of 128 data lanes per processor. This configuration yields a maximum theoretical full-duplex bandwidth aggregated over all SMP connections of 1 TBps.

The generic nature of the interface implementation also allows the use of 128 data lanes to potentially connect accelerator or memory devices through the OpenCAPI protocols. Also, it can support memory cluster and memory interception architectures.

Because of the versatile characteristic of the technology, it is also referred to as *PowerAXON* interface (Power A-bus/X-bus/OpenCAPI/Networking<sup>3</sup>). The OpenCAPI and the memory clustering and memory interception use cases can be pursued in the future and are not used by available technology products at the time of writing.

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<sup>2</sup> The OMI links are also referred to as OMI subchannels.

<sup>3</sup> A-busses and X-busses provide SMP fabric ports that are used between central electronic complex (CEC) drawers or within CEC drawers respectively.

- ▶ Peripheral Component Interconnect Express (PCIe) Version 5.0 interface

To support external I/O connectivity and access to internal storage devices, the Power10 processor provides differential PCIe version 5.0 interface busses (PCIe Gen 5) with a total of 32 lanes. The lanes are grouped in two sets of 16 lanes that can be used in one of the following configurations:

- 1 x16 PCIe Gen 4
- 2 x8 PCIe Gen 4
- 1 x8, 2 x4 PCIe Gen 4
- 1 x8 PCIe Gen 5, 1 x8 PCIe Gen 4
- 1 x8 PCIe Gen 5, 2 x4 PCIe Gen 4

Figure 2-2 shows the Power10 processor die with several functional units labeled. Note, 16 SMT8 processor cores are shown, but only 10-, 12-, or 15-core processor options are available for Power E1080 server configurations.

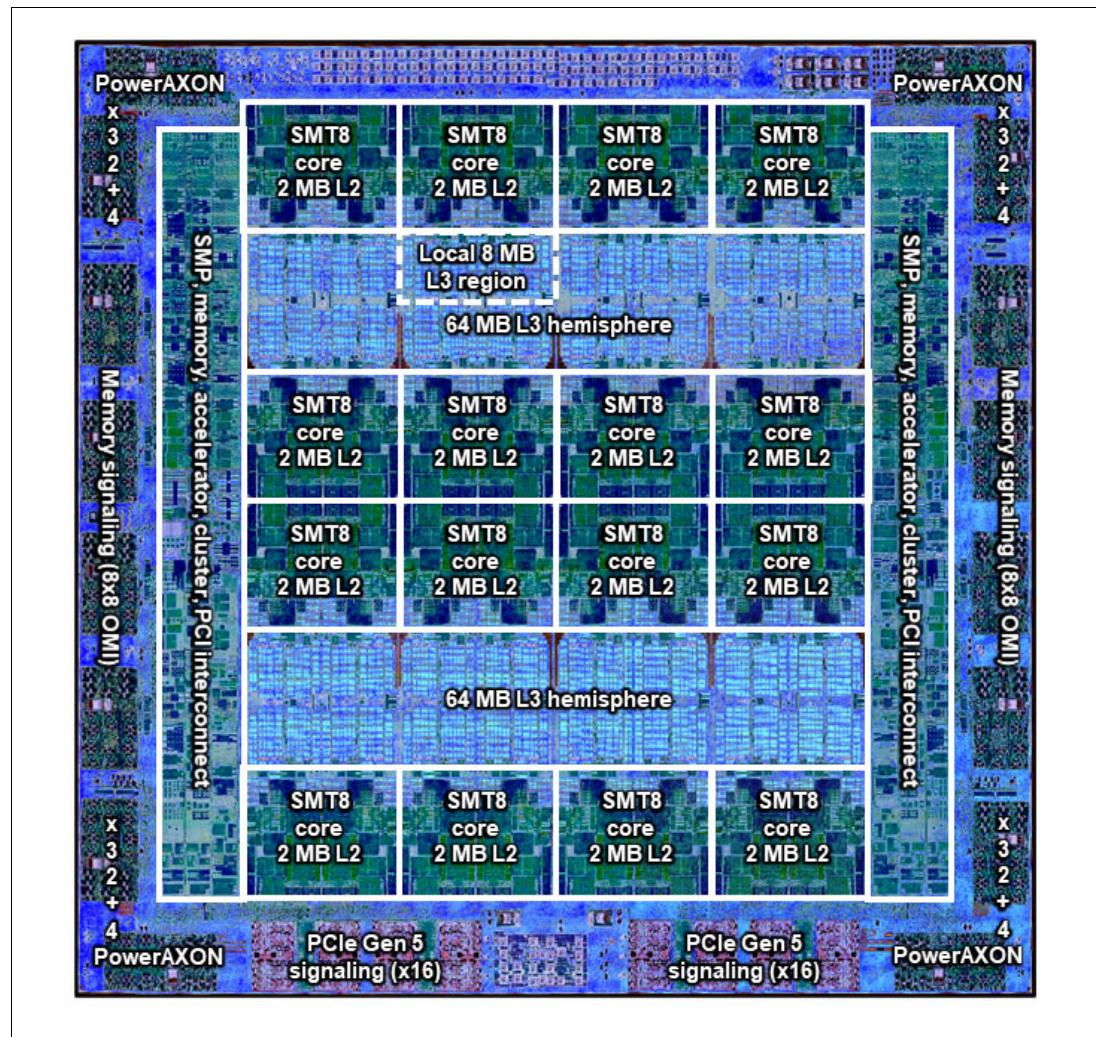


Figure 2-2 The Power10 processor chip (Die photo courtesy of Samsung Foundry)

Important Power10 processor characteristics are listed in Table 2-1.

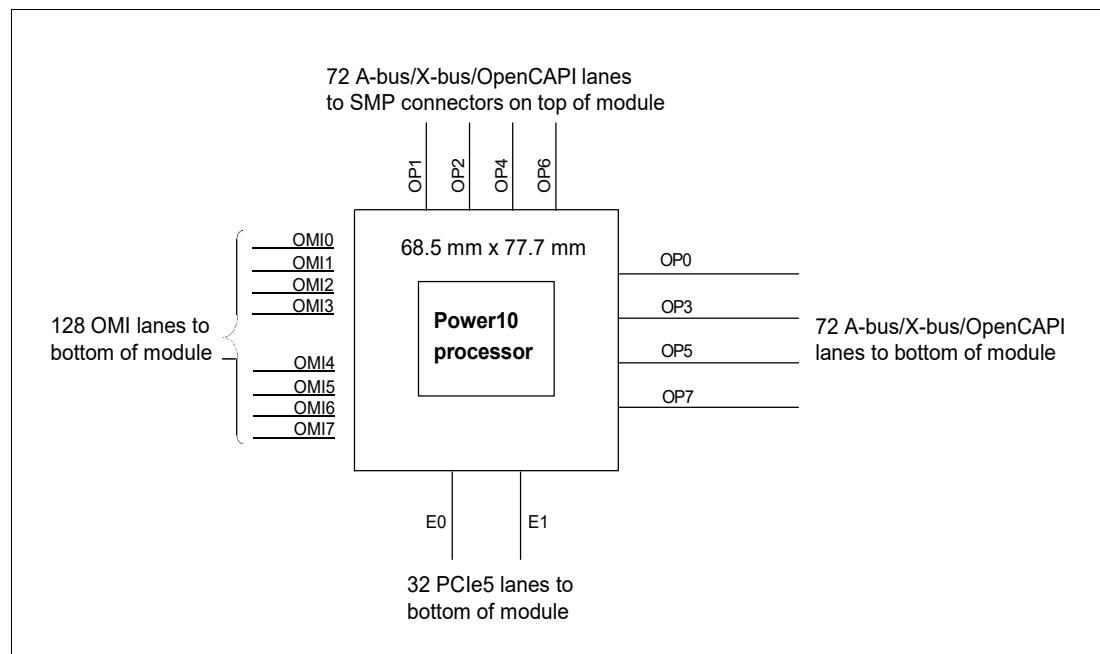
*Table 2-1 Summary of the Power10 processor chip and processor core technology*

Technology	Power10 processor
Processor die size	602 mm <sup>2</sup>
Fabrication technology	<ul style="list-style-type: none"> <li>▶ CMOS 7-nm lithography</li> <li>▶ 18 layers of metal</li> </ul>
Maximum processor cores per chip	15
Maximum execution threads per core / chip	8 / 120
Maximum L2 cache core	2 MB
Maximum On-chip L3 cache per core / chip	8 MB / 120 MB
Number of transistors	18 billion
Processor compatibility modes	Support for Power ISA <sup>a</sup> of Power8 and Power9

a. Power ISA

The Power10 processor is packaged as a single-chip module (SCM) for exclusive use in the Power E1080 servers. The SCM contains the Power10 processor plus more logic that is needed to facilitate power supply and external connectivity to the chip. It also holds the connectors to plug SMP cables directly onto the socket to build 2-, 3-, and 4-node Power E1080 servers.

Figure 2-3 shows the logical diagram of the Power10 SCM.



*Figure 2-3 Power10 single-chip module*

As indicated in Figure 2-3 on page 49, the PowerAXON interface lanes are grouped in two sets of 72 lanes each. One set provides four interface ports (OP1, OP2, OP4, and OP6), which are accessible to SMP connectors that are physically placed on the top of the SCM module.

The second set of ports (OP0, OP3, OP5, and OP7) are used to implement the fully connected SMP fabric between the four sockets within a system node. Eight OMI ports (OMI0 to OMI7) with two OMI links each provide access to the buffered main memory DDIMMs. The 32 PCIe Gen 5 lanes are grouped in two PCIe host bridges (PHBs) (E0, E1).

Figure 2-4 shows a physical diagram of the Power10 SCM. The eight SMP connectors (OP1A, OP1B, OP2A, OP2B, OP4A, OP4B, OP6A, and OP6B) externalize 4 SMP busses, which are used to connect system node drawers in 2-, 3-, and 4-node Power E1080 configurations. The OpenCAPI connectivity options are also indicated, although they are not used by any commercially available product.

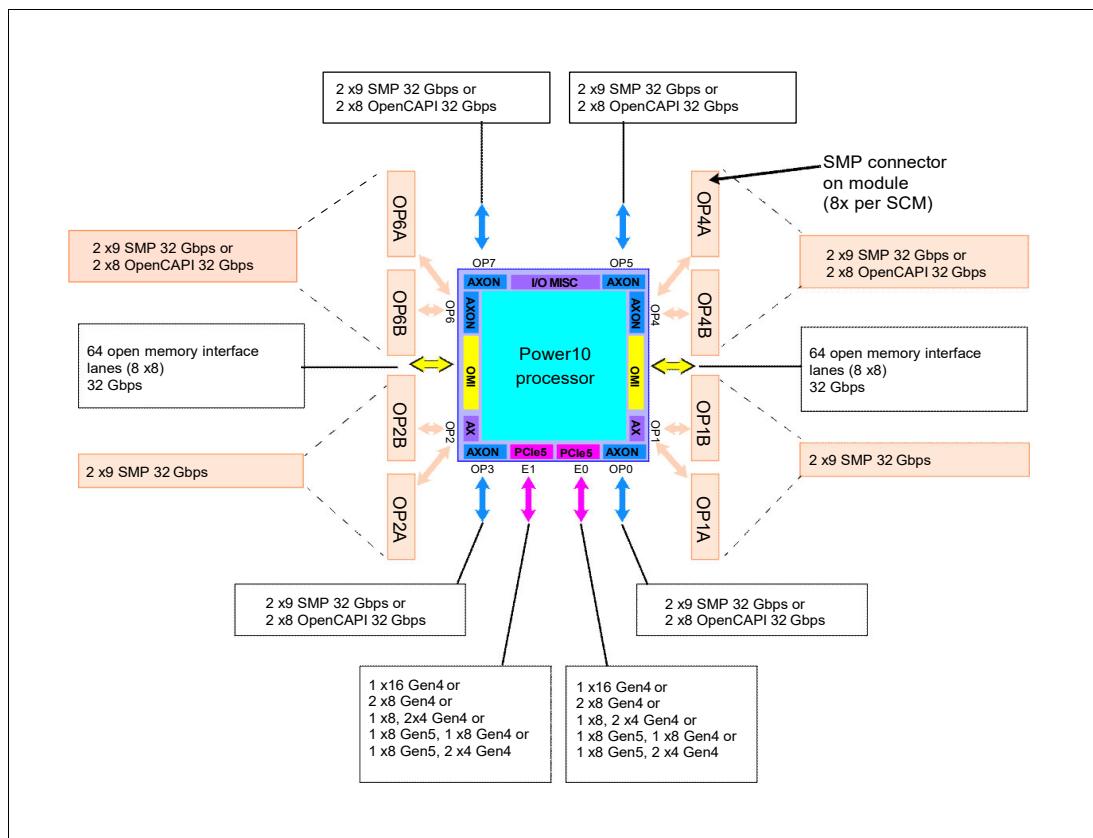


Figure 2-4 Power10 single-chip module physical diagram

## 2.1.2 Power10 processor core

The Power10 processor core inherits the modular architecture of the Power9 processor core, but the redesigned and enhanced micro-architecture significantly increases the processor core performance and processing efficiency. The peak computational throughput is markedly improved by new execution capabilities and optimized cache bandwidth characteristics. Extra matrix math acceleration engines can deliver significant performance gains for machine learning, particularly for AI inferencing workloads.

The Power E1080 server uses the Power10 enterprise-class processor variant in which each core can run with up to eight independent hardware threads. If all threads are active, the mode of operation is referred to as 8-way simultaneous multithreading (SMT8) mode. A Power10 core with SMT8 capability is named Power10 SMT8 core or SMT8 core for short. The Power10 core also supports modes with four active threads (SMT4); that is, two active threads (SMT2) and one single active thread (ST).

The SMT8 core includes two execution resource domains. Each domain provides the functional units to service up to four hardware threads.

Figure 2-5 shows the functional units of an SMT8 core where all 8 threads are active. The two execution resource domains are highlighted with colored backgrounds in two different shades of blue.

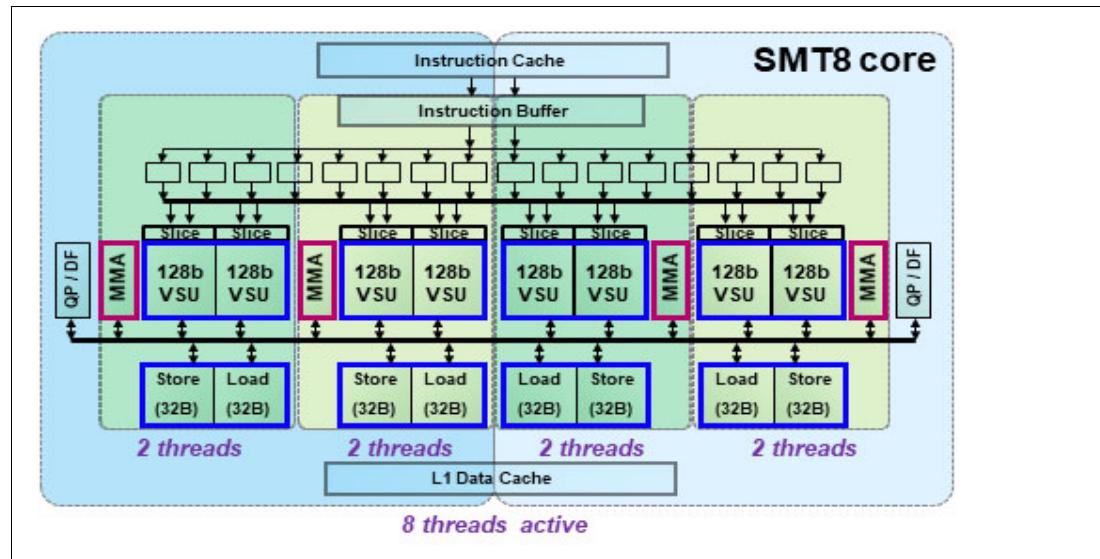


Figure 2-5 Power10 SMT8 core

Each of the two execution resource domains supports between one and four threads and includes 4 vector scalar units (VSUs) of 128-bit width, two Matrix Math Accelerator (MMA) accelerators, and one quad-precision floating-point (QPFP) and decimal floating-point (DFP) unit.

One VSU and the directly associated logic are called an execution *slice*. Two neighboring slices can also be used as a combined execution resource which is then named *super-slice*. When operating in SMT8 mode, eight simultaneous multithreading (SMT) threads are subdivided in pairs that collectively run on two adjacent slices as indicated through colored backgrounds in different shades of green.

In SMT4 or lower thread modes, one to two threads each share a 4-slice resource domain. Figure 2-5 also indicates other essential resources that are shared among the SMT threads, such as instruction cache, instruction buffer and L1 data cache.

The SMT8 core supports automatic workload balancing to change the operational SMT thread level. Depending on the workload characteristics, the number of threads that are running on one chiplet can be reduced from four to two and even further to only one active thread. An individual thread can benefit in terms of performance if fewer threads run against the core's executions resources.

Micro-architecture performance and efficiency optimization lead to a significant improvement of the performance per watt signature compared with the previous Power9 core implementation. The overall energy efficiency is better by a factor of approximately 2.6, which demonstrates the advancement in processor design that is manifested by Power10.

The Power10 processor core includes the following key features and improvements that affect performance:

- ▶ Enhanced load and store bandwidth
- ▶ Deeper and wider instruction windows
- ▶ Enhanced data prefetch
- ▶ Branch execution and prediction enhancements
- ▶ Instruction fusion

Enhancements in the area of computation resources, working set size, and data access latency are described next. The change in relation to the Power9 processor core implementation is provided in parentheses.

## **Enhanced computation resources**

The following are major computational resource enhancements:

- ▶ Eight VSU execution slices, each supporting 64-bit scalar or 128-bit single instructions multiple data (SIMD) +100% for permute, fixed-point, floating-point, and crypto (Advanced Encryption Standard (AES)/Secure Hash Algorithm (SHA)) +400% operations.
- ▶ Four units for Matrix Math Accelerator (MMA) acceleration each capable of producing a 512-bit result per cycle (new), +400% Single and Double precision FLOPS plus support for reduced precision AI acceleration).
- ▶ Two units for QPFP and DFP operations additional instruction types.

## **Larger working sets**

The following major changes were implemented in working set sizes:

- ▶ L1 instruction cache: 2 x 48 KB 6-way (96 KB total) (+50%)
- ▶ L2 cache: 2 MB 8-way (+400%)
- ▶ L2 translation lookaside buffer (TLB): 2 x 4 K entries (8 K total) (+400%)

## **Data access with reduced latencies**

The following major changes reduce latency for loading data:

- ▶ L1 data cache access at four cycles nominal with zero penalty for store-forwarding (-2 cycles) for store forwarding
- ▶ L2 data access at 13.5 cycles nominal (-2 cycles)
- ▶ L3 data access at 27.5 cycles nominal (-8 cycles)
- ▶ TLB access at 8.5 cycles nominal for effective-to-real address translation (ERAT) miss, including for nested translation (-7 cycles)

Micro-architectural innovations that complement physical and logic design techniques and specifically address energy efficiency include the following examples:

- ▶ Improved clock-gating
- ▶ Reduced flush rates with improved branch prediction accuracy
- ▶ Fusion and gather operating merging
- ▶ Reduced number of ports and reduced access to selected structures
- ▶ Effective address (EA)-tagged L1 data and instruction cache yield ERAT access only on a cache miss

In addition to significant improvements in performance and energy efficiency, security represents a major architectural focus area. The Power10 processor core supports the following security features:

- ▶ Enhanced hardware support that provides improved performance while mitigating for speculation-based attacks
- ▶ Dynamic Execution Control Register (DEXCR) support
- ▶ Return-oriented programming (ROP) protection

### 2.1.3 Simultaneous multithreading

Each core of the Power10 processor supports multiple hardware threads that represent independent execution contexts. If only one hardware thread is used, the processor core runs in single-threaded (ST) mode.

If more than one hardware thread is active, the processor runs in SMT mode. In addition to the ST mode, the Power10 processor supports the following different SMT modes:

- ▶ SMT2: Two hardware threads are active.
- ▶ SMT4: Four hardware threads are active.
- ▶ SMT8: Eight hardware threads are active.

SMT enables a single physical processor core to simultaneously dispatch instructions from more than one hardware thread context. Computational workloads can use the processor core's execution units with a higher degree of parallelism. This ability significantly enhances the throughput and scalability of multi-threaded applications and optimizes the compute density for ST workloads.

SMT is primarily beneficial in commercial environments where the speed of an individual transaction is not as critical as the total number of transactions that are performed. SMT typically increases the throughput of most workloads, especially those workloads with large or frequently changing working sets, such as database servers and web servers.

Table 2-2 lists a historic account of the SMT capabilities that are supported by each implementation of the IBM Power Architecture® since POWER4.

*Table 2-2 SMT levels that are supported by POWER processors*

Technology	Cores/system	Supported hardware threading modes	Maximum hardware threads per partition
IBM POWER4	32	ST	32
IBM POWER5	64	ST and SMT2	128
IBM POWER6	64	ST and SMT2	128
IBM POWER7	256	ST, SMT2, and SMT4	1024
IBM Power8	192	ST, SMT2, SMT4, and SMT8	1536
IBM Power9	192	ST, SMT2, SMT4, and SMT8	1536
IBM Power10	240	ST, SMT2, SMT4, and SMT8	1920 <sup>a</sup>

a. PHYP supports a maximum  $240 \times \text{SMT8} = 1920$ . AIX support up to 1920 (240xSMT8) total threads in a single partition, starting with AIX v7.3 + Power10.

## 2.1.4 Matrix Math Accelerator AI workload acceleration

The Matrix Math Accelerator (MMA) facility was introduced by the Power ISA v3.1. The related instructions implement numerical linear algebra operations on small matrices and are meant to accelerate computation-intensive kernels, such as matrix multiplication, convolution, and discrete Fourier transform.

To efficiently accelerate MMA operations, the Power10 processor core implements a *dense math engine* (DME) microarchitecture that effectively provides an accelerator for cognitive computing, machine learning, and AI inferencing workloads.

The DME encapsulates compute efficient pipelines, a physical register file, and associated data-flow that keeps resulting accumulator data local to the compute units. Each MMA pipeline performs outer-product matrix operations, reading from and writing back a 512-bit accumulator register.

Power10 implements the MMA accumulator architecture without adding an architected state. Each architected 512-bit accumulator register is backed by four 128-bit Vector Scalar eXtension (VSX) registers.

Code that uses the MMA instructions is included in OpenBLAS and Eigen libraries. This library can be built by using the most recent versions of the GNU Compiler Collection (GCC) compiler. The latest version of OpenBLAS is available at [this web page](#).

OpenBLAS is used by Python-NumPy library, PyTorch, and other frameworks, which make it simple to use the performance benefit of the Power10 MMA accelerator for AI workloads.

For more information about the implementation of the Power10 processor's high throughput math engine, see the white paper [A matrix math facility for Power ISA processors](#).

For more information about fundamental MMA architecture principles with detailed instruction set usage, register file management concepts, and various supporting facilities, see *Matrix-Multiply Assist Best Practices Guide*, REDP-5612.

## 2.1.5 Power10 compatibility modes

The Power10 core implements the Processor Compatibility Register (PCR) as described in the Power ISA version 3.1, primarily to facilitate Live Partition Mobility (LPM) to and from previous generations of IBM Power hardware.

Depending on the specific settings of the PCR, the Power10 core runs in a compatibility mode that pertains to Power9 (Power ISA version 3.0) or Power8 (Power ISA version 2.07) processors. The support for processor compatibility modes also enables older operating systems versions of AIX, IBM i, Linux, or Virtual I/O Server (VIOS) environments to run on Power10 processor-based systems.

The Power10 processors of the Power E1080 server support the following compatibility modes:

- ▶ Power8: Enabled by firmware level FW810
- ▶ Power9 Base: Enabled by firmware level FW910
- ▶ Power9: Enabled by firmware level FW940
- ▶ Power10: Enabled by firmware level FW1010

## 2.1.6 Processor Feature Codes

Each system node in a Power E1080 server provides four sockets to accommodate Power10 SCMs. Three different SCM types with core density of 10-, 12-, and 15-cores are offered. The processor configuration of a system node is determined by one of three available processor features. Each feature represents a set of four Power10 SCMs of identical core density. All system nodes in a Power E1080 server must be configured with the same processor feature.

Table 2-3 lists the processor Feature Codes that are available for Power E1080 servers. Power10 processors automatically optimize their core frequencies based on workload requirements, thermal conditions, and power consumption characteristics. Each processor Feature Code that is listed is associated with a processor core frequency range within which the SCM cores typically operate. Also, the maximum frequency that is supported by the relevant SCM type is indicated.

*Table 2-3 Power E1080 processor features*

Feature Code	Description
EDP2	40-core (4x10) Typical 3.65 GHz - 3.90 GHz (max) Power10 Processor with 5U system node drawer
EDP3	48-core (4x12) Typical 3.60 GHz - 4.15 GHz (max) Power10 Processor with 5U system node drawer
EDP4	60-core (4x15) Typical 3.55 GHz - 4.00 GHz (max) Power10 Processor with 5U system node drawer

## 2.1.7 On-chip L3 cache and intelligent caching

The Power10 processor includes a large on-chip L3 cache of up to 120 MB with a NUCA architecture that provides mechanisms to distribute and share cache footprints across a set of L3 cache regions. Each processor core can access an associated local 8 MB of L3 cache. It can also access the data in the other L3 cache regions on the chip and throughout the system. Each L3 region serves as a victim cache for its associated L2 cache and also can provide aggregate storage for the on-chip cache footprint.

Intelligent L3 cache management enables the Power10 processor to optimize the access to L3 cache lines and minimize cache latencies. The L3 includes a replacement algorithm with data type and reuse awareness. It also supports an array of prefetch requests from the core, including instruction and data, and works cooperatively with the core, memory controller, and SMP interconnection fabric to manage prefetch traffic, which optimizes system throughput and data latency.

The L3 cache supports the following key features:

- ▶ Enhanced bandwidth that supports up to 64 bytes per core processor cycle to each SMT8 core.
- ▶ Enhanced data prefetch that is enabled by 96 L3 prefetch request machines that service prefetch requests to memory for each SMT8 core.
- ▶ Plus-one prefetching at the memory controller for enhanced effective prefetch depth and rate.

- ▶ Power10 software prefetch modes that support fetching blocks of data into the L3 cache.
- ▶ Data access with reduced latencies.

## 2.1.8 Open memory interface

The Power10 processor introduces a new and innovative OMI. The OMI is driven by 8 on-chip MCUs and is implemented in two separate physical building blocks that lie in opposite areas at the outer edge of the Power10 die. Each area supports 64 OMI lanes that are grouped in four ports. One port in turn consists of two links with 8 lanes each, which operate in a latency-optimized manner with unprecedented bandwidth and scale at 32 Gbps speed.

The aggregated maximum theoretical full-duplex bandwidth of the OMI interface culminates at  $2 \times 512 \text{ GBps} = 1 \text{ TBps}$  per Power10 SCM.

The OMI physical interface enables low-latency, high-bandwidth, and technology-neutral host memory semantics to the processor. It enables attaching established and emerging memory elements. With the Power E1080 server, OMI initially supported one main tier, low-latency, and enterprise-grade Double Data Rate 4 (DDR4) DDIMM per OMI link. In August 2024, IBM announced support for a new DDIMM that uses Double Data Rate 5 memory. The DDR5 technology DDIMMs are available in the same capacities as the DDR4 features, but have a higher memory throughput. The higher memory throughput is due to two enhancements in the new DDR5-based DDIMM:

- ▶ The DDR5 memory runs at 4000 MHz versus a maximum of 3200 MHz for some of the DDR4-based DDIMMs (the larger DDIMMs ran at 2933 MHz). This new memory provides 25% - 36% bandwidth improvement.
- ▶ The DDR5 DDIMM includes a second DRAM port from the OMI buffer in the DDIMM to the DRAM. It provides up to 50% more sustained total bandwidth with mixed read/write traffic. This DDIMM also reduces the latency when memory is loaded by up to 15%.

This configuration yields a total memory capacity of 16 DDIMMs per SCM and 64 DDIMMs per Power E1080 system node. The memory bandwidth depends on the DDIMM density that is configured for a specific Power E1080 server.

The maximum theoretical duplex memory bandwidth when using DDR4-based DDIMMs is 409 GBps per SCM if 32 GB or 64 GB DDIMMs that are running at 3200 MHz are used. The maximum memory bandwidth is reduced to 375 GBps per SCM if 128 GB or 256 GB DDIMMs that are running at 2933 MHz are used. When using the DDR5-based memory, the maximum theoretical duplex memory bandwidth is 1024 GBps regardless of the DDIMM capacity because all DDR5 DDIMMs run at 4000 MHz.

In summary, the Power10 SCM supports 128 OMI lanes with the following characteristics:

- ▶ 32 Gbps signaling rate
- ▶ Eight lanes per OMI link
- ▶ Two OMI links per OMI port (2 x 8 lanes)
- ▶ Eight OMI ports per SCM (16 x 8 lanes)

## 2.1.9 Pervasive memory encryption

The Power10 MCU provides the system memory interface between the on-chip SMP interconnect fabric and the OMI links. This design qualifies the MCU as an ideal functional unit to implement memory encryption logic. The Power10 on-chip MCU encrypts and decrypts all traffic to and from system memory that is based on the AES technology.

The Power10 processor supports the following modes of operation:

- ▶ AES XTS mode

XTS is an abbreviation for the xor–encrypt–xor based tweaked-codebook mode with ciphertext stealing. AES XTS provides a block cipher with strong encryption, which is useful to encrypt persistent memory.

Persistent DIMM technology retains the data that is stored inside the memory DIMMs, even if the power is turned off. A malicious attacker who gains physical access to the DIMMs can steal memory cards. The data that is stored in the DIMMs can leave the data center in the clear if not encrypted.

Also, memory cards that leave the data center for repair or replacement can be a potential security breach. Because the attacker might have arbitrary access to the persistent DIMM data, the stronger encryption of the AES XTS mode is required for persistent memory. The AES XTS mode of the Power10 processor is supported for future use if persistent memory solutions become available for IBM Power servers.

- ▶ AES CTR mode

CTR stands for *Counter* mode of operation and designates a low-latency AES block cipher. Although the level of encrypting is not as strong as with the XTS mode, the low-latency characteristics make it the preferred mode for memory encryption of volatile memory. AES CTR makes it more difficult to physically gain access to data through the memory card interfaces. The goal is to protect against physical attacks, which becomes increasingly important in the context of cloud deployments.

The Power E1080 servers support the AES CTR mode for pervasive memory encryption. Each Power10 processor holds a 128-bit encryption key that is used by the processor's MCU to encrypt the data of the DDIMMs that are attached to the OMI links.

The MCU crypto engine is transparently integrated into the data path, which helps ensure that the data fetch and store bandwidth are not compromised by the AES CTR encryption mode. Because the encryption has no noticeable performance effect and because of the obvious security benefit, the pervasive memory encryption is enabled by default and cannot be turned off through any administrative interface.

**Note:** The PowerVM LPM data encryption does not interfere with the pervasive memory encryption. Data transfer during an LPM operation uses the following general flow:

1. On the source server, the Mover Server Partition (MSP) provides the hypervisor with a buffer.
2. The hypervisor of the source system copies the partition memory into the buffer.
3. The MSP transmits the data over the network.
4. The data is received by the MSP on the target server and copied in to the related buffer.
5. The hypervisor of the target system copies the data from the buffer into the memory space of the target partition.

To facilitate LPM data compression and encryption, the hypervisor on the source system presents the LPM buffer to the on-chip nest accelerator (NX) unit as part of the process in Step 2. The reverse decryption and decompress operation is applied on the target server as part of the process in Step 4.

The pervasive memory encryption logic of the MCU decrypts the memory data before it is compressed and encrypted by the NX unit on the source server. It also encrypts the data before it is written to memory but after it is decrypted and decompressed by the NX unit of the target server.

**Note:** The pervasive memory encryption of the Power10 processor does not affect the encryption status of a system dump content. All data that is coming from the DDIMMs is decrypted by the MCU before it is passed onto the dump devices under the control of the dump program code. This statement applies to the traditional system dump under the operating system control and the firmware assist dump utility.

## 2.1.10 Nest accelerator

The Power10 processor has an on-chip accelerator that is called an NX unit. The coprocessor features that are available on the Power10 processor are similar to the features on the Power9 processor. These coprocessors provide specialized functions, such as the following examples:

- ▶ IBM proprietary data compression and decompression
- ▶ Industry standard gzip compression and decompression
- ▶ AES and SHA cryptography
- ▶ Random number generation

Figure 2-6 on page 59 shows a block diagram of the NX unit.

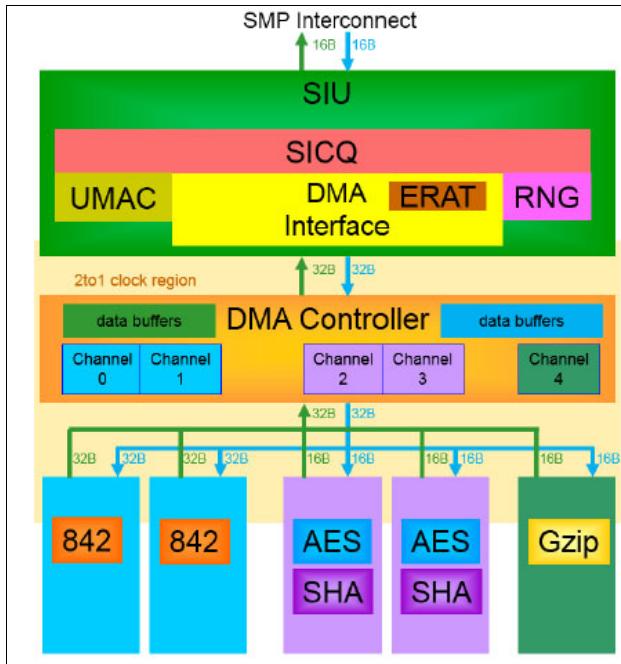


Figure 2-6 Block diagram of the NX unit

Each one of the AES/SHA engines, data compression, and Gzip units consist of a coprocessor type and the NX unit features three coprocessor types. The NX unit also includes more support hardware to support coprocessor invocation by user code, use of EAs, high-bandwidth storage accesses, and interrupt notification of job completion.

The direct memory access (DMA) controller of the NX unit helps to start the coprocessors and move data on behalf of coprocessors. SMP interconnect unit (SIU) provides the interface between the Power10 SMP interconnect and the DMA controller.

The NX coprocessors can be started transparently through library or operating system kernel calls to speed up operations that are related to data compression, LPM migration, IPsec, JFS2 encrypted file systems, PKCS11 encryption, random number generation, and the most recently announced logical volume encryption.

In effect, this on-chip NX unit on Power10 systems implements a high throughput engine that can perform the equivalent work of multiple cores. The system performance can benefit by offloading these expensive operations to on-chip accelerators, which in turn can greatly reduce the CPU usage and improve the performance of applications.

The accelerators are shared among the logical partitions (LPARs) under the control of the PowerVM hypervisor and accessed by way of hypervisor call. The operating system, along with the PowerVM hypervisor, provides a send address space that is unique per process requesting the coprocessor access. This configuration allows the user process to directly post entries to the first in - first out (FIFO) queues that are associated with the NX accelerators. Each NX coprocessor type has a unique receive address space corresponding to a unique FIFO for each of the accelerators.

For more information about the use of the xgzip tool that uses the gzip accelerator engine, see the following resources:

- ▶ [Using the Power9 NX \(gzip\) accelerator in AIX](#)
- ▶ [Power9 GZIP Data Acceleration with IBM AIX](#)

- ▶ [Performance improvement in OpenSSH with on-chip data compression accelerator in Power9](#)
- ▶ [The nxstat Command](#)

### 2.1.11 SMP interconnect and accelerator interface

The Power10 processor provides a highly optimized, 32 Gbps differential signaling technology interface that is structured in 16 entities. Each entity consists of eight data lanes and one spare lane. This interface can facilitate the following functional purposes:

- ▶ First- or second-tier, SMP link interface, enabling up to 16 Power10 processors to be combined into a large, robustly scalable, single-system image.
- ▶ Open Coherent Accelerator Processor Interface (OpenCAPI) to attach cache coherent and I/O-coherent computational accelerators, load/store addressable host memory devices, low latency network controllers, and intelligent storage controllers.
- ▶ Host-to-host integrated memory clustering interconnect, enabling multiple Power10 systems to directly use memory throughout the cluster.

**Note:** The OpenCAPI interface and the memory clustering interconnect are Power10 technology options for future use.

Because of the versatile nature of signaling technology, the 32 Gbps interface is also referred to as Power/A-bus/X-bus/OpenCAPI/Networking (*PowerAXON*) interface. The IBM proprietary X-bus links connect two processors on a system board with a common reference clock. The IBM proprietary A-bus links connect two processors in different drawers on different reference clocks by using a cable.

OpenCAPI is an open interface architecture that allows any microprocessor to attach to the following items:

- ▶ Coherent user-level accelerators and I/O devices
- ▶ Advanced memories are accessible through read/write or user-level DMA semantics

The OpenCAPI technology is developed, enabled, and standardized by the OpenCAPI Consortium. For more information about the consortium's mission and the OpenCAPI protocol specification, see [OpenCAPI Consortium](#).

The PowerAXON interface is implemented on dedicated areas that are at each corner of the Power10 processor die. The Power E1080 server uses this interface to implement single-drawer chip-to-chip and drawer-to-drawer chip interconnects.

The Power E1080 single-drawer chip-to-chip SMP interconnect features the following properties:

- ▶ Three (2 x 9)-bit on system board buses per Power10 SCM
- ▶ Eight data lanes, plus one spare lane in each direction per chip-to-chip connection
- ▶ 32 Gbps signaling rate providing 128 GBps per chip-to-chip SMP connection bandwidth, an increase of 33% compared to the Power E980 single-drawer implementation
- ▶ 4-way SMP architecture implementations build out of four Power10 SCMs per drawer in a 1-hop topology

The Power E1080 drawer-to-drawer SMP interconnect features the following properties:

- ▶ Three (2 x 9)-bit buses per Power10 SCM
- ▶ Eight data lanes plus one spare lane in each direction per chip-to-chip connection
- ▶ Each of the four SCMs in a drawer is connected directly to an SCM at the same position in every other drawer in a multi-node system
- ▶ 32 Gbps signaling rate, which provides 128 GBps per chip-to-chip inter-node SMP connection bandwidth
- ▶ 8-socket, 12-socket, and 16-socket SMP configuration options in 2-hop topology

Figure 2-7 shows the SMP connections for a fully configured 4-node 16-socket Power E1080 system. The blue lines represent the chip-to-chip connections within one system node. The green lines represent the drawer-to-drawer SMP connections.

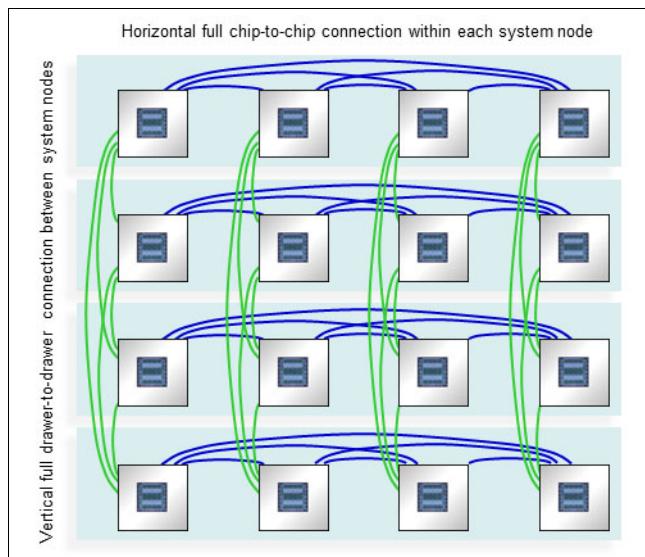


Figure 2-7 SMP interconnect in a 4-node 16-socket Power E1080 server

From the drawing that is shown in Figure 2-7, you can deduce that each socket is directly connected to any other socket within one system node and only one intermediary socket is required to get from a chip to any other chip in another CEC drawer.

## 2.1.12 Power and performance management

Power10 processor-based servers implement an enhanced version of the power management EnergyScale technology. As in the previous Power9 EngeryScale implementation, the Power10 EnergyScale technology supports dynamic processor frequency changes that depend on several factors, such as workload characteristics, the number of active cores, and environmental conditions.

Based on the extensive experience that was gained over the past few years, the Power10 EnergyScale technology evolved to use the following effective and simplified set of operational modes:

- ▶ Power-saving mode
- ▶ Static mode (nominal frequency)
- ▶ Maximum performance mode (MPM)

The Power9 dynamic performance mode (DPM) has many features in common with the Power9 MPM. Because of this redundant nature of characteristics, the DPM for Power10 processor-based systems was removed in favor of an enhanced MPM. For example, the maximum frequency is now achievable in the Power10 enhanced MPM (regardless of the number of active cores), which was not always the case with Power9 processor-based servers.

The Power10 processor-based Power E1080 system features MPM enabled by default. This mode dynamically adjusts processor frequency to maximize performance and enable a higher processor frequency range. Each of the power saver modes delivers consistent system performance without any variation if the nominal operating environment limits are met.

For Power10 processor-based systems that are under control of the PowerVM hypervisor, the MPM is a system-wide configuration setting, but each processor module frequency is optimized separately.

The following factors determine the maximum frequency that a processor module can run at:

- ▶ Processor utilization: Lighter workloads run at higher frequencies.
- ▶ Number of active cores: Fewer active cores run at higher frequencies.
- ▶ Environmental conditions: At lower ambient temperatures, cores are enabled to run at higher frequencies.

The following Power10 EnergyScale modes are available:

- ▶ Power-saving mode

The frequency is set to the minimum frequency to reduce energy consumption. Enabling this feature reduces power consumption by lowering the processor clock frequency and voltage to fixed values. This configuration reduces power consumption of the system while delivering predictable performance.

- ▶ Static mode

The frequency is set to a fixed point that can be maintained with all normal workloads and in all normal environmental conditions. This frequency is also referred to as *nominal frequency*.

- ▶ MPM

Workloads run at the highest frequency possible, depending on workload, active core count, and environmental conditions. The frequency does not go below the static frequency for all normal workloads and in all normal environmental conditions.

In MPM, the workload is run at the highest frequency possible. The higher power draw enables the processor modules to run in an MPM typical frequency range (MTFR), where the lower limit is well above the nominal frequency and the upper limit is given by the system's maximum frequency.

The MTFR is published as part of the system specifications of a specific Power10 system if it is running by default in MPM. The higher power draw potentially increases the fan speed of the respective system node to meet the higher cooling requirements, which in turn causes a higher noise emission level of up to 15 decibels.

The processor frequency typically stays within the limits that are set by the MTFR, but can be lowered to frequencies between the MTFR lower limit and the nominal frequency at high ambient temperatures above 27 °C (80.6 °F). If the data center ambient environment is less than 27 °C, the frequency in MPM consistently is in the upper range of the MTFR (roughly 10% - 20% better than nominal). At lower ambient temperatures (below 27 °C, or 80.6 °F), MPM mode also provides deterministic performance. As the ambient temperature increases above 27 °C, determinism can no longer be ensured. This mode is the default mode in the Power E1080.

- ▶ Idle power saver (IPS) mode

IPS mode lowers the frequency to the minimum if the entire system (all cores of all sockets) is idle. It can be enabled or disabled separately from all other modes. The Power E1080 does not support this mode.

Figure 2-8 shows the comparative frequency ranges for the Power10 power-saving mode, static or nominal mode, and the MPM. The frequency adjustments for different workload characteristics, ambient conditions, and idle states are also indicated.

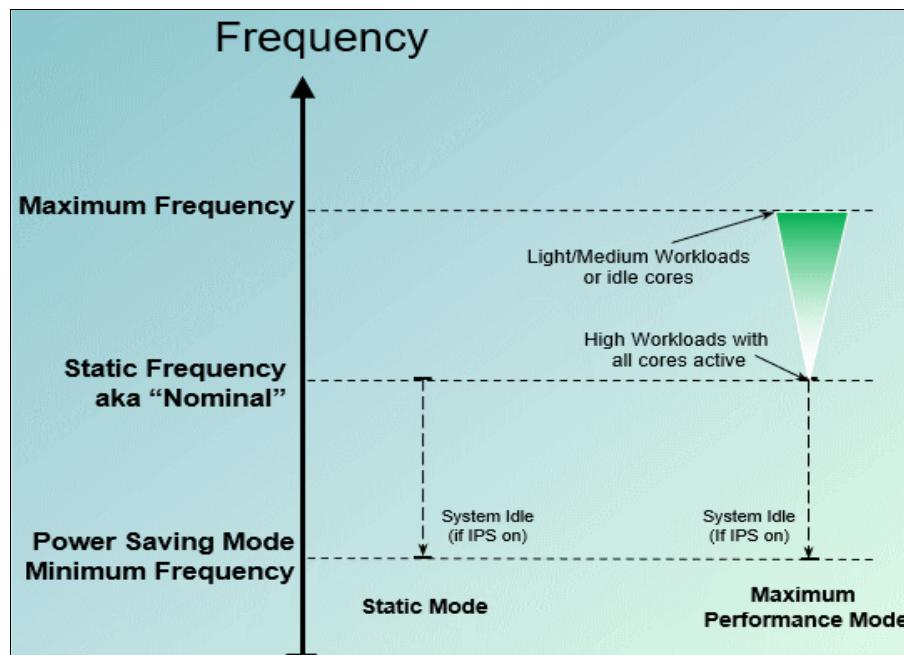


Figure 2-8 Power10 power management modes and related frequency ranges

Table 2-4 shows the power-saving mode and the static mode frequencies, and the frequency ranges of the MPM for all three processor module types that are available for the Power E1080 server.

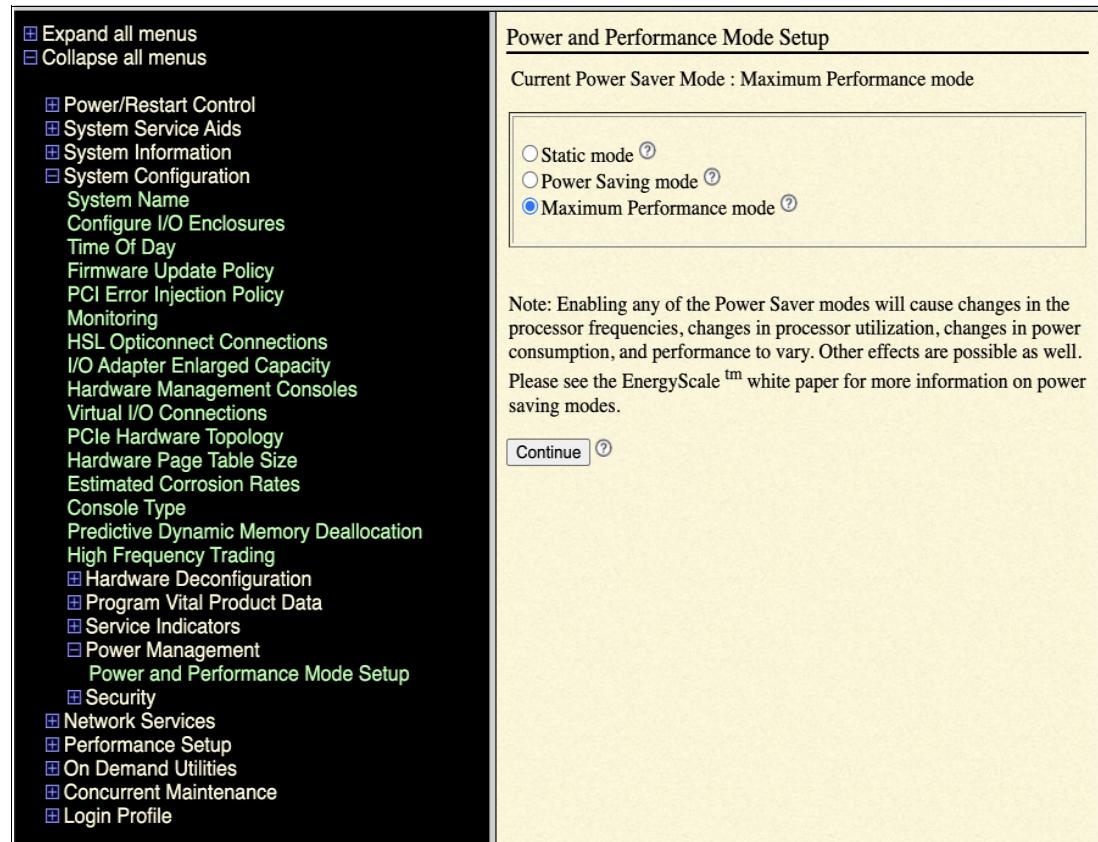
Table 2-4 Characteristic frequencies and frequency ranges for Power E1080 server

Feature code	Cores per SCM	Power-saving mode frequency [GHz]	Static mode frequency [GHz]	MPM frequency range [GHz]
EDP2	10	3.25	3.65	3.65 - 3.90 GHz (max)
EDP3	12	3.40	3.60	3.60 - 4.15 GHz (max)
EDP4	15	3.25	3.55	3.55 - 4.00 GHz (max)

For Power E1080 servers, the MPM is enabled by default.

The controls for all power saver modes are available on the Advanced System Management Interface (ASMI) and can be dynamically modified. A system administrator can also use the Hardware Management Console (HMC) to set power saver mode or to enable static mode or MPM.

Figure 2-9 shows the ASM interface menu for Power and Performance Mode Setup on a Power E1080 server.



### Power and Performance Mode Setup

Current Power Saver Mode : Maximum Performance mode

- Static mode [?](#)
- Power Saving mode [?](#)
- Maximum Performance mode [?](#)

Note: Enabling any of the Power Saver modes will cause changes in the processor frequencies, changes in processor utilization, changes in power consumption, and performance to vary. Other effects are possible as well. Please see the EnergyScale™ white paper for more information on power saving modes.

[Continue](#) [?](#)

Figure 2-9 Power E1080 ASMI menu for Power and Performance Mode setup

Figure 2-10 shows the HMC menu for power and performance mode setup.

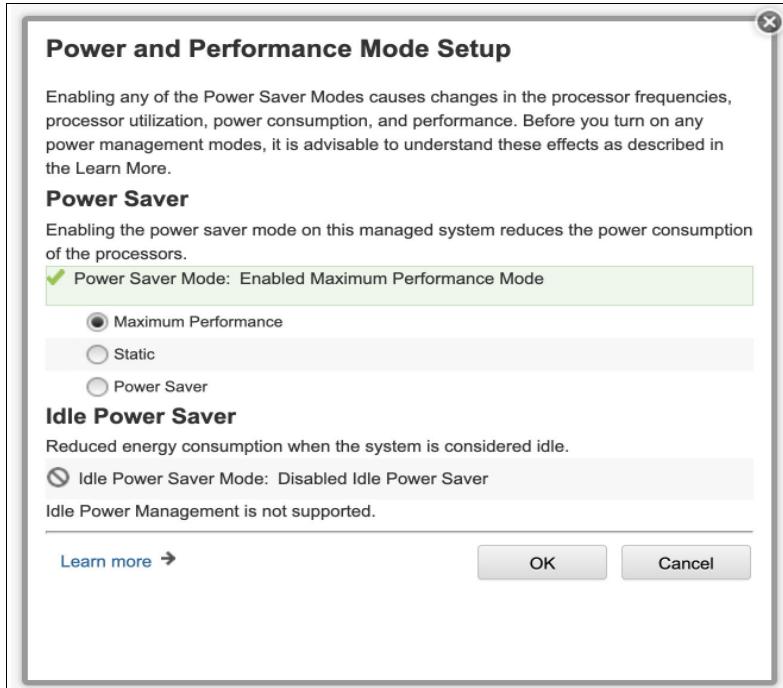


Figure 2-10 Power E1080 HMC menu for Power and Performance Mode setup

### 2.1.13 Comparing Power10, Power9, and Power8 processors

The Power E1080 enterprise class systems use exclusively SCM with up to 15 active SMT8 capable cores. These SCM processor modules are structural and performance optimized for usage in *scale-up multi-socket* systems.

Table 2-5 compares key features and characteristics of the Power10, Power9, and Power8 processor implementations as used in enterprise class scale-up servers.

Table 2-5 Comparing the Power10 processor technology to prior processor generations

Characteristics	Power10	Power9	Power8
Technology	7 nm	14 nm	22 nm
Die size	602 mm <sup>2</sup>	693 mm <sup>2</sup>	649 mm <sup>2</sup>
Processor module size	68.5 mm x 77.5 mm	68.5 mm x 68.5 mm	71.5 mm x 71.5 mm
Number of transistors	18 billion	8 billion	4.2 billion
Maximum cores	15	12	12
Maximum hardware threads per core	8	8	8
Maximum static frequency / high-performance frequency range	3.75 - 4.15 GHZ	3.9 - 4.0 GHz	4.15 GHz
L2 Cache per core	2048 KB	512 KB	512 KB

Characteristics	Power10	Power9	Power8
L3 Cache	8 MB of L3 cache per core with each core having access to the full 120 MB of L3 cache, on-chip high-efficiency SRAM <sup>a</sup>	10 MB of L3 cache per core with each core having access to the full 120 MB of L3 cache, on-chip eDRAM <sup>b</sup>	8 MB of L3 cache per core with each core having access to the full 96 MB of L3 cache, on-chip eDRAM
Support memory technology	DDR4 <sup>c</sup>	DDR4 and DDR3 <sup>d</sup>	DDR3 and DDR4
I/O bus	PCIe Gen 5	PCIe Gen 4	PCIe Gen 3

- a. Static random-access memory.
- b. Embedded dynamic random-access memory.
- c. Power10 processor memory logic and the Power E1080 memory subsystem can use DDR5 technology DIMMs.
- d. Only DDR3 memory CDIMMs, which are transferred in the context of a model upgrade from Power E870, Power E870C, Power E880, or Power E880C systems to a Power E980 server, are supported.

## 2.2 SMP interconnection

Each of the four Power10 processor chips in the system node drawer is connected directly to a Power10 processor chip at the same position in every other system node drawer by using the SMP OP-bus. Each OP-bus connection between any two system node drawers uses a pair of cables for the connection, with each cable carrying one half of the data lanes.

Power System E980 SMP cables cannot be used on Power E1080 because the Power10 processor-based server uses a different set of cables.

Figure 2-11 shows how each Power10 processor socket in a system node drawer has the bus routed to the rear tail stock of the chassis. The Power10 processor chip in the first socket (see processor chip socket #0 in Figure 2-11) uses ports T0 and T1 for the OP6 bus connection (see upper left in Figure 2-11).

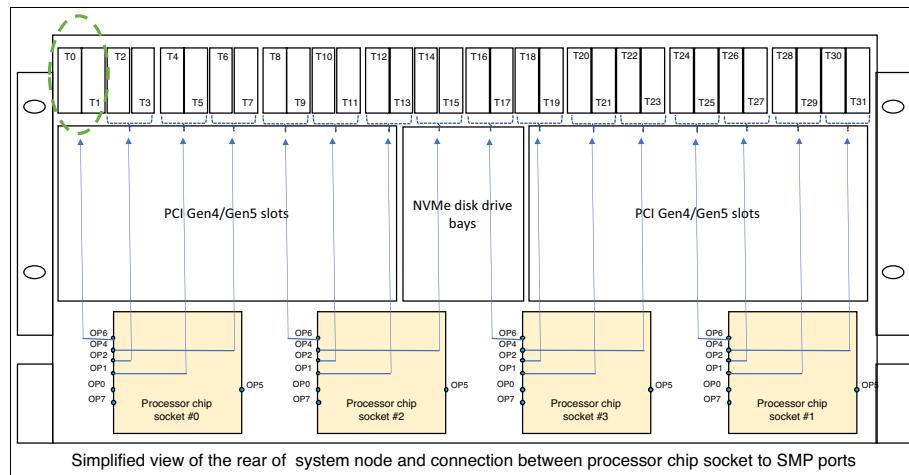


Figure 2-11 Logical connection from processor chip sockets to SMP external ports

Each Power10 processor chip socket externalizes four SMP/OpenCAPI buses:

- ▶ OP6: SMP or OpenCAPI
- ▶ OP2: SMP only
- ▶ OP1: SMP only
- ▶ OP4: SMP or OpenCAPI

The same cables are used for two different modes:

- ▶ SMP for interconnecting the system node drawers
- ▶ OpenCAPI

Each cable contains 9-bit lanes:

- ▶ SMP mode uses nine of the nine lanes that are available.
- ▶ OpenCAPI mode uses eight of the nine lanes that are available.

### 2.2.1 Two-system node drawers OP-bus connection

In the 2-system drawer configuration, two OP-buses interconnect the processors between the two drawers. Figure 2-12 shows all the connections between the SMP ports of the first system node drawer with the SMP ports of the second system node drawer that are accomplished by using the proper set of cables.

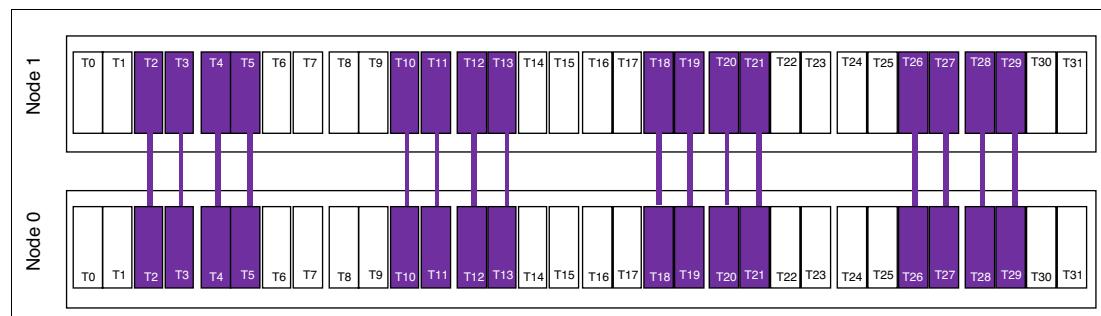


Figure 2-12 Two-system node drawers SMP connection

The length of every cable is 775 mm (2.5 ft.) and its tape color is violet. As Figure 2-12 shows, 16 cables are needed for this configuration.

### 2.2.2 SMP cable reliability, availability, and serviceability attribute

Each SMP bus has 18 lanes and it is split between two separate cables, where each cable has nine lanes. An SMP spare lane is used on each SMP cable (eight lanes for data and one lane as spare). If one of the two SMP cables fail, all the traffic is routed to the one remaining cable, which reduces the bandwidth by half.

The Power E1080 supports concurrent repair of the external SMP cables; therefore, the entire server does not need to be shut down to replace an external SMP cable.

The concurrent repair process enables the system to restore the OP-bus to the full function without a system outage.

## 2.3 Memory subsystem

The Power E1080 server supports two variations of DDIMMs, which are high-performance, high-reliability, high-function memory cards that contain a buffer chip, and intelligence. and either DDR4 DRAM memory running at 2933/3200 MHz or DDR5 DRAM memory running at 4000 MHz. DDIMMs are placed in the DDIMM slots in the system node. Mixing DDR4 and DDR5 DDIMMs in different nodes is supported, but all DDIMMs within a single node must be homogeneous.

Every Power10 chip MCU provides the system memory interface between the on-chip SMP interconnect fabric and the OpenCAPI memory interface (OMI) links. Logically eight, essentially independent MCU channels are on every chip that interface to a total of 16 high-speed OMI links.

Each memory channel supports two OMI links (referred to as subchannels A and B) as shown in Figure 2-13, which also shows the memory slot locations that are associated to the related subchannels, channels, and MCUs.

All 16 of the OMI subchannels come off the Power10 SCM and are wired to 16 memory buffer based DDIMM slots, with one DDIMM connected to each OMI subchannel.

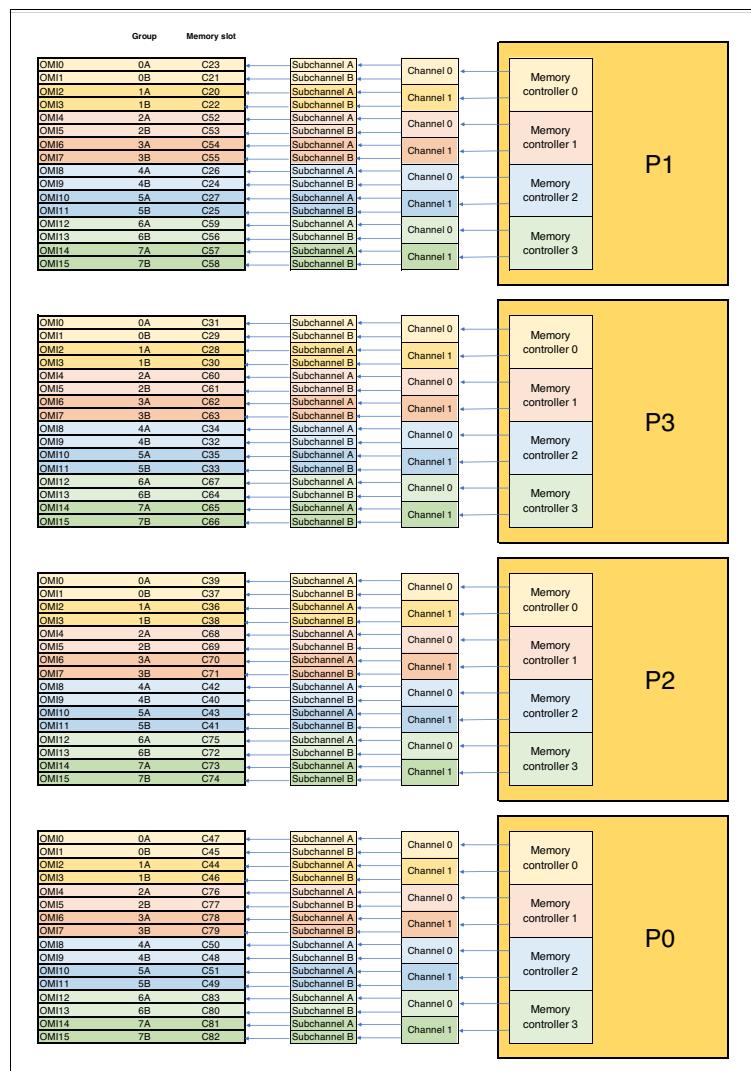


Figure 2-13 Memory subsystem logical diagram

## DDR5 DDIMM enhancements

One of the benefits of using the OMI for connecting memory in Power10 is that it allows memory technology to be swapped out without having to change the system board connections. This flexibility enabled DDR5-based memory technology to be installed in existing Power E1080 servers.

IBM designed a new DDIMM to support DDR5 memory DIMMs. The new DDIMM connects to the same interfaces in the Power E1080 nodes. DDR5 is designed to run at higher speeds, and the new DDIMMs all run at 4000 MHz, regardless of the DIMM capacity. This DDIMM is differentiated from the existing DDR4-based DDIMMs where the larger DDIMMs ran at a slower speed than the smaller capacity DIMMs.

With this new memory speed, IBM added an extra port on the memory buffer to connect to the DIMMs in the DDIMM. This extra port enables the processor to leverage the new memory speed, improves memory throughput, and reduces latency.

Figure 2-14 shows the new DDR5 DDIMM architecture.

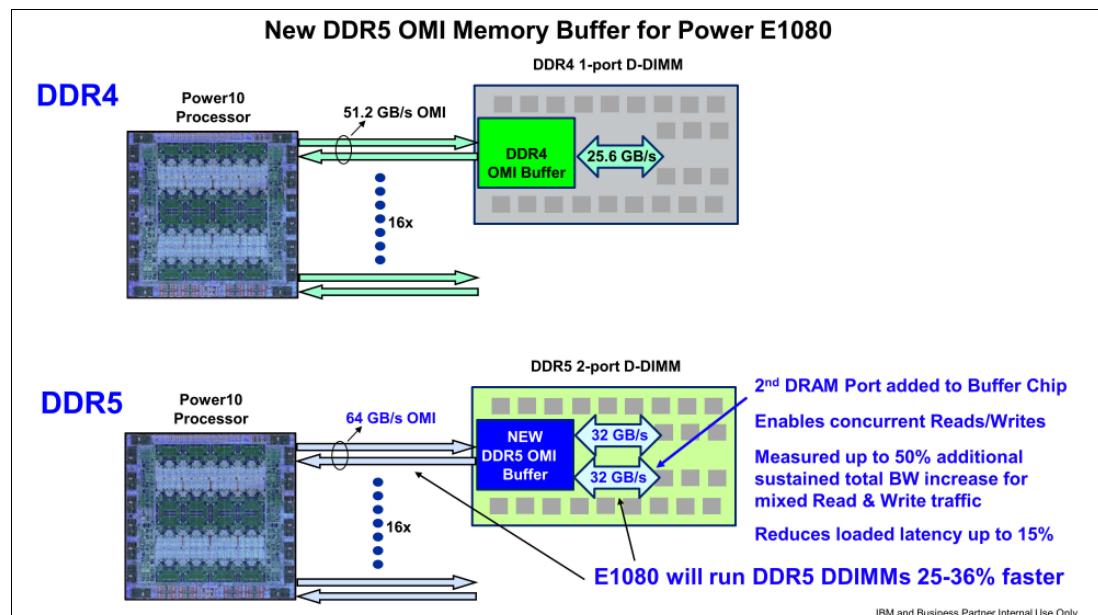


Figure 2-14 DDR5 architecture enhancements

Each Power10 processor chip supports 16 DDIMMs, so a maximum of 64 DDIMMs in each Power E1080 CEC drawer can support up to 16 TB of memory.

The DDIMM densities that are supported in the Power E1080 are 32 GB, 64 GB, 128 GB, and 256 GB, and any memory Feature Code provides four DDIMMs. The DDIMMs have their own voltage regulators and are n+1 redundant. Two Power Management Integrated Circuits (PMICs) plus two spares are used.

It takes two PMICs to supply all the voltage levels that are required by the DDIMM. On the DDIMM, four PMICs are used, which consist of two redundant pairs. If one PMIC in each of the redundant pairs is still functional, the DDIMM is not called for replacement.

As described in 1.5.3, “Memory features” on page 19, the Power E1080 requires the activation of 50% or more of the installed physical memory.

PowerVM hypervisor provides Active Memory Mirroring, which is designed to help ensure that system operation continues (even in the unlikely event of an uncorrectable error occurring in the main memory).

### 2.3.1 Memory bandwidth

The Power10 SCM supports 16 OMI links. One DDIMM is driven by each OMI link. One OMI link represents a bundle of eight lanes that can transfer 8 bytes with one transaction.

The Power E1080 offers four different DDIMM sizes in both DDR4 and DDR5 technologies: 32 GB, 64 GB, 128 GB, and 256 GB. When using DDR4 DDIMMs, the 32 GB and 64 GB DDIMMs run at a data rate of 3200 Mbps and the 128 GB and 256 GB DDIMMs at a data rate of 2933 Mbps. When using DDR5 DDIMMs, all the DDIMMs run at 4000 MHz regardless of the capacity. DDR4 and DDR5 technology DDIMMs can be mixed within a system, but not within a single node.

**Important:** You may not mix DDR4 and DDR5 memory in a node. DDR5 nodes operate at 3200 Mhz if they are in a system with DDR4 nodes.

Table 2-6 lists the available DDIMM capacities and their related maximum theoretical bandwidth figures per OMI link and Power10 SCM.

*Table 2-6 Memory bandwidth of supported DDIMM sizes*

	DDR4 DDIMMS		DDR5 DDIMMS	
DDIMM capacity	Clock speed	Maximum theoretical bandwidth per SCM <sup>a</sup>	Clock speed	Maximum theoretical bandwidth per SCM <sup>b</sup>
32 GB	3200 MHz	409.6 GBps	4000 MHz	1024 GBps
64 GB	3200 MHz	409.6 GBps	4000 MHz	1024 GBps
128 GB	2933 MHz	375.4 GBps	4000 MHz	1024 GBps
256 GB	2933 MHz	375.4 GBps	4000 MHz	1024 GBps

a. DDIMM modules that are attached to one SCM must be all the same size.

b. Mixed DDIMM sizes are supported by DDR5 DDIMMs and Feature Code EMC.

**Important:** For the best possible performance, it is a best practice that memory is installed in all memory slots and evenly across all system node drawers and all SCMs in the system.

Balancing memory across the installed system board cards enables memory access in a consistent manner and typically results in better performance for your configuration.

The Active Memory Expansion (AME) feature is an option that can increase the effective memory capacity of the system. AME uses the on-chip NX unit to compress or decompress memory content. This separately priced hardware feature is enabled at the partition (LPAR) level. The related LPAR profile parameter allows it to configure the compression factor in accordance with memory capacity needs and performance tradeoff consideration.

## 2.3.2 Memory placement rules

In a Power E1080 single node system, each SCM must have eight of the 16 memory DDIMMs slots populated. Only increments of four DDIMMs are supported, all of which have the same capacity. These four DDIMMs must all be plugged into four of the eight remaining slots that are connected to an SCM.

DDIMMs cannot be installed in such a way that an odd number of DDIMM slots are populated behind an SCM. DDIMMs also cannot be installed in a configuration that results in 10 or 14 DDIMM slots being populated behind an SCM. The only valid number of DDIMMs plugged into slots that are connected to a specific SCM is 8, 12, or 16.

The Power E1080 server must adhere to the following DDIMM plug rules:

- ▶ The minimum memory that is allowed is 1 TB (see 1.5.1, “Minimum configuration” on page 15).
- ▶ All DDR4 DDIMMs under each SCM must have the same capacity. DDR5 DDIMMs can be intermixed on the same SCM with Feature Code EMCM.
- ▶ DDIMMs must be plugged in as groups of four (quads).
- ▶ Each DDIMM quad must be the same size and type (identical to each other) and must be the same as the other DDIMM quads under each SCM when using DDR4 memory, but they can be different from other DDIMM quads from other SCMs. DDR5 memory capacities can be mixed within a single SCM with Feature Code EMCM.

For example, in a one system node configuration:

- The first SCM can be connected to 8x32 GB DDIMMS.
- The second SCM can be connected to 8x64 GB DDIMMS.
- The third SCM can be connected to 8x128 GB DDIMMS.
- The Fourth SCM can be connected to 8x256 GB DDIMMS.

Overall system performance improves when all the quads match each other. Physical memory features from a previous generation of servers cannot be migrated to Power E1080.

For the best possible performance, it is recommended that memory is installed in all memory slots and evenly across all system node drawers and all SCMs in the system.

Balancing memory across the installed system board cards enables memory access in a consistent manner and typically results in better performance for your configuration.

Account for any plans for future memory upgrades when you decide which memory feature size to use at the time of the initial system order.

### Plug sequence for minimum memory

A Power E1080 drawer requires a minimum of 32 DDIMMs. Two quads of DDIMMs per SCM are required.

Spreading the DDIMMs evenly between the two memory controllers provides maximum performance. The DDIMMs within each quad must be the same size and type and all the DDIMMs under each SCM must be the same capacity.

A DDIMM quad can be different from the DDIMM quads plugged elsewhere.

Adhere to the following order to plug the 32 DDIMMs and use Figure 2-13 on page 68 as reference:

- ▶ C20, C21, C22, C23, C24, C25, C26, C27 (slots connected to SCM P1)
- ▶ C28, C29, C30, C31, C32, C33, C34, C35 (slots connected to SCM P3)
- ▶ C36, C37, C38, C39, C40, C41, C42, C43 (slots connected to SCM P2)
- ▶ C44, C45, C46, C47, C48, C49, C50, C51 (slots connected to SCM P0)

### Plug sequence for the remaining DDIMMs

For a Power E1080 drawer, the next quad of DDIMMs sequence and rules is described in this section.

For the next quad of DDIMMs to be installed in slots that are connected to one of the four pSCMs, consider the following rules:

- ▶ The DDIMMs within each quad must be the same size and type.
- ▶ All DDIMMs under each SCM must have the same capacity.
- ▶ The DDIMM quad can be different from the DDIMM quads plugged elsewhere, including the other quad connected to the same SCM.
- ▶ Plug the remaining quad of DDIMMs in any of the remaining open quad of DIMM slots and all DDIMMs under each SCM must have the same capacity

Adhere to the following order and use Figure 2-13 on page 68 as reference:

- ▶ C52, C53, C54, C55 (slots connected to SCM P1) or
- ▶ C60, C61, C62, C63 (slots connected to SCM P3) or
- ▶ C68, C69, C70, C71 (slots connected to SCM P2) or
- ▶ C76, C77, C78, C79 (slots connected to SCM P0) or
- ▶ C56, C57, C58, C59 (slots connected to SCM P1) or
- ▶ C64, C65, C66, C67 (slots connected to SCM P3) or
- ▶ C72, C73, C74, C75 (slots connected to SCM P2) or
- ▶ C80, C81, C82, C83 (slots connected to SCM P0)

**Note:** In a multi-system node configuration, a drawer can be fully populated. The other drawers can be partially populated or have all the drawers symmetrically populated.

## 2.4 Capacity on Demand

Starting with IBM Power Private Cloud with Shared Utility Capacity (Power Enterprise Pools 2.0), multiple types of offerings are available on the Power E1080 server to help meet changing resource requirements in an on-demand environment by using resources that are installed on the system but that are not activated.

For more information about Capacity on Demand (CoD) Activation codes, see [Power Capacity on Demand](#).

## 2.4.1 New CoD features

The Power E1080 server features similar capabilities that are offered for the Power E980 server with a few changes:

- ▶ With IBM Power Private Cloud with Shared Utility Capacity (Power Enterprise Pools 2.0) configuration, it is possible to order a Power E1080 server with as few as one Base Processor Activation and 256 GB Base Memory activations. When the Power Enterprise Pools 2.0 configuration is used, all the resources are activated; therefore, other CoD features are not supported.
- ▶ Without IBM Power Private Cloud with Shared Utility Capacity configuration:
  - Each Power E1080 server requires a minimum of 16 permanent processor core activations that use static activations or Linux on Power activations. The remaining cores can be permanently or temporarily activated by using extra features.
  - A minimum of 50% of installed memory capacity must have activations. These activations can be static, mobile, or Linux on Power.
  - At least 25% of memory capacity must have static activations or Linux on Power activations.
  - The Power E1080 server can participate in the same IBM Power Enterprise Pool 1.0 with other Power E1080 servers and with previous generation Power E980 servers, but not with Power E870C, Power E880, and Power E880C servers.
  - CUoD, Pre-paid Elastic CoD (4586-COD), and Trial CoD (Trial CoD) are available with Power E1080 server.
  - Utility CoD (Utility CoD) is not supported on Power E1080 server.
  - Post-Pay Elastic CoD offering is not available on Power E1080 server.
  - Enterprise Capacity Backup (CBU) offering is not available on Power E1080 server.
  - Mobile-Enabled activations are not available on the Power E1080 server.

## 2.4.2 IBM Power Private Cloud with Shared Utility Capacity

IBM Power Private Cloud with Shared Utility Capacity solution (Power Enterprise Pools 2.0) is an infrastructure offering model that enables cloud agility and cost optimization with pay-for-use pricing.

All installed processors and memory on systems in a pool are activated and made available for immediate use when a pool is started. Processor and memory usage on each server are tracked by the minute and aggregated across the pool.

The capacity in this model consists of Base Activations and Capacity Credits, which are shared across the pool without having to move them from server to server. The unpurchased capacity in the pool can be used on a pay-as-you-go basis.

Resource usage that exceeds the pool's aggregated base resources is charged as metered capacity by the minute. It is also debited against purchased Capacity Credits on a real-time basis, as shown in Figure 2-15.

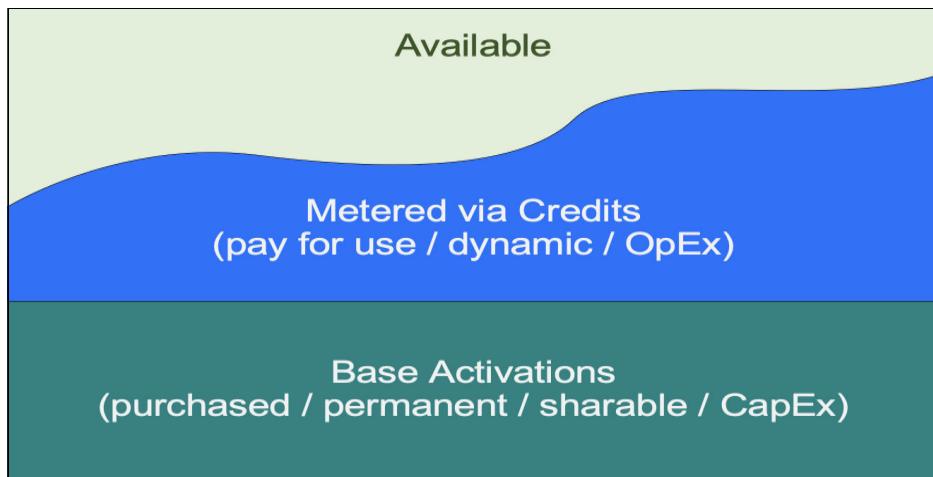


Figure 2-15 IBM Power Private Cloud with Shared Utility Capacity

IBM Power Private Cloud with Shared Utility Capacity solution is supported only on specific Power9 and Power10 processor-based systems. Power E1080 servers can co-exist with Power E980 systems in the same pool.

A single Power Enterprise Pool 2.0 supports up to 2000 virtual machines (VMs); up to 1000 VMs are supported per HMC. At the time of this writing, up to 200 VMs are supported per Power E1080 server, which is planned to be increased to 750 VMs per Power E1080.

In addition to processor and memory metering, Power Enterprise Pools 2.0 enables metering AIX and IBM i software entitlements and SUSE Linux Enterprise Server and Red Hat Enterprise Linux (RHEL) subscriptions in the pool.

For more information and requirements, see *IBM Power Systems Private Cloud with Shared Utility Capacity: Featuring Power Enterprise Pools 2.0*, SG24-8478.

### 2.4.3 Static, Mobile, and Base activations

Static processor and Memory activations are restricted to a single system. They are enabled by entering a code into the HMC that manages the system. The extra cores or memory are immediately available for use by workloads on the system.

Static activations are available in two versions:

- ▶ Static activations: This standard processor or memory activation can run VIOS, AIX, IBM i, and Linux workloads.
- ▶ Static activations for Linux: This processor or memory activation can run only VIOS and Linux workloads.

Mobile activations are ordered against a specific server, but can be moved to any server within the Power Enterprise Pool 1.0 and support any type of application. Mobile activations can be purchased in the initial order or with a Miscellaneous Equipment Specification (MES) upgrade.

Base Processor and Memory activations are associated with a single system and initially act as Static activations. When a system is added to a Power Enterprise Pools 2.0 configuration, all of its Base activations are added to the pool's base capacity.

Base activations for processor and memory resources are available in the following types:

- ▶ Base activations: This processor or memory activation can run VIOS, AIX, IBM i, and Linux workloads. Initially, Base activations act like Static activations until the system is added to a Power Enterprise Pool 2.0. Static and Mobile activations can be converted to Base activations with an MES order.
- ▶ Base Linux activations: This Base Processor activation can run only VIOS and Linux workloads.

Table 2-7 lists the Static, Mobile, and Base processor activation features that are available for initial order on the Power E1080 server.

*Table 2-7 Static, Mobile, and Base processor activation features*

Processor feature	EDP2 (3.65 - 3.90 GHz 40-core)	EDP3 (3.60 - 4.15 GHz 48-core)	EDP4 (3.55 - 4.00 GHz 60-core)
Static activation	EDPB	EDPC	EDPD
Static activation for Linux	ELCL	ELCQ	ELCM
Base activation	EPDC	EPDD	EPDS
Base activation for Linux	EPDU	EPDW	EPDX
Mobile activation	EDPZ	EDPZ	EDPZ

Table 2-8 lists the Static, Mobile, and Base memory activations that are available for initial order on the Power E1080 server.

*Table 2-8 Static, Mobile, and Base Memory activation features*

Feature Code	Description
EMAZ	1 GB Memory activation for HEX - Static
EMQZ	100 GB Memory activation for HEX - Static
EMBZ	512 GB Memory activation for HEX - Static
ELME	512 GB Memory activations for Linux on Power HEX - Static
EDAG	256 GB Base Memory activation for Pools 2.0
EDAH	512 GB Base Memory activation for Pools 2.0
EDAB	100 GB DDR4 Mobile Memory Activation for HEX
EMBK	500 GB DDR4 Mobile Memory Activation for HEX

#### 2.4.4 Capacity Upgrade on Demand

The Power E1080 server includes several active processor cores and memory units. It can also include inactive processor cores and memory units.

Active processor cores or memory units are processor cores or memory units that are available for use on your server when it comes from the manufacturer. Inactive cores or units are processor cores or memory units that are included with your server, but not available for use until you activate them.

Inactive processor cores and memory units can be permanently activated by purchasing an activation feature that is called CUoD and entering the provided activation code on the HMC for the server.

With the CUoD offering, you can purchase more static processors or memory capacity and dynamically activate them without restarting your server or interrupting your business. All the static processor or memory activations are restricted to a single server.

CUoD features several benefits that enable a more flexible environment. One benefit is reducing the initial investment in a system. Traditional projects that use other technologies mean that a system must be acquired with all the resources available to support the entire lifecycle of the project. As a result, you pay up front for capacity that you do not need until the later stages of the project or possibly at all, which affects software licensing costs and Software Maintenance (SWMA).

By using CUoD, a company starts with a system with enough *installed* resources to support the entire project lifecycle, but uses only *active* resources that are necessary for the initial project phases. Resources can be added as the project proceeds by activating resources as needed. Therefore, a company can reduce the initial investment in hardware and acquire software licenses only when they are needed for each project phase, which reduces the total cost of ownership (TCO) and total cost of acquisition (TCA) of the solution.

Figure 2-16 shows a comparison between two scenarios: a fully activated system versus a system with CUoD resources being activated along the project timeline.

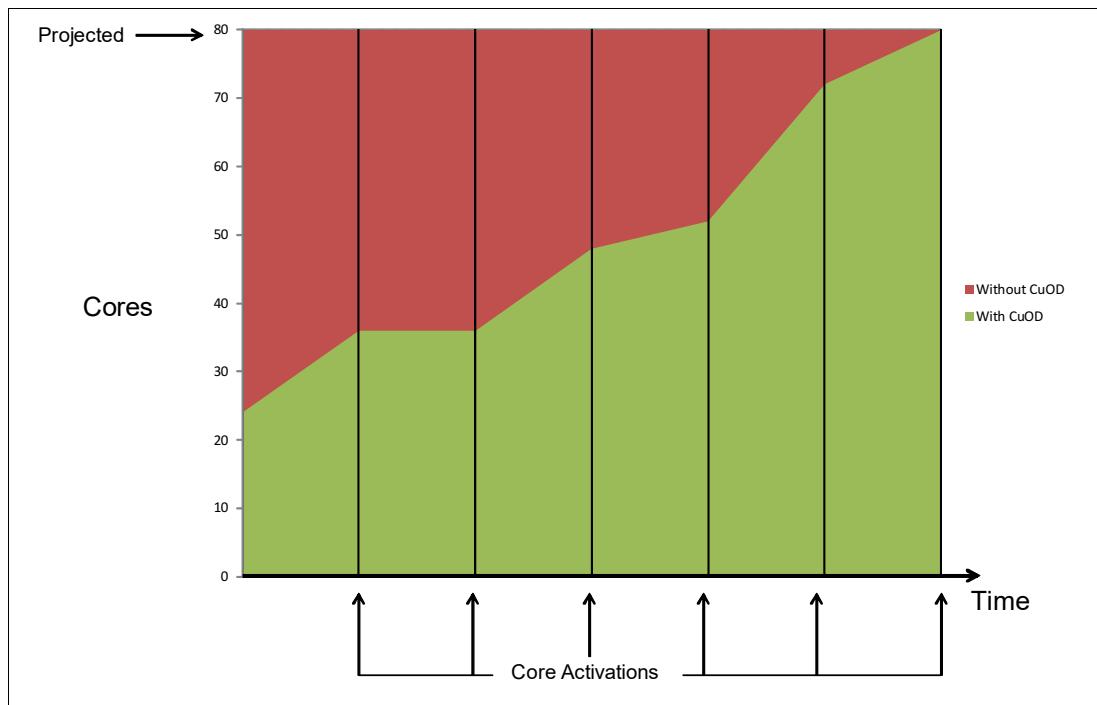


Figure 2-16 Active cores scenarios comparison during a project lifecycle

## 2.4.5 Elastic CoD (Temporary)

With the Elastic CoD offering, you can temporarily activate and deactivate processor cores and memory units to help meet the demands of business peaks, such as seasonal activity, period-end, or special promotions. When you order an Elastic CoD feature, you receive an enablement code that allows a system to make requests for more processor and memory capacity in increments of one processor day or 1 GB memory day. The system monitors the amount and duration of the activations. With the Power E1080 server, only the prepaid Elastic CoD option is available with Feature Code 4586-COD in eConfig or directly from Entitled Systems Support (ESS).

Processors and memory can be activated and turned off an unlimited number of times when more resources are needed.

This offering provides a system administrator an interface at the HMC to manage the activation and deactivation of resources. Before temporary capacity is used on your server, you must enable your server. To enable your server, an enablement feature (MES only) must be ordered and the required contracts must be in place. The 90-day enablement feature is *not* available for the Power E1080 processors.

For more information about enablement and usage of Elastic CoD, see [Power Capacity on Demand](#).

## 2.4.6 IBM Power Enterprise Pools 1.0 and Mobile CoD

Although static activations are valid for a single system, some customers might benefit from moving processor and memory activations to different servers because of workload rebalance or disaster recovery.

IBM Power Enterprise Pools 1.0 is a technology for dynamically sharing processor and memory activations among a group (or pool) of IBM Power servers. By using Mobile CoD activation codes, the systems administrator can perform tasks without contacting IBM.

With this capability, you can move resources between Power E1080 and Power E980 systems and have unsurpassed flexibility for workload balancing and system maintenance. The supported Power Enterprise Pool 1.0 members are listed by pool type in Table 2-9.

**Note:** Only two consecutive generations of Power servers are supported in the same Power Enterprise Pools 1.0; therefore, Power E1080 can be mixed with Power E980 servers only.

Table 2-9 Supported Power Enterprise Pool 1.0 members by pool type

Power Enterprise Pool type	Pool members
Midrange Power Enterprise Pool 1.0	770+, E870, E870C, and E880C
High-end Power Enterprise Pool 1.0	780+, 795, E880, E870C, and E880C
Power Enterprise Pool 1.0	E870, E880, E870C, E880C, and E980
Power Enterprise Pool 1.0 (with Power E1080)	E980 and E1080

A pool can support systems with different clock speeds or processor generations.

Mobile CoD features the following basic rules:

- ▶ The Power E1080 server requires a minimum of 16 static processor activations.
- ▶ The Power E980 server requires a minimum of eight static processor activations.
- ▶ For all systems, 50% of the installed memory must have activations, and a minimum of 25% of those activations must be static.

An HMC can manage multiple IBM Power Enterprise Pools and systems that are not part of an IBM Power Enterprise Pool. Systems can belong to only one IBM Power Enterprise Pool at a time. Powering down an HMC does not limit the assigned resources of participating systems in a pool, but does limit the ability to perform pool change operations.

After an IBM Power Enterprise Pool is created, the HMC can be used to perform the following tasks:

- ▶ Mobile CoD processor and memory resources can be assigned to systems with inactive resources. Mobile CoD resources remain on the system to which they are assigned until they are removed from the system.
- ▶ New systems can be added to the pool and existing systems can be removed from the pool.
- ▶ New Mobile CoD processor and memory resources can be added to the pool.
- ▶ Pool information can be viewed, including pool resource assignments, compliance, and history logs.

For the mobile activation features to be configured, an IBM Power Enterprise Pool and the systems that are going to be included as members of the pool must be registered with IBM. Also, the systems must have #EB35 for mobile enablement configured, and the required contracts must be in place.

**Note:** The following convention is used in the Order type column in the tables in this section:

- ▶ Initial: Only available when ordered as part of a new system
- ▶ MES: Only available as a MES upgrade
- ▶ Both: Available with a new system or as part of an upgrade
- ▶ Supported: Unavailable as a new purchase, but supported when migrated from another system or as part of a model conversion

Table 2-10 lists the mobile processor and memory activation features that are available for the Power E1080 server.

*Table 2-10 Mobile activation features*

Feature Code	Description	Maximum	Order <sup>a</sup> type
EDAB	100 GB Mobile Memory activation for HEX	480	Both
EMBK	500 GB Mobile Memory activation for HEX	130	Both
EDPZ	Mobile processor activation for HEX	224	Both

a. For more information about order types, see 2.4, "Capacity on Demand" on page 72.

For more information about IBM Power Enterprise Pools, see *Power Enterprise Pools on IBM Power Systems*, REDP-5101.

## 2.4.7 Utility CoD

Utility CoD is *not* supported on the Power E1080 server.

## 2.4.8 Trial CoD

A *standard request* for Trial CoD requires you to complete a form that includes contact information and vital product data (VPD) from your Power E1080 server with inactive CoD resources.

A standard request activates eight processors or 64 GB of memory for 30 days. Subsequent standard requests can be made after each purchase of a permanent processor activation. An HMC is required to manage Trial CoD activations.

An *exception request* for Trial CoD requires you to complete a form that includes contact information and VPD from your Power E1080 server with inactive CoD resources. An exception request activates all inactive processors or all inactive memory (or all inactive processor and memory) for 30 days. An exception request can be made only once over the life of the machine. An HMC is required to manage Trial CoD activations.

To request either a Standard or an Exception Trial, see [Power Capacity on Demand: Trial Capacity on Demand](#).

## 2.4.9 Software licensing and CoD

For software licensing considerations for the various CoD offerings, see the most recent revision of the [Power Capacity on Demand User's Guide](#).

# 2.5 Internal I/O subsystem

This section provides more information about the internal PCIe architecture of the Power E1080 server.

## 2.5.1 Internal PCIe Gen 5 subsystem and slot properties

The internal I/O subsystem on the Power E1080 server is connected to the PCIe Gen 5 controllers on a Power10 chip in the system. Each Power10 processor module has two PHBs. The PHBs (PHB0 and PHB1) have 16 PCIe lanes each.

The PHBs provide different type of end-point connections. Both the PHBs from Power10 sockets P0 and P1 and one PHB from sockets P2 and P3 connect directly to a PCIe Gen 4 x16 or PCIe Gen 5 x8 slot to provide six PCIe Gen 4 x16 or PCIe Gen 5 x8 slots per system node.

The second PHB on each Power10 socket P2 and P3 is split between a PCIe Gen 5 x8 slot and two Internal Non-Volatile Memory Express (NVMe) solid-state drive (SSD) PCIe Gen 4 x4 slots. The design overall provides each system node of Power E1080 with the following components:

- ▶ Six PCIe Gen 4 x16 or PCIe Gen 5 x8
- ▶ Two PCIe Gen 5 x8
- ▶ Four Internal NVMe SSDs, each using a PCIe Gen 4 x4 connection

Bandwidths for the connections are listed in Table 2-11.

*Table 2-11 Internal I/O connection speeds*

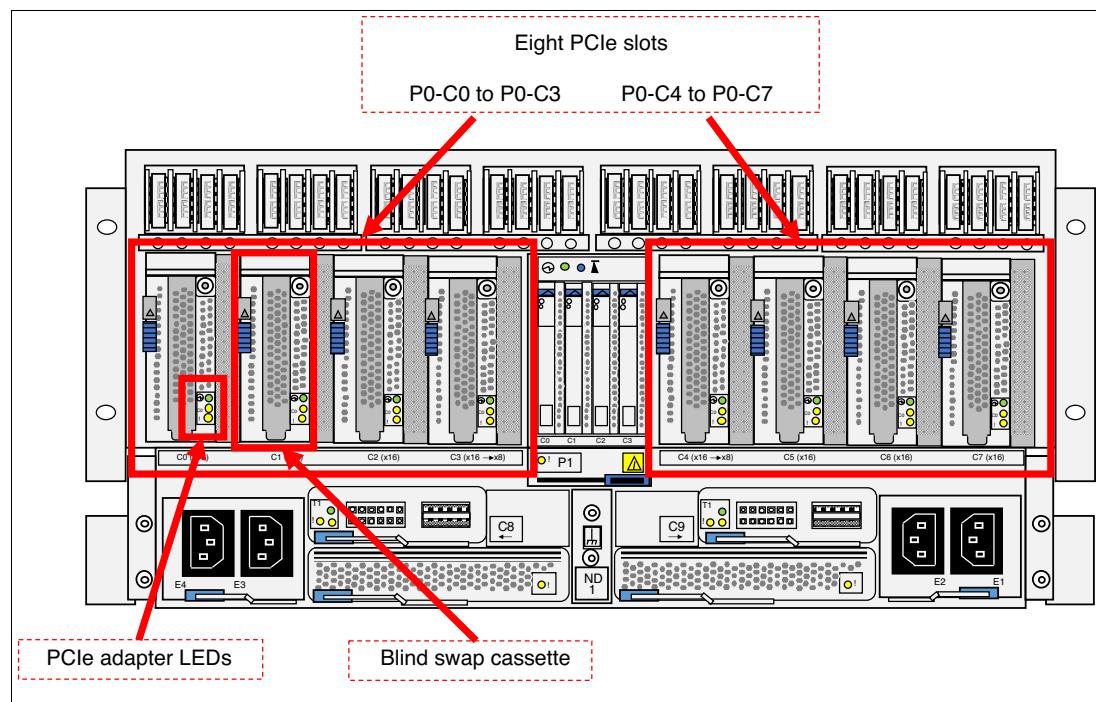
Connection	Type	Speed (duplex)
PCIe adapter slot	PCIe Gen4 x16	64 GBps
PCIe adapter slot	PCIe Gen5 x8	64 GBps
NVMe slot	PCIe Gen4 x4	16 GBps

The following theoretical maximum I/O bandwidths in each system node are available:

- ▶ Six PCIe Gen 4 x16 / PCIe Gen 5 x8 slots at 64 GBps = 384 GBps
- ▶ Two PCIe Gen 5 x8 Slots at 64 GBps = 128 GBps
- ▶ Four NVMe slots at 16 GBps = 64 GBps

Total of 576 GBps = 384 GBps + 128 GBps + 64 GBps.

The rear view of a Power E1080 system node is as shown in Figure 2-17 and Figure 2-18 on page 81.



*Figure 2-17 Rear view of a Power E1080 system node highlighting PCIe slots*

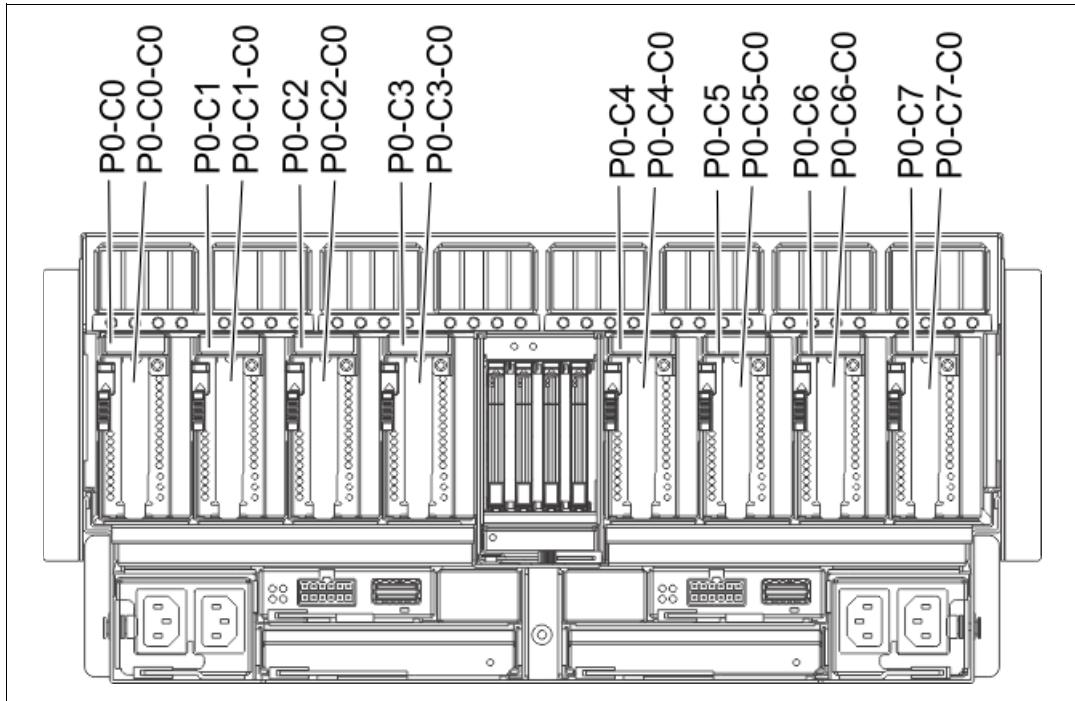


Figure 2-18 Rear view of a E1080 system node with PCIe slot location codes

Adapters that are used in the Power E1080 server are enclosed in a specially designed adapter cassette. The cassette includes a special mechanism for holding the adapter within a socket and helps for insertion and removal of the adapter into a PCIe slot at the rear side of the server.

The cassette locations are P0-C0 - P0-C7. The adapter locations are P0-C0-C0 - P0-C7-C0.

All slots are of the low-profile (LP) type; that is, half-height, half-length (HHHL). They support Enhanced Error Handling (EEH) and can be serviced with the system power turned on. The slots also support Gen 1 to Gen 3 adapters.

All the PCIe slots support Single Root I/O Virtualization (SR-IOV) adapters.

Currently, no adapter can dissipate more than 25 watts. Special considerations are needed to exceed this limit.

The Power E1080 server supports concurrent maintenance (hot plugging) of PCIe adapters. The adapter cassette is provided with three LEDs that can indicate power and activity (green), identify function (amber) for the adapter (labeled C0), and fault function LED (amber) for the cassette. The server can be located by using the blue identify LED on the enclosure.

The internal connections are shown in Figure 2-19.

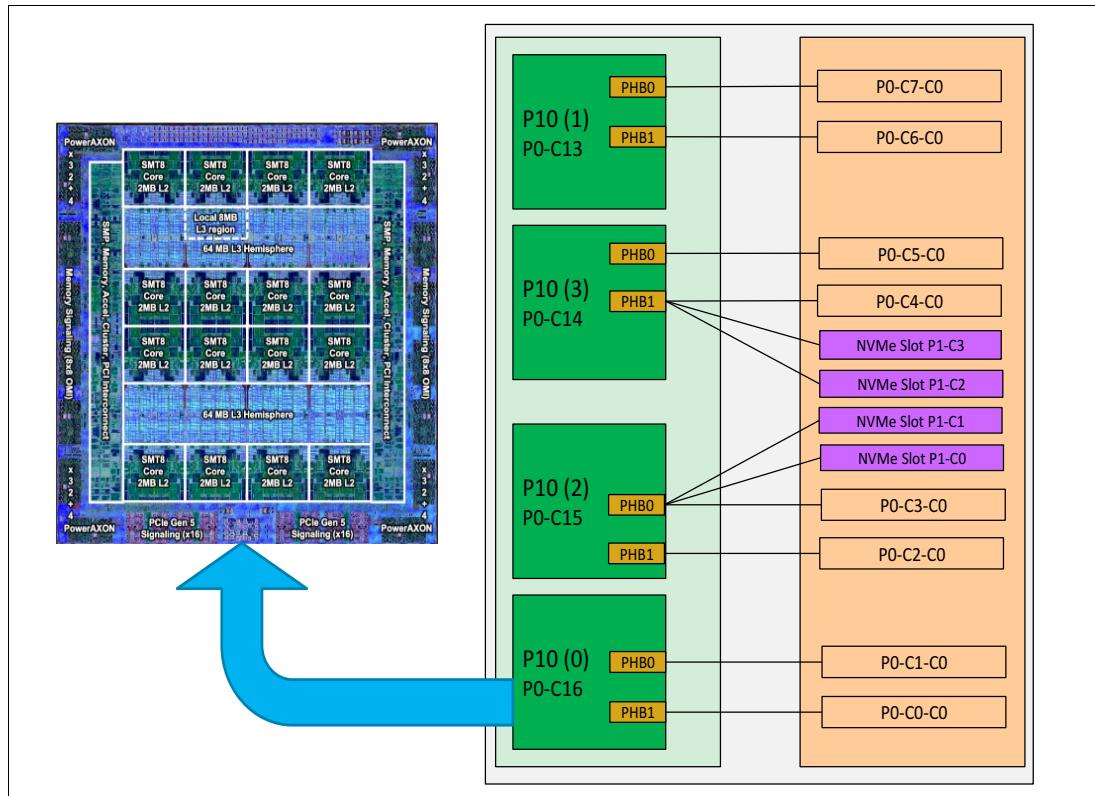


Figure 2-19 Power E1080 system node to PCIe slot internal connection schematics

The PCIe slots are numbered from P0-C0 - P0-C7.

Slot locations and descriptions for the Power E1080 servers are listed in Table 2-12.

Table 2-12 Internal PCIe Slot number and Location codes

Location code	Description	Socket / PHB	Slot number	SRIOV
P0-C0	PCIe Gen 4 x16 or PCIe Gen 5 x8	P0/1	1	Yes
P0-C1	PCIe Gen 4 x16 or PCIe Gen 5 x8	P0/0	2	Yes
P0-C2	PCIe Gen 4 x16 or PCIe Gen 5 x8	P2/1	3	Yes
P0-C3	PCIe Gen 5 x8	P2/0	4	Yes
P1-C0	PCIe Gen 4 x4	P2/0	NVMe Slot 1	NA
P1-C1	PCIe Gen 4 x4	P2/0	NVMe Slot 2	NA
P1-C2	PCIe Gen 4 x4	P3/1	NVMe Slot 3	NA
P1-C3	PCIe Gen 4 x4	P3/1	NVMe Slot 4	NA
P0-C4	PCIe Gen 5 x8	P3/1	5	Yes
P0-C5	PCIe Gen 4 x16 or PCIe Gen 5 x8	P3/0	6	Yes

Location code	Description	Socket / PHB	Slot number	SRIOV
P0-C6	PCIe Gen 4 x16 or PCIe Gen 5 x8	P1/1	7	Yes
P0-C7	PCIe Gen 4 x16 or PCIe Gen 5 x8	P1/0	8	Yes

PCIe x16 cards are supported only in PCIe x16 slots and the slot priority is (1, 3, 7, 2, 6, 8).

PCIe adapters with x8 and lower lanes are supported in all the PCIe slots and the slot priority is (1, 7, 3, 6, 2, 8, 4, 5).

Place 8x and 16x adapters in same size slots first before mixing connector size with slot size. Adapters with smaller connectors are allowed in larger PCIe slot sizes, but larger connectors are not compatible in smaller PCIe slots sizes.

The system nodes allow for eight PCIe slots of which six are PCIe Gen4 x16 or PCIe Gen5 x8 slots and two are PCIe Gen5 x8 slots. Slots can be added by attaching PCIe expansion drawers; serial-attached SCSI (SAS) disks can be attached to EXP24S small form factor (SFF) Gen2 expansion drawers. and more NVMe drives can be added by using the NED24 NVMe expansion drawer. For more information on expansion drawers, see 1.6, “I/O drawers” on page 25.

The PCIe expansion drawer and the NED24 NVMe expansion drawer are connected by using an #EJ24 adapter. The EXP24S storage enclosure can be attached to SAS adapters on the system nodes or on the PCIe expansion drawer.

For a list of adapters and their supported slots, see 2.6, “Supported PCIe adapters” on page 89.

**Disk support:** SAS disks that are directly installed on the system nodes and PCIe Expansion Drawers are not supported. If directly attached SAS disks are required, they must be installed in a SAS disk drawer and connected to a supported SAS controller in one of the PCIe slots.

As a best practice, the adapters that do not require high bandwidth should be placed in an external expansion drawer. Populating a low-latency, high-bandwidth slot with a low-bandwidth adapter is not the best use of system resources.

As a best practice, use the high-profile version of all adapters whenever the system includes a PCIe expansion drawer. This configuration allows the user to place most of the adapters within the PCIe expansion drawer. Typically, it is advised to use node slots for the cable adapters (#EJ24) or high bandwidth PCIe Gen 4 or PCIe Gen 5 adapters.

## 2.5.2 Internal NVMe storage subsystem

The Power E1080 supports NVMe storage technology. The NVMe subsystem is available in each of the E1080 system node drawers. Four internal NVMe U.2 drive slots are present in each of the system nodes in the center of the rear of the system. These slots can be configured as either 4 x 7 mm slots by using the #EBJC backplane or 2 x 15 mm slots by using the #EJBD or EJBE backplane. The slots can be independently assigned to any of the partitions (see Figure 2-20).

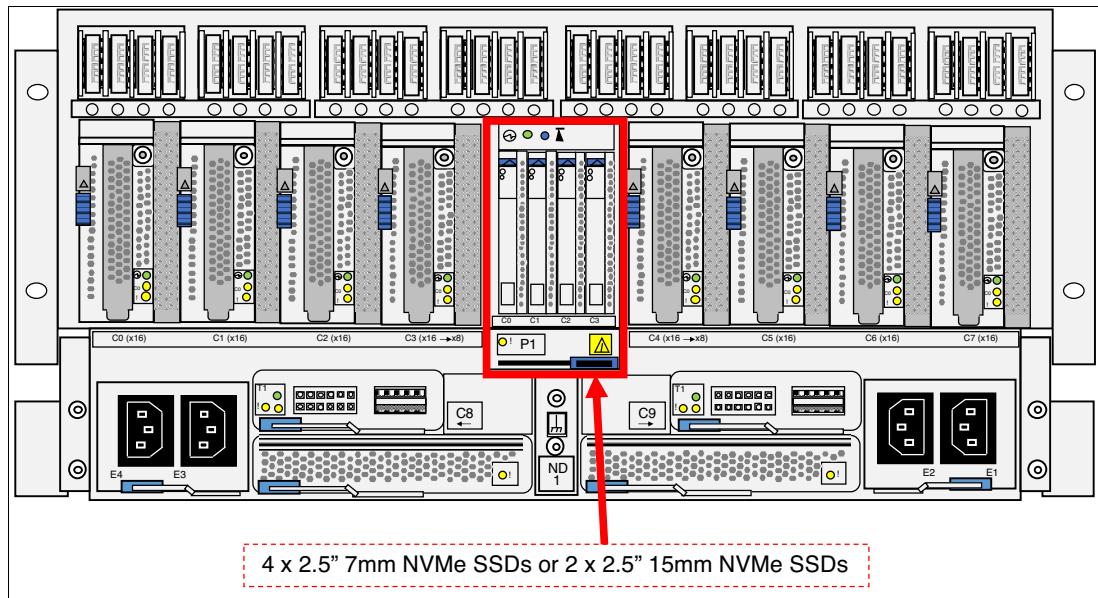


Figure 2-20 Rear view of a E1080 system node highlighting NVMe slots

The internal 7 mm NVMe devices support only one namespace. The primary use of the devices is to host VIOSs. None of the 7 mm devices support IBM i, IBM i support requires the #EJBD or EJBE backplane and 15 mm NVMe devices.

The location of the NVMe U.2 drives in the system node is shown in Figure 2-21 on page 85.

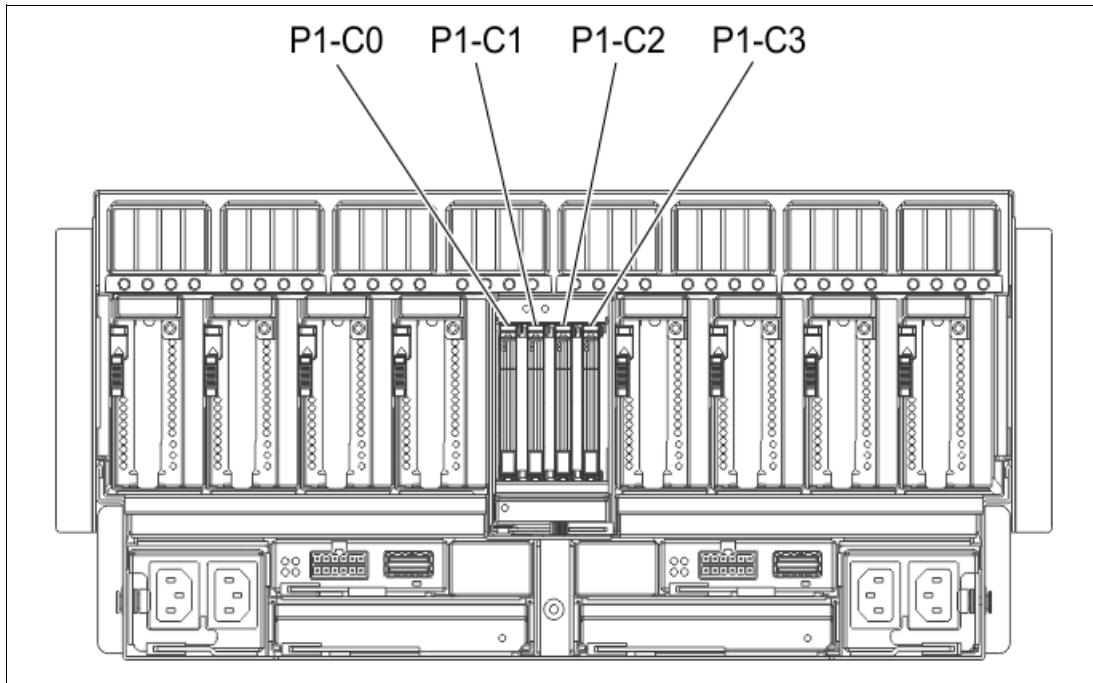


Figure 2-21 Rear view of a Power E1080 system node with NVMe slot location codes

Each slot is driven from a x4 PCIe connection, with two SSDs that are connected to the PHB on the P2 CPU socket and two SSDs that are connected to the PHB of the P3 CPU socket, as shown in Figure 2-19 on page 82. The buses are routed through the system board from the CPU to the NVMe slot interface card, and then up through the SSD riser card and into the SSD.

The NVMe slots support U.2 NVMe flash SSD drives. Four 2.5-inch 7 mm form-factor SSDs or two 2.5-inch 15 mm NVMe SSDs can be used. To determine which drives are available for the Power E1080, see the [E1080 Sales Manual](#).

Slot locations P1 - C2 and P1 - C3 remain empty if #EJBD backplane is selected to allow for spacing of the 15 mm option.

**Important:** Choose the type of NVMe SSD drives carefully based on your planned usage. Match the drive characteristics such as DWPD and number of namespaces to your intended use case.

### Internal SSD plug order

For redundancy purposes, it is a best practice to distribute the NVMe drives across the system nodes if they are present as follows:

- ▶ Populate slot C0 in each system node starting with node 1 and then, other C0 slots if other nodes are present.
- ▶ Populate slot C2 in each system node starting with node 1 and then, other C2 slots if other nodes are present.
- ▶ Populate slot C1 in each system node starting with node 1 and then, other C1 slots if other nodes are present.
- ▶ Populate slot C3 in each system node starting with node 1 and then, other C3 slots if other nodes are present.

Each NVMe U.2 drive has two LEDs at the top of the drive that indicates the following status:

- ▶ A power and activity LED (green)
- ▶ An error and identify function LED (amber)

The location of the NVMe U.2 drive LEDs in the system is shown in Figure 2-22.

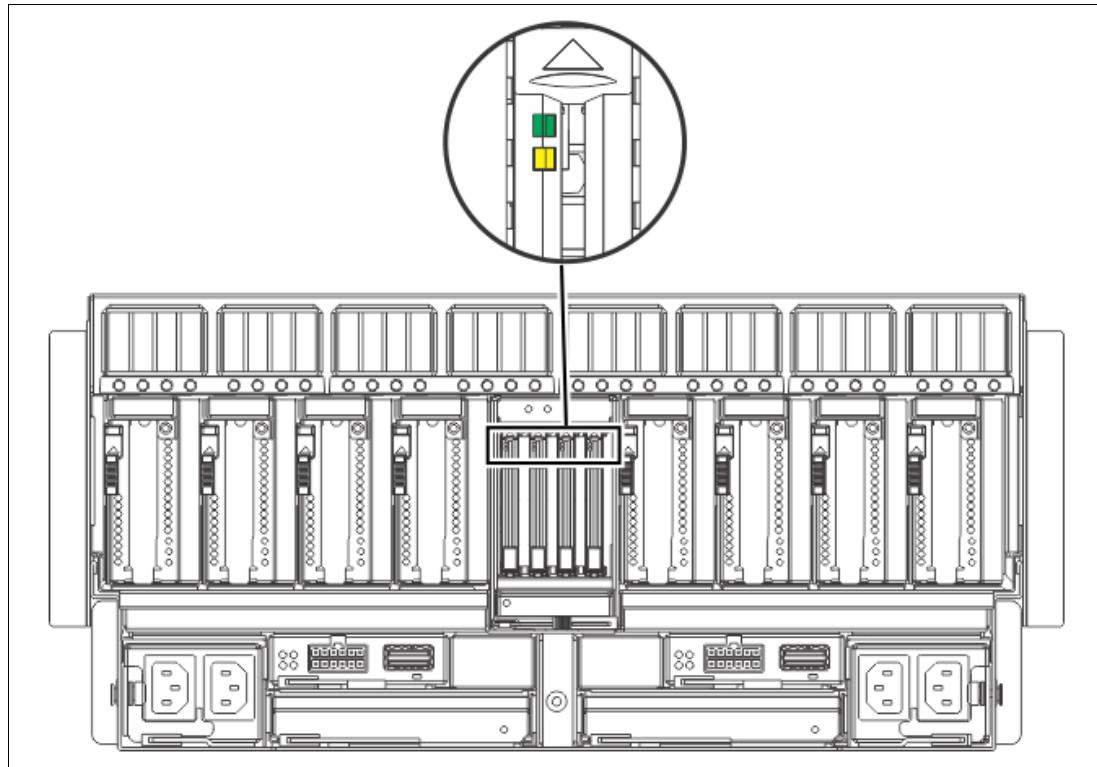


Figure 2-22 Rear view of a Power E1080 system node with the NVMe slot LED location

Concurrent maintenance of the NVMe drives is supported.

You can find the remaining life on a NVMe device from the LPAR that owns the device.

To determine the remaining life of an NVMe device, complete the following steps:

- ▶ For an IBM AIX operating system:
  - a. From the AIX CLI, enter diag and press Enter.
  - b. From the Function Selection menu, select **Task Selection → NVMe general health information**.
  - c. Select the NVMe device that you want to check the remaining life for and press Enter.
  - d. View the Percentage of NVM subsystem life used field.
- ▶ For a Linux operating system:
  - a. From the Linux CLI, enter the following command and press Enter:

```
nvme smart-log /dev/nvmeX -H
```

Where *nvmeX* is the resource name of the NVMe device.
  - b. View the Percentage used field.

The NVMe device that is nearing its end of life must be replaced. The device soon reaches the limit for the number of write operations that are supported. Write operations to the NVMe device become slower over time, and at some point the NVMe device becomes a read-only device.

When the operating system writes data to a read-only device, the write operations are rejected, and the operating system considers the device as if a failure occurred. To support normal write operations, the NVMe device must be replaced.

### 2.5.3 USB subsystem

The Power E1080 has no integrated USB controllers or ports in the system nodes. The USB PCIe adapter must be used for enabling USB access. The PCIe2 2-PORT USB 3.0 LP adapter (#EC6J) is supported in the system node. This adapter is typically placed in the PCIe Slot 4/5 of system node1 or node2.

A USB Cable (#EC6N) is used for connecting the #EC6J adapter port to the rear side USB port in the system control unit (SCU), which is internally routed to a front-accessible USB port on the SCU (see Figure 2-23).



Figure 2-23 Rear view of the SCU showing the USB port for connection

The following USB devices are supported and available for the Power E1080:

- ▶ #EUA5: Stand-alone USB DVD Drive with cable
- ▶ #EUA4: RDX USB External Docking Station

The front view of the SCU in which the System USB port and Flexible Service Processor (FSP) USB ports are highlighted is shown in Figure 2-24.

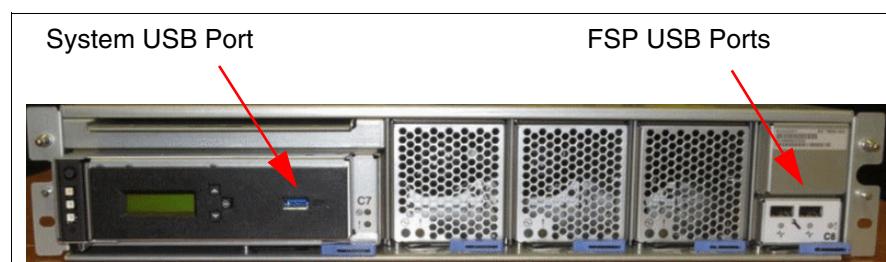


Figure 2-24 Front view of SCU showing the System USB port and FSP USB ports

## 2.5.4 PCIe slots features

Each system node provides 8 PCIe Gen5 hot-plug enabled slots; therefore, a 1-node system provides eight slots, a 2-node system provides 16 slots, a 3-node system provides 24 slots, and a 4-node system provides 32 slots.

You can connect up to four I/O expansion drawer features EMX0 per node with the slot capacity that is listed in Table 2-13.

*Table 2-13 PCIe slots availability for different system node configurations*

System node number	I/O expansion number	LP slots	Full-height slots
1	4	8	48
2	8	16	96
3	12	24	144
4	16	32	192

Each I/O expansion drawer consists of two Fanout Module features EMXH, each providing six PCIe slots. Each Fanout Module connects to the system by using a pair of CXP cable features. The CXP cable features are listed in Table 2-14. The RPO Only cables in this list are not available for ordering new or MES upgrade but for migration from a source system. Select a longer length feature for inter-rack connection between the system node and the expansion drawer.

*Table 2-14 Optical CXP cable feature*

Feature Code	CCIN	Description	OS support	Order type
ECCR		2 M Active Optical Cable (AOC) Pair for PCIe Gen 3 Expansion Drawer		Both
ECCY		10 M AOC Pair for PCIe Gen 3 Expansion Drawer		Both
ECCZ		20 M AOC Pair for PCIe Gen 3 Expansion Drawer		Both

The one pair of CXP optical cables connects to a system node by using one 2-ports PCIe optical cable adapter feature EJ24 placed in the CEC.

The CXP optical cable pair and the optical cable adapter features are concurrently maintainable. Therefore, careful balancing of I/O, assigning adapters through redundant EMX0 expansion drawers, and different system nodes can help ensure high availability for the I/O resources that are assigned to partitions.

For more information about internal buses and the architecture of internal and external I/O subsystems, see 2.5, “Internal I/O subsystem” on page 79.

## 2.6 Supported PCIe adapters

In this section, we provide more information about supported PCIe I/O adapters on Power E1080 server as on system general availability date September 17th, 2021. This list tends to update frequently as more PCIe I/O adapters are tested and certified. The latest list of supported adapters through announcement letters is available at [this web page](#).

The Order type table column in the following subsections is defined as:

<b>Initial</b>	Denotes the orderability of a feature for <i>only</i> the new purchase of the system.
<b>MES</b>	Denotes the orderability of a feature for <i>only</i> the MES upgrade purchases on the system.
<b>Both</b>	Denotes the orderability of a feature for <i>both</i> new and MES upgrade purchases.
<b>Supported</b>	Denotes that a feature is <i>not</i> orderable, but is <i>supported</i> ; that is, the feature can be migrated only from existing systems.

### 2.6.1 LAN adapters

The supported LAN adapters are listed in Table 2-15.

Table 2-15 LAN adapters

Feature Code	CCIN	Description	Min	Max	OS support	Order type
5260	576F	PCIe2 LP 4-port 1 GbE Adapter	0	32	AIX, IBM i, and Linux	Supported
5899	576F	PCIe2 4-port 1 GbE Adapter	0	192	AIX, IBM i, and Linux	Supported
EC2T	58FB	PCIe Gen 3 LP 2-Port 25/10 Gb NIC&ROCE SR/Cu Adapter <sup>a</sup>	0	32	AIX, IBM i, and Linux	Both
EC2U	58FB	PCIe Gen 3 2-Port 25/10 Gb NIC&ROCE SR/Cu Adapter <sup>a</sup>	0	192	AIX, IBM i, and Linux	Both
EC67	2CF3	PCIe Gen 4 LP 2-port 100 Gb ROCE EN LP Adapter	0	24	AIX, IBM i, and Linux	Both
EC77	2CFA	PCIe4 LP 2-port 100 Gb Crypto Connectx-6 DX QFSP56	0	24	AIX, IBM i, and Linux	Both
EN0S	2CC3	PCIe2 4-Port (10 Gb+1 GbE) SR+RJ45 Adapter	0	192	AIX, IBM i, and Linux <sup>b</sup>	Supported
EN0T	2CC3	PCIe2 LP 4-Port (10 Gb+1 GbE) SR+RJ45 Adapter	0	32	AIX, IBM i, and Linux <sup>a</sup>	Supported
EN0W	2CC4	PCIe2 2-port 10/1 GbE BaseT RJ45 Adapter	0	192	AIX, IBM i, and Linux <sup>b</sup>	Both
EN0X	2CC4	PCIe2 LP 2-port 10/1 GbE BaseT RJ45 Adapter	0	32	AIX, IBM i, and Linux <sup>a</sup>	Both
EN24	EC2A	PCIe4 LPX 4-Port 25/10/1 GbE RoCE SFP28 Adapter	0	32	AIX, IBM i, and Linux	Both

Feature Code	CCIN	Description	Min	Max	OS support	Order type
EN25	EC2A	PCIe4 4-Port 25/10/1 GbE RoCE SFP28 Adapter	0	32	AIX, IBM i, and Linux	Both
EC2R	58FA	PCIe3 LP 2-Port 10 Gb NIC&ROCE SR/Cu Adapter	0	32	AIX, IBM i, and Linux	Supported
EC2S	58FA	PCIe3 2-Port 10 Gb NIC&ROCE SR/Cu Adapter	0	192	AIX, IBM i, and Linux	Supported
EC2W	2F04	PCIe3 4-port 10GbE BaseT RJ45 Adapter	0	64	AIX, IBM i, and Linux <sup>b</sup>	Both
EC2X	2F04	PCIe3 LP 4-port 10GbE BaseT RJ45 Adapter	0	16	AIX, IBM i, and Linux <sup>b</sup>	Both

a. Requires Service Focal Point (SFP) to provide 10 Gb, 2 Gb, or 1 Gb BaseT connectivity.  
b. IBM i supported through VIOS.

## 2.6.2 Fibre Channel adapters

The supported Fibre Channel adapters are listed in Table 2-16.

Table 2-16 Fibre Channel adapters

Feature Code	CCIN	Description	Min	Max	OS support	Order type
EN1A	578F	PCIe Gen 3 32 Gb 2-port Fibre Channel Adapter	0	192	AIX, IBM i, and Linux	Both
EN1B	578F	PCIe Gen 3 LP 32 Gb 2-port Fibre Channel Adapter	0	32	AIX, IBM i, and Linux	Both
EN1C	578E	PCIe Gen 3 16 Gb 4-port Fibre Channel Adapter	0	192	AIX, IBM i, and Linux	Both
EN1D	578E	PCIe Gen 3 LP 16 Gb 4-port Fibre Channel Adapter	0	32	AIX, IBM i, and Linux	Both
EN1E	579A	PCIe3 16 Gb 4-port Fibre Channel Adapter	0	192	AIX, IBM i, and Linux <sup>a</sup>	Both
EN1F	579A	PCIe Gen 3 LP 16 Gb 4-port Fibre Channel Adapter	0	32	AIX, IBM i, and Linux <sup>a</sup>	Both
EN1G	579B	PCIe3 16 Gb 4-port Fibre Channel Adapter	0	192	AIX and Linux	Both
EN1H	579B	PCIe Gen 3 LP 2-Port 16 Gb Fibre Channel Adapter	0	32	AIX and Linux	Both
EN1J	579C	PCIe4 32 Gb 2-port Optical Fibre Channel Adapter	0	192	AIX, IBM i, and Linux	Both
EN1K	579C	PCIe Gen 4 LP 32 Gb 2-port Optical Fibre Channel Adapter	0	32	AIX, IBM i, and Linux	Both
EN1L	2CFC	PCIe4 32 Gb 4-port Optical Fibre Channel Adapter	0	192	AIX, IBM i, and Linux	Both

Feature Code	CCIN	Description	Min	Max	OS support	Order type
EN1M	2CFC	PCIe4 LPX 32 Gb 4-port Optical Fibre Channel Adapter	0	32	AIX, IBM i, and Linux	Both
EN1N	2CFD	PCIe4 64 Gb 2-port Optical Fibre Channel Adapter	0	192	AIX, IBM i, and Linux	Both
EN1P	2CFD	PCIe4 LP 64 Gb 2-port Optical Fibre Channel Adapter	0	32	AIX, IBM i, and Linux	Both
EN2A	579D	PCIe Gen 3 16 Gb 2-port Fibre Channel Adapter	0	192	AIX, IBM i, and Linux	Both
EN2B	579D	PCIe Gen 3 LP 16 Gb 2-port Fibre Channel Adapter	0	32	AIX, IBM i, and Linux	Both
EN2L	2CFC	PCIe4 32 Gb 4-port Optical Fibre Channel Adapter	0	192	AIX, IBM i, and Linux	Both
EN2M	2CFC	PCIe4 LPX 32 Gb 4-port Optical Fibre Channel Adapter	0	32	AIX, IBM i, and Linux	Both
EN2N	2CFD	PCIe4 64 Gb 2-port Optical Fibre Channel Adapter	0	192	AIX, IBM i, and Linux	Both
EN2P	2CFD	PCIe4 LP 64 Gb 2-port Optical Fibre Channel Adapter	0	32	AIX, IBM i, and Linux	Both

a. IBM i supported through VIOS.

### 2.6.3 SAS adapters

The supported SAS adapters are listed in Table 2-17.

Table 2-17 SAS adapters

Feature Code	CCIN	Description	Min	Max	OS support	Order type
EJ0J	57B4	PCIe Gen 3 RAID SAS Adapter Quad-port 6 Gb x8	0	128	AIX, IBM i, and Linux	Both
EJ0M	57B4	PCIe Gen 3 LP RAID SAS Adapter Quad-Port 6 Gb x8	0	32	AIX, IBM i, and Linux	Both
EJ0L	57CE	PCIe3 12 GB Cache RAID SAS Adapt Quad-port 6 Gb x8	0	128	AIX, IBM i, and Linux	Supported
EJ10	57B4	PCIe Gen 3 SAS Tape/DVD Adapter Quad-port 6 Gb x8	0	128	AIX, IBM i, and Linux	0
EJ11	57B4	PCIe Gen 3 LP SAS Tape/DVD Adapter Quad-port 6 Gb x8	0	32	AIX, IBM i, and Linux	Both

Feature Code	CCIN	Description	Min	Max	OS support	Order type
EJ14	57B1	PCIe Gen 3 12 GB Cache RAID PLUS SAS Adapter Quad-port 6 Gb x8	0	128	AIX, IBM i, and Linux	Both
EJ2B	57F2	PCIe3 12 Gb x8 SAS Tape HBA Adapter	0	128	IBM i	Both
EJ2C	57F2	PCIe3 LP 12 Gb x8 SAS Tape HBA Adapter	0	32	IBM i	Both

## 2.6.4 Crypto adapter

The supported crypto adapter is listed in Table 2-18.

Table 2-18 *Crypto adapters*

Feature Code	CCIN	Description	Min	Max	OS support	Order type
EJ37	C0AF	PCIe Gen 3 Crypto Coprocessor BSC-Gen3 4769	0	192	AIX, IBM i, and Linux	Both

## 2.6.5 USB adapter

The supported USB adapter is listed in Table 2-19.

Table 2-19 *USB adapter*

Feature Code	CCIN	Description	Min	Max	OS support	Order type
EC6J	590F	PCIe2 LP 2-Port USB 3.0 Adapter	0	32	AIX, IBM i, and Linux	Both

## 2.6.6 I/O expansion drawers

The supported I/O expansion drawers are listed in Table 2-20.

Table 2-20 *I/O expansion drawer feature*

Feature Code	CCIN	Description	Min	Max	OS support	Order type
EMX0	N/A	PCIe Gen3 I/O Expansion Drawer	0	16	AIX, IBM i, and Linux	Supported
EMXH	50CD	PCIe Gen 3 6-Slot Fanout Module for PCIe Gen 3 Expansion Drawer	0	32	AIX, IBM i, and Linux	Supported

Feature Code	CCIN	Description	Min	Max	OS support	Order type
ENZ0	N/A	PCIe Gen4 I/O Expansion Drawer	0	12	AIX, IBM i, and Linux	Both
EMXH	50CD	PCIe4 6-Slot Fanout Module for PCIe Gen4 I/O Expansion Drawer	0	24	AIX, IBM i, and Linux	Both

## 2.6.7 Disk drawer

The supported disk drawer is listed in the Table 2-21.

Table 2-21 Disk drawer feature

Feature Code	CCIN	Description	Mix	Max	OS support	OS type
ESLS	78D1	EXP24SX SAS Storage Enclosure	0	168	AIX, IBM i, and Linuxf	Both

## 2.6.8 SFP transceiver

The supported SFP transceivers are listed in Table 2-22. The SFP provides connectivity to the #EC2T and EC2U LAN adapters.

Table 2-22 SFP / QSFP features

Feature Code	CCIN	Description	Min	Max	OS support	Order type
EB46		10 GbE Optical Transceiver SFP+ SR	0	9999	N/A	Both
EB47		25 GbE Optical Transceiver SFP28	0	9999	N/A	Both
EB48		1 GbE Base-T Transceiver RJ45	0	9999	AIX, IBM i, and Linux	Both
EB49		QSFP28 to SFP28 Connector	0	32	N/A	Both
EB57		QSFP+ 40 GbE Base-SR4 Transceiver	0	32	N/A	Both
EB59		100 GbE Optical Transceiver QSFP28	0	9999	N/A	Both

## 2.7 External I/O subsystems

The I/O capacity of the Power E1080 can be expanded by using extra external PCIe expansion drawers and external disk expansion drawers. The I/O expansion drawers provide more PCIe slots, and the disk expansion drawers provide more disk or NVMe drive slots for storage capacity.

### 2.7.1 PCIe Gen4 I/O expansion drawer

This 19 inch, 4U (4 Electronic Industries Alliance (EIA)) enclosure provides PCIe Gen4 slots outside of the system unit. It has two module bays. One 6-slot Fanout Module (#ENZF) can be placed in each module bay. Two 6-slot modules provide a total of 12 PCIe Gen4 slots. Each fanout module is connected to a PCIe4 Optical Cable adapter that is installed in the system unit over a CXP AOC pair or CXP copper cable pair.

The PCIe Gen4 I/O Expansion Drawer has two redundant, hot-plug power supplies. Each power supply has its own separately ordered power cord. The two power cords plug in to a power supply conduit that connects to the power supply. The single-phase AC power supply is rated at 1025 W and can use 100 - 127 V or 200 - 240 V. It is a best practice that the power supply connects to a power distribution unit (PDU) in the rack. IBM Power PDUs are designed for a 200 - 240 V electrical source.

A blind-swap cassette (BSC) is used to house the full-height adapters that are installed in these slots. The BSC is the same BSC that is used with previous generation PCIe Gen 3 12X attached I/O drawers (#5802, #5803, #5877, #5873, and #EMX0). The drawer includes a full set of BSCs, even if the BSCs are empty.

Concurrent repair, and adding or removing PCIe adapters, is done by HMC-guided menus or by operating system support utilities.

IBM PCIe Gen4 I/O expansion drawer BSCs are mechanically the same as the previous PCIe Gen3 I/O expansion drawers, but the color is different for the touch points. Instead of the terracotta color, the BSCs in the Gen4 I/O expansion drawer are blue. For that reason, cassettes from Gen3 I/O expansion drawers should not be moved to the Gen4 I/O expansion drawer.

Figure 2-25 shows a PCIe4 expansion drawer from the front.

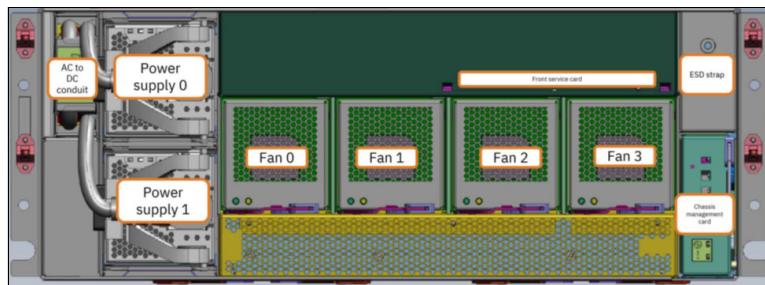


Figure 2-25 Front view of a PCIe Gen4 expansion drawer

Figure 2-26 on page 95 shows a PCIe Gen4 expansion drawer 3D from the rear.

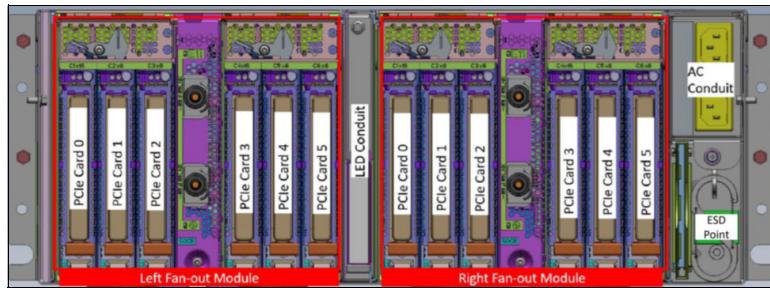


Figure 2-26 Rear view of a PCIe Gen4 expansion drawer

### PCI slots that are available in the PCIe Gen4 expansion drawer

Table 2-23 lists the PCI slots in the PCIe Gen4 I/O expansion drawer that is equipped with two PCIe4 6-slot fan-out modules.

Table 2-23 PCIe slot configuration in the PCIe Gen4 I/O expansion drawer

Slot	Location Code	Description
Left I/O module Slot 0	P0-C0	PCIe x16 adapter
Left I/O module Slot 1	P0-C1	PCIe x16 adapter
Left I/O module Slot 2	P0-C2	PCIe x16 adapter
Left I/O module Slot 3	P0-C3	PCIe x16 adapter
Left I/O module Slot 4	P0-C4	PCIe x8 adapter <sup>a</sup>
Left I/O module Slot 5	P0-C5	PCIe x8 adapter <sup>a</sup>
Right I/O module Slot 0	P1-C0	PCIe x16 adapter
Right I/O module Slot 1	P1-C1	PCIe x16 adapter
Right I/O module Slot 2	P1-C2	PCIe x16 adapter
Right I/O module Slot 3	P1-C3	PCIe x16 adapter
Right I/O module Slot 4	P1-C4	PCIe x8 adapter <sup>a</sup>
Right I/O module Slot 5	P1-C5	PCIe x8 adapter <sup>a</sup>

a. All 6 slots, including the x8 slots, use x16 connectors.

- ▶ All slots are PCIe4 slots.
- ▶ All slots support full-length, full-height adapters or short form-factor with a full-height tail stock in single-wide generation 3 BSCs.
- ▶ Slots C0 - C3 in each PCIe4 6-slot fanout module are PCIe4 x16 buses, and slots C4 and C5 are PCIe4 x8 buses.
- ▶ All slots support EEH.
- ▶ All PCIe slots can be serviced with the power on.
- ▶ All six slots in a PCIe4 6-slot Fanout Module support Single Root I/O Virtualization (SR-IOV) shared mode.
- ▶ Only four Feature Code EC2S, Feature Code EC2U, or Feature Code EC72 Adapters Can Be In SR-IOV Mode Simultaneously Per 6-slot Fanout module.

## Fanout modules that are supported by a system

The number of fanout modules that are supported in a system differs by the system type. The number of fanout modules determines the number of additional PCIe slots that are supported by the system.

Table 2-24 lists the maximum number of fanout modules that are supported and the total number of cables per system for each Power E1080 server.

*Table 2-24 Number of supported fanout modules per system*

System name	Maximum fanout modules	Maximum number of G4 copper cables	Maximum number of G4 AOC cables
IBM Power E1080	12	12	12

## Supported PCIe4 cable adapters

The supported cable card adapters for Power10 servers are listed in Table 2-25.

*Table 2-25 Supported cable adapters by system type*

System name	Adapter Feature Code and CCIN
IBM Power E1080	PCIe4 cable adapter (Feature Code EJ24; CCIN 6B92)

## PCIe Gen4 I/O expansion drawer optical cabling

Cables and part numbers that are used for the PCIe Gen4 expansion drawer (Feature Code ENZ0) are not compatible and should not be used with previous PCIe Gen3 expansion drawers. Cables from PCIe Gen3 expansion drawers should not be used and are not compatible with the PCIe Gen4 expansion drawer.

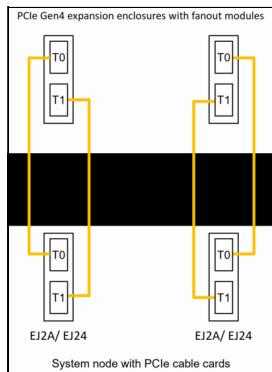
The supported cables and part numbers are listed in Table 2-26.

*Table 2-26 Supported cable features*

CCIN	Feature Code	Part number	Description
C1B0	ECLS	03NG620	3-meter expansion drawer cable (copper)
C1B4	ECLR	78P7687	2-meter AOC
C1B3	ECLX	78P7688	3-meter AOC
C1B2	ECLY	78P7689	10-meter AOC
C1B1	ECLZ	78P7690	20-meter AOC

A PCIe Gen4 I/O expansion drawer with two I/O fanout modules is connected to one host system node through two PCIe4 cable adapters with four expansion drawer cables (two expansion drawer cable pairs). One pair is used for each of the PCIe4 6-slot fanout modules.

Figure 2-27 on page 97 illustrates the connection of two expansion drawer cable pairs for two PCIe4 6-slot Fanout Modules.



*Figure 2-27 Cabling setup for a PCIe Gen4 expansion drawer*

## 2.7.2 PCIe Gen3 I/O Expansion Drawer

This section describes the PCIe Gen3 I/O Expansion Drawer (#EMX0)<sup>4</sup> that can be attached to the Power E1080 server.

The PCIe Gen3 I/O Expansion Drawer (#EMX0) is a 4U high, PCIe Gen3-based and rack-mountable I/O drawer. It offers two PCIe Fanout Modules (#EMXH), each providing six PCIe Gen3 full-high, full-length slots (two x16 and four x8).

The Power E1080 supports four PCIe Gen3 I/O drawer per system node, which yields a maximum of eight I/O drawers per 2-node Power E1080 server configuration. One I/O drawer supports two Fanout Modules that offer six PCIe Gen 3 adapter slots each. This configuration delivers an extra 48 PCIe Gen 3 slot capacity per system node and a maximum of 96 PCIe Gen 3 slots per 2-node server.

All eight slots in a system node can be used to cable the four I/O drawers. It is always a best practice to balance the I/O Drawer connectivity across the available system nodes.

With the availability of 3-node and 4-node Power System E1080 configurations in the later GA period, the number of PCIe Gen 3 I/O drawers scales with a maximum of 16 per 4-node Power E1080. A maximum of 48 PCIe Gen 3 slots per system node and a maximum of 192 PCIe Gen 3 slots per 4-node Power E1080 server to be available at that date.

Each Fanout Module in the PCIe Gen 3 I/O Expansion Drawer (#EMX0) is attached by one optical cable adapter, which occupies one x16 PCIe Gen 4 slot of a system node.

<sup>4</sup> The PCIe Gen 3 I/O Expansion drawer was withdrawn from marketing.

The maximum number of supported I/O drawers and the total number of PCIe slots are listed in Table 2-27.

*Table 2-27 Maximum number of supported I/O drawers and the total number of PCIe slots*

System nodes	Maximum #EMX0 drawers	Total number of slots		
		PCIe Gen 3, x16	PCIe Gen 3, x8	Total PCIe Gen 3
One system node	4	16	32	48
Two system nodes	8	32	64	96
Three system nodes	12	48	96	144
Four system nodes	16	64	128	192

The older Fanout Modules (#EMXF and #EMXG) that are used by Power E870, Power E870C, Power E880, and Power E880C systems cannot be ordered and is not supported by the Power E1080.

For more information about the dimensions of the drawer, see 1.6, “I/O drawers” on page 25.

PCIe Gen 4 cable adapter (#EJ24) CXP 16X AOCs connects the system node to a PCIe Fanout Module in the I/O expansion drawer.

Concurrent repair and addition or removal of PCIe adapters is done by using HMC-guided menus or operating system support utilities.

A BSC is used to house the full-high adapters that are installed into these slots. The BSC is the same BSC that was used with the previous generation server's #5802, #5803, #5877, and #5873 12X attached I/O drawers.

Power consumption is up to 50W per adapter slot.

Figure 2-28 on page 99 shows the rear view of the PCIe Gen3 I/O Expansion Drawer.

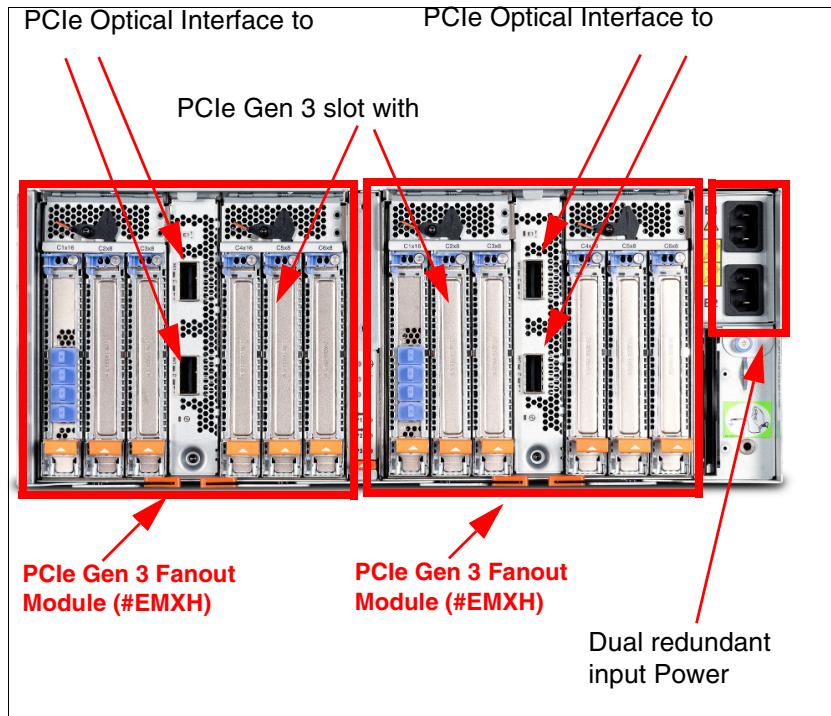


Figure 2-28 Rear view of a PCIe Gen3 I/O Expansion Drawer

### PCIe Gen 4 cable adapter

The PCIe Gen3 I/O Expansion Drawer (#EMX0) is connected to the system node by using a PCIe Gen 4 I/O expansion card (#EJ24) that is placed in any of the PCIe slots within the system node. One expansion card adapter connects to one PCIe Gen 3 6-slot Fanout Module (#EMXH) of the PCIe Gen3 I/O Expansion Drawer(#EMX0) by using a CXP 16X AOC Pair. Therefore, the adapter is also named as PCIe Gen 4 CXP cable adapter.

The PCIe Gen 4 cable adapter is shown in Figure 2-29.

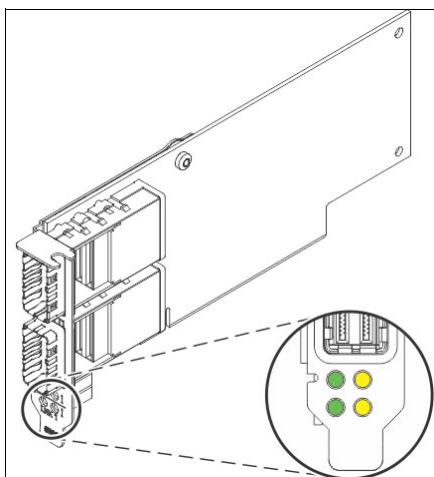


Figure 2-29 PCIe Gen 4 cable adapter (#EJ24)

The PCIe Gen 4 cable adapter (#EJ24) is an HHHL, LP PCIe Gen 4 x16 adapter. The adapter provides two ports for the attachment of CXP 16x AOC pair. One adapter supports the attachment of one PCIe Gen 3 6-slot fanout module in an EMX0 PCIe Gen3 I/O expansion drawer.

Although these cables are not redundant, the loss of one cable reduces the I/O bandwidth (that is, the number of lanes that are available to the I/O module) by 50%.

A total of eight PCIe Gen 4 cable adapters (#EJ24) are allowed per system node to connect to a maximum of eight PCIe Gen 3 6-slot Fanout Modules (#EMXH). Each Fanout Module must go with one CXP 16x AOC cable pair with both ports wired to the same PCIe Gen 4 cable adapter from the system node.

The cable adapter can be placed in any slot in the system node. The following adapter placement sequence in the system node is recommended:

System node slot 1, 7, 3, 6, 2, 8, 4, 5

The maximum number of adapters that are supported is eight per system node and 32 per system, having four system nodes.

Whenever PCIe Gen3 I/O Expansion Drawer(#EMX0) is used, it is recommended to reserve the slots in the system nodes for the PCIe Gen 4 cable adapter (#EJ24) adapters. Place the high-profile adapters within the I/O Expansion Drawers.

Three different types of CXP 16x AOC cable pairs are available for the connection between PCIe Gen 4 cable adapter (#EJ24) and PCIe Gen 3 fanout module (#EMXH) of the I/O Expansion Drawer:

- ▶ 2.0 M (#ECCR)  
This cable is used when I/O drawer is in the *same* rack as the E1080 server.
- ▶ 10.0 M (#ECCY)  
This cable is used when the I/O drawer is in a *different* rack from the E1080 server.
- ▶ 20.0 M (#ECCZ)  
Like the 10.0 M (#ECCY) cable, these cables are used when I/O drawer is in a different rack from the E1080 server.

**Note:** One #ECCR, one #ECCY, or one #ECCZ includes two AOC cables.

### PCIe Gen3 I/O Expansion Drawer optical cabling

I/O drawers are connected to the adapters in the system node by any of the following data transfer cables:

- ▶ 2.0 m CXP 16x AOC Pair (#ECCR)
- ▶ 10.0 m CXP 16x AOC Pair (#ECCY)
- ▶ 20.0 m CXP 16x AOC Pair (#ECCZ)

**Cable lengths:** Use the 2.0 m cables for intra-rack installations. Use the 10.0 m or 20.0 m cables for inter-rack installations.

Older cables #ECC6, #ECC8, and #ECC9 that are used in Power E980 are not supported or orderable on Power E1080. They are supported only as model conversions and announced as RPO.

A minimum of one PCIe Gen 4 Optical Cable Adapter for PCIe Gen 3 Expansion Drawer (#EJ24) is required to connect to the PCIe Gen 3 6-slot Fanout Module in the I/O expansion drawer. The top port of the Fanout Module must be cabled to the top port of the #EJ24 port. Also, the bottom two ports must be cabled together.

To perform the cabling correctly, complete the following steps:

1. Connect an AOC to connector T0 on the PCIe Gen 4 cable adapter (#EJ24) in your server.
2. Connect the other end of the optical cable to connector T1 on one of the PCIe Gen 3 6-slot Fanout Modules in your I/O expansion drawer.
3. Connect another AOC cable to connector T1 on the PCIe Gen 4 cable adapter (#EJ24).
4. Connect the other end of the cable to connector T2 on the same PCIe Gen 3 6-slot Fanout Module in the I/O expansion drawer.
5. Repeat the steps 1 to 4 for the other PCIe Gen 3 6-slot Fanout Module in the I/O expansion drawer, if required.

**Drawer connections:** Each Fanout Module in a PCIe Gen 3 Expansion Drawer (#EMX0) can be connected to only a single PCIe Gen 4 Cable Adapter (#EJ24). However, the two Fanout Modules in a single I/O expansion drawer can be connected to different system nodes in the same server.

Figure 2-30 shows the connector locations of the PCIe Gen3 I/O Expansion Drawer.

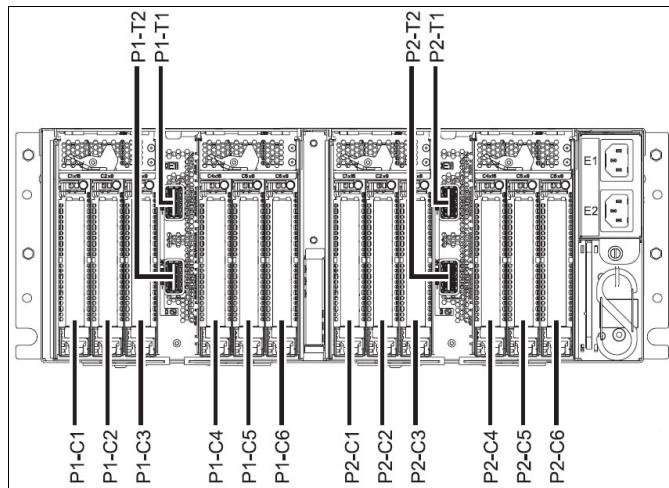


Figure 2-30 Connector locations for the PCIe Gen3 I/O Expansion Drawer

Table 2-28 lists the PCIe slots in the PCIe Gen3 I/O Expansion Drawer.

Table 2-28 PCIe slot locations and descriptions for the PCIe Gen3 I/O Expansion Drawer

Slot	Location code	Description
Slot 1	P1-C1	PCIe Gen 3, x16
Slot 2	P1-C2	PCIe Gen 3, x8
Slot 3	P1-C3	PCIe Gen 3, x8
Slot 4	P1-C4	PCIe Gen 3, x16
Slot 5	P1-C5	PCIe Gen 3, x8

<b>Slot</b>	<b>Location code</b>	<b>Description</b>
Slot 6	P1-C6	PCIe Gen 3, x8
Slot 7	P2-C1	PCIe Gen 3, x16
Slot 8	P2-C2	PCIe Gen 3, x8
Slot 9	P2-C3	PCIe Gen 3, x8
Slot 10	P2-C4	PCIe Gen 3, x16
Slot 11	P2-C5	PCIe Gen 3, x8
Slot 12	P2-C6	PCIe Gen 3, x8

- ▶ All slots support full-length, regular-height adapters or short (LP) adapters with a regular-height tail stock in single-wide, Gen3 BSCs.
- ▶ Slots C1 and C4 in each PCIe Gen 3 6-slot Fanout Module are x16 PCIe Gen 3 buses, and slots C2, C3, C5, and C6 are x8 PCIe buses.
- ▶ All slots support EEH.
- ▶ All PCIe slots are hot-swappable and support concurrent maintenance.

Typical Slot priorities are listed in Table 2-29.

*Table 2-29 PCIe adapter slot priorities for the PCIe Gen3 I/O Expansion Drawer*

<b>Feature Code</b>	<b>Description</b>	<b>Slot priorities</b>
EMX0	Typical Slot priorities	1, 7, 4, 10, 2, 8, 3, 9, 5, 11, 6, 12

For more information about slot priorities for individual adapters, see [IBM Documentation](#).

If the EMX0 PCIe Gen 3 Expansion Drawer is configured with two PCIe Gen 3 6-slot Fanout Modules, distribute the PCIe adapters across both I/O modules whenever possible.

Slots 1, 7, 4, and 10 support SR-IOV capabilities. However, if the total amount of physical memory is less than 128 GB, Slot 4 (P1-C4) and Slot 10 (P2-C4) are not SR-IOV capable.

Figure 2-31 on page 103 shows the connection schematics between system node and PCIe Gen3 I/O Expansion Drawer.

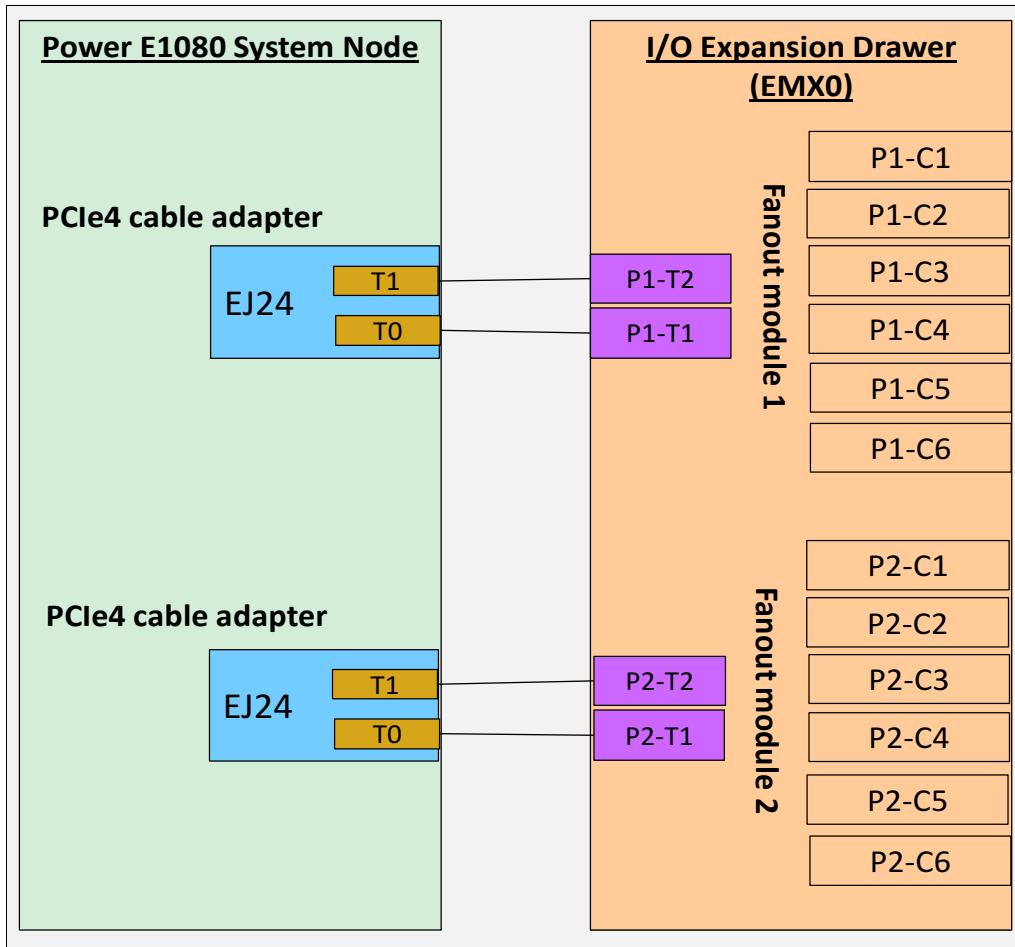


Figure 2-31 Connection schematics between the system node and the Expansion Drawer

### General rules for the PCIe Gen3 I/O Expansion Drawer configuration

The PCIe Gen 4 Cable Adapter (#EJ24) can be in any of the PCIe adapter slots in a Power E1080 system node. However, it is a best practice to first populate the PCIe adapter slots according to the slot priorities that are discussed in this section. If an I/O expansion drawer is present, the PCIe Gen 4 cable adapter (#EJ24) must be given the highest priority.

Each processor module drives two PCIe Gen5 slots, and all slots are equal regarding their bandwidth characteristics. If you first use the slots following the slot priorities, you help ensure that one PCIe Gen5 slot per processor module is populated before you use the second PCIe Gen5 slot of the processor modules.

Table 2-30 lists the PCIe adapter slot priorities in the Power E1080 server. If the sequence is chosen as listed in the slot priority column, the adapters are assigned to the SCM in alignment with the internal enumeration order: SCM0, SCM1, SCM2, and SCM3.

Table 2-30 PCIe adapter slot priorities

Feature Code	Description	Slot priorities
EJ24	PCIe Gen 4 Optical Cable Adapter for PCIe Gen 3 Expansion Drawer	1, 7, 3, 6, 2, 8, 4, 5

The following figures show several examples of supported configurations. (For simplification, we do not show every possible combination of the I/O expansion drawer to server attachments.)

Figure 2-32 shows an example of a Power 1080 that features a single system node and four PCIe Gen3 I/O Expansion Drawers. Each lane between the #EJ24 adapter and I/O drawer fanout module represents a CXP 16x AOC pair.

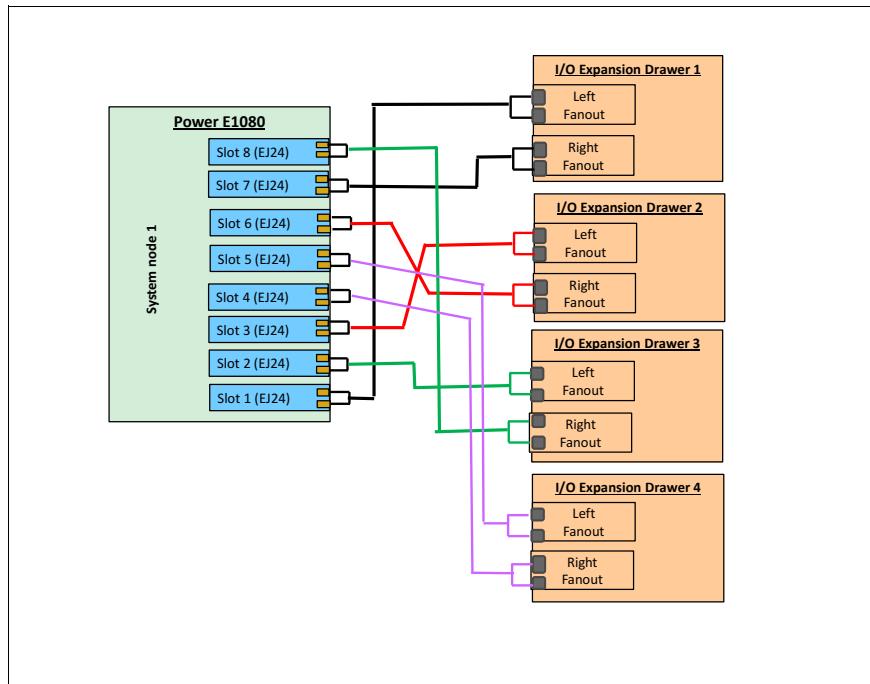


Figure 2-32 Single system node to four PCIe Gen3 I/O Expansion Drawer connections

Figure 2-33 on page 105 shows an example of a Power E1080 having two system nodes and four PCIe Gen3 I/O Expansion Drawers. Each lane between the #EJ24 adapter and I/O drawer fanout module represents a CXP 16x AOC pair.

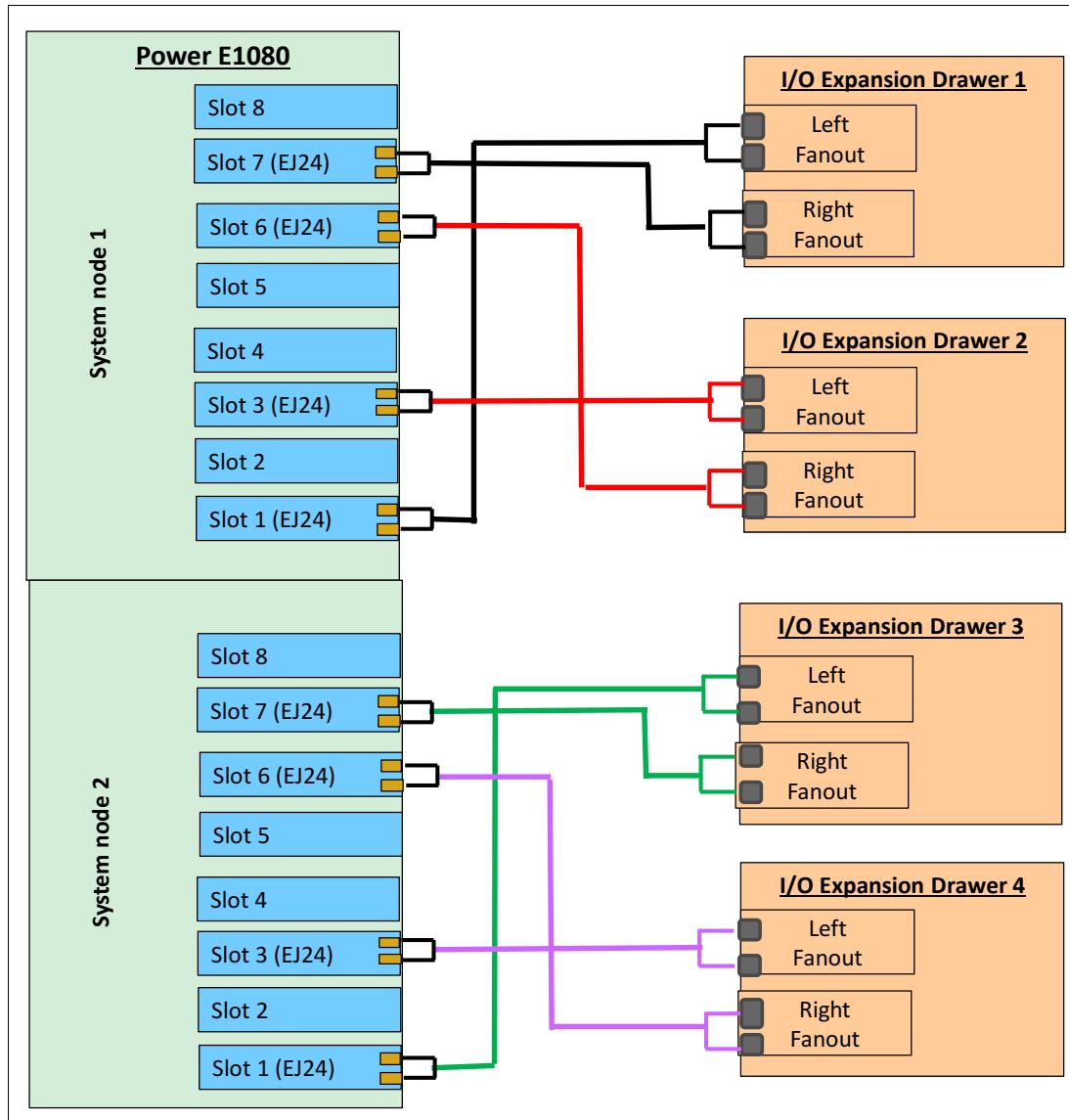


Figure 2-33 Dual-system node to four PCIe Gen3 I/O Expansion Drawer connections

### PCIe Gen3 I/O Expansion Drawer SPCN cabling

No system power control network (SPCN) is used to control and monitor the status of power and cooling within the I/O drawer. SPCN capabilities are integrated into the optical cables.

## 2.8 External disk subsystems

This section describes the following external disk subsystems that can be attached to the Power E1080 server:

- ▶ NED24 NVMe Expansion Drawer
- ▶ IBM EXP24SX SAS Storage Enclosure

### 2.8.1 NED24 NVMe Expansion Drawer

The NED24 NVMe Expansion Drawer (#ESR0) is a storage expansion enclosure with 24 U.2 NVMe bays.

Each of the 24 NVMe bays in the NED24 drawer is separately addressable, and each can be assigned to a specific LPAR or VIOS to provide native boot support for up to 24 partitions. At the time of writing, each drawer can support up to 153 TB.

Figure 2-34 shows a view of the front of the NED24 NVMe Expansion Drawer.



Figure 2-34 NED24 NVMe Expansion Drawer front view

Up to 24 U.2 NVMe devices can be installed in the NED24 drawer by using 15 mm Gen3 carriers. The 15 mm carriers can accommodate either 7 mm or 15 mm NVMe devices. The devices that are shown in Table 2-31 are supported in the NED24 drawer at the time of writing.

Table 2-31 Devices that are supported in the NED24 Expansion Drawer

Feature	Description
ES3H	Enterprise 800 GB SSD PCIe4 NVMe U.2 module for AIX/Linux
ES3A	Enterprise 800 GB SSD PCIe4 NVMe U.2 module for IBM i
ES3B	Enterprise 1.6 TB SSD PCIe4 NVMe U.2 module for AIX/Linux
ES3C	Enterprise 1.6 TB SSD PCIe4 NVMe U.2 module for IBM i
ES3D	Enterprise 3.2 TB SSD PCIe4 NVMe U.2 module for AIX/Linux
ES3E	Enterprise 3.2 TB SSD PCIe4 NVMe U.2 module for IBM i
ES3F	Enterprise 6.4 TB SSD PCIe4 NVMe U.2 module for AIX/Linux
ES3G	Enterprise 6.4 TB SSD PCIe4 NVMe U.2 module for IBM i

Each NED24 NVMe Expansion Drawer contains two redundant AC power supplies. The AC power supplies are part of the enclosure base.

## Prerequisites and support

This section provides information about the operating system and firmware requirements for the NED24 drawer.

### Power10 servers

The NED24 drawer is supported in the Power E1080 by using the same interconnect card that is used for the PCIe Gen 4 and PCIe Gen 3 expansion drawers. A maximum of three NED24 NVMe expansion drawers is supported per system node in the E1080. When mixing the different expansion drawers, the maximum number of drawers that are supported is based on the number of EJ24 fanout cards that are supported.

Two PCIe4 cable adapters are required to connect each NED24 drive enclosure. This adapter is available as Feature Code EJ24. This adapter is the same one that is used to connect the PCIe Gen3 I/O expansion drawer. For more information about the EJ24 adapters, see 1.6.1, “System node PCIe interconnect features” on page 25.

## Installation considerations

This section describes installation considerations for installing and connecting the NED24 drawer to your Power10 scale-out server.

### Connecting the NED24 NVMe Expansion Drawer

The NED24 NVMe Expansion Drawer is connected to a Power server through dual CXP Converter adapters (#EJ24 or #EJ2A). The adapters are connected to the Expansion Service Manager (ESM) modules in the NED24 drawer by using either copper cables (up to 3 m) or optical cables (up to 20 m). The back of the NED24 drawer is shown in Figure 2-35, where you can see the locations to plug in the cables.



Figure 2-35 Back view of the NED24 Expansion Drawer

Both CXP Converter adapters require one of the following cable features:

- ▶ #ECLR - 2.0 M AOC x16 Pair for PCIe4 Expansion Drawer
- ▶ #ECLS - 3.0 M CXP x16 Copper Cable Pair for PCIe4 Expansion Drawer
- ▶ #ECLX - 3.0 M AOC x16 Pair for PCIe4 Expansion Drawer
- ▶ #ECLY - 10 M AOC x16 Pair for PCIe4 Expansion Drawer
- ▶ #ECLZ - 20 M AOC x16 Pair for PCIe4 Expansion Drawer

**Note:** Each Feature Code provides two cables that connect from the server adapter to one of the ESMs. The same Feature Code should be used to connect the second server adapter to the other ESM. Each drawer requires two identical cable Feature Codes to connect.

## Operating system support

The NED24 drawer is supported by the operating systems that are shown in Table 2-32 at the time of writing.

Table 2-32 Operating support for the NED24 Expansion Drawer

Operating system	Levels supported
AIX	7.2 and 7.3
IBM i	7.4 and 7.5
Linux	SUSE Linux Enterprise Server 15 and SUSE Linux Enterprise Server 16 RHEL 8 and RHEL 9
VIOS	3.1.4.21

## Firmware requirements

The minimum system firmware level that is required to support the NED24 drawer is FW1040, which requires HMC 10.2.1040 or later. When running with FW1040 or FW1050, the NED24 drawer runs in single-path mode. In single-path mode, each drive has a single connection to one of the ESMs. As a best practice, use OS mirroring to provide high availability. Multipath connectivity is available starting with FW1060. For more information, see “Multipath support”.

**Important:** The NED24 requires FW1040 or later to be installed on the system that is connected. If you are running FW 1040, then the following adapters are *not supported* by FW1040, and are *not* concurrently installable with the NED24 drawer with FW 1040.

- ▶ PCIe3 12 Gb x8 SAS Tape HBA adapter(#EJ2B/#EJ2C)
- ▶ PCIe4 32 Gb 4-port optical Fibre Channel adapter (#EN2L/#EN2M)
- ▶ PCIe4 64 Gb 2-port optical Fibre Channel adapter (#EN2N/#EN2P)
- ▶ Mixed DDIMM support for the Power E1050 server (#EMCM)
- ▶ 100 V power supplies support for the Power S1022s server (#EB3R)

This restriction is removed with FW 1050 or later.

## Multipath support

From initial availability with firmware levels FW 1040 and FW 1050, only mode 1 (single connect) is supported for the NED24 NVMe Expansion drawer. In mode 1, only one of the ports on the dual-port NVMe drives is enabled and connected to one of the ESMs. As a best practice, use OS mirroring for critical devices because there is a single point of failure. The switch in each of the ESMs is configured to logically drive only 12 of the 24 NVMe drives. No device failover capability is available.

Starting with FW 1060, the NED24 NVMe drawer supports multipath. The multipath function supports two connections for each drive because each of the ports on the multiport drives is connected through both ESMs. This function provides more reliability, availability, and serviceability (RAS) and better performance.

Multipath is automatically enabled with FW 1060 and enabled when the appropriate OS level is installed.

Figure 2-36 on page 109 shows the multipath support for the NED24 drawer.

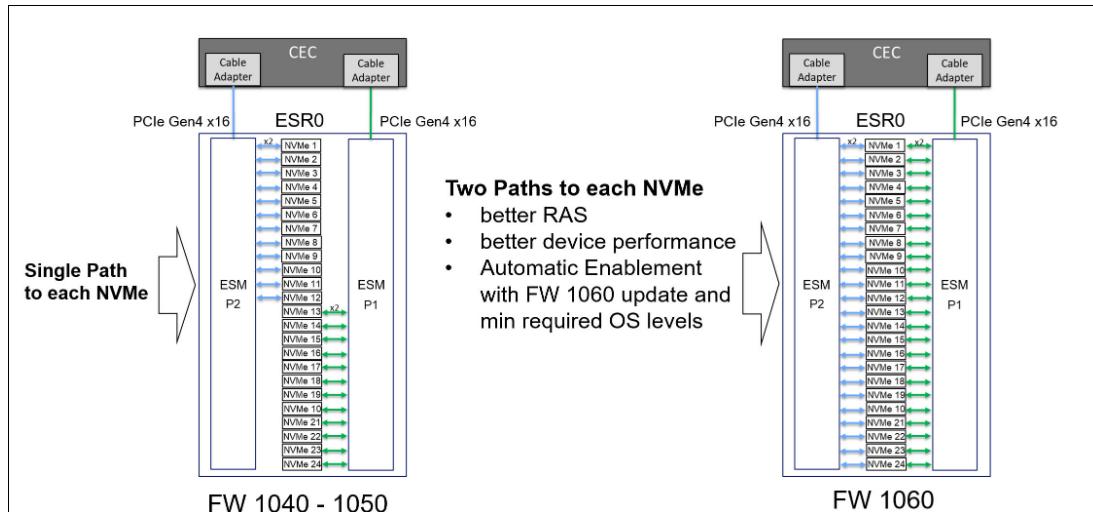


Figure 2-36 NED24 multipath support

Multipath support is provided in the operating systems that are shown in Table 2-33.

Table 2-33 Multipath support by operating system

Operating System	Supported releases
AIX	<ul style="list-style-type: none"> <li>▶ AIX Version 7.3 with the 7300-02 Technology Level and Service Pack 7300-02-02-2420 or later</li> <li>▶ AIX Version 7.2 with the 7200-05 Technology Level and Service Pack 7200-05-08-2420 or later</li> <li>▶ AIX Version 7.3 with the 7300-01 Technology Level and Service Pack 7300-01-04-2420 or later</li> </ul>
IBM i	<ul style="list-style-type: none"> <li>▶ IBM i 7.5 TR4 or later</li> <li>▶ IBM i 7.4 TR10 or later</li> </ul>
Linux	<ul style="list-style-type: none"> <li>▶ SUSE Linux Enterprise Server 15.5 or later</li> <li>▶ RHEL 9.2 or later</li> </ul>

**Important:** Both ESMs must be connected to the same server. Single connections and multiple server connections are not supported.

### Enabling multipath with AIX

IBM AIX operating system is enhanced to support multipath I/O capability with NVMe U.2 drives in NED24 configuration with following releases:

- ▶ AIX Version 7.3 with the 7300-02 Technology Level and Service Pack 7300-02-02-2420 or later
- ▶ AIX Version 7.2 with the 7200-05 Technology Level and Service Pack 7200-05-08-2420 or later
- ▶ AIX Version 7.3 with the 7300-01 Technology Level and Service Pack 7300-01-04-2420 or later

When using FW1060.10 or later, each NVMe U.2 drive in the NED24 NVMe expansion drawer has a “-R1” or “-R2” suffix that is added to the end of its physical location code. Both drive paths must be assigned to a single LPAR by using the HMC’s LPAR Physical I/O Adapters page or through the partition’s profile. The Partner Location Code column can be used to identify the other path to the NVMe U.2 drive in a multipath configuration, as shown in Figure 2-37.

The screenshot shows the 'Physical I/O Adapters' page in the HMC interface. At the top, there are 'Save' and 'Cancel' buttons. Below that, a note says: 'The table lists all the adapters that are connected to the logical partition. Click Add Adapter to add a physical I/O adapter to the logical partition.' A 'Learn More' link is also present. The main area is titled 'Assigned Physical I/O Adapters' and contains a table with three columns: 'Physical Location Code', 'Partner Location Code', and 'Description'. There are two rows in the table:

Action	Physical Location Code	Partner Location Code	Description
<input type="checkbox"/>	U50EE.001.WZS001A-P3-C10-R1	U50EE.001.WZS001A-P3-C10-R2	15.36TB NVMe Gen4 U.2 SSD V
<input type="checkbox"/>	U50EE.001.WZS001A-P3-C10-R2	U50EE.001.WZS001A-P3-C10-R1	15.36TB NVMe Gen4 U.2 SSD V

Figure 2-37 HMC display of multipath NVMe drive in NED24

Each of these device paths is seen by AIX as a separate device, for example, nvme0 and nvme1, as shown in “Drive installation order” on page 111.

```
# lsslot -c pci |grep C10
U50EE.001.WZS001A-P3-C10-R1  PCI-E capable, Rev 4 4x lane slot with 2x lanes, U.2 slot  nvme0
U50EE.001.WZS001A-P3-C10-R2  PCI-E capable, Rev 4 4x lane slot with 2x lanes, U.2 slot  nvme1
```

Figure 2-38 NED24 device listing with multipath

For the data on the NVMe drive to be seen through both paths, the NVMe namespace that you are using must be defined as shared. For load balancing of I/O operations between the two drive paths, the namespaces should be created as shared and attached from both drive paths.

In NVMe technology, a namespace (NS) is a logical grouping of data blocks that are accessible to host software. NVMe supports two namespace types:

- ▶ Private namespaces are exclusive to the controller where they are created and cannot be accessed by other controllers within a multi-controller SSD.
- ▶ Shared namespaces can be accessed from multiple controllers (I/O paths) within an NVMe subsystem, which provides increased flexibility and redundancy.

Figure 2-39 illustrates a shared namespace (B) that is accessible from both controllers.

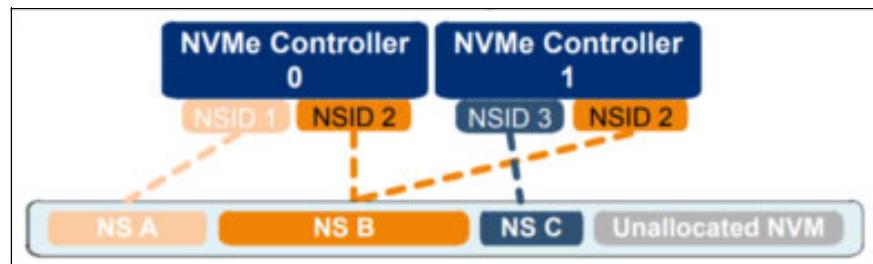


Figure 2-39 Shared and private namespaces

Namespace management within AIX can be done through the SMIT interface.

For more information, see this [blog post](#).

## Drive installation order

Although there is no performance difference for drives in any of the NED24 slots, there is a recommended order for installation of drives within the enclosure. This order is especially important if you are not running in an environment that supports multipath and plan on using OS-level mirroring. The recommendation provides good separation and good support for the suggested mirroring between drives, and also provides optimal cooling and airflow within the enclosure.

Figure 2-40 shows the suggested placement for the first four drives



Figure 2-40 Drive installation order

Table 2-34 shows the suggested placement of all drives.

Table 2-34 Recommended drive installation order

Drive pair	First drive slot	Second drive slot
1	1	13
2	7	19
3	2	14
4	8	20
5	3	15
6	9	21
7	4	16
8	10	22
9	5	17
10	11	23
11	6	18
12	12	24

## Summary

The NED24 drawer provides an excellent method of increasing the internal NVMe storage in the Power10 processor family and should be considered instead of external SAS. NVMe provides a lower price per GB than SAS-based enclosures and also provides better performance.

Table 2-35 shows a summary of the NED24 specifications.

*Table 2-35 Summary of the NED24 specifications*

External storage drawer specifications	ESR0 PCIe NED24
Rack mount	2U 19" rack
Devices supported	24 SFF 15 mm U.2 NVMe devices
Max enterprise class storage capacity	153.6 TB
Internal connectivity	PCIe Gen4
External Connectivity	Dual PCIe Gen4 CXP Cable Adapters
Cables	Copper cables up to 3 m AOCs up to 20 m
Electronics service module	Dual redundant ESMs with 24 PCIe Gen4 lanes each
ESM RAS	Hot insert/removal Power Fault Tolerant
Power supply	Dual 'EU Regulation 2019 42' Compliant Power Supply <ul style="list-style-type: none"> <li>▶ 180 - 264 VAC 50/60 MHz</li> <li>▶ No DC option</li> <li>▶ N-1 power and cooling</li> <li>▶ Hot swappable</li> </ul>
Operating systems	AIX, IBM i, Linux, and VIOS
Platforms supported	Power10
Major Field-Replaceable Unit (FRU) parts	NVMe devices, cable card, ESM, power supply unit (PSU) and PDB, cables, and mid-plane
Concurrent maintenance	NVMe devices, ESM, PSUs, and cables
Cooling and power	Redundant cooling and power
Code updates	Concurrent code download

## 2.8.2 IBM EXP24SX SAS Storage Enclosure

The EXP24SX SAS storage enclosure (#ESLS) is the only SAS connected disk drawer that is available for Power E1080 to provide extra SAS disk drives. The ESLS supports SSDs and hard disk drives (HDDs). The ESLS storage enclosures are connected to system units by using a SAS port in the SAS adapters. The EXP24SX has been withdrawn from marketing but is still supported in the Power10 servers.

The EXP24SX is a storage expansion enclosure with 24 2.5-inch SFF SAS bays. It supports 10K and 15 K SAS HDD having 512 and 4 K format drives and enterprise and mainstream class SAS SSDs.

The enclosures can be split logically into one, two, or four independent groups:

- ▶ One set of 24 bays (mode 1) (D1-D24)
- ▶ Two sets of 12 bays (mode 2) (D1-D12) (D13-D24)
- ▶ Four sets of 6 bays (mode 4) (D1-D6) (D7-D12) (D13-D18) (D19-D24)

The front view of the ESLS storage enclosure with drive locations is shown in Figure 2-41.

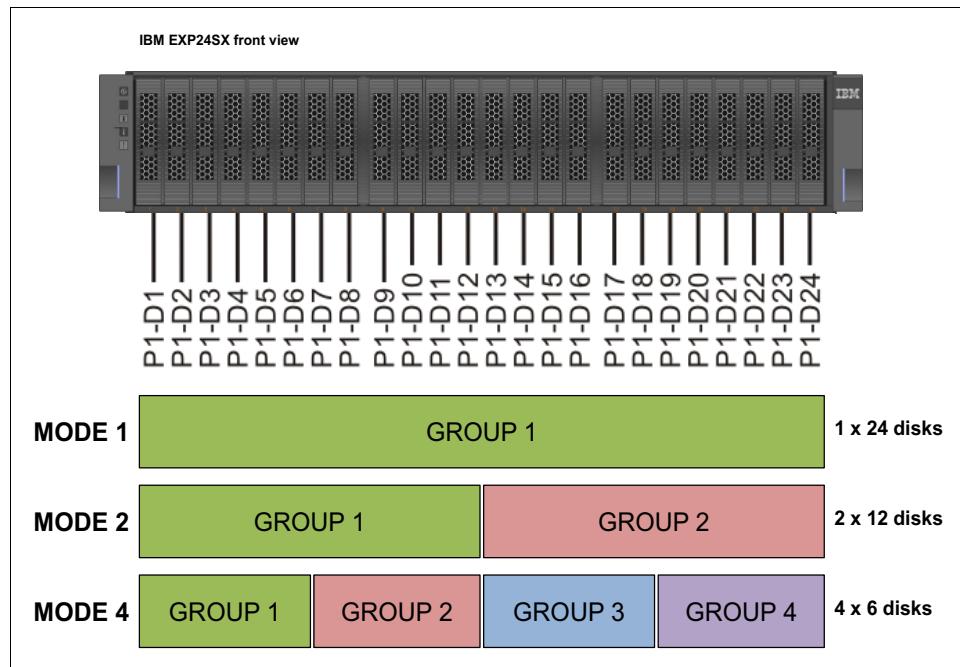


Figure 2-41 Front view of the ESLS Storage Enclosure with mode groups and drive locations

The SAS storage enclosures support the following operating systems:

- ▶ AIX
- ▶ IBM i
- ▶ Linux
- ▶ VIOS

The following PCIe Gen 3 SAS adapters support the EXP24SX drawers:

- ▶ PCIe Gen 3 RAID SAS Adapter Quad-port 6 Gb x8 (#EJ0J)
- ▶ PCIe Gen 3 LP RAID SAS Adapter Quad-Port 6 Gb x8 (#EJ0M)
- ▶ PCIe3 SAS Tape/DVD Adapter Quad-port 6 Gb x8 (#EJ10)
- ▶ PCIe3 LP SAS Tape/DVD Adapter Quad-port 6 Gb x8 (#EJ11)
- ▶ PCIe Gen 3 12 GB Cache RAID Plus SAS Adapter Quad-port 6 Gb x8 (#EJ14)

IBM i configurations require the drives to be protected (RAID or mirroring). Protecting the drives is highly advised, but not required for other operating systems. All Power server operating system environments that use SAS adapters with write cache require the cache to be protected by using pairs of adapters.

The EXP24SX drawers feature the following high-reliability design points:

- ▶ SAS bays that support hot-swap.
- ▶ Redundant and hot-plug power and fan assemblies.
- ▶ Dual power cords.
- ▶ Redundant and hot-plug Enclosure Services Managers (ESMs).
- ▶ Redundant data paths to all drives.

- ▶ LED indicators on drives, bays, ESMs, and power supplies that support problem identification.
- ▶ Through the SAS adapters and controllers, drives that can be protected with RAID and mirroring and hot-spare capability.

**Notes:** Consider the following points about mixing SSDs and HDDs:

- ▶ SSDs and HDDs cannot be mixed when configured in mode 1.
- ▶ SSDs and HDDs can be mixed when configured in mode 2: One disk partition can be SSDs and the other disk partition can be HDDs, but you cannot mix within a disk partition.
- ▶ SSDs and HDDs can be mixed when configured in mode 4. Each disk partition can be SSDs *or* HDDs, but cannot mix within a disk partition.

For example, in a mode 2 drawer with two sets of 12 bays, one set can hold SSDs and one set can hold HDDs, but you cannot mix SSDs and HDDs in the same set of 12-bays.

## SAS cabling

The cables that are used to connect an #ESLS storage enclosure to a server are different from the cables that are used with the 5887 disk drive enclosure. Attachment between the SAS controller and the storage enclosure SAS ports is through the suitable SAS YO12 or X12 cables. The PCIe Gen3 SAS adapters support 6 Gb throughput. The EXP12SX drawer supports up to 12 Gb throughput if future SAS adapters support that capability.

The following cable options are available:

- ▶ 3.0 M SAS X12 Cable (Two Adapter to Enclosure (#ECDJ))
- ▶ 4.5 M SAS X12 AOC (Two Adapter to Enclosure (#ECDK))
- ▶ 10 M SAS X12 AOC (Two Adapter to Enclosure (#ECDL))
- ▶ 1.5 M SAS YO12 Cable (Adapter to Enclosure (#ECDT))
- ▶ 3.0 M SAS YO12 Cable (Adapter to Enclosure (#ECDU))
- ▶ 4.5 M SAS YO12 AOC (Adapter to Enclosure (#ECDV))
- ▶ 10 M SAS YO12 AOC (Adapter to Enclosure (#ECDW))

Six SAS connectors are at the rear of the EXP24SX drawers to which SAS adapters or controllers are attached. They are labeled T1, T2, and T3; two T1s, two T2s, and two T3s connectors. Consider the following points:

- ▶ In mode 1, two or four of the six ports are used. Two T2 ports are used for a single SAS adapter, and two T2 and two T3 ports are used with a paired set of two adapters or a dual adapters configuration.
- ▶ In mode 2 or mode 4, four ports are used, two T2s and two T3 connectors, to access all the SAS bays.
- ▶ The T1 connectors are not used.

Figure 2-42 shows the connector locations for the EXP24SX storage enclosure.

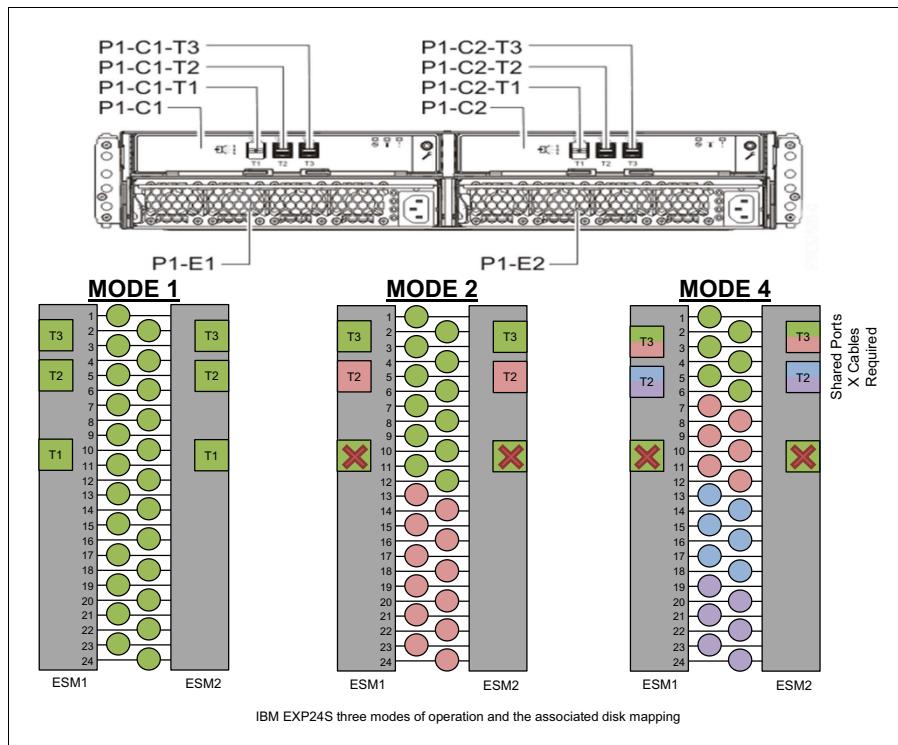


Figure 2-42 Rear view of the EXP24SX with location codes and different split modes

Mode setting is done by IBM Manufacturing. If you need to change the mode after installation, ask your IBM System Services Representative (IBM SSR) for support.

For more information about SAS cabling and cabling configurations, see “Connecting an #ESLS storage enclosure to your system” in [IBM Documentation](#).

## 2.9 System control and clock distribution

Power E1080 server requires universal power interconnect (UPIC), FSP and SMP cables for inter-drawer connections:

- ▶ UPIC cables allow the system nodes to power the SCU.
- ▶ FSP cables are required to provide system control to the components.
- ▶ SMP cables are necessary to extend the A bus interface that connects the Power10 processors together across the system nodes.

Similar to the previous generation of Power System E980 server, two service processors are available for redundancy. They are hosted in the SCU and communicate with the system nodes by using the FRU Service Interface (FSI)/Processor Support Interface (PSI) bus connectors that are at the rear of the SCU and the system nodes.

All the service processor communication between the control unit and the system nodes flows though the service processor cables. In comparison to previous generations, the Power E1080 associated SCU is no longer hosting the system clock. Each system node hosts its own redundant clocks.

The cables that are required for communications between the SCU and system nodes depend on the number of system nodes that are installed. When a system node is added, a new set of cables must be also added.

The cables that are necessary for each system node are grouped under a single Feature Code, which allows for a simpler configuration. Each cable set includes a pair of FSP cables, and when applicable SMP cables and UPIC cables.

Table 2-36 lists the available Feature Codes.

*Table 2-36 Features for cable sets*

Feature Code	Description
EFCH	Cable set for system node drawer 1 (FSP + UPIC)
EFCE	Cable set for system node drawer 2 (FSP + SMP)
EFCF	Cable set for system node drawer 3 (FSP + SMP)
EFCG	Cable set for system node drawer 4 (FSP + SMP)

Initial orders of Power E1080 server include one #EFCH, which is required to connect the system node with SCU. This configuration does not require SMP cables, which are necessary only for configurations with two or more system nodes.

Cable sets Feature Codes are incremental and depend on the number of installed system nodes:

- ▶ One system node: #EFCH
- ▶ Two system nodes: #EFCH and #EFCE
- ▶ Three system nodes: #EFCH, #EFCE, and #EFCF
- ▶ Four system nodes: #EFCH, #EFCE, #EFCF, and #EFCG

The redundant FSP provides proprietary interface communication, such as FSI and PSI to the system nodes.

PSI is used for FSP-host processor unit communication. PSI is a clock synchronous bidirectional interface for control communication. Each FSP in the SCU has four PSI interfaces and are connected such that whichever FSP becomes Primary can control the entire system.

FSI in the Power E1080 server is a serial point-to-point connection that is used for device communication in the overall System Control Structure design.

The FSI connection network is across FSP to FSP connections inside the SCU, FSP to system node through clocking and control logic. They connect FSPs in the SCU to system node elements and the Power10 to Power10 processor chips on the system node system board inside the system node. Similar to PSI network, whichever FSP becomes Primary can control the entire server.

Figure 2-43 on page 117 shows the UPIC and FSP cabling between a single system node and a SCU.

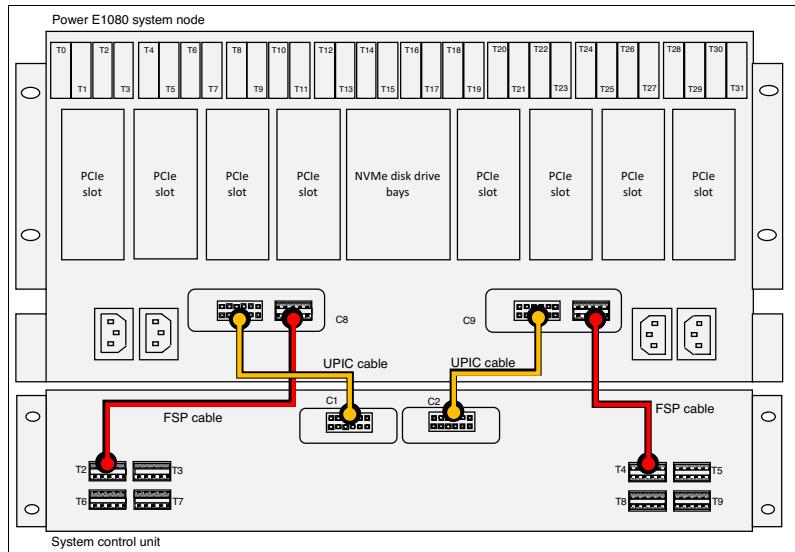


Figure 2-43 UPIC and FSP connection between a SCU and a single system node

Figure 2-44 shows UPIC and FSP cabling between two system nodes and a SCU.

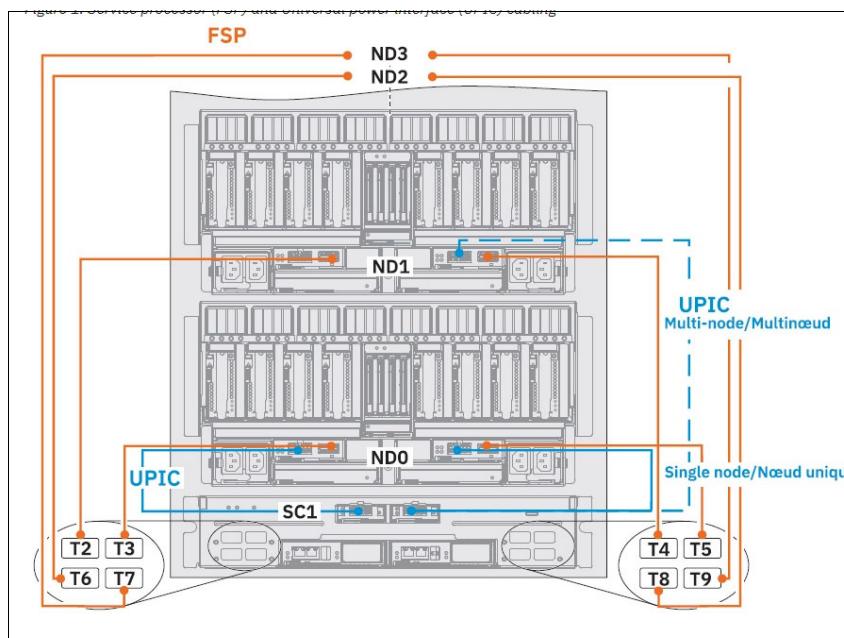


Figure 2-44 UPIC and FSP connection between a SCU and two system nodes

In a single system node configuration, two UPIC cables connect to the SCU and provide a redundant power source from the system node. The SCU power source for two or more system nodes is supplied by the first and second system node. When Power E1080 supports more than two system nodes, power output ports on the third and forth system node are not used.

The system reference clock source is responsible for providing a synchronized clock signal to all functional units. Each system node of a Power E1080 server uses its own private set of two redundant system clock or control cards. If a failure occurs in any of the clock or control cards, the second card helps ensure continued operation of the system until a replacement is scheduled.

Similar to Power E980, the Power E1080 server does not require a global reference clock source in the system control.

Figure 2-45 shows UPIC and FSP cabling between three system nodes and a SCU.

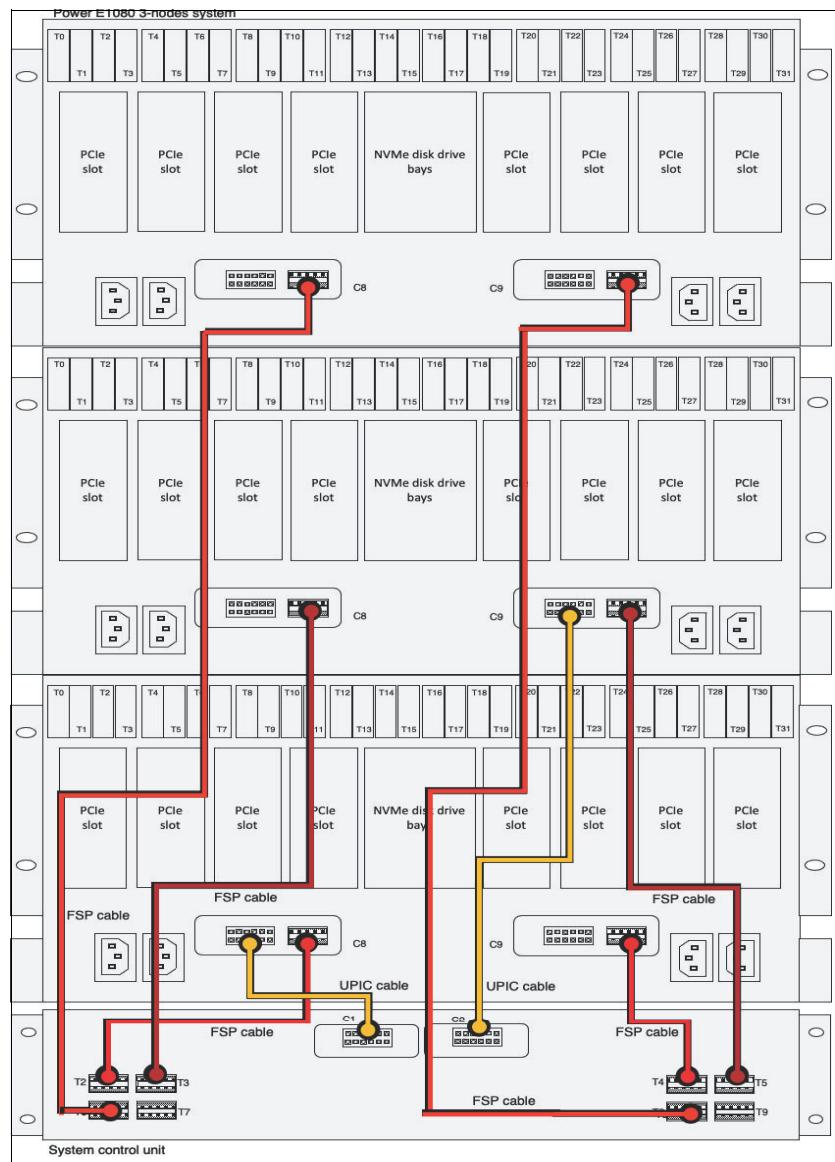


Figure 2-45 UPIC and FSP connection between a SCU and three system nodes

Figure 2-46 shows UPIC and FSP cabling between four system nodes and a SCU.



Figure 2-46 UPIC and FSP connection between a SCU and four system nodes

## 2.10 Operating system support

The Power E1080 server supports the following operating systems:

- ▶ AIX
- ▶ IBM i
- ▶ Linux

In addition, the VIOS can be installed in special partitions that provide support to other partitions running AIX, IBM i, or Linux OSes for the use of various features, such as virtualized I/O devices, or PowerVM LPM.

For more information about the software that is available on Power servers, see [IBM Power Software](#).

### 2.10.1 Power E1080 prerequisites

The minimum supported levels of IBM AIX, IBM i, and Linux at the time of this writing are described in the following sections. For more information about hardware features, see [IBM Power Prerequisites](#).

This tool also helps to plan a successful system upgrade by providing the prerequisite information for features currently in use or planned to be added to a system. It's possible to choose a machine type and model (9080-HEX for Power E1080) and find out all the prerequisites, operating system levels supported and other information.

### 2.10.2 AIX operating system

At announcement, the Power E1080 supports the following minimum level of AIX:

- ▶ AIX 7.1 TL 5 SP 5
- ▶ AIX 7.2 TL 4 SP 1

AIX 7.1 must run on an LPAR in Power8 compatibility mode with VIOS-based virtual storage and networking. The I/O can be supplied only by the VIOS and the system is LPM enabled, excluding Native VF (SR-IOV) directly in the customer LPAR.

AIX 7.2 can run with physical and virtual I/O and requires Power9 compatibility mode.

NVMe over Fibre Channel fabrics (NVMe-OF) is now available on Power E1080 running AIX when the 2-port 32 Gb adapter (#EN1A or #EN1B) and the selected IBM FlashSystem high-end (IBM FlashSystem 9110) and mid-range (IBM FlashSystem 7200) model are used.

IBM periodically releases maintenance packages (service packs or technology levels) for the AIX operating system. For more information about these packages, downloading, and obtaining the CD-ROM, see [Fix Central](#).

The Service Update Management Assistant (SUMA), which can help you automate the task of checking and downloading operating system downloads, is part of the base operating system. For more information about the suma command, see [IBM Documentation](#).

AIX is available as stand-alone (Standard Edition), Enterprise Edition, or through bundle options:

- ▶ AIX 7.1 Standard Edition
- ▶ AIX 7.1 Enterprise Edition 1.6
- ▶ AIX 7.2 Standard Edition
- ▶ AIX 7.2 Enterprise Edition
- ▶ AIX 7.2 Enterprise Cloud Edition

A major update for Enterprise Cloud Edition Bundles version includes PowerSC 2.0.

Customers that are purchasing a new Power E1080 can get this stack with their system purchase. Customers with existing systems and active SWMA by using either of the Bundles can get this Product by using ESS and start using it immediately.

### **Subscription licensing model**

Per the Power E1080 announcement, a new subscription licensing model is available. This model provides customers with more options and flexibility in how they use the software.

A subscription license is a licensing model that provides access to an IBM program and IBM SWMA for a specified subscription term (one or three years). The subscription term begins on the start date and ends on the expiration date, which is reflected in ESS.

Customers are licensed to run the product through the expiration date of the 1- or 3-year subscription term and then can renew at the end of the subscription to continue using the product. This model provides flexible and predictable pricing over a specific term, with lower up-front entry cost.

Another benefit of this model is that the licenses are customer number entitled, which means they are not tied to a specific hardware serial number as with perpetual licenses. Therefore, the licenses can be moved between on-premises and cloud if needed, something that is becoming more of a requirement with hybrid workloads.

The new Product IDs for the subscription licenses are listed in Table 2-37.

*Table 2-37 New subscription license PIDs (1-year or 3-year terms)*

<b>PID</b>	<b>Description</b>
5765-2B1	AIX 7 Standard Edition
5765-2E1	AIX 7 Enterprise Edition 1.6
5765-2C1	Enterprise Cloud Edition 1.6 with AIX 7
5765-6C1	Enterprise Cloud Edition 1.6

The licenses are orderable through IBM configuration tools. The AIX perpetual and monthly term licenses for standard edition are still available.

### **2.10.3 IBM i**

IBM i is supported on the Power E1080 server by the following minimum required levels:

- ▶ IBM i 7.3 TR11 or later
- ▶ IBM i 7.4 TR5 or later

For compatibility information for hardware features and the corresponding IBM i Technology Levels, see [IBM Prerequisites](#).

## **IBM i operating system transfer**

IBM i customers can move to new Power E1080 servers, just like previous new system non-serial preserving upgrades/replacements.

IBM i terms and conditions require that IBM i operating system license entitlements remain with the machine for which they were originally purchased. Under qualifying conditions, IBM allows the transfer of IBM i processor and user entitlements from one machine to another. This capability helps facilitate machine replacement, server consolidation, and load rebalancing while protecting a customer's investment in IBM i software. When the requirements are met, the IBM i license transfer can be configured by using IBM configuration tools.

The following prerequisites must be met for transfers:

- ▶ The IBM i entitlements are owned by the user's enterprise.
- ▶ The donor machine and receiving machine are owned by the user's enterprise.
- ▶ The donor machine must have been owned in the same user's enterprise as the receiving machine for a minimum of 1 year.
- ▶ SWMA is on the donor machine. Each software entitlement to be transferred has SWMA coverage.
- ▶ An electronic Proof of Entitlement (ePoE) exists for the entitlements to be transferred.
- ▶ The donor machine entitlements are IBM i 5.4 or later.
- ▶ The receiving machine includes activated processors that are available to accommodate the transferred entitlements.

Each IBM i processor entitlement that is transferred to a target machine includes one year of new SWMA at no charge. Extra years of coverage or 24x7 support are available options for an extra charge.

### **2.10.4 Linux**

The following types of Linux distributions are available to run on Power E1080:

- ▶ With native Power10 processor technology support
- ▶ Running in Power9 compatibility mode

Distributions with native Power10 processor technology support can also run in Power9 compatibility mode. This feature is important when doing LPM from a Power9 processor-based server to Power E1080.

#### **Red Hat**

RHEL version 8.4 and later can run in native Power10 processor mode. At the time of this writing, RHEL version 8.4 was available.

Red Hat OpenShift and CoreOS are also supported.

#### **SUSE**

SUSE 15 SP3 is the first version with native Power10 processor technology support. Its regular support cycle is 18 months, plus long-term SP support.

## **Ubuntu Server for IBM POWER**

Ubuntu Linux Server is supported on IBM Power10 by Canonical. Ubuntu Server for IBM Power brings Ubuntu Server and Ubuntu Server for Cloud to the Power platform (little endian), opening the door to the scale-out and cloud markets. IBM Power is optimized for workloads in the mobile, social, cloud, big data, analytics and machine learning spaces. With its unique deployment toolset (including Juju and MAAS), Ubuntu makes the management of those workloads simple.

Canonical and the Ubuntu community work together with IBM to help ensure that Ubuntu Server and Ubuntu OpenStack work seamlessly with IBM Power and IBM software applications.

Starting with Ubuntu 22.04 LTS, Power9 and Power10 processors are supported. For more information, see [Ubuntu on IBM Power](#).

### **Older distributions**

The following selected older distributions also are supported on Power E1080:

- ▶ RHEL 8.2 is supported in Power9 compatibility mode only
- ▶ SUSE Linux Enterprise Server 12 SP5 is supported in Power9 compatibility mode only

When an LPAR runs in Power9 compatibility mode, it benefits from most of the features of the Power10 processor technology, including the full eight threads per core. However, program and kernel features that use new Power10 instructions or capabilities are not available.

The Power9 compatibility mode is required when moving partitions back and forth between Power9 processor based-systems and Power10 processor-based systems. After a partition is moved to a Power10 processor-based systems, it can be upgraded to a distribution with native Power10 technology support and restarted in native Power10 mode.

**Note:** No official support for Power9 compatibility mode is available for older service pack of SUSE Linux Enterprise Server 15, such as SUSE Linux Enterprise Server 15 SP2.

### **Enhancements**

One of the main features of the Power10 processor chip is the possibility to support up to 15 cores per SCM. Therefore, on a Power E1080 that is configured with up to 240 processor cores (each capable of running eight threads for up to 1920 possible threads), the Linux distribution with native Power10 technology support can use this capability.

LPARs running in Power9 compatibility mode are restricted to 1536 threads per LPAR, which is the maximum for a Power9 processor-based server.

Table 2-38 lists the maximum logical CPUs, maximum memory, and maximum memory with LPM supported, according to the Linux distribution.

*Table 2-38 Maximum threads versus processing mode*

Linux distribution	Processor mode	Maximum logical CPUs	Maximum memory	Maximum memory with LPM
RHEL 8.2	Power9	1536	64 TB	16 TB
RHEL 8.4	Power10	1920	64 TB	64 TB
SUSE Linux Enterprise Server 12 SP5	Power9	1536	64 TB	32 TB
SUSE Linux Enterprise Server 15 SP3	Power10	1920	64 TB	64 TB

The Power10 specific toolchain is available in [Advance Toolchain](#) 15.0, which allows customers and developers to use all new Power10 processor-based technology instructions when programming. Cross-module function call overhead was reduced because of a new PC-relative addressing mode.

One specific is a 10x-to-20x advantage over Power9 processor-based technology on inferencing workloads because of new memory bandwidth and new instructions. One example is the new special purpose-built matrix math accelerator (MMA) that was tailored for the demands of machine learning and deep learning inference. It also includes many AI data types.

Network virtualization is an area with significant evolution and improvements, which benefit virtual and containerized environments. The following recent improvements were made for Linux networking features on Power E1080:

- ▶ SR-IOV allows virtualization of network cards at the controller level without the need to create virtual Shared Ethernet Adapters (SEAs) in the VIOS partition. It is enhanced with (vNIC) virtual Network Interface Controller, which allows data to be transferred directly from the partitions to or from the SR-IOV physical adapter without transiting through a VIOS partition.
- ▶ Hybrid Network Virtualization (HNV) allows a partition to use the efficiency and performance benefits of SR-IOV logical ports and participate in mobility operations, such as active and inactive LPM and Simplified Remote Restart (SRR). HNV is enabled by selecting a new Migratable option when an SR-IOV logical port is configured.
- ▶ NVMe over Fibre Channel fabrics (NVMe-OF) is now available on Power E1080 running Linux when the 2-port 32 Gb adapter (#EN1A or #EN1B) is and the selected IBM FlashSystem high-end (IBM FlashSystem 9110) and mid-range (IBM FlashSystem 7200) model are used.

## Security

Security is a top priority for IBM and our distribution partners. Linux security on IBM Power is a vast topic that can be the subject of detailed separate material; however, improvements in the areas of hardening, integrity protection, performance, platform security, and certifications are introduced with this section.

Hardening and integrity protection deal with protecting the Linux kernel from unauthorized tampering while allowing upgrading and servicing to the kernel. These topics become even more important when running in a containerized environment with an immutable operating system, such as CoreOS in Red Hat OpenShift.

Performance is also a security topic because specific hardening mitigation strategies (for example, against side-channel attacks), can have a significant performance effect. In addition, cryptography can use significant compute cycles.

The Power E1080 features transparent memory encryption at the level of the controller, which prevents an attacker from retrieving data from physical memory or storage-class devices that are attached to the processor bus.

## 2.10.5 Virtual I/O Server

The minimum required level of VIOS for the Power E1080 server is VIOS 3.1.3.10 or later.

IBM regularly updates the VIOS code. For more information, see [IBM Fix Central](#).

## 2.10.6 Entitled System Support

The ESS website is IBM's goto place to view and manage Power and Storage software and hardware. In general, most products that are offered by IBM Systems that are purchased through our IBM Digital Sales representatives or Business Partners are accessed on this site when the IBM Configurator is used.

The site features the following three main sections:

- ▶ My entitled software: Activities that are related to Power and Storage software that offer to download licensed, no-charge, and trial software media, place software update orders, and manage software keys.
- ▶ My entitled hardware: Activities that are related to Power and Storage hardware that offer to renew Update Access Keys (UAKs), buy and use Elastic CoD, assign or buy credits for new and existing pools in Enterprise Pools 2.0, download Storage CoD codes, and manage Hybrid Capacity credits.
- ▶ My inventory: Activities that are related to Power and Storage inventory that offer to browse software license, SWMA, and hardware inventory, manage inventory retrievals by way of Base Composer or generate several types of reports.

For more information, see [this web page](#).

## 2.10.7 Update Access Keys

Since the introduction of the Power8 processor-based servers, IBM has also introduced the UAK.

When system firmware updates are applied to the system, UAK and its expiration date are checked (see Figure 2-48 on page 128). System firmware updates include a release date.

When attempting to apply system firmware updates, if the release date for the firmware updates passed the expiration date for the UAK, the updates are not processed. As UAKs expire, they need to be replaced by using the HMC or the ASMI on the service processor.

By default, newly delivered systems include an UAK that often expires after three years. Thereafter, the UAK can be extended every six months, but only if a maintenance contract exists. The contract can be verified in the ESS website (for more information, see 2.10.6, “Entitled System Support” on page 125).

Determining when the current UAK runs through the HMC, GUI, or CLI as provided in the following examples. However, it is also possible to display the expiration date by using the suitable AIX or IBM i command.

## Checking the UAK expiration date by using AIX 7.1

In the case of AIX 7.1, use the following command:

```
lscfg -vpl sysplanar0 | grep -p "System Firmware"
```

The output is similar to the output that is shown in Example 2-1 (the Microcode Entitlement Date represents the UAK expiration date).

*Example 2-1 Output of the command to check the UAK expiration date through AIX 7.1*

---

```
$ lscfg -vpl sysplanar0 | grep -p "System Firmware"
System Firmware:
...
Microcode Image.....SV860_138 SV860_103 SV860_138
Microcode Level.....FW860.42 FW860.30 FW860.42
Microcode Build Date.....20180101 20170628 20180101
Microcode Entitlement Date..20190825
Hardware Location Code.....U8284.22A.XXXXXXX-Y1
Physical Location: U8284.22A.XXXXXXX-Y1
```

---

## Checking the UAK expiration date by using AIX 7.2

In the case of AIX 7.2, the output is slightly different from AIX 7.1. Use the following command:

```
lscfg -vpl sysplanar0 |grep -p "System Firmware"
```

The output is similar to the output that is shown in Example 2-2 (the UAK Exp Date represents the UAK expiration date).

*Example 2-2 Output of the command to check the UAK expiration date through AIX 7.2*

---

```
$ lscfg -vpl sysplanar0 |grep -p "System Firmware"
System Firmware:
...
Microcode Image.....SV860_138 SV860_103 SV860_138
Microcode Level.....FW860.42 FW860.30 FW860.42
Microcode Build Date.....20180101 20170628 20180101
Update Access Key Exp Date..20190825
Hardware Location Code.....U8284.22A.XXXXXXX-Y1
Physical Location: U8284.22A.XXXXXXX-Y1
```

---

## Checking the UAK expiration date by using IBM i

By using IBM i as the operating system, it is possible to check the status of the UAK by using the Display Firmware Status window.

If the UAK expired, proceed to the ESS website to replace your UAK. Figure 2-47 shows the output in the IBM i 7.1 and 7.2 releases. In the 7.3 release, the text changes to Update Access Key Expiration Date. The line that is highlighted in Figure 2-47 is displayed whether the system is operating system-managed or HMC managed.

The screenshot shows the 'Display Firmware Status' window. It contains two main sections: system configuration and server firmware details.

**System Configuration:**

	Service partition . . . . . : Yes		Firmware update policy . . . . . : *OPSYS		Server IPL source . . . . . : Permanent		Firmware product ID/release . . . . . : 5733900 VOROMO		Firmware entitlement date . . . . . : 05/07/15		Server IPL required . . . . . : No	
--	-----------------------------------	--	---	--	---	--	--	--	--	--	------------------------------------	--

**Server Firmware Details:**

Copy	--Server firmware--		-Operating system--		Update Status
	Fix pack	PTF ID	Fix pack	PTF ID	
*ACTIVE	ZL780_101	MH00000	ZL780_111	LA00109	None
*TEMP	ZL780_111	LA00109	ZL780_111	FW780.00	None
*PERM	ZL780_101	MH00000	*NONE	*NONE	None
		FW780.00			

Press Enter to continue

F3=Exit F5=Refresh F12=Cancel F14=Display firmware PTFs

Figure 2-47 Display Firmware Status window

## 2.11 Manageability

Manageability of the system is a key component for customers to manage, service, test, and monitor the system performance, security, and reliability.

### 2.11.1 Service user interface

To manage and service the system, the E1080 offers the following service interfaces:

- ▶ ASMI
- ▶ HMC GUI/CLI
- ▶ Operator panel
- ▶ Operating system

ASMI is a graphical interface that is part of the service processor firmware. The ASMI manages and communicates with the service processor. The ASMI is required to set up the service processor and to perform service tasks, such as reading service processor error logs, reading VPD, and controlling the system power.

ASMI can be accessed by using the HMC GUI or CLI or directly attaching a laptop to the FSP port with an Ethernet cable that is crossed or through a switch (the same network subnet is required). Some of the functions in the ASMI are limited only to IBM service representatives, which require celogin or dev user credentials during repair activities.

The control panel functions allow you to interface with the server. Control panel functions range in complexity from functions that display a status (such as IPL speed) to service functions that only service representatives can access.

For more information about a full list of all functions, see [this web page](#).

The HMC GUI/CLI is the main manageable interface for customers. With HMC V10R1, the layout and the steps changed from previous versions.

## 2.11.2 System firmware maintenance

Starting with HMC V10R1 M1010, the main menu was rearranged to classify the features that makes more sense in grouping.

Complete the following steps to update the firmware:

1. Click **Update Firmware** → **System Firmware** → **Update**.
2. Accept the License Agreement (see Figure 2-48). You cannot proceed if you do not accept the agreement. Click **Next**.

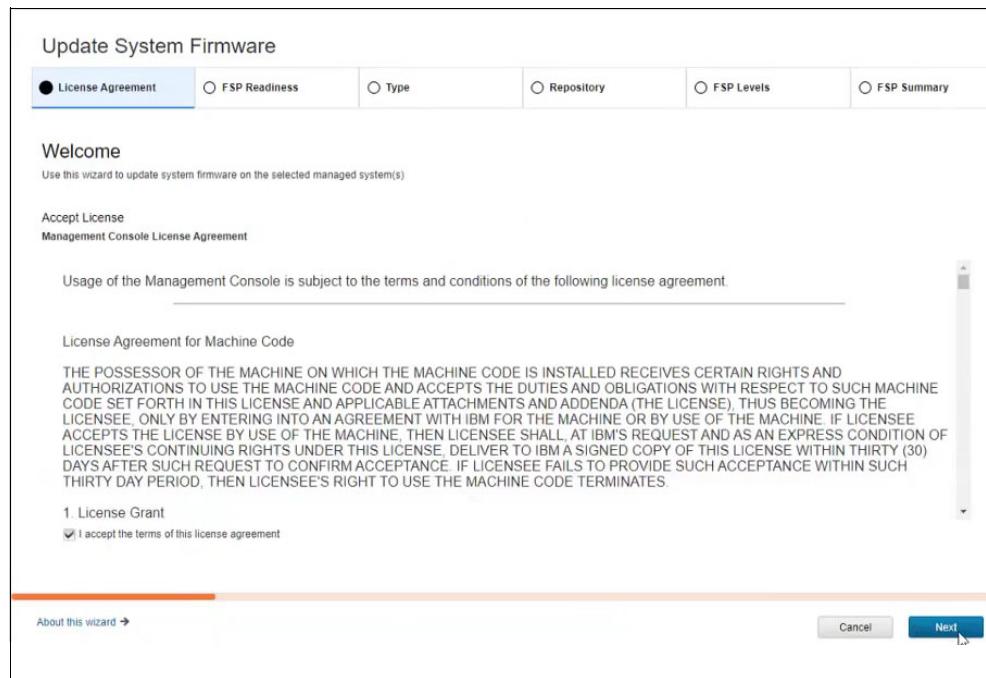


Figure 2-48 Update System Firmware

3. In the next window, the Readiness Status column shows whether the system is ready. If the message is too long, hover around the box to see the entire message.

If two or more systems are selected and one is in a ready state and one is not in a ready state, the system that is *not* in a ready state is skipped and only the system with the ready state progresses (see Figure 2-49 on page 129).

Click **Next**.

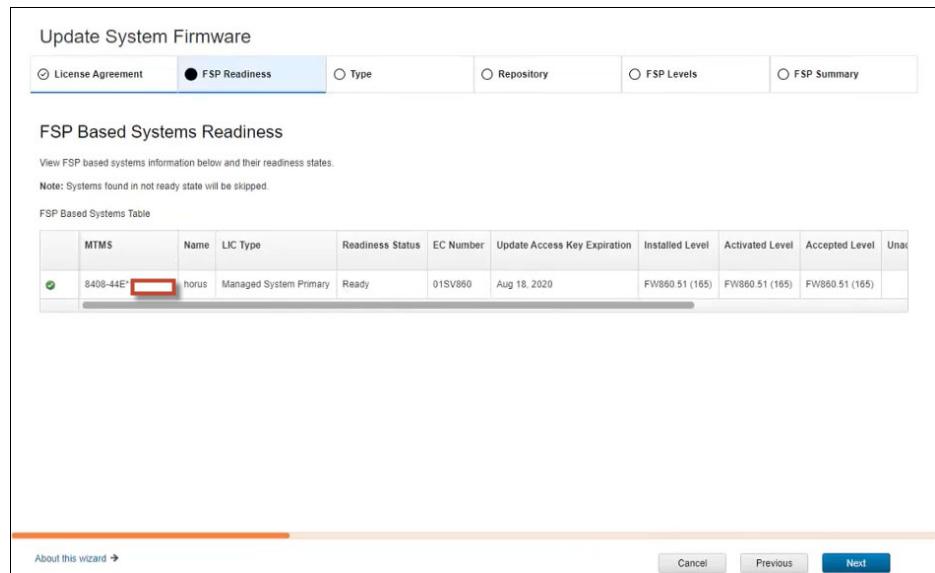


Figure 2-49 FSP Based Systems Readiness window

4. The System Firmware Type window opens. Two options are available: update or upgrade (see Figure 2-50). Click **Update** and then click **Next**.

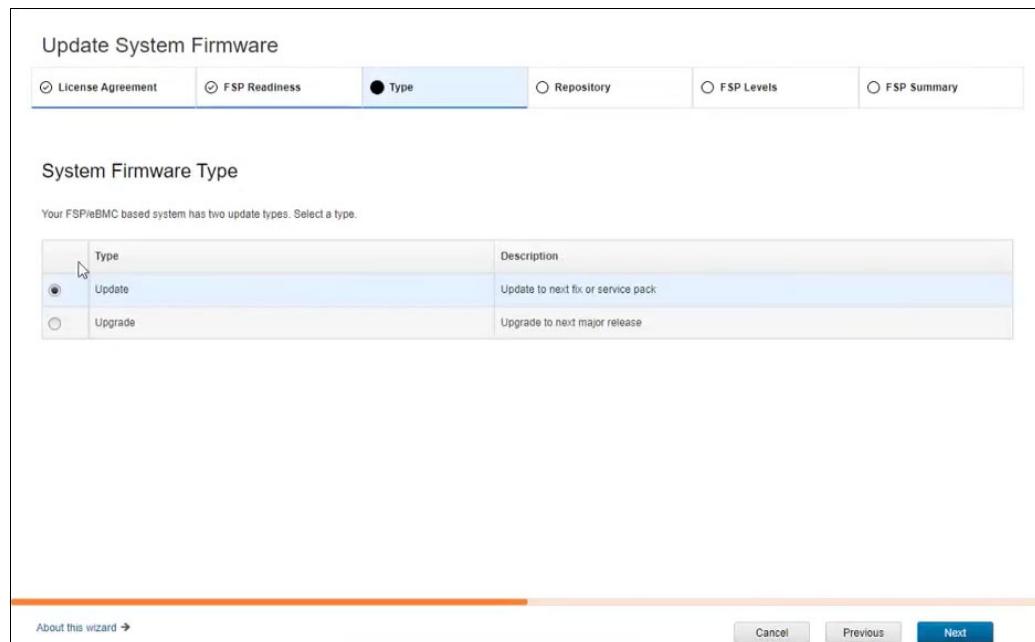


Figure 2-50 System Firmware Type window

5. The System Firmware Repository window opens (see Figure 2-51). Select from one of the following locations for the repository:

- **IBM Service website**
- **Removable Media**
- **FTP Site**
- **Secure FTP Site**
- **Import Staging Location**
- **Mount Point**

Click **Next**.

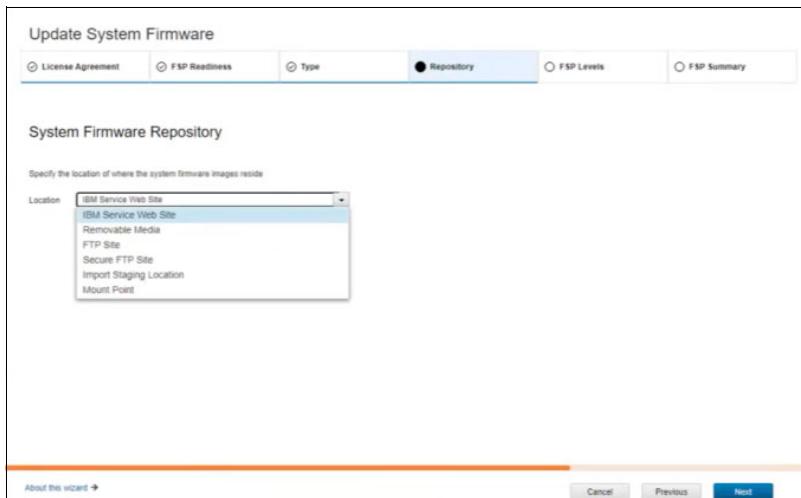


Figure 2-51 System Firmware Repository window

6. The Available Levels for Update window opens. In the target level column, the nature of the update (disruptive or nondisruptive) is shown. If you want to see what is included in the update or upgrade and which LPARs are affected, select the system.

From the drop-down menu, select **View Cover Data** or **View Impacted LPARs** (see Figure 2-52) and then click **Next**.

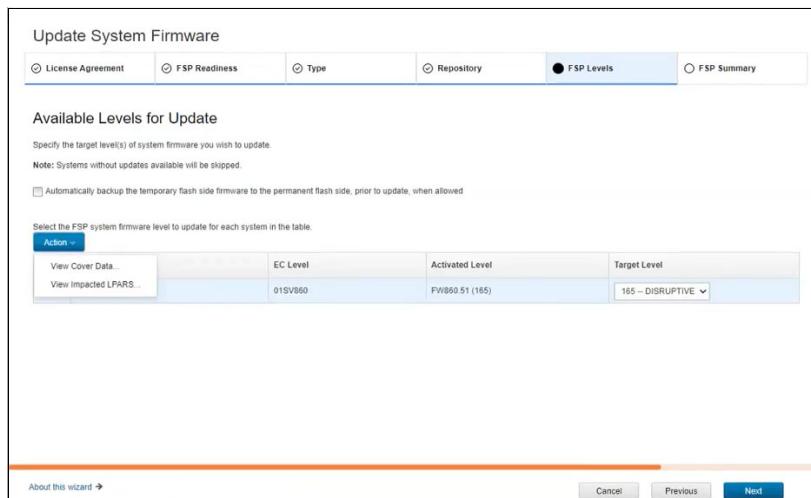


Figure 2-52 Available Levels of Update window

7. The Update Summary window opens. In this window, the progress of the update and whether it successfully completed is shown. If a disruptive upgrade is to occur, select the **I acknowledge that system disruption will occur** option. If this option is not selected when a disruptive upgrade occurs, the wizard cannot progress (see Figure 2-53).

Click **Next**.

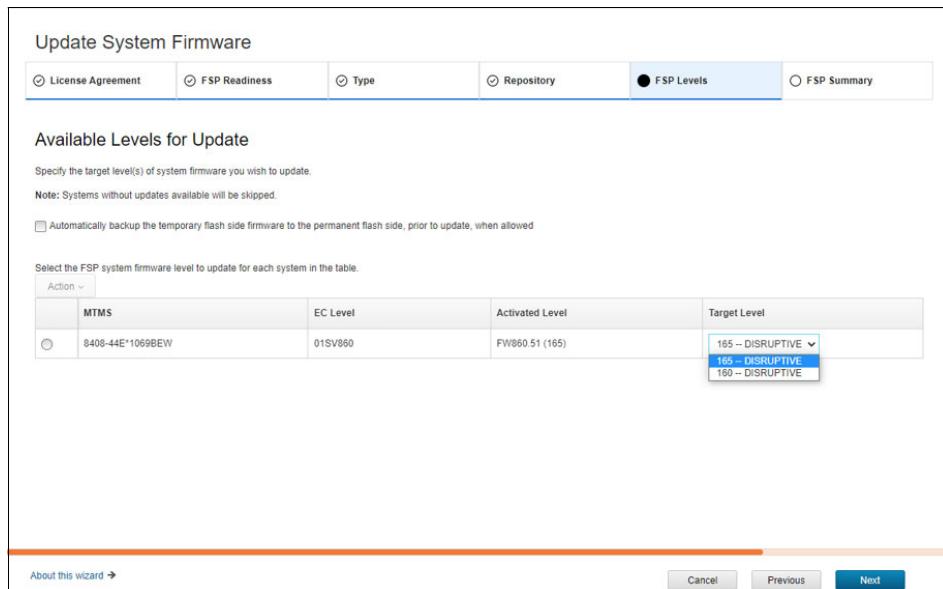


Figure 2-53 Update Summary window

In the system Firmware Update Progress window, window (see Figure 2-54), the estimated time for and the progress of the installation are displayed.

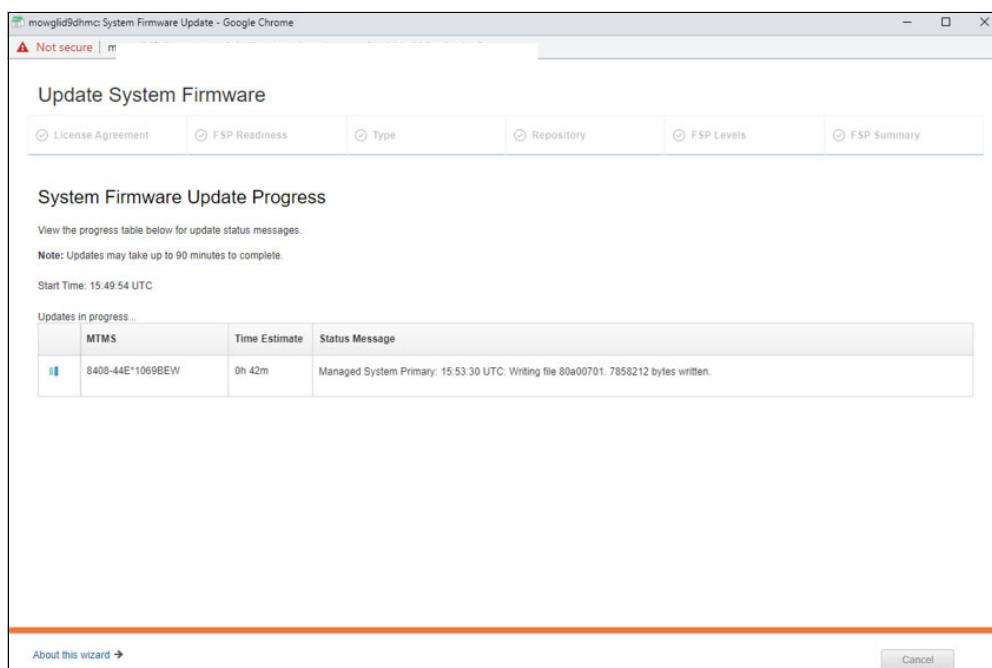


Figure 2-54 System Firmware Update Progress window

### 2.11.3 I/O firmware update

The I/O firmware update was integrated in the old GUI. However, to make the GUI clearer and simple, it now features a new layout that is similar to the system firmware update GUI.

For example, the first and second steps of I/O firmware update include the License Agreement and Repository windows, which are similar to the system firmware update windows.

The next step of the wizard shows the system name and partition name that owns the I/O device, the current level, the available level of the related device microcode, and suggested actions and device description (see Figure 2-55).

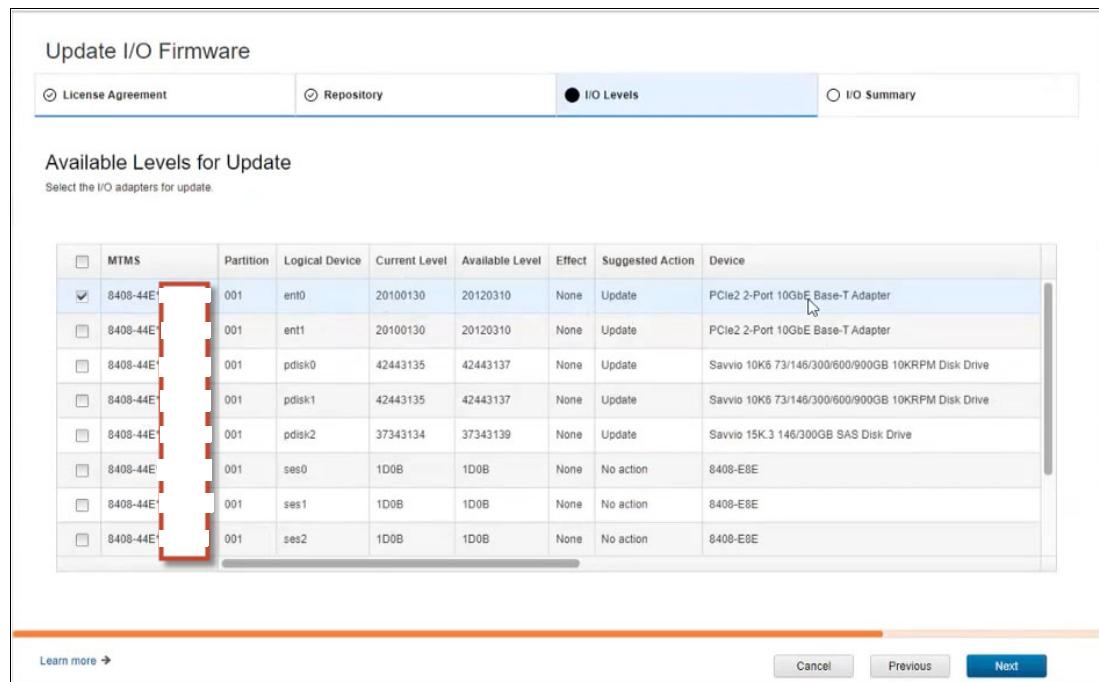


Figure 2-55 I/O firmware update interface

## 2.12 Serviceability

Instances exist in which maintenance procedures are performed on systems and subsystems, including replacing failed components, engineering change implementations, MES hardware upgrades, and migrations. Any of these procedures need the system operations to completely halt or run with a degradation in service.

The productive hours that are lost in performing the service negatively affects the business; therefore, the service strategy includes plans for not only how efficiently the system can be brought back to resume its operations normally, but also to reduce the hours that are needed to service the system.

The success of achieving these goals determines the availability of the system; that is, efficient serviceability means high availability. Power E1080 server carries forward the rich legacy of enterprise class Power servers to deliver the best enterprise RAS features compared to any OEM vendor.

Power E1080 server inherits the fundamental guiding principles and elements of serviceability from the Power E980 enterprise server. The following attributes of its service environment and the interfaces that help it achieve the objectives of serviceability are key:

- ▶ Errors detection
- ▶ Diagnose
- ▶ Reporting
- ▶ Notification
- ▶ Ease of location and service

These key attributes are discussed next.

### 2.12.1 Error detection

System ability to detect errors immediately can greatly enhance its capabilities to take suitable actions in time. For many soft errors, it can recover by self-healing properties. For other unrecoverable errors, it can notify through service interfaces for further actions. The overview of these service interfaces as applicable for Power E1080 server are discussed next.

#### Service interface

Service engineers are assisted by multiple system service interfaces that communicate with the service support applications in a server that is using the operator console, the GUI that is on the management console or service processor menu, or an operating system terminal. The service interface helps the support team to efficiently manage system resources and service information.

Applications that are available through the service interface are configured and placed to give service engineers access to important service functions. Depending on the system state, hypervisor, and the operating environment, one or more service interfaces can be useful in accessing logs and service information and communicating with the system. The following primary service interfaces are available:

- ▶ Light path diagnostics (LPD)
- ▶ Operator panel
- ▶ Service processor menu
- ▶ ASMI
- ▶ Operating system service menu
- ▶ SFP on the HMC or vHMC

The system can identify components for replacement by using FRU-specific LEDs. The service engineer can use the identify function to set the FRU level LED to flash, which lights the blue enclosure locate and system locate LEDs. The enclosure LEDs turn on solid and guide the service engineer to follow the light path from the system to the enclosure and down to the specific FRU in error.

Similar to LPD notifications, other interfaces in the previous bulleted list provide tools to capture logs/dumps and other essential information to identify and detect errors.

For more information about service interfaces and the available service functions, see [this web page](#).

## Error check, first failure data capture, and fault isolation registers

Power processor-based systems feature specialized hardware detection circuits that are used to detect erroneous hardware operations. Error-checking hardware ranges from parity error detection that is coupled with Processor Instruction Retry and bus try again, to ECC correction on caches and system buses.

Within the processor or memory subsystem error checker, error-checker signals are captured and stored in hardware FIRs. The associated logic circuitry is used to limit the domain of an error to the first checker that encounters the error. In this way, runtime error diagnostic tests can be deterministic so that for every check station, the unique error domain for that checker is defined and mapped to FRUs that can be repaired when necessary.

First-failure data capture (FFDC) is a technique that helps ensure that the root cause of the fault is captured without the need to re-create the problem or run any extending tracing or diagnostics program when a fault is detected in a system. For most faults, a good FFDC design means that the root cause can also be detected automatically without service engineers' intervention.

FFDC information, error data analysis, and fault isolation are necessary to implement the advanced serviceability techniques that enable efficient service of the systems and to help determine the failing items.

In the rare absence of FFDC and Error Data Analysis, diagnostics are required to re-create the failure and determine the failing items.

### 2.12.2 Diagnostics

*Diagnostics* refers to identification of errors, symptoms, and determination of the potential causes of the errors identified.

The Power E1080 server is supplemented with several advanced troubleshooting and diagnostic routines that are available through multiple service interfaces, as discussed in 2.12.1, “Error detection” on page 133. For more information about the available aids, see the following IBM Documentation web pages:

- ▶ [Analyzing problems](#)
- ▶ [Isolation procedures](#)

### Reference codes

These codes represent the system IPL status progress codes, OS IPL progress codes, dump progress codes, service request numbers (SRNs), and others, which serve as diagnostic aid to help determine the source of various hardware errors. Diagnostic applications report problems with SRNs.

The support team and service engineers use this information with reference code-specific information to analyze and determine the source of errors or find more information about other isolation procedures.

### Automatic diagnostics

The processor and memory FFDC is designed to perform without the need to re-create the problems or user intervention. Solid and intermittent errors are detected early and isolated at the time of failure. Runtime and boot-time diagnostics fall into this category.

### **Stand-alone diagnostics**

These routines provide methods to test system resources by using diagnostics that are packaged on CD-ROM. They can be accessed by starting the system in service mode.

### **Service processor diagnostic**

A service processor is self-sufficient to monitor unrecoverable errors in the system processor without the need of resources from the system processor. It can also monitor HMC connections and system thermal and operating environments, along with remote power control, reset, and maintenance functions.

## **2.12.3 Reporting**

If a system hardware or environmentally induced failure occurs, the system runtime error diagnostics analyze the hardware error signature to determine the cause of failure.

The analysis is stored in the system NVRAM. The identified errors are reported to the operating system and recorded in the system logs of the operating system.

For an HMC-managed system in the PowerVM environment, an ELA routine analyzes the error, forwards the event to the SFP application that is running on the HMC, and notifies the system administrator about isolation of the likely cause of the system problem. The service processor event log also records unrecoverable checkstop conditions and forwards them to the SFP application.

The system can call home from IBM i and AIX operating systems to report platform recoverable errors and errors that are associated with PCIe adapters and devices. In an HMC-managed system environment, a Call Home service request is started from the HMC and the failure report that carries parts information and part location is sent to the IBM service organization.

Along with such information, customer contact information and system-specific information, machine type, model, and serial number, and error logs also are sent to IBM service organization electronically.

## **2.12.4 Notification**

In this section, we describe the types of notifications that are available.

### **Call Home**

HMC can notify service events that need IBM service organization attention, which uses the Call Home feature. Call Home helps to transmit error logs, server status, or other service-related information to the IBM service organization electronically.

This feature is optional, but customers can gain significant advantages implementing the feature, such as faster problem determination and resolution and, usually, without customer notice or direct involvement. This feature also allows the IBM Service organization to register auto service tickets and send customer-replaceable units (CRU) directly to the customer or dispatching a service engineer to the customer location.

## **IBM Electronic Service Agent**

The Electronic Service Agent (ESA) provides automatic problem reporting functions and can potentially predict and prevent hardware errors by early detection of potential problems. It is supported by IBM i and AIX and is not separately charged for because it is part of the base operating system.

ESA monitors and collects system inventory and service information, which is accessible from a secured web portal.

For more information about ESA planning, implementation, and configuration, see the following web pages:

- ▶ For [AIX](#)
- ▶ For [IBM i](#)

Customers who are skeptical about the information that is shared with IBM can be assured that security protocols are in place. Also, by registering with the [IBM Electronics Services portal](#), the service information is accessible to customers.

### **2.12.5 Ease of location and service**

For maintenance procedures that need service engineers to interact physically with the system, such as hardware MES execution, concurrent maintenance, or replacement of non-concurrent maintainable components, the time that is required for overall service can be greatly improved by using specific system-aided tools that can help with replacement procedures.

Some of the aids that are available with Power 1080 system are discussed next.

#### **Service labels**

Placed at various locations on the system hardware, these labels provide the following ready-to-use, graphics-based information to perform physical maintenance on the system:

- ▶ Location diagrams

Typically, these diagrams consist of placement view of various hardware components (FRUs and CRUs) that are inside the server chassis. This information can help the service engineer to find the location of the FRUs that are being serviced or removed.

- ▶ Remove/ or replace procedures

A pictorial aid that shows the way to remove hardware components from the server chassis. For example, a picture can show thumbs that are pressing the latches, which can help release the component from its place.

- ▶ Arrows

Numbered arrows are used to indicate the order of actions and the serviceability direction of components. Some serviceable parts, such as latches, levers, and touch points, must be pulled or pushed in a specific direction and in a specific order for the mechanical mechanisms to engage or disengage.

- ▶ Physical address diagrams

These diagrams can help map the logical address of failed components to the physical address so that only intended components can be identified and serviced.

## **QR labels**

QR labels are placed on the system to provide access to key service functions through a mobile device. When the QR label is scanned, the mobile device goes to server-specific landing web pages that contain many of the service functions of interest while physically located beside the server rack in the data center. These functions include installation and repair instructions, service diagrams, and reference code look up.

## **Packaging for service**

Power servers deliver great experiences with its ease of service operations design and unique physical packaging, which includes the following characteristics:

- ▶ Color coding (touch points): Blue-colored touch points delineate touch points on service components where the component can be safely handled for service actions, such as removal or installation.
- ▶ Tool-less design: Selected IBM systems support tool-less or simple tool designs. These designs require no tools or simple tools, such as flathead screw drivers, to service the hardware components.
- ▶ Positive retention: Positive retention mechanisms help to ensure proper connections between hardware components, such as cables to connectors, and between two cards that attach to each other. Without positive retention, hardware components run the risk of becoming loose during shipping or installation, which prevents a good electrical connection.

Positive retention mechanisms, such as latches, levers, thumb-screws, pop Nylatches (U-clips), and cables are included to help prevent loose connections and aid in installing (seating) parts correctly. These positive retention items do not require tools.

## **Concurrent maintenance**

The Power E1080 includes many physical components that allow concurrent maintenance, which frees the service engineer to bring the system down for maintenance. The following concurrent maintainable components of E1080 are available:

- ▶ EXP24S SAS storage enclosure drawer
- ▶ Drives in the EXP24S storage enclosure drawer
- ▶ NVMe U.2 drives
- ▶ PCIe extender cards, optical PCIe link I/O expansion card
- ▶ PCIe I/O adapters
- ▶ PCIe I/O drawers
- ▶ PCIe to USB conversion card
- ▶ SMP cables
- ▶ System node AC power supplies: Two functional power supplies must remain installed always while the system is operating
- ▶ System node fans
- ▶ SCU fans
- ▶ SCU operations panel
- ▶ Time of Day clock battery
- ▶ UPIC interface card in SCU
- ▶ UPIC power cables from system node to SCU





# Enterprise solutions

In this chapter, we describe the major pillars that can help enterprises achieve their business goals and the reasons on why Power E1080 provides a significant contribution to that end.

This chapter includes the following topics:

- ▶ 3.1, “PowerVM” on page 140
- ▶ 3.2, “IBM PowerVC overview” on page 149
- ▶ 3.3, “System automation with Ansible” on page 150
- ▶ 3.4, “Protect trust from core to cloud” on page 153
- ▶ 3.5, “Running artificial intelligence where operational data is stored” on page 156

## 3.1 PowerVM

The PowerVM platform is the family of technologies, capabilities, and offerings that delivers industry-leading virtualization for enterprises. It is the umbrella branding term for Power processor-based server virtualization, that is, IBM POWER Hypervisor, logical partitioning, IBM Micro-Partitioning®, Virtual I/O Server (VIOS), Live Partition Mobility (LPM), and more. PowerVM is a combination of hardware enablement and software.

**Note:** PowerVM Enterprise Edition License Entitlement is included with each Power E1080 server. PowerVM Enterprise Edition is available as a hardware feature (#5228), supports up to 20 partitions per core, VIOS, multiple shared processor pools (MSPPs) and also offers LPM.

### 3.1.1 IBM POWER Hypervisor

Power processor-based servers are combined with PowerVM technology and offer the following key capabilities that can help to consolidate and simplify IT environments:

- ▶ Improve server usage and share I/O resources to reduce the total cost of ownership (TCO) and better use IT assets.
- ▶ Improve business responsiveness and operational speed by dynamically reallocating resources to applications as needed to better match changing business needs or handle unexpected changes in demand.
- ▶ Simplify IT infrastructure management by making workloads independent of hardware resources so that business-driven policies can be used to deliver resources that are based on time, cost, and service-level requirements.

Combined with features in the Power E1080, the IBM POWER Hypervisor delivers functions that enable other system technologies, including logical partition (LPAR) technology, virtualized processors, IEEE virtual local area network (VLAN)-compatible virtual switch, virtual SCSI adapters, virtual Fibre Channel adapters, and virtual consoles.

The POWER Hypervisor is a basic component of the system's firmware and offers the following functions:

- ▶ Provides an abstraction between the physical hardware resources and the LPARs that use them.
- ▶ Enforces partition integrity by providing a security layer between LPARs.
- ▶ Controls the dispatch of virtual processors to physical processors.
- ▶ Saves and restores all processor state information during a logical processor context switch.
- ▶ Controls hardware I/O interrupt management facilities for LPARs.
- ▶ Provides VLAN channels between LPARs that help reduce the need for physical Ethernet adapters for inter-partition communication.
- ▶ Monitors the Flexible Service Processor (FSP) and performs a reset or reload if it detects the loss of one of the FSP, notifying the operating system if the problem is not corrected.

The POWER Hypervisor is always active, regardless of the system configuration or whether it is connected to the managed console. It requires memory to support the resource assignment of the LPARs on the server. The amount of memory that is required by the POWER Hypervisor firmware varies according to several factors:

- ▶ Memory usage for hardware page tables (HPTs)
- ▶ Memory usage to support I/O devices
- ▶ Memory usage for virtualization

### **Memory usage for hardware page tables**

Each partition on the system includes its own HPT that contributes to hypervisor memory usage. The HPT is used by the operating system to translate from effective addresses (EAs) to physical real addresses in the hardware. This translation from effective to real addresses allows multiple operating systems to run simultaneously in their own logical address space. Whenever a virtual processor for a partition is dispatched on a physical processor, the hypervisor indicates to the hardware the location of the partition HPT that can be used when translating addresses.

The amount of memory for the HPT is based on the maximum memory size of the partition and the HPT ratio. The default HPT ratio is 1/128th (for AIX, VIOS, and Linux partitions) of the maximum memory size of the partition. AIX, VIOS, and Linux use larger page sizes (16 KB and 64 KB) instead of using 4 KB pages. The use of larger page sizes reduces the overall number of pages that must be tracked; therefore, the overall size of the HPT can be reduced. For example, the HPT is 2 GB for an AIX partition with a maximum memory size of 256 GB.

When defining a partition, the maximum memory size that is specified is based on the amount of memory that can be dynamically added to the dynamic logical partition (DLPAR) without changing the configuration and restarting the partition.

In addition to setting the maximum memory size, the HPT ratio can be configured. The `hpt_ratio` parameter for the `chsyscfg` Hardware Management Console (HMC) command can be issued to define the HPT ratio that is used for a partition profile. The valid values are 1:32, 1:64, 1:128, 1:256, or 1:512.

Specifying a smaller absolute ratio (1/512 is the smallest value) decreases the overall memory that is assigned to the HPT. Testing is required when changing the HPT ratio because a smaller HPT might incur more CPU consumption because the operating system might need to reload the entries in the HPT more frequently. Most customers choose to use the IBM provided default values for the HPT ratios.

### **Memory usage for I/O devices**

In support of I/O operations, the hypervisor maintains structures that are called the *translation control entities* (TCEs), which provide an information path between I/O devices and partitions. The TCEs provide the address of the I/O buffer, indications of read versus write requests, and other I/O-related attributes. Many TCEs are used per I/O device, so multiple requests can be active simultaneously to the same physical device. To provide better affinity, the TCEs are spread across multiple processor chips or drawers to improve performance while accessing the TCEs.

For physical I/O devices, the base amount of space for the TCEs is defined by the hypervisor that is based on the number of I/O devices that are supported. A system that supports high-speed adapters can also be configured to allocate more memory to improve I/O performance. Linux is the only operating system that uses these extra TCEs so that the memory can be freed for use by partitions if the system uses only AIX.

## **Memory usage for virtualization features**

Virtualization requires more memory to be allocated by the POWER Hypervisor for hardware statesave areas and various virtualization technologies. For example, on Power10 processor-based systems, each processor core supports up to eight simultaneous multithreading (SMT) threads of execution, and each thread contains over 80 different registers.

The POWER Hypervisor must set aside save areas for the register contents for the maximum number of virtual processors that are configured. The greater the number of physical hardware devices, the greater the number of virtual devices, the greater the amount of virtualization, and the more hypervisor memory is required. For efficient memory consumption, wanted and maximum values for various attributes (processors, memory, and virtual adapters) must be based on business needs, and not set to values that are higher than actual requirements.

## **Predicting memory that is used by the POWER Hypervisor**

The IBM System Planning Tool (SPT) is a resource that can be used to estimate the amount of hypervisor memory that is required for a specific server configuration. After the SPT executable file is downloaded and installed, you can define a configuration by selecting the correct hardware platform and the installed processors and memory, and defining partitions and partition attributes. SPT can estimate the amount of memory that is assigned to the hypervisor, which assists you when you change a configuration or deploy new servers.

The POWER Hypervisor provides the following types of virtual I/O adapters:

- ▶ Virtual SCSI

The POWER Hypervisor provides a virtual SCSI mechanism for the virtualization of storage devices. The storage virtualization is accomplished by using two paired adapters: a virtual SCSI server adapter and a virtual SCSI customer adapter.

- ▶ Virtual Ethernet

The POWER Hypervisor provides a virtual Ethernet switch function that allows partitions fast and secure communication on the same server without any need for physical interconnection or connectivity outside of the server if a Layer 2 bridge to a physical Ethernet adapter is set in one VIOS partition, also known as *Shared Ethernet Adapter* (SEA).

- ▶ Virtual Fibre Channel

A virtual Fibre Channel adapter is a virtual adapter that provides customer LPARs with a Fibre Channel connection to a storage area network through the VIOS partition. The VIOS partition provides the connection between the virtual Fibre Channel adapters on the VIOS partition and the physical Fibre Channel adapters on the managed system.

- ▶ Virtual (TTY) console

Each partition must have access to a system console. Tasks, such as operating system installation, network setup, and various problem analysis activities, require a dedicated system console. The POWER Hypervisor provides the virtual console by using a virtual TTY or serial adapter and a set of hypervisor calls to operate on them. Virtual TTY does not require the purchase of any other features or software, such as the PowerVM Edition features.

## Logical partitions

LPARs and virtualization increase the usage of system resources and add a level of configuration possibilities.

*Logical partitioning* is the ability to make a server run as though it were two or more independent servers. When you logically partition a server, you divide the resources on the server into subsets, called *LPARs*. You can install software on an LPAR, and the LPAR runs as an independent logical server with the resources that you allocated to the LPAR.

LPAR is also referred to in some documentation as a *virtual machine* (VM), which makes it look similar to what other hypervisors offer. However, LPARs provide a higher level of security and isolation and other features that are described in this chapter.

Processors, memory, and I/O devices can be assigned to LPARs. AIX, IBM i, Linux, and VIOS can run on LPARs. VIOS provides virtual I/O resources to other LPARs with general-purpose operating systems.

LPARs share a few system attributes, such as the system serial number, system model, and processor Feature Codes. All other system attributes can vary from one LPAR to another.

## Micro-Partitioning

When you use the Micro-Partitioning technology, you can allocate fractions of processors to an LPAR. An LPAR that uses fractions of processors is also known as a *shared processor partition* or *micropartition*. Micropartitions run over a set of processors that is called a *shared processor pool* (SPP), and virtual processors are used to enable the operating system manage the fractions of processing power that are assigned to the LPAR.

From an operating system perspective, a virtual processor cannot be distinguished from a physical processor, unless the operating system is enhanced to determine the difference. Physical processors are abstracted into virtual processors that are available to partitions.

On the Power10 processor-based server, a partition can be defined with a processor capacity as small as 0.05 processing units. This number represents 0.05 of a physical core. Each physical core can be shared by up to 20 shared processor partitions, and the partition's entitlement can be incremented fractionally by as little as 0.05 of the processor. The shared processor partitions are dispatched and time-sliced on the physical processors under the control of the Power Hypervisor. The shared processor partitions are created and managed by the HMC.

The Power E1080 supports up to 240 cores in a single system and 1000 micropartitions (1000 is the maximum that PowerVM supports).

**Note:** Although the Power E1080 supports up to 1000 micropartitions, the real limit depends on application workload demands in use on the server.

## Processing mode

When you create an LPAR, you can assign entire processors for dedicated use, or you can assign partial processing units from an SPP. This setting defines the processing mode of the LPAR.

### Dedicated mode

In dedicated mode, physical processors are assigned as a whole to partitions. The SMT feature in the Power10 processor core allows the core to run instructions from two, four, or eight independent software threads simultaneously.

### ***Shared dedicated mode***

On Power10 processor-based servers, you can configure dedicated partitions to become processor donors for idle processors that they own, which allows for the donation of spare CPU cycles from dedicated processor partitions to an SPP. The dedicated partition maintains absolute priority for dedicated CPU cycles. Enabling this feature can help increase system usage without compromising the computing power for critical workloads in a dedicated processor mode LPAR.

### ***Shared mode***

In shared mode, LPARs use virtual processors to access fractions of physical processors. Shared partitions can define any number of virtual processors (the maximum number is 20 times the number of processing units that are assigned to the partition). The Power Hypervisor dispatches virtual processors to physical processors according to the partition's processing units entitlement. One processing unit represents one physical processor's processing capacity. All partitions receive a total CPU time equal to their processing unit's entitlement. The logical processors are defined on top of virtual processors. Therefore, even with a virtual processor, the concept of a logical processor exists, and the number of logical processors depends on whether SMT is turned on or off.

## **3.1.2 Multiple shared processor pools**

MSPPs are supported on Power10 processor-based servers. This capability allows a system administrator to create a set of micropartitions with the purpose of controlling the processor capacity that can be used from the physical SPP.

Micropartitions are created and then identified as members of the default processor pool or a user-defined SPP. The virtual processors that exist within the set of micropartitions are monitored by the Power Hypervisor. Processor capacity is managed according to user-defined attributes.

If the Power server is under heavy load, each micropartition within an SPP is assured of its processor entitlement, plus any capacity that might be allocated from the reserved pool capacity if the micropartition is uncapped.

If specific micropartitions in an SPP do not use their processing capacity entitlement, the unused capacity is ceded and other uncapped micropartitions within the same SPP can use the extra capacity according to their uncapped weighting. In this way, the entitled pool capacity of an SPP is distributed to the set of micropartitions within that SPP.

All Power servers that support the MSPP capability have a minimum of one (the default) SPP and up to a maximum of 64 SPPs.

This capability helps customers reduce TCO significantly when the cost of software or database licenses depends on the number of assigned processor-cores.

### 3.1.3 Virtual I/O Server

The VIOS is part of PowerVM. It is the specific appliance that allows the sharing of physical resources among LPARs to allow more efficient usage (for example, consolidation). In this case, the VIOS owns the physical I/O resources (SCSI, Fibre Channel, network adapters, or optical devices) and allows customer partitions to share access to them, which minimizes and optimizes the number of physical adapters in the system.

The VIOS eliminates the requirement that every partition owns a dedicated network adapter, disk adapter, and disk drive. The VIOS supports OpenSSH for secure remote logins. It also provides a firewall for limiting access by ports, network services, and IP addresses.

Figure 3-1 shows an overview of a VIOS configuration.

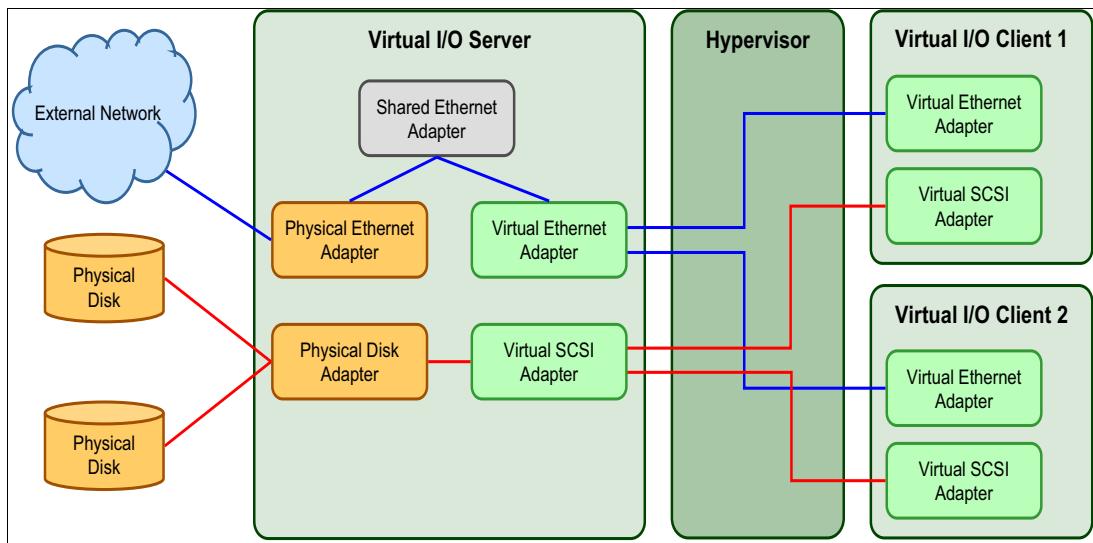


Figure 3-1 Architectural view of the VIOS

It is a best practice to run dual VIO servers per physical server.

#### Shared Ethernet Adapter

A SEA can be used to connect a physical Ethernet network to a virtual Ethernet network. The SEA provides this access by connecting the Power Hypervisor VLANs to the VLANs on the external switches. Because the SEA processes packets at Layer 2, the original MAC address and VLAN tags of the packet are visible to other systems on the physical network. IEEE 802.1 VLAN tagging is supported.

By using the SEA, several customer partitions can share one physical adapter. You can also connect internal and external VLANs by using a physical adapter. The SEA service can be hosted only in the VIOS (not in a general-purpose AIX or Linux partition) and acts as a Layer 2 network bridge to securely transport network traffic between virtual Ethernet networks (internal) and one or more (Etherchannel) physical network adapters (external). These virtual Ethernet network adapters are defined by the Power Hypervisor on the VIOS.

#### Virtual SCSI

Virtual SCSI is used to view a virtualized implementation of the SCSI protocol. Virtual SCSI is based on a customer/server relationship. The VIOS LPAR owns the physical I/O resources and acts as a server or, in SCSI terms, a target device. The client LPARs access the virtual SCSI backing storage devices that are provided by the VIOS as clients.

The virtual I/O adapters (a virtual SCSI server adapter and a virtual SCSI client adapter) are configured by using an HMC. The virtual SCSI server (target) adapter is responsible for running any SCSI commands that it receives, and is owned by the VIOS partition. The virtual SCSI client adapter allows a client partition to access physical SCSI and SAN-attached devices and LUNs that are mapped to be used by the client partitions. The provisioning of virtual disk resources is provided by the VIOS.

### **N\_Port ID Virtualization**

N\_Port ID Virtualization (NPIV) is a technology that allows multiple LPARs to access one or more external physical storage devices through the same physical Fibre Channel adapter. This adapter is attached to a VIOS partition that acts only as a pass-through that manages the data transfer through the Power Hypervisor.

Each partition features one or more virtual Fibre Channel adapters, each with their own pair of unique worldwide port names. This configuration enables you to connect each partition to independent physical storage on a SAN. Unlike virtual SCSI, only the client partitions see the disk.

For more information and requirements for NPIV, see *IBM PowerVM Virtualization Managing and Monitoring*, SG24-7590.

### **3.1.4 Live Partition Mobility**

LPM enables you to move a running LPAR from one system to another without disruption. Inactive partition mobility allows you to move a powered-off LPAR from one system to another one.

LPM provides systems management flexibility and improves system availability by avoiding the following situations:

- ▶ Planned outages for hardware upgrade or firmware maintenance.
- ▶ Unplanned downtime. With preventive failure management, if a server indicates a potential failure, you can move its LPARs to another server before the failure occurs.

For more information and requirements for LPM, see *IBM PowerVM Live Partition Mobility*, SG24-7460.

HMCV10R1 and VIOS 3.1.3 or later provide the following enhancements to the LPM Feature:

- ▶ Automatically choose the fastest network for LPM memory transfer.
- ▶ Allow LPM when a virtual optical device is assigned to a partition.

### **3.1.5 Active Memory Expansion**

Active Memory Expansion (AME) is an optional Feature Code (#EM8F) that belongs to the technologies under the PowerVM umbrella and enables memory expansion on the system.

AME is an innovative technology that supports the AIX operating system. It helps enable the effective maximum memory capacity to be larger than the true physical memory maximum. Compression and decompression of memory content can enable memory expansion up to 100% or more. This expansion can enable a partition to complete more work or support more users with the same physical amount of memory. Similarly, it can enable a server to run more partitions and do more work for the same physical amount of memory.

AME uses CPU resources to compress and decompress the memory contents. The tradeoff of memory capacity for processor cycles can be an excellent choice, but the degree of expansion varies about how compressible the memory content is. It also depends on having adequate spare CPU capacity available for this compression and decompression.

The Power E1080 includes a hardware accelerator that is designed to boost AME efficiency and uses less processor core resources. Each AIX partition can turn on or turn off AME. Control parameters set the amount of expansion that is wanted in each partition to help control the amount of CPU used by the AME function.

An IPL is required for the specific partition that is turning memory expansion. When enabled, monitoring capabilities are available in standard AIX performance tools, such as `lparstat`, `vmstat`, `topas`, and `svmon`.

A planning tool is included with AIX, which enables you to sample workloads and estimate how expandable the partition's memory is and much CPU resource is needed. The feature can be ordered with the initial order of the Power E1080 or as a Miscellaneous Equipment Specification (MES) order. A software key is provided when the enablement feature is ordered, which is applied to the system node. An IPL is not required to enable the system node. The key is specific to an individual system and is permanent. It cannot be moved to a different server.

IBM i does not support AME.

### 3.1.6 Remote Restart

Remote Restart is a high availability option for partitions. If an error occurs that causes a server outage, a partition that is configured for Remote Restart can be restarted on a different physical server. At times, it might take longer to start the server, in which case the Remote Restart function can be used for faster reprovisioning of the partition. Typically, Remote Restart can be done faster than restarting the server that stopped and then restarting the partitions. The Remote Restart function relies on technology that is similar to LPM where a partition is configured with storage on a SAN that is shared (accessible) by the server that hosts the partition.

HMC V10R1 provides an enhancement to the Remote Restart Feature that enables remote restart when a virtual optical device is assigned to a partition.

### 3.1.7 POWER processor modes

Although they are not virtualization features, the POWER processor modes are described here because they affect various virtualization features.

On Power servers, partitions can be configured to run in several modes, including the following modes:

- ▶ Power8

This native mode for Power8 processors implements Version 2.07 of the IBM Power Instruction Set Architecture (ISA). For more information, see [IBM Documentation](#).

- ▶ Power9

This native mode for Power9 processors implements Version 3.0 of the IBM Power ISA. For more information, see [IBM Documentation](#).

- ▶ Power10

This native mode for Power10 processors implements Version 3.1 of the IBM Power ISA. For more information, see [IBM Documentation](#).

Figure 3-2 shows the available processor modes on a Power E1080.

Processor compatibility mode is important when LPM migration is planned between different generations of servers. An LPAR that might be migrated to a machine that is managed by a processor from another generation must be activated in a specific compatibility mode.

**Note:** Migrating an LPAR from a POWER7 processor-based server to Power E1080 by using LPM is not supported; however, the following steps can be completed to accomplish this task:

1. Migrate LPAR from POWER7 processor-based server to Power9 processor-based server by using LPM.
2. Migrate then the LPAR from Power9 processor-based server to Power E1080.

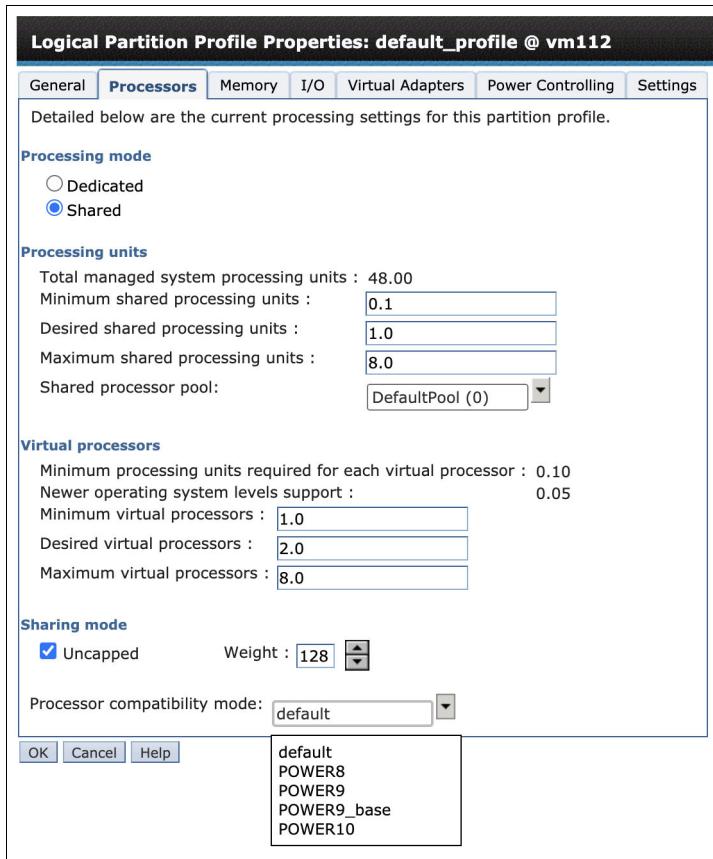


Figure 3-2 Processor modes

### 3.1.8 Single Root I/O Virtualization

Single Root I/O Virtualization (SR-IOV) is an extension to the Peripheral Component Interconnect Express (PCIe) specification that allows multiple operating systems to simultaneously share a PCIe adapter with little or no runtime involvement from a hypervisor or other virtualization intermediary.

SR-IOV is a PCI standard architecture that enables PCIe adapters to become self-virtualizing. It enables adapter consolidation through sharing much like logical partitioning enables server consolidation. With an adapter capable of SR-IOV, you can assign virtual *slices* of a single physical adapter to multiple partitions through logical ports without using a VIOS.

### 3.1.9 More information about virtualization features

The following IBM Redbooks publications provide more information about the virtualization features:

- ▶ *IBM PowerVM Best Practices*, SG24-8062
- ▶ *IBM PowerVM Virtualization Introduction and Configuration*, SG24-7940
- ▶ *IBM PowerVM Virtualization Managing and Monitoring*, SG24-7590
- ▶ *IBM Power Systems SR-IOV: Technical Overview and Introduction*, REDP-5065

## 3.2 IBM PowerVC overview

IBM Power Virtualization Center (PowerVC) is an advanced virtualization and cloud management offering (which is built on OpenStack) that provides simplified virtualization management and cloud deployments for IBM AIX, IBM i, and Linux VMs running on IBM Power servers. PowerVC is designed to improve administrator productivity and simplify the cloud management of VMs on Power servers.

By using PowerVC, you can perform the following tasks:

- ▶ Create VMs and resize the VMs CPU and memory.
- ▶ Attach disk volumes or other networks to those VMs.
- ▶ Import VMs and volumes so that they can be managed by IBM PowerVC.
- ▶ Monitor the use of resources in your environment.
- ▶ Take snapshots of or clone a VM.
- ▶ Migrate VMs while they are running (live migration between physical servers).
- ▶ Remote restart VMs if there is a server failure.
- ▶ Use advanced storage technologies, such as VDisk mirroring or IBM Global mirror.
- ▶ Improve resource usage to reduce capital expense and power consumption.
- ▶ Increase agility and execution to respond quickly to changing business requirements.
- ▶ Increase IT productivity and responsiveness.
- ▶ Simplify the Power virtualization management.
- ▶ Accelerate repeatable, error-free virtualization deployments.

IBM PowerVC can manage AIX, IBM i, and Linux-based VMs that are running under PowerVM virtualization that is connected to an HMC or by using NovaLink. This release supports the scale-out and the enterprise Power servers that are built on IBM Power8, IBM Power9, and subsequent technologies.

### 3.2.1 IBM PowerVC functions and advantages

Why IBM PowerVC? Why do you need another virtualization management offering? When more than 70% of IT budgets are spent on operations and maintenance, IT customers legitimately expect vendors to focus their new development efforts to reduce IT costs and foster innovation within IT departments.

IBM PowerVC gives IBM Power customers the following advantages:

- ▶ It is deeply integrated with Power servers.
- ▶ It provides virtualization management tools.
- ▶ It eases the integration of servers that are managed by PowerVM in automated IT environments, such as clouds.
- ▶ It is a building block of IBM Infrastructure as a Service (IaaS), based on Power servers.

- ▶ PowerVC integrated with other cloud management tool, such as Ansible, Terraform, or Red Hat OpenShift, and can be integrated into orchestration tools, such as the IBM Cloud Automation Manager, VMware vRealize, or the SAP Landscape Management (LaMa).
- ▶ PowerVC also provides the exchange of VM images between private and public clouds.

IBM PowerVC is an addition to the PowerVM set of enterprise virtualization technologies that provide virtualization management. It is based on open standards and integrates server management with storage and network management.

Because IBM PowerVC is based on the OpenStack initiative, Power servers can be managed by tools that are compatible with OpenStack standards. When a system is controlled by IBM PowerVC, it can be managed in one of three ways:

- ▶ By a system administrator by using the IBM PowerVC GUI (GUI)
- ▶ By a system administrator that uses scripts that contain the IBM PowerVC Representational State Transfer (REST) application programming interfaces (APIs)
- ▶ By higher-level tools that call IBM PowerVC by using standard OpenStack API

The following PowerVC offerings are positioned within the available solutions for a Power cloud:

- ▶ IBM PowerVC: Advanced Virtualization Management
- ▶ IBM PowerVC for Private Cloud: Basic Cloud
- ▶ IBM Cloud Automation Manager: Advanced Cloud
- ▶ VMware vRealize: Advanced Cloud

PowerVC provides a systems management product that enterprise customers require to manage effectively the advanced features that are offered by IBM premium hardware. It reduces resource use and manages workloads for performance and availability.

### **3.3 System automation with Ansible**

Enterprises can spend many precious administrative time performing repetitive tasks and using manual processes. Tasks, such as updating, patching, compliance checks, provisioning new VMs or LPARs, and helping ensure that the correct security updates are in place, are taking time away from more valuable business activities.

The ability to automate by using Ansible returns valuable time to the system administrators.

Red Hat Ansible Automation Platform for Power is fully enabled, so enterprises can automate several tasks within AIX, IBM i, and Linux that include deploying applications. Ansible can also be combined with HMC, PowerVC, and Power Virtual Server to provision infrastructure anywhere you need, including cloud solutions from other IBM Business Partners or third-party providers based on Power processor-based servers.

A first task after the initial installation or set up of a new LPAR is to help ensure that the correct patches are installed. Also, extra software (whether it is open source software, independent software vendor (ISV) software, or perhaps their own enterprise software) must be installed. Ansible features a set of capabilities to roll out new software, which makes it popular in Continuous Delivery/Continuous Integration (CD/CI) environments. Orchestration and integration of automation with security products represent other ways in which Ansible can be applied within the data center.

Despite the wide adoption of AIX and IBM i in many different business sectors by different types of customers, Ansible can help introduce the Power processor-based technology to customers who believe that AIX and IBM i skills are a rare commodity that are difficult to locate in the marketplace but want to take advantage of all the features of the hardware platform. The Ansible experience is identical across Power or x86 processor-based technology and the same steps can be repeated in IBM Cloud®.

AIX and IBM i skilled customers can also benefit from the extreme automation solutions that are provided by Ansible.

The Power processor-based architecture features unique advantages over commodity server platforms, such as x86, because the engineering teams that are working on the processor, system boards, virtualization, and management appliances collaborate closely to help ensure an integrated stack that works seamlessly. This approach is in stark contrast to the multi-vendor x86 processor-based technology approach, in which the processor, server, management, and virtualization must be purchased from different (and sometimes competing) vendors.

The Power stack engineering teams work closely to deliver the enterprise server platform, which results in an IT architecture with industry-leading performance, scalability, and security (see Figure 3-3).

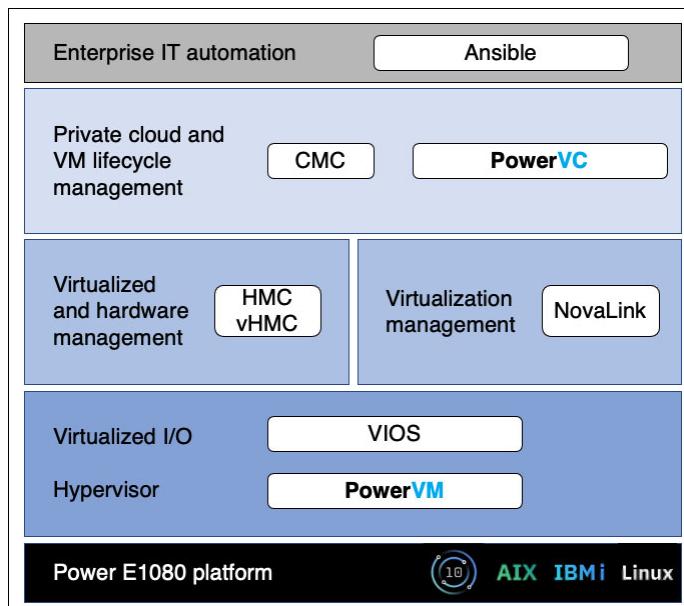


Figure 3-3 Power stack

Every layer in the Power stack is optimized to make the Power10 processor-based technology the platform of choice for mission-critical enterprise workloads. This stack includes the Ansible Automation Platform, which is described next.

### 3.3.1 Ansible Automation Platform

Ansible Automation Platform integrates with IBM Power processor-based technology, which is included in the [Certified Integrations section](#) of the Red Hat Ansible website.

The various Ansible collections for IBM Power processor-based technology, which (at the time of this writing) were downloaded more than 25,000 times by customers, are now included in the Red Hat Ansible Automation Platform. As a result, these modules are covered by Red Hat's 24x7 enterprise support team, which collaborates with the respective Power processor-based technology development teams.

### 3.3.2 Power servers in the Ansible ecosystem

A series of Ansible collections is available for the Power processor-based platform. A *collection* is a group of modules, playbooks, and roles. Embracing Ansible in the Power community, our AIX and IBM i community have the right set of modules available. Some examples are the development of tools to manage AIX logical volumes, which put module interfaces over the installation key command, or managing the AIX init tab entries.

From an IBM i perspective, an example is the ability to run SQL queries against the integrated IBM Db2® database that comes built into the IBM i platform, manage object authorities, and other tasks. All of these things mean something to an AIX administrator or IBM i administrator.

Our operating system teams develop modules that are sent to the open source community (named Ansible Galaxy). Every developer can post any object that can be a candidate for a collection in the open Ansible Galaxy community and possibly certified to be supported by IBM with a subscription to Red Hat Ansible Automation Platform (see Figure 3-4).

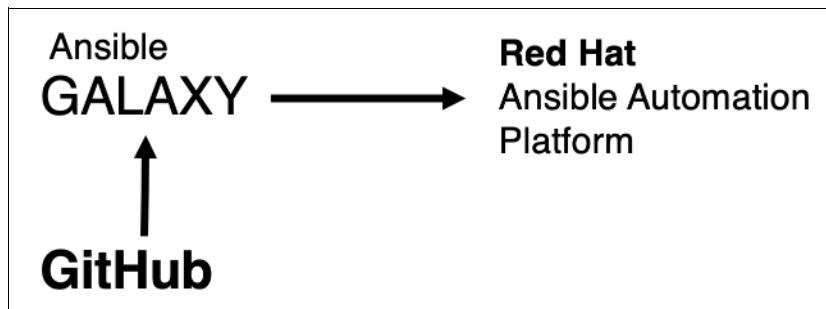


Figure 3-4 Power content in the Ansible ecosystem

For more information about Ansible in the IBM Power environment, see *Using Ansible for Automation in IBM Power Environments*, SG24-8551.

### 3.3.3 Ansible modules for AIX

IBM Power AIX collection, as part of the broader offering of Ansible Content for IBM Power, is available from Ansible Galaxy and has community support.

The collection includes modules and sample playbooks that help to automate tasks and is available starting at [this web page](#).

### **3.3.4 Ansible modules for IBM i**

IBM i provides modules, action plug-ins, roles, and sample playbooks to automate tasks on IBM i, including the following example:

- ▶ Command execution
- ▶ System and application configuration
- ▶ Work management
- ▶ Fix management
- ▶ Application deployment

For more information about the collection, see [this web page](#).

### **3.3.5 Ansible modules for HMC**

IBM Power HMC collection provides modules that can be used to manage configurations and deployments of HMC systems. The collection content helps to include workloads on Power processor-based platforms as part of an enterprise automation strategy through the Ansible ecosystem.

For more information about this collection, see [this web page](#).

### **3.3.6 Ansible modules for VIOS**

IBM Power VIOS collection provides modules that can be used to manage configurations and deployments of Power VIOS systems. The collection content helps to include workloads on Power processor-based platforms as part of an enterprise automation strategy through the Ansible system.

For more information, see [this web page](#).

## **3.4 Protect trust from core to cloud**

Although enforcing a data encryption policy is an effective way to minimize the risk of a data breach that, in turn, minimizes costs, at the time of this writing, only 17% of enterprises surveyed indicated that they protected more than 50% of their sensitive data in cloud with encryption<sup>1</sup>. Only a few enterprises at the worldwide level have an encryption strategy applied consistently across the entire organization, largely because it adds complexity, costs, and negatively affects performance, which means missed SLAs to the business.

The rapidly evolving cyberthreat landscape requires a focus on cyber resilience. Persistent and end-to-end security is the only way to reduce exposure to threats.

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<sup>1</sup> Source: Thales Data Threat Report - Global Edition:  
<https://cp1.thalesgroup.com/resources/encryption/2021/data-threat-report>

Power processor-based platforms always offered the most secure and reliable servers in its class. The Power E1080 further extends the industry-leading security and reliability of the Power processor-based platform, with focus on protecting applications and data across the hybrid cloud environments. It also introduces significant innovations along the following major dimensions:

- ▶ Advanced Data Protection that offers simple to use and efficient capabilities to protect sensitive data through mechanisms, such as encryption and multi-factor authentication.
- ▶ Platform Security helps ensure that the server is hardened against tampering, continuously protects its integrity, and helps ensure strong isolation among multi-tenant workloads. Without strong platform security, all other system security measures are at risk.
- ▶ Security Innovation for Modern Threats stay ahead of new types of cybersecurity threats by using emerging technologies.
- ▶ Integrated Security Management addresses the key challenge of helping ensure correct configuration of the many security features across the stack, monitoring them, and reacting if unexpected changes are detected.

The Power E1080 is enhanced to simplify and integrate security management across the stack, which reduces the likelihood of administrator errors.

In the Power E1080, all data is protected by a greatly simplified end-to-end encryption that extends across the hybrid cloud without detectable performance impact and prepares for future cyberthreats.

Power10 processor-core technology features built-in security integration:

- ▶ Stay ahead of current and future data threats with better cryptographic performance and support for quantum-safe cryptography and fully homomorphic encryption (FHE).
- ▶ Enhance the security of applications with more hardened defense against return-oriented programming (ROP) attacks.
- ▶ Simplified single-interface hybrid cloud security management without any required setup.
- ▶ Protect your applications and data with the most secure VM isolation in the industry with orders of magnitude lower Common Vulnerability Exposures (CVEs) than hypervisors related to x86 processor-based servers.

Also, workloads on the Power E1080 benefit from cryptographic algorithm acceleration, which allows algorithms, such as Advanced Encryption Standard (AES), SHA2, and SHA3 to run faster than Power9 processor-based servers on a per core basis. This performance acceleration allows features, such as AIX Logical Volume Encryption, to be enabled with low performance overhead.

### **3.4.1 Crypto engines and transparent memory encryption**

Power10 processor technology is engineered to achieve faster encryption performance with quadruple the number of AES encryption engines. In comparison to IBM Power9 processor-based servers, Power E1080 is updated for today's most demanding standards and anticipated future cryptographic standards, such as post-quantum and full FHE, and brings new enhancements to container security.

Transparent memory encryption is designed to simplify encryption and support end-to-end security without affecting performance by using hardware features for a seamless user experience. The protection that is introduced in all layers of an infrastructure is shown in Figure 3-5 on page 155.

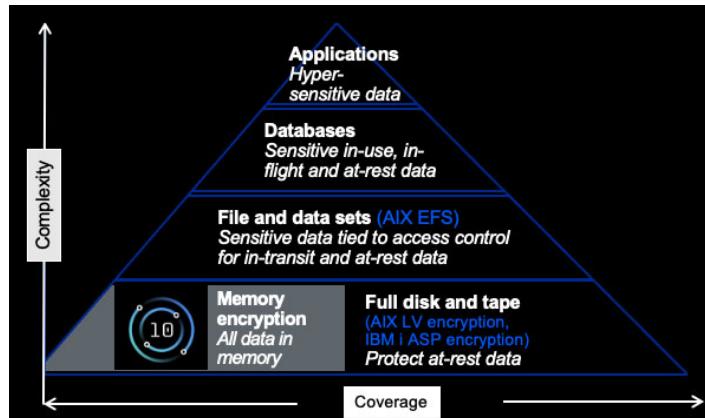


Figure 3-5 Protecting data in memory with transparent memory encryption

### 3.4.2 Quantum-safe cryptography support

To be prepared for the Quantum era, the Power E1080 is built to efficiently support future cryptography, such as Quantum-safe cryptography and FHE. The software libraries for these solutions are optimized for the Power10 processor-chip ISA and are or will be available in the respective open source communities.

*Quantum-safe cryptography* refers to the efforts to identify algorithms that are resistant to attacks by classical and quantum computers in preparation for the time when large-scale quantum computers are built.

*Homomorphic encryption* refers to encryption techniques that permit systems to perform computations on encrypted data without decrypting the data first. The software libraries for these solutions are optimized for the Power processor-chip ISA.

### 3.4.3 IBM PowerSC support

The Power E1080 benefits from the integrated security management capabilities that are offered by:

- ▶ IBM PowerSC
- ▶ The Power software portfolio for managing security and compliance on every Power processor-based platform that is running AIX
- ▶ IBM i or the supported distributions
- ▶ Versions of Linux

PowerSC is introducing more features to help customers manage security end-to-end across the stack to stay ahead of various threats. Specifically, PowerSC 2.0 adds support for Endpoint Detection and Response (EDR), host-based intrusion detection, block listing, and Linux.

## 3.5 Running artificial intelligence where operational data is stored

Separate platforms for artificial intelligence (AI) and business applications make deploying AI in production difficult. The result is reduced end-to-end availability for applications and data access, risk of violating service level agreements because of overhead of sending operational data and receiving predictions from external AI platforms, and increased complexity and cost of managing different environments and external accelerators.

As the world is set to deploy AI everywhere, attention is turning from how fast to build AI to how fast to inference with the AI.

To support this shift, the Power E1080 delivers faster business insights by running AI *in place* with four Matrix Math Accelerator (MMA) units to accelerate AI in each Power10 technology-based processor-core. The robust execution capability of the processor cores with MMA AI acceleration, enhanced single instructions multiple data (SIMD), and enhanced data bandwidth provide an alternative to external accelerators, such as GPUs, and related device management for execution of statistical machine learning and inferencing workloads. These features, combined with the possibility to consolidate multiple environments for AI model execution on a Power E1080 platform together with other different types of environments, reduces costs and leads to a greatly simplified solution stack for AI.

Operationalizing AI inferencing directly on a Power E1080 brings AI closer to data. This ability allows AI to inherit and benefit from the Enterprise Qualities of Service (QoS): reliability, availability, and security of the Power10 processor-based platform and support a performance boost. Enterprise business workflows can now readily and consistently use insights that are built with the support of AI.

The use of data gravity on Power10 processor-cores enables AI to run during a database operation or concurrently with an application, for example. This feature is key for time-sensitive use cases. It delivers fresh input data to AI faster and enhances the quality and speed of insight.

As no-code application development, pay-for-use model repositories, auto-machine learning, and AI-enabled application vendors continue to evolve and grow, the corresponding software products are brought over to the Power10 platform. Python and code from major frameworks and tools, such as TensorFlow, PyTorch, and XGBoost, run on the Power10 processor-based platform without any changes.

Open Neural Network Exchange (ONNX) models can be brought over from x86 processor-based servers or other platforms and small-sized VMs or Power Virtual Server (PowerVS), for deployment on Power E1080, which gives customers the ability to build on commodity hardware but deploy on enterprise servers.

Power10 processor-core architecture includes an embedded matrix math accelerator (MMA). This MMA is extrapolated for an E1080 system to provide up to 5x faster AI inference for FP32 to infuse AI into business applications and drive greater insights, or up to 10 times faster AI inference by using reduced precision data types, such as Bfloat16 and INT8, when compared with a prior generation IBM Power9 server.

IBM optimized math libraries so that AI tools benefit from acceleration that is provided by the MMA units of the Power10 chip. The benefits of MMA action can be realized for statistical machine learning and inferencing, which provides a cost-effective alternative to external accelerators or GPUs.

### 3.5.1 Training anywhere, and deploying on Power E1080

IBM Power10 processor-based technology addresses challenges through hardware and software innovation. Models that are trained on any cloud that is based on Power or x86 processor-based servers (even with different Endianness) can be deployed on the Power E1080 and run without any changes.

Power10 cores are equipped with four Math Engines for matrix and tensor math. Applications can run models with colocated data without the need for external accelerators, GPUs, or extra AI platforms. Power10 technology uses the “train anywhere, deploy here” principle to operationalize AI.

A model can be trained on a public or private cloud (see Figure 3-6) by using the following procedure:

1. The model is registered with its version in the so-called *model vault*, which is a VM or LPAR with tools, such as Watson OpenScale, BentoML, or Tensorflow Serving.
2. The model is pushed out to the destination (in this case, it is a VM or an LPAR running a database with an application) and the model might be used by the database or the application.
3. Transactions that are received by the database and application trigger model execution and generate predictions or classifications. These predictions can also be stored locally. For example, these predictions can be the risk or fraud that is associated with the transaction or product classifications to be used by downstream applications.
4. A copy of the model output (prediction or classification) is sent to the model operations (ModelOps) engine for calculation of drift by comparison with Ground Truth.
5. If the drift exceeds a threshold, the model retrain triggers are generated.
6. Retrained models are then taken through steps 1 - 5.

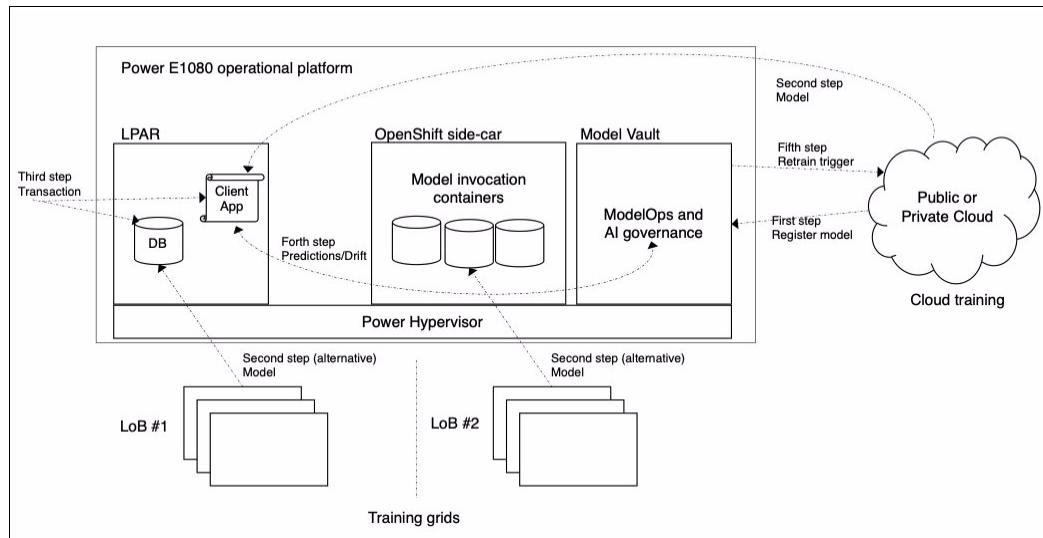


Figure 3-6 Operationalizing AI

By using a combination of software and hardware innovation, Power E1080 can meet the model performance, response time, and throughput KPIs of databases and applications that are infused with AI.



# Related publications

The publications that are listed in this section are considered suitable for a more detailed description of the topics that are covered in this paper.

## IBM Redbooks

The following IBM Redbooks publications provide more information about the topics in this document. Some publications that are referenced in this list might be available in softcopy only.

- ▶ *IBM PowerAI: Deep Learning Unleashed on IBM Power Systems Servers*, SG24-8409
- ▶ *IBM Power System AC922 Technical Overview and Introduction*, REDP-5494
- ▶ *IBM Power System E950: Technical Overview and Introduction*, REDP-5509
- ▶ *IBM Power System E980: Technical Overview and Introduction*, REDP-5510
- ▶ *IBM Power System L922 Technical Overview and Introduction*, REDP-5496
- ▶ *IBM Power Systems H922 and H924 Technical Overview and Introduction*, REDP-5498
- ▶ *IBM Power Systems LC921 and LC922: Technical Overview and Introduction*, REDP-5495
- ▶ *IBM Power Systems Private Cloud with Shared Utility Capacity: Featuring Power Enterprise Pools 2.0*, SG24-8476
- ▶ *IBM Power System S822LC for High Performance Computing Introduction and Technical Overview*, REDP-5405
- ▶ *IBM Power Systems S922, S914, and S924 Technical Overview and Introduction Featuring PCIe Gen 4 Technology*, REDP-5595
- ▶ *IBM PowerVM Best Practices*, SG24-8062
- ▶ *IBM PowerVC Version 2.0 Introduction and Configuration*, SG24-8477
- ▶ *IBM PowerVM Virtualization Introduction and Configuration*, SG24-7940
- ▶ *IBM PowerVM Virtualization Managing and Monitoring*, SG24-7590
- ▶ *SAP HANA Data Management and Performance on IBM Power Systems*, REDP-5570
- ▶ *Using Ansible for Automation in IBM Power Environments*, SG24-8551

You can search for, view, download, or order these documents and other Redbooks publications, Redpapers, web docs, drafts, and additional materials, at the following website:

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## Online resources

The following websites are also relevant as further information sources:

- ▶ IBM Documentation:  
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# Abbreviations and acronyms

<b>AES</b>	Advanced Encryption Standard	<b>FSI</b>	FRU Service Interface
<b>AI</b>	artificial intelligence	<b>FSP</b>	Flexible Service Processor
<b>AME</b>	Active Memory Expansion	<b>GCC</b>	GNU Compiler Collection
<b>AOC</b>	Active Optical Cable	<b>GTps</b>	giga-transfers per second
<b>API</b>	application programming interface	<b>HDD</b>	hard disk drive
<b>ARI</b>	analog rack interface	<b>HHHL</b>	half-height, half-length
<b>ASMI</b>	Advanced System Management Interface	<b>HMC</b>	Hardware Management Console
<b>BMC</b>	baseboard management controller	<b>HNV</b>	Hybrid Network Virtualization
<b>BSC</b>	blind-swap cassette	<b>IaaS</b>	hardware page table
<b>CBU</b>	Capacity Backup	<b>IBM</b>	Infrastructure as a Service
<b>CEC</b>	central electronic complex	<b>IPS</b>	International Business Machines Corporation
<b>CMOS</b>	complimentary metal-oxide-semiconductor	<b>ISA</b>	idle power saver
<b>CoD</b>	Capacity on Demand	<b>ISV</b>	Instruction Set Architecture
<b>CRU</b>	customer-replaceable unit	<b>KVM</b>	independent software vendor
<b>CVE</b>	Common Vulnerability Exposure	<b>LaMa</b>	Keyboard/Video/Mouse
<b>DDIMM</b>	differential dual inline memory module	<b>LP</b>	Landscape Management
<b>DDR4</b>	Double Data Rate 4	<b>LPAR</b>	low-profile
<b>DDR5</b>	Double Data Rate 5	<b>LPD</b>	logical partition
<b>DEXCR</b>	Dynamic Execution Control Register	<b>LPM</b>	light path diagnostics
<b>DFP</b>	decimal floating-point	<b>MCU</b>	Live Partition Mobility
<b>DLPAR</b>	dynamic logical partition	<b>MES</b>	memory controller unit
<b>DMA</b>	direct memory access	<b>MMA</b>	Miscellaneous Equipment Specification
<b>DME</b>	dense math engine	<b>MPM</b>	Matrix Math Accelerator
<b>DPM</b>	dynamic performance mode	<b>MSP</b>	maximum performance mode
<b>EA</b>	effective address	<b>MSPP</b>	Mover Server Partition
<b>EDR</b>	Endpoint Detection and Response	<b>MTFR</b>	multiple shared processor pools
<b>EEH</b>	Enhanced Error Handling	<b>NPIV</b>	MPM typical frequency range
<b>EIA</b>	Electronic Industries Alliance	<b>NS</b>	N_Port ID Virtualization
<b>ePoE</b>	electronic Proof of Entitlement	<b>NUCA</b>	namespace
<b>ERAT</b>	effective-to-real address translation	<b>NVMe</b>	non-uniform cache access
<b>ESA</b>	Electronic Service Agent	<b>NX</b>	Non-Volatile Memory Express
<b>ESM</b>	Expansion Service Manager	<b>OMI</b>	nest accelerator
<b>ESS</b>	Entitled Systems Support	<b>ONNX</b>	open memory interface
<b>FFDC</b>	first-failure data capture	<b>OSHA</b>	Open Neural Network Exchange
<b>FHE</b>	fully homomorphic encryption	<b>PCIe</b>	Occupational Safety and Health Administration
<b>FIFO</b>	first in - first out		Peripheral Component Interconnect Express
<b>FRU</b>	Field-Replaceable Unit	<b>PCR</b>	Processor Compatibility Register

<b>PDU</b>	power distribution unit	<b>VLAN</b>	virtual local area network
<b>PHB</b>	PCIe host bridge	<b>VM</b>	virtual machine
<b>PMIC</b>	Power Management Integrated Circuit	<b>VPD</b>	vital product data
<b>PSI</b>	Processor Support Interface	<b>VRM</b>	voltage regulator module
<b>PSU</b>	power supply unit	<b>VSU</b>	vector scalar unit
<b>QoS</b>	quality of service	<b>VSX</b>	Vector Scalar eXtension
<b>QPFP</b>	quad-precision floating-point		
<b>RAS</b>	reliability, availability, and serviceability		
<b>REST</b>	Representational State Transfer		
<b>RHEL</b>	Red Hat Enterprise Linux		
<b>ROP</b>	return-oriented programming		
<b>SAS</b>	serial-attached SCSI		
<b>SCM</b>	single-chip module		
<b>SCU</b>	system control unit		
<b>SEA</b>	Shared Ethernet Adapter		
<b>SFF</b>	small form factor		
<b>SFP</b>	Service Focal Point		
<b>SHA</b>	Secure Hash Algorithm		
<b>SIMD</b>	single instructions multiple data		
<b>SIU</b>	SMP interconnect unit		
<b>SMP</b>	symmetric multiprocessing		
<b>SMT</b>	simultaneous multithreading		
<b>SPCN</b>	system power control network		
<b>SPP</b>	shared processor pool		
<b>SPT</b>	System Planning Tool		
<b>SRN</b>	service request number		
<b>SRR</b>	Simplified Remote Restart		
<b>SSD</b>	solid-state drive		
<b>SSIC</b>	IBM System Storage Interoperation Center		
<b>ST</b>	single-threaded		
<b>SUMA</b>	Service Update Management Assistant		
<b>SWMA</b>	Software Maintenance		
<b>TCA</b>	total cost of acquisition		
<b>TCE</b>	translation control entity		
<b>TCO</b>	total cost of ownership		
<b>TDR</b>	time domain reflectometry		
<b>TLB</b>	translation lookaside buffer		
<b>TPM</b>	Trusted Platform Module		
<b>UAK</b>	Update Access Key		
<b>UPIC</b>	universal power interconnect		
<b>VIOS</b>	Virtual I/O Server		





REDP-5649-01

ISBN 073846189X

Printed in U.S.A.

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