POWER9 Enterprise

Power Systems POWER9 Enterprise E980
- 192 POWER9 CPU cores @ 4.0 GHz
- 64 TB DDR4 CDIMM Memory
- 16 Internal NVMe for VIOS or OS booting
- 32 PCIe Gen4 adapters
- 30% jump in performance from E880
  - due to whole system enhancements

Power Systems POWER9 Enterprise E950
- 48 POWER9 CPU cores @ 3.8 GHz
- 16 TB DDR4 ISDMM Memory
- 4 Internal NVMe for VIOS or OS booting
- 10 PCIe Gen4 adapters + 1 Gen3
- 42% jump in performance from E850

POWER9 Server performance:
- Super strength SMT threads
- CPU memory caching
- SMP bus bandwidth
- Memory sizes
- PCIe Gen4 boost

This Presentation
### Announcement Date:
- August 7th, both E950 & E980

### eConfig Date:
- August 8th

### General Availability Date:
- August 17th, E950
- Sept 21st, E980 2 nodes = 96 core
- Nov 16th, E980 4 nodes = 192 core

### Upgrade from POWER8 & POWER9 2 to 4 node MES upgrades:
- In Q4 for easy upgrades

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### Before we start

**PDF of today's slides & replay from**
- [http://tinyurl.com/PowerVUG](http://tinyurl.com/PowerVUG)

**- Not going to cover every point**
**- Not covering all the slides**
**- Not covering the market slides**

**Going to share the PowerPoint on the Power VUG website**
- [http://tinyurl.com/AIXpert](http://tinyurl.com/AIXpert)

**I have ~250 slides including**
- ~100 picture slides of the server
- Pictures are of a beta machine
- GA servers might differ slightly

**Plus loads of link to more information**
There will be typo’s, mistakes and more information becoming available

Check for updates on the Power System VUG website

If you spot mistakes please report them to me Nigel Griffiths ➔ nag@uk.ibm.com

POWER9 requires HMC 920 software (an update to HMC 910)
• Supported on CR7, CR8, CR9 or
• HMC 7063-CR1 POWER8 based
  • More CPU, RAM, Disk & slightly lower cost
  • Simple: remote start/stop with ipmitool +WebUI

Gotchas
• HMC Enhanced+ GUI (No Classic GUI)
• No POWER6 support
• HMC hardware too old
• IVM not supported
• Intel based HMC out of stock in many countries
POWER9 Processor
features that effect the Servers

POWER Generation
Transistor Count (in billions)


POWER4 POWER5 POWER6 POWER7 POWER8 POWER9

0.2 0.3 0.8 1.2 4.2 8.0
POWER9 Chip Variations

**Slim core**
- Up to 22 CPU Cores
- SMT=4 optimised for Linux, HPC, & KVM
- Dec 2018
- OpenPOWER
- Models: AC922, LC922, LC921

**Fused core**
- 12 CPU core
- SMT=8 optimised for PowerVM, throughput
- Q3 2018
- IBM Enterprise
- Models: E950, E980

**IBM Scale-Out**
- SMT8
- Up to 12 cores
- Centaur with DDR4 RAM
- AIX + IBM i + Linux

The E950 does not support IBM i

**Wikipedia on POWER9 fast core**

Each of the eight CPU core threads gets at least a slice & up to 8 slices
### POWER9 Fused core STRENGTH

#### POWER8 SMT8 Core Resources

**Issue of VSU and AGEN**
- 2x load AGEN / simple-ALU
- 2x load/store AGEN
- 2x scalar-64b / vector-128b
- 2x FXU

**Vector Scalar Unit (VSU) Pipes**
- 2x FP (64b/128b) + Complex (128b)
- 2x ALU (128b)
- 2x Permute (128b)
- 1x Decimal FP
- 1x Cryptography

**Fixed Point (FXU) Pipes**
- 2x ALU (64b)
- 2x FX-MUL + Fixed Divide (64b)

**Load Store Unit (LSU) Slices**
- 64kB, 8-way Data Cache
- Up to 4 DW load or 2 store
- 1x Store complete

#### POWER9 SMT8 Core Resources

**Issue of VSU and AGEN**
- 8x scalar-64b / 4x vector-128b
- 8x load/store AGEN

**Vector Scalar Unit (VSU) Pipes**
- 8x FP + FX-MUL + Complex (64b slice)
- 8x ALU + Simple (64b slice)
- 4x Permute (128b)
- 4x Quad Fixed (128b)
- 4x Fixed Divide (64b)
- 2x Quad FP / Decimal FP
- 2x Cryptography

**Fixed Point (FXU) Pipes**
- 2x ALU (64b)
- 2x FX-MUL + Fixed Divide (64b)

**Load Store Unit (LSU) Slices**
- 64kB, 8-way Data Cache
- Up to 8 DW load or store
- 2x Store complete

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### POWER9 Processor Peripherals
New 19” Rack  7965-S42

<table>
<thead>
<tr>
<th>Feature</th>
<th>S42</th>
<th>T42</th>
<th>94Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>42U</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>600mm Wide (datacenter floor tile)</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Ship Loaded from Factory</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Flat surface for mounting HDD Manifolds and Strip PDUs</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>1200mm Depth (rack w/ covers)</td>
<td>1070+130cvs</td>
<td>1016+ cers</td>
<td>1040 + cvrs</td>
</tr>
<tr>
<td>Rear door heat exchanger</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td># Vertical, 1U Pockets</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Height Reduction – fit standard doorways</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Back cable depth (mm)</td>
<td>280</td>
<td>246</td>
<td>261</td>
</tr>
<tr>
<td>Earthquake certified</td>
<td>Yes – 45lbs / EIA</td>
<td>Yes – 35lbs/ EIA</td>
<td>No</td>
</tr>
</tbody>
</table>

OK. it is only a Rack! Perhaps, it is time to retire the older T42. Warning: E950 is tight in a T42!

POWER9 Adapters

- PCIe GEN 4
  - Good timing for future proofing
  - Double the I/O rates
  - GEN 4 for next generation adapters like of 40+ Gb /sec

- Initially most adapters will be GEN 3
  - Fast enough for line speeds
  - Can use GEN2 or GEN3 inGEN4 adapters slots

- Warning: Not all adapters are supported at initial GA
  - See later lists in this deck
POWER9 U.2 NVMe support for E950

E950 has four external storage bays
Independent of SAS controllers
   NVMe ~price of a SAS adapter
Concurrent 8 SAS disks and 4 NVMe drives
   SAS takes 1 or 2 PCIe slots
U.2 NVMe
   • A maximum of four x U.2 NVMe drives
   • Higher performance than SAS SSD
   • Support concurrent maintenance (unlike Scale-Out S922/S924)
   • Write endurance is 2.4 drive write per day DWPD (5 years)
   • Intended primarily to store and boot OS (AIX / VIOS) images
   • Each NVMe device is a separate PCIe endpoint = assign to different LPARs
     • On the HMC, it looks like each has own adapter slots
     • NVMe drives may be assigned to the VIOS & virtualized to client OS
   • Warranty: 5 years if not warn out. A “fuel gauge” to monitor wear is provided for AIX/Linux

POWER9 No internal DVD support

This should not be surprising with 22 year old Tech!
• It is old, slow, hot, unreliable = dead = get over it!

Alternative is a USB Memory Key
1. Faster: USB 3.0 reads at 90 MB/s
2. Larger: lowest GB per buck now is 32 GB USB
3. Memory Key is €$£ ~10

If you must go DVD:
• Use external USB DVD or USB DVD-RAM but at your own risk
• IBM now offered a External USB DVD (at a stiff price but supported)
  • FC#EUA5 Standalone USB DVD drive w/cable €$£122.82
• Use the front USB sockets (provide more electricity power for mechanical DVD drive)

POWER9 OS Install:
• AIX, VIOS & Linux all supported installing from USB memory key
POWER9
The Server Range

POWER8 range

- S824(L) – 4U
  - 16 - 48 Cores
  - 4U
  - 128 GB – 4 TB RAM
  - 7 - 51 PCI Adapters

- S822(L) – 2U
  - 6 - 24 cores

- E850
  - 8 - 96 Cores
  - 10U
  - 256 GB – 16 TB RAM
  - 8 - 96 PCI Adapters

- S822LC – 2U
  - 8 - 80 Cores
  - 10U
  - 256 GB – 16 TB RAM
  - 8 - 96 PCI Adapters

- S821LC – 1U
  - 8 - 80 Cores
  - 10U
  - 256 GB – 16 TB RAM
  - 8 - 96 PCI Adapters
POWER9 range in 2018

- **Enterprise Q3+Q4**
  - 7U to 22U
  - 4 to 16 socket
  - 8 to 192 cores
  - 16TB RAM

- **Midrange Q3**
  - 4U
  - 2 or 4 socket
  - 16 to 48 cores
  - 16TB RAM

- **Scale-Out Q2**
  - S924
  - 2U or 4U
  - 1 or 2 socket
  - 4 to 24 cores
  - 4TB RAM

- **S922**
  - 2U or 4U
  - 1 or 2 socket
  - 4 to 24 cores
  - 4TB RAM

- **AC922 Q4 2017**
  - LC922/LC921 Q2

POWER9 Model Details
POWER9 E950

Software Stack
- HMC 920+
- PowerVM 2.2.6.23+
- AIX 6 TL9 sp12, 7.1 TL5 sp4 & 7.2 TL3 (full P9 support)
- Linux
  - SLES 11 sp4, 12 sp3, 15
  - RHEL 7.4, 7.5
- IBM i not supported

System (9040-MR9) – 4U

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER9 Fast/Fused Core Processors</td>
<td>Two or four processors → 16, 20, 22, 24, 32, 40, 44, 48 CPU cores</td>
</tr>
<tr>
<td>Sockets</td>
<td>2 or 4 Field Upgradable</td>
</tr>
<tr>
<td>Memory</td>
<td>8 Riser Cards each with 16 x DDR4 ISDIMMs = 128 total DIMM sizes; 8, 16, 32, 64, 128 GB; 16 TB max Memory (four times the E850)</td>
</tr>
<tr>
<td>Media Bays</td>
<td>DVD via external USB DVD or USB flash key</td>
</tr>
<tr>
<td>Integrated PCIe - Full Height</td>
<td>PCIe Gen 4: eight x16 + two x8 (2 processors = 4 x16) PCIe Gen 3: one x8 (default Ethernet @ 2x10GB + 2x1Gb) PCIe slots are Full High, Half Length and Blind swap</td>
</tr>
<tr>
<td>Internal SAS Bays</td>
<td>- Up to 8 SAS 2.5 inch, 15mm via 1 or 2 SAS adapters (x8) Split disk capable JBOD, RAID 1,5,6 or 10 - U.2 format 1 to 4 NVMe slots for 1 to 4 NVMe devices 2.5 inch 7mm 800GB, 1.6TB 3.2TB - USB 3.0 (2 front and 2 rear)</td>
</tr>
<tr>
<td>Max I/O Drawers</td>
<td>4 EMX I/O Drawer (PCIe Adapter drawer)</td>
</tr>
<tr>
<td>External Storage Drawers</td>
<td>EXP12SX, ESP24SX &amp; EXP24S Each requires: PCIe SAS adapter or SAS port</td>
</tr>
</tbody>
</table>

POWER9 4 Socket Server E950

Memory Riser
POWER9 Enterprise E950 Server - (Front view w/o Bezel)

- Op Panel LCD
- Op Panel Base
- System Fans A1, A2, A3, A4
- PCIe Cassettes (11x)
- Power Supplies (4x) 2000W
- RAID cable bulkhead (not shown)

POWER9 Enterprise E950 Server - (Rear view)

- Service Proc C1
- Service Proc C2
- Service Proc C12
- USB 3.0 (2x)
- RAID cable bulkhead (not shown)
Processors

Initially
- 2 or 4 Processors = 2 or 4 POWER9 chips
- Can 2 to 4 MES upgrade

E950 Processor Architecture Highlights
Four directly connected POWER9 Processors = 1 hop

Future GPU & CAPI
Four High Speed 25Gb Ports
(A Buses)

RAM I/O
8 Memory Channels
9.6Gb/s

Adapter I/O
48 lanes PCIe GEN4 16Gb/s

SMP Comms

P9

P9

P9

P9

48 X Buses 16Gb/s
### E950 Processor options

<table>
<thead>
<tr>
<th>CPU cores per POWER9</th>
<th>CPU cores per 2 Proc Server</th>
<th>CPU cores per 4 Proc Server</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>24</td>
<td>48</td>
<td>Max throughput</td>
</tr>
<tr>
<td>11</td>
<td>22</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>16</td>
<td>32</td>
<td>Max core strength</td>
</tr>
</tbody>
</table>

These CPU cores counts are available on the S924
E950 makes sense if you:
  a) plan to upgrade later or
  b) need 8 TB memory, S924 max is 4TB

---

### E950 Processor options

<table>
<thead>
<tr>
<th>CPU cores per POWER9</th>
<th>CPU cores per 2 Proc Server</th>
<th>CPU cores per 4 Proc Server</th>
<th>rPerf</th>
<th>rPerf / core</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>24</td>
<td>48</td>
<td>1146</td>
<td>23.8</td>
</tr>
<tr>
<td>11</td>
<td>22</td>
<td>44</td>
<td>1072</td>
<td>24.3</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>40</td>
<td>1034</td>
<td>25.9</td>
</tr>
<tr>
<td>8</td>
<td>16</td>
<td>32</td>
<td>870</td>
<td>27.2</td>
</tr>
</tbody>
</table>

Much higher performance
Full 16 TB memory available

These CPU cores counts are available on the S924
E950 makes sense if you:
  a) plan to upgrade later or
  b) need 8 TB memory, S924 max is 4TB
Server Generation

rPerf for E950 48 CPU cores

POWER9

POWER8

POWER7+

POWER7

POWER6

POWER5

p595

p595

770C

770D

E850

E850C

E950

Memory
POWER9 Processor Family

Two Memory Architectures

Scale Out
Direct Attach Memory
- 8 Direct DDR4 Ports
- Max 2-Socket Systems

Scale Up
Buffered Memory
- 8 Buffered Channels
- 4 to 16 Socket Systems

Three Memory Architectures

Scale Out
Direct Attach Memory
- 8 Direct DDR4 Ports
- POWER9 → DDR4
- Lower cost
- Max 2-Socket Systems

Scale Up
Buffered Memory
- 8 Buffered Channels
- POWER9 → Centaur chip → DDR4
- Best of both!

E950 4 Socket Systems

Scale Up
Buffered Memory
- 8 Buffered Channels
- POWER9 → Centaur chip → RAM
- Higher performance & higher RAS

E980 16 Socket Systems
Memory Riser Card

16 x DDR4 DIMMs

4 Centaurs
L4 Cache

8 white slots is the minimum on a Riser

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E950 Memory Subsystem Highlights

DDIR4 DIMMS sizes
✓ 8, 16, 32, 64, 128GB
Per E950 Server
✓ Max 920 GB/s Memory Bandwidth
✓ Min 2 Socket: 64 GB Memory
✓ Min 4 Socket: 128 GB Memory
✓ Max of 16TB Memory
✓ 8 Riser Cards with 128 DIMMs slots
✓ Minimum of 50% Memory Activated

Per POWER9 processor
✓ Max 230 GB/s Memory Bandwidth
✓ Up to 4TB Memory
✓ 2 Memory Riser cards (like below) each with
  ✓ 4 Centaur chips
  ✓ 16 DIMM slots
Memory increment
✓ 8 DIMMs
POWER9 2 Socket Server E950 Organization

E950 Infrastructure
### Key Power E950 technical enhancements over Power E850C

<table>
<thead>
<tr>
<th>Features</th>
<th>E850C</th>
<th>E950</th>
<th>Enhancements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>P8 (DCM)</td>
<td>P9 (SCM)</td>
<td>More efficient processor communication</td>
</tr>
<tr>
<td>Sockets</td>
<td>2 to 4</td>
<td>2 to 4</td>
<td></td>
</tr>
<tr>
<td>Cores</td>
<td>32 or 40 or 48</td>
<td>32 or 40 or 44 or 48</td>
<td>More processor options</td>
</tr>
<tr>
<td>Maximum Memory</td>
<td>4 TB</td>
<td>16 TB</td>
<td>4X Maximum Memory</td>
</tr>
<tr>
<td>DIMM Type/DIMM slots count</td>
<td>Up to 32 CDIMMs</td>
<td>Up to 128 ISDIMMs</td>
<td>More Memory Capacity and Flexibility</td>
</tr>
<tr>
<td>Memory Bandwidth</td>
<td>768 GB/sec</td>
<td>920 GB/sec</td>
<td>20% more Memory Bandwidth</td>
</tr>
<tr>
<td>IO Expansion Slots</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>PCIe slots</td>
<td>11</td>
<td>11</td>
<td>8 Gen4 x16 + 2 Gen4 x8 + 1 Gen3</td>
</tr>
<tr>
<td>Acceleration Ports</td>
<td>Yes (CAPI 1.0)</td>
<td>Yes (CAPI 2.0 + OpenCAPI)</td>
<td>Enabled for enhanced acceleration for AI environments</td>
</tr>
<tr>
<td>PCIe Hot Plug Support</td>
<td>Yes</td>
<td>Yes + Blindswap</td>
<td></td>
</tr>
<tr>
<td>IO bandwidth</td>
<td>315 GB/sec</td>
<td>630 GB/sec</td>
<td>~2X IO bandwidth</td>
</tr>
<tr>
<td>Ethernet ports</td>
<td>Quad 1 Gbit (x8 Slot)</td>
<td>Quad 1 Gbit (x8 Slot)</td>
<td></td>
</tr>
<tr>
<td>Internal Storage Bays</td>
<td>12 (8 x 2.5&quot; SAS bays + 4 x 1.8&quot; SSD bays)</td>
<td>12 (8 x 2.5&quot; SAS bays + 4 x NVMe bays)</td>
<td>NVMe for high-bandwidth, low latency local boot</td>
</tr>
<tr>
<td>Internal Storage Controllers</td>
<td>Integrated</td>
<td>Optional &amp; Conc Maintainable</td>
<td>Improved cost and serviceability</td>
</tr>
<tr>
<td>RAS</td>
<td>Enhanced DC-DC Reg</td>
<td>Enhanced Fan Conc Maint</td>
<td>More reliable power/cooling</td>
</tr>
</tbody>
</table>

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### E950 follows the Enterprise Server package traditions

Included with the Server
- **PowerVM** at no cost*
  - Includes Hypervisor, VIOS, Firmware and HMC** support for server management, virtualization and RAS
- **PowerVC** at no cost*
- **Power to Cloud Rewards** (Education or Lab Services days)
- **Cloud Management Console** (Server status reports on you mobile/cell phone or tablet)
- **Warranty**: 3 years of 24x7 service included

Regular & popular Power Server options with a cost:
- Elastic Capacity on Demand (CoD) for both processor cores & memory
- Enterprise Pool Capacity (n-1 so the pool can be POWER8 and POWER9)
- IBM Active Memory Expansion for AIX
- IBM Active Memory Mirroring for Hypervisor

* There is a SWMA cost  ** HMC is orderable separately at a cost
POWER9

eConfig view of the Features

E950 Processor GHz

<table>
<thead>
<tr>
<th>Feature code</th>
<th>CPU cores per POWER9</th>
<th>CPU cores per Server (max)</th>
<th>Nominal GHz</th>
<th>No-name GHz</th>
<th>Max GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPWT</td>
<td>12</td>
<td>48</td>
<td>2.8</td>
<td>3.15</td>
<td>3.8</td>
</tr>
<tr>
<td>EPWY</td>
<td>11</td>
<td>44</td>
<td>2.85</td>
<td>3.28</td>
<td>3.8</td>
</tr>
<tr>
<td>EPWS</td>
<td>10</td>
<td>40</td>
<td>3.0</td>
<td>3.4</td>
<td>3.8</td>
</tr>
<tr>
<td>EPWR</td>
<td>8</td>
<td>32</td>
<td>3.3</td>
<td>3.6</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Number of Processor sockets filled:
1 – not allowed
2 – minimum
3 – possible future offering
4 – maximum

GHz reported by some commands

Default and GHz in Practice
AIX: lparstat –E 1 3
POWER9 Energy & CPU GHz Balance

Enables higher dynamic operational frequencies

**Important Frequencies**
- **High** – Overclocking (~15%)
- **Medium** – Overclocking (~10%)
- **Nominal** – Fixed normal GHz
- **Power Saver** – Fixed reduce GHz
  - Reduces electrical power use = saves money
- **Zero GHz** – The server is powered off!

**Static Power Saver Mode**
- Reduced electrical use to lower costs – lower GHz

**Disabled All Mode** → “overclocking” disabled
- Fixed Frequency

**Dynamic Performance Mode**
- Variable Frequency (Nominal to High GHz) based in workload
  - Higher the workload, the lower the GHz

**Maximum Performance Mode** – E950 default
- Variable Frequency (Medium to High GHz) based in workload
  - If necessary, speeds up fans
  - In a hot 27+C computer room, can lower GHz to Nominal GHz

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On Twitter? @mr_nmon

P9 GHz **part 1**: #POWER9 servers in practice run at (max) ~3.7-4 GHz, other server chips eat our dust! I see: normal GHz+overclocking, I am told to not use the “o” word, oops!

#EnergyScale guys say run full speed but will lower GHz, if getting hot like your air-conditioning fails!

P9 GHz **part 2**: #POWER9 servers **How to get too hot!** If you don’t have: max CPU count+ max memory size+ max disks+ max high-speed adapter AND max server workload+ computer room is warm then your server may never get too hot and still be at that (max) GHz. I know as I tried!!!

P9 GHz **part 3**: One quirk on AIX: commands like Iparstat -E 1 9 report the varying current GHz but others report the non-overclocking (oops!) GHz value called Nominal So don’t worry is you buy 3.9 GHz but nmon or lsattr -El proc0 reports a lower Nominal GHz between 2.3 to 3.3 GHz
Memory Options

<table>
<thead>
<tr>
<th>Feature Code</th>
<th>DIMM Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>EM6A</td>
<td>8GB DIMM</td>
</tr>
<tr>
<td>EM6B</td>
<td>16GB DIMM</td>
</tr>
<tr>
<td>EM6C</td>
<td>32GB DIMM</td>
</tr>
<tr>
<td>EM6D</td>
<td>64GB DIMM</td>
</tr>
<tr>
<td>EM6E</td>
<td>128GB DIMM</td>
</tr>
</tbody>
</table>

- Up to 230 GB/s peak memory bandwidth per socket
- Up to 920 GB/s peak memory bandwidth per Server
- Memory Riser card: 16 DDR4 DIMMs & imbedded 4 Centaur L4 Cache chips
- Max Memory Riser card: 8
- Maximum 2 TB per Riser so a total of 16 TB
- Industry Standard DDR4 memory Registered DIMMs (server class)
- DDR4 ISDIMMs rated 2400MHz but running at 1600MHz behind Centaurs
- Only IBM DIMMs are supported
- Minimum config is 1 Riser Card with 8 DIMMs x 8 GB per Processor (64 GB / processor)
- DIMM plug rules are complex
  - A single Riser card recommended all memory the same size
  - A single Riser card can have 2 DIMM sizes (8 one size + 8 another size)

Memory rules min and max for 2 or 4 procs

- All memory is DDR4 - No POWER8 E850 RAM is supported
- All memory is the same speed
- Only difference is the DIMM size
- Each Processor socket has 2 Riser cards, each with 16 DIMM slots
- 2 Processor Socket: min 64 GB* & max 8 TB Memory
- 4 Processor Socket: min 128 GB* & max 16 TB Memory
- Add DIMMs in packs of eight = half a Riser Card
- More DIMMs = more performance

* Poor performance as ¾ of the ports are not used.
  - Recommend not going below 256 GB and 512GB
### NVMe storage Options

<table>
<thead>
<tr>
<th>Feature Code</th>
<th>DIMM Size</th>
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<tbody>
<tr>
<td>EC5J</td>
<td>800 GB</td>
</tr>
<tr>
<td>EC5K</td>
<td>1.6TB</td>
</tr>
<tr>
<td>EC5L</td>
<td>3.2TB</td>
</tr>
</tbody>
</table>

- Three sizes of internal NVMe boot devices
- Ideal for VIOS boot or OS boot devices (two for redundancy)
- Faster than SSD - skipping SAS protocol level
- 2.4 drive write per day DWPD (5 years warranty)
  - Meaning complete Drive Writes Per Day
  - `nvmemgr` command to determine drive wear
  - They will issue warning messages at 100% used
  - Customer to backup and replace

### Three Backplane options

Depends on the SAS internal disk support that you need

- All have four NMVe bays

One of these SAS options must be selected:

1. Zero DASD Backplane no disks (only NMVe), so no SAS adapter
   - FC#EJ0B
2. Base DASD backplane with 1 SAS PCIe adapter + selected SAS drives
   - FC#EJBB - all disks connect to the 1 adapter
3. Split DASD backplane with 2 SAS PCIe adapters + selected SAS drive
   - FC#EJ0J - disks are split between the two SAS adapters 4 + 4
Internal SAS cabling

All 8 disks on one SAS EJ0K adapter

Split Disk 4 + 4 with EJ0K SAS adapters

Internal SAS cabling

High Performance with large shared adapter disk cache – 2 x EJ14 adapters
Dual VIOS suggestions

Network
• 2 or 4 (for redundancy) Ethernet adapters

Storage
A. 1 to 4 NVMe drives
   – Fast (possible AIX flash Cache use too)
   – No system downtime to replace NVMe drives
B. 2 or 4 (for redundancy) Fibre Channel SAN
   – SAN booting VIOS is standard these days & fast. Assumes you have a SAN
C. Internal disks or SSD via two SAS adapter (Split backplane)
   – 8 disk at the front (redundancy using AIX mirroring)
   – If not SSD its pretty slow I/O
   – Requires 2 SAS adapters & uses 2 PCIe slots
D. Remote Disk Drawer

Internal storage numbering

SAS disks
1 2 3 4 5 6 7 8
   – SAS adapter 1 + 2

NVMe
1 2 3 4
   – VIOS A
   – VIOS B
Operating Systems for Enterprise

AIX
- AIX with POWER9 support can LPM from P7 & P8 to POWER9 in P7/P8 mode
- Once on POWER9 reboot required to get to POWER9 mode
- AIX on POWER66 can’t LPM to POWER9

---

**AIX for new POWER9 Generally**

**AIX 7.2 TL2 + SP2 (Mar 2018)**

- Random number generator
  - User-mode accessible
  - For application exploitation
- Power 3.0B ISA extensions
  - VSX3, string, video encode, quad floating point, pc relative addressing, 32-bit overflow, Memory Atomics
  - For application exploitation
- NVMe support

**AIX 7.2 TL3 (2H 2018)**

- Dynamic System Optimizer
  - Enabled for P9 systems
- 1536-thread single LPAR
  = 192-core/SMT8 single system image support
- 32 TB max RAM in an LPAR

---

Reference Chart not E950 specific
AIX Level Support at E950  RELEASE-TL-SP-YYWW

Virtualised and LPM
• AIX 7200-02-01-1732 or later
• AIX 7200-01-01-1642 or later
• AIX 7100-05-01-1731 or later
• AIX 7100-04-02-1614 or later
• AIX 6100-09-07-1614 or later*

AIX with Adapters at 17th August
• AIX 7200-02-02-1832 or later
• AIX 7100-05-02-1832 or later

AIX with Adapters later in 2018
• AIX 7200-01-05-1837 Dec 2018
• AIX 7100-04-07-1837 Dec 2018
• AIX 6100-09-12-1838 Sept 2018*

* AIX 6 service extension required

Linux
Linux on POWER9 E950

• Linux on E950 only available under PowerVM

• Older Linux version run fine in POWER8 mode
  – SLES 11 sp4 and 12 sp3
  – RHEL 7.4

• Refreshed releases in 2018 have some POWER9 support – ask the vendor

• For POWER9 optimisation best chance is:
  – SLES 15
  – RHEL 7.5 for POWER9 also know as the ALT version
    like RHEL-ALT-7.5-20180315.0-Server-ppc64le-dvd1.iso

Linux on POWER9 E950

• Ubuntu on PowerVM no longer being supported by IBM
  – Includes 16.04 and 18.04
  – Include POWER8 and POWER9
  – Does actually work – just no support

• If you previously purchased support Ubuntu 16.04 in POWER8 mode on PowerVM, then support continues and is available for 2 more years

• Native Ubuntu on base metal & for KVM hosting is fully supported by IBM
  – Native meaning “not PowerVM” environment (also known as OPAL mode)
  – For example: POWER9 Servers AC922 & LC922 and LC921
IBM i

IBM i is not supported on the E950

VIOS

2.2.6.23 or the latest on 17th August 2018

Do not use older versions due to new E950 devices like NVMe

VIOS 3.1 is coming soon (based on AIX 7.2)
Storage Remote Drawers
Adapter Remote Drawers

Same drawers & connections as POWER9 Scale-Out Servers
- this should all be business as usual
- also used in POWER8

Remote Disk drawers for Disks

• SAS Disk Drawers EXP12SX | EXP24SX | EXP 24S
  – FC#ESLL | FC#ESLS | FC#5887 (slider, slider & homerun)
  – Supported via PCIe SAS adapter
    FC#EJ0J (full height) & FC#EJ0M (low profile) (GTO)
    – As used on POWER8

  – Care needed if the old “migrating” drawer is back level

EXP12SX = 12x 3.5 inch disks
EXP24SX = 24 x 2.5 inch disks
Remote Adapter drawers - FC#EMX (know as MEX drawers)

• Four Processor E950 supports
  – 8 FC#EJ08 cards (Bear Mountain) In x16 PCIe Slots
  – 8 Fan-out drawer halves = Four #EMX Drawers
  – Each Fan-out has 6 adapters slots (12 per drawer)

• Eight Adapter slots → 48 Adapter slots plus
  3 slower E950 slots = total 51!

I/O support for 17th August release of E950
Adapters, disks & related bits

Important for early migration & quick adoption
### POWER9 I/O currently planned for GA1 on Power E950

<table>
<thead>
<tr>
<th>FC</th>
<th>CCIN</th>
<th>Description</th>
<th>Max</th>
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<tbody>
<tr>
<td>5729</td>
<td>5729</td>
<td>PCIe2 8Gb 4-port Fibre Channel Adapter</td>
<td>50</td>
<td>AIX Linux</td>
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<tr>
<td>5735</td>
<td>577D</td>
<td>8 Gigabit PCI Express Dual Port Fibre Channel Adapter</td>
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<tr>
<td>E0A</td>
<td>577F</td>
<td>PCIe1 16Gb 2-port Fibre Channel Adapter</td>
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<td>Linux</td>
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<td>EN12</td>
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<td>PCIe3 32Gb 2-port Fibre Channel Adapter</td>
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### POWER9 I/O currently planned for Aug 17th on Power E950

<table>
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<tr>
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<td>EJ0K</td>
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<td>PCIe3 RAID SAS Adapter Quad-port 6Gb x8 for MR9</td>
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<td>EJ10</td>
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<td>PCIe3 SAS Tape/DVD Adapter Quad-port 6Gb x8</td>
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<td>PCIe3 12GB Cache RAID PLUS SAS Adapter Quad-port 6Gb x8</td>
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### Disk Drawer

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<td>EXP12SX SAS Storage Enclosure</td>
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<td>EXP245X SAS Storage Enclosure</td>
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Lime color found in eConfig has “Withdrawn” could be migrated from POWER8 & supported.
### POWER9 I/O currently planned for August 17th on Power E950

<table>
<thead>
<tr>
<th>FC</th>
<th>CCIN</th>
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### POWER9 I/O currently planned for August 17th on Power E950

<table>
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<th>FC</th>
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### POWER9 I/O currently planned for August 17th on Power E950

<table>
<thead>
<tr>
<th>FC</th>
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<th>Max OS support</th>
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<tr>
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<td>PCIe2 4-port 1GbE Adapter</td>
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<td>EC66</td>
<td>2CF3</td>
<td>PCIe4 2-port 100Gb ROC EN CAPI adapter</td>
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<td>EN0H</td>
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<td>PCIe3 4-port (10Gb FCoE &amp; 1GbE) SR&amp;RJ45</td>
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<td>PCIe3 4-port (10Gb FCoE &amp; 1GbE) SFP+Copper&amp;RJ45</td>
<td>51 AIX Linux</td>
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<td>EN0S</td>
<td>2CC3</td>
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<td>EN15</td>
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<td>PCIe3 4-port 10GbE SR Adapter</td>
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</table>

NOTE: The adapters with FCoE in the description are supported for Ethernet usage but you require an RPQ if you intend to use FCoE in POWER9.

### POWER9 I/O currently planned for August 17th on Power E950

<table>
<thead>
<tr>
<th>FC</th>
<th>CCIN</th>
<th>Description</th>
<th>Max OS support</th>
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<td>EM6B</td>
<td>16 GB DDR4 Memory (2666 MHz)</td>
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<tr>
<td>EM6C</td>
<td>32 GB DDR4 Memory (2666 MHz)</td>
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<tr>
<td>EM6D</td>
<td>64 GB DDR4 Memory (2666 MHz)</td>
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<td>EM6E</td>
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<tr>
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### CPU + RAM

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<td>800 GB Mainstream U.2 SSD NVMe</td>
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<td>3.2 TB Mainstream U.2 SSD NVMe</td>
<td>16 AIX/Linux</td>
</tr>
</tbody>
</table>
POWER9 E950 Power Supply

Concurrent maintenance & redundant power – four units

Rating
• 2000 W 200- 240 VAC
• Redundancy 2+2 → if cabled correctly

Energy Efficiency
• 80+ Platinum Power Supply Compliant
• EPA Energy Star Compliant
• Built-in Advanced Thermal & Power Management

Physicals
POWER9 E950

E950 size
- Width: 448 mm (17.5 in.)
- Height: 175 mm (6.9 in.) → 4 EIA units
- Depth: 902 mm (35.6 in.) → 5 inches greater than E850
  → T42 needs a 8 inch extension for rear cables

E950 Weight:
- 69 kg (152 lb) → Heavier than the E850
- With weight reduction (removing parts) ~121 lb
- Four person lift recommended or better yet a lifting tool

POWER9 E950

E950 Electrical Power
- Operating voltage: 200 - 240 V AC
- Operating frequency: 50 - 60 Hz +/- 3 Hz
- Power consumption: 3,850 watts maximum
- Power source loading: 3.9 kVA maximum

Note:
- Model 9040-MR9 use four power supply units
- C19/C20 connectors for higher amps → different to the E850 C13’s
POWER9 E950

E950 Thermal output
• 14,403 Btu/hr maximum (per system node)

E950 Maximum altitude:
• 3,050 m (10,000 ft)

E950 Noise level
• Acoustics A-weighted Upper-Limit Sound Power Levels
  One typically configured Four 8-core or 12-core, 2 TB memory:
  • 7.4 bels (operating/idle: 25 C, 500 m)
  One maximum configured Four 12-core, 2 TB memory:
  • 8.1 bels (heavy workload, 25 C, 500 m)

Call to Action
→ We need to make sure every one understands

Good News
1. E950 many improvement to the already good E850
2. Up to 48 CPU cores: POWER9 performance boost ~42%
3. Memory jump → 4 TB to 16 TB
4. Adapters → Easy to use rear PCIe cassette access
5. HMC – get them ready ASAP

Challenges
1. Electricity → C19/C20 connectors for higher amps, may need PDU changes
2. Size → It's a lot longer – need to check racks & doors
3. Heavy → Loading in to a rack needs extra care, use the Lifting Device
4. Noisy → May need ear protection, check the computer room policy
Power E950 Specification Highlights

- 4U Server - 19” Rack Enclosure
- 2 or 4 POWER9 Enterprise SMT8 processors
- Processor SCMs enables efficient 1-Hop processor fabric interconnect
- Up to 16TB Total DDR4 DIMMs – up to 4TB per processor
  - 920 GB/s memory bandwidth per System
  - 230 GB/s memory bandwidth per Processor
  - 128 DIMM slots on 8 memory riser cards
  - 16 DIMM slots on each riser
- Capacity on Demand for Processor and Memory
- 10 PCIe Gen4 slots, 1 PCIe Gen3 - Blind swap, Full Height, Half Length
- Four High Speed 25Gb/s acceleration ports to attach to future accelerators
- 4 x NVMe Flash U.2 Bays (bootable)
- 8 x internal 8 SFF (2.5”) SAS bays
- Storage controller adapters plug into PCIe slots
  - Single backplane for 0 or 1 SAS storage PCIe adapters
  - Split backplane for two storage SAS PCIe adapters
  - SAS PCIe adapters are concurrently maintainable
- Enhanced DC-DC Regulator Redundancy
- Full Fan Concurrent Maintenance
- I/O Expansion and Storage drawers support
- 4U Server - 19” Rack Enclosure

No Charge: &