Power Systems is part of IBM Cognitive Systems

Accelerated compute and storage delivered on premise, in the cloud or via Watson
The value of computing is changing, from scaling process automation to scaling knowledge via actionable insights.
The Path to the Digital Business and Beyond

Source: Gartner, “Architecting the On-Demand Digital Business”; Drue Reeves, Kyle Hilgendorf, Kirk Knoernschild, August 16, 2016
IBM Power Systems

Best optimized System for business applications

Designed for cognitive era
Power technology designed for big data and analytics workloads

Cloud delivery
Hyperscale or hybrid cloud with improved economics

Open, collaborative innovation platform
Enabling cognitive business and cloud economics through Linux and open collaborations
<table>
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<th>Industry</th>
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</tr>
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<tr>
<td>Financial sector</td>
<td>Oracle</td>
<td>Best Economics / TCO</td>
</tr>
<tr>
<td>Retail</td>
<td>SAP &amp; SAP HANA</td>
<td>Hybrid Cloud</td>
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<tr>
<td>Telecom</td>
<td>Temenos</td>
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<tr>
<td>Public &amp; security</td>
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<tr>
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<tr>
<td>Transportation</td>
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</tr>
<tr>
<td>Defence</td>
<td>Comptel</td>
<td>Solid roadmap</td>
</tr>
</tbody>
</table>

Power Systems represents over 60% of Unix market.
Strategy built around a Solid Technology Roadmap

POWER8/8NV
22nm
- Twelve Cores
- SMT++
- On Chip IO Buses
- Transactional Memory
- FPGA Support
- CAPI
- Encryption
- PCIe Acceleration
- NVLINK2.0 (Power8')

POWER7/7+
45/32 nm
- Eight Cores
- On-Chip eDRAM
- Power-Optimized Cores
- Memory Subsystem ++
- SMT++
- Reliability +
- VSM & VSX
- Protection Keys+

POWER6/6+
65/65 nm
- Dual Core
- High Frequencies
- Virtualization +
- Memory Subsystem +
- Altivec
- Instruction Retry
- Dynamic Energy Mgmt
- SMT +
- Protection Keys

POWER5/5+
130/90 nm
- Dual Core
- Enhanced Scaling
- SMT
- Distributed Switch +
- Core Parallelism +
- FP Performance +
- Memory Bandwidth +
- Virtualization

POWER9
14nm
- Extreme Analytics Optimization
- Extreme Big Data Optimization
- On-chip accelerators
- NVLINK2.0
IBM POWER8 brings performance and scale

**4X**
- threads per core vs. x86 (up to 1536 threads per system)

**Processors**
- flexible, fast execution of analytics algorithms

**4X**
- memory bandwidth vs. x86\(^1\) (up to 16TB of memory)

**Memory**
- large, fast workspace to maximize business insight

**4X**
- more cache vs. x86\(^2\) (up to 800MB cache per socket)

**Cache**
- ensure continuous data load for fast responses

---

Optimized for a broad range of big data & analytics workloads:

- **UNSTRUCTURED**
- **IN-MEMORY**
- **STRUCTURED**

---

\(^1\) up to 16TB of memory
\(^2\) up to 800MB cache per socket
POWER8 Product Line

65% for Scale Out
80% for Enterprise

Guaranteed Utilization vs. industry average of 30–40%

Outperforming Industry Standards

Power E870C
Power E880C

Power S814
Power S822
Power S814, S824
Power E850C

S812LC
S822LC
Power S812L
Power S824L

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Top 5 Reasons to Upgrade to POWER8

1. Greater Performance
2. Significant Cost Savings
3. Increased Capacity, Flexibility, and Scale
4. Seamless Integration and Simple Migration
5. Future Proof, Cloud Ready Solution
POWER8 Cost Savings Estimator
Developed by the IBM Eagle Team
IT Economics Practice
High-end system capacity increases with POWER8

Power E880 offers nearly 40% more performance with 25% fewer cores, enabling workload growth and lowering software costs.
Performance per core moves up with POWER8

...up to 1.5X over POWER7+
up to 2X over POWER7
up to 2.5X over fastest POWER6
The Path to High Availability

A Power Enterprise Pool puts a client in the drivers seat on the road to continuous availability with reduced TCO.

• Full redundancy has always been the best option for high availability
• Traditionally, this path has been out of reach for most clients
• Power Enterprise Pools makes it possible
• Move your applications with Live Partition Mobility and move activations as well!
  • Supports your cloud environment
  • Enables workload balancing
  • Simplifies systems maintenance
  • Works for disaster recovery
  • User controlled, always available, no hassle
  • Move everything
What makes IBM Power Systems the best platform for clients’ mission critical SAP HANA deployments?

**Flexibility**
- Superior virtualization and management features to afford flexibility and maximum utilization

**Resiliency**
- Unsurpassed RAS (reliability, availability, serviceability) characteristics to support mission critical SAP applications

**Performance**
- Highest throughput per core to deliver faster business results – up to 2x Intel-based alternatives
New World record set by IBM Power E870 on SAP BW Enhanced Mixed Load Standard Application Benchmark with 2 Billion records

"IBM set a world record in the industry leading SAP BW-EML Standard Application Benchmark at 2 billion records ... twice the performance per core over previous benchmarks.”

Kyle Garman
SVP & Managing Director,
Global Strategic Partners
SAP
<table>
<thead>
<tr>
<th></th>
<th>IBM Power Systems</th>
<th>SPARC M7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HW/OS RAS Features</strong></td>
<td>Includes all key RAS features:</td>
<td>Lacks key RAS features:</td>
</tr>
<tr>
<td></td>
<td>• Redundant system clocks and controllers</td>
<td>• No concurrent firmware updates</td>
</tr>
<tr>
<td></td>
<td>• Concurrent firmware updates</td>
<td>• No dynamic processor sparing…and less</td>
</tr>
<tr>
<td></td>
<td>• Dynamic processor sparing…and more</td>
<td></td>
</tr>
<tr>
<td><strong>Performance</strong></td>
<td>• Industry-leading performance and benchmarks from 2-16 sockets per server</td>
<td>• Unsubstantiated performance claims</td>
</tr>
<tr>
<td></td>
<td>• 2x - 3x greater per core performance over SPARC when leveraging PowerVM</td>
<td>• Exaggerated claims using unrealistic or unavailable configurations</td>
</tr>
<tr>
<td></td>
<td>• LPM can be used to ensure the workloads and users are not disrupted during planned maintenance</td>
<td>• Industry benchmarks show poor per core performance</td>
</tr>
<tr>
<td><strong>Planned Downtime</strong></td>
<td>• LPM can be used to ensure the workloads and users are not disrupted during planned maintenance</td>
<td>• OracleVM for SPARC has limited and restricted capabilities for moving workloads. Not available at all on Solaris containers. Requires VCS or Sun Cluster for planned downtime</td>
</tr>
<tr>
<td></td>
<td>• Allows optimization of Oracle licenses to reduce number required by driving sustained utilization levels higher through dynamic resource reallocation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• All features are certified and supported for use with Oracle</td>
<td>No CPU or memory virtualization:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Logical domains are allocated physical CPUs; No shared processor pools; No micro-partitioning support</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No shared memory or memory compression</td>
</tr>
<tr>
<td><strong>Virtualization</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Risk</strong></td>
<td>• Proven platform for Oracle workloads, both DB and Applications with many industry references to support reliability and stability of platform</td>
<td>• M7 is new Oracle platform: The only enterprise class industry benchmark results show lackluster per core performance. Limited RAS features mean the systems are designed to be clustered using expensive Oracle software</td>
</tr>
<tr>
<td><strong>Roadmap</strong></td>
<td>• History of a clear roadmap with timely execution</td>
<td>• Three of the last seven server generations were late; Missed on server capacity and performance targets</td>
</tr>
</tbody>
</table>
POWER8 vs. SPARC performance

Oracle M6-32 result touted as “World Record for 32-Processor Systems”

(it had 384 cores)

IBM Power Systems E870:
- 2.7x more users per core than M6-32 (SPARC M6)
- 2.1x more users per core than T7-2 (SPARC M7)
- 2.0x more users per core than M7-8 (SPARC M7)

---

(1) Oracle SPARC Server M5-32 on the two-tier SAP SD standard application benchmark running SAP enhancement package 5 for the SAP ERP 6.0 application; 32 processors/192 cores/1536 threads, SPARC M5; 3.60 GHz, 4,096 GB memory; 85,050 SD benchmark users, running Solaris® 11 and Oracle 11g; Certification # 2013009. Source: [http://www.sap.com/benchmark](http://www.sap.com/benchmark).
(2) Oracle SPARC Server M6-32 on the two-tier SAP SD standard application benchmark running SAP enhancement package 5 for the SAP ERP 6.0 application; 32 processors/384 cores/3072 threads, SPARC M6; 3.60 GHz, 16 TB memory; 140,000 SD benchmark users, running Solaris® 11 and Oracle 11g; Certification # 2014003. Source: [http://www.sap.com/benchmark](http://www.sap.com/benchmark).
(3) Oracle SPARC Server T7-2 on the two-tier SAP SD standard application benchmark running SAP enhancement package 5 for the SAP ERP 6.0 application; 2 processors/64 cores/512 threads, SPARC M7; 4.133 GHz, 1 TB memory; 30,800 SD benchmark users, running Solaris® 11 and Oracle 12c; Certification # 2015050. Source: [http://www.sap.com/benchmark](http://www.sap.com/benchmark).
(4) Oracle SPARC Server M7-8 on the two-tier SAP SD standard application benchmark running SAP enhancement package 5 for the SAP ERP 6.0 application; 8 processors/256 cores/2048 threads, SPARC M7; 4.133 GHz, 4 TB memory; 130,000 SD benchmark users, running Solaris® 11 and Oracle 12c; Certification # 2016020. Source: [http://www.sap.com/benchmark](http://www.sap.com/benchmark).

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# IBM Power Systems Enterprise Cloud Offering (C-models)

## On-Premises Cloud
- OpenStack-based Cloud Management: enabling DevOps to Full production
- Open source automation: installation and config. recipes
- Flexible elastic private cloud capacity and consumption models
- Cross Data Center Inventory and Performance Monitoring via the IBM Cloud

## Hybrid Infrastructure
- Manage VMs across on and off-premises clouds with a single pane of glass (e.g., VMware vRealize)
- Securely connect traditional workloads with cloud-native apps (Power & API Connect, BlueMix)
- Optional DR as a Service (GDR for Power)
- Free access and capacity flexibility with SoftLayer:
  - Free SoftLayer starter pack (12 server months)
  - Flexibility to run capacity On Premises or in SoftLayer

## Built-in Cloud Deployment Service Options
- Design for Cloud Provisioning and Automation
- Build for Infrastructure as a Service
- Build for Cloud Capacity Pools across Data Centers
- Design for Hybrid Cloud with BlueMix
- Deliver with automation for DevOps
- Deliver with Database as a Service
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Our industry continues to transform through waves of change

- **Data**
  - Transactional Database

- **Reporting**
  - Business Intelligence

- **Context**
  - Big Data & Analytics

- **Insight**
  - Actionable Insight in context

---

- Centralized Mainframes
- Distributed Computing
- E-Business
- Smarter Planet
- Big Data & Predictive Analytics
- Cognitive
Q7: What level of ROI have you realized based on your implementation of these technologies? – Institute of Business Value: Who’s leading the cognitive pack in digital operations?
Overall Cognitive / Artificial Intelligence (AI) Space

Cognitive / ML/DL

Human Intelligence Exhibited by Machines

Machine Learning
“Trained” using large amounts of data & ability to learn how to perform the task

Deep Learning
Break tasks into Artificial Neural Networks

New Data Sources: NoSQL, Hadoop & Analytics

New class of applications
Opportunity in ML Training
- Pattern matching
- Image matching (Consumer Photos)
- Real-time decision support
- Complex workflows
- Data Lakes

Extend Enterprise applications
- Finance: Fraud detection / prevention
- Retail: shopping advisors
- Healthcare: Diagnostics and treatment
- Supply chain and logistics

Extend Predictive Analytics to Advance Analytics with AI

Growing across Compute, Middleware, and Storage
In five years, what we say and write will be indicators of our mental health and physical wellbeing. Patterns in our speech and writing analyzed by cognitive systems will provide doctors and patients tell-tale signs to predict and track early-stage developmental disorders, mental illness and degenerative neurological diseases more effectively and prompt us to seek treatment.

**Analyze speech for early detection:** Find patterns in speech to accurately predict and monitor psychosis, schizophrenia, mania and depression.

**Written words provide indicators:** Analyze written words to help evaluate our mental health, alerting us to a decline before it occurs.

**Cognitive assistants for mental health:** Cognitive assistants and sensors in our smart phones could “listen” out for our wellbeing

**Automated mental health tools:** Create automated tools to help doctors track and treat the progression of a patient’s neurological disease.

https://youtu.be/DnYUNQVcVhI
Hyper-imaging and AI will give us superhero vision. In five years, our ability to “see” beyond visible light will reveal new insights to help us understand the world around us. This technology will be widely available throughout our daily lives, giving us the ability to perceive or see through objects and opaque environmental conditions anytime, anywhere.

- **Health and nutrition**: Take images of food to show its nutritional value or whether it’s safe to eat.
- **Pharmaceuticals**: A hyperimage of a pharmaceutical drug could be used to determine if it’s fraudulent.
- **Driving**: See through fog or rain and detect black ice or if something is in the road.
- **Gaming**: Combine hyperimaging and augmented reality to create video games that allow users to see through objects.

https://youtu.be/TaOOb89IYk
Macrosopes will help us understand Earth's complexity in infinite detail. The physical world before our eyes only gives us a small view into what’s an infinitely interconnected and complex world. Instrumenting and collecting masses of data from every physical object, big and small, and bringing it together will reveal comprehensive solutions for our food, water and energy needs.

Organize the IoT: New tools like macrosopes will organize all the world's data -- whether gathered by microscopes, telescopes or everything in between.

Transform industries: Macrosopes will reveal new insights about some of the most fundamental problems we face, such as the availability of food, water and energy.

Search data by time and space: Macroscope technology will be built on platforms that collect and curate geospatial data so it can be easily searched.

https://youtu.be/qKMugpYD8tA
Medical labs “on a chip” will serve as health detectives for tracing disease at the nanoscale

"Medical “labs on a chip” will serve as health detectives for tracing disease at the nanoscale. Nanotechnology “detectives” will let us know we’re unwell before we experience any symptoms. New techniques that detect tiny bio particles found in bodily fluids will reveal clues that, when combined with data from the Internet of Things, will give a full picture of our health.

**Early detection:** Nanobiotechnology techniques will enable the detection of nanoscale-sized clues into our health, letting us know immediately if we have reason to see a doctor.

**Noninvasive testing:** Convenient handheld devices could allow people to quickly and regularly measure the presence of biomarkers found in small amounts of bodily fluids to potentially reveal signs of disease.

**Know when we aren't contagious:** Easily analyze fluids to know when you can no longer pass illnesses like the flu on to others.

**Complete view of health:** Stream information from nanotechnology "detectives" into the cloud where it can be combined with data from other IoT enabled devices, like sleep monitors and smart watches, and analyzed by AI systems for insights.

https://youtu.be/c0o0myb7Te4
Smart sensors will detect environmental pollution at the speed of light. Environmental pollutants won’t be able to hide thanks to new sensing technologies that accurately pinpoint and monitor the quality of our environment. Together with physical analytics combined with artificial intelligence, these technologies will unlock insights to help us prevent pollution and fully harness the promise of cleaner fuels like natural gas.

**Detect leaks:** Pinpoint invisible methane and other chemical leaks in real-time.

**New insights:** Use AI to analyze and extract sensor data to gain new insights about the spread of pollutants.

**Complex models:** Combine sensor data with IoT data sets to build complex environmental models to detect pollutants.

**Respiratory illness detection:** Detect contaminants in exhaled human breath to improve diagnosis of respiratory disease.

https://youtu.be/8NiVUrKF1zI
Cognitive disruption in the enterprise: from big data to intelligent data + fast insights

If the business can **dream** it...

- Prevent fraud
- Personalize customer journeys
- Predict terrorist attacks
- Prevent disease

...IT can **address** it.

IT leaders are machine learning heroes who bring **cognitive visions** to life.
Cognitive - Data & Analytics Use Cases

AUTOMOTIVE
Auto sensors reporting location, problems

COMMUNICATIONS
Location-based advertising

CONSUMER PACKAGED GOODS
Sentiment analysis of what’s hot, problems

FINANCIAL SERVICES
Risk & portfolio analysis
New products

EDUCATION & RESEARCH
Experiment sensor analysis

HIGH TECHNOLOGY / INDUSTRIAL MFG.
Mfg. quality
Warranty analysis

LIFE SCIENCES
Clinical trials

MEDIA/ENTERTAINMENT
Viewers / advertising effectiveness

ON-LINE SERVICES / SOCIAL MEDIA
People & career matching

HEALTH CARE
Patient sensors, monitoring, EHRs

OIL & GAS
Drilling exploration sensor analysis

RETAIL
Consumer sentiment

TRAVEL & TRANSPORTATION
Sensor analysis for optimal traffic flows

UTILITIES
Smart Meter analysis for network capacity,

LAW ENFORCEMENT & DEFENSE
Threat analysis - social media monitoring, photo analysis
Deep Learning Is Sweeping Across Industries

- **Internet Services**
  - Image/Video classification
  - Speech recognition
  - Natural language processing

- **Medicine**
  - Cancer cell detection
  - Diabetic grading
  - Drug discovery

- **Media & Entertainment**
  - Video captioning
  - Content based search
  - Real time translation

- **Security & Defense**
  - Face recognition
  - Video surveillance
  - Cyber security

- ** Autonomous Machines**
  - Pedestrian detection
  - Lane tracking
  - Recognize traffic signs

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Offerings for the Cognitive Era

AI, deep learning and machine learning
- PowerAI + Minsky
- Kinetica

Advanced analytics and open source databases
- ODP: IBM BigInsights, Hortonworks
- EDB, MongoDB, Redis

Hybrid and private cloud deployments
- SAP HANA on Power
- HE Cloud models
- IBM’s OpenPOWER LC
Power System Built with Collaborative Innovation

**OpenPOWER**
299 OpenPOWER members contribute to 87 OpenPOWER ready products and 17 servers delivering choice to industry

Close partnership with major AI/accelerator industry leader Nvidia

**Open Source Workloads**
Now hyper-focused on expanding Cognitive/AI industry applications

Enterprise Support/Subscription model

**OpenCAPI**
High bandwidth open interconnect to attach to accelerators and SCM

**Open Frameworks**
Highly optimized & accelerated Cognitive/AI frameworks

Cognitive/AI SDK for deployment and deployment tools

Making machine learning and AI more affordable
The Cognitive Era demands datacenter innovation

IT innovation can no longer come from just the processor

The next era of innovation comes from:

- Accelerators
- I/O Attach Devices
- Software Optimization

Moore's Law

Technology and Processors

Firmware / OS

Accelerators

Software

Storage

Network

Full Stack Acceleration

(Lower is better)

Full system stack innovation required
IBM’s OpenPOWER Servers

DIFFERENT BY DESIGN

Disrupt your industry without disrupting your datacenter
Solve data intensive business challenges

Faster insights for data intensive deployments like supply chain optimization, agile asset management, fraud prevention and enterprise data management.

Drive datacenter efficiency

Compatible with your existing datacenter and cloud environments, delivering superior price-performance for data analytics workloads.

Accelerate innovation to become a disruptor

Only system ready for the cognitive era with solution-specific hardware accelerators and the POWERAccel family of technologies.
New “POWER8 with NVLink” Chip
First CPU Designed for Accelerated Computing

High Performance Cores

Fast & Large Memory System

Fast PowerAccel Interconnects for Accelerators

Faster Cores than x86

Larger Caches Per Core than x86

5x Faster Data Communication between CPU & GPUs
PowerAI takes advantage of NVLink between POWER8 & P100 to increase system bandwidth

- NVLink between CPUs and GPUs enables fast memory access to large data sets in system memory

- Two NVLink connections between each GPU and CPU-GPU leads to faster data exchange
BMW & IBM Partnership to develop in-car AI and IOT services with IBM’ Watson

Six distinct areas
• Self-healing
• Self-socializing
• Self-learning
• Self-figuring
• Self-integrating
• Fully autonomous
Solve data intensive business challenges

Supply Chain Optimization
- kinetica

Agile Asset Management
- mongoDB

Fraud Prevention
- neo4j

Enterprise Data Management
- EDB
Performance claims & Proof points

IBM Power System S822LC with 4 Tesla P100s –v- Xeon E5-2640 v4 system with 4 Tesla K80s

Date of test: Aug 12, 2016

All results are based on running Kinetica “Filter by geographic area” queries on data set of 280 million simulated Tweets with 1 up to 80 simultaneous query streams each with 0 think time


2.5x better performance

IBM Power® System S822LC for Big Data virtualized with Maria DB –v- Intel Xeon E5-2690 v4 running on sysbench workload

Results are based on IBM internal testing of single system running multiple virtual machines with Sysbench read-only workload and are current as of August 22, 2016. Performance figures are based on running 24 M record scale factor per VM. Power8 total system throughput produced 15,903 tps and Xeon E5-2690 produced 11,727 tps. Individual results will vary depending on individual workloads, configurations and conditions. Source: https://www.ibm.com/developerworks/linux/perfcol/virtualization.html

1.8x price-performance advantage
35% more tps/server
IBM Power® System S822LC for Big Data delivers 2.12x price-performance leadership over Intel Xeon E5-2699 v4 with virtualized EDB Postgres Server 9.5.

Results are based on IBM internal testing of single system running multiple virtual machines with pgbench select only work and are current as of August 25, 2016. Performance figures are based on running a 300 scale factor running processor in favor performance modes. Power8 total system throughput produced 577,671 tps and Xeon E5-2699 produced 588,901 tps.


Power S822LC for HPC with four P100 GPUs using IBM Caffe compared to Intel Xeon E5-2640 v4 with eight M40 GPUs

Competitor testing was done on 27-Sep-2016
Power S822LC testing was done on 04-Oct-2016:
Simplifying the Use of Accelerators

Software

- Advancements in directives based software approach and libraries to lessen the effort for software to take advantage of the power of accelerators

```
module madd_device_module
  use cudafor
  contains
  subroutine madd_dev(a,b,c,sum,n1,n2)
    real,dimension(:,:),device :: a,b,c
    real :: sum
    integer :: n1,n2
    type(dim3) :: grid, block
    !$cuf
    do (2) <<<(*,*),(32,4)>>>
      do j = 1,n2
        do i = 1,n1
          a(i,j) = b(i,j) + c(i,j)
          sum = sum + a(i,j)
        enddo
      enddo
  end subroutine
end module
```

Hardware

- Innovation such as Power8 with NVLink and CAPI/OpenCAPI which integrates accelerators in such as way that that are user for software to use.

```
module madd_device_module
  use cudafor
  contains
  subroutine madd_dev(a,b,c,sum,n1,n2)
    real,dimension(:,:),device :: a,b,c
    real :: sum
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    do (2) <<<(*,*),(32,4)>>>
      do j = 1,n2
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          a(i,j) = b(i,j) + c(i,j)
          sum = sum + a(i,j)
        enddo
      enddo
  end subroutine
end module
```
Thank you
Useful URLs & #tags

- [Deep Learning on OpenPOWER](#)
Work on these stories (not all AI)