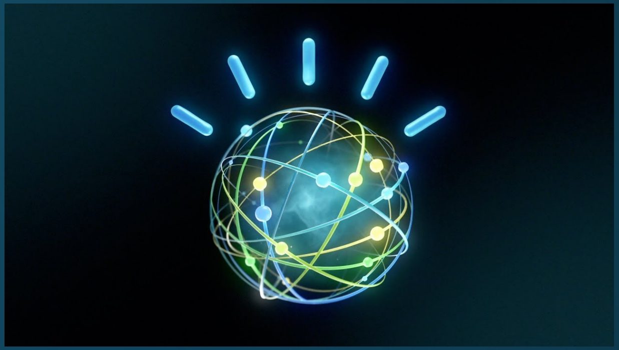
Power and ML



built with Scott Soutter & Mandie Quartly inputs

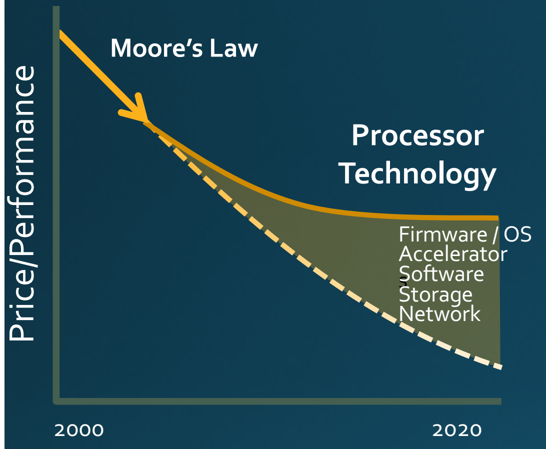
Speed to innovation | Standards | Choice

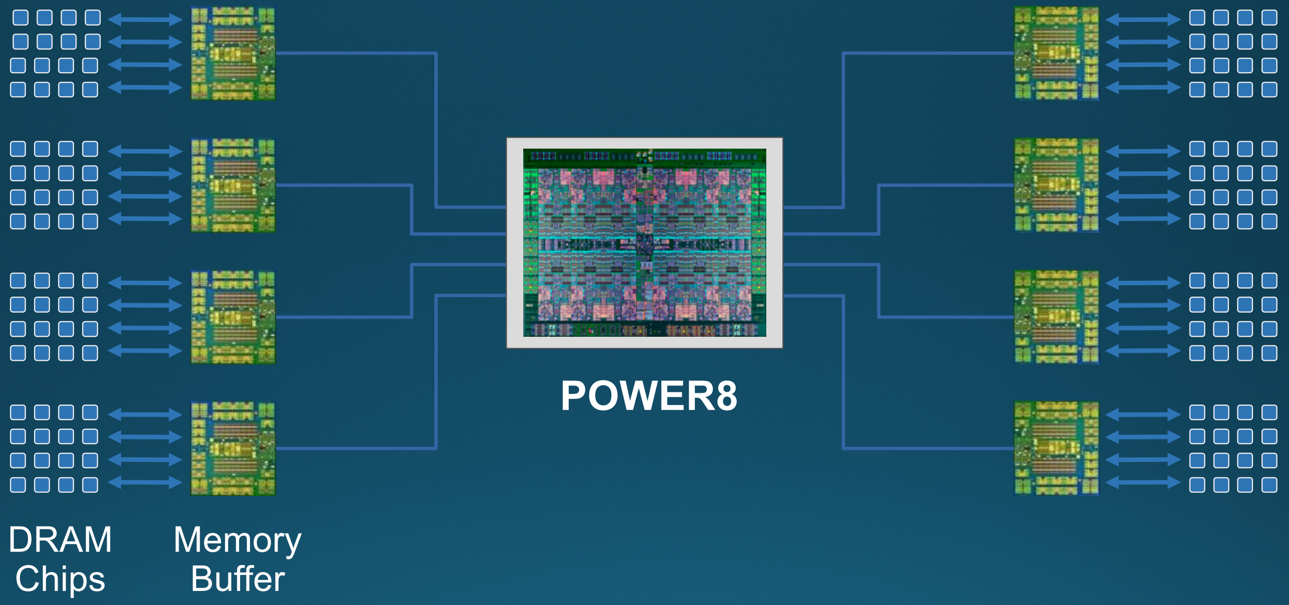
Started in SW first

Leader in UNIX (firmware virtualization...)
Underdog in Linux

Then GOOGLE called…

Fast Cores, Fast memory IO … and 8 SMT





Linux
OpenStack
…

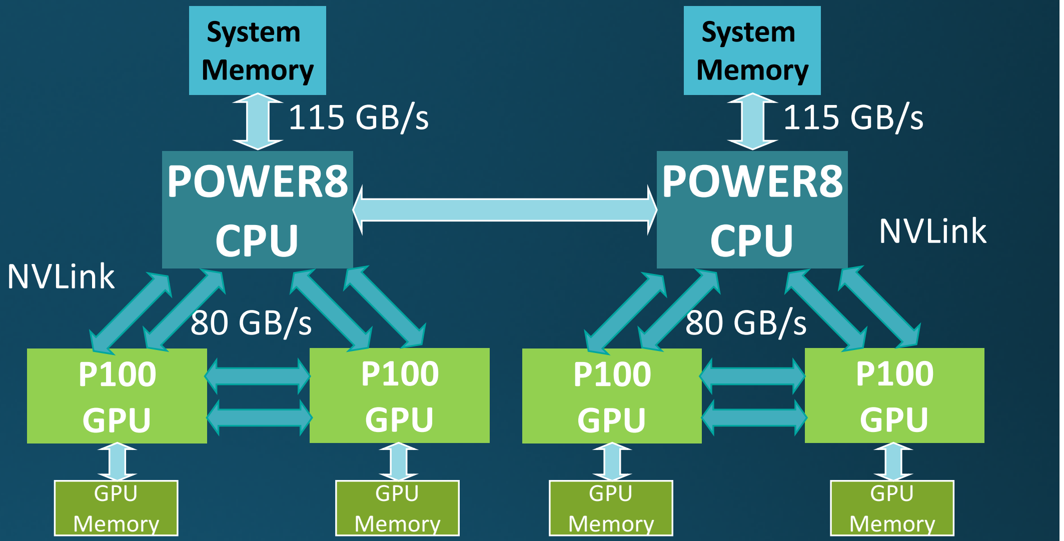
Power8: Up to 12 Cores, up to 96 Threads
L1, L2, L3 + L4 Caches
Up to 1 TB per socket
Up to 230 GB/s sustained memory bandwidth

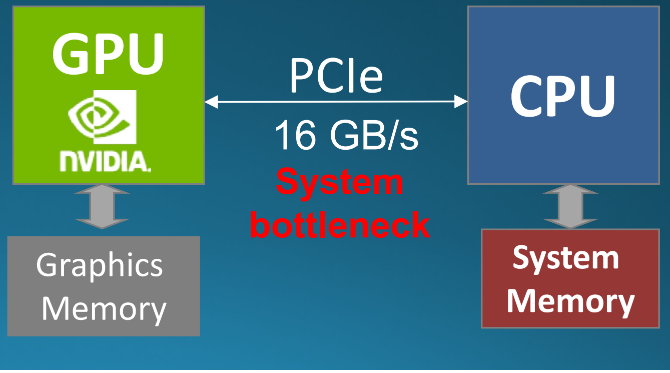
https://www.ibm.com/blogs/systems/power-systems-openpower-enable-acceleration/

ADD: CPU---P100 GPU NVLink

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

- Two NVLink connections between each GPU and CPU-GPU leads to faster data exchange



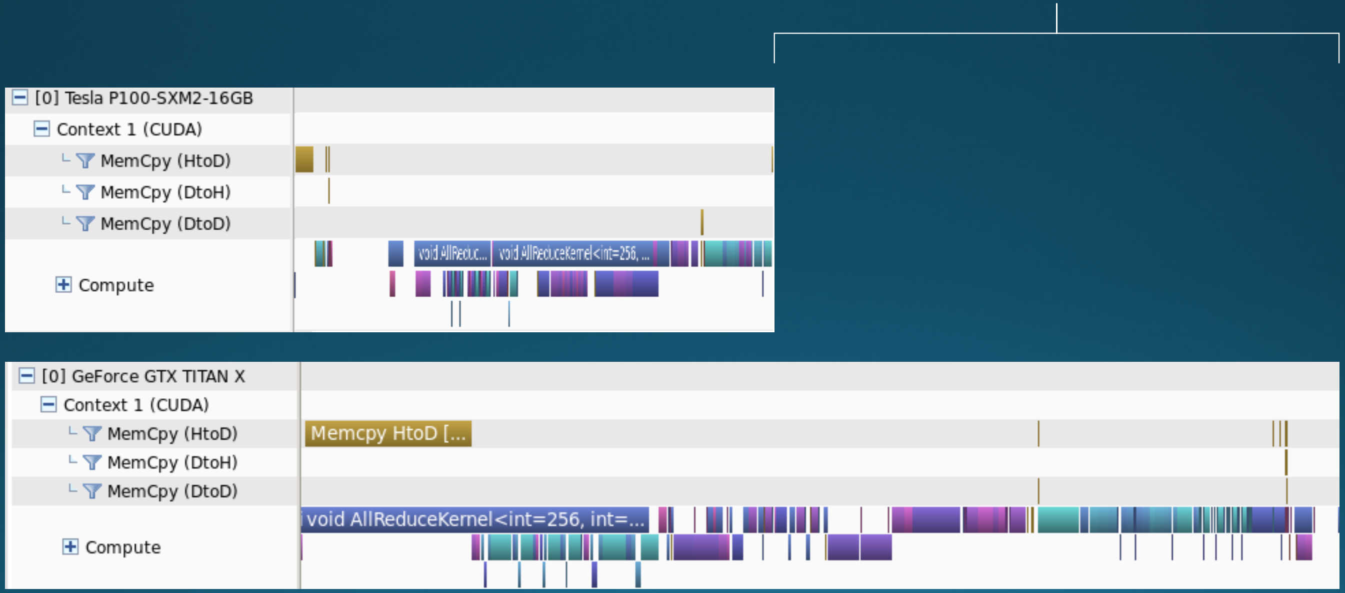


NVLink and P100 advantage:

reducing communication time, incorporating the fastest GPU for deep learning

- NVLink reduces communication time and overhead
- Data gets from GPU-GPU, Memory-GPU faster, for shorter training times

IBM advantage: data communication and GPU performance



POWER8 +
Tesla
P100+NVLink

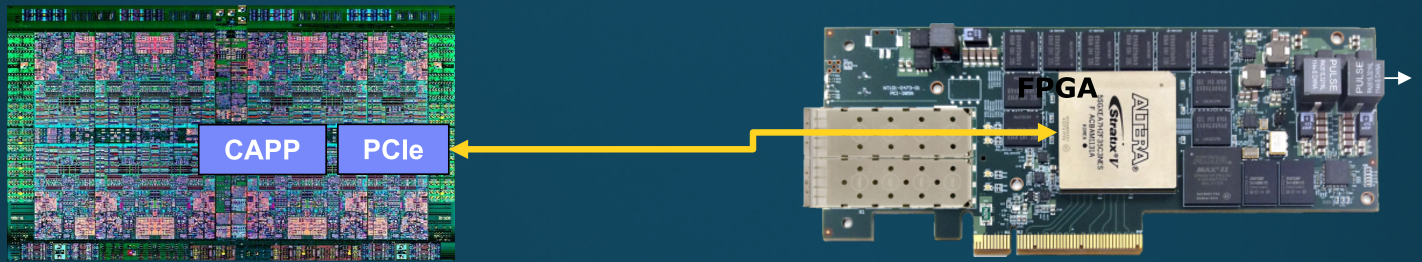
78 ms

x86 based
GPU system

170 ms

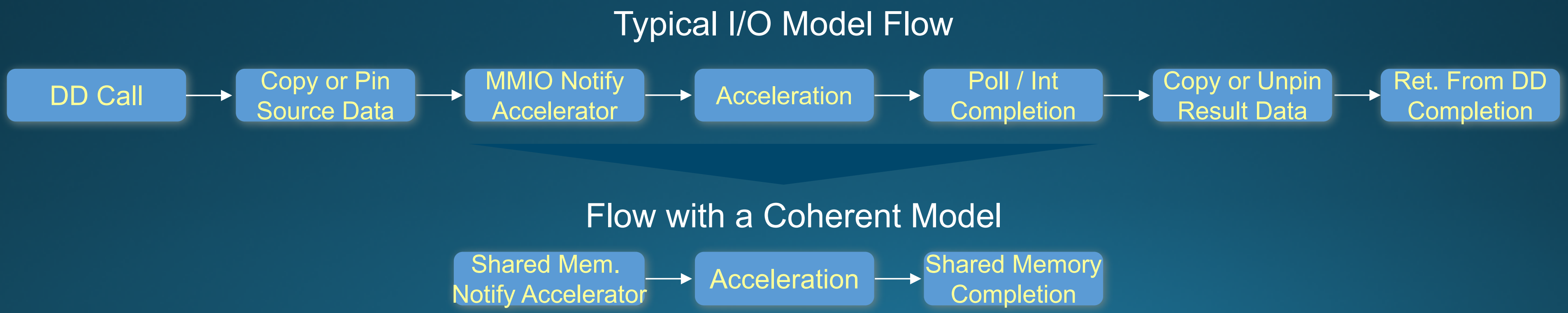
ImageNet / Alexnet: Minibatch size = 128

ADD: Coherent Accelerator Processor Interface (CAPI)



POWER8 Processor

...FPGAs, networking, memory...



Typical I/O Model Flow

DD Call → Copy or Pin Source Data → MMIO Notify Accelerator → Acceleration → Poll / Int Completion → Copy or Unpin Result Data → Ret. From DD Completion

Flow with a Coherent Model

Shared Mem. Notify Accelerator → Acceleration → Shared Memory Completion

IBM

POWER/OpenPower Processor evolution

Focus on Enterprise Scale-Up Technology and Performance Driven				Focus on Scale-Out and Enterprise Cost and Acceleration Driven						Future
POWER6 Architecture		POWER7 Architecture		POWER8 Architecture		POWER9 Architecture			Partner Chip POWER8/9	POWER10
2007 POWER6 2 cores 65nm New Micro-Architecture New Process Technology	2008 POWER6+ 2 cores 65nm+ Enhanced Micro-Architecture Enhanced Process Technology	2010 POWER7 8 cores 45nm New Micro-Architecture New Process Technology	2012 POWER7+ 8 cores 32nm Enhanced Micro-Architecture New Process Technology	2014 POWER8 12 cores 22nm New Micro-Architecture New Process Technology	2016 POWER8 w/ NVLink 12 cores 22nm Enhanced Micro-Architecture With NVLink	2017 P9 SO 24 cores 14nm New Micro-Architecture Direct attach memory New Process Technology	TBD P9 SU 12 cores 14nm Enhanced Micro-Architecture Buffered Memory	T B D	2018 - 20 P9 SO 10nm - 7nm Existing Micro-Architecture Foundry Technology	2020+ New Micro-Architecture New Technology

Add a community...

300+ members **80+ technologies revealed**

Google
XILINX
redislabs
NVIDIA
rackspace the #1 managed cloud company
IBM
ALPHA DATA
Nallatech
ubuntu Supported by Canonical
Groupe T2i
E4 COMPUTER ENGINEERING
Mellanox TECHNOLOGIES
SAMSUNG
HITACHI Inspire the Next
NEC
inspur 浪潮
wistron
TYAN

30 countries **6 continents** **100s innovations under way**

Community

Accelerates innovation

- Over **2,500 Linux ISVs** developing on Power
- 50 IBM Innovation Centers
- Compelling PoCs
- Support for little endian applications

HPC

CHARMM
GROMACS
NAMD
AMBER
RTM
GAMESS
WRF
HYCOM
HOMME
LES
MiniGhost
AMG2013
OpenFOAM

miniDFT
CTH
BLAST
Bowtie
BWA
FASTA
HMMER
GATK
SOAP3
STAC-A2
SHOC
Graph500
Ilog

Cloud

openstack
TOMCAT
Apache
Chef
STORIX
REFLEXIS
DIASOFT
OneView Commerce
POWERSENSE
IFS
KANA.
FIS
YUCHENG™ Technologies Limited
sky solutions
betasystems
EXIGEN.
ProjectWare
ALPHINAT

Big Data & Machine Learning

hadoop
PostgreSQL
MariaDB
redislabs
SUGARCRM.
gpudb
Datameer
Spark
neo4j
EDB
AsiaInfo
InterSystems
CROSSVIEW.
POLARIS
ZAO
Valogix

Mobile Enterprise

zend
亿阳信通 BOCO Inter-Telecom
php
CSC
RabbitMQ Open Source Enterprise Messaging
Kingdee 金蝶，企业管理专家
SYBASE An SAP Company
FIS
NARI 南瑞集团公司 NARI GROUP CORPORATION
FINEOS
ALPHINAT
comptel
Corent
KUTIR
TEMENOS The Banking Software Company

ubuntu
SuSE
redhat
FreeBSD

Major Linux Distros

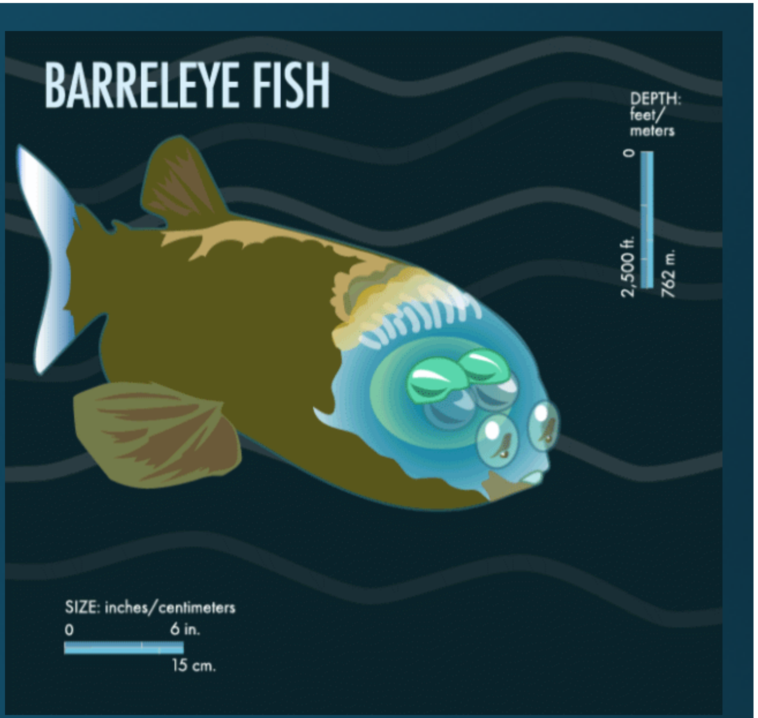
Linux

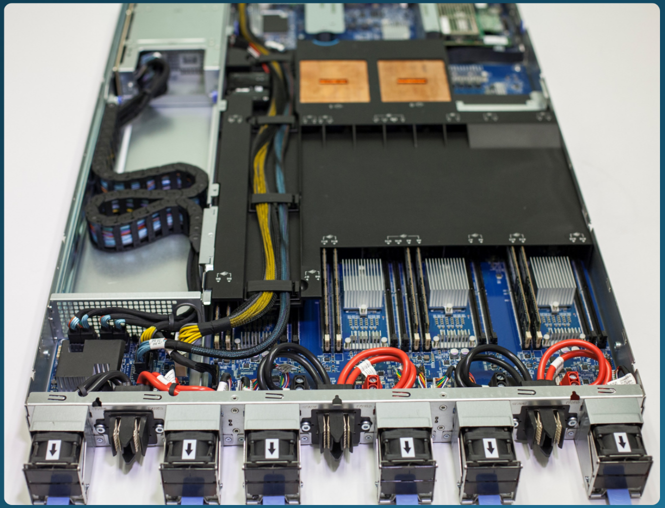
rackspace HOSTING

OPEN Compute Project

Available now: Barreleye G1

In partnership with Avago, IBM, Mellanox, PMC & Samsung





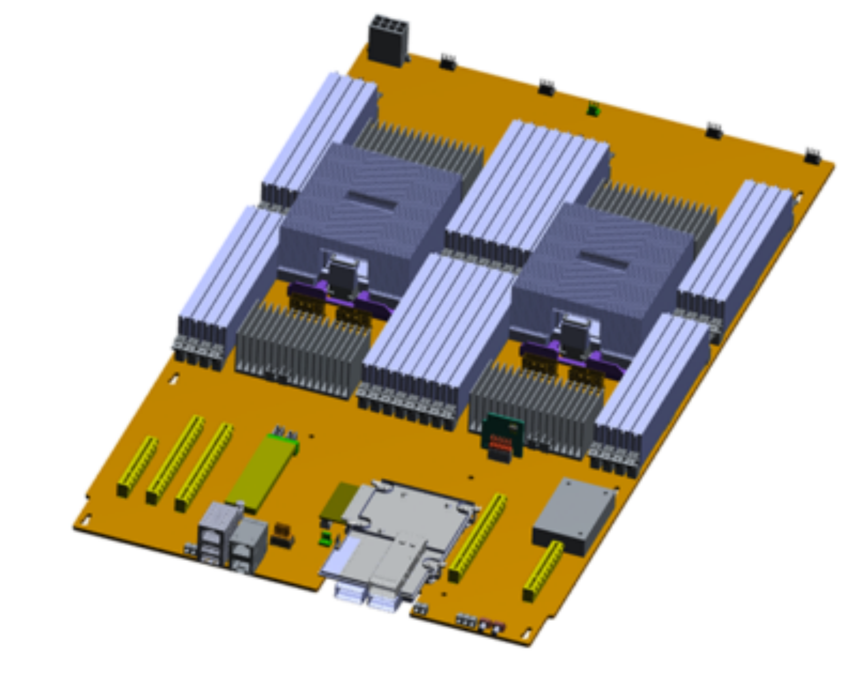
Mark III Systems

PENGUIN COMPUTING

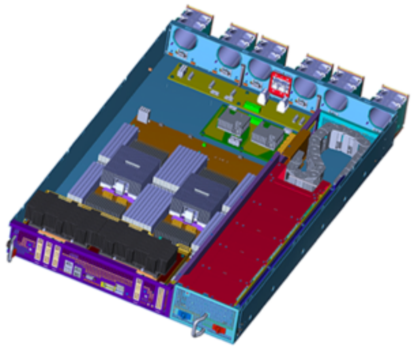
STACK VELOCITY

rackspace HOSTING Google

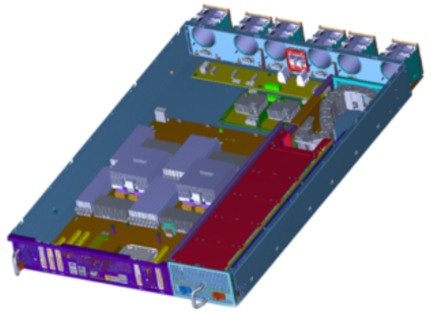
OPEN Compute Project



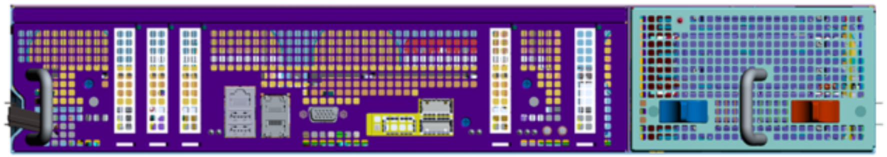
ZAIUS MOTHERBOARD, USED IN BARRELEYE G2



CHASSIS: BARRELEYE G2
WITH CACHE COHERENT GPU



CHASSIS: BARRELEYE G2
WITH ALL PCIe SLOTS EXPOSED



FRONT OF BARRELEYE G2 2OU CHASSIS

http://blog.rackspace.com/first-look-zaius-server-platform-google-rackspace-collaboration

IBM

The **IBM Power Systems LC Line**

OpenPOWER servers for cloud and cluster deployments that are different by design

Big Data

S812LC

- 1 socket, 2U
- Storage rich for big data applications
- Memory Intensive workloads

TYAN

S822LC For Big Data

- 2 socket, 2U
- Storage-centric and high through-put workloads
- Big data acceleration with work CAPI and GPUs

SUPERMICRO

High Performance Computing

S822LC For High Performance Computing

- 2 socket, 2U
- POWER8 with NVIDIA NVLink
- Up to 4 integrated NVIDIA “Pascal” P100 GPUs

wistron

S821LC

- 2 sockets, 1U
- Dense computing

SUPERMICRO

Compute Intensive

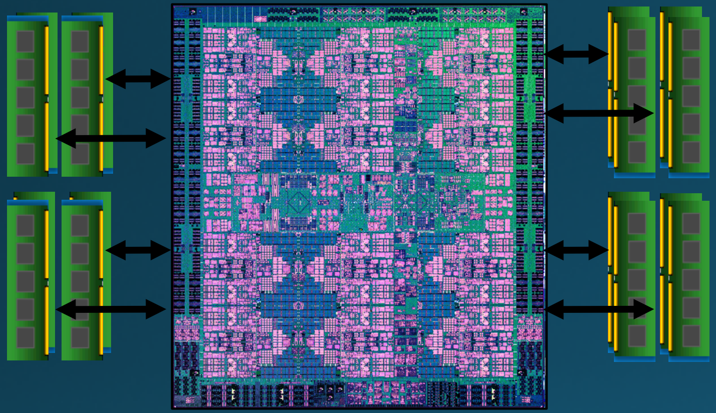
S822LC

- 2 socket, 2U
- Memory Intensive workloads

wistron

POWER9 – dual memory subsystems

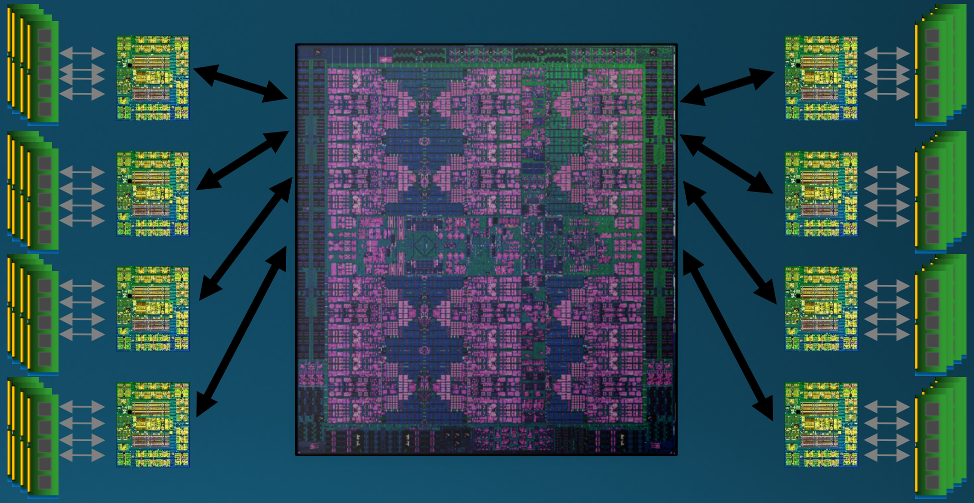
Scale Out
Direct Attach Memory



8 Direct DDR4 Ports

- Up to 120 GB/s of sustained bandwidth
- Low latency access
- Commodity packaging form factor
- Adaptive 64B / 128B reads

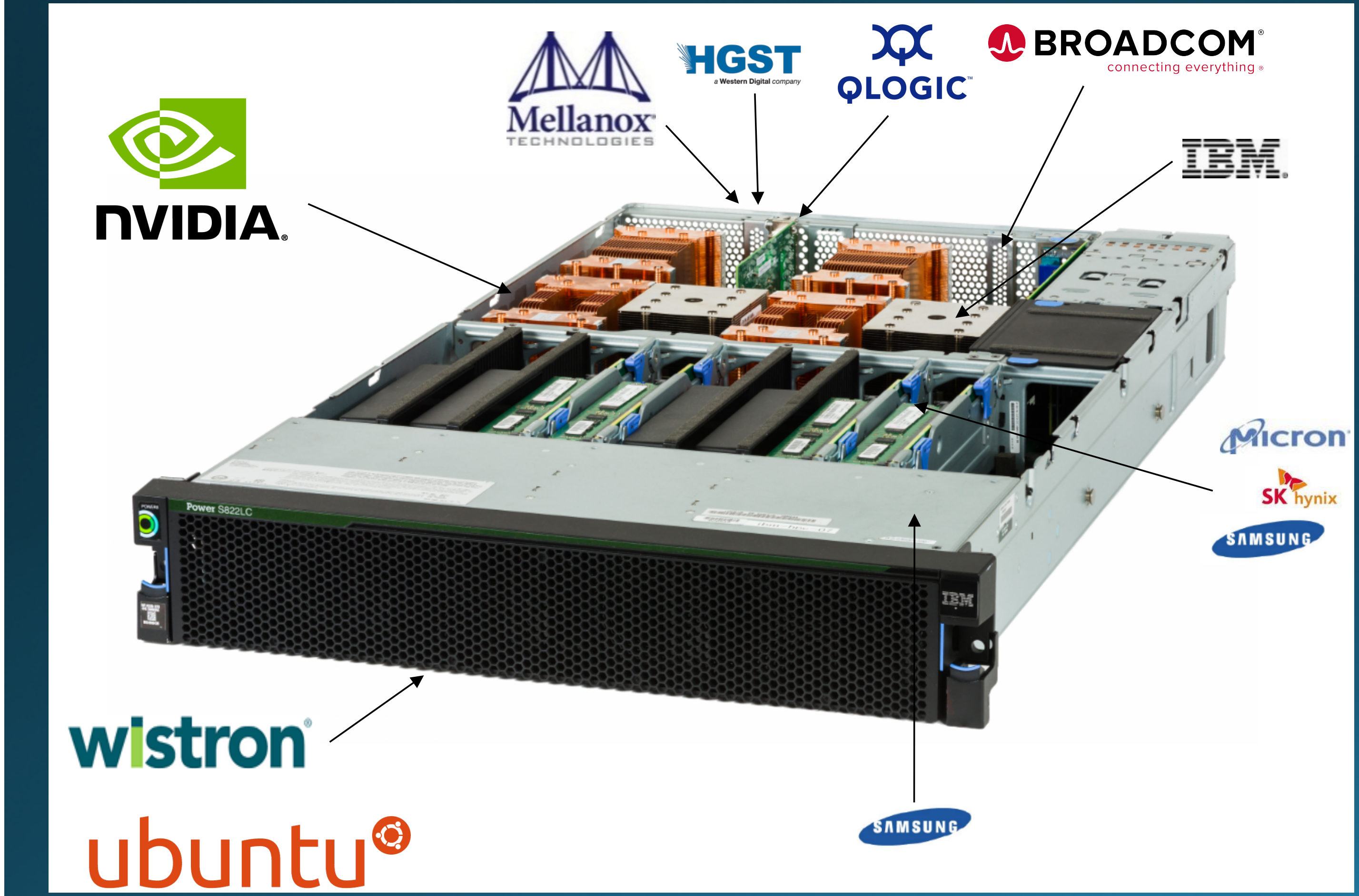
Scale Up
Buffered Memory



8 Buffered Channels

- Up to 230GB/s of sustained bandwidth
- Extreme capacity – up to 8TB / socket
- Superior RAS with chip kill and lane sparing
- Compatible with POWER8 system memory
- Agnostic interface for alternate memory innovations

Power Systems for High Performance Computing (aka Minsky)



NVIDIA:
Tesla P100 GPU Accelerator with NVLink

Ubuntu by Canonical:
Launch OS supporting NVLink and Page Migration Engine

Wistron: Platform co-design

Mellanox: InfiniBand/Ethernet Connectivity in and out of server

HGST: Optional NVMe Adapters

Broadcom: Optional PCIe Adapters

QLogic: Optional Fiber Channel PCIe

Samsung: 2.5” SSDs

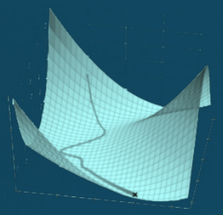
Hynix, Samsung, Micron: DDR4

IBM: POWER8 CPU with NVLink

PowerAI: Enterprise Deep Learning Distribution

Enterprise Software Distribution

Binary Package of Major Deep Learning Frameworks with Enterprise Support



Tools for Ease of Development

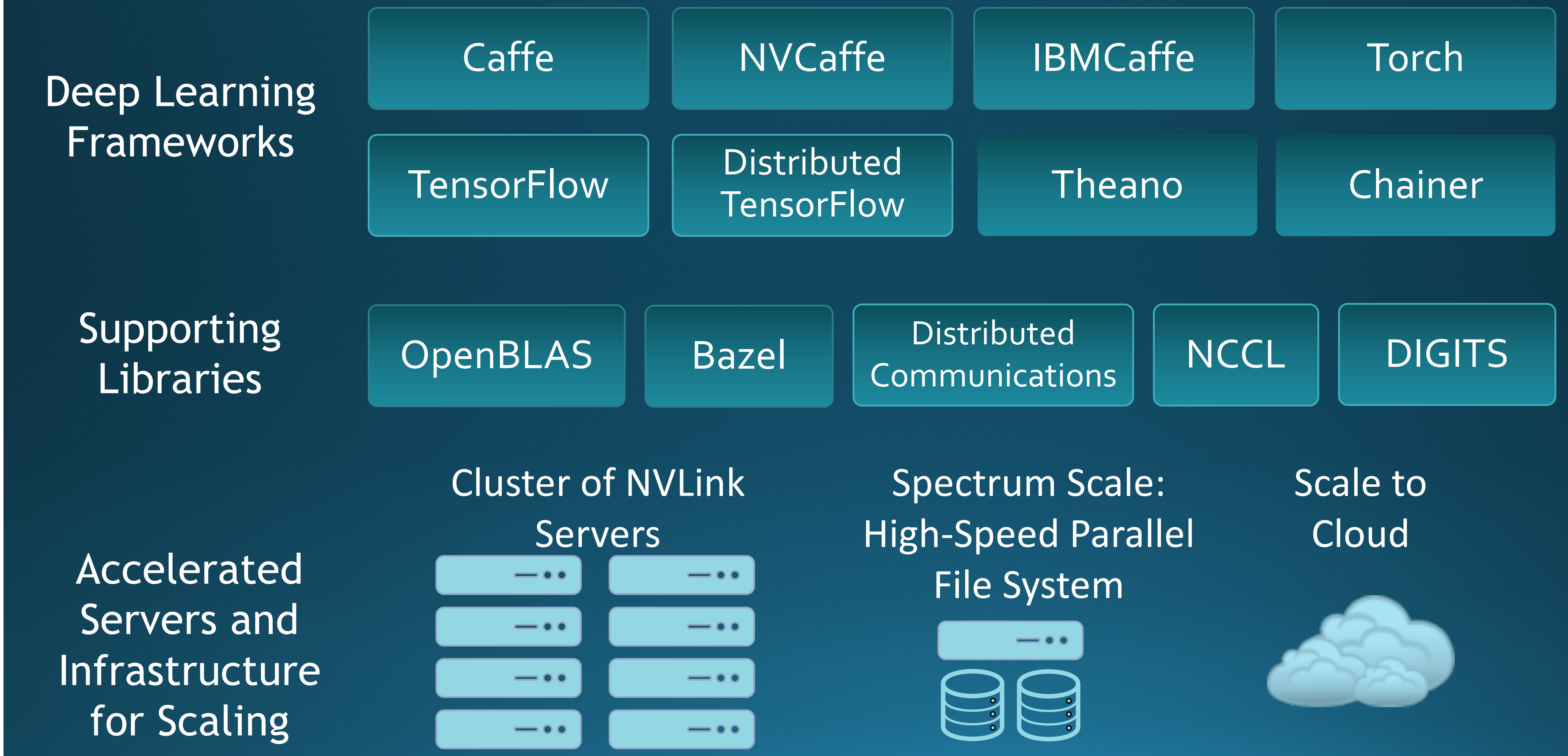
Graphical tools to Enhance Data Scientist Developer Experience

Faster Training Times for Data Scientists

Performance Optimized for Single Node & Distributed Computing Scaling

PowerAI Deep Learning Software Distribution

IBM



Deep Learning Frameworks

- Caffe
- NVCaffe
- IBMCaffe
- Torch
- TensorFlow
- Distributed TensorFlow
- Theano
- Chainer

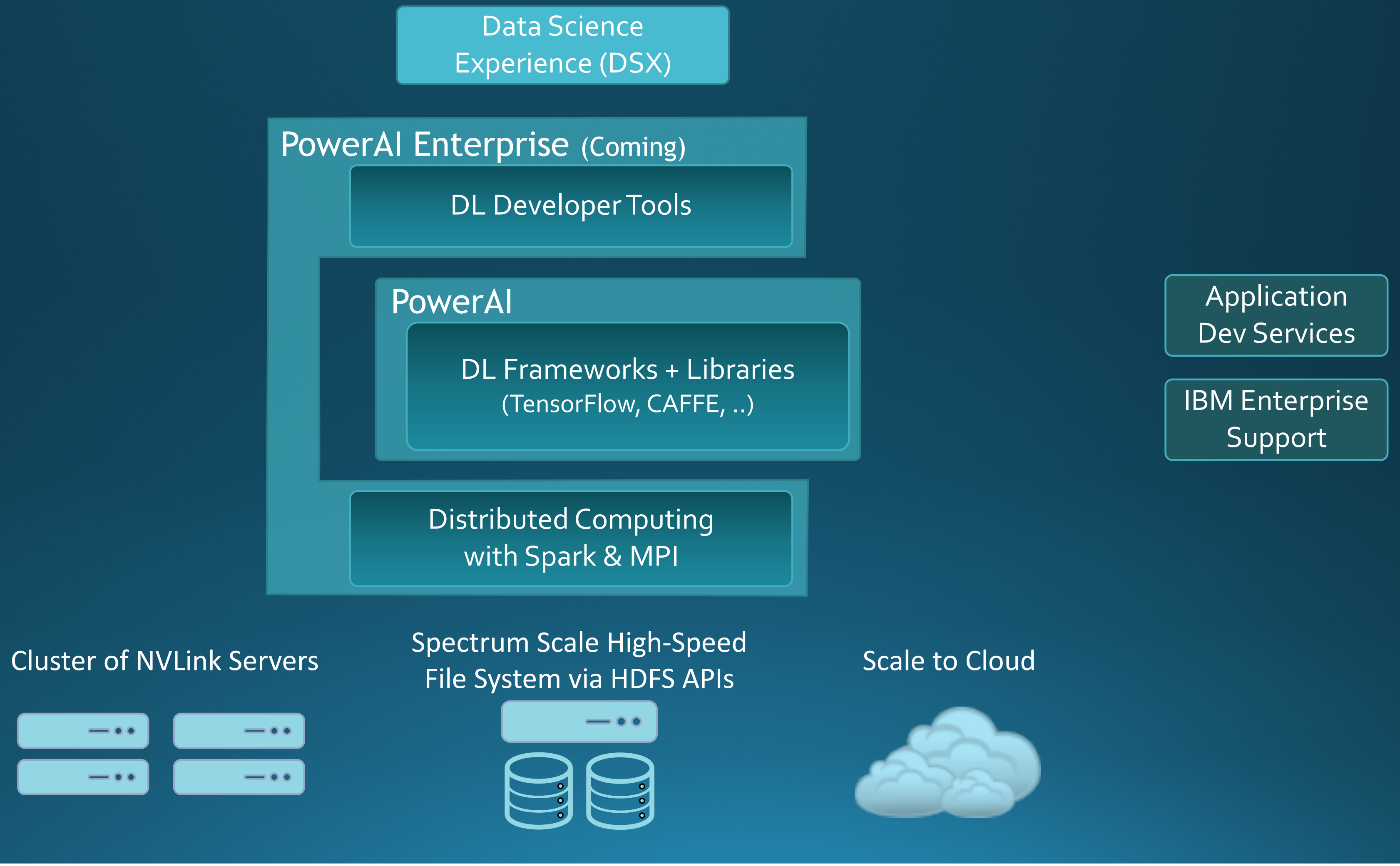
Supporting Libraries

- OpenBLAS
- Bazel
- Distributed Communications
- NCCL
- DIGITS

Accelerated Servers and Infrastructure for Scaling

- Cluster of NVLink Servers
- Spectrum Scale: High-Speed Parallel File System
- Scale to Cloud

PowerAI Enterprise: Enhancing Developer Experience



Data Science Experience (DSX)

PowerAI Enterprise (Coming)

DL Developer Tools

PowerAI

DL Frameworks + Libraries (TensorFlow, CAFFE, ..)

Distributed Computing with Spark & MPI

Application Dev Services

IBM Enterprise Support

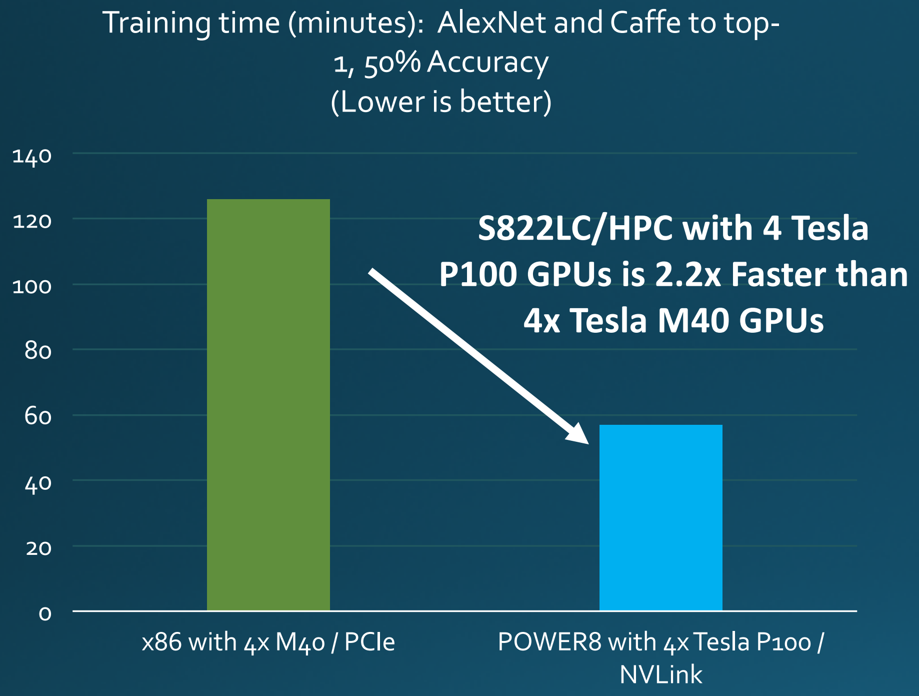
Cluster of NVLink Servers

Spectrum Scale High-Speed File System via HDFS APIs

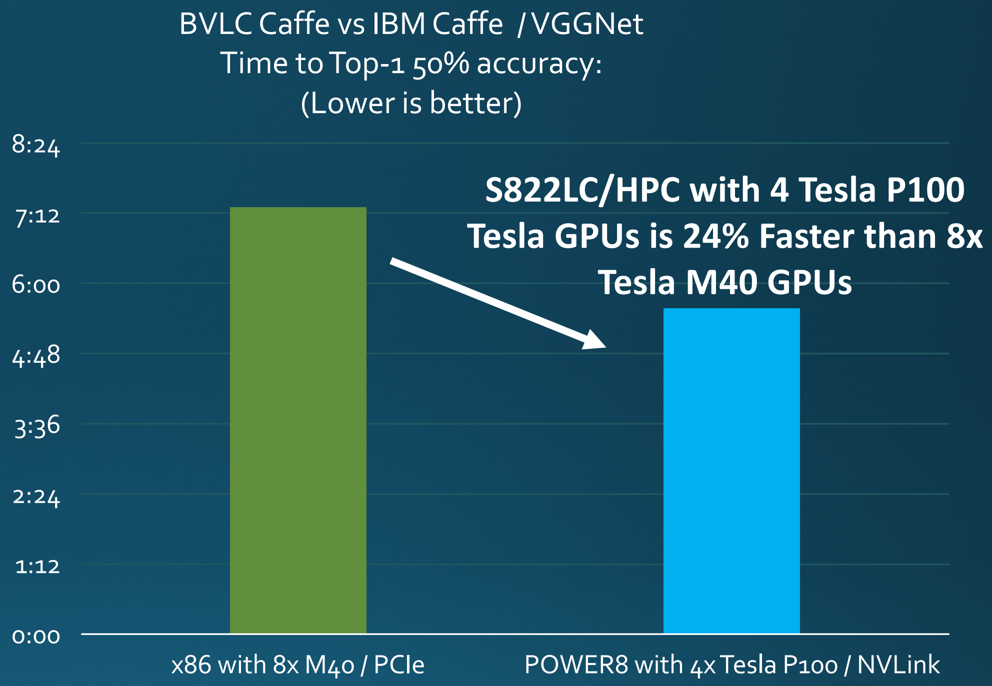
Scale to Cloud

PowerAI on Power8 Minsky Server: 2.2x Faster than Previous Generation x86 Servers

IBM



S822LC/HPC with 4 Tesla P100 GPUs is 2.2x Faster than 4x Tesla M40 GPUs



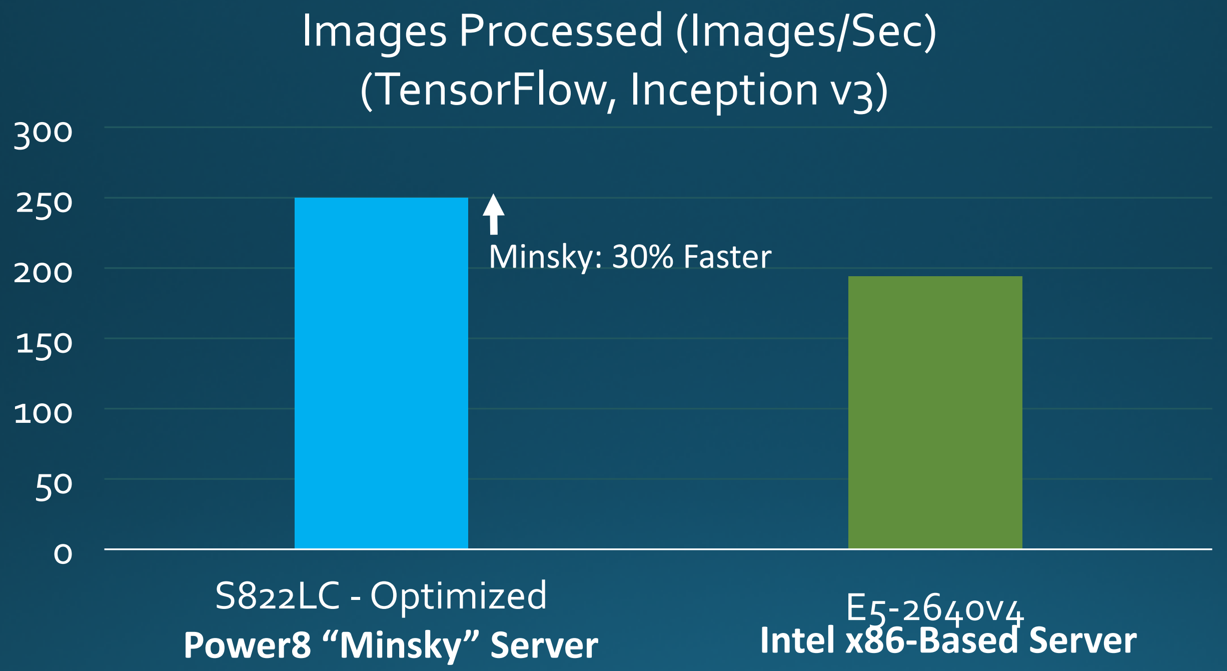
S822LC/HPC with 4 Tesla P100 Tesla GPUs is 24% Faster than 8x Tesla M40 GPUs

IBM S822LC (Minsky) 20-cores 2.86GHz 512GB memory / 4 NVIDIA Tesla P100 GPUs / Ubuntu 16.04 / CUDA 8.0.44 / cuDNN 5.1 / IBM Caffe 1.0.0-rc3 / Imagenet Data

Intel Broadwell E5-2640v4 20-core 2.6 GHz 512GB memory / 8 NVIDIA TeslaM40 GPUs / Ubuntu 16.04 / CUDA 8.0.44 / cuDNN 5.1 / BVLC Caffe 1.0.0-rc3 / Imagenet Data

TensorFlow on Tesla P100: PowerAI is 30% faster

(larger is better)



IBM S822LC 20-cores 2.86GHz 512GB memory / 4 NVIDIA Tesla P100 GPUs / Ubuntu 16.04 / CUDA 8.0.44 / cuDNN 5.1 / TensorFlow 0.12.0 / Inception v3 Benchmark (64 image minbatch)

Intel Broadwell E5-2640v4 20-core 2.6 GHz 512GB memory / 4 NVIDIA Tesla P100 GPUs/ Ubuntu 16.04 / CUDA 8.0.44 / cuDNN 5.1 / TensorFlow 0.12.0 / Inception v3 Benchmark (64 image minbatch)

PowerAI Provides Latest DL Frameworks

No need to compile from open-source

- Tested, binary builds of common Deep Learning frameworks for ease of implementation
- Simple, complete installation process documented on ibm.biz/powerai
- Future focus on optimizing specific packages for POWER: OpenBLAS, NVIDIA Caffe, TensorFlow, and Torch

	PowerAI
OS	Ubuntu 16.04
CUDA	8.0
cuDNN	5.1
Built w/ MASS	Yes
OpenBLAS	0.2.19
Caffe	1.0 rc5
NVIDIA Caffe	0.14.5 + 0.15.14
IBM Caffe	1.0 rc3
Chainer	1.20.1
NVIDIA DIGITS	5
Torch	7
Theano	0.9
TensorFlow	1.0.0+ 0.12
GPU	4 x P100
Base System	S822LC/HPC

Getting Started with PowerAI

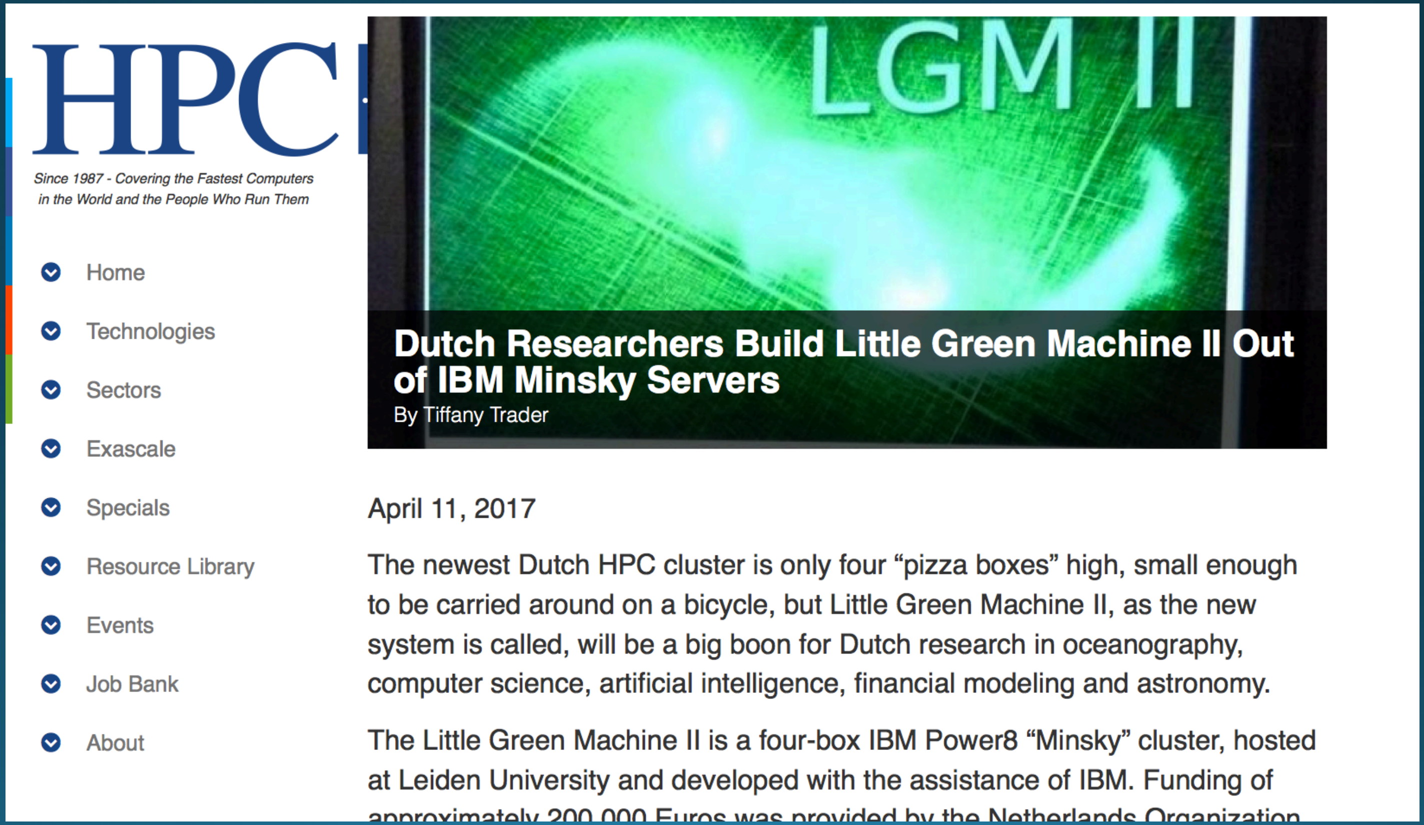
- Install PowerAI on your existing S822LC for HPC server

  http://ibm.biz/powerai

- Don’t have an S822LC for HPC?
  - Reference architecture / system requirements are available for the first system shipping with POWER8, NVLink, and Tesla P100 (next slide)
  - Visit IBM POWER HPC Cloud partners to test drive these frameworks on POWER8/P100 today
    - https://power.jarvice.com/ (Nimbix HPC Cloud)

You can start small

https://www.hpcwire.com/2017/04/11/dutch-uni-builds-little-green-machine-ii-out-of-ibm-minsky-servers/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Since 1987 - Covering the Fastest Computers in the World and the People Who Run Them
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Exascale
Specials
Resource Library
Events
Job Bank
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LGM II

Dutch Researchers Build Little Green Machine II Out of IBM Minsky Servers

By Tiffany Trader

April 11, 2017

The newest Dutch HPC cluster is only four "pizza boxes" high, small enough to be carried around on a bicycle, but Little Green Machine II, as the new system is called, will be a big boon for Dutch research in oceanography, computer science, artificial intelligence, financial modeling and astronomy.

The Little Green Machine II is a four-box IBM Power8 "Minsky" cluster, hosted at Leiden University and developed with the assistance of IBM. Funding of approximately 200,000 Euros was provided by the Netherlands Organization

Thank you and may the force be with you