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intel experience what's inside™

DATA-CENTRIC HPC

MINIMIZING DATA IN MOTION

DELL Accelerating Understanding Summit
May 31 –June 1, 2016
Paris, France

Herbert Cornelius
Intel Corporation

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Notice revision #20110804

INDUSTRIAL REVOLUTION 4.0

1.0

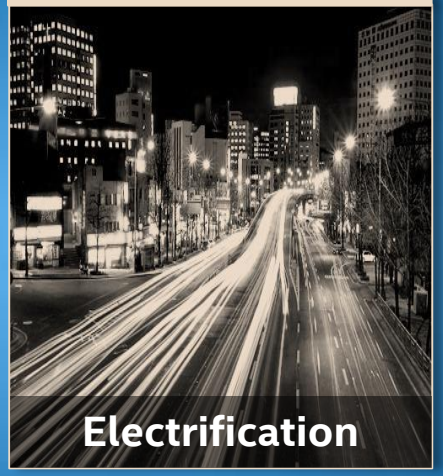
1760's

Steam

Coal
Railways
Factories
Printing Press
Mass Education

2.0

1860's

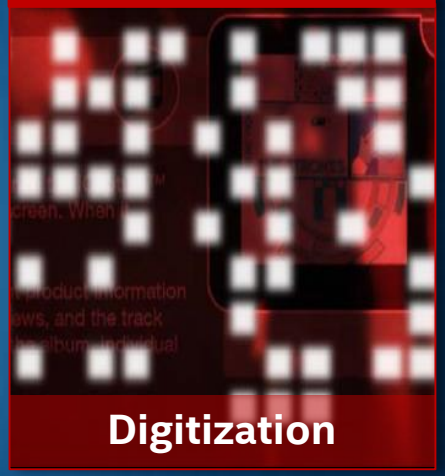


Electrification

Communication,
Oil, Combustion Engine
New materials
Highways, Automobiles
Mass Production

3.0

2000's



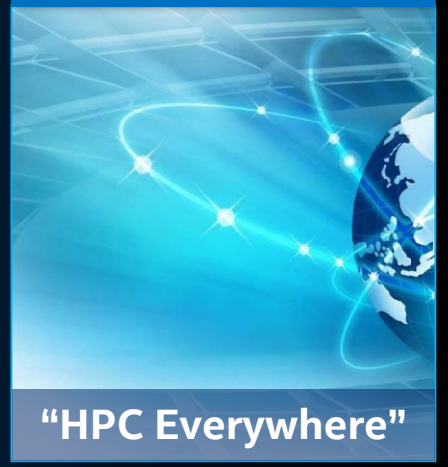
Digitization

WWW
Molecular Biology
Green Energy
Mobility
Automation

FUTURE VISION

4.0

2020's



"HPC Everywhere"

Cloud Computing
Super Information Data Highways
Industrial Internet, M2M
Internet of Things (IoT)
Smart "everything"
Personalized Medicine
Big Data (Analytics) & AI

New Findings: The ROI Is Very High[1]

New results indicate higher ROI returns related to investments in HPC, compared to the pilot study

- On average, from the latest data:
  - **$514.7** in revenue per dollar of HPC invested
  - **$43.2** of profits/cost savings per dollar of HPC invested
  - The average HPC investment per innovation was **$3.0M**
- From the 2013 pilot study:
  - $357 in revenue per dollar of HPC invested
  - $39 of profits/cost savings per dollar of HPC invested
  - The average HPC investment per innovation was $3.1M
- Note that an additional outcome of this research is an expansive list of HPC success stories

2

IDC Analyze the Future

[1] hpcuserforum.com/presentations/Colorado-sept2015/PublicIDCDOEROIResearchUpdate8.19.2015.pdf
[2] www.hpcwire.com/2014/01/02/top-supercomputing-discoveries-2013

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TRANSFORMATION & DEMOCRATIZATION OF HIGH-PERFORMANCE COMPUTING

1970's
CRAY-1

Proprietary

1990's
ASCI RED

Industry Standards

2010's
KNIGHTS LANDING**

Miniaturization

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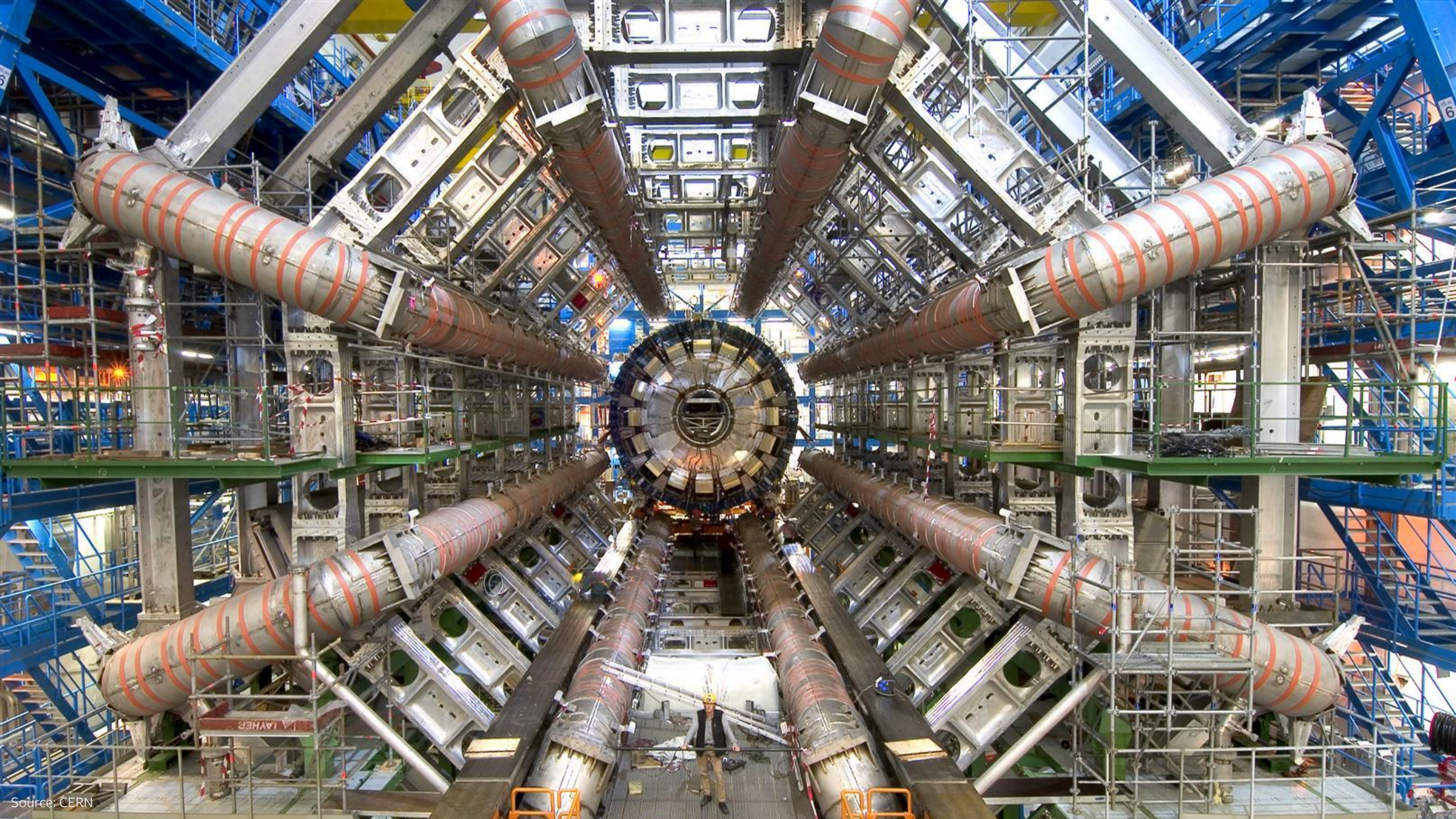
DATA IS EXPLODING



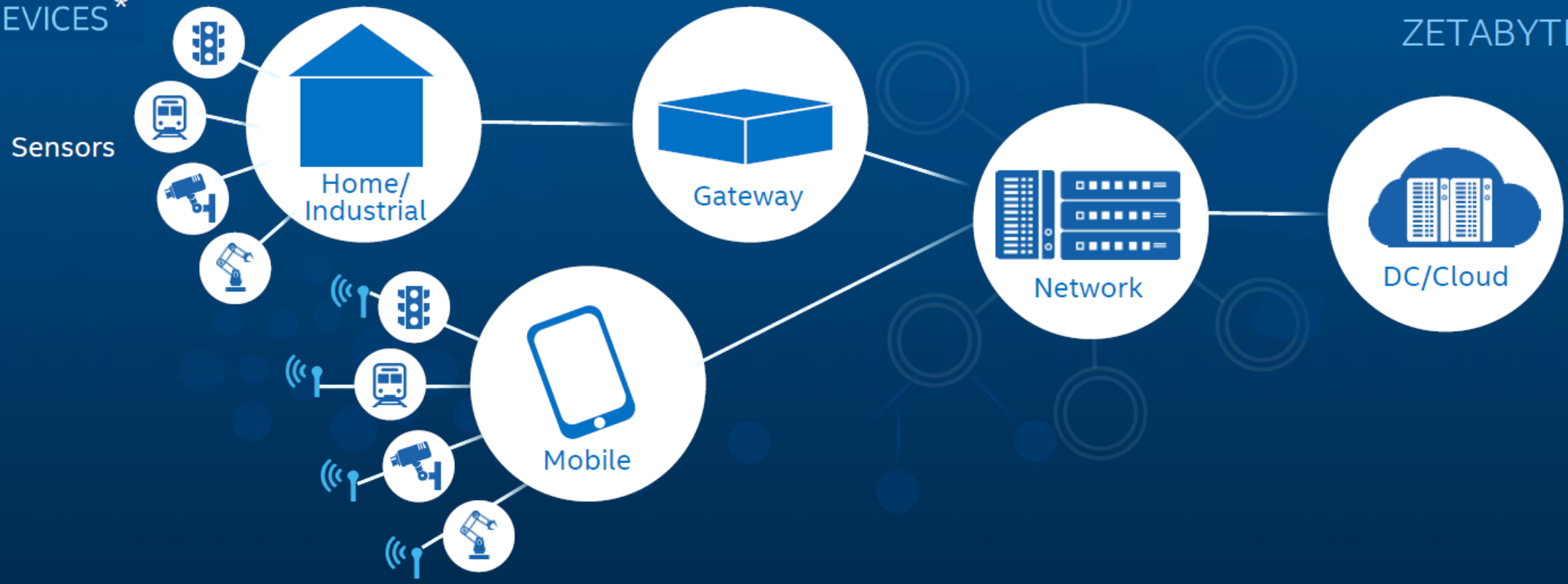
Source: CERN

Source: SKA Organization - https://www.skatelescope.org

The Internet of Things is...

50B
DEVICES *

44
ZETABYTES**



COST OF SENSORS **2X** PAST 10 YEARS

COST OF BANDWIDTH **40X** PAST 10 YEARS

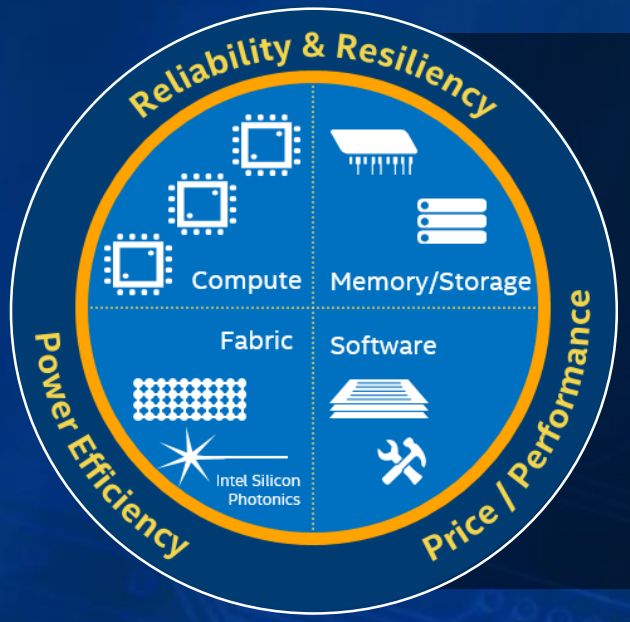
COST OF PROCESSING **60X** PAST 10 YEARS ***

* IDC

** IMC/EDC: The Digital Universe of Opportunities

*** Goldman Sachs

A HOLISTIC DESIGN SOLUTION FOR HPC
INTEL® SCALABLE SYSTEM FRAMEWORK (SSF)



Small Clusters Through Supercomputers

Compute and **Data-Centric** Computing

Standards-Based Programmability

On-Premise and Cloud-Based

Tighter Integration

Intel® Xeon® Processors
Intel® Xeon Phi™ Processors
Intel® Xeon Phi™ Coprocessors
Intel® Server Boards and Platforms

Intel® Solutions for Lustre*
Intel® SSDs
Intel® Optane™ Technology
3D XPoint™ Technology

Intel® Omni-Path Architecture
Intel® True Scale Fabric
Intel® Ethernet
Intel® Silicon Photonics

HPC System Software Stack
Intel® Software Tools
Intel® Cluster Ready Program
Intel® Visualization Toolkit

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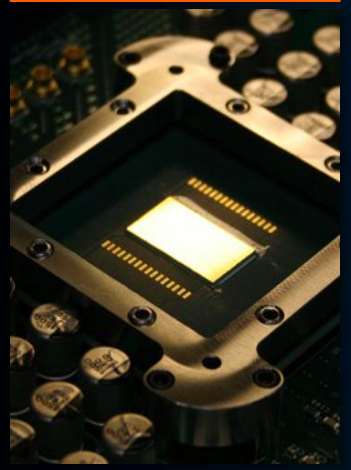
NEW INTEL TECHNOLOGIES TRANSFORMING HPC & BIG DATA

XEON® XEON PHI™



COMPUTE

OMNI-PATH ARCHITECTURE

FABRIC

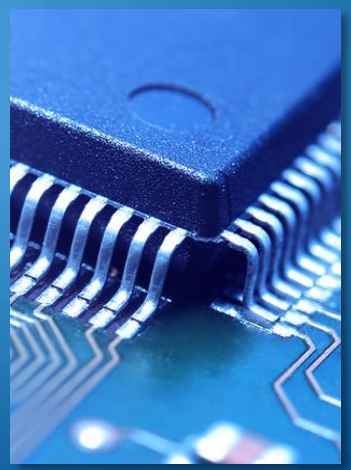
SILICON PHOTONICS

I/O

3D-NAND 3D XPOINT™

MEMORY STORAGE

FPGAs



ACCELERATION

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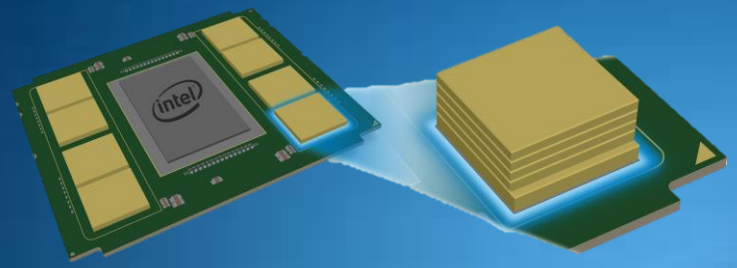
HIGHLY PARALLEL PROCESSING

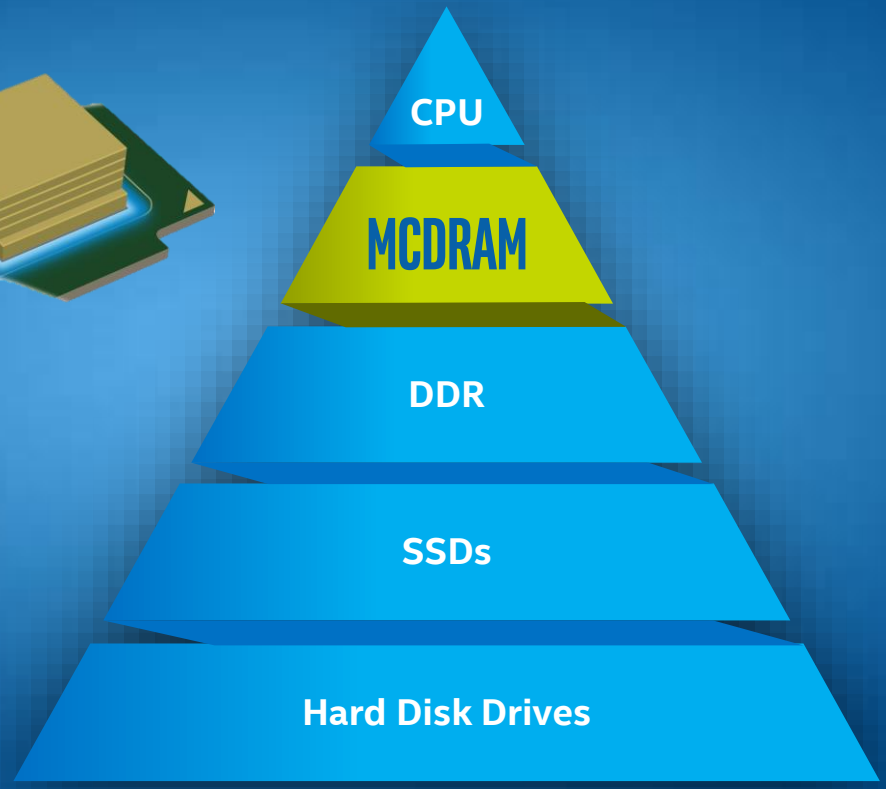
KNIGHTS LANDING
NEXT-GEN INTEL® XEON PHI™ PROCESSOR



>3TF
PEAK DP
PERFORMANCE

3X
FASTER
ST PERFORMANCE VS. KNC

5X
FASTER
MCDRAM VS. DDR4 DIMMs



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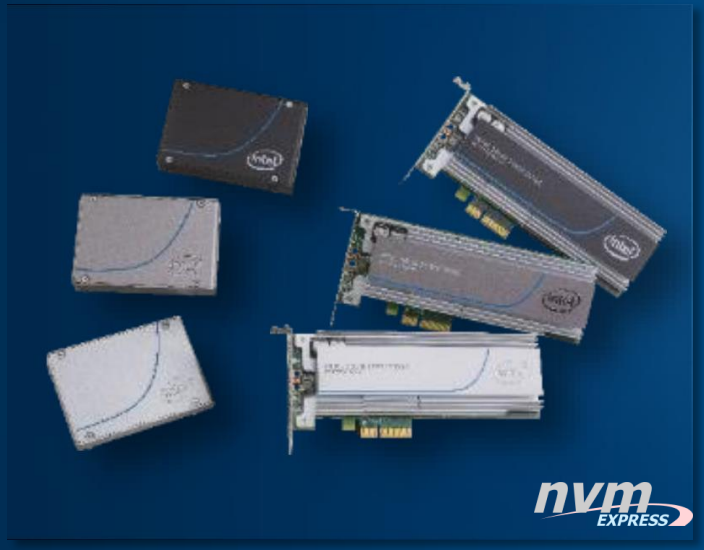
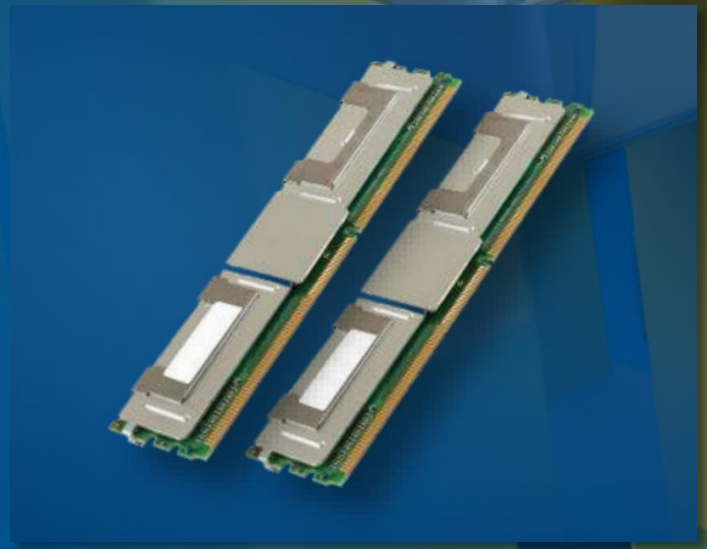
3D XPoint™ TECHNOLOGY (NVM)

INTEL® OPTANE™ SSD



NEW CLASS OF NON-VOLATILE STORAGE
10x faster than NAND
1000x endurance of NAND

DIMMs** BASED ON 3D XPoint™



NEW CLASS OF NON-VOLATILE MEMORY**
4x more memory capacity
½ cost of DRAM

**For illustration only, future potential options are forecasts and subject to change without notice.

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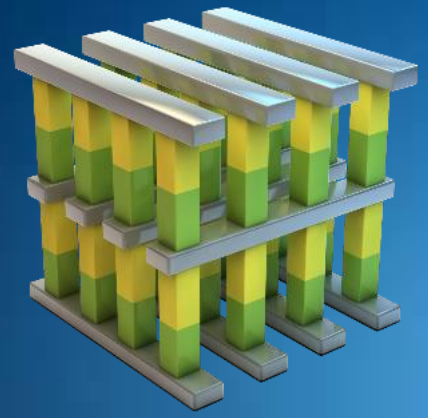
NEW MEMORY & STORAGE

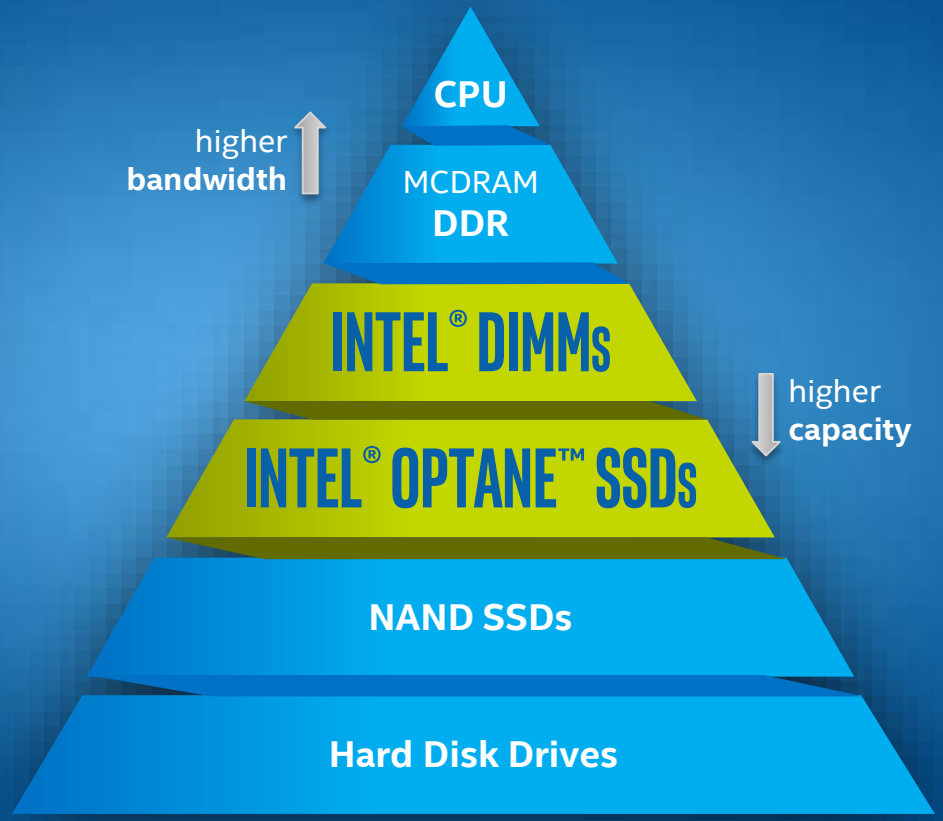
3D XPOINT™ TECHNOLOGY



10X FASTER THAN NAND (LATENCY)

1000X ENDURANCE OF NAND

10X DENSER THAN DRAM



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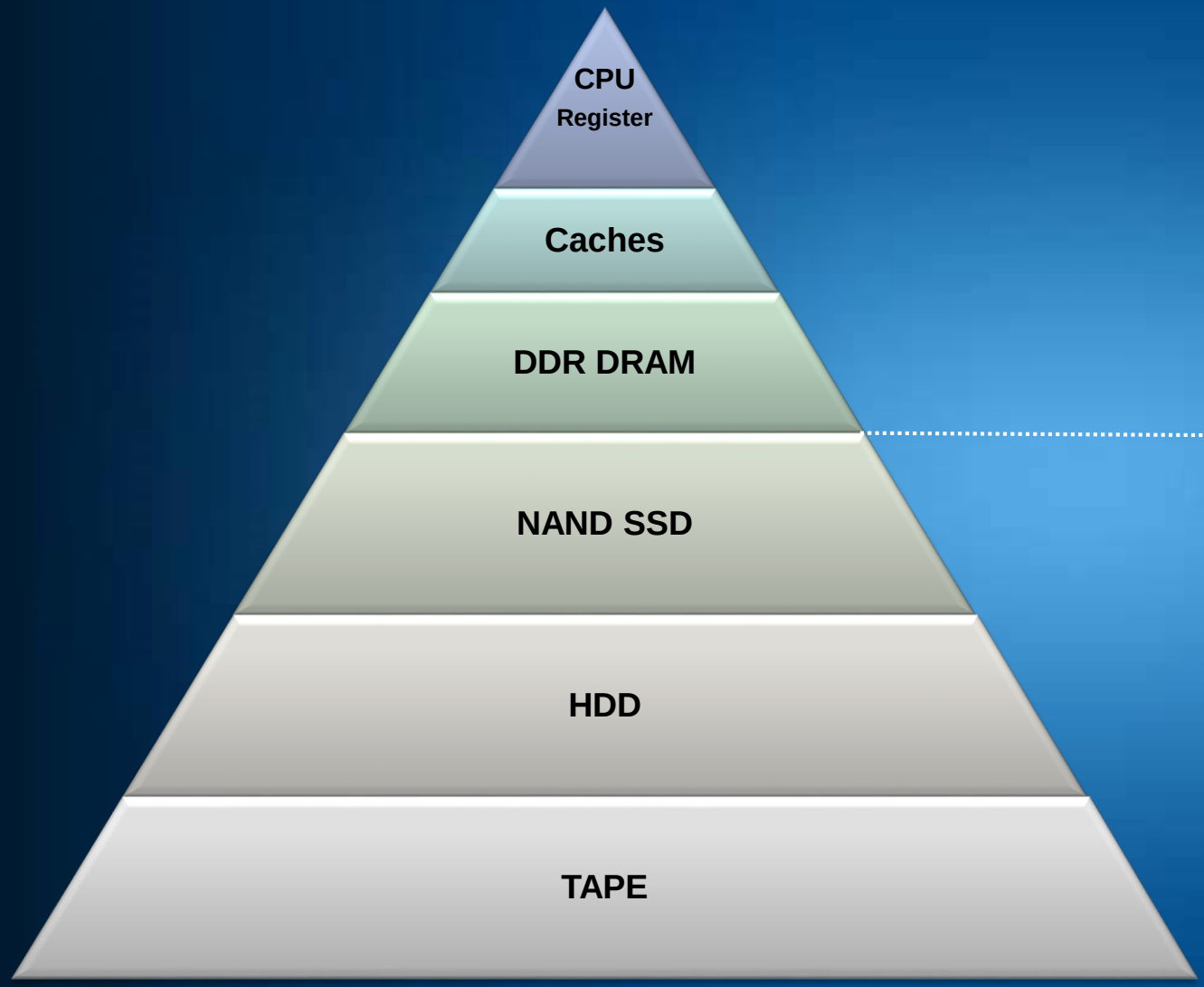
TODAY'S MEMORY & STORAGE HIERARCHY

More expensive
Lower latency
Higher bandwidth
Lower capacity



Less expensive
Higher latency
Lower bandwidth
Higher capacity

Volatile

Persistent

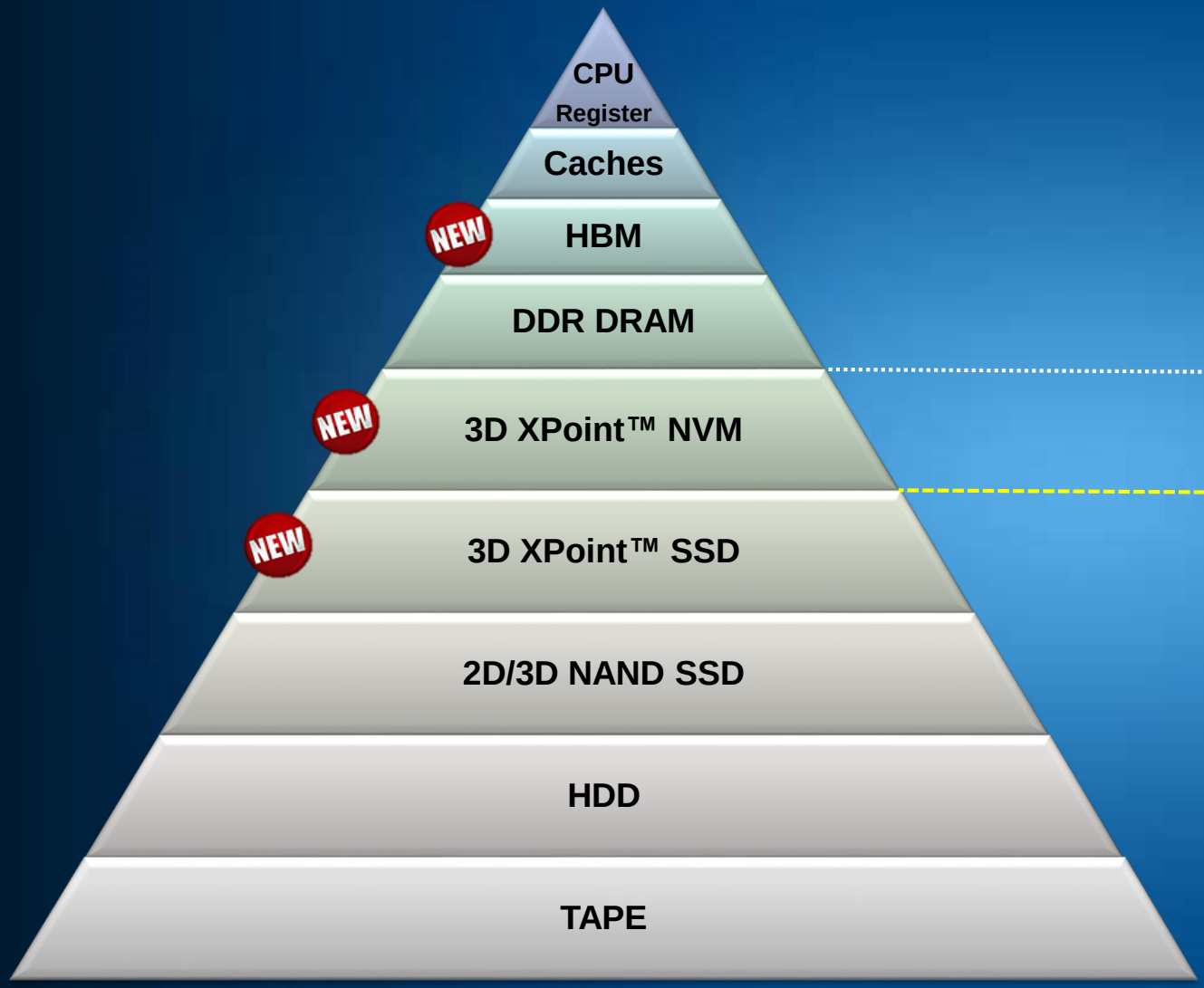
Memory

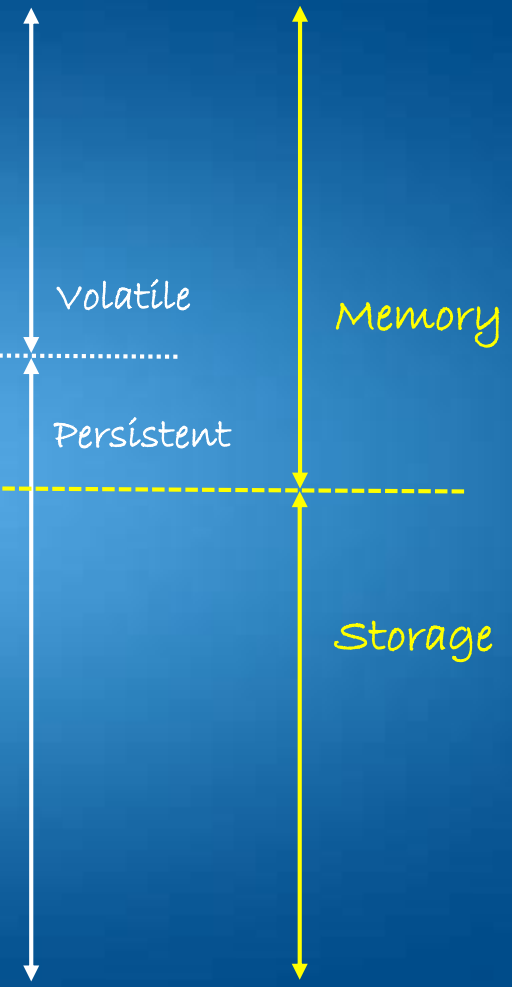
Storage

For illustration only, not drawn to scale

EVOLVING NEW MEMORY & STORAGE HIERARCHY

More expensive
Lower latency
Higher bandwidth
Lower capacity





Less expensive
Higher latency
Lower bandwidth
Higher capacity

For illustration only, not drawn to scale

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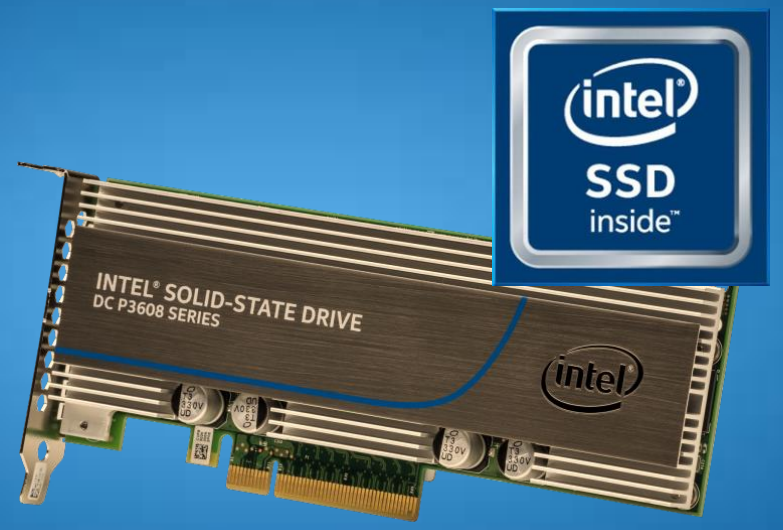
MAKING STORAGE FASTER

High Performance . Efficiency . Reliability . Consistency

INTEL® SSDs 2D/3D NAND



10GB/S BANDWIDTH[1]
USING x16 PCIe* NVMe

FASTER

LOWER LATENCY
USING PCIe

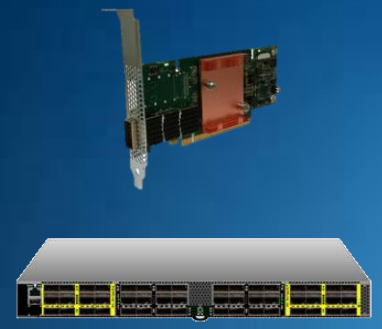
LOWER OVERHEAD
OPTIMIZED PCIe NVMe

[1] Up to 10GB/s peak bandwidth for sequential read performance with two Intel® DC P3608 (4TB) SSDs

*Other names and brands may be claimed as the property of others.

THE NEW HPC FABRIC

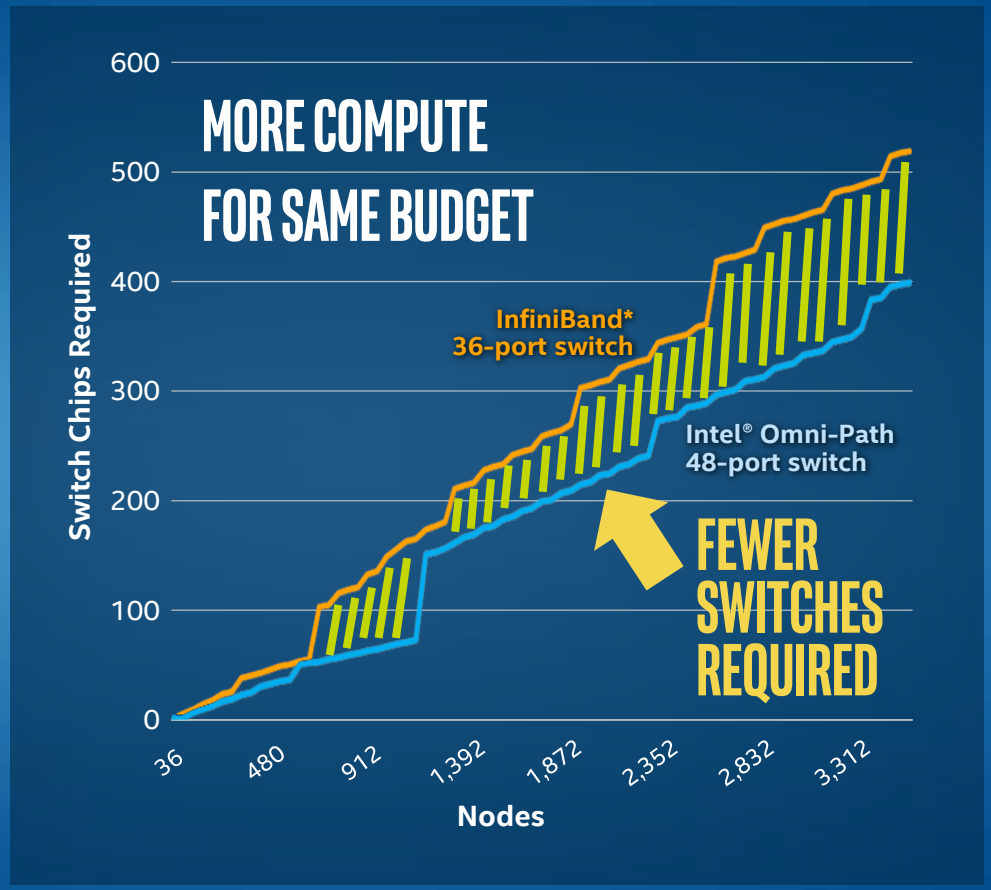
INTEL® OMNI-PATH™ ARCHITECTURE



100 GBIT/S PER PORT

1.3X HIGHER SWITCH DENSITY

2.3X GREATER FABRIC SCALABILITY



Number of switch chips required, switch density, and fabric scalability are based on a full bisectional bandwidth (FBB) Fat-Tree configuration, using a 48-port switch for Intel® Omni-Path Architecture and 36-port switch ASIC for either Mellanox* or Intel® True Scale Fabric. *Other names and brands may be claimed as the property of others. 2.3X fabric scalability based on a 27,648-node cluster configured with the Intel® Omni-Path Architecture using 48-port switch ASICs, as compared with a 36-port switch chip that can support up to 11,664 nodes.

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SOFTWARE DEFINED VISUALIZATION
http://www.sdvis.org/
intel

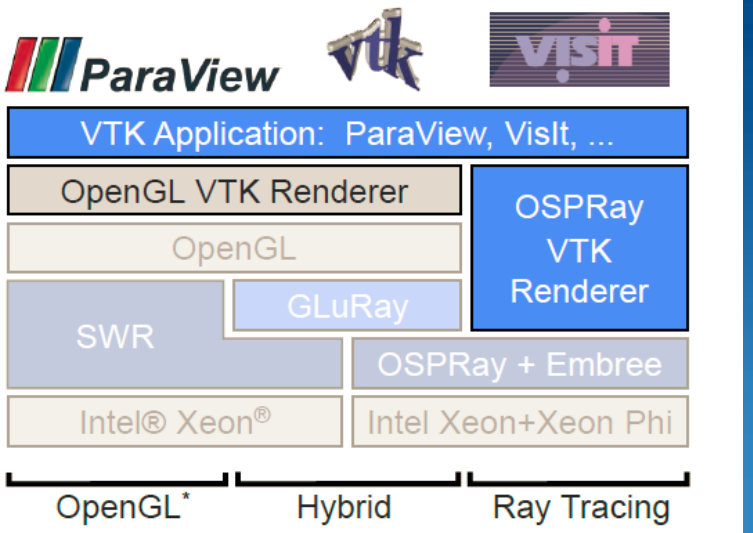
HIGH FIDELITY VISUALIZATION: IN SOFTWARE – IN SITU

Render Method and Target Architecture

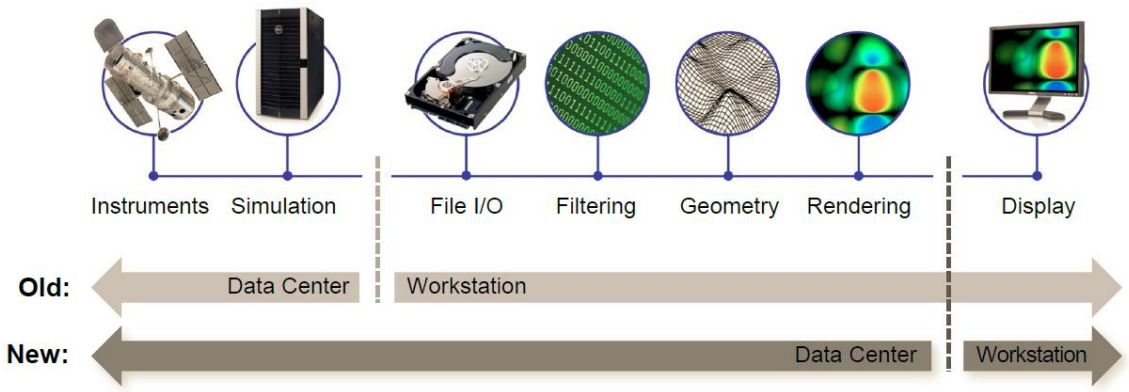
	Simple Shading	Advanced Shading	OpenGL	Ray Tracing
Data Size < GPU Memory	OpenGL* (many existing apps in this space)	Ray Tracing	Intel® Iris™ Pro Graphics GPU	Intel Xeon or Intel® Xeon Phi™
Data Size > GPU Memory	OpenGL or Ray Tracing	Ray Tracing	Intel® Xeon®	Intel Xeon or Intel Xeon Phi

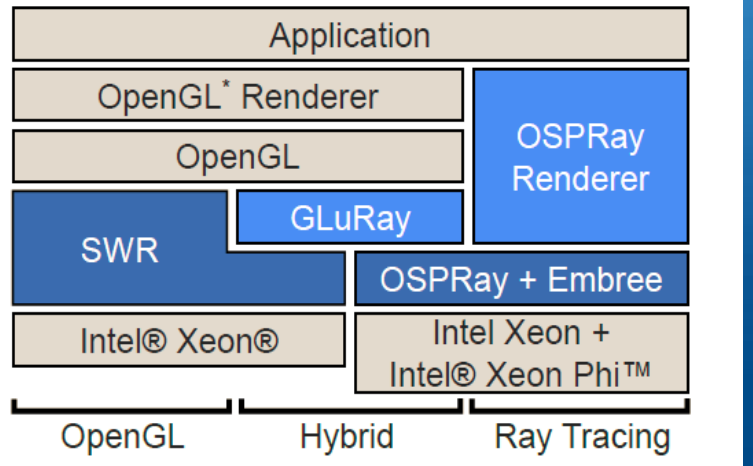
Increasing Data Size

Increasing Image Quality



Corollary: Workflow Moving into Data Center...





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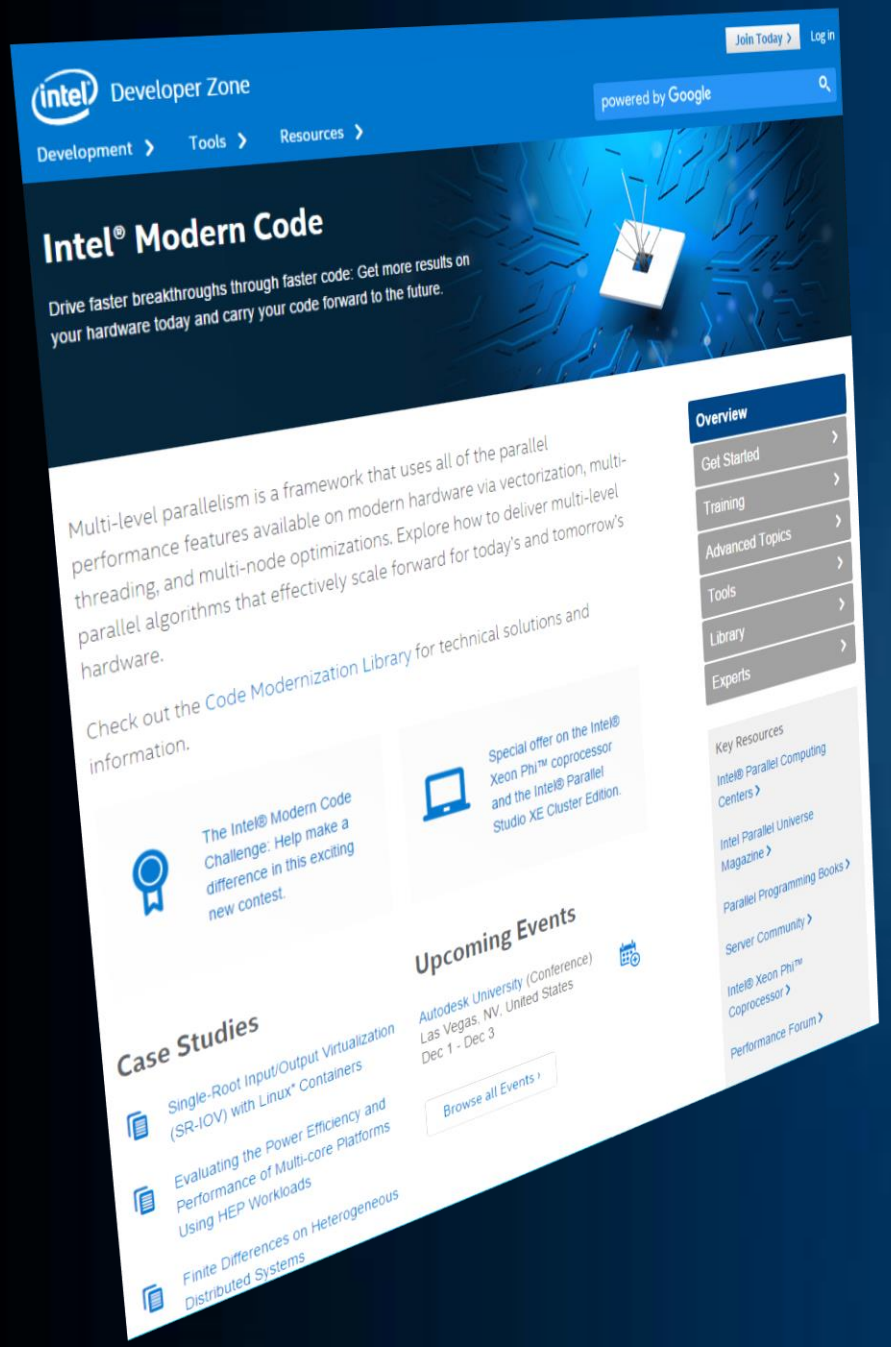

MODERN CODE DEVELOPER COMMUNITY

software.intel.com/en-us/modern-code

INTEL CODE MODERNIZATION PROGRAM

software.intel.com/en-us/code-modernization-enablement

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experience
what's inside™
THANK YOU.

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Rev. 4/15/14