The Machine:
The future of technology

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Agenda

1: Vision

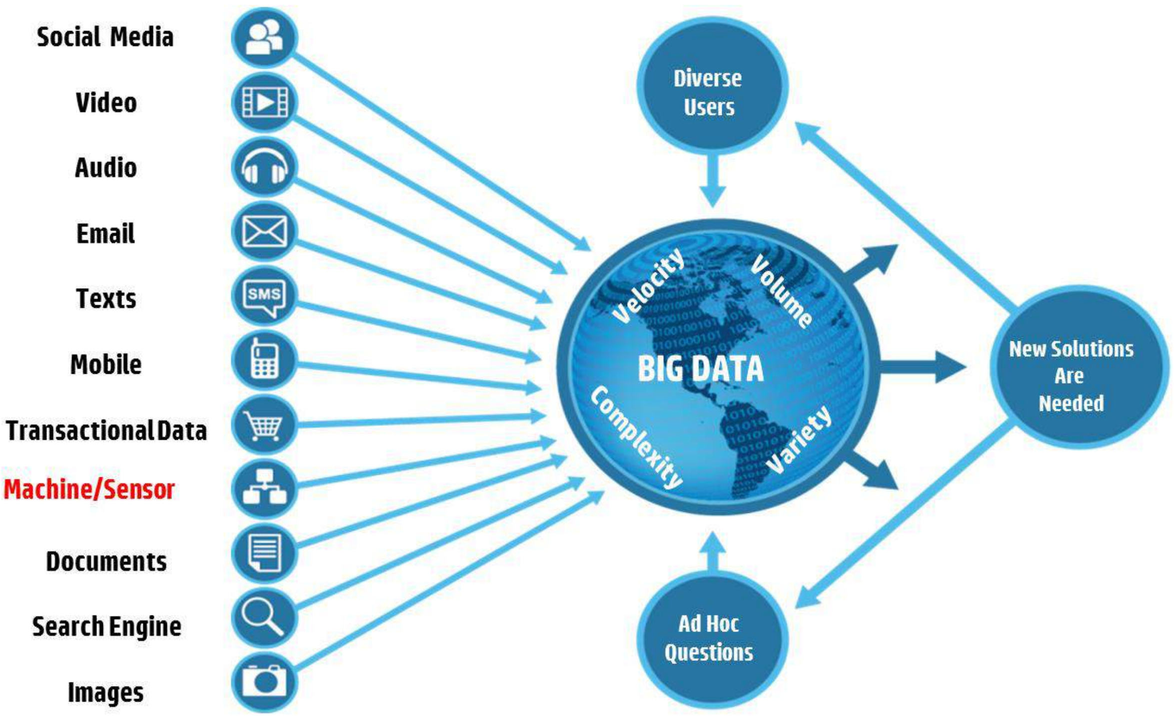
2: Core Technologies

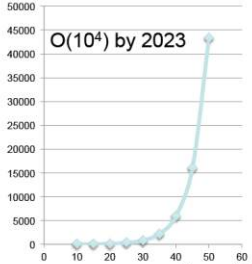
3: Systems

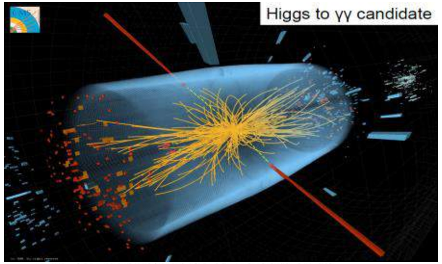
- Moonshot
- The Machine

Tsunami of data on the horizon

202X will be the decade of Extreme Data; massive compute is required for Extreme Analytics







Problem: Hoped for solution:

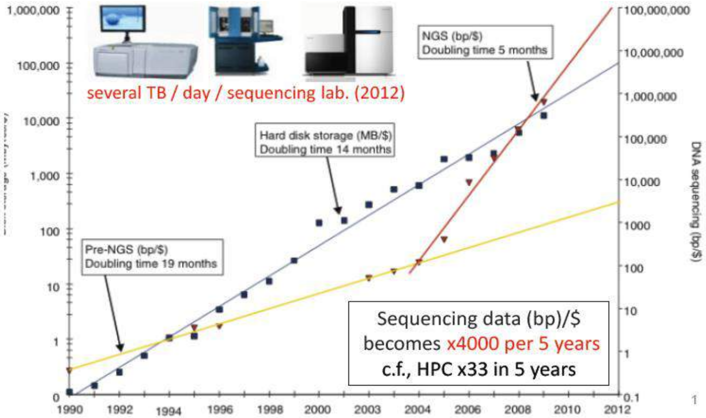
$O(10^4) \sim O(10) \times O(10) \times O(10) \times O(10)$

Moore's law

New hardware architectures

New algorithms

Built a better detector



Lincoln Stein, Genome Biology, vol. 11(5), 2010

Today's computing infrastructure unable to keep up

You won't be able to get more capacity for less

Big Data will be too big to extract meaning from

You won't be able to move your data from where it's created – useful data may get ignored or discarded

By the time you've analyzed your data – it will be out of date

Your infrastructure will require more resources than you can get

Securing your enterprise will take more computing resources than you have

Internet of Everything

Pervasive Connectivity | **Smart Device Expansion** | **Explosion of Information**

By 2020

IoT "Things" — 200 Billion [(1)]

Connected Devices — 30 Billion [(2)]

Smart Meters — 1 Billion [(3)]

... for 8 Billion [(4)]

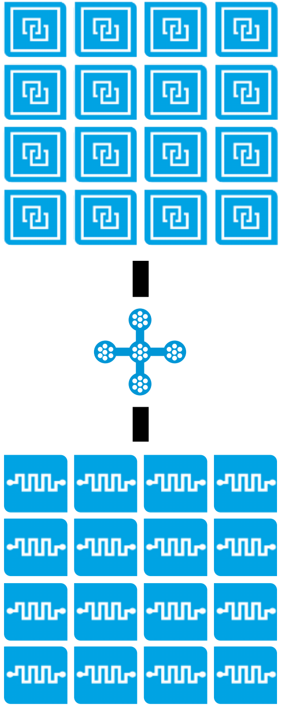
(1) IDC "Worldwide Internet of Things (IoT) 2013-2020 forecast" October 2013. (2) IDC "The Digital Universe of Opportunities: Rich Data and the Increasing Value of the Internet of Things" April 2014 (3) Global Smart Meter Forecasts, 2012-2020. Smart Grid Insights (Zypryme), November 2013 (4) http://en.wikipedia.org

Projects and roadmap

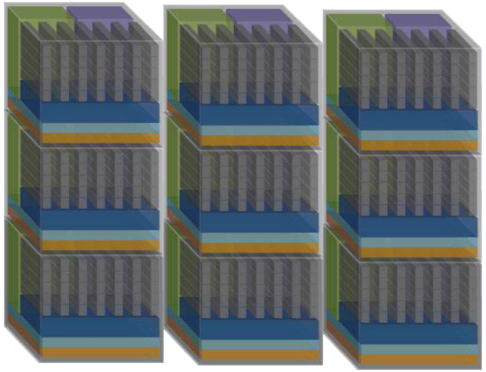
Holistic, systematic & step-wise roadmap to revolutionary impact

Moonshot

HP Labs innovations for 10X improvment on TCO,energy,complexity,density



DCDC for extreme analytics driving a gigantic mesh of things



The Machine

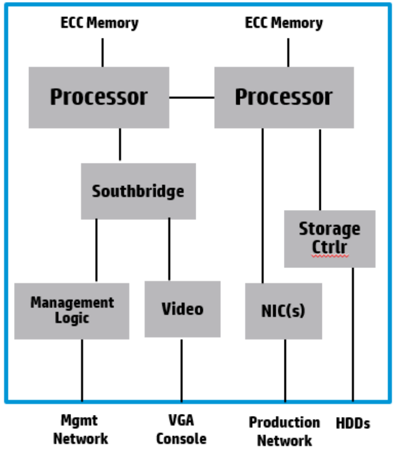
HP Labs innovations for 10-100X disruptions & new information-to-insight markets

Moonshot

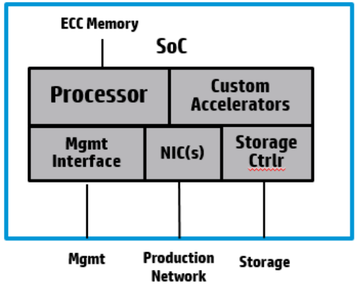
HP Moonshot: the first step

Special purpose SoCs

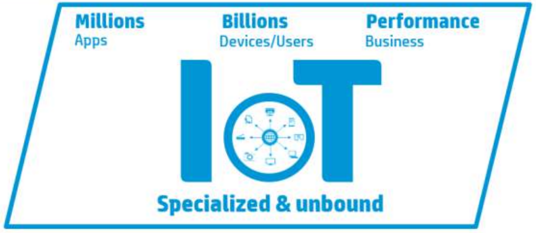
Traditional Server Motherboard



System on a Chip (SoC)-based Server



- Less general-purpose, more workload focused
- Dramatic reduction in power, cost, and space
- SoC vendors bring their own differentiated features and opportunities to disrupt markets
- Rapide cadence of innovation



*Source: HP internal research

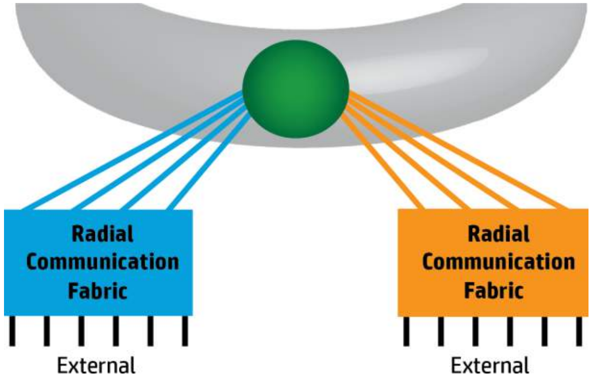
Where does Moonshot fit in your data center?

The flexibility to choose from combinations of CPU, memory, storage, and networking

ProLiant	Compute	Specialized cores	Networking	Memory	Storage	Density	Typical workloads
m300	Atom™ C2750 8 core/Soc	N/A	Dual port 1GbE /CPU	32GB	SFF HDD or SSD	45/4.3U	Web infrastructure, dedicated hosting, distributed analytics, NoSQL databases
m350	Atom™ C2730 8 core/SoC	N/A	Dual port 1GbE /CPU	64GB 16GB/SoC	Local SSD (NGFF/m.2)	180/4.3U	Web hosting, distributed analytics
m400	ARM 64bit 8 cores/SoC	N/A	Dual port 10GbE /CPU	64GB	Local SSD (NGFF/m.2)	45/4.3U	Memory caches, in-memory analytics, science and engineering applications
m700	Opteron™ X2150 4 core /SoC	GPU 128 cores/SoC	Dual port 1GbE /CPU	32GB 8GB/SoC	4 x 64GB iSSD	180/4.3U	Hosted desktop infrastructure, gaming, content distribution network (CDN)
m710	Xeon E3 4 cores/SoC	GPU Iris Pro + 128MB eDDR	Dual port 10GbE /CPU	32GB	Local SSD (NGFF/m.2)	45/4.3U	Video transcoding, gaming, application delivery, extreme file transfer
m800	ARM A15 4 cores / SoC	C66x DSP 8 cores/ SoC	Dual port 1GbE /CPU + 2D Torus	32GB 8GB/SoC	Local SSD (NGFF/m.2)	180/4.3U	Real-time data processing, complex event processing, IP transcoding

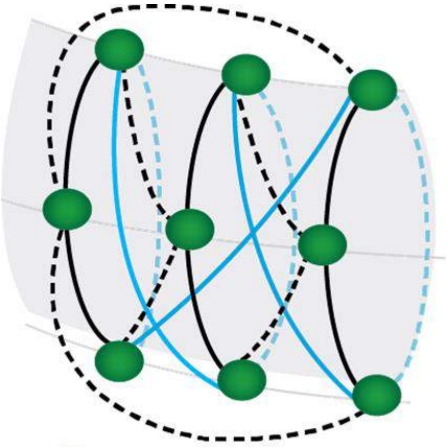
Moonshot Data Fabrics

Radial Communication



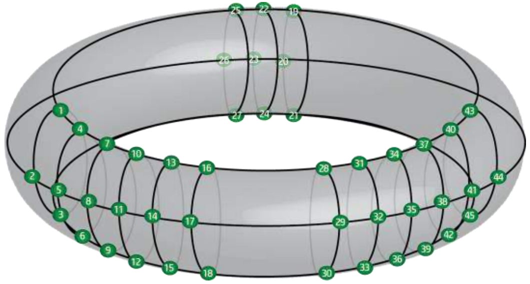
- High speed interfaces between each cartridge and two radial fabric slots; external connectivity

Proximal Array



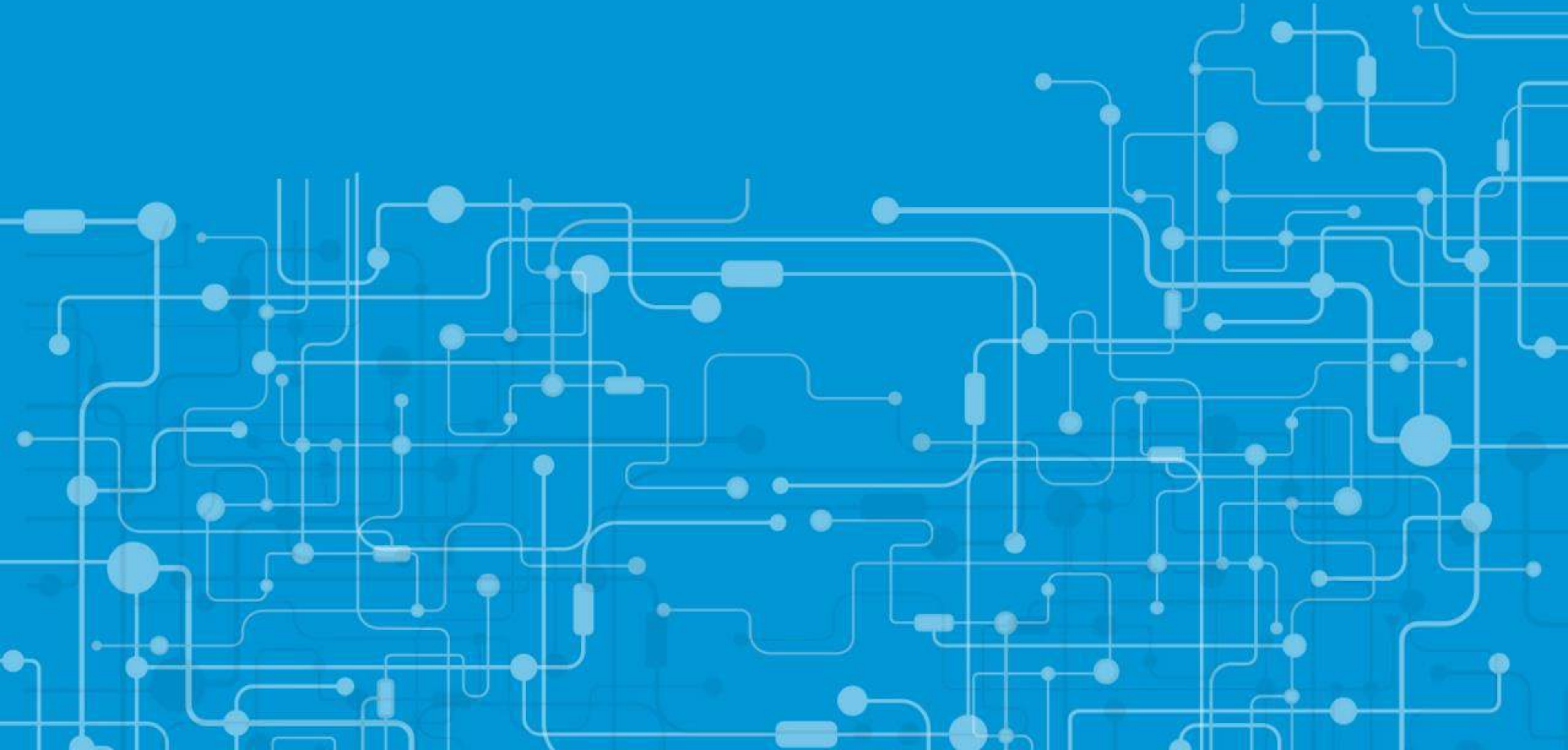
- Five separate 3x3 proximal array fabrics within 2D Torus Mesh

2D Torus Mesh

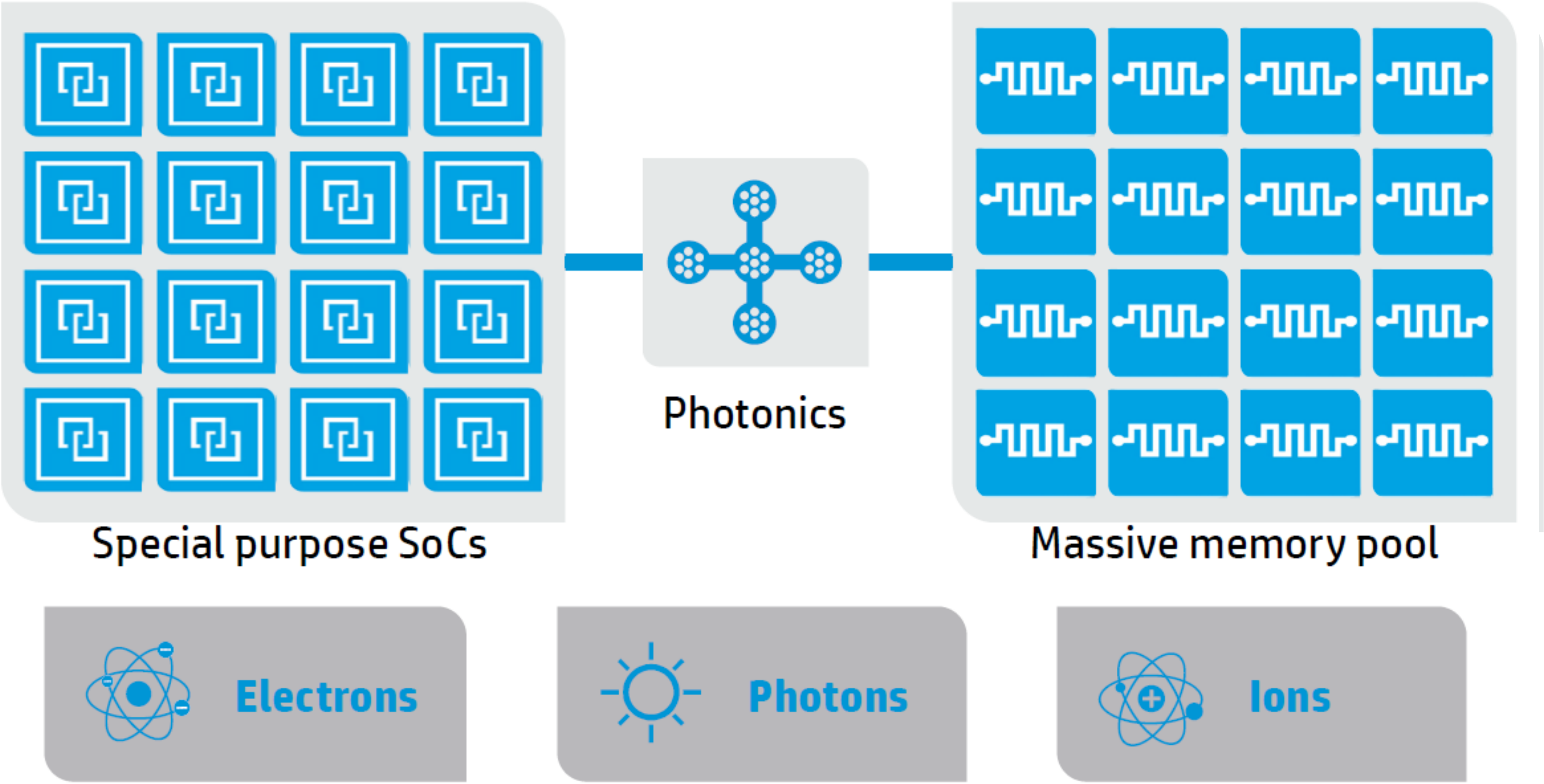


- High bandwidth cartridge-to-cartridge communication (North, South, East, West)

Technologies for Extreme computing



3 disruptive technologies to the rescue



Disruption #1: Non-volatile memories

Breakthrough in storage and memory technology

Scientists Create First Memristor: Missing Fourth Electronic Circuit Element

BY BRYAN GARDINER 04.30.08 | 10:03 AM | PERMALINK

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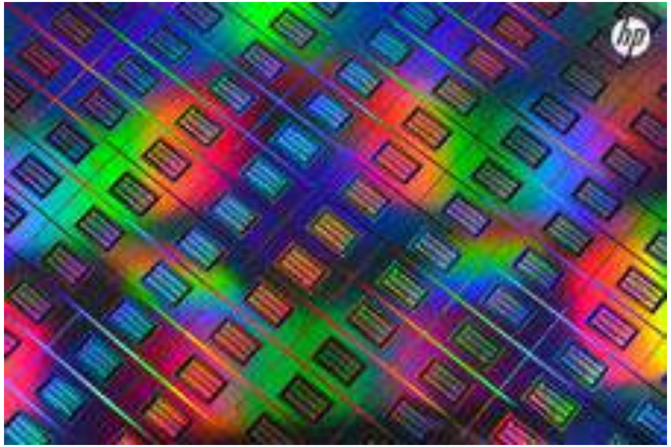
Researchers at HP Labs have built the first working prototypes of an important new electronic component that may lead to instant-on PCs as well as analog computers that process information the way the human brain does.

The new component is called a memristor,

Technology	Density (μm^2/bit)	Bandwidth (GB/s)	Latency Read (ns)	Latency Write (ns)	Energy Read (pJ/b)	Energy Write (pJ/b)
Hard Disk	N/A	0.5	3,000,000	3,000,000	2500	2500
Flash SSD [3] [6]	0.0021	1.0	25,000	200,000	250	250
DRAM [6] [30]	0.0038	51.2	55	55	24	24
PCRAM (22nm) [30]	0.0058	variable	48	150	2	19.2
Memristor (22nm) [8]	0.0048	variable	100	100	1-3	1-3



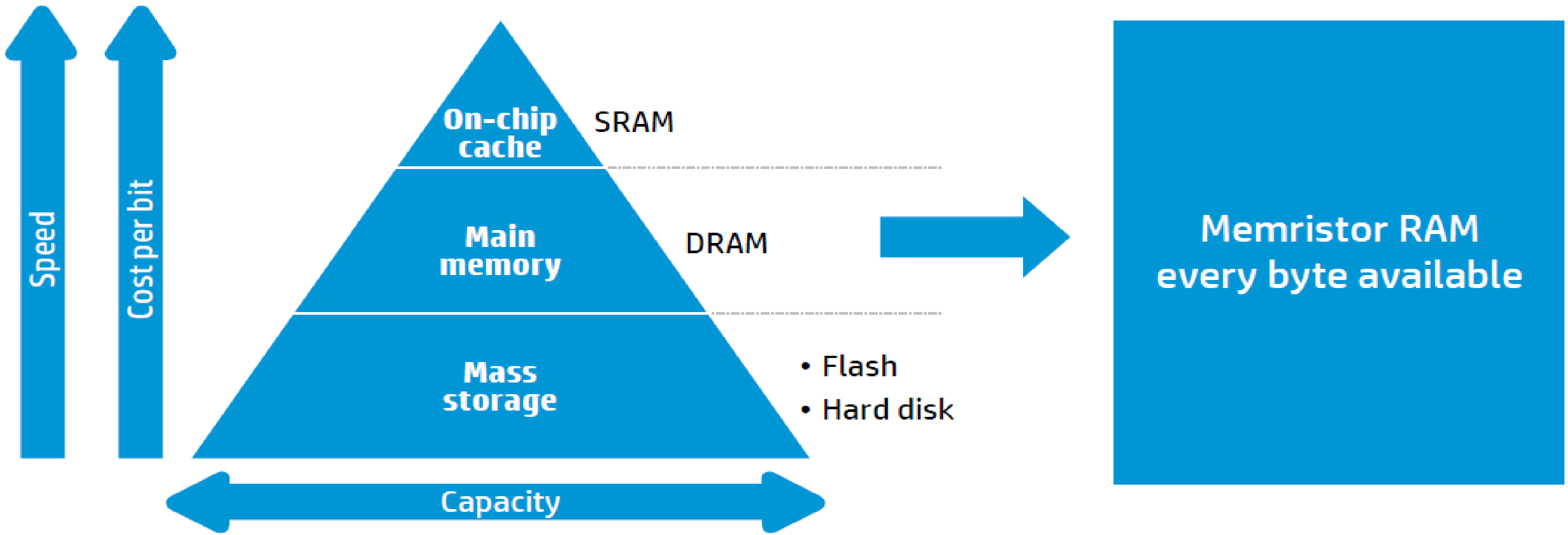
Store large amounts of data permanently like hard disks, but 100,000 times faster, and at much lower energy

UNIVERSAL MEMORY

Massive memory pool

A drastic reduction of the memory stack complexity and cost

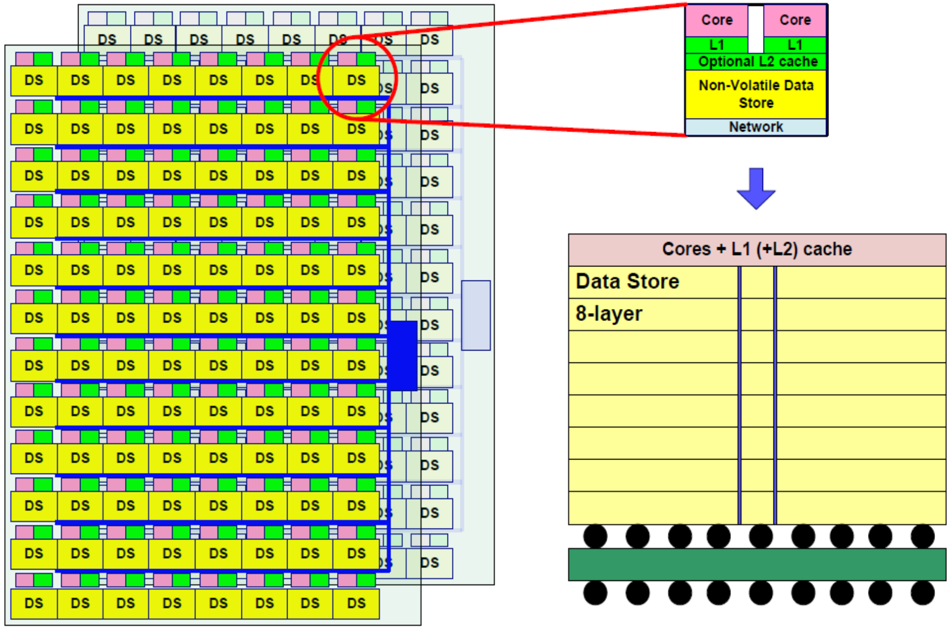
But requires a complete software stack redesign to leverage the full potentiality of the new architecture



Memristors change how and where data are stored

Nanostores: in-memory compute

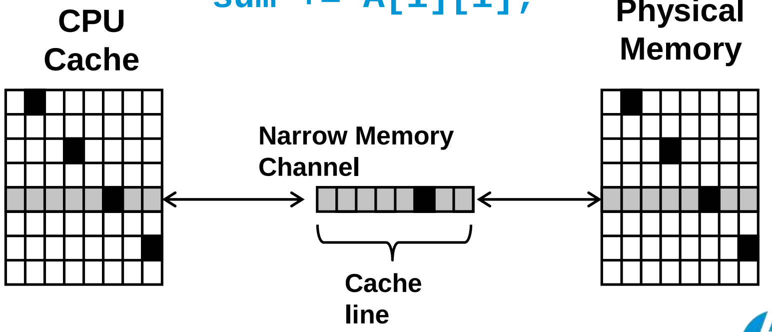
Shortly we will produce so much data that it will be impossible to move them, even with photonic



Flat converged storage hierarchy with compute colocation for 10x-100x improvement in performance per Watt

Example: Matrix Computation

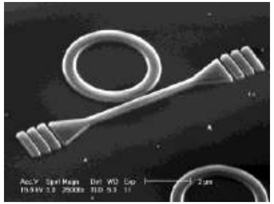
```
for (i = 0; i < n; i++)
    sum += A[i][i];
```

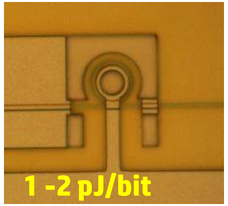


Disruption #2: HP Photonics

for faster data transmission and lower energy

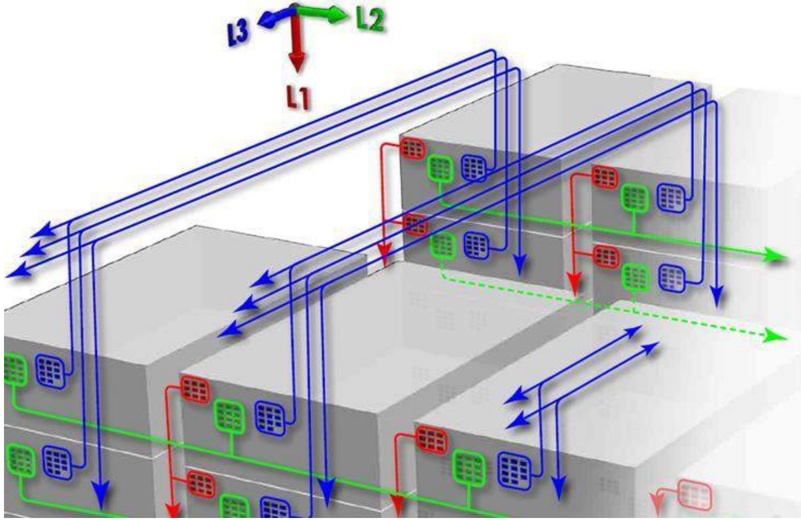
Transmit data using light for **30-fold more** bandwidth at **one-tenth the energy**





All communications will be optical

- **Bandwidth scaling**
  - 30x improvement over copper
- **Lower Power**
  - 10x improvement over copper links
  - Improved airflow & cooling
- **Equivalent cost**



Photonics destroys distance

6 words to summarize the vision

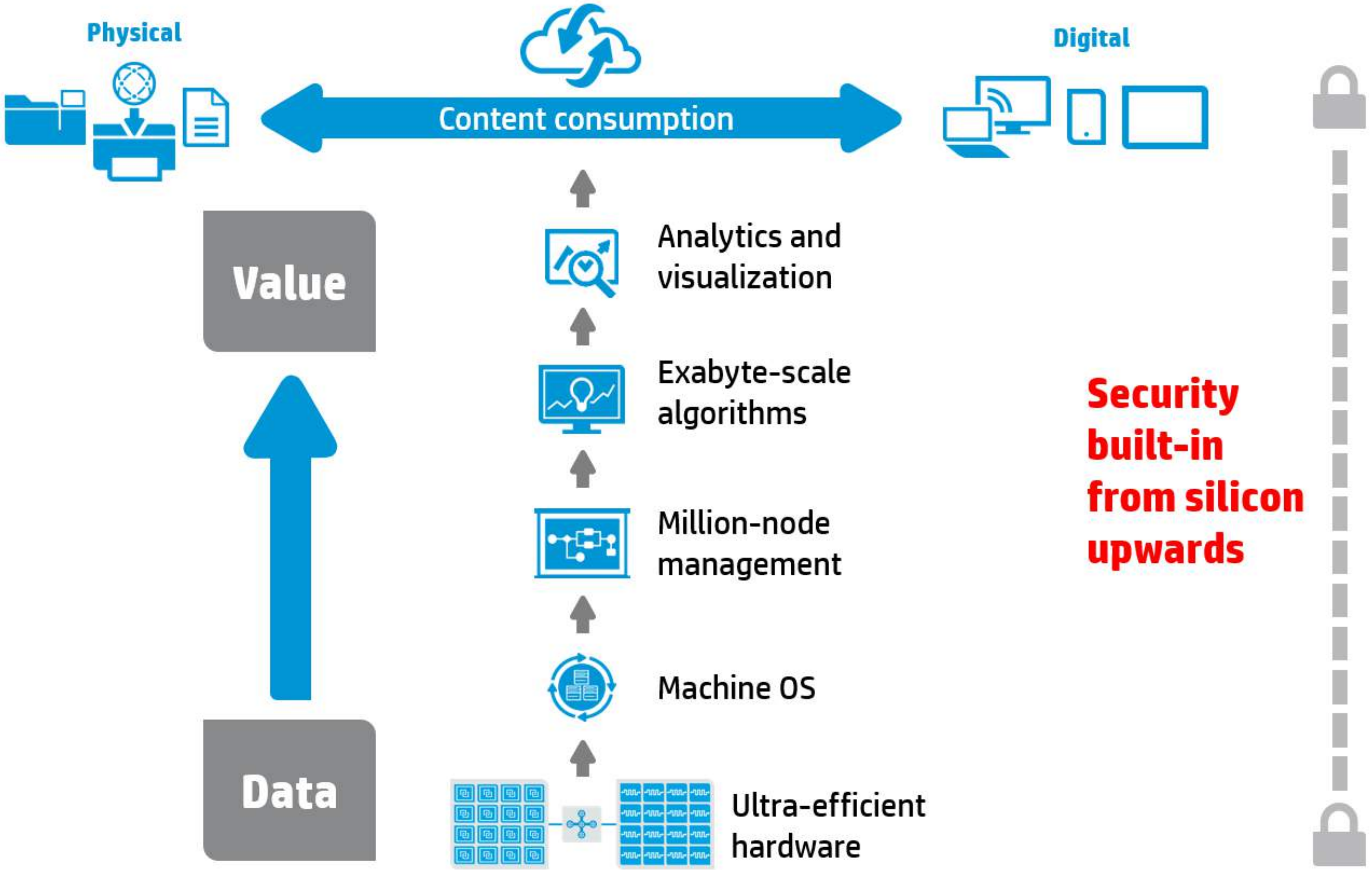
Electrons	→	**Compute**
Photons	→	**Communicate**
Ions	→	**Store**

Not substitutional technologies

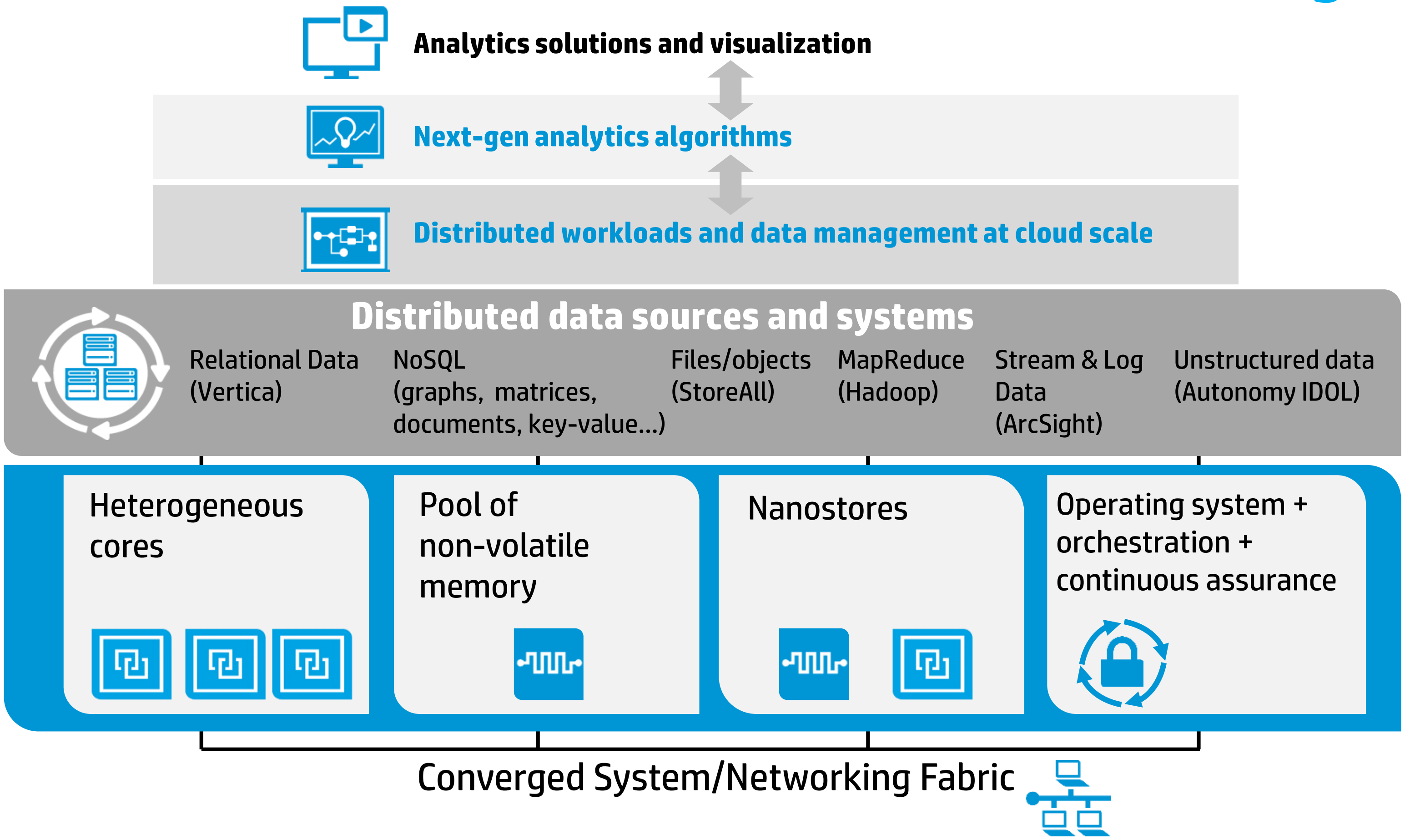
Holistic re-architecting to get all benefits

The MACHINE

The Machine: towards a new computing paradigm

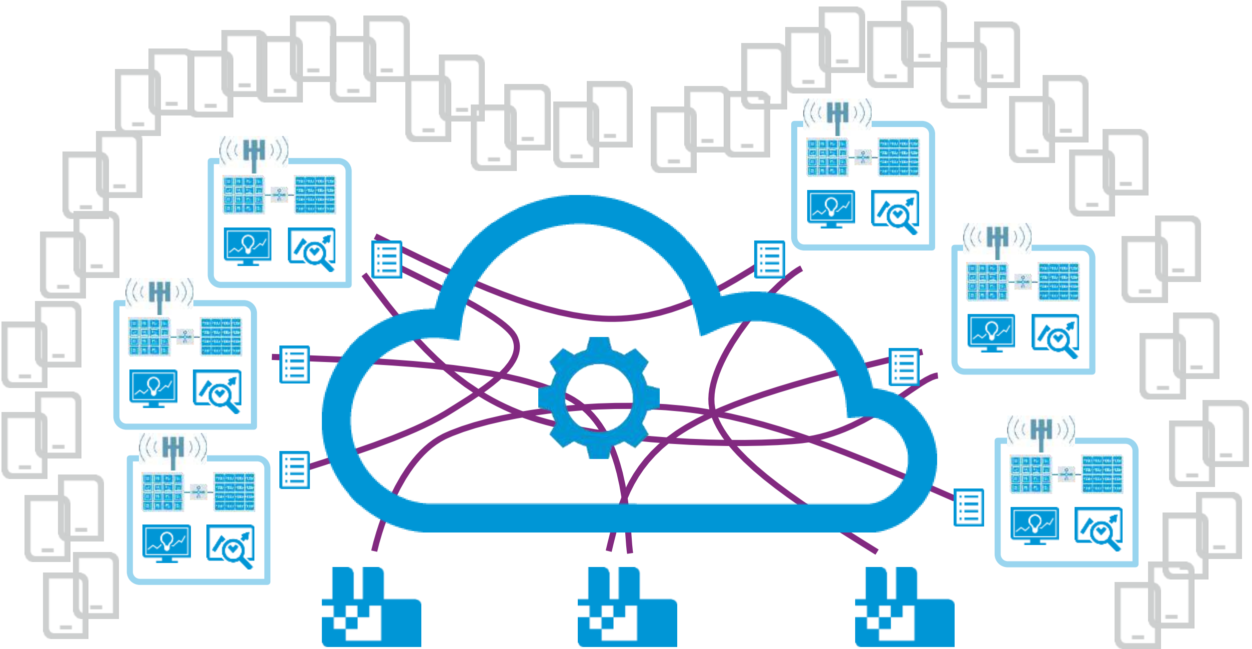


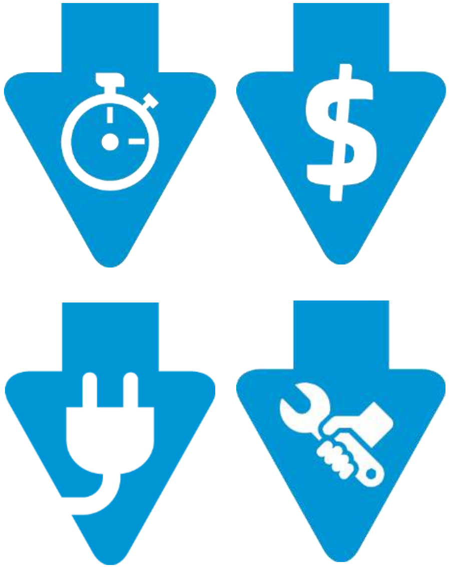
New architecture enables fundamental changes



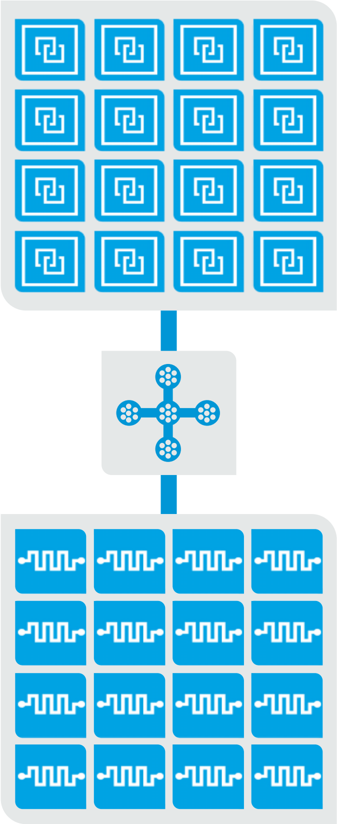
A Massive Mesh of intelligent objects

Use case: the smart cell tower





Aspirational History



- SoC Partners selected for co-development
- Machine OS development begins

- Memristors begin sampling
- Physical infrastructure of Core prototypes established
- Open Source Machine OS SDK and emulators released
- ISV Partner collaborations begin

- Edge devices ship in volume
- Core Machines running real-world workloads at scale
- Machine OS released

- Core devices at volume
- Machine available as product, service, and as a business process transformation

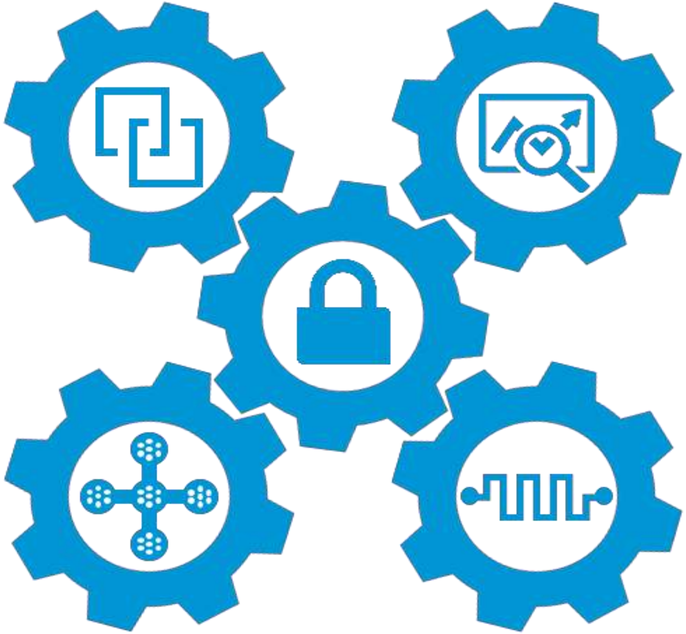
2014 2015 2016 2017 2018 2019 2020

- Memristor DIMMs launched
- Integrated core technologies demonstrated

- Edge devices begin sampling
- Machine OS enters public beta

Distributed mesh compute goes mainstream

The MACHINE .....



[The Machine Webpage]

[The Machine 3 min video]

[Memristor Lab Tour]

[Photonics Lab Tour]

[HP Analytics Lab]

[HP Security and Cloud Lab]

This changes everything

Any questions?