The Machine: The future of technology

HP Labs

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What are the questions you can’t ask today?

Magnitude of the data

Flash flooding of legacy data bases

Unable to secure

Time consuming data integration

Real-time insight needed

Insufficient resources

The end of cheap hardware

= $
The Past 60 Years

1950s

1960s

1970s

1980s

1990s

2000s

Today
Special purpose cores

Photonics

Massive memory pool

The Machine
Customize the hardware to the workload
Photonics destroys distance
Universal memory obsoletes this hierarchy

Massive memory pool

- SRAM
- DRAM
- Flash
- Hard disk

On-chip cache
Main memory
Mass storage

Speed
Cost per bit
Capacity
Imagine if a computer ran at human speed …

**Processor cycle**  
1 second

**Time to retrieve a byte from**  
- **SRAM**  
  5 seconds
- **DRAM**  
  2 minutes
- **Flash**  
  1 day
- **Hard drive**  
  2 months
- **Tape**  
  1,000 years!
Processor

CPU registers
Level 1 cache
Level 2 cache
Level 3 cache

Main memory
Flash accelerator
SSD
Local disk

Network drive array*
Network backup
Archive

* actually an entire computer system with its own hierarchy
Electrons → Compute
Photons → Communicate
Ions → Store
Content consumption

Value

Data

Analytics and visualization
Exabyte-scale algorithms
Million-node management
Machine OS
Ultra-efficient hardware

Physical

Digital

Security built-in from silicon upwards
Hardware/software co-development

Hardware development

The Simulated Machine

The Machine

Software development
Performance estimates – graph traversal

What could you do if you could traverse 16 trillion graph edges per second?

Graph 500-like workload

**Sequoia, Blue Gene Q at Livermore**
64,000 nodes, > 1M cores total

**HP – The Machine**
20 racks, 256 SoCs / rack, 122k cores total
256 GB NVM per SoC, 1.3 PB total
256 NICs per rack, 2*100 Gbps links / NIC
Utilization < 70%

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<th>Performance</th>
<th>Power</th>
<th>Problem size</th>
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<td>16 TTEPS</td>
<td>7,900 kW</td>
<td>4 trillion</td>
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<td>15.3 TTEPS</td>
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The Machine | Blue Gene Q
Translator
Coordinator
Orchestrator
Arbitrator
Aggregator
Replicator
Anonymizer
Border guard
Learning engine
A mesh of connected aircraft ...
Use case: the smart cell tower
**Future History**

- Memristors begin sampling
- Physical infrastructure of Core prototypes established
- Open Source Machine OS SDK and emulators released
- ISV Partner collaborations begin
- Memristor media controller, protocols and standards established
- SoC Partners selected for co-development
- Machine OS development begins
- Memristor DIMMs launched
- Integrated core technologies demonstrated
- Edge devices begin sampling
- Machine OS enters public beta
- 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
- Distributed mesh cloud goes mainstream

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This changes everything
Resources to share with customers

The Machine External Webpage
The Machine (German) 3 min video
The Machine classic 3 min video
Memristor Lab Tour
Photonics Lab Tour
HP Analytics Lab
HP Security and Cloud Lab