Data Center and Cloud Computing
Market Landscape and Challenges

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Outline

- Data Center Trends
- Technology Challenges
- Solution Options
- Xilinx Focus
- OpenPOWER Developments

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Data Center Trends

- Software Defined Data Center
  - Physical
  - Virtual
  - Cloud

- Evolving Architectures & Standards

- Need for Workload Acceleration

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Exponential Growth

Compute

100K → Millions

2010 → 2014

Storage

10s of PB → Exabytes

2010 → 2014

Network Capacity

10s of Tbps → Pbps

2010 → 2014

Source: ONS2014 Keynote, Microsoft / Azure

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Technology Challenges

- Power/thermal density is limiting Fmax scaling
  - End of Dennard scaling \( \Rightarrow \) End of Moore’s law

- CPU performance scaling problematic
  - Difficulties in exploiting task-level parallelism with multi-core \( \Rightarrow \) Dark silicon

- Heterogeneous computing \( \Rightarrow \) Best of both worlds
  - Higher performance and lower power
  - Increased compute density

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Need for New Data Center Architecture

- Think beyond traditional architecture
  - Need scalable architecture to boost system performance & reduce latency

- Design for application acceleration & processor offload
  - Heterogeneous processing for specialized workloads

- Need to improve customer CAPEX and OPEX
  - Performance/Watt must be key consideration

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### How can FPGAs help Acceleration?

#### COMPUTE
- **Image Search**
  - 8x throughput
- **Video Transcode**
  - 20x throughput
- **Image Processing**
  - 50x throughput

#### STORAGE
- **Hybrid memory**
  - Latency hiding
  - 10x power saving
- **Key-Value Stores**
  - 36x RPS/Watt
  - 10x-100x latency reduction
- **Compression/Encryption**
  - Customize algorithms
  - Latency sub 5us
  - Encryption rate 10x

#### NETWORKING
- **Secure socket**
  - Latency sub 5us
  - Encryption rate 10x
- **TCP endpoint**
  - Latency sub 2us
  - 10x virtual circuits
- **Packet switch**
  - Latency sub 100ns
  - Protocol choices

### FPGA Architecture
(Conceptual)

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## Barriers to Adoption: Ease of Programming

<table>
<thead>
<tr>
<th>Need</th>
<th>Solution Attributes</th>
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<tbody>
<tr>
<td>High Performance / Watt</td>
<td>Architecturally Optimizing Compilation</td>
</tr>
<tr>
<td></td>
<td>▪ Compiler needs to be fast and efficiently utilize resources</td>
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<tr>
<td></td>
<td>▪ Can develop accelerators with high performance/watt</td>
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<tr>
<td>Complete SW Development Environment</td>
<td>Software Development Flow for FPGA Hardware</td>
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<tr>
<td></td>
<td>▪ Single Environment for software workflows</td>
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<tr>
<td></td>
<td>▪ CPU/GPU like development environment</td>
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<tr>
<td>Easily Upgradeable</td>
<td>Reconfigurable Optimized Accelerators</td>
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<td></td>
<td>▪ Need accelerator flexibility for different applications</td>
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<td>▪ Require always on IO and networking interfaces</td>
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Xilinx Has Complete Hardware and Software Solutions

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Software Defined Development Environments

- SDAccel for OpenCL, C, C++ enables up to 25x better performance per watt
- SDSoC provides greatly simplified ASSP-like C, C++ programming experience
- SDNet allows creation of ‘Softly’ Defined Networks

Expand Users to Broad Community of Software and Systems Engineers
First Complete CPU/GPU Development Experience on FPGAs

**Only FPGA Vendor with C, C++, OpenCL**

- Complete software workflow for developers with little to no prior FPGA experience
- CPU emulation, co-simulation and native hardware
- Automatic instrumentation of compiled accelerators with profiling visibility across host and kernels

**SDAccel Environment**

CPU/GPU-Like Development Experience

Leverage Existing C & C++ Code Base

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OpenPOWER and Xilinx Driving Heterogeneous Computing

- Open Innovation required to innovate across full HW & SW stack
  - OpenPOWER has setup impressive ecosystem for collaboration

- FPGAs are a natural fit in rapidly evolving markets
  - Parallel architecture, flexibility and configurability are its strengths

- Power8 + FPGA with CAPI (Coherent Accelerator Processor Interface)
  - Custom acceleration engine on coherent fabric of the POWER8

- CAPI removes overhead & complexity of IO subsystem
  - Allows FPGA accelerator to operate as part of an application

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Convey CAPI Developer Kit for Xilinx FPGAs

- CAPI Developer Kit enables application specific acceleration on IBM Power 8 systems
- Convey's Eagle coprocessor delivers high density FPGA acceleration and large, high bandwidth on-board memory in a PCIe form factor
- Xilinx XC7VX980T FPGA provides capacity and bandwidth for complex, highly parallel designs
Xilinx Key-Value-Store with CAPI

- Power8 + FPGA connectivity with CAPI
  - Enables seamless application acceleration

- Acceleration
  - 35x performance per watt improvement

- 10x latency reduction
  - Enables hybrid memory system

- Combines DRAM & SSD
  - Integration with OpenCL
Summary

- Rethink data center architecture to address scaling
- Need for workload acceleration – FPGA acceptance
- SDAccel offers CPU/GPU development experience on FPGAs
- Xilinx demonstrating CAPI-based acceleration solutions
- Excited to drive Innovation through OpenPOWER
- Visit Xilinx Booth #913

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