A Dramatic Shift in Network Architecture

Presented by:
Antonella Rubicco, CEO
Emilio Billi, CTO
Stephen Ozoigbo, Chief Strategy Officer

Under NDA until February 25, 2014
Company

- Headquartered in the Silicon Valley
- Founded in 2012 as a result of more than 5 years of research and development operations
- Assembled a very skilled and experienced A-class team in engineering and management with proven track records and success stories
  - Antonella Rubicco – Founder and CEO
  - Emilio Billi – Founder and Chief Technology Officer
  - Stephen Ozoigbo – Chief Strategy Officer
- Employees – Under 25

U.S. Patents filed

- #61786560 - Massive parallel petabyte scale storage system architecture
- #61786537 - PCIe non-transparent bridge designed for scalability and networking enabling the creation of complex architecture with ID based routing
- #61786551 - Low-profile half length PCI Express form factor embedded PCI express multiport switch and related accessories
Why the need for a fundamental shift in network architecture?

- Conventional architectures to move stored data are still based on design concepts that have been largely unchanged since the advent of storage, using single-threaded sequential communication processes.

- The huge disparity between computing power and storage performance has created a massive I/O performance gap in the enterprise as well as Big Data, HPC and data centers.

- The emergence of enterprise SSD technology has simply shifted the storage I/O bottleneck from the storage device to the interconnection between storage and the CPU, exposing the limitations of conventional PCI Express and other flash architectures.

- Scale-out systems today require end-to-end synchronization of metadata, or offer a limited number of ingress/egress networking ports.
Competition from traditional network standards

**Ethernet**
- Very well established
- Many clustering topologies used
- **Relatively high cost** (above Gigabit Ethernet)
- **Very high latency**
- **High power** (above Gigabit Ethernet)
- Needs additional adapter cards (above Gigabit Ethernet)

**Infiniband**
- Established in supercomputing systems
- Driver model exists
- **Very expensive**
- **High power**
- Not as widely available as Ethernet or PCIe
- Requires additional adapter cards

**Standard PCIe**
- It’s everywhere
- It’s the standard for the server I/O interface
- **It is not a real fabric, just a connect**
- It does not scale
A new High-Performance Cluster Interconnect based on a disruptive pure memory mapped communication paradigm

**The In Memory Network**

* A re-architected Network Interface Card
  Merging Storage and Compute

- A new ‘Brain Inspired’ Interconnection Fabric providing low latency CPU to CPU and IO to IO traffic via a next generation Network Interface Card
- A revolutionary extension of PCI Express memory mapping features
- A multi-dimensional network topology with A3CUBE’s patent pending distributed non-transparent bridging (dNTB) architecture
- RONNIEE Express fabric extends the standard PCIe architecture, introducing a new architecture based on a globally shared memory container that makes clusters, expansion boxes and shared-I/O applications easy to develop and deploy
Why RONNIEE Express is more powerful than PCIe as a network fabric

- RONNIEE Express is the first multi-dimensional interconnection technology with high bandwidth, low latency, continuous availability and linear scalability for exascale out storage

- A revolutionary RAID-less storage architecture for hyper-scale data systems based on an innovative “In-Memory” network design approach, enabling bottleneck-free storage in HPC, Big Data, and the datacenter for vastly improved storage performance and vastly lower TCO

- Creates scale out storage that can deliver hundreds of gigabytes of throughput and millions of IOPS with massive linear scalability in both storage capacity and bandwidth

- Extends PCIe, adding features to enable a real interconnection fabric, not just a simple interconnect
Why use PCI Express as starting point for a cluster interconnect

- PCIe is ubiquitous and has a well developed ecosystem
- PCI Express standards have seen continuous development
- PCIe 2.x and 3.0 offer enormous scalable bandwidth compared with Infiniband and 100 Gb/s Ethernet

- **PCIe 1.x** – 2.5Gbps (2002)
- **PCIe 2.x** – 5Gbps (2006)
- **PCIe 3.0** – 8Gbps (2010)
- **PCIe 4.0** → ...

- PCI Express is the “de-facto” I/O interconnect on 90% of the CPUs/Chipsets
- Using only PCIe inside the network avoids the overhead of bridging to and from multiple protocols
Why RONNIEE Express is different and so powerful?

- The RONNIEE Express NIC uses memory as the main communication paradigm.
- With PCIe you can have direct access to memory using “memory windows”.
- A3CUBE’s unique NIC architecture uses these “memory windows” to create a shared global memory container that permits direct communication between:
  - Local CPUs and remote CPUs
  - Memory to memory
  - Local and remote I/O
ByOS is designed to provide a **Massively Parallel Supercomputing Experience** applied to data access and computing

- Highly parallel architecture with intelligent relationship between available CPUs and I/O
- Leverages supercomputing's massively parallel design concepts for exascale data access and computing
- Bottleneck-free no-metadata server architecture
- Scaling of capacity and I/O independently
Modern Server Architecture

- CPU
- Memory
- PCIe
- South Bridge

10 Gb/ETH or IB

FC

DATA CENTER NETWORK
Eth/IB Switches

- Multiple Protocols to Manage
- Dedicated IO Interface Cards
- Each server has its own cluster and storage adapters
- Higher power consumption and overall cost

FC Switch (Storage)
Modern Server Architecture with RONNIEE Express NIC

- Shared memory model using Non-Transparent Bridging
  - Removes the latency penalty for bridging to other protocols
- High bandwidth connections between hosts
- Integrated DMA, RDMA, QoS and advanced flow control
  - Communicates with I/O devices directly with PCIe
- PCIe integrated in CPUs and chipsets

A memory mapped unified fabric with multi-dimensional local to remote direct communication
RONNIEE Express Use Cases

**Building Blocks For**

- Big Data / Datacenter
- High-Performance Computing
- Biotech
- CFD

- High End Routers
- Parallel Storage

- Embedded Computing
- Redundant Servers

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RONNIEE Express new standard in performance

Benchmark example: Extreme performance

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<td>RONNIEE Express</td>
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1000s of messages / second
RONNIE Express a new standard in performance

Benchmark example applied to storage: Unmatched IOPS

Same Capacity

![Graph comparing storage performance]

- RONNIE + ByOS
- NetApp EF540
- IBM Flash System 810

Millions of IOPS
# RONNIE Express topology advantages

<table>
<thead>
<tr>
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<th>10Gbe Network</th>
<th>RONNIE Express pure 3D</th>
<th>RONNIE Express Switch</th>
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<tbody>
<tr>
<td>Power consumption</td>
<td>~ 170 KW</td>
<td>110 KW</td>
<td>75 KW</td>
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<tr>
<td>Power consumed for cooling</td>
<td>60.9 KW</td>
<td>39.4 KW</td>
<td>26.8 KW</td>
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<tr>
<td>Total Power consumed</td>
<td>230.9 KW</td>
<td>149.4 KW</td>
<td>101.8 KW</td>
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<tr>
<td>Cost per Kwh</td>
<td>10 cents</td>
<td>10 cents</td>
<td>10 cents</td>
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<tr>
<td>Cost per year</td>
<td>$202,232</td>
<td>$130,850</td>
<td>$89,220</td>
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<tr>
<td>CO2 emitted per year</td>
<td>458 tons</td>
<td>297 tons</td>
<td>212 tons</td>
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Using these figures: Network Power Saving

- For 10,000 nodes over a year the A3CUBE RONNIE Express 3D solution typically saves close to $70,000. **In a five-year period this saving rises to $350,000**
- The RONNIEE Switch solution typically saves close to $113,000. **In a five-year period this saving rises to $565,000**
- Reduced power consumption also leads to a decrease in the carbon footprint. In a five-year period the 10,000 nodes with RONNIEE 3D, when compared to a typical 10Gbe Network, lead to a **reduction of 805 tons in CO2 emissions** and RONNIEE Switch lead to a **reduction of 1,230 tons in CO2 emissions**
Thank You

- Unmatched cost/performance by providing an affordable solution for high-end applications and use cases

- New Standard of bandwidth and latency; support for an efficient IPC paradigm, through use of non-transparent shared memory; IO virtualization in a multi-host environment

- RONNIEE Express is the new data plane designed to accelerate Big Data, HPC and I/O intensive applications

Questions?