Gen-Z Technology: Enabling Memory Centric Architecture
Why Gen-Z?

GROWTH IN THE INTERNET OF THINGS
THE NUMBER OF CONNECTED DEVICES WILL EXCEED 50 BILLION BY 2020

BILLONS OF DEVICES
50
45
40
35
30
25
20
15
10
5
0
1M 0.5B 8.7B 11.2B 18.2B 22.9B 28.4B 42.1B 50.1B

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Why Gen-Z?

- Data created

Zettabytes

- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021
- 2022
- 2023
- 2024
- 2025

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Why Gen-Z?

Businesses’ Need to ‘Monetize’ Data

Worldwide Total Data Revenue by Segment ($M) 2014-2019

Source: 451 Research Market Monitor

Big Data
AI
Machine Learning
Deep Learning
BI
Why Gen-Z?

Need Answers ... FAST!

Value of Analyzed Data

- Businesses demanding real-time insight
- Increasing amounts of data to be analyzed
Challenge: Multiple Memory Types Need Support

Memory Operations

- Processor 1 ns
- SRAM 5 ns
- DRAM 100 ns

Block Operations

- Flash 200,000 ns
- Hard Drive 10,000,000 ns
- Tape 40,000,000,000 ns

• Byte Addressability
• High Bandwidth/Low Latency
• Simple & Efficient Load/Store operations

• Data Protection methods (RAID, EC)
• Device management: Hotplug-ability
• Rich Data Services (ie deduplication, replication, thin provisioning, etc)
Challenge: Memory Bandwidth Per Core Is Shrinking

Pin limitations lead to memory channel limitations that leads to memory bandwidth limitations.
Challenge: We Are Out Of Real Estate & Resources

Power, Cooling, and Physical Limitations
- CPU power consumption is increasing
- DIMM power consumption is increasing
- Number of memory channels is slowly increasing
- Physical size of CPU is increasing
- Physical size of DIMM is increasing
- Speed of Memory Channel is increasing
- Number of Cores in each Socket is increasing
- Dataset Memory Requirements are increasing
Challenge: IO Bandwidth Per Core is Shrinking

Memory Bandwidth: 100 GB/s

HBM Memory Bandwidth: 732+ GB/s

- Cores have limited bandwidth as the number of cores increases
- Bottleneck for heterogeneous compute environment

PCIe Bandwidth per core

- 2012 (8)
- 2013 (12)
- 2014 (18)
- 2016 (22)
- 2017 (28)
- 2019 (~60) (Projected)
What Can Address These Challenges?

A Memory Semantic Fabric!

What is a Memory Semantic Fabric?

• A communication protocol that speaks the same language the CPU speaks: load/store, put/get, and read/write

• Connectivity that extends beyond the server to the rack

Communication at the speed of memory
Gen-Z: A New Data Access Technology

- High Bandwidth, Low Latency
- Packetized Memory Semantic Protocol
- Abstracted Hardware Interface
- Simplify HW/SW Boundary
- Compatible & Economical
- Universal democratized communication
Gen-Z Allows Memory Innovation

Processor

Media Module

Memory Bus

4-8 Memory Channels
17-25 GB/s / Channel
288pins / DIMM
Synchronous Interface
Gen-Z Allows Memory Innovation

Processor

Gen-Z Logic

Gen-Z Memory

Semantic Fabric

Media Module

Media Controller

DRAM

DRAM

DRAM

2-8 High-speed Serial Links
Low Latency, High performance
Split Memory Controller
Asynchronous Interface
Processor is media agnostic
Gen-Z is Media Agnostic & Composable

Gen-Z Fabric

Storage Class Memory

Multiple resources enabled by Universal Interconnect
Gen-Z Creates More Real Estate

- Gen-Z can be used to connect to devices inside and outside the server enabling a composable system
- Gen-Z’s pin efficient interface and ability to multiplex with PCIe pins allows for an overall increase in memory bandwidth
Fully Composable Through Disaggregation Using Gen-Z
Example Gen-Z System with Gen-Z & PCIe® I/O

- Gen-Z systems may contain a mix of Gen-Z I/O components and PCI Express® I/O devices
- **PCIe worked immediately with unmodified OSs by appearing to SW as conventional PCI devices & bridges**
- Gen-Z is using a similar strategy via the concept of **logical PCI devices (LPDs)**
I/O Component Sharing

- With suitable Gen-Z fabric management SW, a single Gen-Z I/O component can be shared among multiple Gen-Z systems.
- Component sharing offers significant availability benefits, e.g., system failover for continued operation and avoidance of stranded resources.
- Each Gen-Z system running an unmodified OS only “sees” LPDs assigned to it by Gen-Z fabric management SW.
- Each Gen-Z system’s BDF space for LPDs is orthogonal to the BDF space in other systems.
- A Gen-Z I/O component designed to be shared by multiple systems must ensure that the virtual device instances do not interfere with each other.
- Gen-Z can deliver the major benefits of PCIe MR-IOV* with less cost & complexity.

*MR-IOV: Multi-Root I/O Virtualization and Sharing
More Gen-Z Benefits

• Gen-Z’s 112GT/s Connector
  ▪ The connector supports vertical, horizontal, right angle and cabled solutions
  ▪ Same connectors for memory, accelerators, I/O, etc.
  ▪ Gen-Z defined the connector and is donating it to SFF

• Leverage High Volume Industry PHYs
  ▪ Derivative of the IEEE 802.3 PHY
  ▪ PCIe PHY
  ▪ Lower development and product costs

• Unmodified OS Support
  ▪ Minimize cost & effort to adopt Gen-Z solutions

• Enables Right Sized Solutions
  ▪ Enables the right amount of compute, memory, storage, acceleration, and networking to be applied to each workload
Open With Broad Industry Support

**GENZ Consortium Members**

- Alpha Data
- AMD
- Amphenol
- ARM
- Avery Design Systems
- Broadcom
- Cadence
- Cavium
- Cray
- Dell EMC
- Everspin
- FIT
- HP Enterprise
- Huawei
- IBM
- IDT
- IntelliProp
- Jabil
- Lenovo
- Lotes
- Luxshare-ICT
- Mellanox
- Mentor Graphics
- Micron
- Microsemi
- Molex
- NetApp
- Nokia
- Numascale
- PLDA Group
- Red Hat
- Samsung
- Seagate
- SK hynix
- Smart Modular
- Spin Transfer Technologies
- TE
- Tyco Electronics
- VMware
- Western Digital
- Xilinx
- Yadro
Gen-Z Summary

- Scalable system interconnect and protocol
- Optimized for memory-semantic communications
- Breaks processor-memory innovation dependency
- Opportunity to simplify software overhead and complexity
- Unmodified OS support
- Common modular connector and mechanical form factors
- Visit the Gen-Z booth, #739, for more information and see the demonstrations
- Attend “Chat with the Experts” tonight to speak with Mike Krause about Gen-Z at the Fabrics Table
- Visit us at genzconsortium.org