The Best Interface for Emerging Memory Technologies

Presented by: Valerie Padilla, Technology Strategist in the Server CTO, Dell EMC
Several key factors are impacting infrastructure architectures:
EXPLOSIVE GROWTH OF DATA

More than 37% of total data generated in 2020 (40 ZB) will have significant business value.

A SOLUTION IS NEEDED

Increasing amounts of data to be analyzed & businesses demand real-time insight.
Infrastructure Maxed Out

Two-socket server architecture is stretched to its limit

- Relentless drive for performance
- Greater core counts
- Processors are more complex than ever
  - DDR data rates & DDR channel counts are increasing
  - DIMMs per channel are decreasing
  - PCIe data rates & lane counts are increasing
  - Storage data rates & lane counts are increasing
- More complex system designs drive up costs

SATA GEN 4
PCIE GEN 5
CCIX
OPENCAPI

SATA GEN 3
SAS GEN 4
PCIE GEN 4
CXL

SATA GEN 2
PCIE GEN 3
SAS GEN 2

NVLINK
NVME
INTER-PROCESSOR LINKS

(future protocols)
Infrastructure Maxed Out

NORMALIZED PROPERTIES OF TYPICAL SERVER PROCESSORS

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<th>IO bandwidth per core</th>
<th>Memory capacity per core</th>
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Additional Challenges

• Infrastructure networks & fabrics have challenges
• Still maintain a wide variety of networks/fabrics
  • Each has its special purposes
• None are designed to support native CPU load/store
  • To support memory/storage convergence
With memory/storage convergence, memory semantic operations become predominant (volatile & non-volatile).
Processor to Memory Centric

Flash Memory Summit 2019 - Santa Clara, CA

8 of 30
A New Data Access Technology

- Media/Compute Agnostic
- Increased Bandwidth
- Low Latency
- Open Innovation
- High Availability
- Security
The Gen-Z Solution

Memory Semantic Fabric
- Open
- High-performance
- Reliable
- Secure
- Flexible
- Compatible
- Economic

Gen-Z (switch-based / any topology)

DRA M SC M DRA M SC M DRA M SC M

SoC FGPA SoC GPU FGPA

Dedicated or shared memory

I/O

NETWORK STORAGE
How Does Gen-Z Help Us?

TRADITIONAL MEMORY BUS

- Media specific logic integrated into SoC
- Tight coupling of SoC & memory technology evolution
- Limits the types of memory that can be supported

TRADITIONAL

- SoC & memory are in generational lock-step
- Limited memory types
How Does Gen-Z Help Us?

**GEN-Z MEMORY INTERCONNECT**
- Media specific logic integrated into memory module
- Independent SoC and memory technology evolution
- Accelerates innovation, enables variety of media support

**GEN-Z**
- SoC & memory evolve freely
- Type & generation independent
How Does Gen-Z Help Us?

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Flash Memory Summit 2019 - Santa Clara, CA
Gen-Z Memory Use Case Example

- Seamlessly augments DDR / HBM solutions
  - Supports unmodified OS, applications, middleware
  - Load-stores transparently translated into read-writes
- Abstracts media to break processor-memory interlock
- Very high bandwidth (16 GT/s to 112 GT/s signaling)
  - Delivers 32 GB/s to 400+ GB/s per memory module
- Supports legacy and new high-capacity form factors
Low Latency Data Access

Low Latency Access to SCM

- Load/Store byte-addressable access to SCM
- Reduced CPU utilization = more workloads per core/CPU

Persistent Memory File System

- Gen-Z utilizes PMFS developed for NVDIMMs
Traffic Management

TRADITIONAL NETWORKS
• Modest traffic prioritization
• Modest multi-path support
• Challenging to mix bulk data and low latency

GEN-Z
• Hardware driven Multi-Link
• Hardware driven Multi-Path
• 32 Virtual Channels (VCs) per link
• 256 byte max packet size
= Industry leading performance
• Any device connected into any topology
• No dedicated memory, I/O, or storage links
• Enables fluid deployments
• Enables construction of “right-sized” infrastructure

Universal System Interconnect

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Industry Leading System RELIABILITY, AVAILABILITY, and SERVICEABILITY

- Multiple links and paths between components with H/W load-balancing, automatic fail-over/fail-back
- Applicable to CPUs, GPUs, FPGAs, DRAM, SCM, storage, etc.
- No OS or software teaming drivers necessary
Gen-Z is Designed to be Secure

ACCESS KEYS
- Link & device partitioning
- Similar to VLANs or Zones
- Enforced by Gen-Z switches

MEMORY REGION KEYS
- Component memory partitioning
- Enables multiple requesters
- Enforced by target component

CRYPTO AUTHENTICATION
- Crypto-signed packets (HMAC)
- Multi-tenant, Gov, Financial
- Enforced by target component

ANTI-REPLAY TAGS
- Prevents "in-the-middle" attacks
- HMAC protected sequence

Dropped packets are reported to fabric management (to identify misconfigurations or malicious attacks)
Unmodified OS Support

Storage Class Memory (SCM)
- SCM driver for block & persistent memory stacks
  - Use Persistent Memory File System developed for NVDIMMs

Benefit from the rich set of Gen-Z features while maintaining compatibility with legacy software.
Logical systems composed of physical components

- Or subparts or subregions of components (e.g. memory/storage)

Logical systems match exact workload requirements

- No stranded resources overprovisioned to workloads

Facilitates data-centric computing via shared memory

- Eliminates data movement: Do more with less, reduces cost

Right-Sized Solutions

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• Vertical, horizontal, right angle, straddle mount
• Same connectors for memory, I/O, storage, etc.
• Cabled solutions: for copper & optical
• Eliminates “hard choices”
  • Universal connector eliminates industry fragmentation
  • Any component, any slot, any time
  • Multi-connector option to provide added scalability
  • Supports internal and external cable applications
  • Multipath—can bifurcate connector into multiple links
  • Supports multiple interconnect technologies
Scalable Resource Enclosures

RESOURCE ENCLOSURES SUPPORT MULTIPLE DRAWERS

- Fixed or hot-plug drawers
- Supports any mix of component types
- Supports memory-centric & data-centric architectures
- Eliminates / reduces need for TOR switches
- Supports multiple interconnect technologies

BENEFITS

- Reduces customer CAPEX / OPEX
- Fully enable / exploit composable infrastructure
- Eliminates stranded media, stranded communication capacity (e.g., no stranded memory channels / I/O links), etc.
- Unlocks solution innovation and agility

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Modular, Scalable Form Factors

Supports any component type

- Memory: Flash, SCM, DRAM, etc.

Single/double-wide: scales in x-y-z directions

- Double-wide fits into pairwise single slots

Flexibility

- Media types, power, performance, thermal, capacity

Consistent, low-cost customer experience

- Similar look and feel as SSD drives
- Agile deployment for right sized solutions
- Leverage all Gen-Z benefits (reliability, no SPOF, etc.)

SCM 68W, x16
Up to 5TB
64 +64 GB/s*

DRAM (~70W, x16)
Up to 280GB**
128 + 128 GB/s*

* Bandwidth calculated using 32 GT/s Signaling
** DRAM module provides 3.5x the highest-capacity DDR5 DIMM

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Memory-Composability

**CURRENT**

- Memory is captive of the host device (processor)
- Can’t scale memory independently of processing
- All accesses must traverse host processor

**GEN-Z**

- Memory and processing scale independently
- Heterogeneous compute & memory deployments
- Direct access to memory devices across fabric
- Memory can be dedicated or shared by processors
- Any topology can be supported
Memory: Freedom of Placement

**GEN-Z ENABLED SYSTEM / CHASSIS**
- DRAM/SCM can be placed wherever storage is placed - utilize existing or new form factors

**GEN-Z ENABLED RACK SCALE**
- DRAM/SCM can be placed anywhere in a rack
- Utilize compute, storage, or new form factors

**GEN-Z ENABLED MOTHERBOARDS**
- DRAM/SCM can be placed anywhere
- Relieves electrical/thermal constraints
# Open: Broad Industry Support

## GENZ Consortium Members

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Resources

Gen-Z demo at our Booth!

View Gen-Z educational materials, membership details and links to related information at www.GenZConsortium.org

Interested in MEMBERSHIP? Have QUESTIONS? EMAIL: admin@genzconsortium.org
THANK YOU