Innovative Chipset Solutions for Accelerating the Data Economy

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Growing waves of innovation & productivity growth

1st Wave 1983
Personal computing

2nd Wave 1995
Internet era

3rd Wave 2007
Mobile era

4th Wave 2011
Cloud era

5th Wave 2018
Data era
Infrastructure must transform to proliferate Data era

Unprecedented demand & growth velocity

Low latency & data volume is decentralizing the Cloud

Driving the need for optimized architectures

5G & Artificial Intelligence will accelerate transformation
What is 5G?

1G
1980s
Analog voice

2G
1990s
Digital/SMS

3G
2000s
Data

4G
2010s
Video streaming

5G
2019+
100X capacity
400X faster
Machine-machine communication
How 5G will disrupt

Real-time speed

- 5G <1ms (real time)
- 4G/LTE = 200ms
- Human reaction = 300ms

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Ultra-high bandwidth

- 5G = 20Gbps
- Stream 400 8K movies at once
- 4G/LTE = 10-20Mbps

Ubiquitous connectivity

- 5G = 1M devices in 1 square km
- 4G/LTE = 1M devices in 500 square km
5G combined with AI will power the Data era

- Factory automation
- Connected transport & smart vehicles
- Industrial IoT & extreme mobile broadband
- Immersive experiences
Impact on Flash storage solutions

New SSD protocol interfaces & form factors

New architectures & business models

Optimized platform solutions

Platform-managed Flash
Key-value Flash
Computational storage
Ethernet Bunch of Flash (EBOF)
Disruptive Flash solutions for the Data era

- NVMe-oF Ethernet SSDs
  - Cloud data center disaggregated storage
  - Enterprise storage systems

- DRAMless m.2230 PCIe Gen4 Form Factor SSDs
  - Distributed Edge computing systems
  - Client computing platforms
NVMe over Fabric Ethernet SSDs
Disruptive NVMe-oF Ethernet SSD architecture

Today's disaggregated SSD storage (JBOF)

- NVMe SSD
- NVMe SSD
- NVMe SSD
- NVMe SSD
- NVMe SSD
- NVMe SSD
- NVMe SSD
- NVMe SSD

Limited performance, high CPU power & high BOM

End-to-end NVMe-oF Ethernet Bunch of Flash (EBOF)

- NVMe-oF Ethernet SSD
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Simple native scalable performance with extremely lower power consumption

>65%* TCO savings excluding SSDs

*Toshiba & Marvell TCO analysis
NVMe-oF Ethernet SSD & EBOF architecture update #1
Industry’s 1st 2.5” in-form factor NVMe-oF Ethernet SSD

2018 Flash Memory Summit

- Industry’s 1st NVMe-oF SSD Converter Controller
- Dual-ported 25GE to PCIe Gen3x4
- <1.5W operating power
- up to random 700kIOPs
- 13mm x 13mm package
- Toshiba Memory, Aupera & Marvell demo >14M IOPS EBOF

2019 Flash Memory Summit

- Industry's 1st 2.5” In-Form Factor NVMe-oF Ethernet SSD
- Embeds Marvell’s NVMe-oF SSD Converter Controller
- Toshiba Memory, Aupera & Marvell demo >15.5M IOPS EBOF
- Live at Toshiba Memory FMS booth #307
- Live at Marvell FMS booth #511
NVMe-oF Ethernet SSD & EBOF architecture update #2
Industry’s 1st 2.5” NVMe-oF Ethernet SSD controller

2018
Flash Memory Summit

Industry’s 1st NVMe-oF SSD Converter Controller
Dual-ported 25GE to PCIe Gen3x4
<1.5W operating power
13mm x 13mm package
88SS1098 Data Center PCIe Gen3x4 SSD controller
Up to 700 kIOPs
17mm x 17mm package
2-chip SSD solution

2019
Flash Memory Summit

Industry’s 1st Native NVMe-oF Ethernet SSD Controller
Dual-ported 25GE to eight 800MT/s NAND channels
<5W operating power
Up to random 700kIOPs
21mm x 21mm package
Single chip SSD solution
Enabling in-form factor 2.5" NVMe-oF Ethernet SSDs

- Dual-ported 25GE Ethernet
- SFF-8639 / 9639 connector with Ethernet pinout
- Up to 8TB capacity
- Up to random 700kIOPs
- Live at Marvell FMS booth #511
NVMe-oF Ethernet SSD & EBOF architecture update #3
Industry’s 1st Storage Aware Flow Engine (SAFE) Ethernet switches

2018
Flash Memory Summit

Prestera® CX 84xx
1.8Tb/s Ethernet Switch Family
10GE, 25GE & 100GE
Multiple configurations & packages

2019
Open Compute Summit

Prestera® CX 85xx
2Tb/s to 12.8 Tb/s Ethernet Switch Family
25GE, 50GE, 100GE & 400GE
Multiple configurations & packages

Industry’s 1st Switches supporting Storage Aware Flow Engine (SAFE) IP
End-to-end NVMe-oF EBOF chipset architecture solution

ThunderX2® ARM Servers & FastLinQ® NVMe-oF NICs

Ethernet Bunch of Flash (EBOF) with redundancy

Enabling optimal disaggregated data center flash storage
DRAMless m.2230 Form Factor PCIe Gen4 SSDs
Why m.2230 form factor for edge & client computing SSDs?

- **62.5% space savings**
- **Lowers power by >30%* with DRAM eliminated**
- Capacities up to 1TB** on a single side
- Comparable high sequential & random performance*

* Controller & NAND configuration dependent
** Assumes 1Tb DDR-1200MT/s NAND Package
How? Capitalizing on three NAND component trends

- NAND Die Capacity: 2015: 128Gb, 2019: 512Gb, Up 4x
- NAND Interface Speed: 2015: 533 MT/s, 2019: 1200 MT/s, Up >2.25x
- NAND Die Planes: 2015: 1 plane, 2019: 4 planes, Up 4x

= Reduced NAND Dies per Equivalent SSD: 2015: 16 dies, 2019: 4 dies, 75% reduction

Mainstream <1TB SSDs will no longer require larger & higher-power 8 channel SSD controllers
Introducing the industry’s 1st 12nm PCIe Gen4 NVMe DRAMless 4CH SSD controllers

- PCIe Gen4x4 & PCIe Gen4x2
- Four 1200MT/s NAND channels
- Less than 2W* of dissipated power
- Up to 3.9GB/s sequential performance
- Up to 500kIOPS of random performance
- Ultra small 8mm x 11mm package

* Actual power may vary on multiple parameters including temperature, SSD configuration & workload usage
Summary

• 5G & AI will proliferate Data era & require new Flash solutions
• EBOF is optimal flash storage disaggregation architecture
• Ethernet SSDs are here today: Toshiba Memory & Marvell demo
• m.2230 DRAMless SSDs optimal for edge & client computing
• Industry’s 1st 12nm PCIe Gen4 DRAMless controllers available now

Visit Marvell FMS booth #511 for latest EBOF & Flash innovations
Visit Toshiba Memory booth #307 for industry’s 1st 2.5” NVMe-oF Ethernet SSD