Chelsio Webinar: T7 DPU Storage Applications and Use Cases

Discussion Agenda and Introductions

Opening Remarks

Chelsio T7 Unified Wire data processing units (DPUs) optimally accelerate a variety of data-centric applications such as networking and security protocols supporting a wide range of network storage workloads. In this webinar, you'll learn about Industry trends, storage and server I/O application and use cases, Data Processing Units (DPU) and Chelsio T6 and T7 storage I/O offload capabilities, along with performance proof points.

Introductions

- Greg Schulz – Independent Industry Analyst, Author, Consultant, Founder Server StorageIO™
- Bob Dugan – Director of Engineering at Chelsio Communications

Brief Presentation and Perspectives

- Industry and Data Center Trends "Big Picture, Setting the Stage" – Greg Schulz
- Chelsio Perspectives Presentation – Bob Dugan

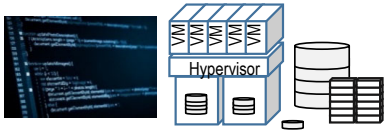
Panel and Audience Q&A Discussion, Wrap-up

Industry Trends – The Big Picture Challenges and Opportunities

No such thing as a data or information recession, there are budget & other considerations…

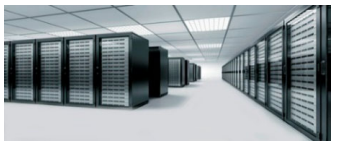
- Budget and energy constraints at odds with demand growth

  More apps and data being captured, processed, stored, moved from mobile and IoT, to edge to core across on-prem and cloud hybrid. Growth driving demand for more compute, I/O networking, and storage hardware (also software).



- Hardware needs software, software needs hardware

  Software stacks are becoming more robust using more compute cycles on servers. Software functionality location and packaging transitions from software running on general purpose CPU (including ARM) to offloads (GPU, DPU, xPU, etc.).

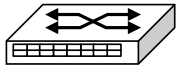


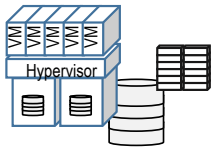
- Technology improvements (HW, SW, Packaging)

  Smaller footprints, more processing & capacity (memory, storage), higher bandwidth, less overhead, lower latency, expand from efficiency focus to also effectiveness. Flexible packaging options, enhanced media/mediums, protocols, speeds and feeds.

Industry Trends – The Big Picture: Demand Drivers & Technology Enablers

Where Demand Drivers and Technology Evolution Meet = Enabling Solutions





Demand Drivers	Solutions Need To Be Flexible, Scalable Adaptable with Good PACE Characteristics	Technology Evolution
Use Case, App & Data Growth		Storage Architectures
Improved PACE characteristics		Server Storage IO Protocols
Various Deployment Locations		Storage & Device Packaging
Budget & Cost Considerations		PACE & F(x) Improvements

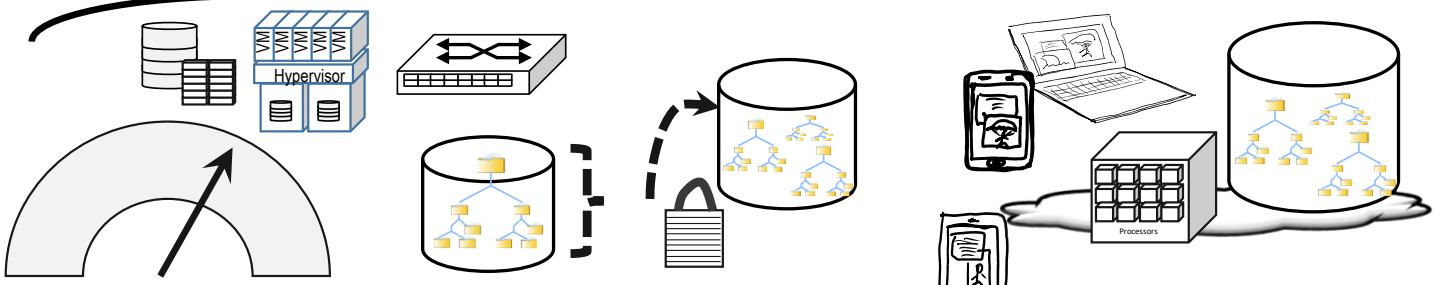
PACE = Performance Availability Capacity Economics including security, energy effectiveness and management

F(x) = Functionality such as offloads, security, encryption, RAID/Parity, data footprint reduction (dedupe, compress, etc.)

Industry Trends – All Application Workloads Have PACE Attributes

PACE attributes vary by workload characteristics requiring different resources

Application Workloads Resource Needs



Performance

Activity rates
(IOP, TPS, Get, API calls)
Data movement
(Bandwidth, Throughput)
Latency, Response

Availability

Data Protection
Backup/Restore
Archive, HA, BR
BC, DR, Security
Durability

Capacity

Resources
CPU, Memory, I/O
Storage, Network
Ports, Services
Software Licenses

Economics

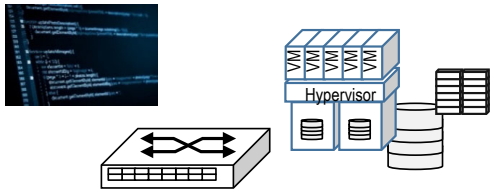
Buy, Lease, Rent, Subscribe
Upfront, Recurring
Capex, Opex, Facilities
HW, SW, Services
Management

PACE = Performance Availability Capacity Economics including security, energy effectiveness and management
F(x) = Functionality such as offloads, security, encryption, RAID/Parity, data footprint reduction (dedupe, compress, etc.)

Source: Software-Defined Data Infrastructure Essentials (CRC)

Industry Trends – The Big Picture: Need For Flexible, Scalable Solutions

Demand Drivers that need flexible, scalable Server, Storage, IO Networking Solutions



Demand Drivers
Use Case, App & Data Growth
Improved PACE characteristics
Various Deployment Locations
Budget & Cost Considerations

No Such Thing As An Data or Information Recession

IoT, AI/ML, Video, Security, Analytics, M&E, Web

Need for Speed, Space, Savings, Scalability

Local, Remote, Mobile, Edge, Core (On-Prem & Cloud)

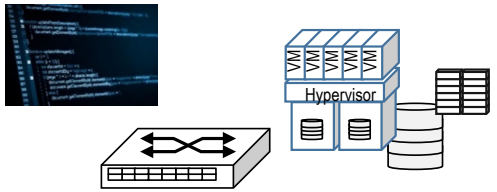
Good PACE characteristics, Cost Effective & Productive

PACE = Performance Availability Capacity Economics including security, energy effectiveness and management

F(x) = Functionality such as offloads, security, encryption, RAID/Parity, data footprint reduction (dedupe, compress, etc.)

Industry Trends – The Big Picture: Enabling Technologies For Solutions

Enabling Technologies evolving to support Server, Storage, IO Networking Solutions



On-Prem, Public, Private, Hybrid Cloud

SW Defined, CI, HCI, Aggregated, Disaggregated

PCIe, Ethernet, NVMe, NVMe over Fabrics/TCP

HDD, SSD/Flash, U.2, M.2, E1, JBOD/JBOF

Good PACE characteristics, BM, VM, Containers

- Technology Evolution
- Storage Architectures
- Server Storage IO Protocols
- Storage & Device Packaging
- PACE & F(x) Improvements

PACE = Performance Availability Capacity Economics including security, energy effectiveness and management

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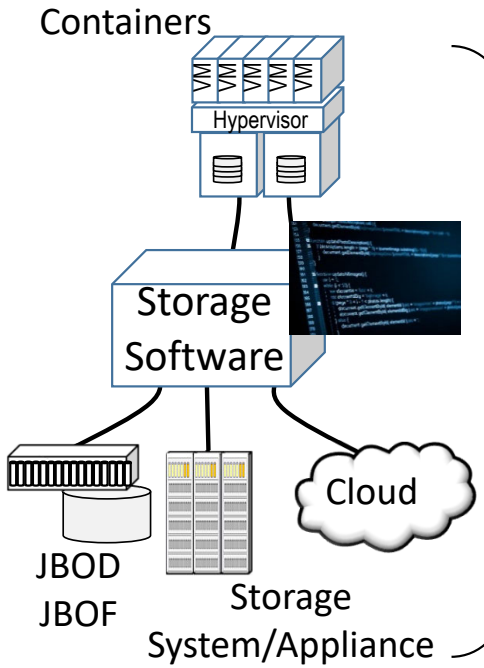
Industry Trends – Storage Solution Architecture Characteristics

Storage Software and Functionality, Personality, Protocols packaged in various ways



Data Services and Storage Functionality

Access and interface
Metadata and monitor
Data services and PACE
Roles, Personalities
Reporting and analytics
Device management
Device Drivers, Plugins
Data & Control Planes
East/West & North/South

Block	File	Object
iSCSI, FCP, NBD	POSIX, NFS, pNFS	S3, Swift, ODBC
SAS, NVMe	CIFS/SMB, HDFS, FUSE	Key Value, API

Storage System Functionality (Personality)
PACE, Name space and end-pint management
Optional data services, tiering, cache, gateway
Access, device emulation, protocol implementation
Management, Automation, monitoring, security
In-band, Out-of-band, **Offloads (GPU, DPU, xPU)**

Block	File	Blob/Object, API, Services
SAS, SATA, PCIe	SMB/CIFS	S3 and others
NVMe/NVMeoF/TCP	NFS, HDFS	Replication/Mirror
FC/FCP, IB/SRP, IP/iSCSI		

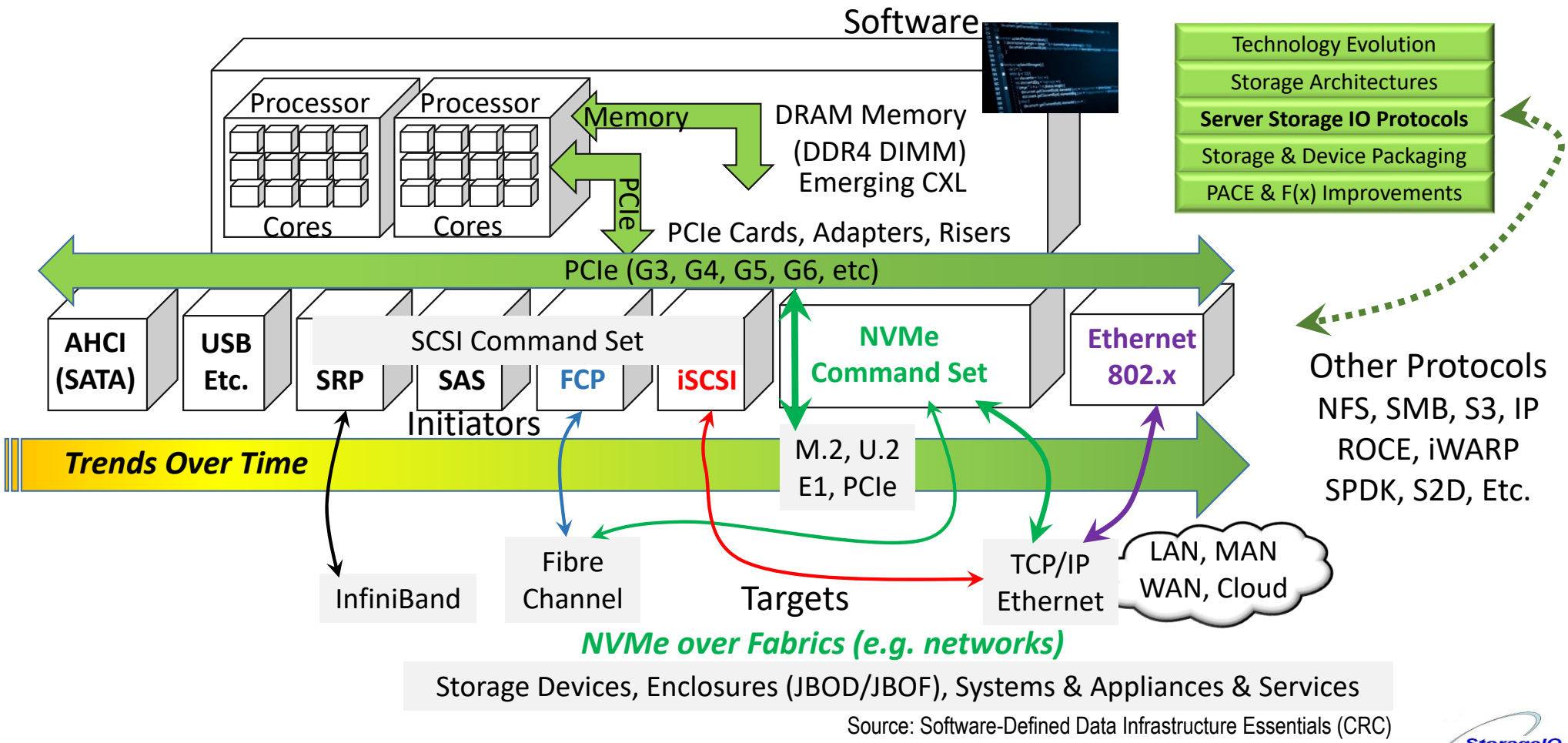
Common Denominator Ethernet & TCP

Storage is Packaged, Presented, Consumed various ways
PM / CM / VSA / Container / Guest / AI / ML / Analytics
Plugins, Apps, F(x), guests/containers/vm, tiggers vs. polling

Source: Software-Defined Data Infrastructure Essentials (CRC)

Industry Trends – Networking With Your Servers and Storage (and enclosures)

SAN LAN & Fabrics, MAN and WAN – IO Networks, Interfaces and Protocols



Source: Software-Defined Data Infrastructure Essentials (CRC)

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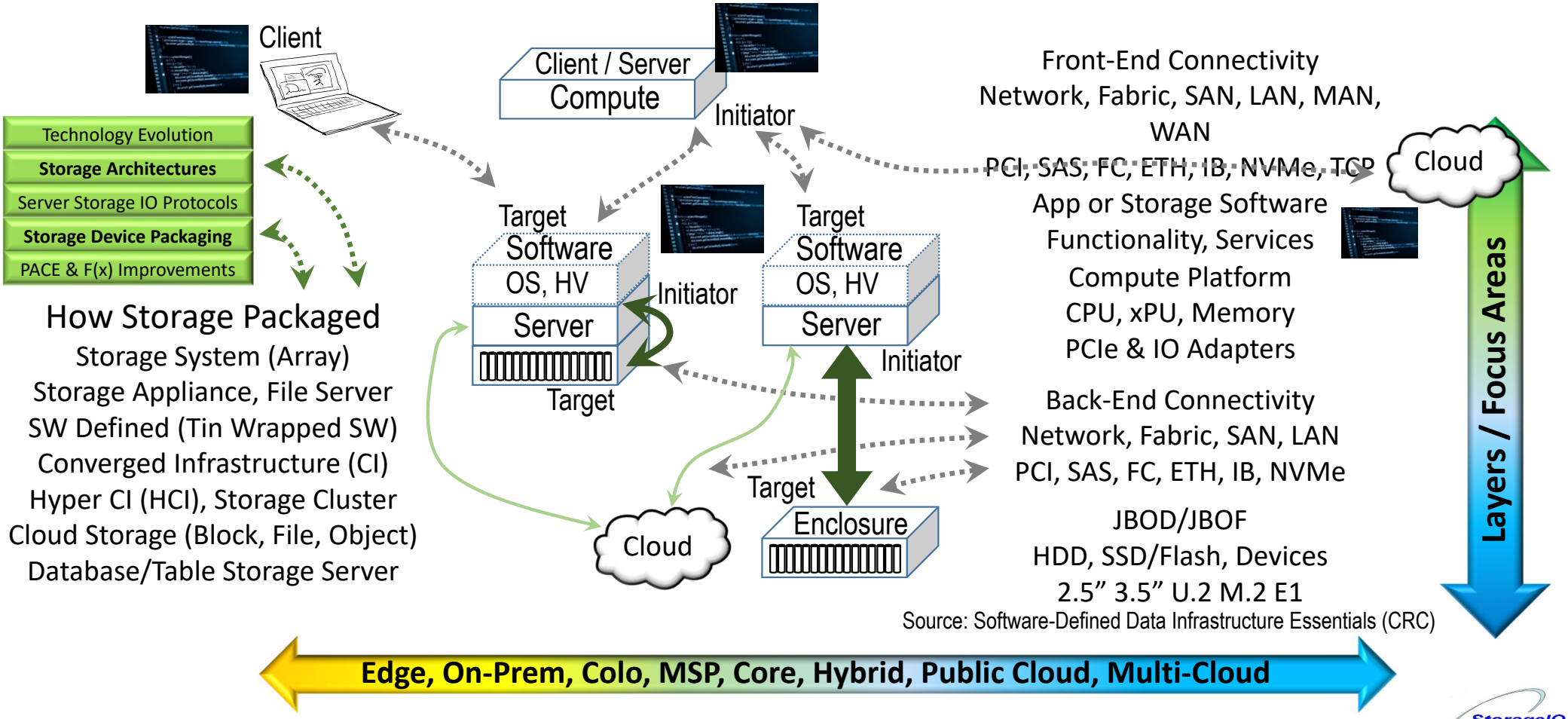


Source: Software-Defined Data Infrastructure Essentials (CRC)

Chelsio T6 and T7 Presentation Discussion

Bob Dugan – Chelsio Communications

Chelsio T6/T7 Storage Applications and Uses

A Webinar

Agenda

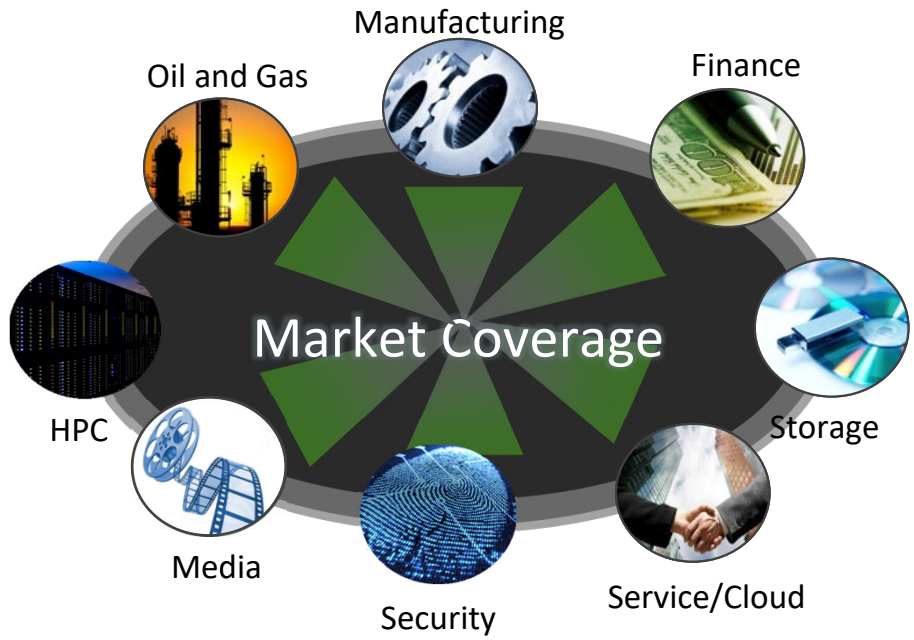
- Company Overview
- T6 SmartNIC Overview
- T6 Storage Performance Benchmarking
- T7 DPU Overview
- Q&A and General Discussion

Chelsio Company Overview

Chelsio Corporate Snapshot

Leader in High Speed Converged Ethernet Adapters

- Leading Ethernet Adapter and silicon vendor
  - Millions of ports shipped
- Specialize in offloading software onto silicon, thus enabling cheaper CPU's, higher performance, lower power, fabric convergence
- Feature rich, scalable, flexible solution
- Recent industry trends driving the need for Chelsio's technology
- Focused on storage and data centers. Moving into servers and storage array markets.
- Design centers in Sunnyvale and India



Leading Smart NIC Architecture

Converged Network Architecture with all-in-one Adapter and Software

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Networking

- ✓ 10/25/40/50/100 GbE speeds
- ✓ Full Protocol Offload
- ✓ Data Center Bridging
- ✓ Hardware Firewall
- ✓ Wire Analytics
- ✓ DPDK/Netmap

Storage

- ✓ NVMe/Fabrics
- ✓ SMB Direct
- ✓ iSCSI and FCoE with T10-DIX
- ✓ iSER and NFS over RDMA
- ✓ pNFS (NFS 4.1) and Lustre
- ✓ NAS Offload
- ✓ Diskless boot
- ✓ Replication and failover

Virtualization

- ✓ Hypervisor offload
- ✓ SR-IOV with embedded VEB
- ✓ VEPA, VN-TAGs
- ✓ VXLAN/NVGRE
- ✓ NFV and SDN
- ✓ OpenStack storage
- ✓ Hadoop RDMA

Media Streaming

- ✓ Traffic Management
- ✓ Video segmentation Offload
- ✓ Large stream capacity

HPC

- ✓ iWARP RDMA over Ethernet
- ✓ GPUDirect RDMA
- ✓ Lustre RDMA
- ✓ pNFS (NFS 4.1)
- ✓ OpenMPI & MVAPICH

HFT

- ✓ WireDirect Technology
- ✓ Ultra low latency
- ✓ Highest messages/sec
- ✓ Wire rate classification

Encryption

- ✓ IPsec/TLS/SSL Offload
- ✓ SMB Direct AES Offload

Chelsio Unified Adapter
10/25/40/50/100 GbE

Single Qualification – Single SKU, Single FW
Concurrent Multi-Protocol Operation

T6 SmartNIC Overview

T6 Architecture

High-Performance Purpose-Built Protocol Processor

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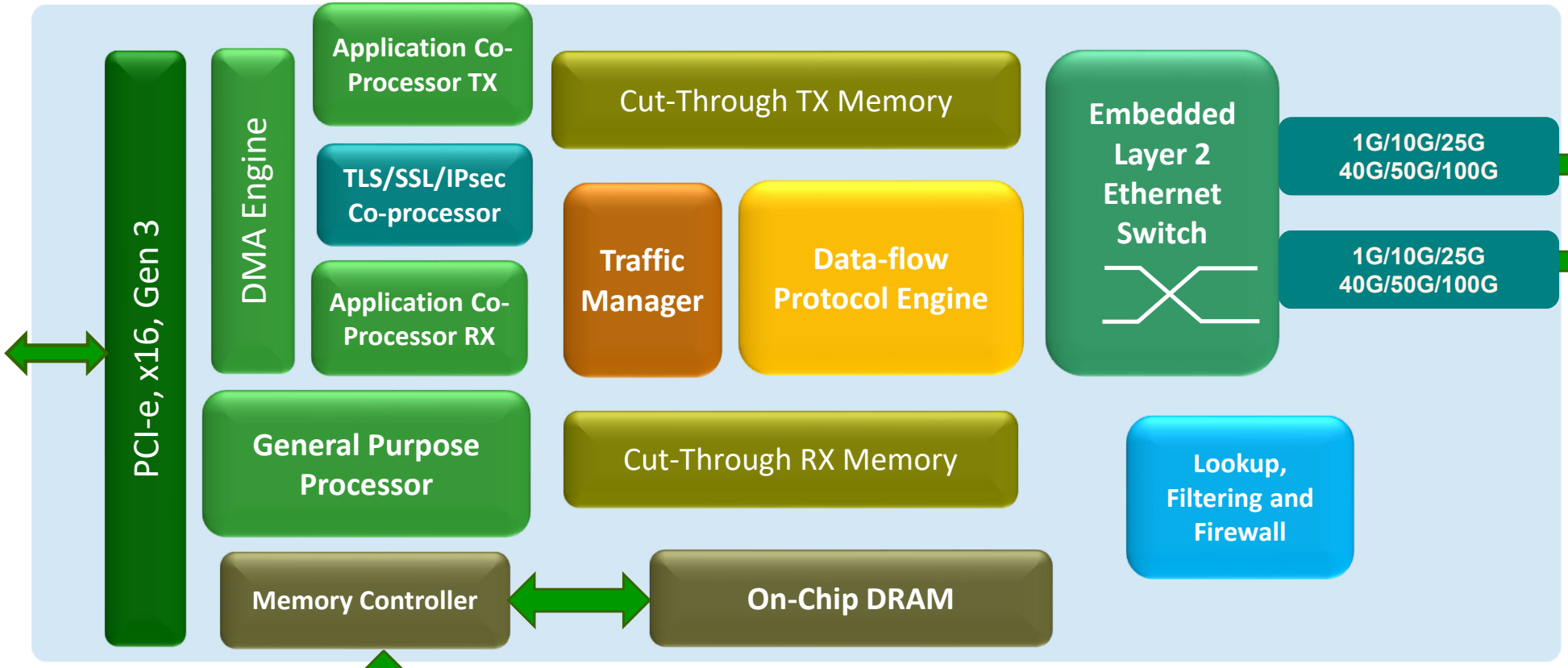
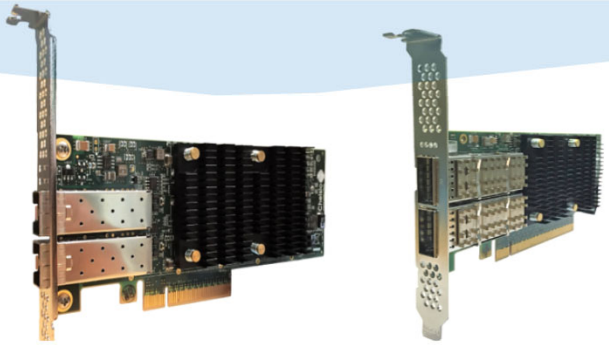




- Single processor data-flow pipelined architecture
- Up to 1M connections
- Concurrent Multi-Protocol Operation

Single connection at 100Gb. Low Latency.

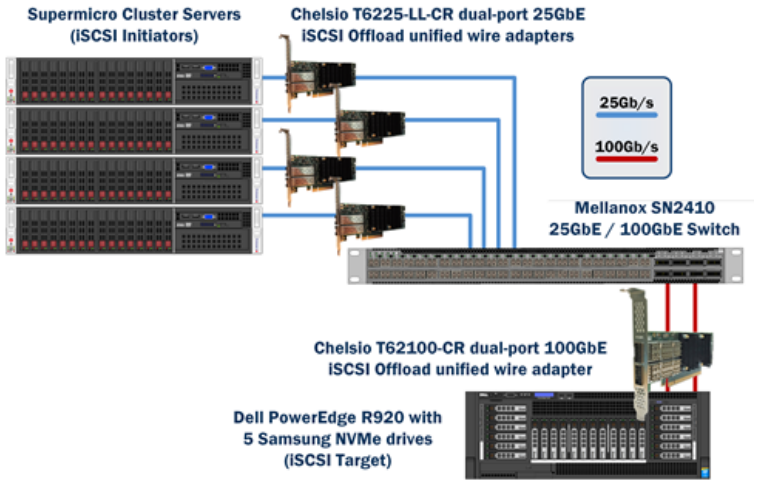
T6 Software Offering

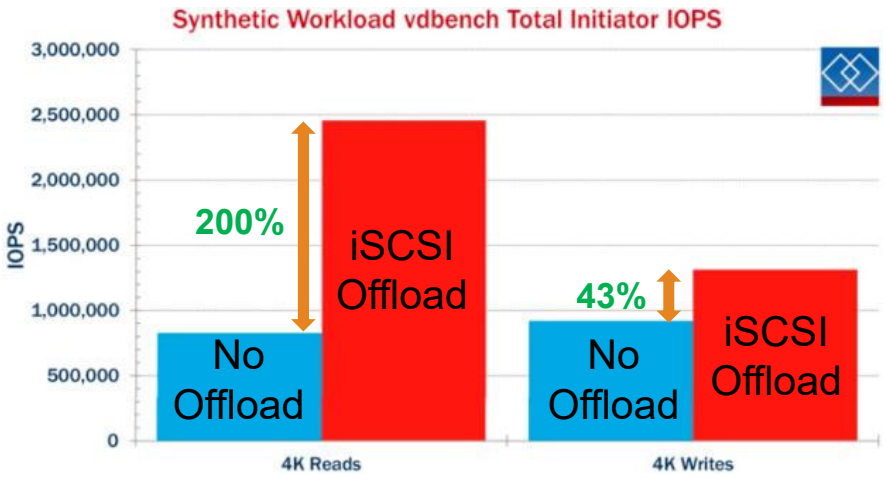
Operating System	OS Version	Package	Where to download?
Linux	RHEL/Rocky Linux 9.0/8.6, RHEL7.9, Ubuntu 22.04.1/20.04.5, Debian 11.5, K.org 5.15.79/5.10.155, RHEL7.6/ 7.4 P8, RHEL 7.6 ARM	Chelsio Unified Wire v3.17.0.1	GA Page
	K.org, RHEL, SLES, Ubuntu	Inbox	Distro Websites
Windows	Server 2022/2019/2016, Client 11/10	Chelsio Unified Wire v6.16.1.0_WIN_006.0.93	MS Download Page
	Server 2022/2019/2016, Client 11/10	Windows Update	Windows Update Website
FreeBSD	13.1/12.3	Inbox	FreeBSD.org
Solaris	Illumos	Inbox	Illumos.org
ESXi	7.0 6.7	Chelsio Unified Wire v5.3.0.20/v5.3.0.25	GA Page Beta Page
MAC OS X	10.15 10.14 - 10.11	Chelsio Network Driver v1.24.5b0/v1.23.4b2	GA Page
Boot		Chelsio Unified Boot v2.1.0.0 Chelsio PXE Boot v2.1.0.0	GA Page

iSCSI Benchmarks

A Comparison With and Without Offload

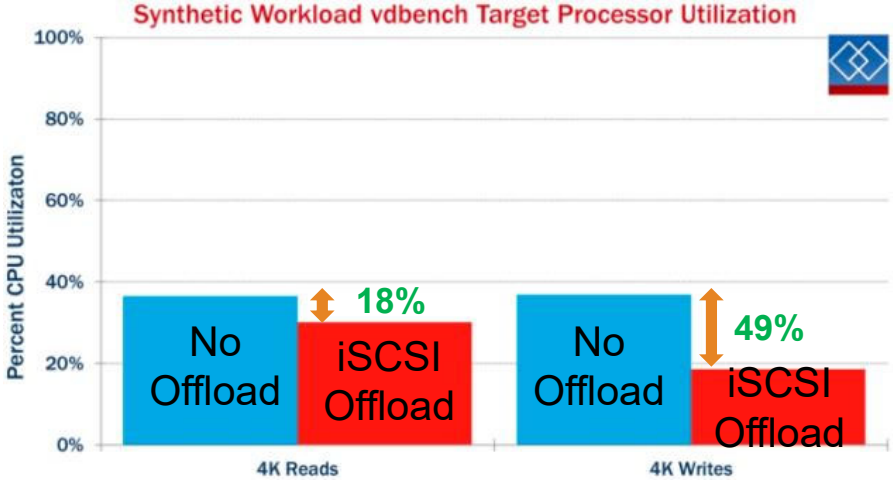
iSCSI Target Performance with T6 Offload Versus w/o Offload[1]





IOPS Increase

- 200% on 4K Reads
- 43% on 4K Writes



% CPU Utilization Reduction

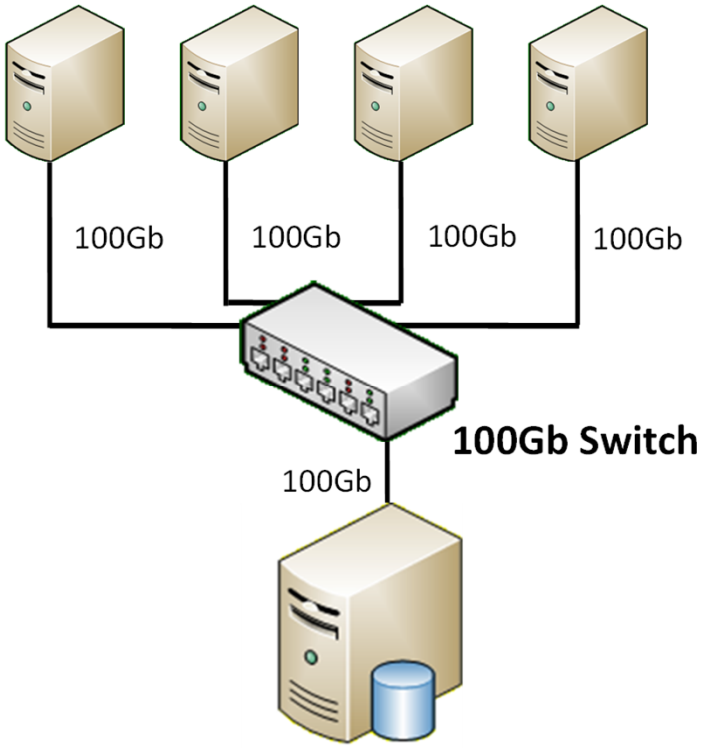
- 18% on 4K Reads
- 49% on 4K Writes

[1] Evaluation of Chelsio Terminator 6 (T6) Unified Wire Adapter iSCSI Offload (Principled Technologies)

T6/FADU Storage NVME/TCP & NVMe-oF Performance Benchmarking

A Comparison With and Without Offload

BW & IOPs, %CPU Test Configuration

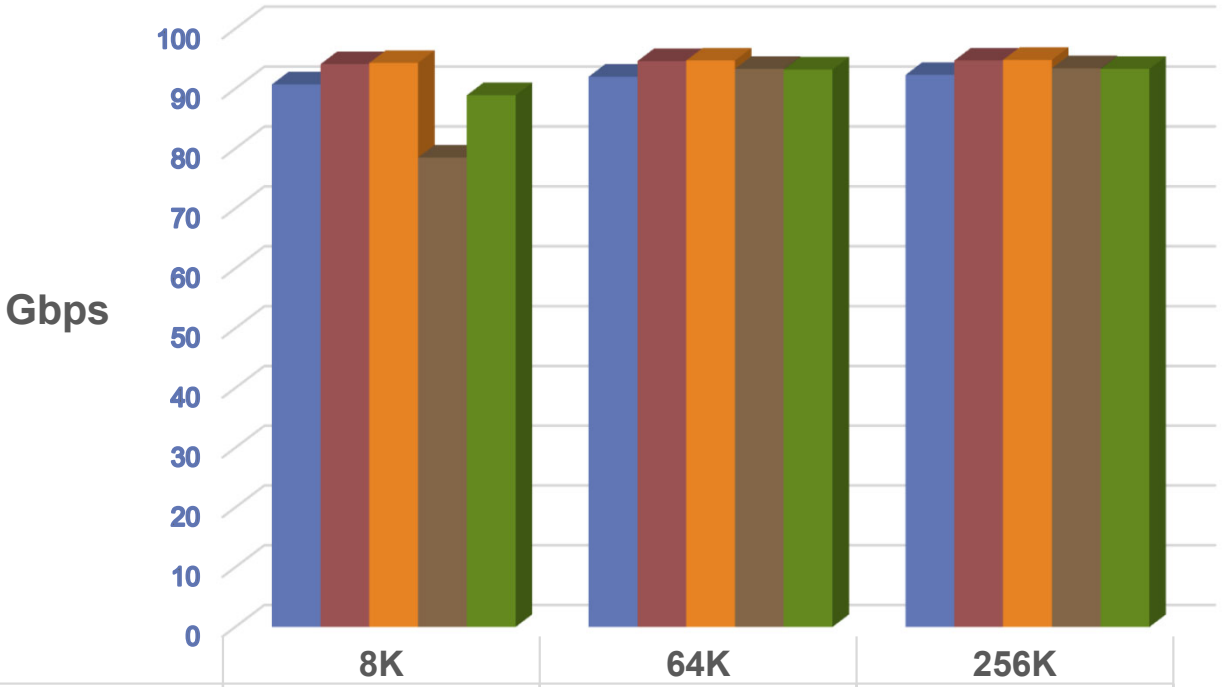


- Supermicro X10DRH hosts/initiators
- 2 Intel Xeon CPUs E5-2650 v3 10-core @ 2.30 GHz (HT disabled)
- 128 GB RAM
- RHEL 8.5
- T62100-CR adapter

- Supermicro X12DPi-N6 Target with 2 FADU Delta U.2 3.84 TB SSDs
- 2 Intel Xeon Silver CPUs 4310 12-core @ 2.10 GHz (HT disabled)
- 128 GB RAM
- RHEL 8.5
- T62100-CR adapter

- FIO tool is used for Random READ IOs
- iWARP offloaded with T6 adapters in all systems
- For more information, please refer to: https://www.chelsio.com/wp-content/uploads/resources/t6-100g-jbof-fadu.pdf

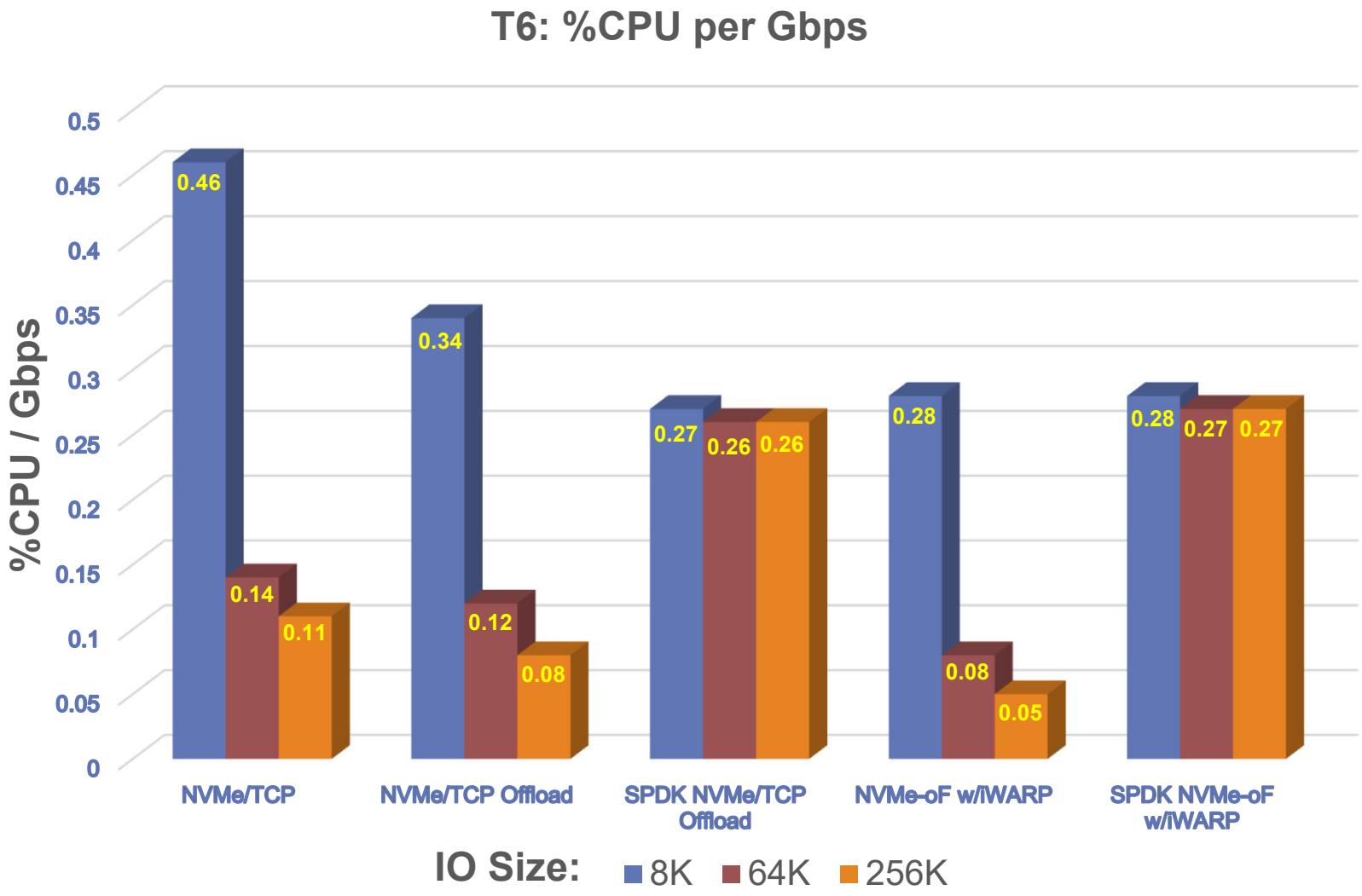
Storage Protocols: Bandwidth



	8K	64K	256K
NVMe/TCP	90.7	92	92.3
NVMe/TCP Offload	94.1	94.6	94.7
SPDK NVMe/TCP Offload	94.3	94.7	94.8
NVMe-oF w/iWARP	78.5	93.3	93.4
SPDK NVMe-oF w/iWARP	88.9	93.2	93.3

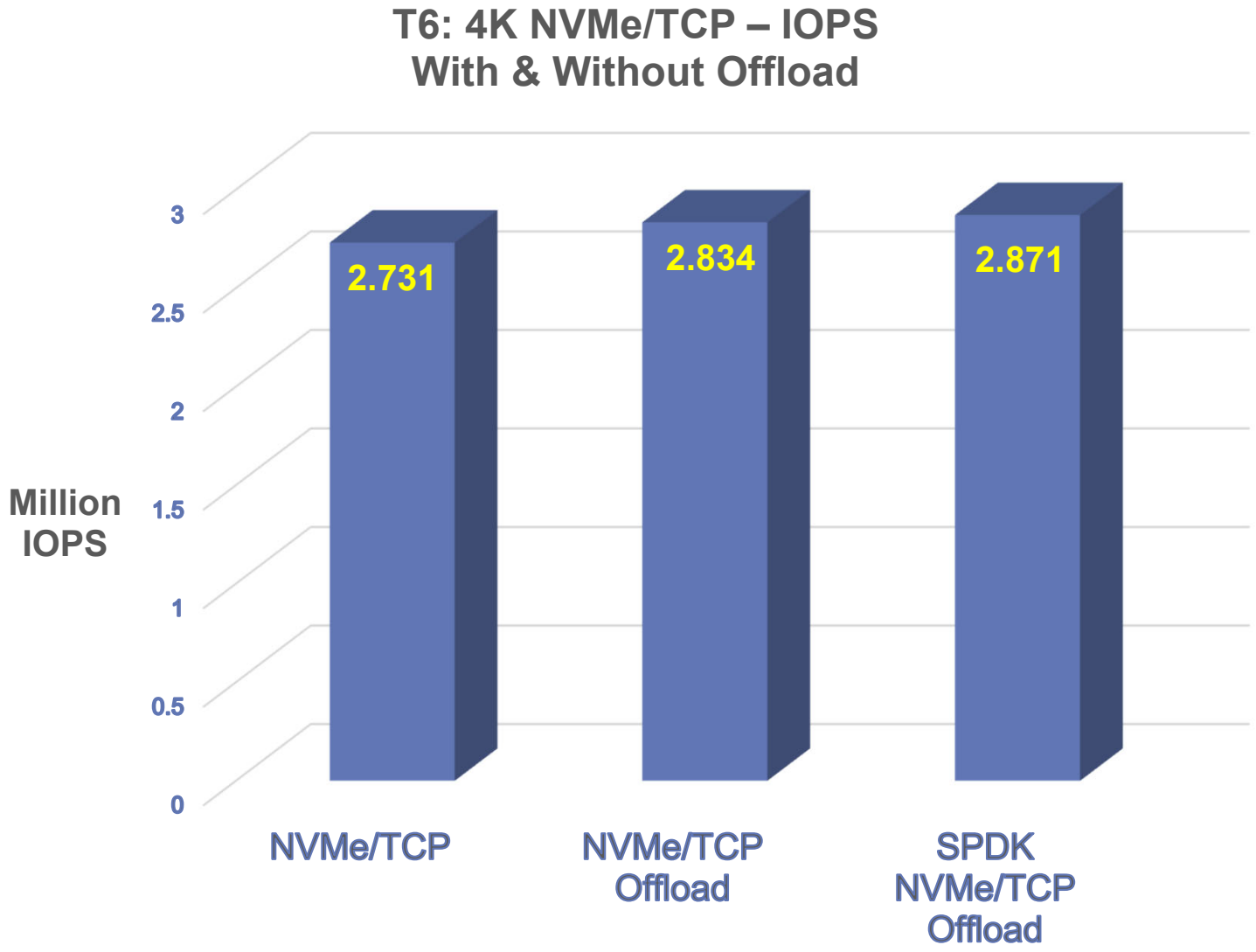
- T6 delivers line-rate READs using FADU's NVMe SSD solution

Storage Protocols: %CPU per Gbps



- T6 Offload saves up to 41% CPU @ 8K IO size compared to SW based NVMe/TCP

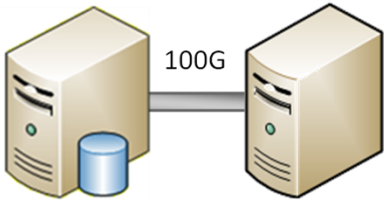
NVMe/TCP 4K Random READ IOPs



- T6 SPDK NVMe/TCP Offload delivers 2.87M random READ IOPs at 4K IO Size.

Latency Test Configuration

- Supermicro X12DPi-N6 Target with 1 FADU Delta U.2 3.84 TB SSD
- 2 Intel Xeon Silver CPUs 4310 12-core @ 2.10 GHz (HT disabled)
- 128 GB RAM
- RHEL 8.5
- T62100-CR



- Supermicro X10DRH host/Initiator
- 2 Intel Xeon CPUs E5-2650 v3 10-core @ 2.30 GHz (HT disabled)
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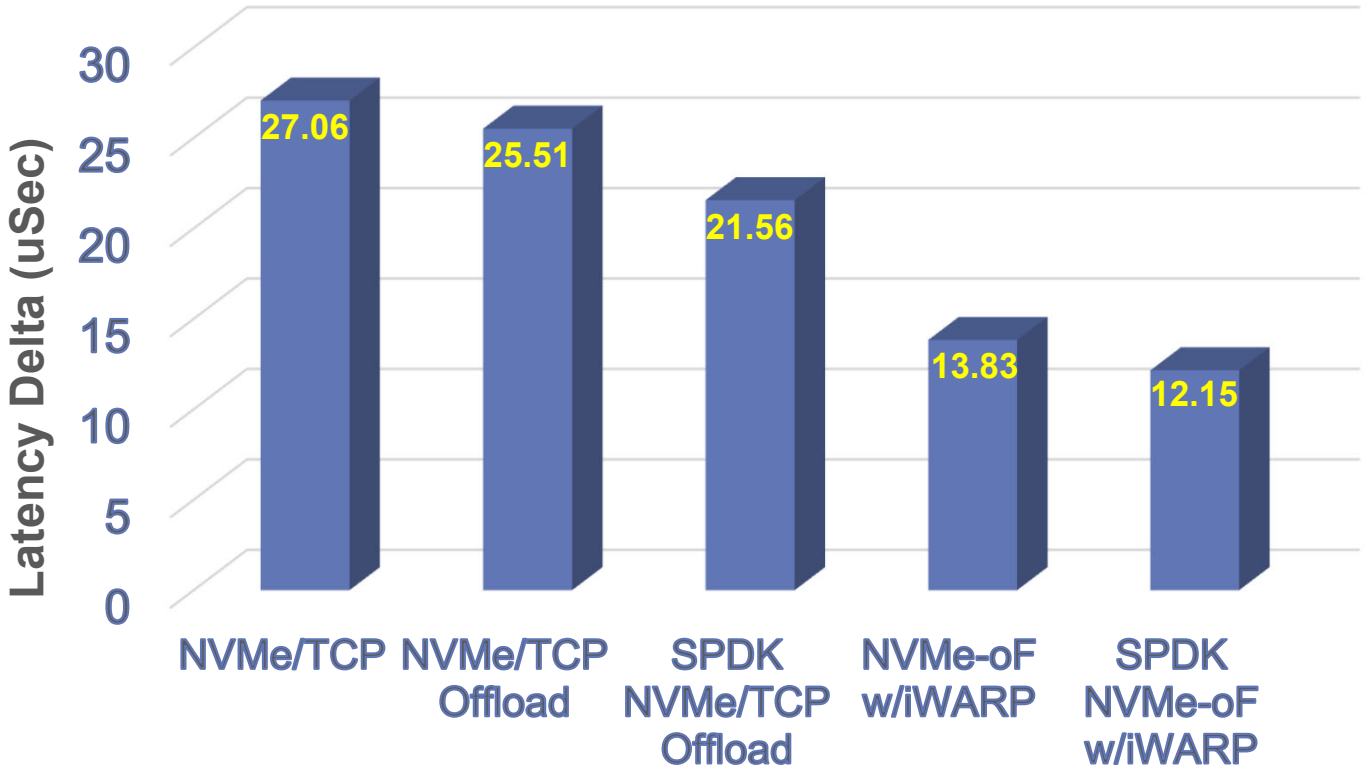
T6: 4K Random Read Latency Delta



- Delta latency shown above is the difference between the measured local drive latency on the target and the measured latency from the remote initiator

NVMe/TCP SW Stack vs T6 Offloads Performance Highlights

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	Throughput	Latency Advantage	CPU Utilization Advantage	Comments
NVMe/TCP Offload	Line Rate	Up to 6%	Up to 26%	Initiator & Target NICs can be different
NVMe/TCP SPDK Offload	Line Rate	Up to 20%	Up to 41%	CPU utilization advantage erased on larger IOs
NVMe-oF Offload	Line Rate	Up to 49%	Up to 39%	Requires R-NIC on both Initiator & Target
NVMe-oF SPDK Offload	Line Rate	Up to 55%	Up to 39%	CPU utilization advantage erased on larger IOs

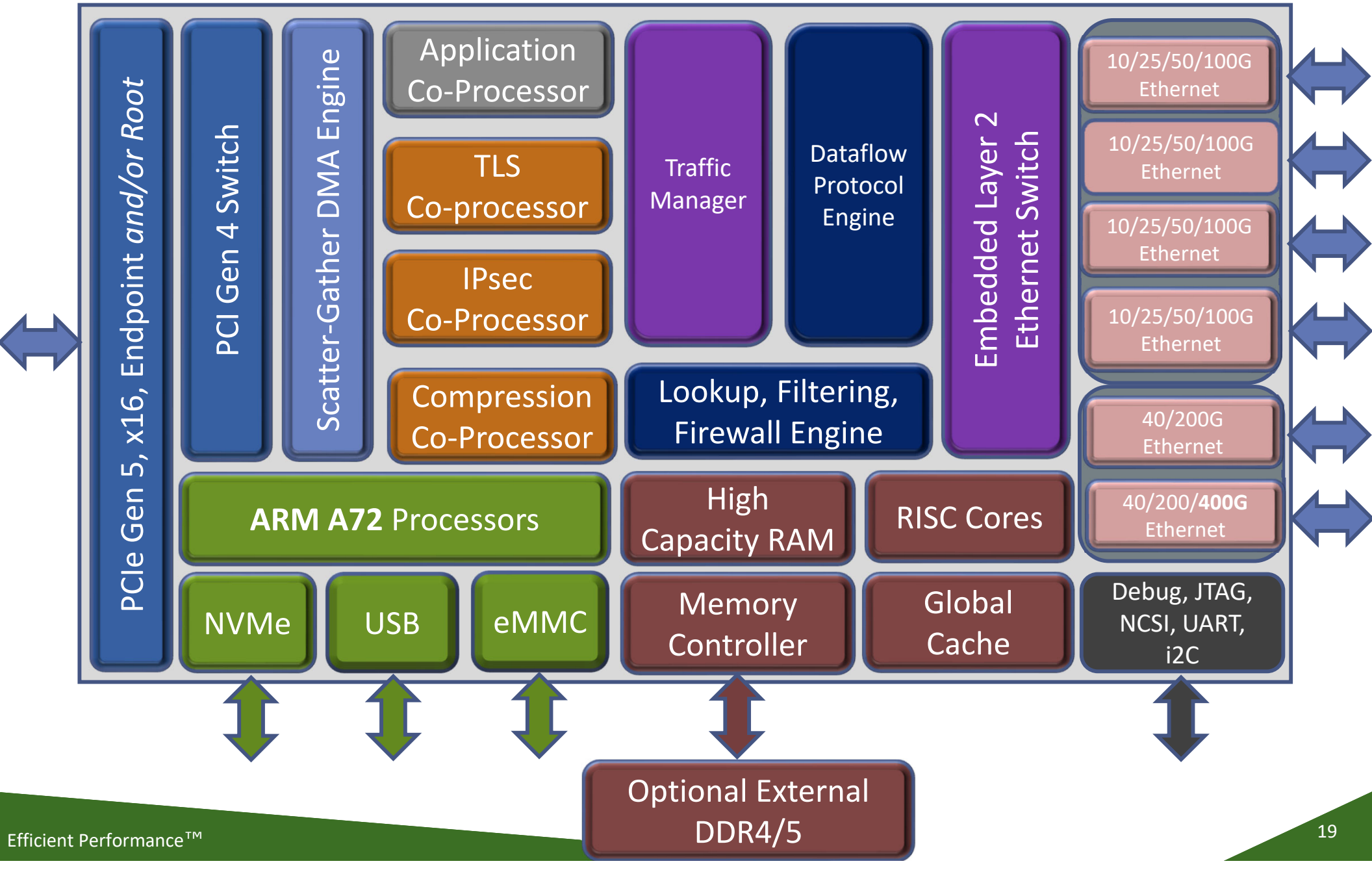
Offload Summary

- Delivers line-rate 94 Gbps READ throughput at significantly lower latency
- Reaches 2.9 Million IOPs at 4K I/O size
- Provides local-like access to remote storage
- Provides significant CPU savings compared to non-offloaded NVMe/TCP

T7 DPU Overview

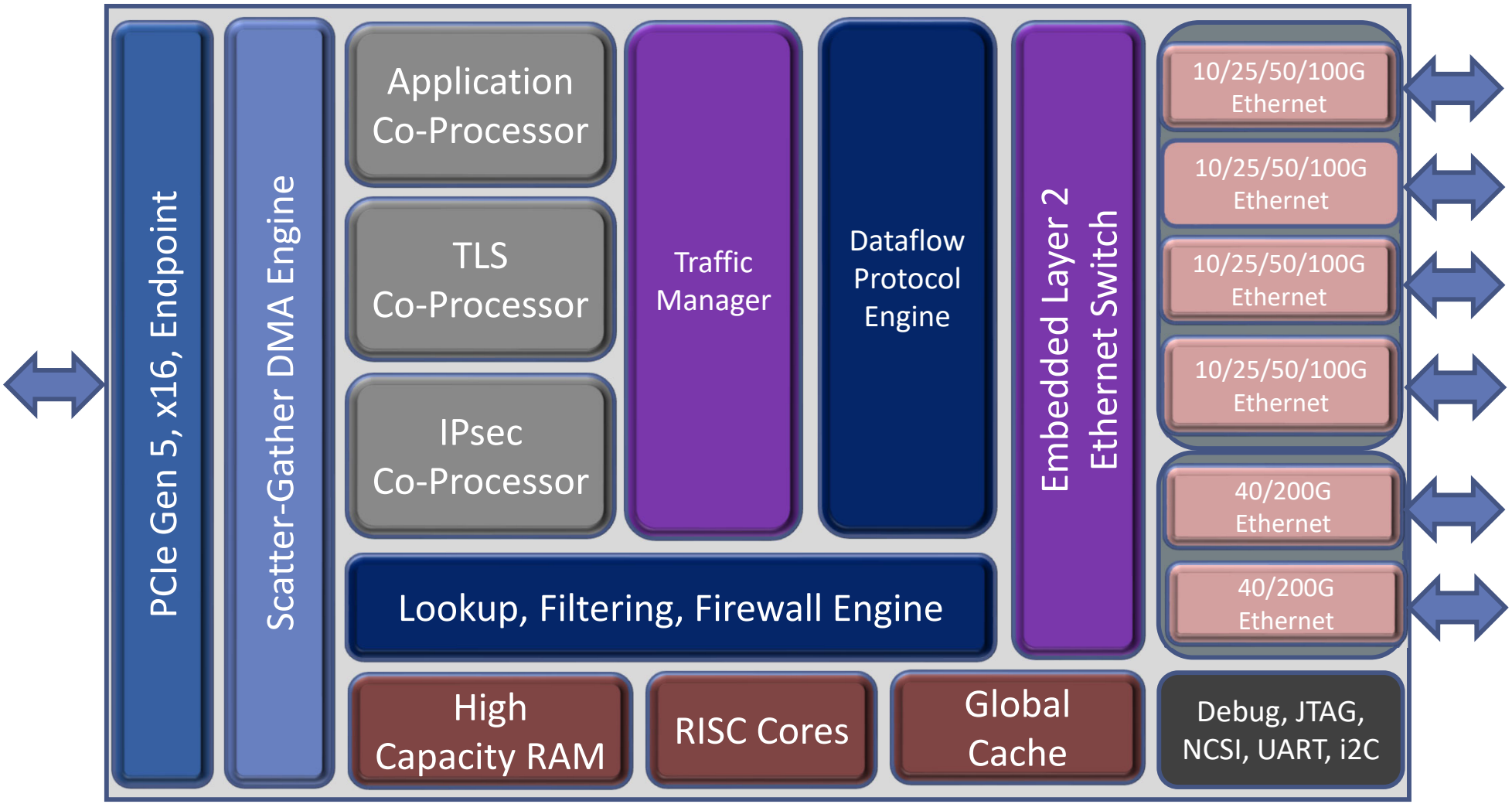
T7 DPU Block Diagram

High-Performance Purpose-Built Protocol Processor



S7 DPU Block Diagram

High-Performance Single Chip Protocol Processor



Single chip, mem-free, 200Gb smart-NIC

Sample Applications

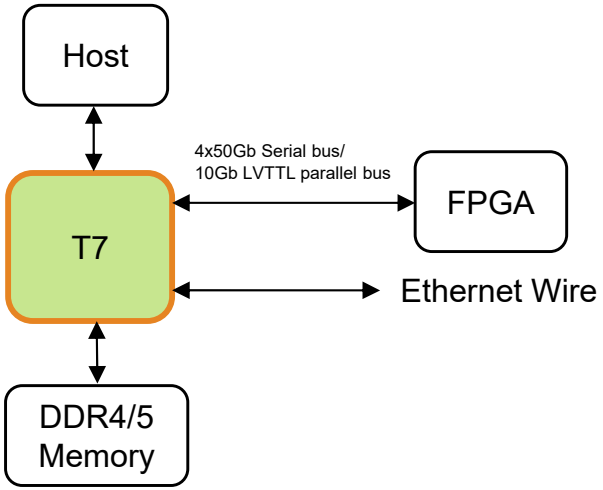


Figure 1 – iNIC Application

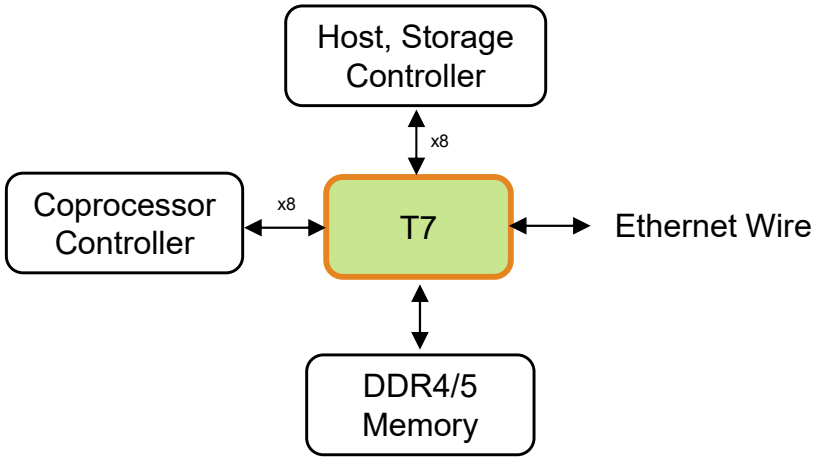


Figure 2 – Generalized Bridge

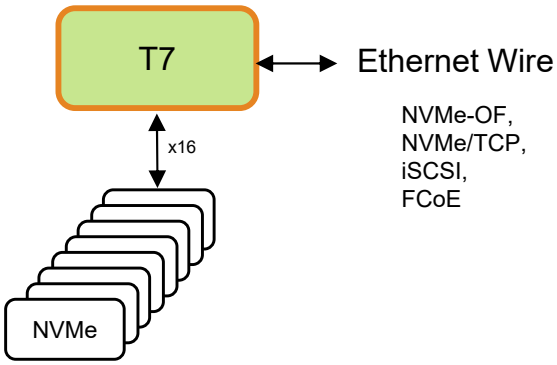


Figure 3 – NVMe - Ethernet Bridge

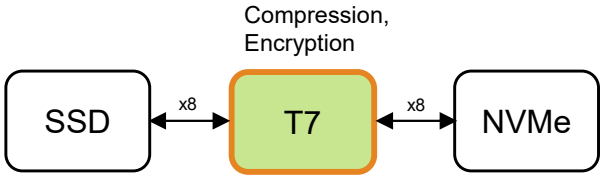


Figure 4 – NVMe - NVMe Bridge

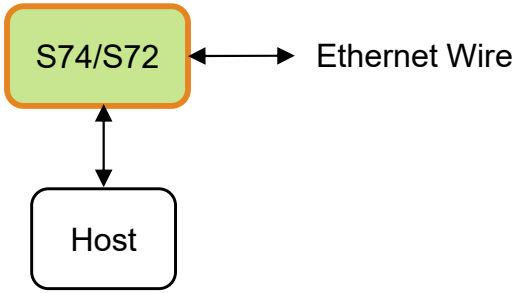


Figure 5 – Legacy Application

Next Steps & Call to Action

- Webinar recording & slide deck available by 1/22/2023
  - https://www.chelsio.com/chelsio-t7-dpu-webinar/
- Webinar attendee-only **Special** for T6 SmartNICs
  - Order using code: 'ChelsioSmart' via sales@chelsio.com
- Explore T7 DPU capabilities
  - Schedule 1/1 calls via sales@chelsio.com

Q&A and General Discussion

Contact info

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