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An Approach for Implementing NVMeOF based Solutions

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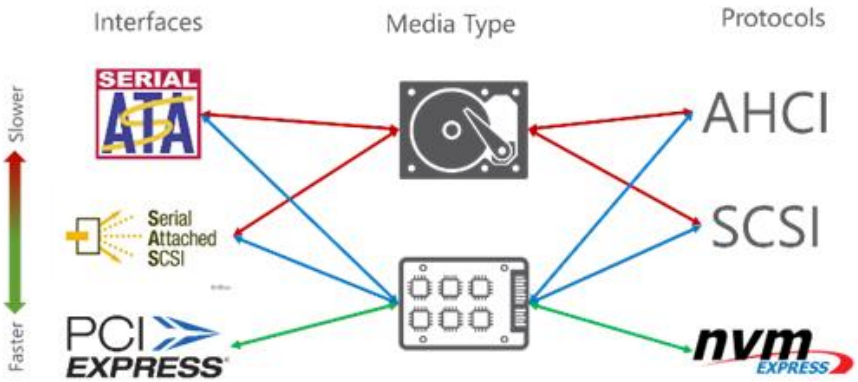
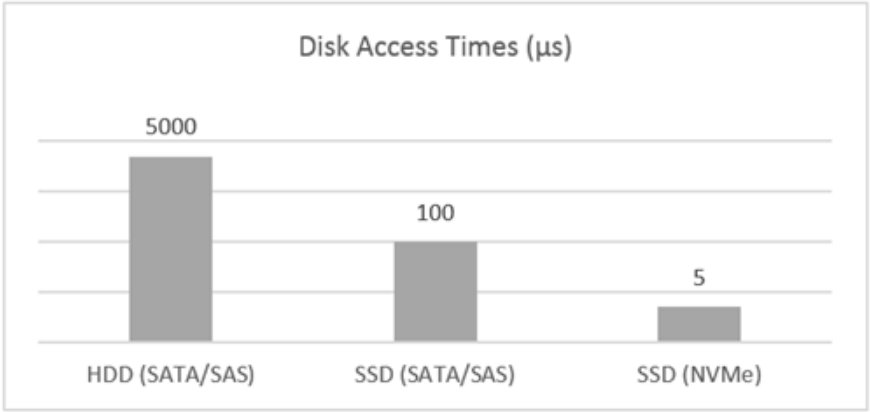
Agenda

- Recap of NVMeOF Evolution
- Network Fabric – Which one to Choose ?
- Implementing NVMeOF based solution
- Drivers support for NVMeOF

Recap of NVMeOF Evolution

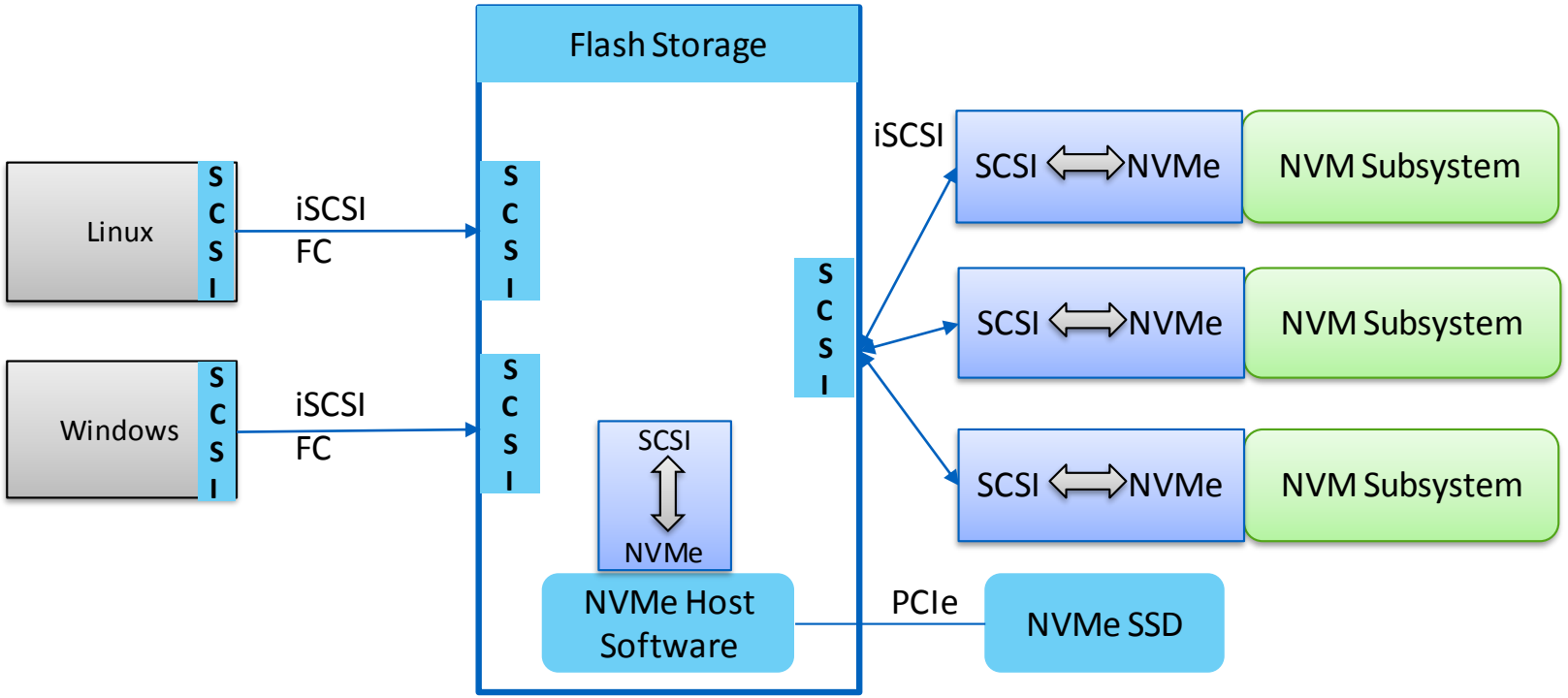
Recap of Communication Protocols





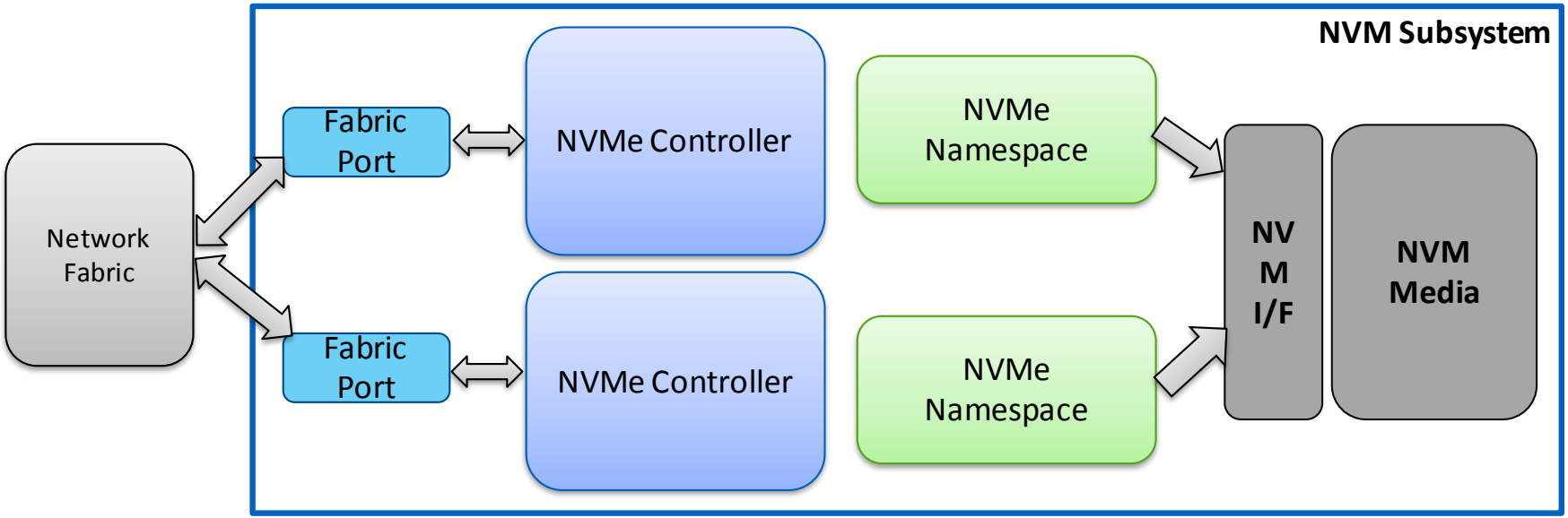
- SAS and SATA performance increased over time but protocols have not changed much
- NVMe was created to allow direct access to the logical block based architecture of SSDs and to do highly-parallel IO enabling SSD to execute more IO threads than any other protocol before.
- NVMe Protocol Specification latest Version 1.3b launched on May 2018.

Data Flow with Enterprise Storage Over Network : Limitations



Protocol conversion bridge is required to access the data over network which increases the NVMe latency

What is a NVM Subsystem ?



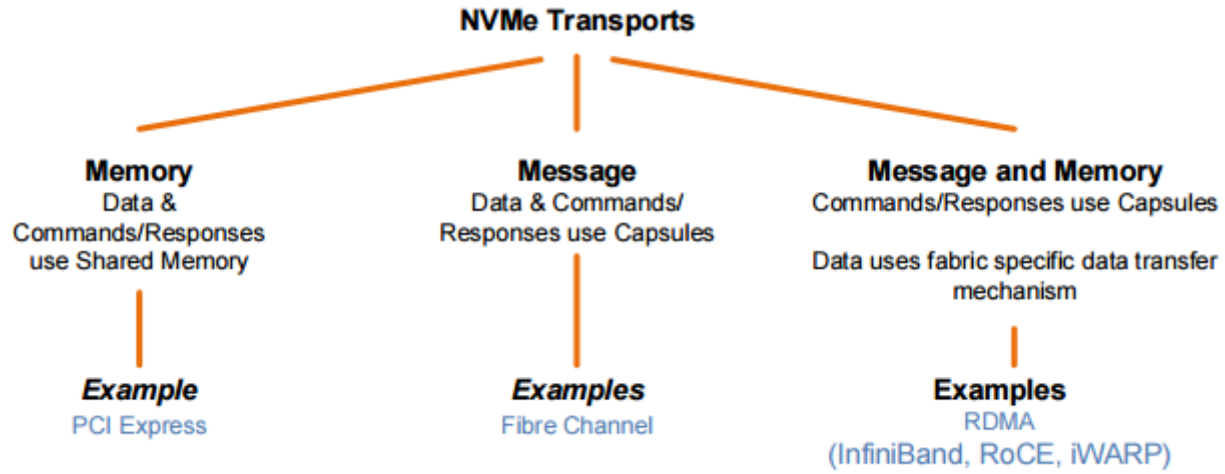
NVMe Over Fabric Solution

- Launched a new specification “NVMe Over Fabric 1.0” on June 2016.
- Is a way to send NVMe commands over networking protocols (“Fabrics”). E.g.
  - RDMA (Infiniband, iWarp, RoCE, ..)
  - Fibre Channel
- Defines a common architecture that supports a range of storage networking fabrics for NVMe block storage protocol over a storage networking fabric
- Inherent parallelism of NVMe multiple I/O Queues is exposed to the host (64k Queues & 64k commands per Q)
- NVMe commands and structures are transferred end-to-end
- Maintains the NVMe architecture across a range of fabric types
- Maintains architecture and software consistency between fabric types by standardizing a common abstraction and encapsulation definition

Design goal of NVMe over Fabrics :
Provide distance connectivity to NVMe devices with no more than 10 microseconds (µs) of additional latency

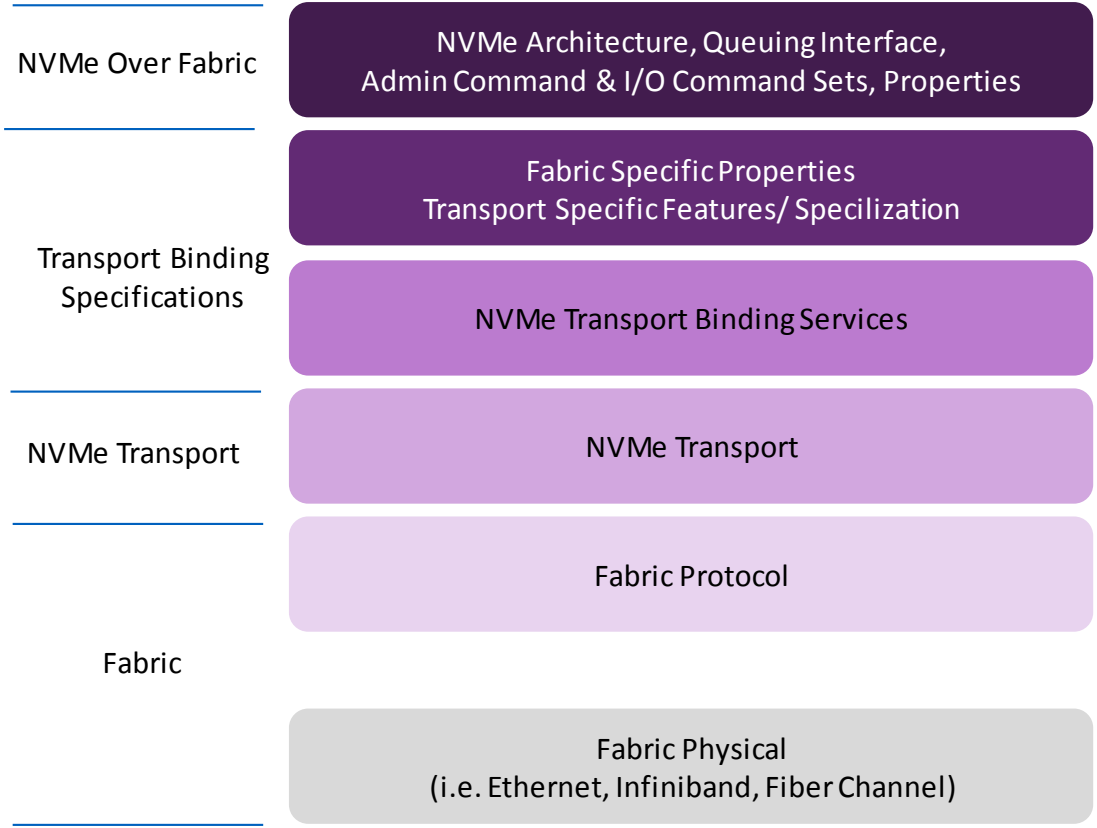
Network Fabric – Which one to Choose ?

NVMe Over fabric Protocol – Transport Mode



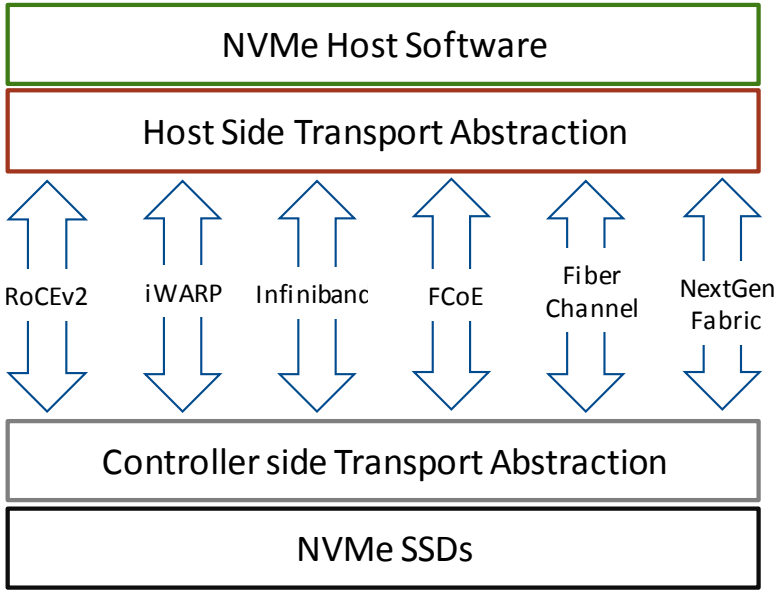
Source: nvmexpress.org

NVMe Over Fabric Stack Architecture



Network Fabrics

- NVMe Over Fabric describe how to transport the NVMe interface across several scalable fabrics
- NVMe Over Fabric initially defines two type of fabrics for NVMe transport as Fiber Channel and RDMA

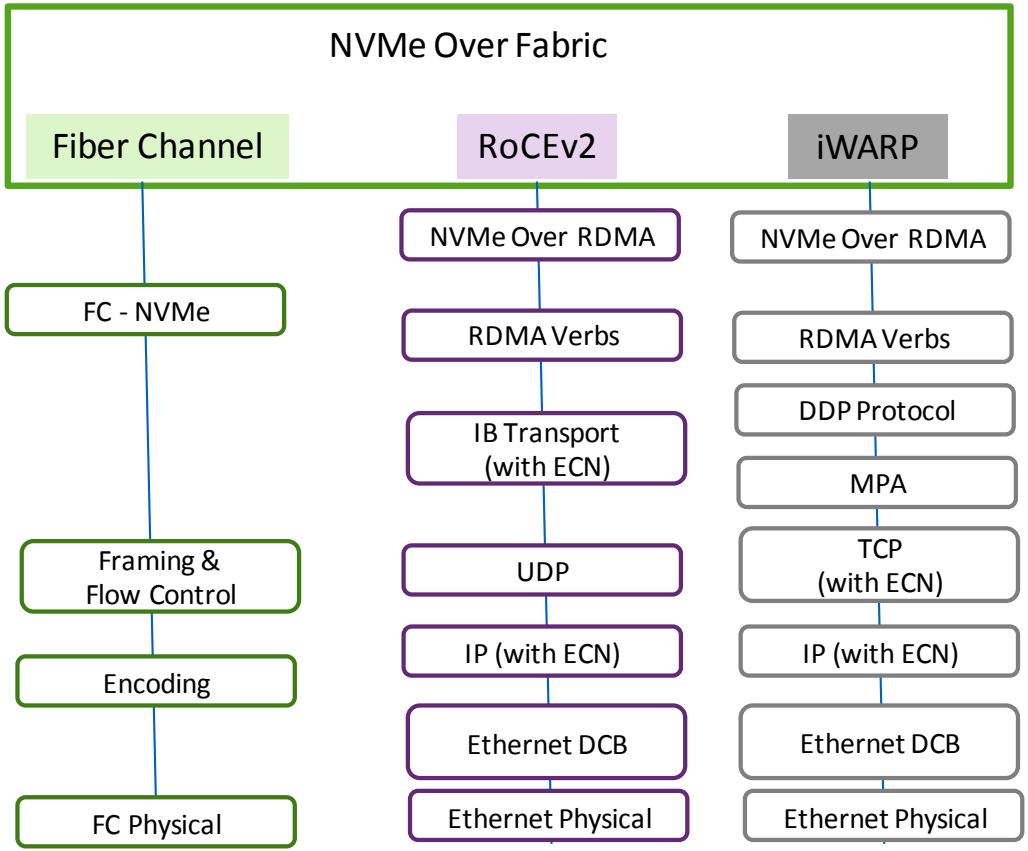


Comparative Analysis

RoCEv2	iWARP	Infiniband	FCoE	FC	iNVMe
RDMA over Converged Ethernet v2	Internet Wide Area RDMA Protocol	Infiniband	Fiber Channel over Ethernet	Fiber Channel	NVMe Over TCP
Promoted by Mellanox	Promoted by Intel	Promoted by Mellanox	Promoted by CISCO	Promoted by CISCO, Brocade	Promoted by Facebook, DELL EMC and Intel
RDMA based	RDMA based	RDMA based	Leverage FC- NVMe	Non RDMA based	Non RDMA based
Not Compatible with Other Ethernet Options	Not Compatible with Other Ethernet Options	Very Rarely Deployed. Special usecases like HPC or Server-Server cluster	Not Compatible with Other Ethernet Options	Compatible with both SCSI and NVMe protocol	Not Yet a part of NVMe oF standard
Lossless Ethernet support (ECN- Explicit Congestion Notification)	Lossless Ethernet not required	Already a lossless protocol	Require a DCB network(Lossless Ethernet)	Already a lossless protocol	Leverage s/w implementation of NVMe

NVMe Over Fabric Protocol Stacks

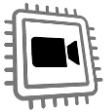
- Three dominant protocol
- Fiber Channel is a lossless network fabric, NVMe is just a new upper layer protocol where RDMA is not needed
- RDMA + IP + Lossless Ethernet (DCB) layer add complexity to RoCEv2 & iWARP protocols
- Ethernet /IP based protocol are using commodity and internet scale.



Business Drivers to Adapt NVMeOF based Solution

AI/ Machine Learning

Analytics



Video Processing

High Performance Computing

Hyper Converged Infrastructure

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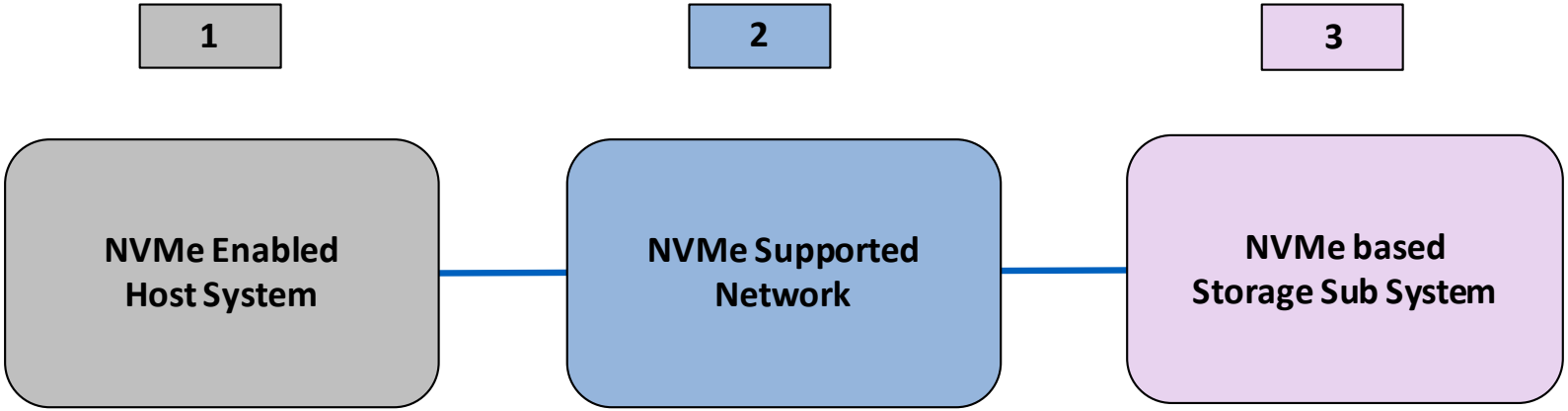
Implementing NVMeOF based Solution

Core Elements for Implementing NVMe Over Fabric Solutions

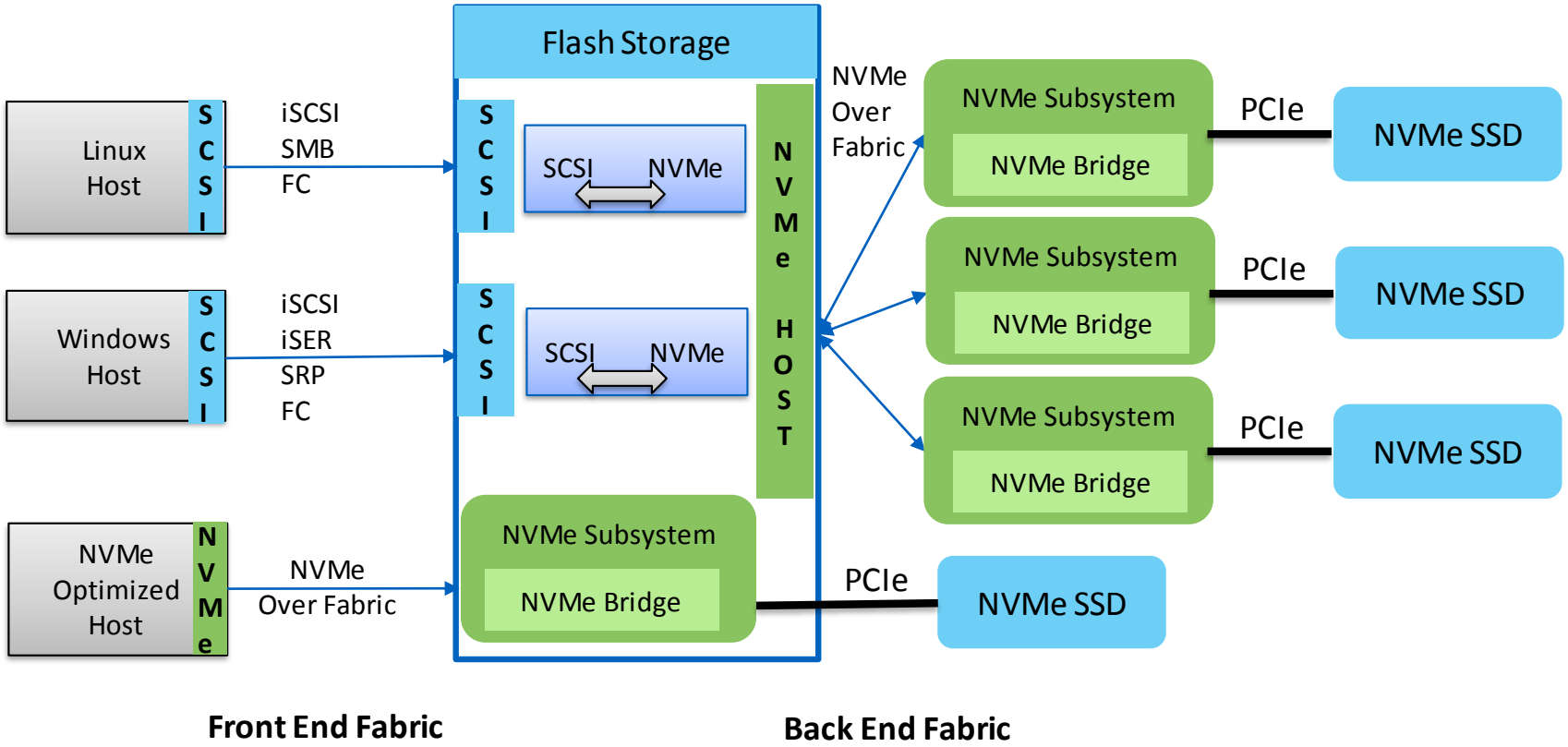


- Windows
- Linux
- Unix
- Solaris
- VMware

- Fiber Channel
- RoCE v2
- iWARP

- NVMe Controller
- NSID (NVMe Name Space ID)
- NVM Interface
- MVM Media(Chip, SSD, NVDIMM)

Reference Architecture for NVMeOF Solution for Enterprise Storage



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Linux Based NVMeOF Driver

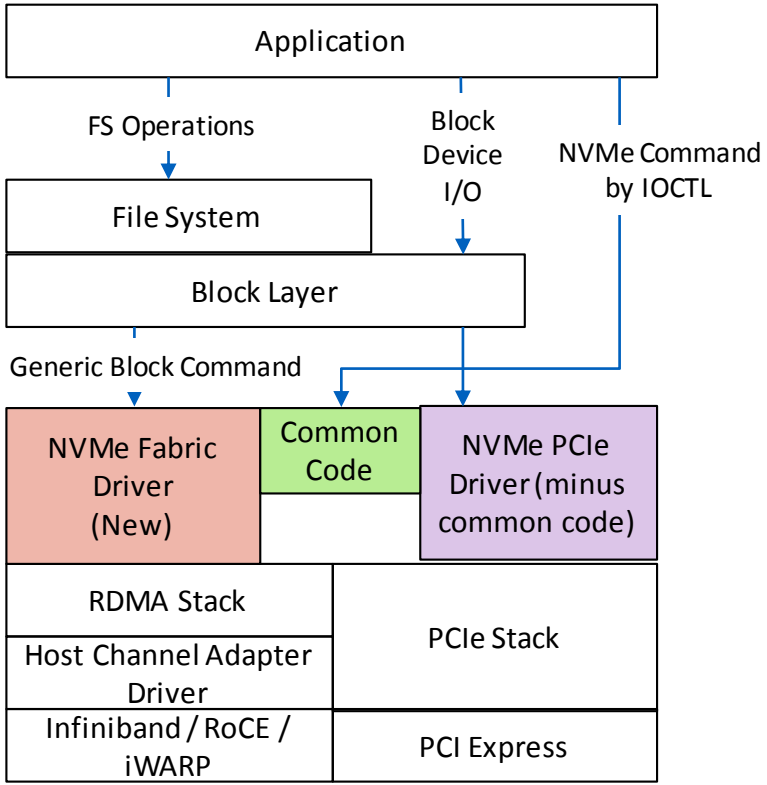
NVMe Over Fabric Support in Linux

- Current functionality implemented for NVMe Host Driver
  - Support for RDMA transport (Infiniband/ RoCE /iWARP)
  - Connect/Disconnect to multiple controllers
  - Transport of NVMe commands/data generated by NVMe core
  - Initial Discovery service implementation
  - Multi-Path

- Current functionality implemented for NVMe Target Driver
  - Support for mandatory NVMe core and Fabrics commands
  - Support for multiple hosts/subsystems/controls/namespaces
  - Namespaces backed by Linux block devices
  - Initial Discovery service; Discovery Subsystem/Controller(s)
  - Target Configuration interface using Linux configfs
  - Create NVM and Discovery Subsystems

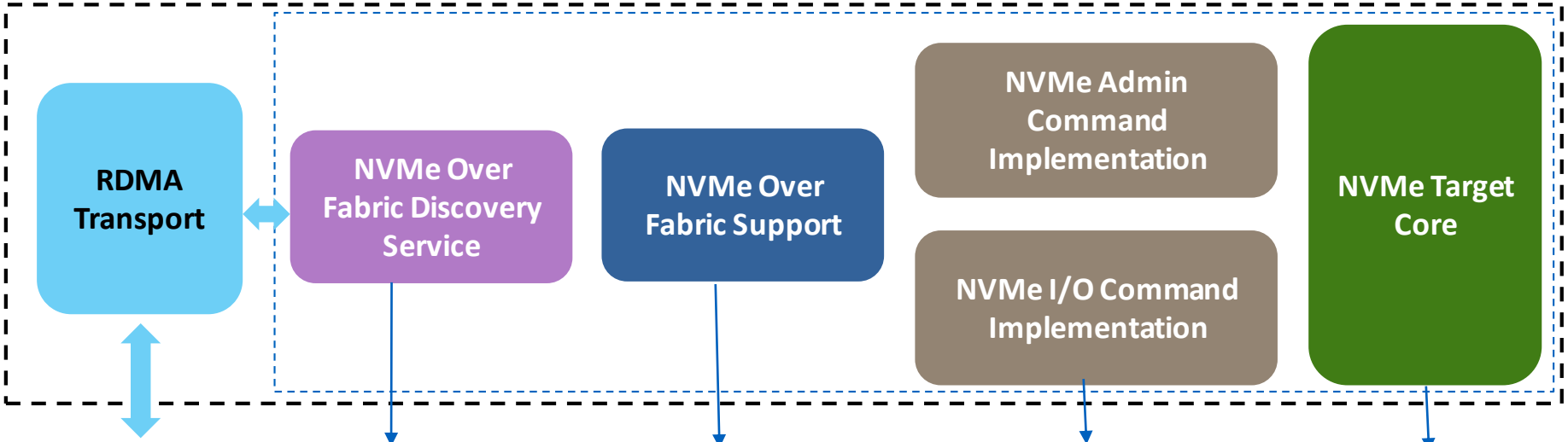
Linux Fabrics Driver is a part of Linux Kernel 4.8 onwards

NVMe Over Fabric Host Driver Implementation in Linux



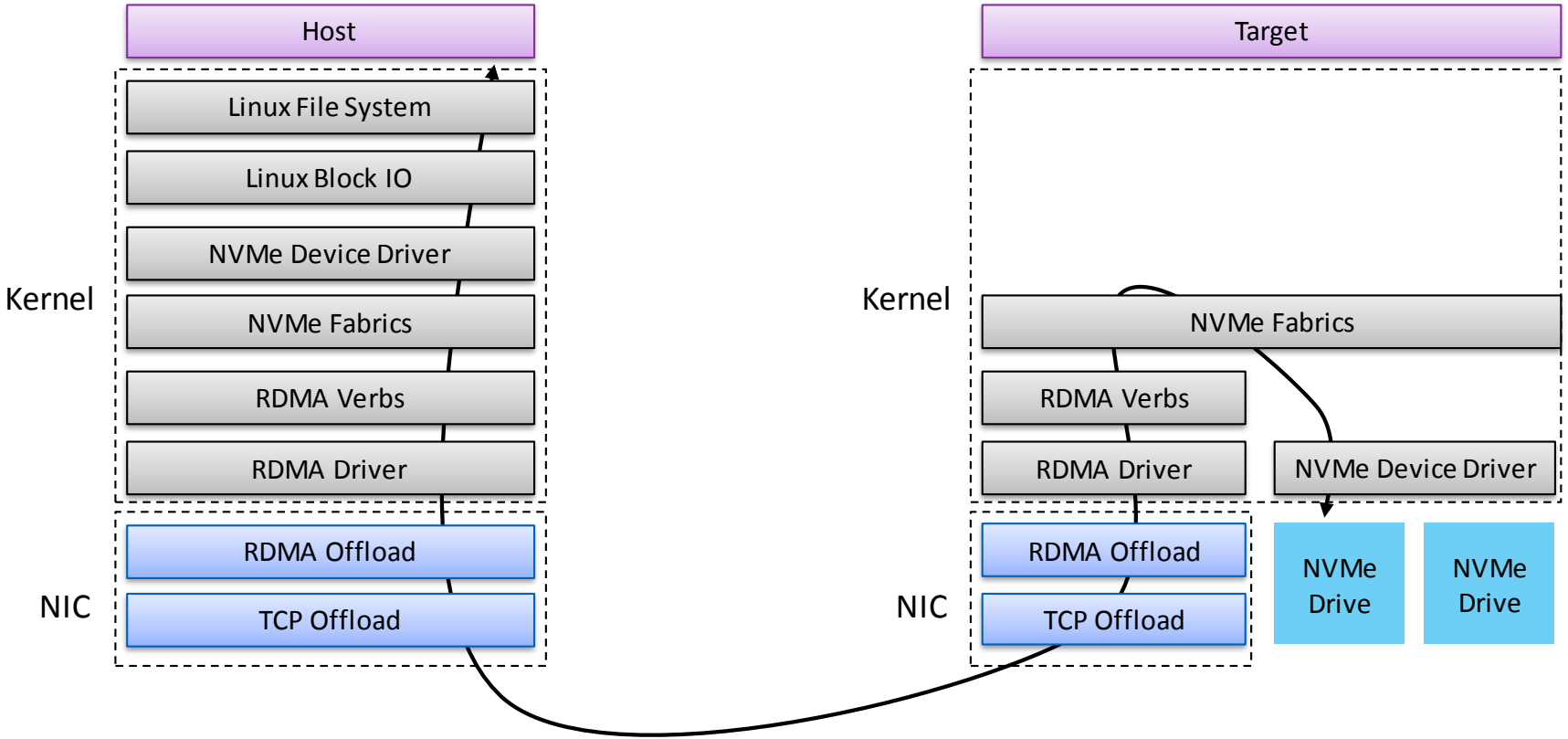
- New Fabric Driver uses the existing common code
- Additional it is split into a small common fabrics library and the actual transport driver
- Existing user space APIs of the PCIe driver are also supported when using fabrics
- Uses new sub-command of the existing nvme-cli tool to connect to remote controllers

NVMe Over Fabric Target Driver Implementation in Linux



- Responsible for discovering NVMe Subsystems available to Host, Namespace and multipath
- Responsible for servicing Fabrics commands (connect, property get/set)
- **Admin:** Responsible for parsing and servicing admin commands such as controller identify, set features, keep-alive, log page, …)
- **I/O :** Responsible for performing the actual I/O (Read, Write, Flush, Deallocate.
- Defines and manages the NVMe entities (subsystems, controllers, namespaces, …) and their allocation
- Responsible for initial commands processing and correct orchestration of the stack setup and tear down

How Data Flows from Host to Target in NVMeOF?



NVMe Supported Storage Array Today

- NetApp – E570 All Flash Array (FC -NVMe)
- PureStorage - DirectFlash
- DELL EMC
- IBM
- Supermicro
- Mangstor
- E8 Storage
- Pavillion Data
- Excelero
- Aperion

Q&A

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