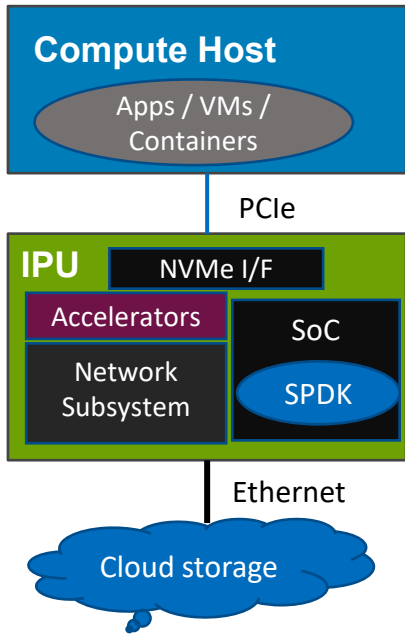# SPDK Based IPU/DPU Storage Solutions

Naru Sundar, Principal Engineer, Intel

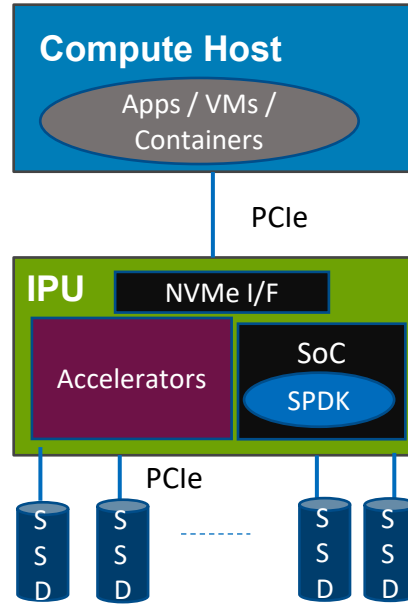Yadong Li, Principal Engineer, Intel

Agenda

- IPU/DPU Storage Usages and SPDK support
- SPDK Enhancements for IPU/DPU support
- Storage Management Agent
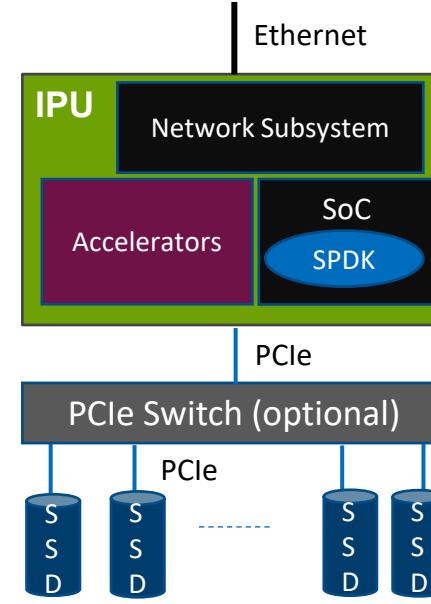- SPDK and IPDK/OPI
- Summary

IPU Storage Usages and SPDK

NVMe-oF Initiator Usage

- Storage Disaggregation in Cloud
- Bare-metal hosting
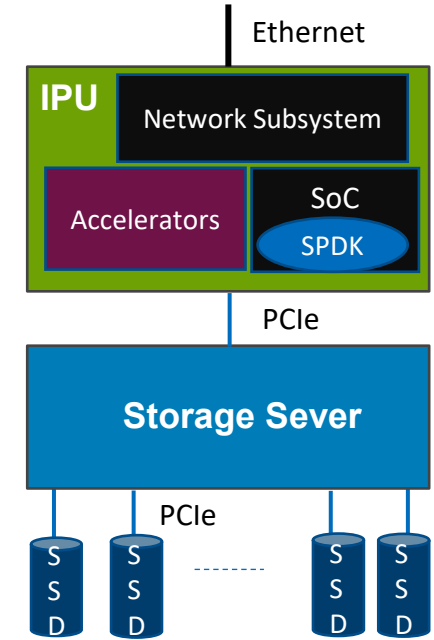- **SPDK provides NVMe-oF initiators**

Local Storage Disaggregation

- IPU provides NVMe virtualization
- **SPDK for NVMe driver and local storage provisioning**

IPU based JBOF Design

- Storage datapath acceleration
- Optional PCIe switch for fanout
- **SPDK provides full solution for NVMe-oF targets**

**IPU + Storage Server**

- Storage datapath acceleration
- **SPDK for initiator and target usages**

SPDK NVMe-oF Software Stack

- SPDK provides a flexible architecture for supporting a choice of protocols and enables customizations.
- SPDK is an ideal framework for IPU/DPU based storage solutions.

SPDK Components for NVMe-oF solutions. For details, please refer to **https://spdk.io/**
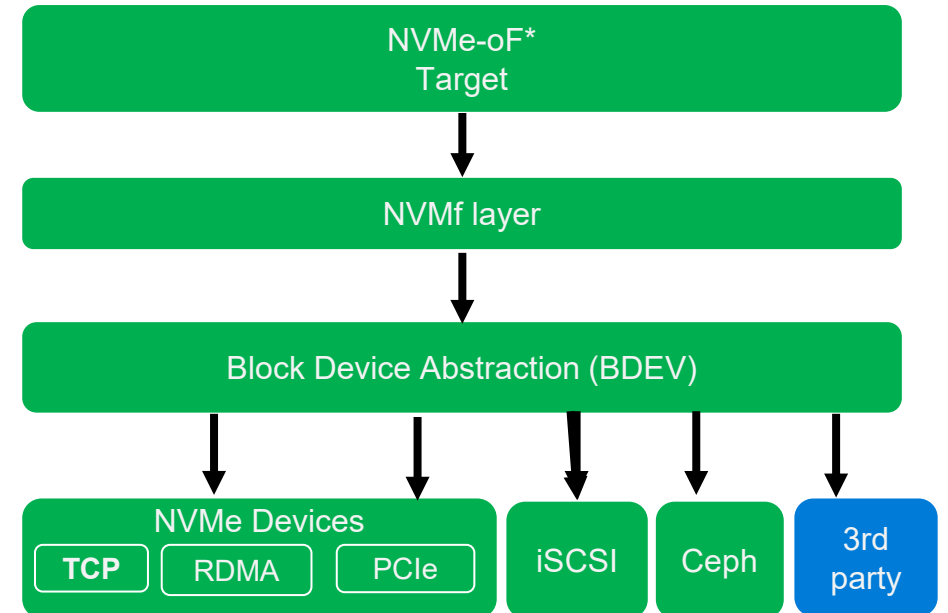
Example: SPDK in IPU based JBOF
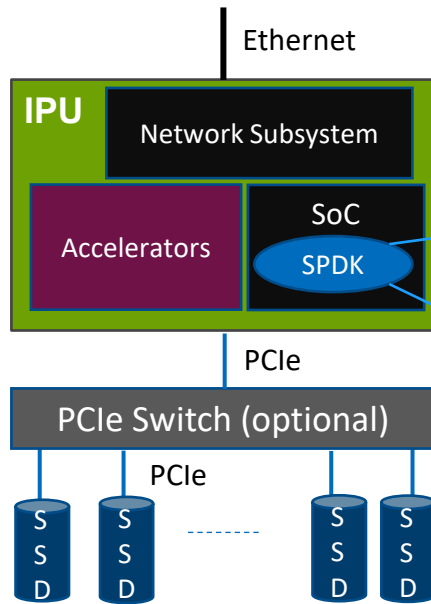
IPU based JBOF Design

- Storage datapath acceleration
- Optional PCIe switch for fanout
- **SPDK provides a full solution for NVMe-oF targets**

Example: IPU based NVMe/TCP Initiator

Compute Host
- Apps / VMs / Containers

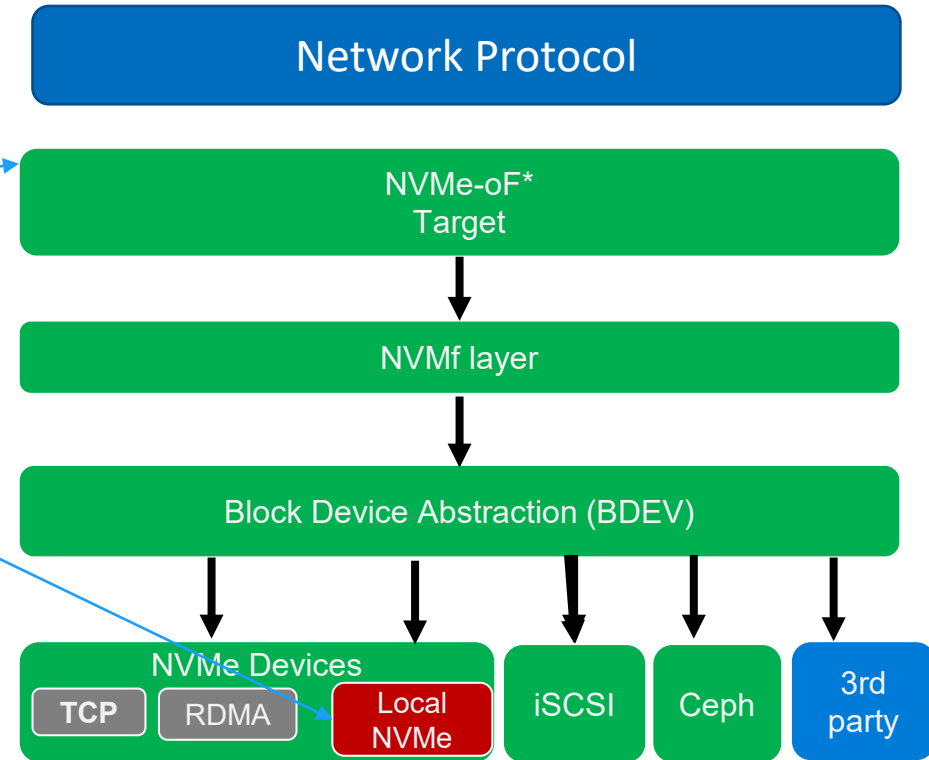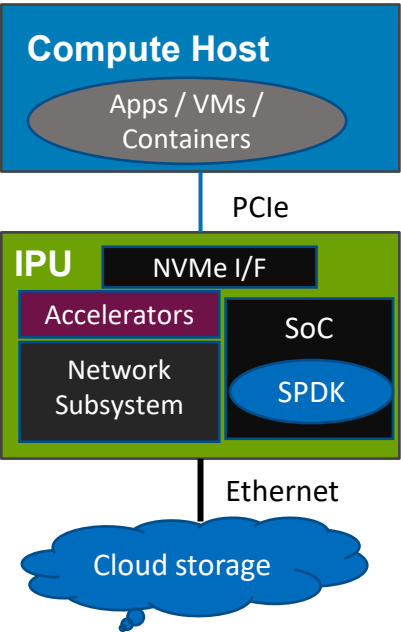PCIe

IPU
- NVMe I/F
- Accelerators
- Network Subsystem
- SoC
  - SPDK

Ethernet

Cloud storage

NVMe-oF Initiator Usage

- Storage Disaggregation in Cloud
- Bare-metal hosting
- **SPDK provides NVMe-oF initiators**

Intel® Xeon®

Linux VM
- nvme driver

Linux Kernel
- nvme driver

kubernetes

PF | VF | VF | QAT

NVMe Protocol Initiator (NPI)

NVMe CPF

RDMA

Processing pipeline

Ethernet MAC

LAN PF

CMDs

Configure

Compute/SoC | SMA

QAT SDK

NPI Transport

nvmf layer

BDEV Layer

NVMe over TCP Initiator

SPDK

NVMe Initiator Config Driver

Intel(R) IPU E2000 Series

NVMe over TCP Initiator Flow
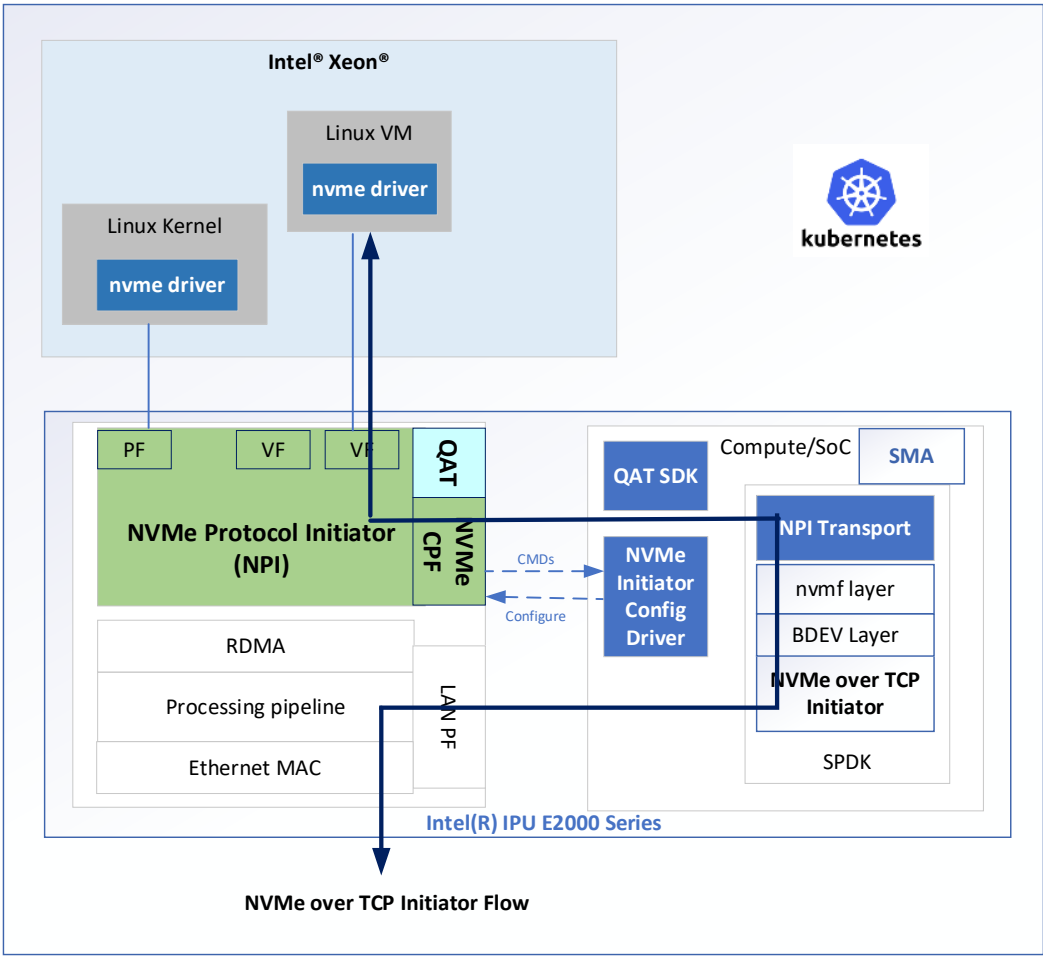
NVMe over TCP Initiator on Intel® IPU E2000 series

- SPDK modular design enables a clean integration with an IPU NVMe initiator
- NPI (NVMe Protocol Initiator) Transport to interface with nvmf layer
- NPI Transport interacts with IPU SDK and API for device configurations and CMDs processing.
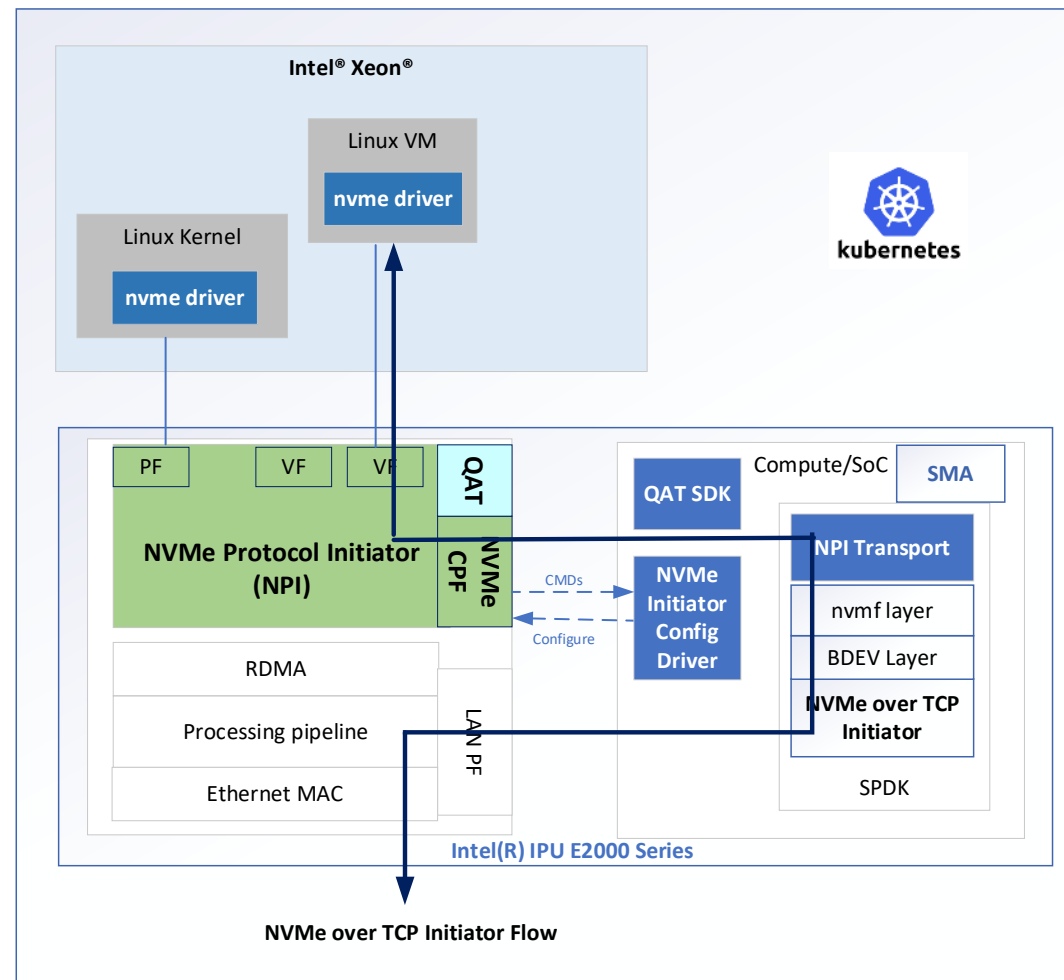
SPDK Enhancements for IPU/DPU Support
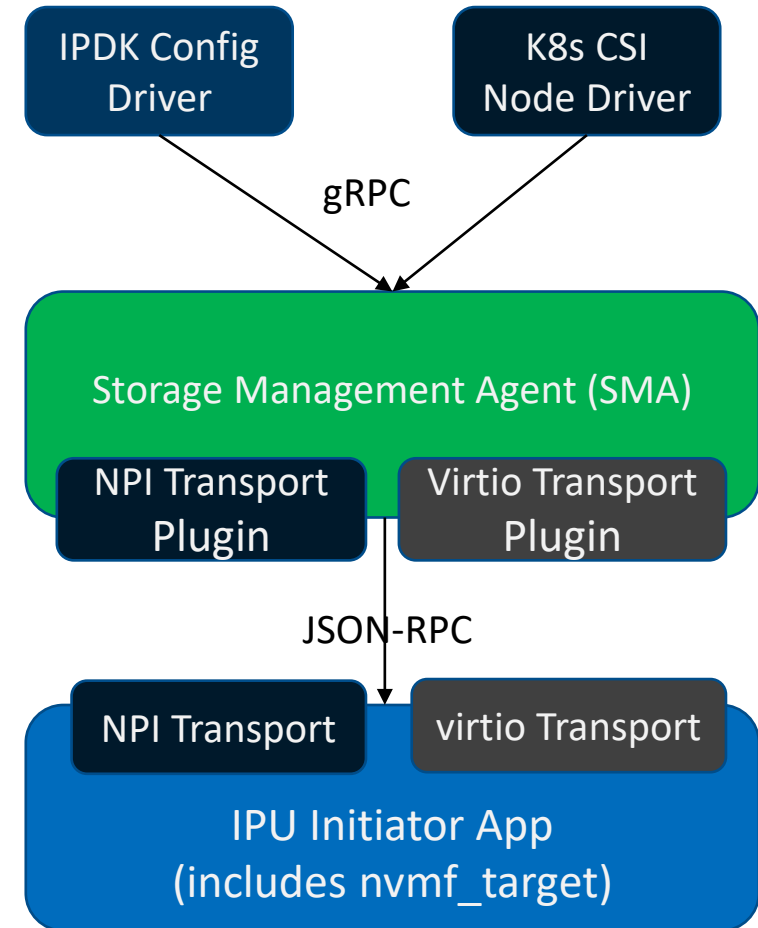
- Enhancements over last couple of years enabled a clean integration with IPU storage initiators (e.g. NPI transport).

- Add Storage Management Agent (SMA) to simplify the integration of IPU storage initiators with orchestration frameworks (e.g. K8s CSI node driver)

- Add auto discovery service

- Asymmetric Namespace Access (ANA) and Multi-path support

- Look forward
  - Storage data-path accelerations, compression/crypto/CRC/HASH
  - NVMe/RDMA offload
  - …

Storage Management Agent

- Storage Management Agent (SMA) is a service providing a gRPC interface for orchestrating SPDK applications.
  - Provides a secure and authenticated configuration channel for IPU storage applications.
  - Abstracts out low-level details of SPDK JSON RPCs.
  - Simplifies integrations with K8s and OpenStack.
- For details, please refer to https://spdk.io/doc/sma.html

IPDK Config Driver

K8s CSI Node Driver

gRPC

Storage Management Agent (SMA)

NPI Transport Plugin

Virtio Transport Plugin

JSON-RPC

NPI Transport

virtio Transport

IPU Initiator App (includes nvmf_target)

SPDK, a key component for IPDK and OPI

OPI – Open Programmable Infrastructure
IPDK – Infrastructure Programmer Development Kit

SPDK and IPDK Storage Recipes

- SPDK is a key component for IPDK to enable different storage recipes
- SPDK containers for IPU initiator and target simplifies IPU SW developments
- IPDK proposes an environment for IPU SW development
- OPI discusses interfaces for devices like IPU

IPDK Introduction

IPDK is a **community-driven target agnostic** framework for **infrastructure programming** that runs on a CPU, IPU, DPU, or network switch.
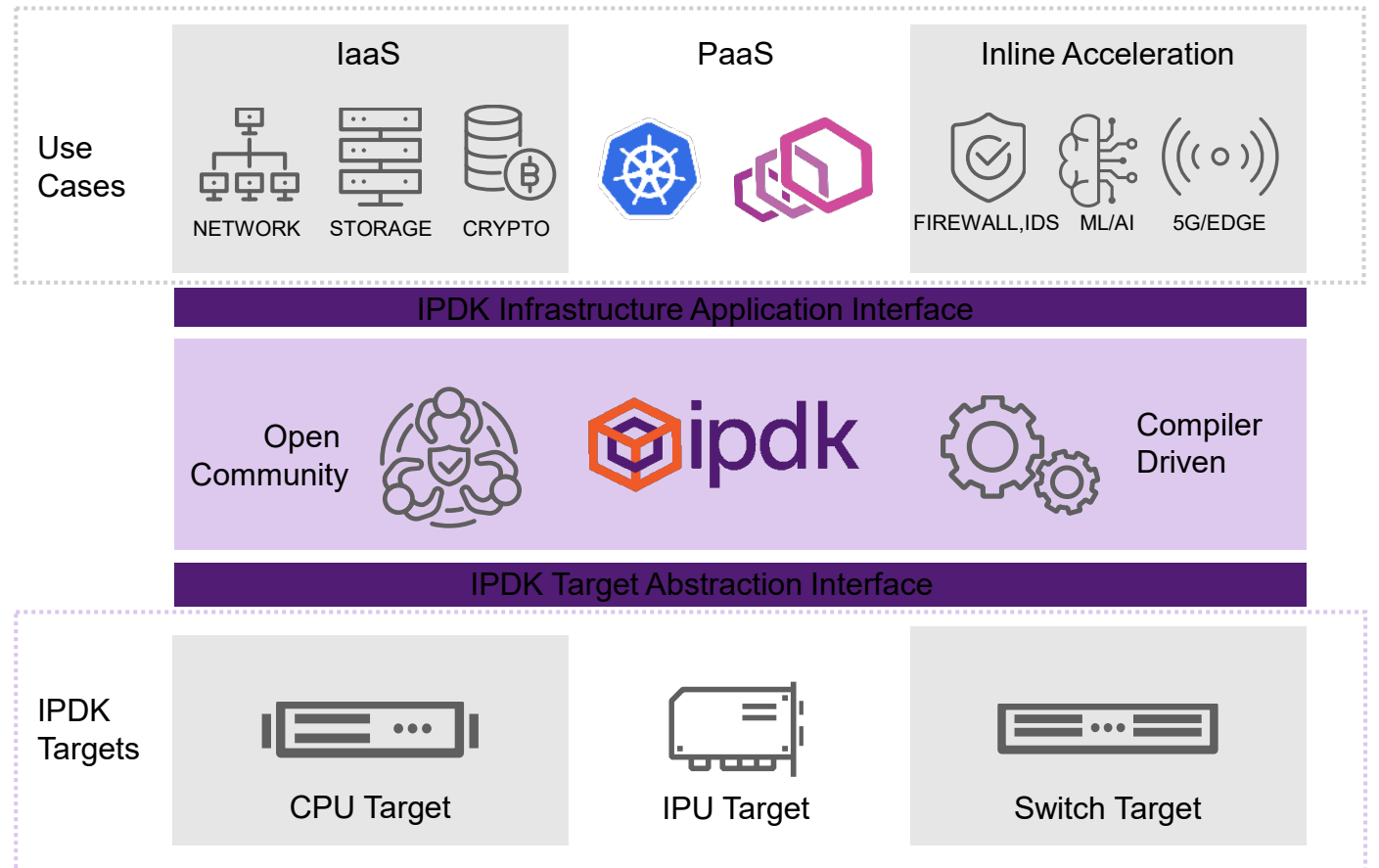
IPDK and OPI

- IPDK and OPI coexist
- IPDK is an official sub project of OPI
- IPDK development is now under OPI umbrella
- OPI defines management API across IPU/DPU vendors
  - Opi-spdk-bridge enables integration with SPDK based storage solutions
  - https://github.com/opiproject/opi-spdk-bridge

IPDK Storage Recipes

[IPDK Virtual Block Storage Recipe](#)

IPDK recipes simplify and make it easy for IPU/DPU application development

   - ipu-storage-container

   - storage-target container

   - ipu management API (based on OPI bridge)
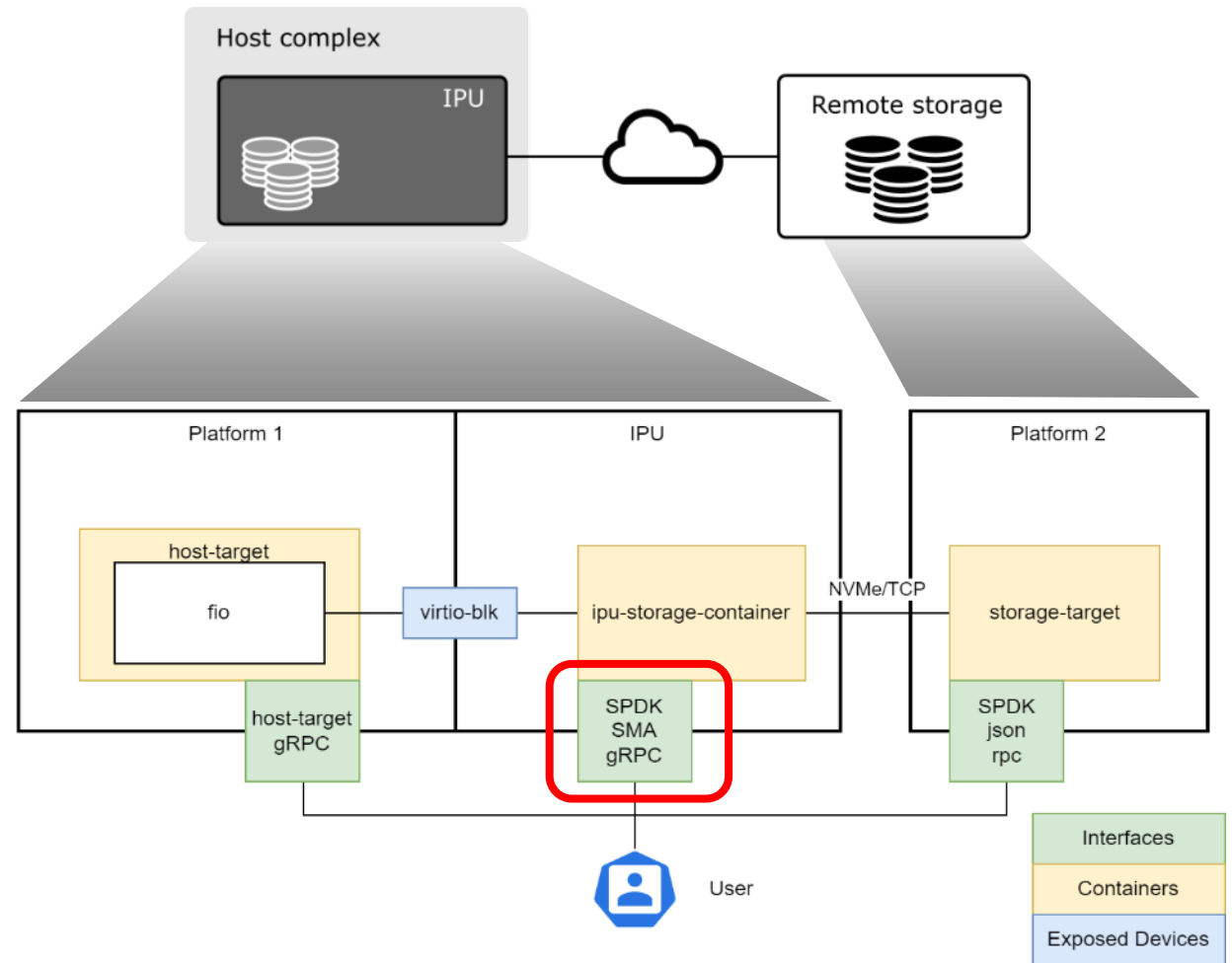
Summary

- SPDK is an ideal framework for supporting IPU/DPU storage solutions.
- SPDK enhancements make IPU/DPU storage solutions better and better.
- We highly recommend SPDK for IPU/DPU storage solutions.
- We encourage and welcome to SPDK development and integration with IPDK/OPI.

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