



Open Networking Conference Japan 2020

データプレーン高速化技術の最新アップデート

インテル株式会社 森 直之, 2020/10/15

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intel®

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Intel® AES-NI requires a computer system with an AES-NI enabled processor, as well as non-Intel® software to execute the instructions in the correct sequence. AES-NI is available on select Intel® processors. For availability, consult your reseller or system manufacturer. For more information, see [Intel® Advanced Encryption Standard Instructions \(AES-NI\)](#)

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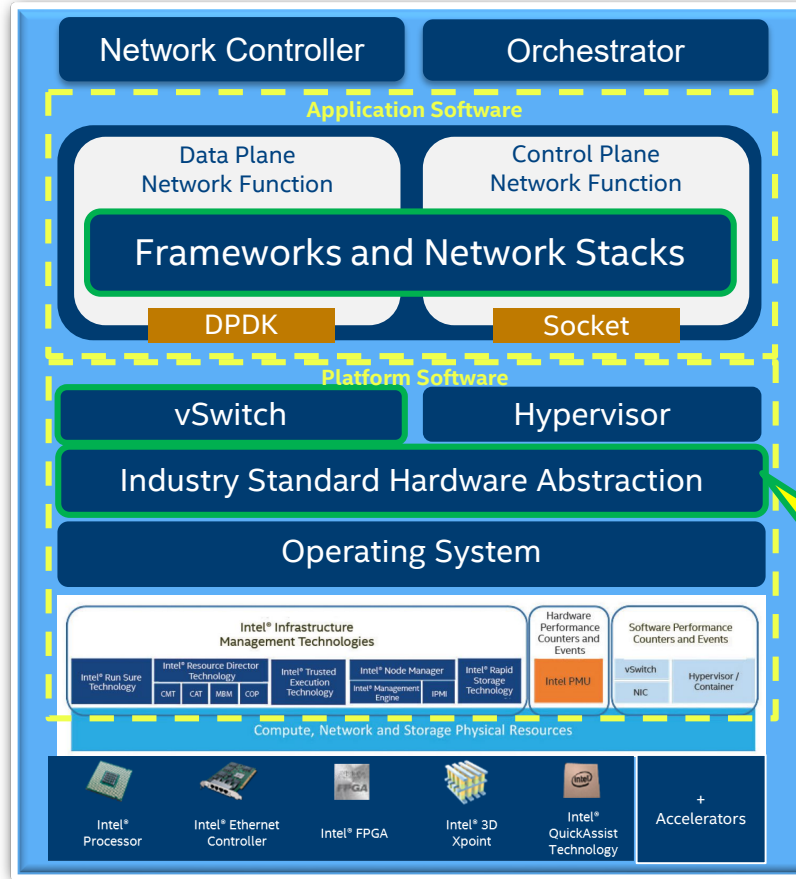
Agenda

- DPDK* Overview
- DPDK and AF_XDP
- Intel® Ethernet Adaptors and processors
- DPDK Roadmap
- Intel® Scalable I/O Virtualization
- Further Information

DPDK OVERVIEW



Network Platform Framework (Data Plane View)



DPDK

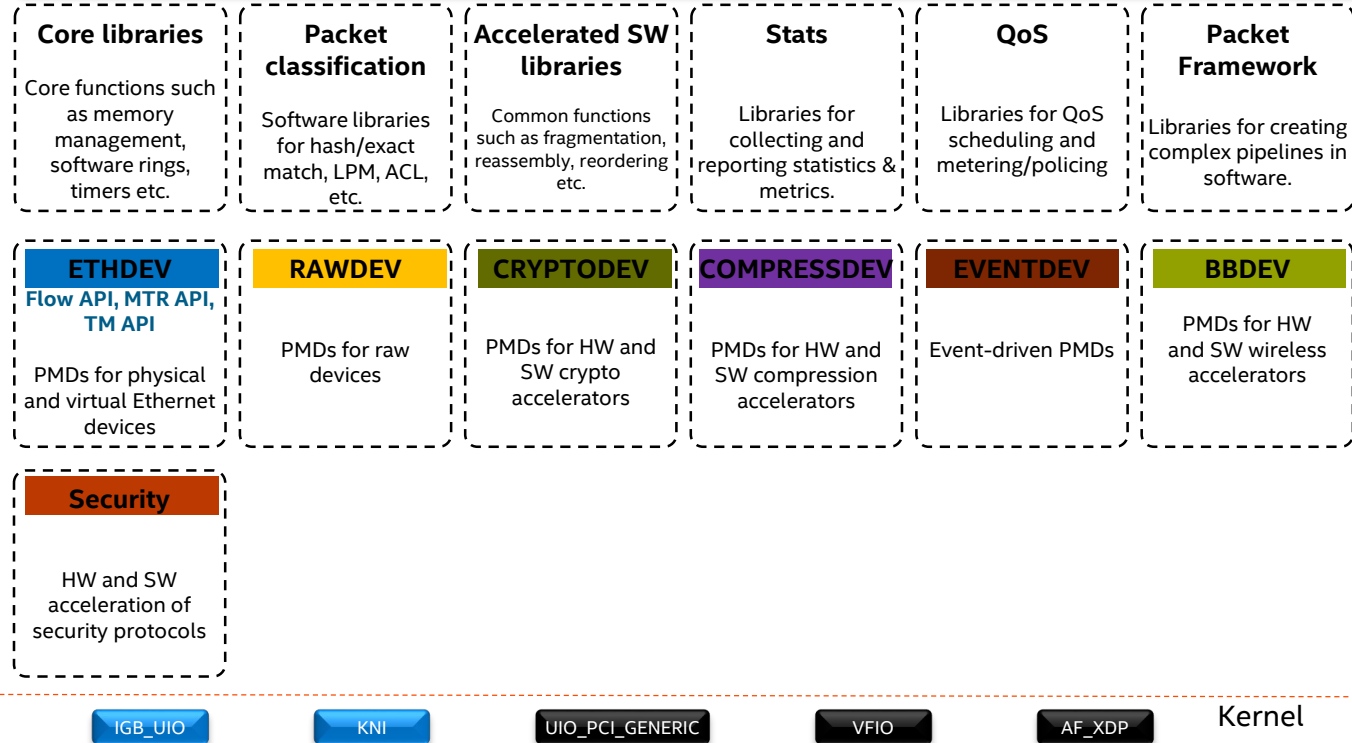
DPDK is the de facto user space I/O and HW acceleration abstraction layer.

DPDK Components

DPDK Fundamentals

- Implements run-to-completion and pipeline models
- No scheduler - all devices accessed by polling
- Supports 32-bit and 64-bit OSs, with and without NUMA
- Scales from Intel® Atom® to Intel® Xeon® processors
- Number of cores and processors is not limited
- Optimal packet allocation across DRAM channels
- Use of 2M & 1G hugepages and cache aligned structures
- Uses bulk concepts - processing 'n' packets simultaneously
- Open source and BSD licensed
- **Ease of Development** - quick prototyping with samples, debugging (gdb), Analysis (VTune™, Intel® Performance Counter Monitor (Intel® PCM), PROX)

DPDK Applications - Network Functions (Cloud, Enterprise, Telco)



Projects Using DPDK

vSwitches/vRouters



BESS



DPDK in OS Distros



Storage (<https://spdk.io/>)

Storage Performance Development Kit



Packet Generators



Pktgen



Ostinato

PROX

TCP/IP Stacks

mTCP



Seastar LWIP DPDK

Intel Virtual Switch Investment

Open Source



OvS



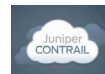
Tungsten Fabric



FD.io/VPP

- Advancements in open source scales to commercial solutions
- Complete all commercial vSwitch with DPDK Optimization
- VMware NSX-T 2.2, Launched in 2018
- DPDK Capable VMs in Azure

Commercial



Juniper Contrail



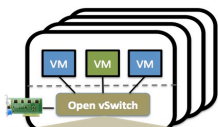
NSX



RH OSP



Hyper-V



<p>Security: VLAN isolation, traffic filtering</p>	<p>Monitoring: Netflow, sFlow, SPAN, RSPAN</p>
<p>QoS: traffic queuing and traffic shaping</p>	<p>Automated Control: OpenFlow, OVSDB mgmt. protocol</p>



2009

First OVS release

2013

OpenContrail & open source DPDK projects launched

2015

DPDK acceleration of OVS

2016

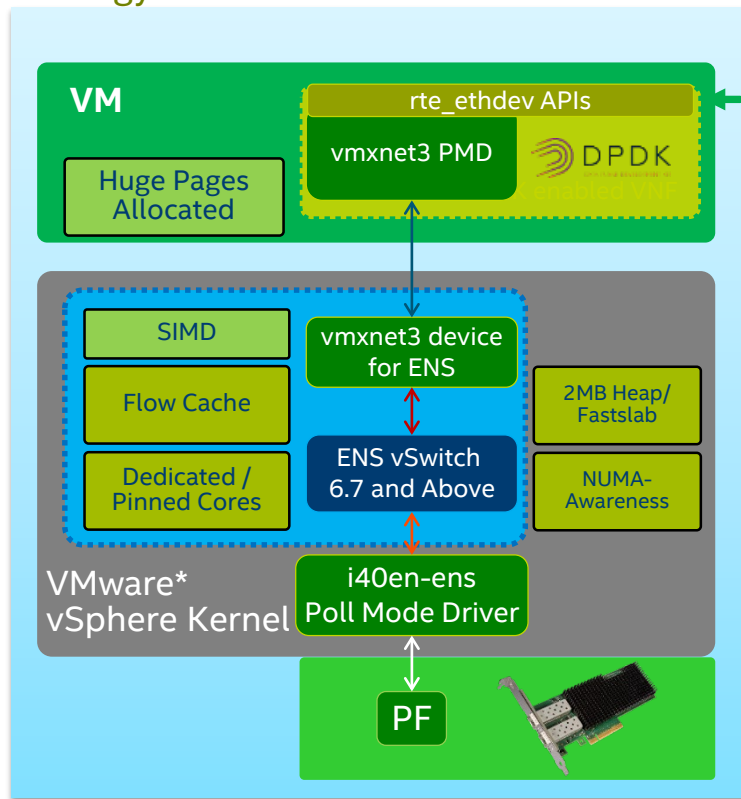
First release of FD.io

2018

Tungsten Fabric moves to LF

VMware vCloud Accelerated Performance

N-VDS Based on DPDK technology



Accelerate VNF ecosystem for more performance with DPDK APIs

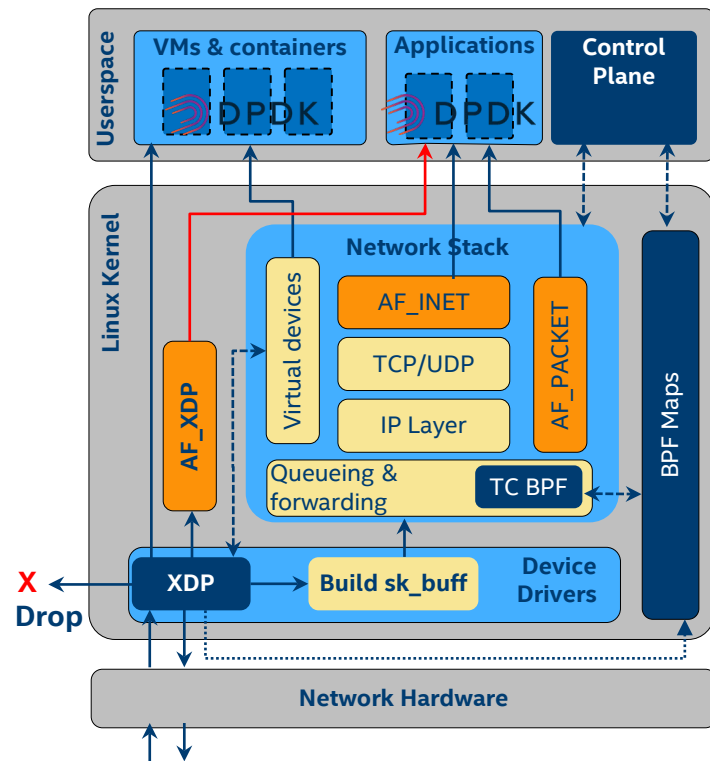
DPDK AND AF_XDP



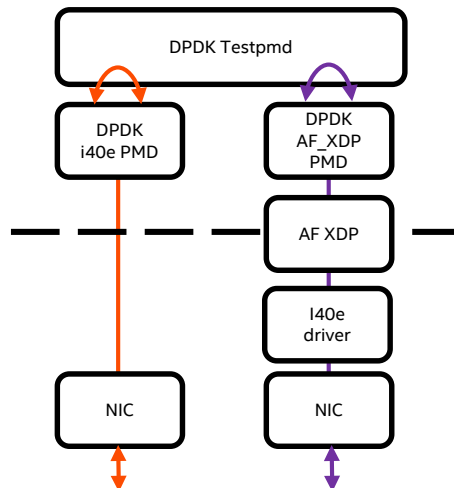
AF_XDP Overview

Packet movement between kernel and userspace

- New socket AF_XDP is an address family for high performance packet processing in the kernel
- XDP (eXpress Data Path) can redirect frames to a memory buffer in userspace by eBPF (or route packets to Linux stack)
- DMA transfers use user space memory (zero copy between user space and kernel space)
- Connect XDP pass-through to user-space directly
- No change in DPDK apps, kernel driver handles hardware
- Maintains Linux properties (Security, isolation, robustness).
- Can be used with Drivers that support XDP
- Lots of new possible uses, other net drivers (Virtio, vEth)



DPDK + AF_XDP PMD Performance Summary



- **AF_XDP PMD is 50% of DPDK i40e PMD driver performance.**

- Additional 2 cores (2C4T) for IRQ handling will be utilized in AF_XDP

Testpmd	DPDK i40e	DPDK AF-XDP
64B	0% loss rate	0% loss rate
1C1T	18.4 Gbps 27.3 Mpps	9.0 Gbps 13.4 Mpps
1C2T	23.8 Gbps 35.4 Mpps	12.2 Gbps 18.2 Mpps

Intel® Xeon® Gold 6230 CPU @2.10GHz
 DPDK 20.02 + patch, Open vSwitch* 2.13 , Ubuntu*-19.04 (Kernel 5.4.25)

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 Source: Intel internal testing. Features & schedule are subject to change.

INTEL[®] ETHERNET ADAPTORS



Intel® Ethernet Adapter Roadmap Summary

(10GbE and higher by series)

PCIe, OCP and Custom Mezzanine Cards

500 Series

X520 10GbE SFP+

World's Best Selling
10GbE CNA



X540 10GBASE-T

World's First
Single Chip 10GBASE-T



700 Series

XL710 (40GbE QSFP+)

Network Virtualization
Overlays Acceleration



X710 (10GbE SFP+)

Cloud and Network
Virtualization Overlays
(Dual- and Quad-Port)



X550 10GBASE-T

Second Generation
Single Chip 10GBASE-T



XXV710 (25GbE SFP28)

Cloud and Network
Virtualization Overlays



X722 (10GbE SFP+)

iWARP, Cloud and Network
Virtualization Overlays, Dual-
and Quad-Port



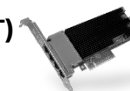
X710-T4 (10GBASE-T)

Quad-Port 10GBASE-T



X710-T4L/T2L (10GBASE-T)

Quad-Port / Dual-Port 10GBASE-T



800 Series

E810 (100GbE QSFP28)

Software defined port configurations for
2x100GbE to 8x10GbE

E810 (50GbE SFP28)

PAM4 SerDes enables single lane 50GbE
connectivity

E810 (25GbE SFP28)

Configurations for 2x25GbE and 4x25GbE on
PCIe* and OCP adapters

Available in
Q3'20



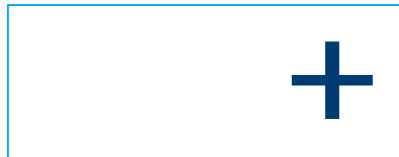
...

2015

2017

2019

Intel® Ethernet Architecture Enhanced with DPDK



- Queue and Steering Hardware Assists**
- Application Device Queues (ADQ)
- Fully Programmable Pipeline**
- Table definition with DDP profile packages
- Storage**
- RDMA (iWARP & RoCEv2)

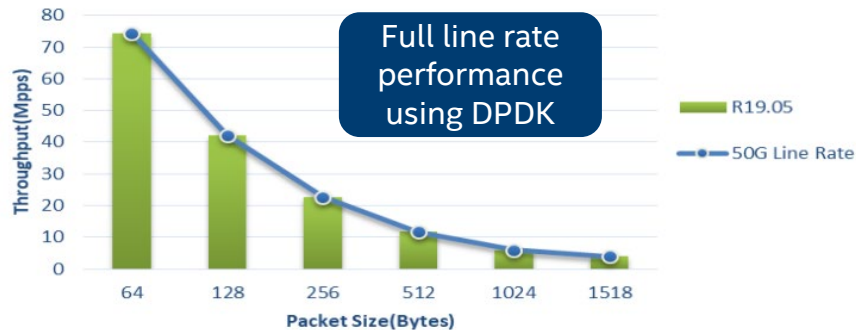
Partially Programmable Pipeline

- Table definition modifications with a Dynamic Device Personalization (DDP) profile package

Intel® Ethernet Adaptive Virtual Function (Intel® Ethernet AVF)



DPDK L3fwd RFC2544 Zero Packet Loss Performance on 2x Intel(R) Ethernet Network Adapter XXV710-DA2(1port per NIC)



4 logical cores, 4 queues for 2 ports

Packet Size (Bytes)	Throughput with 2c2t2q per port(Mpps)	Line rate%
64	74.4	100
128	42.22	100
256	22.64	100

Note: All packet sizes over 64B reach line rate.

http://fast.dpdk.org/doc/perf/DPDK_20_05_Intel_NIC_performance_report.pdf

Features & schedule are subject to change. All products, computer systems, dates and figures specified are preliminary based on current expectations, and are subject to change without notice.

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Changing Network Landscapes – Changes Protocol Needs

Significant expansion of protocol types that network adapters need to parse



Enterprise

Network Virtualization over Layer 3 (NVO3)

Virtual Extensible LAN (VXLAN) [RFC7348]

Generic Protocol Extension for VXLAN
(VXLAN-GPE)

Network Virtualization using Generic Routing
Encapsulation (NVGRE) [RFC7637]

Generic Network Virtualization Encapsulation
(GENEVE)

Network Service Header (NSH)



Service Providers

C-VLAN Tag (C-Tag)

Customer VLAN (C-VLAN)

S-VLAN tag (S-Tag)

Service VLAN (S-VLAN)

Customized Protocols



Network Edge

GPRS Tunneling Protocol (GTP)

Internet Protocol over Ethernet (IPoE)

Layer 2 Tunneling Protocol (L2TP)

Multiprotocol Label Switching (MPLS)

Multi-Service BNG (MS-BNG)

Residential Gateway (RG)

Point to Point Protocol (PPP)

PPP over Ethernet (PPPoE)

Control and Provisioning of Wireless Access
Points (CAPWAP)



SECURITY

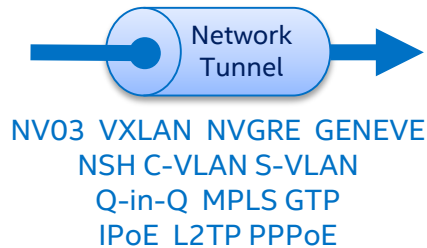
Internet Protocol Security (IPsec)

Encapsulating Security Payloads (ESP)

Authentication Headers (AH)

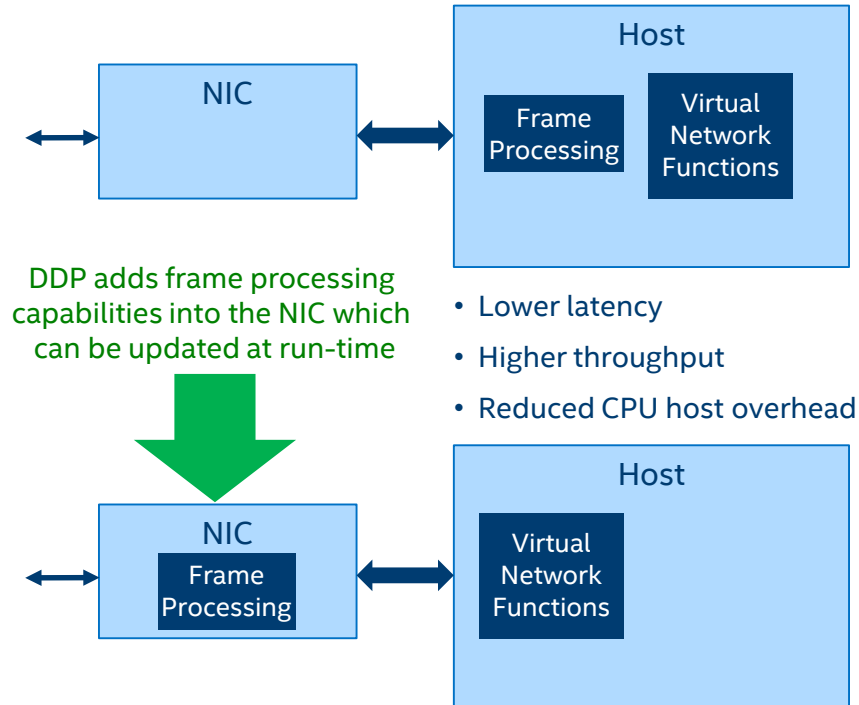
Security Associations (SA)

The Need for Dynamic Device Personalization (DDP)



Support for Evolving Network Tunneling Protocols

Flexible frame processing pipeline can adopt new protocols reducing host CPU overhead



DDP supports new protocols - **increases packet throughput, reduces packet latency** for Intel® Ethernet 700 Series and Intel® Ethernet 800 Series

Dynamic Device Personalization (DDP)

RUN-TIME PROGRAMMABILITY

Packet pipeline customization to meet a wide range of customer deployment needs

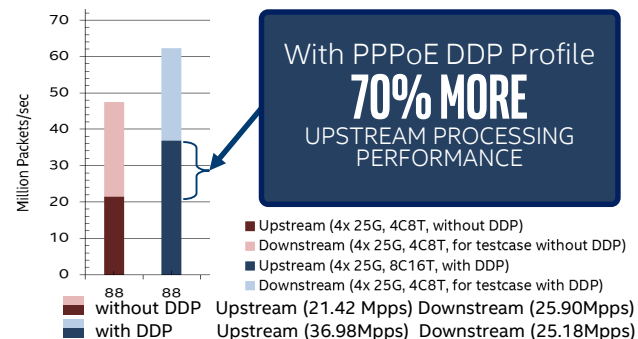
Available on
Intel® Ethernet 700 Series

OPTIMIZE PERFORMANCE

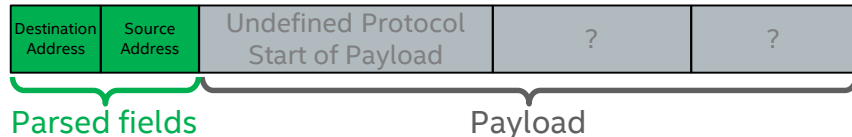
- Lower Latency
- Higher Throughput
- Improved CPU Utilization

Improved Packet
Processing Efficiency

Broadband Remote Access Server (BRAS) Aggregated Forwarding Test

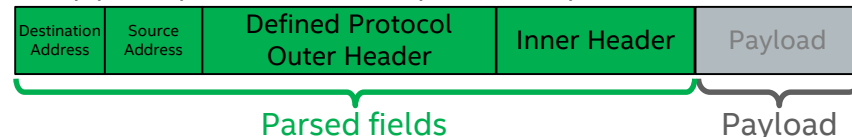


Unsupported protocols in the pipeline rely on the host to parse them



Dynamic Device Personalization (DDP) profile enabled

The pipeline parser can look deeper into the packets



AVAILABLE NOW

See user guide on the Intel Developer Zone
<https://software.intel.com/en-us/articles/dynamic-device-personalization-for-intel-ethernet-700-series>

Intel® Ethernet 700 Series DDP Profiles

Publicly Released: GTPv1, PPPoE

Others: MPLSoGRE/MPLSoUDP, L2TPv3, QUIC, IPv4 Multicast, 4G Fronthaul, eCPRI, VXLAN-GPE, IPsec

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Source: Intel internal testing as of November 2017. ¹ Features & schedule are subject to change. Calculation: Upstream DDP vs w/o DDP ((36.98-21.42)/21.42*100%) = 72.6%

Summary of Dynamic Device Personalization (DDP)

When used with DPDK

Enables processing of new protocols using existing hardware

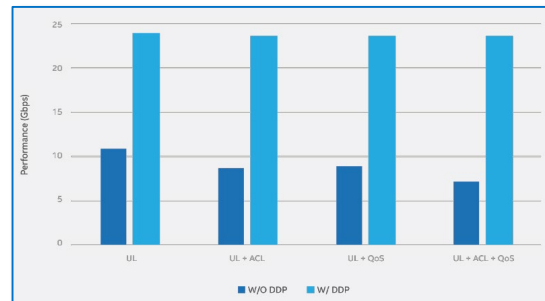
- Intel® Ethernet 700 and 800 Series
- Industry standard or custom profiles

Intel provides a wide variety of 700 and 800 Series products

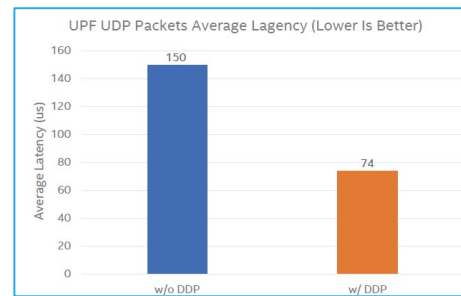
- 10GbE, 25GbE, 40GbE, 100GbE
- PCI-Express* or OCP* form factors
- Single, dual or quad ports

Improves network performance while reducing CPU utilization

- Improves packet per second processing rates
- Reduces processing latency and latency variation
- Reduces CPU utilization



2-3x throughput improvement in vBNG test case¹



2x latency reduction with TCP in GTP-U traffic test case²

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¹Data from Intel-NetElastic [white paper](#) ²Data from Intel-ZTE [case study](#)

*Other names and brands may be claimed as the property of others



Intel® Ethernet Controller E810

General Purpose Ethernet Controller with Programmable Pipeline for broad deployment

Features

Three SKUs:

- **E810-CAM2(100Gb throughput):**25x25mm; PCI Express* 4.0/3.0 x16/x8; 2x100Gb, 8x10Gb, and more
- **E810-CAM1(100Gb throughput):**25x25mm; PCI Express* 4.0/3.0 x16/x8; 1x100Gb, and more
- **E810-XXVAM2(50Gb throughput):**21x21mm; PCI Express* 4.0/3.0 x8; 1x50Gb, 2x25Gb, and more

NFV and Network Virtualization Overlay (NVO) Support

- **Dynamic Device Personalization (DDP) with fully programmable pipeline for flexible frame format support**
- **Intelligent Flow Direction:** Receiver Side Scaling (RSS), Intel® Ethernet Flow Director, **Application Device queues (ADQ)**
- **Comprehensive Network Virtualization Overlay protocols Support**
- **vSwitch Assist**
- **QoS:** Priority-based Flow Control(802.1Qbb); Enhanced Transmission Selection(802.1Qaz); Differentiated Services Code Point (DSCP)

Server Virtualization Support

- SR-IOV: 8PFs, 256VFs, 256 Queues per PF, 2k queue pairs total, 768 VSIs;
- **Adaptive VF driver;**
- Programmable Virtual Ethernet Bridging (VEB) with **ACL**;
- Virtual Machine Device Queue (VMDq); Virtual Machine QoS (VMQoS)

Remote Direct Memory Access (RDMA)

- **Both iWARP and RoCEv2 support selectable via software per port**

Storage Networking

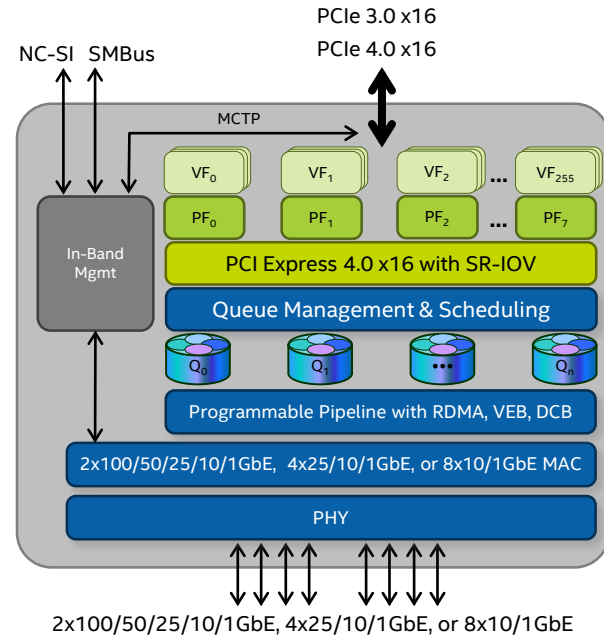
- Data Center Bridging (DCB);
- Stateless L3/L4 offloads for iSCSI, NAS, NFS;
- Server Message Block (SMB)

Precision Clocks Synchronization

- IEEE 1588 PTP/802.1AS

Management

- **NC-SI 1.1, MCTP over SMBus, MCTP over PCIe, OS2BMC;**
- **PXE boot support and EFI based iSCSI boot;** WoL (Wake On LAN);





INTEL® XEON® PROCESSOR SCALABLE FAMILY

NFV SKU



Intel Networking/NFV Specialized SKUs

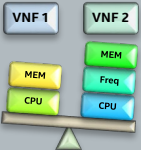
– 5218N, 6230N and 6252N

1

SPEED

Incremental ~10% Performance Increase (2.3GHz vs 2.1GHz)¹ without any code changes on NFV workloads for 6230N & 6252N

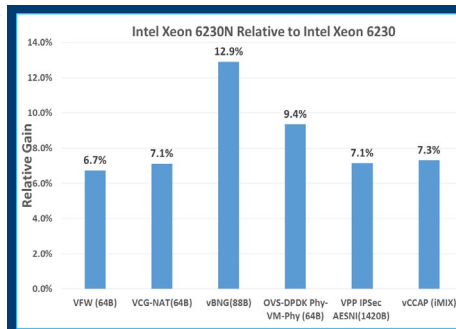
2



Dynamic configuration of CPU Frequency Boost Performance for target NFV Workload at Runtime

¹Exclude 5218N, 5218N provides Thermal Design Specification at 110W over 5218 at 125W

²Please contact your vendor for product support details



1 2 3 4
vRTR vFW vLB vSW
All running at rated frequency Without enabling SST-BF

2.3GHz



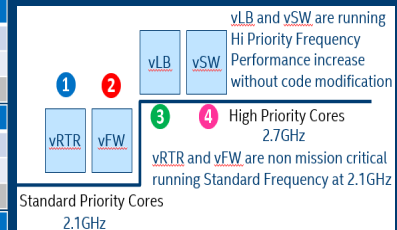
Performance at same TDP

Intel® Speed Select Technology – Base Frequency

CLX 6252N (24C@2.3ghz @ 150W)			
High Priority		Standard Priority	
Cores	Base Freq	Cores	Base Freq
8	2.8 (GHz)	16	2.1 (GHz)

CLX 6230N (20C@2.3ghz @ 125W)			
High Priority		Standard Priority	
Cores	Base Freq	Cores	Base Freq
6	2.7 (GHz)	14	2.1 (GHz)

CLX 5218N (16C@2.3ghz @ 110W)			
High Priority		Standard Priority	
Cores	Base Freq	Cores	Base Freq
4	2.7 (GHz)	12	2.1 (GHz)



Performance Boost for VNF

Performance results are based on testing Intel as of 2/4/2019 and may not reflect all publicly available security updates. See configuration disclosure for details. No product or component can be absolutely secure. Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more complete information visit www.intel.com/benchmarks.

1 ~10% PERF INCREASE (2.3GHZ VS 2.1GHZ) WITHOUT ANY CODE CHANGES (6230N vs. 6230)

SKX SKUs

16C 2.1G 125W 6130 \$1,894

CLX SKUs

20C 2.3G* 125W 6230N

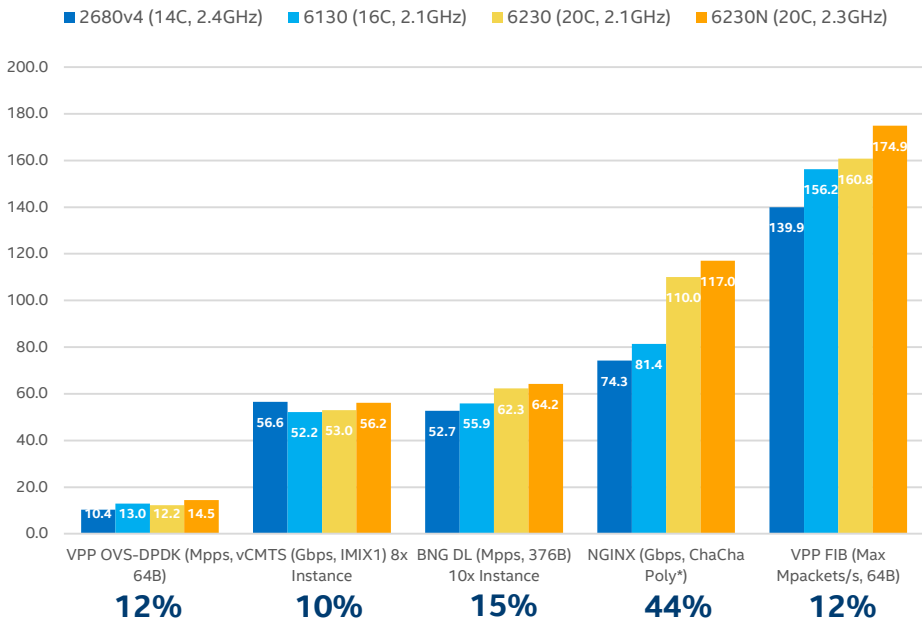
20C 2.1G 125W 6230

List Price as of 3/10/20

Network/NFV Specialized SKU

	6130	6230N
Cores	16	20
Freq	2.1	2.3
TDP	125W	125W
**List Price	\$1,894	\$1,452
Price difference		-23%

Network/NFV specialized SKU 6230N enables higher P1 freq and enable improved energy efficiency while delivering up to 44% performance increase



G2G Perf

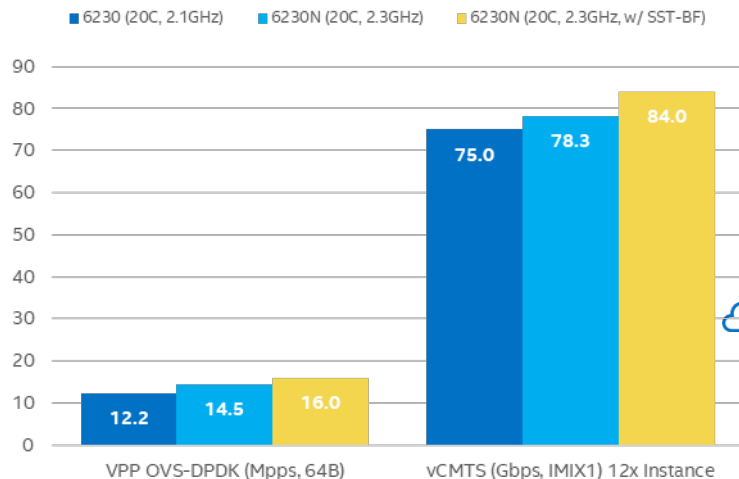
12% 10% 15% 44% 12%

Performance results are based on testing by Intel as of 8/8/2019 and may not reflect all publicly available security updates. For more complete information about performance and benchmark results, visit www.intel.com/benchmarks. See configuration slide for details. For optimization, please visit <https://software.intel.com/en-us/articles/optimization-notice>.

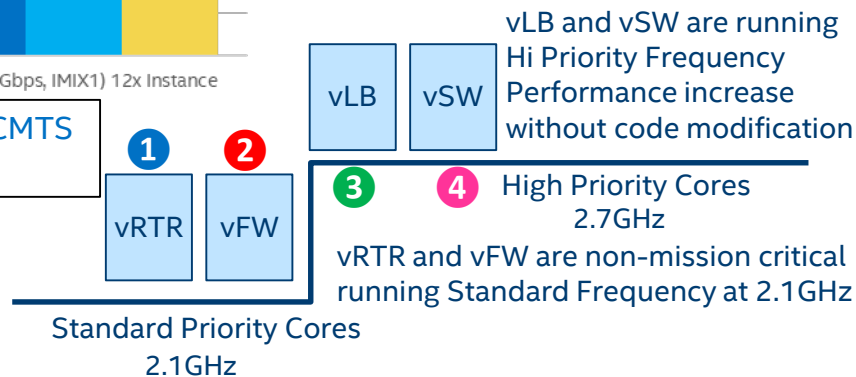
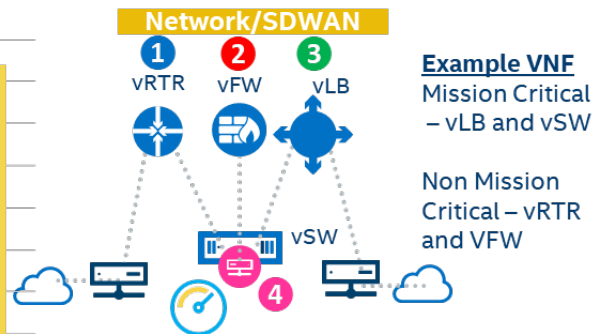
*ECDHE-RSA2K CHACHA20-POLY1305

2 DYNAMIC CONFIG OF CPU FREQUENCY DELIVERS MORE PERFORMANCE FOR NFV

CLX 6230N (20C@2.3ghz @ 125W)			
High Priority		Standard Priority	
Cores	Base Freq	Cores	Base Freq
6	2.7 (GHz)	14	2.1(GHz)



SST-BF enables an increase of 31% for VPP OVS-DPDK & 12% for vCMTS compared to standard CLX SKU

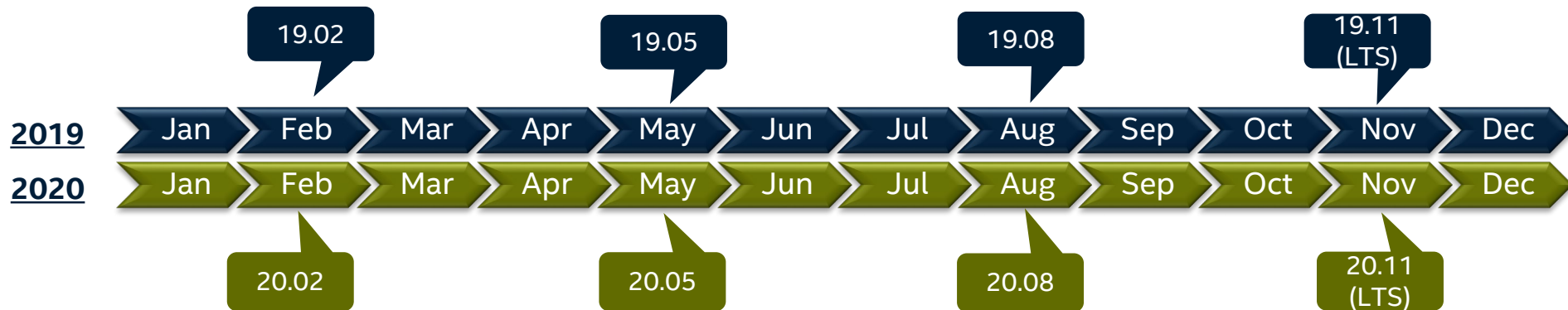


DPDK ROADMAP



2019 & 2020 Releases

Using Ubuntu* numbering scheme of YY.MM as of 16.04



DPDK Long-Term Support (LTS) provides a stable release maintained for 2 years with back-ported bug fixes. Provides a stable target on which to base applications or packages.

- Bug fixes that do not change the ABI will be back-ported.
- In general, new features will not be back-ported. There may be occasional exceptions where the following criteria are met:
 - There is a justifiable use case (for example a new PMD).
 - The change is non-invasive.
 - The work of preparing the back-port is done by the proposer.
 - There is support within the community.

DPDK Roadmap Priorities

New Hardware Support

- CPUs, standard NICs, smart NICs, look-aside and inline accelerators, coherent FPGAs, programmable accelerator cards etc.
- DPDK FPGA reference layer



Common Acceleration APIs

HW Accel

SW Accel

Hardware Abstraction (Acceleration APIs)

- Completion of compression
- Intel QAT acceleration for asymmetric crypto
- Hardware acceleration for eventdev (HQM) and bbdev

Power Management

- Provide intelligence to match power consumption to processing load
- Expose CPU power management features through DPDK



DPDK Roadmap Priorities

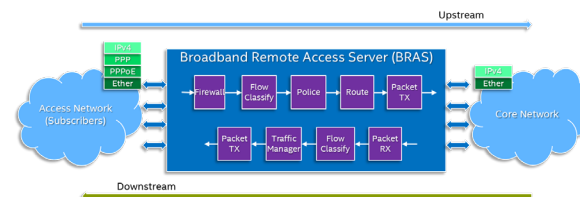


Cloud Friendly Features

- Dynamic memory allocation
- Improved sharing of I/O resources. Improved usability/configurability

Next-Generation Central Office (NGCO)

- Functional improvements and performance optimizations to support NGCO initiative
- QoS enhancements to support vRouters



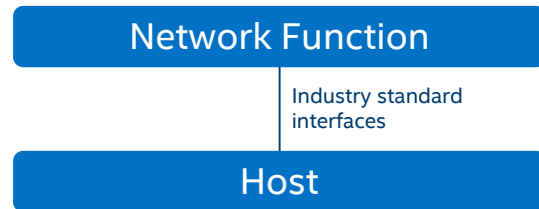
Security Protocol Acceleration

- Native DPDK IPsec library to support hardware and software acceleration
- Optimized SA/SP database look-up to improve scalability

DPDK Roadmap Priorities

Network Function (VNF/CNF) Abstraction

- Continued enhancements to vhost-virtio (performance improvements, virtio 1.1, mdev, memif, hotplug/live migration etc.)
- Intel® Ethernet Adaptive Virtual Function software back-end to support vswitch and live migration



Broad Market

- Support for DPDK on Windows, Azure, VMware

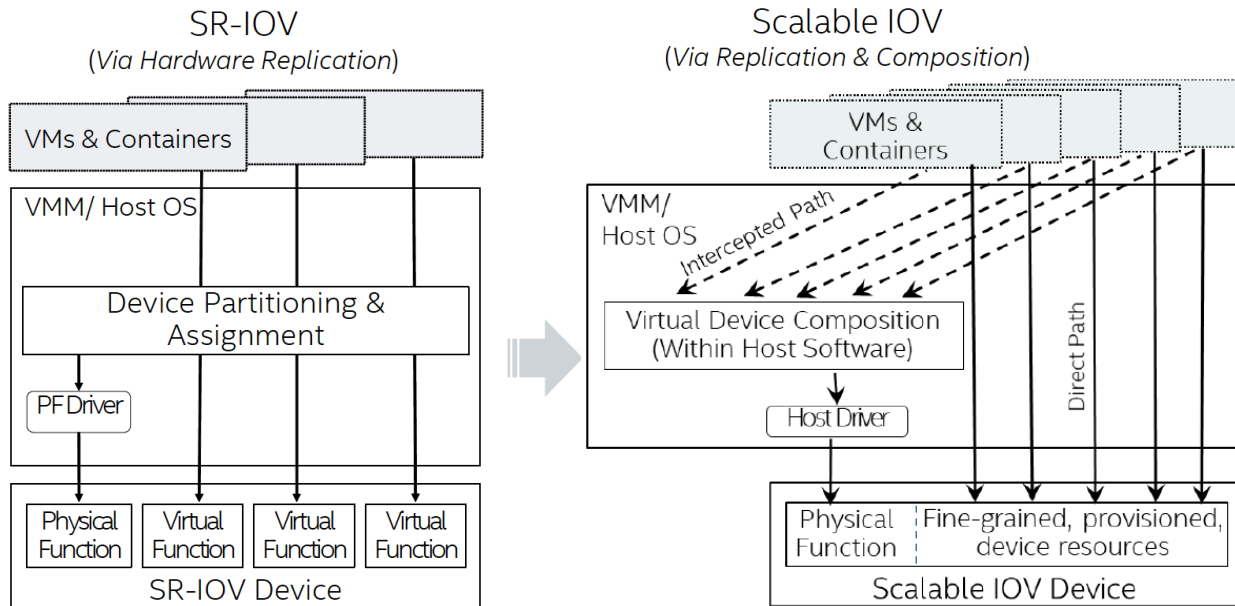
Notes:

1. Items listed in this slide and the previous two slides are not in priority order.
2. Roadmap is subject to change without prior notice.

INTEL[®] SCALABLE I/O VIRTUALIZATION



SR-IOV と Intel® Scalable IOV



Intel® Scalable I/O Virtualization Technical Specification

Sep 2020, Reference Number: 337679-002, Revision: 1.1 and Jun 2018, Reference Number: 337679-001, Revision: 1.0

<https://software.intel.com/sites/default/files/managed/cc/0e/intel-scalable-io-virtualization-technical-specification.pdf>

FURTHER INFORMATION



- Plan on attending a future Summit to get involved and make connections. Find out about events at <https://www.dpdk.org/events/>
- Check out the great video content from the years full of useful information and ideas of new concepts and how to get better performance. All sessions will be recorded and available on the [DPDK YouTube Channel](#) after the events



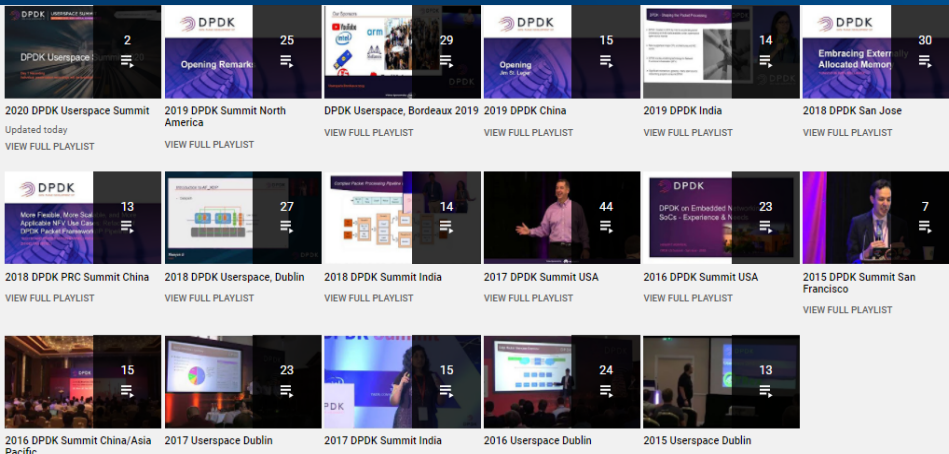
USERSPACE SUMMIT

SEPTEMBER 22-23, 2020 • VIRTUAL EXPERIENCE

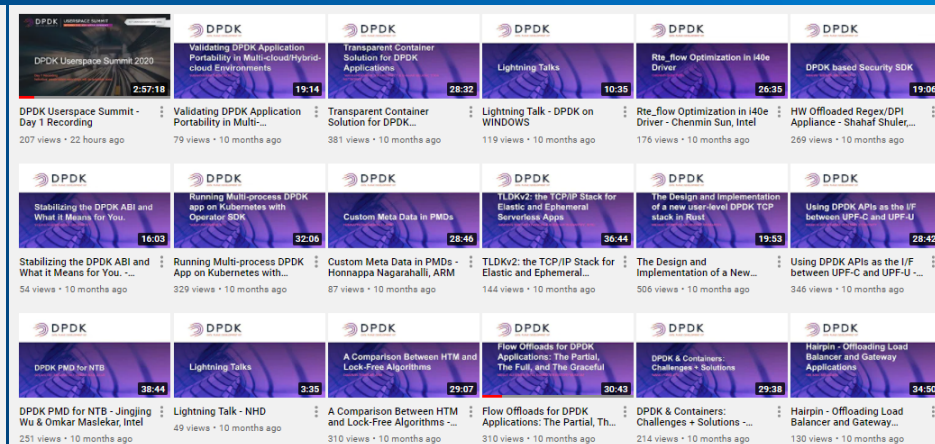
2020 Topics

Story of perfect system tuning for latency measurement
 DPDK for ultra low latency applications
 Do DPDK APIs provide the highest performance?
 Introducing flow performance application
 Debugging DPDK applications using rr
 eBPF Probes in DPDK applications for troubleshooting and monitoring
 Cheat sheet to migrate from GNU make to meson
 Stateful Flow Table (SFT) - Connection tracking in DPDK
 Device virtualization in DPDK
 vDPA: on the road to production
 Key take aways from QUIC acceleration with DPDK
 Accelerating O-RAN fronthaul with DPDK

Summits from the years & different locations



Video's from all the summits available



WHAT ARE EXPERIENCE KITS?

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Architecture



Feature
Briefs



SW
Script



Feature Application
Notes



Benchmark
Report



DEMOS

Check the Network Transformation Experience Kits on Intel Network Builder:
<https://networkbuilders.intel.com/network-technologies/network-transformation-exp-kits>

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Notice revision #20110804

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