

State of Open Networking & Edge - Implications for Data Plane

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GM, Networking, Edge & IOT

The Linux Foundation

 THE **LINUX** FOUNDATION

 **LF** NETWORKING

 **LF** EDGE

What is the Buzz in the Open Source Ecosystem?

How the SmartNIC ecosystem take advantage of this disruption

1

LF Intro

2

End to End Solutions & Use Cases

3

Where is Open Source Heading?

1









Linux Foundation Overview



The Linux Foundation's goal is to create the **greatest shared technology investment in history** by enabling open collaboration across companies, developers and users.

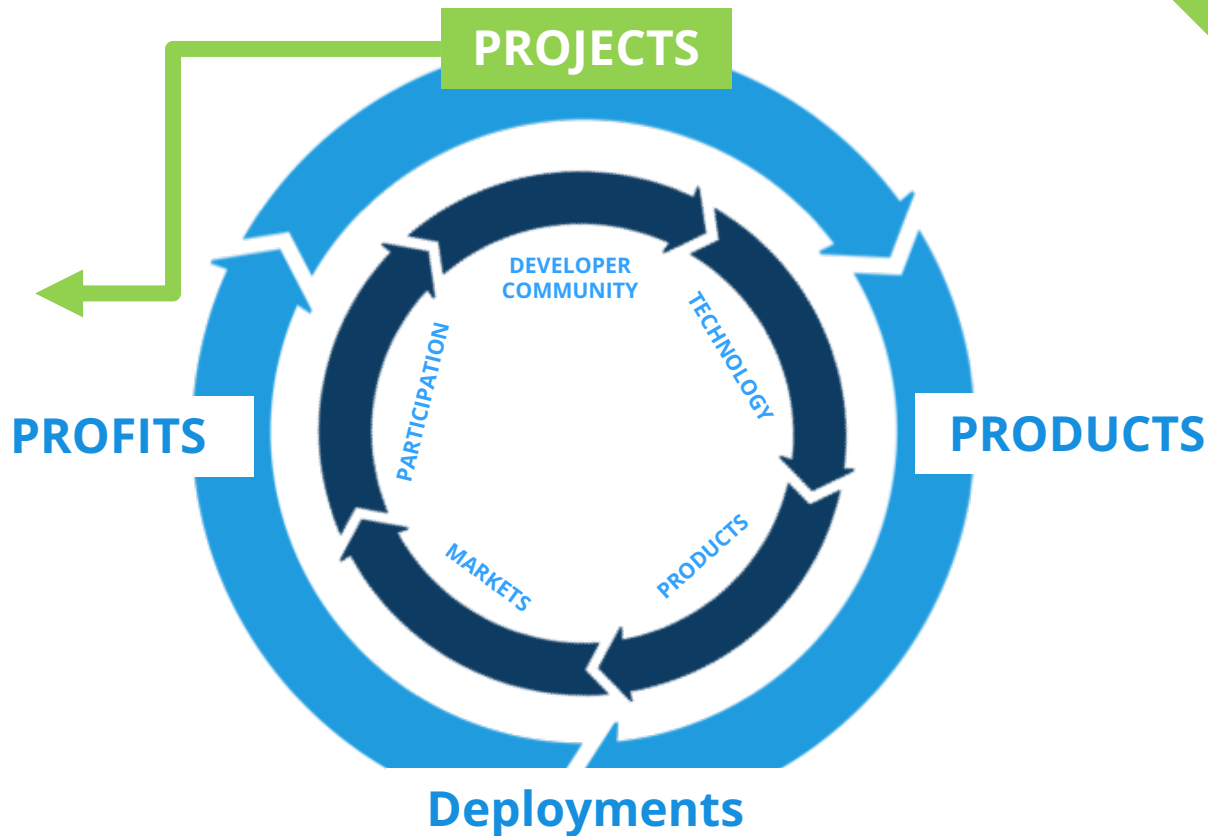
We are the nonprofit organization of choice to **build ecosystems** that **accelerate** open source technology development and commercial adoption on a global scale.

We are behind some of the most critical projects in the world

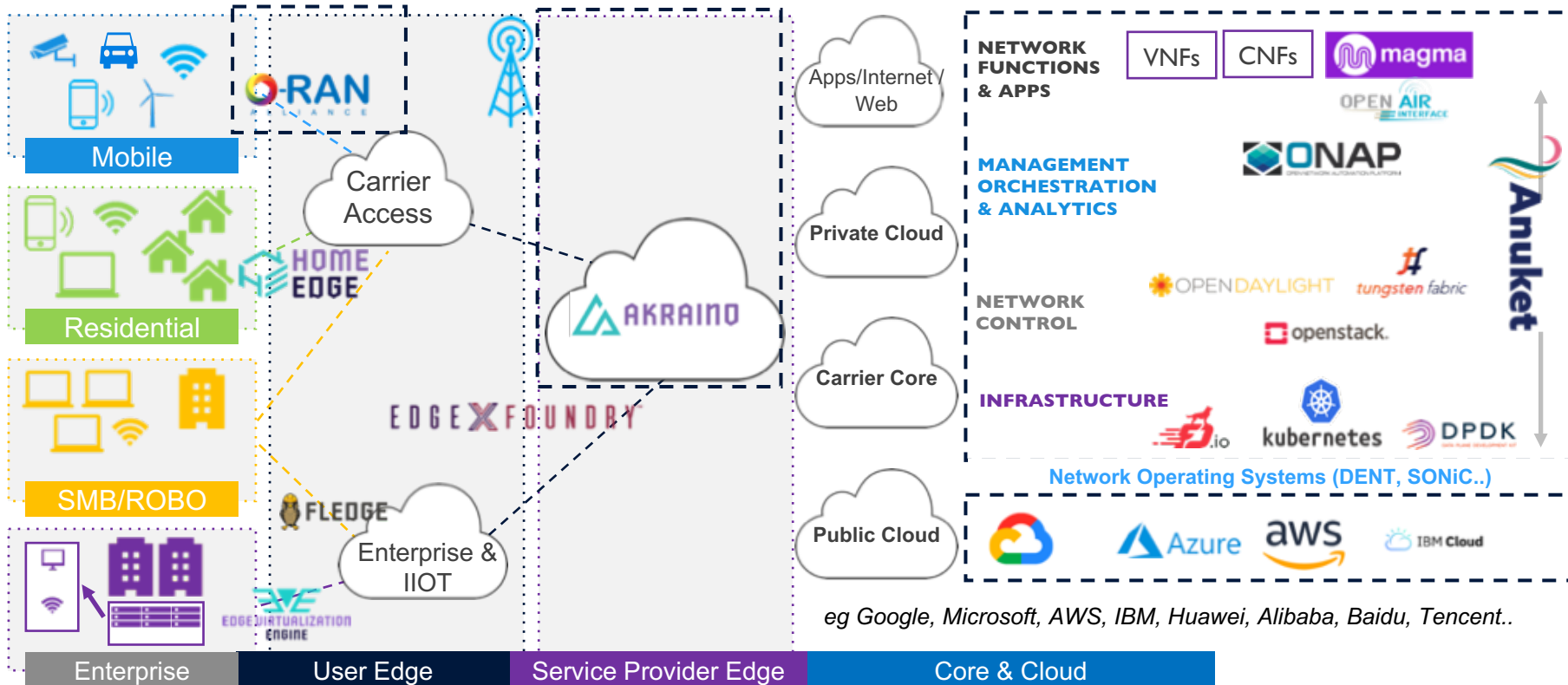
Security	 Let's Encrypt	 CORE INFRASTRUCTURE INITIATIVE	 OpenSSF OPEN SOURCE SECURITY FOUNDATION	 Falco	 ./rtp	 CONFIDENTIAL COMPUTING CONSORTIUM	 SEL4 Security Performance Proof	 OPEN SECURITY CONTROLLER	
Networking	 OLF NETWORKING	 ONAP	 OPEN DAYLIGHT	 redpanda.io	 Anuket	 SONIC	 DENT	 ODANOS	
Cloud	 CLOUD NATIVE COMPUTING FOUNDATION	 kubernetes	 argo	 envoy	 KUDO	 Crossplane	 CLOUD FOUNDRY		
Automotive	 AUTOMOTIVE GRADE LINUX	 ELISA ENABLING LINUX IN SAFETY APPLICATIONS	 KernelCI						
Blockchain	 HYPERLEDGER	 HYPERLEDGER FABRIC	 HYPERLEDGER SAWTOOTH	 ACCORD PROJECT	 ERGO	 DIF			
Edge/IoT	 OLF EDGE	 yocto PROJECT	 Zephyr™	 ACRN	 Dronecode	 FLEDGE	 SOUND OPEN FIRMWARE	 OpenEEW	
Web	 node	 OpenJS Foundation	 GraphQL	 appium®	 jquery	 REACTIVE FOUNDATION	 DOJO	 ESLint	
AI	 OLF AI	 ONNX	 DELTA LAKE	 ForestFlow	 JanusGraph	 kepler.gl	 LDWIG	 soda Foundation	
Film	 ASWF ACADEMY SOFTWARE FOUNDATION	 OpenColorIO	 OpenVDB	 OpenEXR	 OpenTimelineIO	 OpenEXR	 OSL Open Shading Language		
CI/CD	 cd CD FOUNDATION	 Jenkins	 Spinnaker	 TEKTON	 TERN	 StackStorm	 Vitess	 etcd	 SPIRE
Energy	 OLF ENERGY	 OLF ENERGY RIAPS	 OLF ENERGY EM2	 OLF ENERGY POWSYBL	 OLF ENERGY GXF	 OLF ENERGY CoMPAS	 OLF ENERGY OPENEEMETER	 OLF ENERGY OPERATORFABRIC	
Hardware	 RISC-V	 OpenPOWER™	 CHIPS ALLIANCE	 UNIMATRIX		 3MF CONSORTIUM			
Standards	 ALLIANCE FOR OPEN MEDIA	 OPENCHAIN	 COMMUNITY DATA LICENSE AGREEMENT	 JOINT DEVELOPMENT FOUNDATION	 CLOUD INFORMATION MODEL	 CHAOSS		 OPEN MANUFACTURING PLATFORM	

Open Source Journey – First Come Projects

Successful Open Source Development depends on the complete life cycle of projects, products that market will adopt and deploy



End to End Open Source Software Collaboration



eg Google, Microsoft, AWS, IBM, Huawei, Alibaba, Baidu, Tencent..

2

End to End Solutions and Use cases

Vertical Market Adoption of End to End Open Source Software

OPEN NETWORKING, EDGE AND IOT MARKET ADOPTION



Industrial
Manufacturing



Energy (Oil,
Gas Utilities)



Commerce &
Retail



Home



Automotive



Fleet &
Transportation



Logistics



Building
Automation



Cities &
Government



Healthcare



ENTERPRISE NETWORKING

1. Private Networks 5G/LTE
2. Workloads across Multi-clouds
3. End to end visibility and monitoring



SERVICE PROVIDERS

1. Built on end to end open source 5G & edge
2. Developing countries with 5G and edge
3. Global connectivity



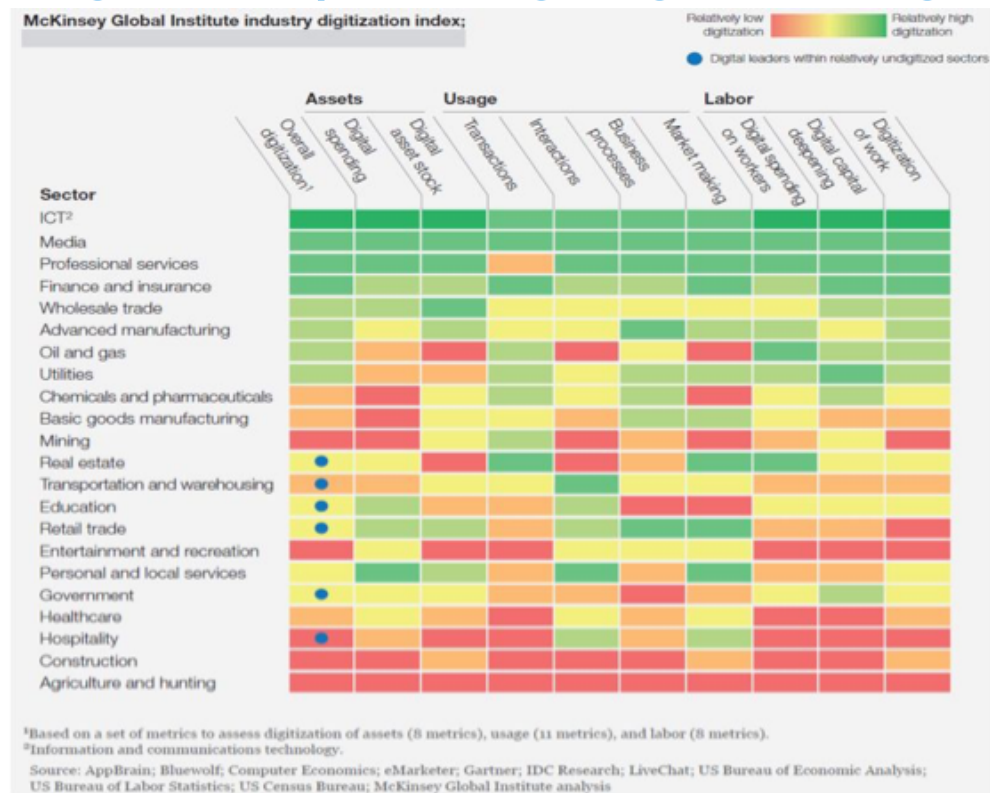
END USERS, GOVERNMENTS

1. Built on Open Source projects
2. Open Solutions and Blueprints
3. Unified Cloud, Enterprise, Telco

5G SUPER BLUEPRINTS BUILT ON END TO END OPEN SOURCE PROJECTS



Edge Compute aligning with Digital Transformation



Verticals with higher level of Digital transformation are taking advantage of Edge Compute & Open Source

Open Source foundations + Standards + Alliances 2022

Open Source Software Foundations

- ✓ Linux Foundation & its sub-foundations (LFN, LF Edge, CNCF, Magma, ORAN, LF Energy...)
- ✓ Open Infrastructure Foundation (Openstack, Magma)
- ✓ Eclipse Foundation (Edge)
- Others (Single Vendor/Open)

Standards/Specs/Ref Arch/API

- ✓ GSMA (LFN, OPG, CAMARA)
- ✓ ETSI (Edge, Core)
- ✓ 3GPP
- ✓ ORAN Alliance (RAN)
- ✓ NGMN (Disagg, Green, 6G)
- ✓ TMForum (API)
- ✓ MEF (API)
- TIP (Open hardware)
- IETF (Lower Layers)
- ✓ OCP (Co-Design hardware-software)

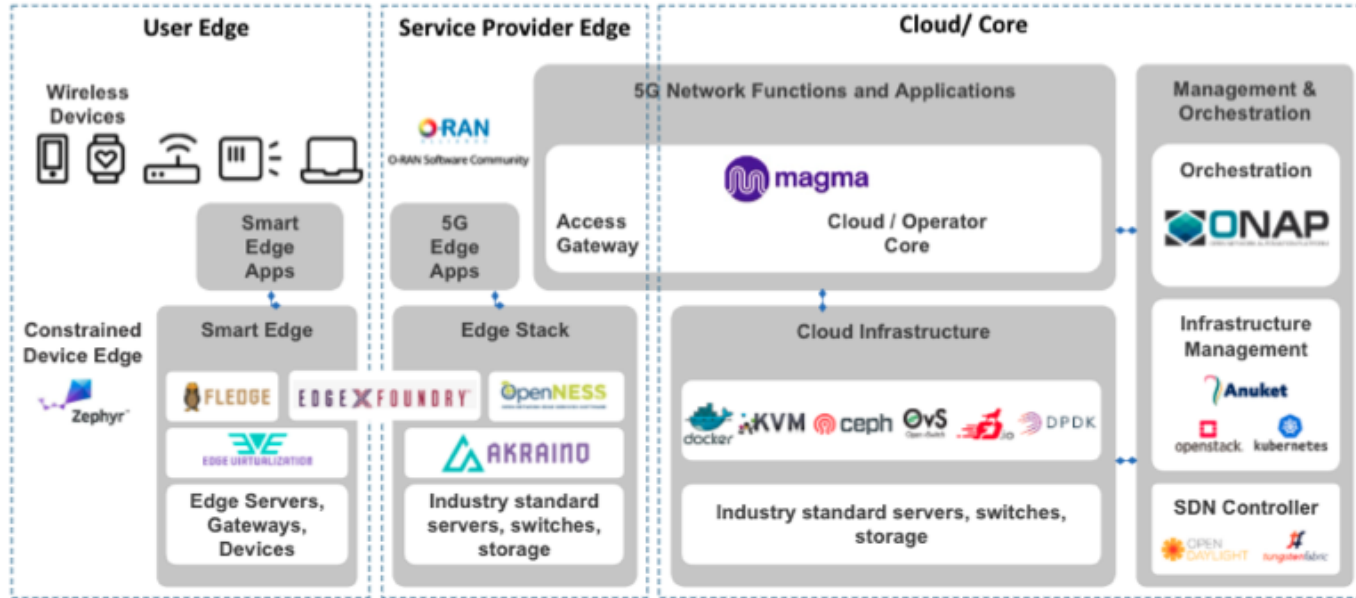
Open Alliances & Consortia

- ✓ AECC
- ✓ IIC
- ✓ Digital Twin Consortium
- ✓ IOTA Foundation
- ✓ Open-IX
- ✓ Several Vertical specific

Collaboration has increased significantly across foundations, SDOs, Alliances and Consortia

Multi-Collaboration in an Open World Takes Center Stage With Super Blueprints

LF Open Source Component Projects for 5G



Learn more: <https://www.lfnetworking.org/5g-super-blueprint/>

Read the FAQ: <https://wiki.lfnetworking.org/display/LN/5G+Super+Blueprint+FAQ>

SmartNIC & Open Source Use Cases

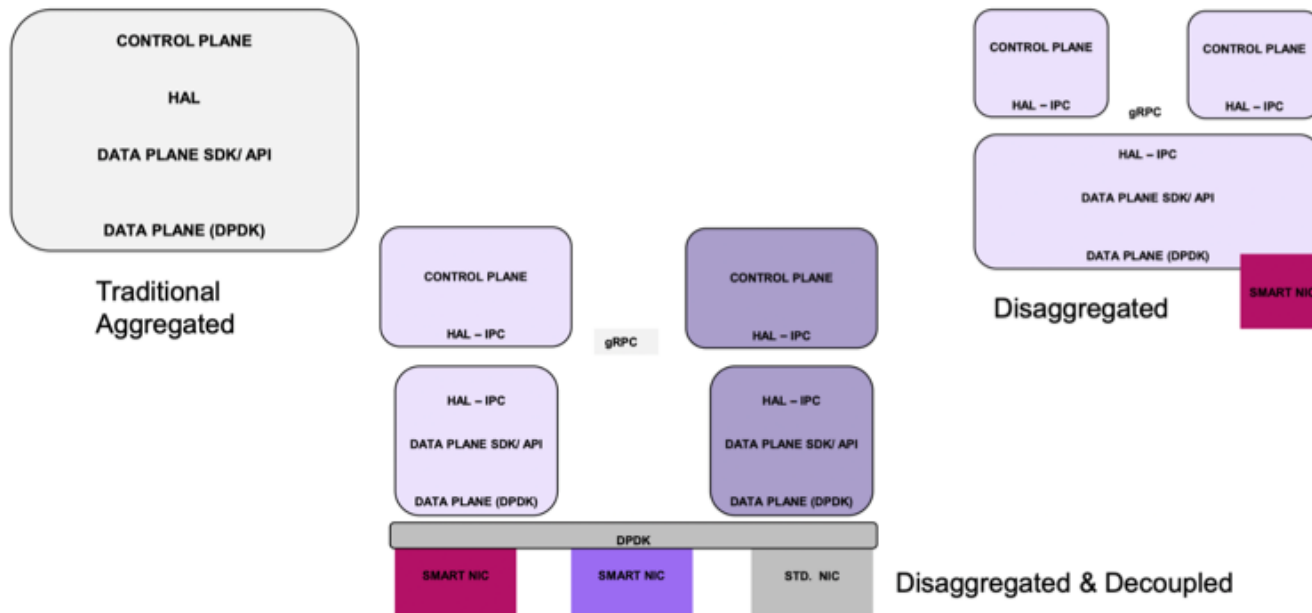
Unparalleled Packet Processing + No Vendor Lock-in

- Act as a mini server, mini network switch, or storage accelerator unit
- Telco & Enterprise Use cases
 - a. 5G—containerization of network mobile components
 - b. Network Functions & acceleration of Traffic
 - c. Network Slicing
 - d. Private 5G with SmartNICs
- Edge Use Cases
 - a. IoT
 - b. Security
- AI/ML Offload
 - a. Data & Video analytics
 - b. Machine Learning (ML)
 - c. Connect directly to GPU

SmartNIC & Open Source Solutions

Software Architectures for Telco VNFs

CP-DP Disaggregated Models

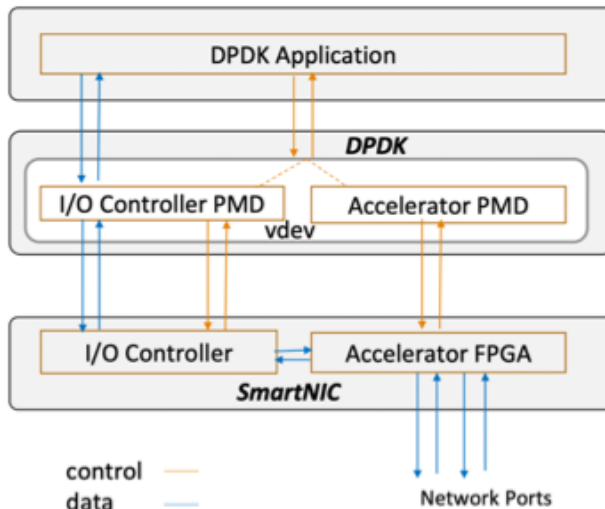


SmartNIC & Open Source Solutions

DPDK and Smart NICs



- Wrapper vdev encapsulates Accelerator PMD and I/O Controller PMD
- Any I/O Controller & any accelerator can be used
- Active/Active mode
- Application sees a single entity
- Split logic is inside wrapper
- Application transparency



SmartNICs built on/
leveraging DPDK tooling:

[Netronome](#)

[Bittware's SmartNIC
Shell for
PacketProcessing](#)

[DPDK on NVIDIA
Bluefield SmartNIC](#)

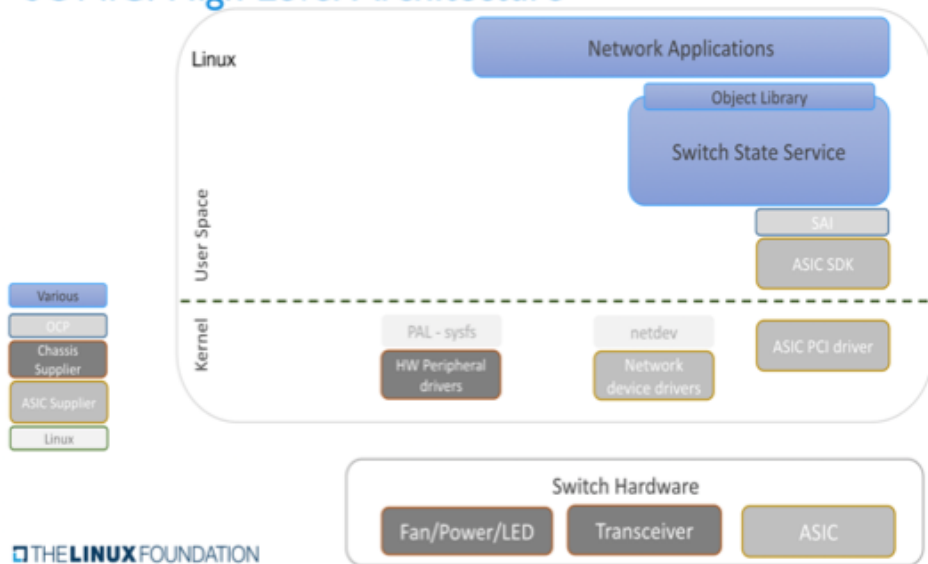
[Napatech](#)

[Intel](#)

SmartNIC and SONiC

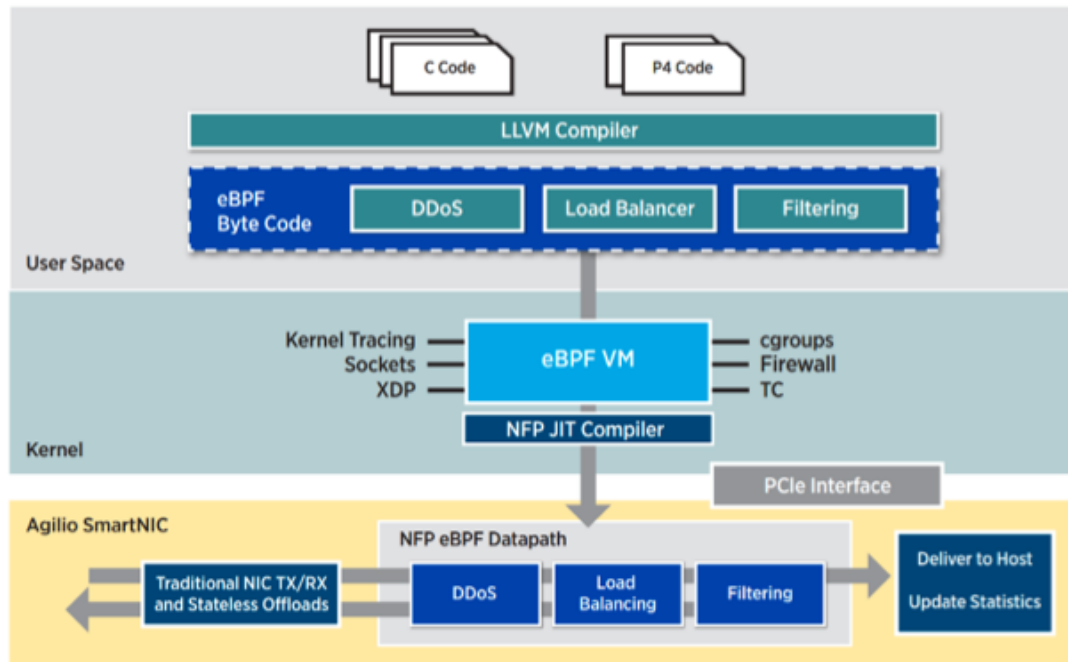


SONiC: High Level Architecture



- › Containerized components of SONiC NOS can run on SmartNICs
- › Customized for Hardware Integration based on Switch Abstraction Interface
- › SmartNICs + P4 programmability
- › Value
 - › Offloads networking and security functions
 - › Allows for acceleration engines to tackle a variety of tasks including encryption/decryption, firewalling, packet inspection, routing, storage networking, monitoring, telemetry, observability

eBPF & SmartNICs



Use Cases

- › OVS, vRouter, SSL/SSH visibility, virtual firewall, and eBPF programs.
- › Pre-built eBPF functions for XDP offload, TC (traffic classification) offload, match/action, filtering, load balancing, DDoS mitigation, and chained filter functions.

Examples

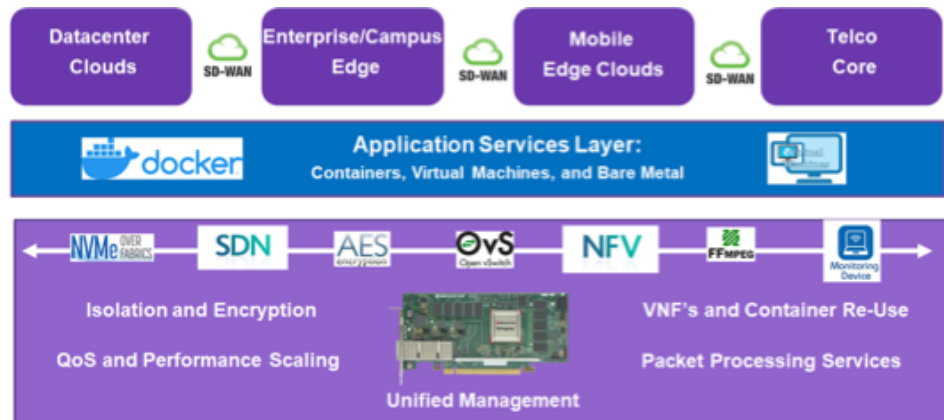
- › Netronome has been using eBPF as a standard interface for their SmartNICs, and developed a compiler that translates eBPF programs to SmartNIC code
- › Throughput of an NFP-offloaded bpf filter was 5.5-times that of the same rules processed via iptables in the host CPU.

Source: packetpushers

LF Edge Akraino, IEC Type 5: SmartNIC



BP Family: IEC



Target Industry: Telco and other carriers

Purpose/Features:

IEC Type 5 is focused on SmartNIC, which can accelerate network performance and provide more management convenience. In general, the architecture consists of two layers: IaaS (IEC), SmartNIC layer. But in R4, we have two simple layers: Host Layer, SmartNIC Layer.

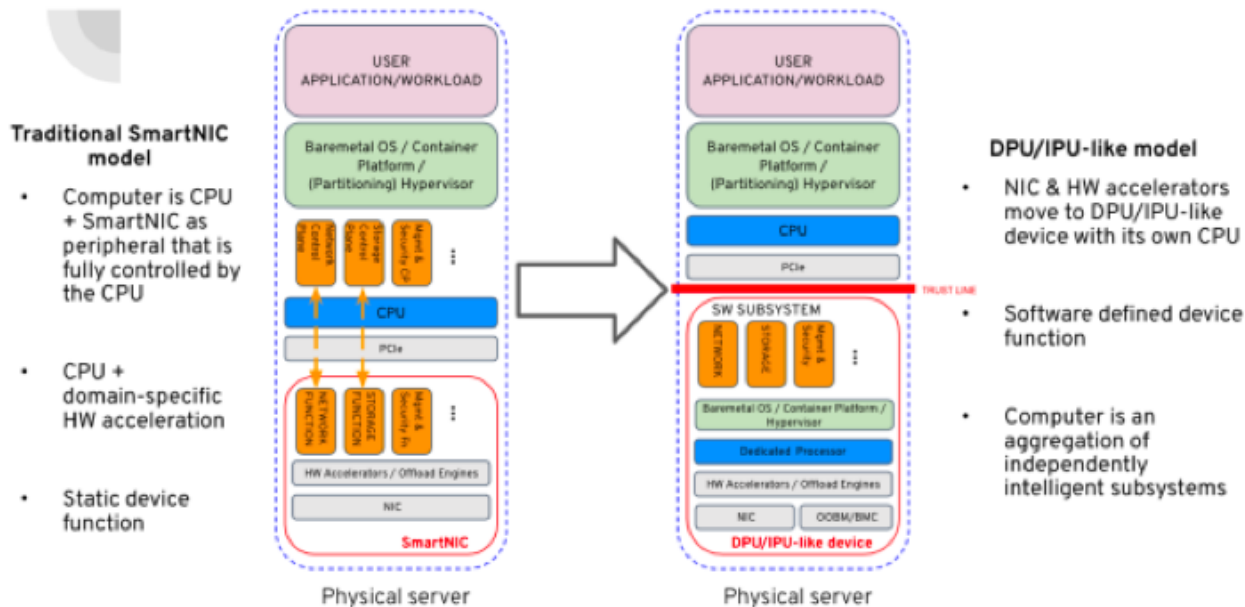
Use cases:

- **CT based OVS-DPDK offload into SmartNic:** accelerates network performance, saves computing resources and providing security managements.
- **Part of the UPF and VPC functions,** like load balancing, forwarding, dpi, etc offloaded into SmartNIC to enhance the performance of UPF that will be deployed in carrier's edge cloud datacenters

Other community open source projects

Diamond - Bluff Project (DPU/IPU model)

Generalized example of a new system architecture



Key Functions

- › Presence of their own GPU
- › The ability to boot a general purpose OS
- › Domain-specific HW acceleration capabilities
- › Software-defined device functions
- › Offloading of whole software subsystems, such as the Networking or Storage stack, including their control planes
- › Strict security isolation from the host on the hardware-level
- › Unique network identity
- › Out-of-band management

Open Source enables companies to unleash the power of SmartNICs while avoiding vendor lock in

Open Source collaboration on “non-differentiated” software speeds up innovation of standardized frameworks for Edge, IOT, Networking Use cases

3

Where is Open Source Heading

Research & Survey - Open Source Security



98
%

Use Open Source

95
%

Concerned about
Security

47
%

Use SBOMs

Open Source Security Research and Lessons Learnt



- ✓ Entire Software Development life cycle is important beyond Vulnerability Mgmt
- ✓ Packaging & Integration are part of the securing the entire software supply chain
- ✓ Top projects within domains determine the criticality of security

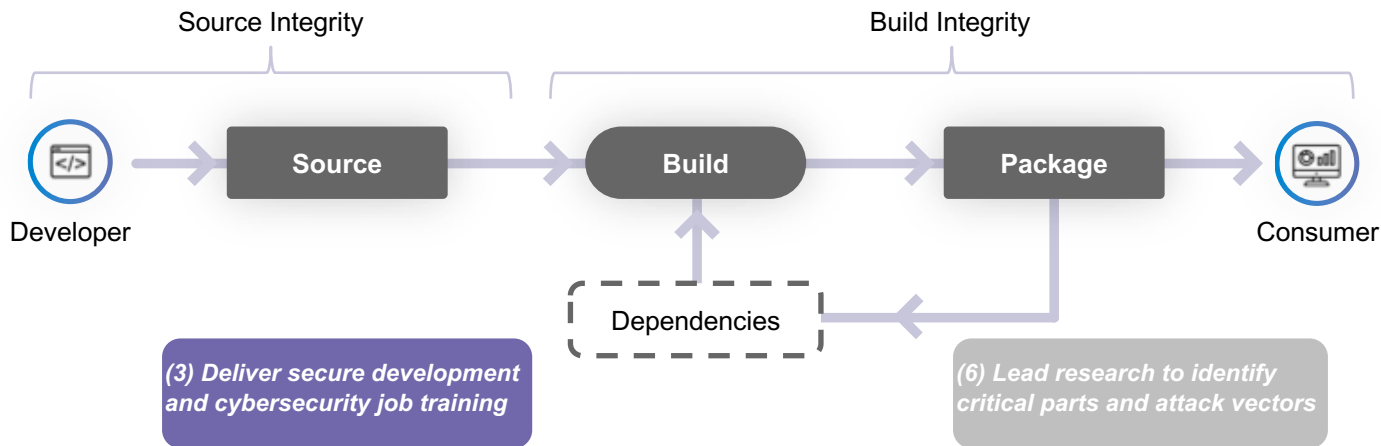
Securing the Open Source Supply chain - 6 top actions

(1) Secure 200 most critical components

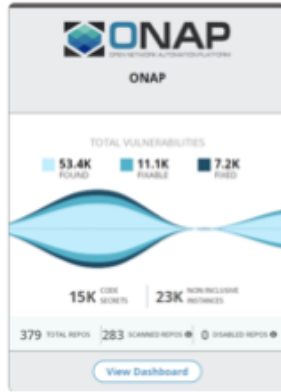
(2) Automated security tooling for 10,000 components

(4) Secure open source software “factories”

(5) Enable improved tracking and tracing with “SBOMs”

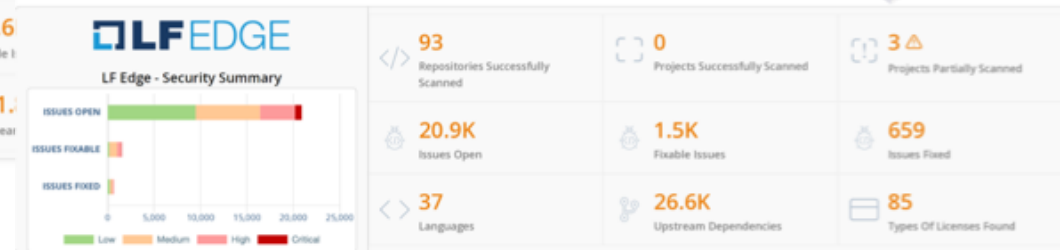


Networking and Edge - Open source security



Networking & Edge Projects
on track as leading examples
of secure open source

<https://security.lfx.linuxfoundation.org/#/>



Announcing a new white paper by LFN Security



Securing Open Source 5G from End-to-End

- Designing a Secure Architecture & Creating Best Practices
- Creating a Framework for Developing Secure Software
- Tracking & Managing Vulnerabilities
 - LFX Security
 - SBOMs
- 5G Super Blue Print

Please join: Work groups, Task forces, Security Committees - design through deployment

Next Big Things - 6G, Role of SmartNICs just got harder

6G - Driving Forces !

Pull from increasing expectations

Trustworthiness

trusted communication and computing for industry and society relying on critical information

Sustainable world

communication and networking as part of and enabler for sustainable development

Simplified life

massive use of AI across systems for optimal assistance and efficiency

Application demands

extended and new services requiring extreme connectivity performance

Push from technology advancements



Hardware
Generic HW acceleration, metamaterials, future devices



Open source
Higher reliance on open source components



Integrated AI
Widespread use of AI for automation and cost-efficiency in cognitive and data-driven networks



Cloud
Continued cloudification for cost/efficiency, also in RAN, adapted implementation/standard, programmability

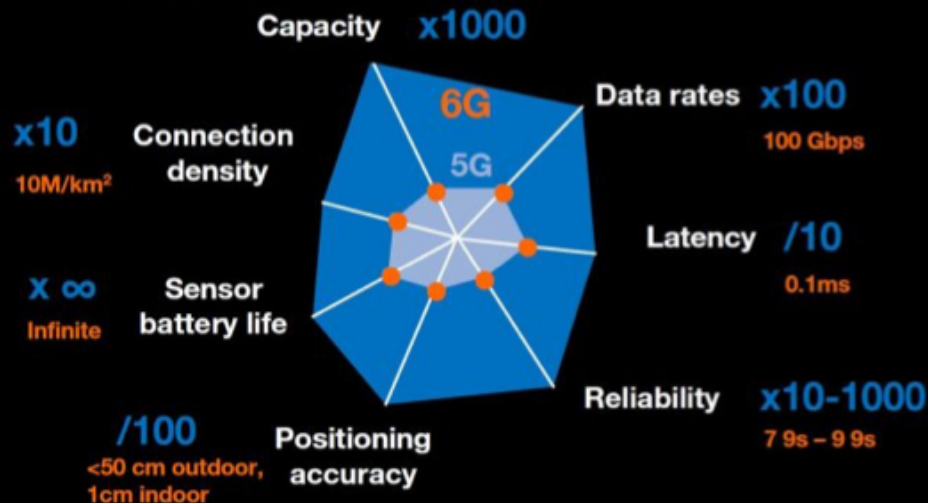


Continuous evolution
Fast evolution of underlying tools and development (DevOps) at a higher pace



Internet evolution
Distributed resilient services, evolving multi-path tailorable

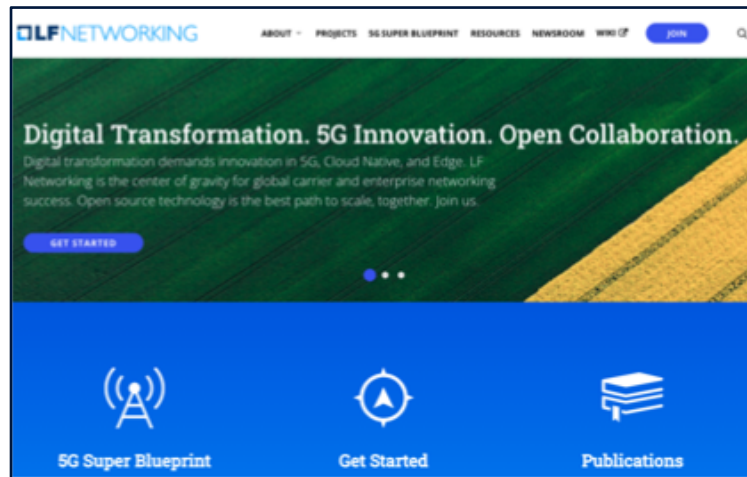
6G requirements, as proposed in the literature



Source: Ericsson

Call to Action

1. Expand your horizon on how end to end solutions are driving use of SmartNICs
2. Participate in Upstream open source data plane projects
3. Join the open revolution for your non-differentiated software



<https://www.lfnetworking.org/>

Open Source enables companies to reshape their industry value chain in ways that are both neutral (to create **Industry Platforms**) and that drive their own competitive goals (through active **Stakeholdership**)

www.linuxfoundation.org

 THE **LINUX** FOUNDATION