

OSN Days Nanjing

October 15, 2018

Phil Robb

V.P. Operations, Networking

 THE **LINUX** FOUNDATION

Networking is the fabric for Growth & Innovation Across Industries



Automotive

Connected Cars

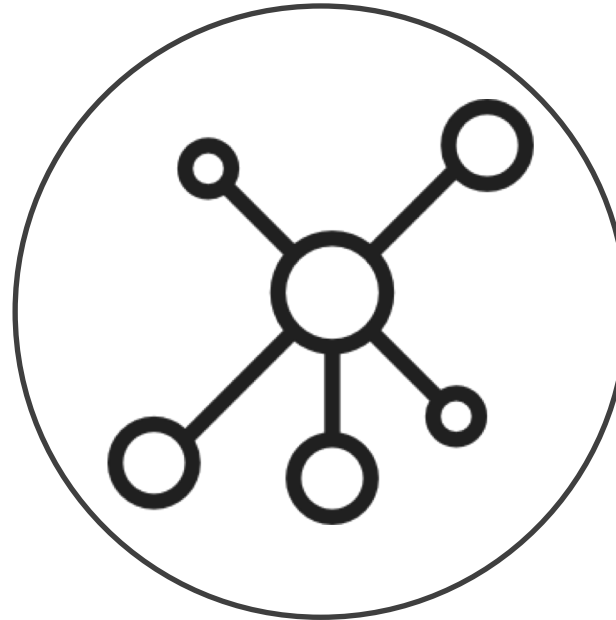
Connected cars market projected to reach
USD \$219.21 billion by 2025*



Retail

Connected Stores

82% of smartphone user say they consult
their phones for in-store purchases***



Networking

Carrier, Cloud, Enterprise



Energy

Connected Homes

Global Smart Home Market to Exceed
\$53.45 Billion by 2022**



Agriculture

Connected Cows

Global Connected Cow and Farm Market Set
to Exceed \$10 Billion in 2021****

Linux Foundation Leads Modern Networking Innovation



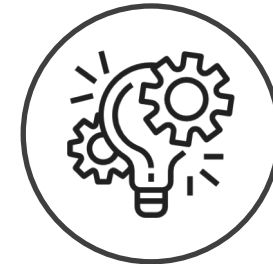
21

Open Source
Networking Projects



10/10

Networking Vendors Active



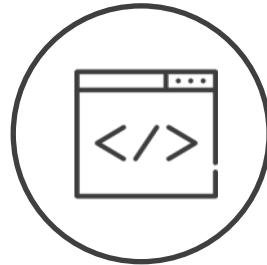
\$576 M

Shared Innovation



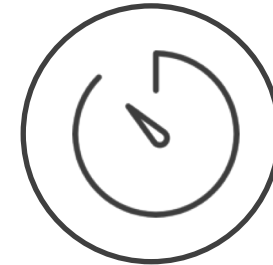
9/10

Most Important Projects



~70%

Global Subscribers
Represented

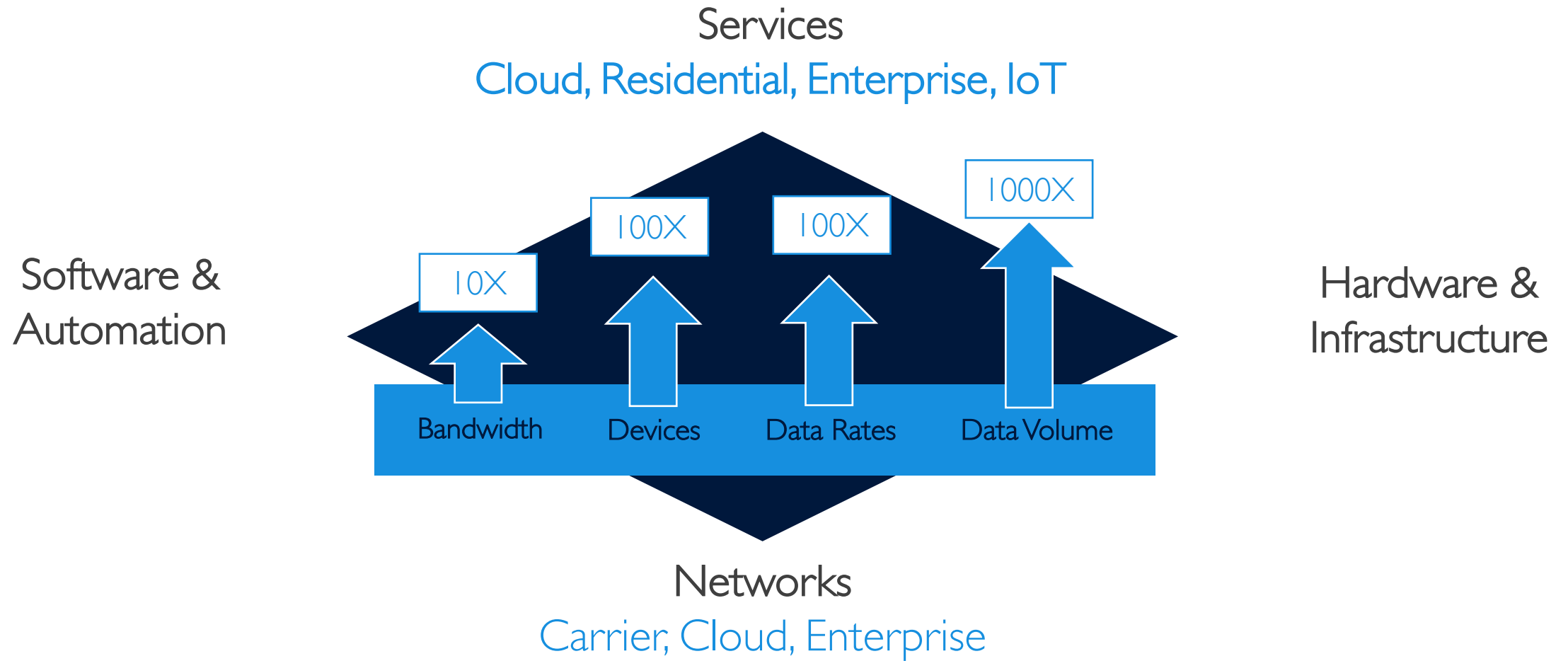


15 Minute

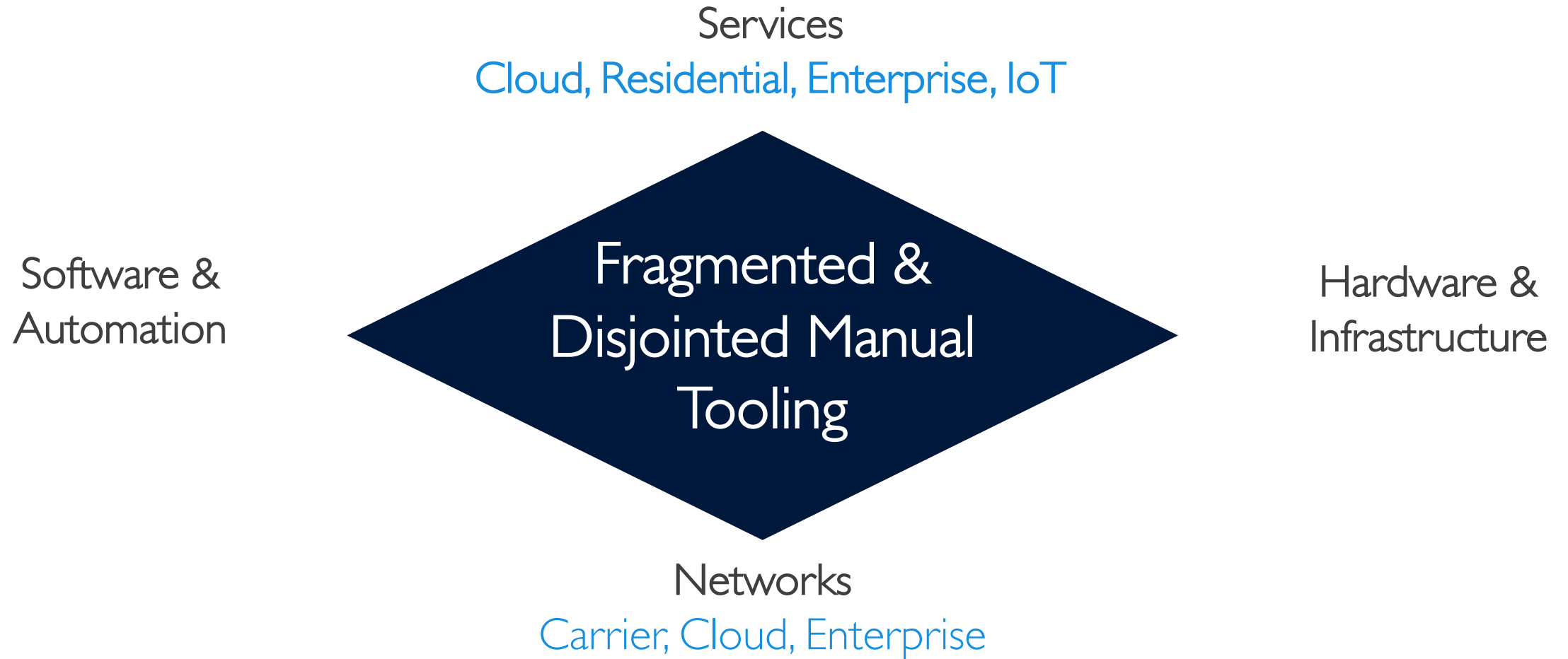
New Service Creation

The Challenge

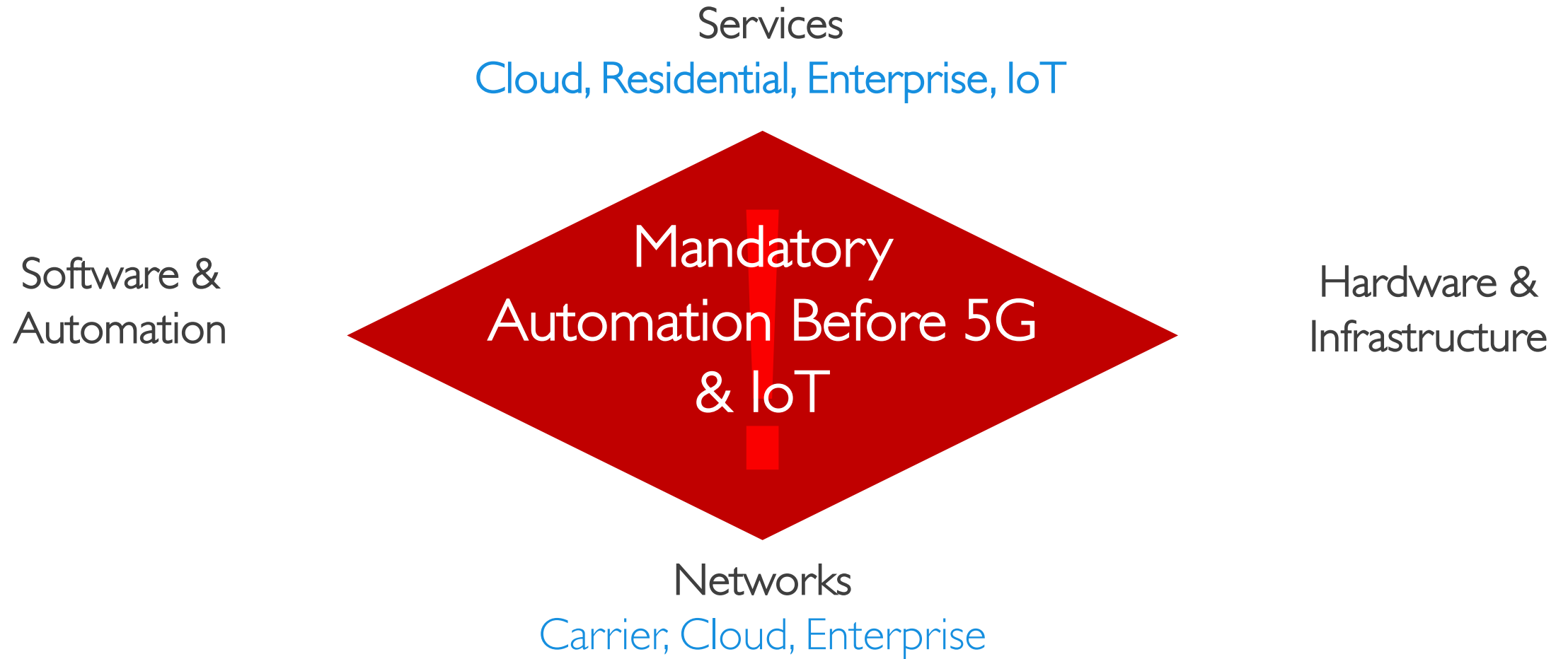
Tsunami of Change Hitting Networks



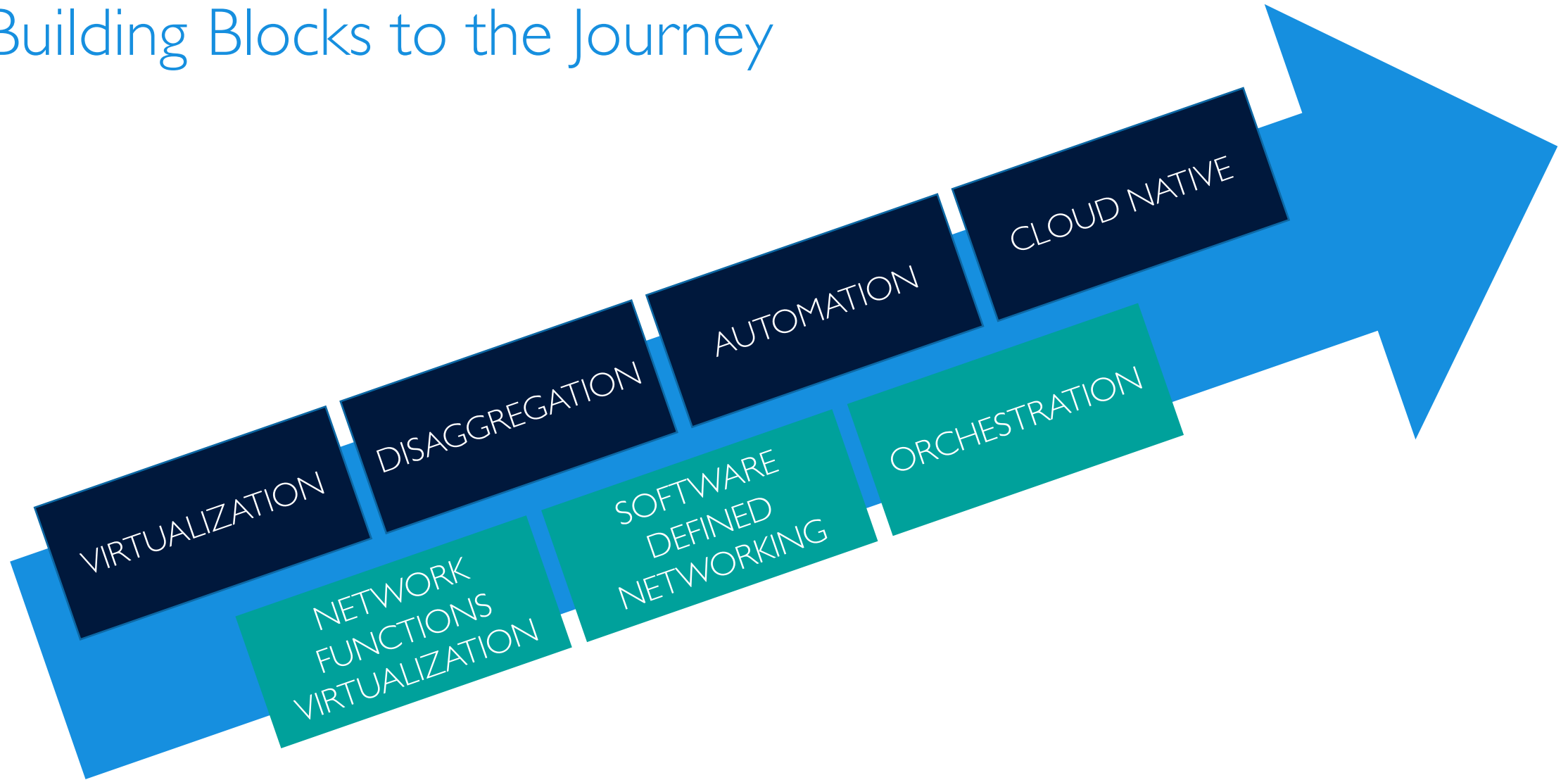
Challenge: Automating Cloud, Network, & IOT Services



Challenge: Automating Cloud, Network, & IoT Services



Building Blocks to the Journey



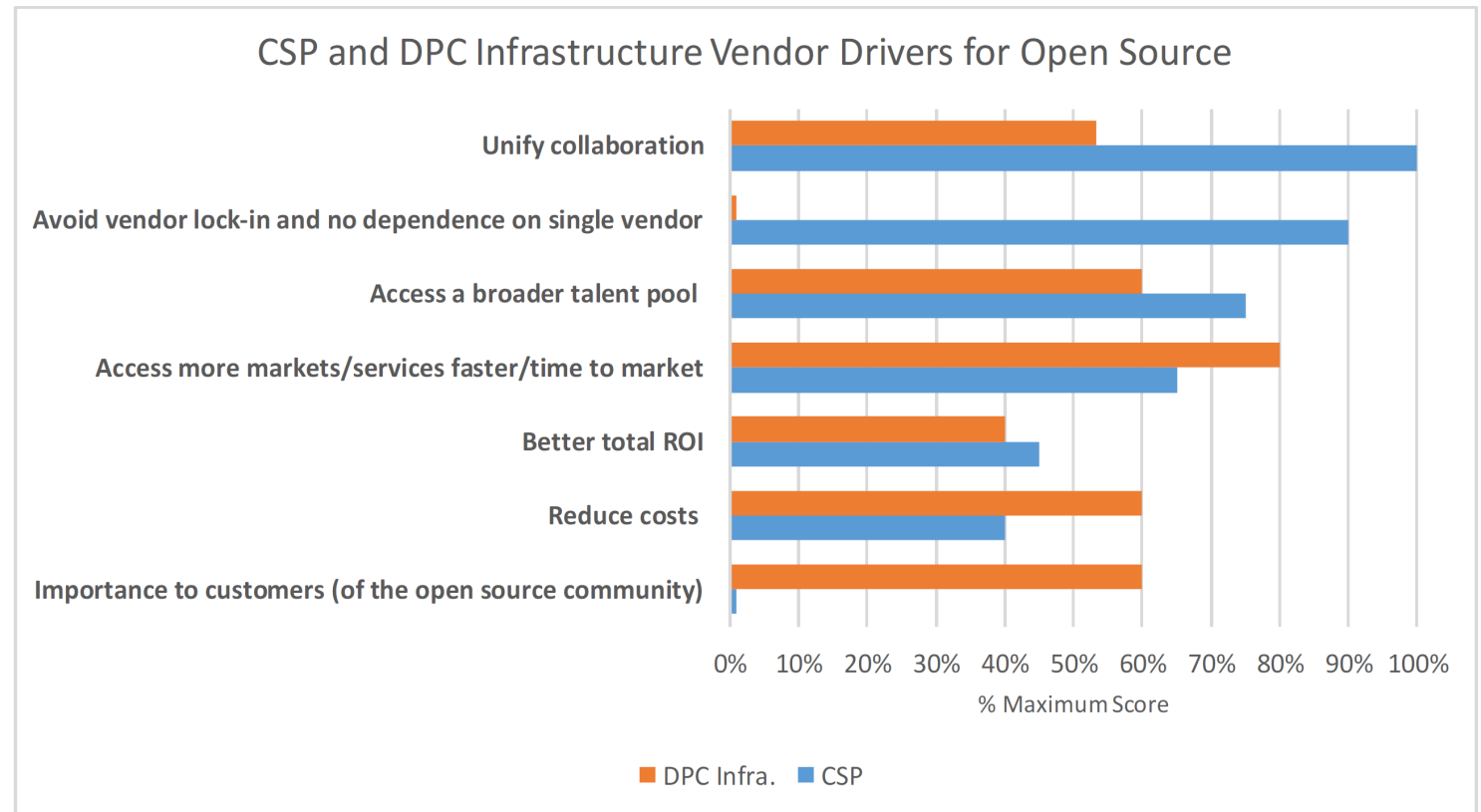
How Does Open Networking Solve the Challenge?

Revolution in the Networking Ecosystem



Why Open Source Networking?

- › Choose each element of your networking stack, with assured interoperability
- › Improve efficiency & quality for development & implementation reduce risk & cost
- › Deliver exactly the network services you need, as you need them



\$11B at Stake in Next 5 Years
“Future Strategic Vendors
Will Be Those Who Embrace
Open Source”



Orange Plans '5G Plus
Automation' RFP This Year
“Orange plans to use ONAP
as the single interface to all
automated processes.”



The LF is Changing the
Fabric of Networking
“bringing top networking
vendors, operators,
service providers, and
users together.”



APP LAYER

MANAGEMENT & ANALYTICS

NETWORK CONTROL

NETWORK OPERATIONS

IO ABSTRACTION & DATA PATH

OPNFV

SYSTEM INTEGRATION & TEST AUTOMATION

AKRAINO EDGE STACK

ONAP

OPEN NETWORK AUTOMATION PLATFORM

pnda

SNAS.io

Acumos AI

openstack.

Open Source MANO

CLOUD NATIVE COMPUTING FOUNDATION

OPEN SECURITY CONTROLLER

CORD

ARIA

OPEN DAYLIGHT

tungstenfabric

ONOS

Open Network Operating System

DANOS

FREERANGEROUTING

P4

Open Switch

STRATUM

SONiC

.io

OvS

Open vSwitch

VISOR PROJECT

DPDK

DATA PLANE DEVELOPMENT KIT

OPEN CONTAINER INITIATIVE

OpenDataPlane.org

CI / CD

OPEN Compute Project

TELECOM INFRA PROJECT

Logos of various international organizations and standards bodies:

- MEF (Metropolitan Ethernet Forum)
- ITU (International Telecommunication Union)
- tmforum
- ILETF (International Light/Electrical and Thermal Forum)
- NIST (National Institute of Standards and Technology)
- ONF (Open Networking Foundation)
- ETSI (European Telecommunications Standards Institute)
- World Class Standards
- OIF (Optical Interconnectivity Forum)
- IEEE 802
- 3GPP (3rd Generation Partnership Project)
- A GLOBAL INITIATIVE
- CableLabs

 LFN

* ALL OTHER PROJECTS
HOSTED OUTSIDE LF

Open Source Data Plane and NOS Projects

Rapid feature iteration independent of hardware lifecycle

What

Innovative features that may not exist in commercial offerings.

Why

NFV options enable near-instant delivery of new network services.

How Consume

May be OEM'd in commercial offerings, or implemented in white box environments



Open Source Control Plane Projects

The backbone of modern network management

What

Execute the detailed network requirements of larger orchestration and automation frameworks (ONAP, OpenStack, CORD).

Why

Assume multi-vendor, mixed P/V environments.

How Consume

Range of open source and/or packaged distribution options.



Management Plane, Monitoring and Analytics Projects

Translate business layer intent to network - ensure healthy operations

What

Capture large amounts of real-time data, cut down weeks/months of big data stack integration effort for network analytics to *just 1 hour*.

Why

Cloud & carrier focus on network automation = **doubling** of investment in orchestration layer in the next 5 years.

How Consume

Multi-team design, implementation efforts

Open source platforms + custom development + integration services.



Introducing LF Networking (LFN)

LF NETWORKING

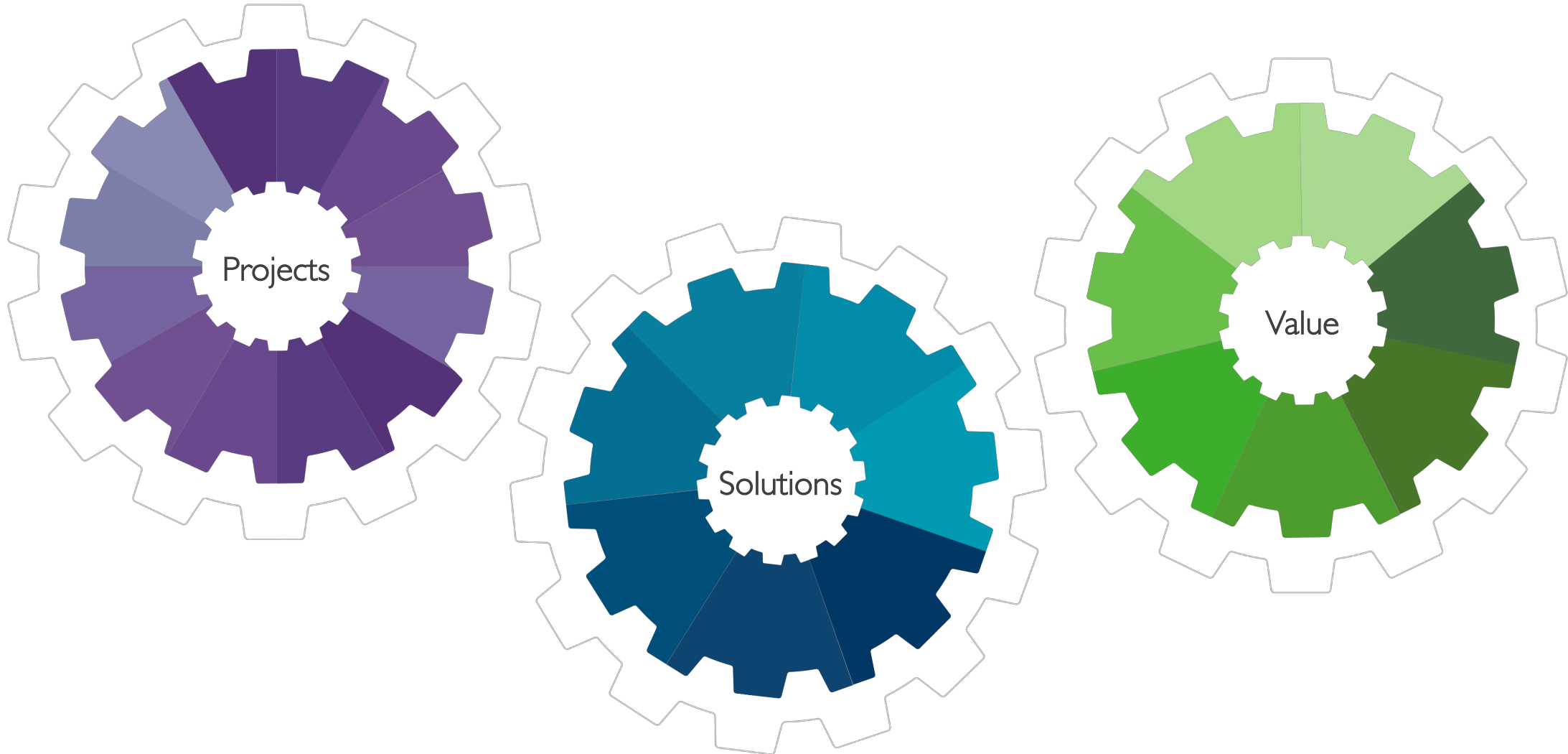
LF Networking (LFN) brings together seven top networking projects to increase harmonization across platforms, communities, and ecosystems.



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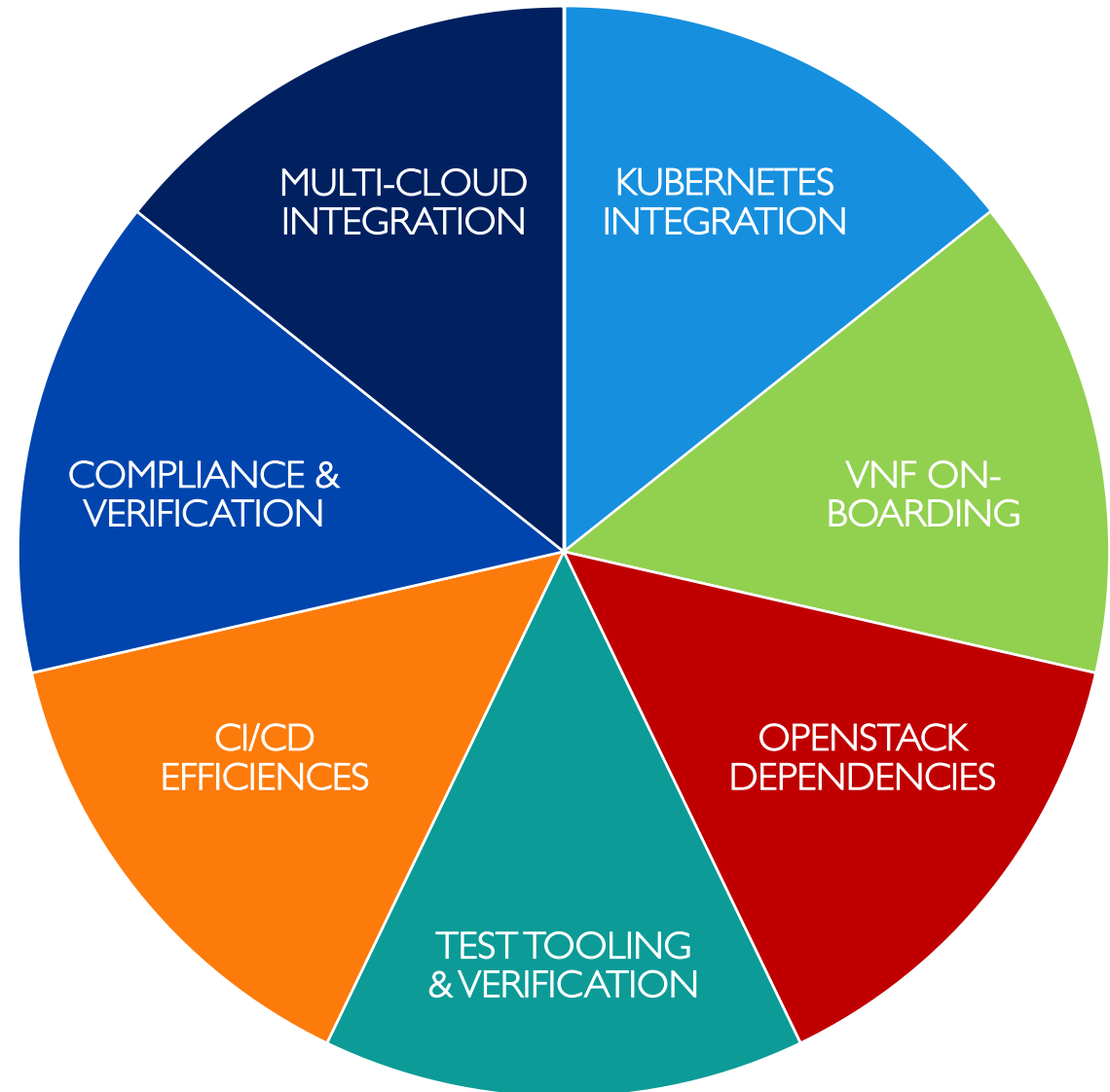
LF Networking Milestone 100 Members in Under 100 Days

LF Networking Drives X-Project Value, Ecosystem Growth



LF Networking X-Project Collaboration Areas

Projects crossing boundaries to interoperate and create more value



Harmonizing Open Source & Standards

Collaboration on external APIs



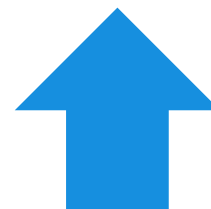
IPv6 Collaboration



Co-located Plugtest/fest with
ETSI in June 2018

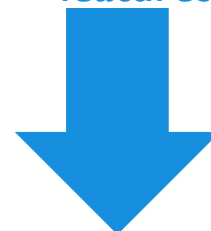


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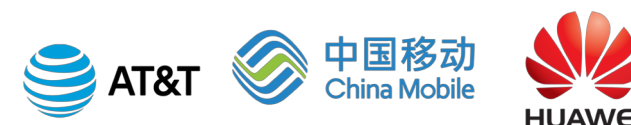


Requires both top-down and
bottom-up approaches to harness the
differences and complementary

features



Documentation of impact of on
harmonizing open source and
standards



Common Base Type Yang Models



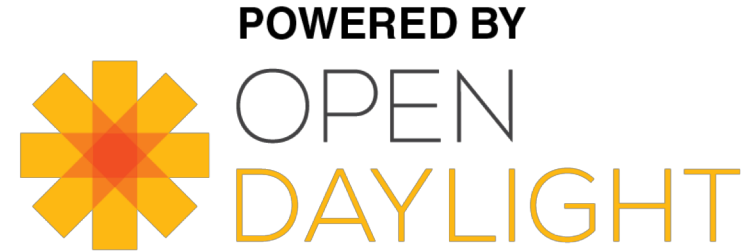
Also working with...



Verification Programs

Network Operator Benefits

- › Ensure baseline compliance and component interoperability
- › Validate specific features
- › Reduce integration and adoption risks
- › Accelerate deployments



OS Networking: From Carrier & Cloud to the Enterprise

NEWS

Gartner: Networking innovation in the cloud tops vendors

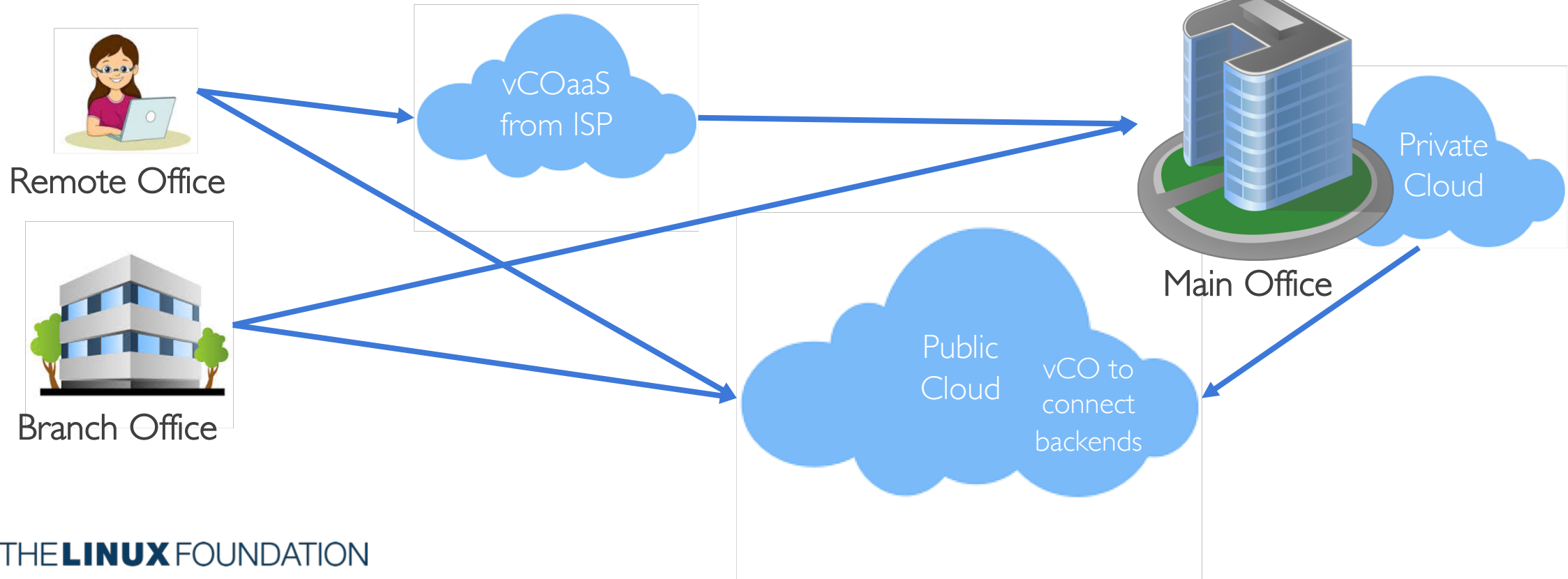
A Gartner report says enterprises waiting on vendors for networking innovation are missing out on the better technology coming from cloud providers.



SearchNetworking

Leading Use Cases:

- SD-WAN
- Virtual Central Office (vCO)
- DC Optimization



LF Networking (LFN) Projects Power Next Generation Orange Networks

Challenge

Full network automation, achieve full-benefits of SDN/NFV, retrain company for rapid evolution of software solutions

Solution

Actively participate in LFN Projects / incorporate into real use cases

Benefits

- › Testing/Interop of NFV Architecture
- › VNF/Service Onboarding & Design
- › Full Network Automation
- › Time To Market
- › Support Customer's Digital Transformation

Ambitious strategy includes 5G trials in France for 2018, and Orange aims to deliver an operational 5G network by 2020

Orange Plans '5G Plus Automation' RFP This Year
“Orange plans to use ONAP as the single interface to all automated processes.”



Critical components of Orange's next generation SDN/NFV initiatives to enable 5G, big data, AI and IoT network services.

ONAP Deployment Updates



OPNFV



1. **Leading contribution**
Successful transition from dominant role (ECOMP) to community-led project ONAP
2. **POC & deployment continue with ONAP**
SDN & Virtualization journey. ONAP is a critical element of Cross Project transformation including AcumosAI, DANOS (NOS) and Akraino (Edge)
3. **CI/CD – ONAP**
Pulling from ONAP into their internal environment



1. **VoLTE Trials** ongoing in Zhejiang province. CMCC built α release including NFVO, did customization & contribution to Beijing release.
2. **Beijing Release** now aligned with China Mobile's enterprise requirements. (NFVO+/GVNFM products will be used for China Mobile pilot test)
3. **Cross Carrier ONAP** - Casablanca release for SOTN/SD-WAN including interconnection between ONAPs. (prototype pilot Vodafone, Huawei & CMCC)



1. **Demonstrate a complete VNF lifecycle management:** create VNF Descriptor, Validate Package, On-board and deploy commercial vMRF and vProbe
2. **Demonstrate how to automate network operation tasks** for SD-WAN and SDN network connectivity
3. **Opening first ONAP Open Lab** with 70+ users from operators, VNF vendors and academics
4. **Development of 3 external APIs** to ease integration with BSS (Order, Inventory, Catalog)

ONAP Deployment Updates



1. Network-Cloud integration PoC of vCPE use case in CT lab
2. **ONAP Maturity test:** build up auto test environment and contribute on ONAP S3P tests.
3. **Development and deployment:** add intelligence and automation for agile provisioning and onboarding, introduce SO MSB A&AI into practice, and engage in Service Model definition



1. Driving modularity and pluggability of ONAP Components within Verizon SDN architecture. Contribute code with emphasis on SDC, SO, SDN-C, A/AI, DCAE and web scale evolution support
2. Striving for SO/VNFM ETSI MANO-compliant interface to external VNFs
3. CI/CD enabled ONAP Verizon developer test bed and onboarding internal VNF's to validate platform and vendors to participate in the journey



1. Amsterdam Release in **production** since Q42017
2. Heavy focus on simplified deployment & OOM contribution
3. Expanding use cases across Carrier and Internal IT Data Center automation.

ONAP Deployment Updates



1.Lab: Focus on SDC, A&AI, SO, DCAE.
Vodafone sees ONAP as a crucial platform for standardization across various areas for Telco Cloud adoption

2.POC: ONAP based TM Forum Catalyst projects - Blade Runner, Automating Network As A Service, 5G Intelligent Service Operations - for the first time built on a common reference architecture of ONAP, TM Forum open-APIs and MEF-defined service payloads.

3.On-Boarding: Focus on SDC, Compliance & Verification(On-Boarding) of Resources and Services - an industry standard for On-Boarding at various levels



1.Last Mile Enabler
Africa & Middle East

2.POCs with ONAP
by modifying community vFW blueprint to separate PG and vFW_SINC across two OpenStack regions connected by E-Line

3.Demonstrated at MEF
Athens meeting on 4/19



1.End to End POC and Demo
Leading ONAP and CORD test across network

2.Testbeds and POC
Working with Vendor ecosystem to enable POCs for ONAP focusing on fixed and mobile use cases.

3.Focus on providing end-to-end, closed-loop automation to design, orchestrate, automate and manage new services

ONAP Commercial Ecosystem – Early Leadership



1. NFV Orchestration Platform is a packaged software and services solution for end to end NFV service lifecycle management and orchestration. Offers a portfolio of modular capabilities that accelerate service design, virtualization and operation.
2. Addresses the full range of ONAP use cases: vCPE, SD-WAN + security, vEPC, vRAN, more
3. Foundation of Amdocs service portfolio addressing domain orchestration, mobile services orchestration and Enterprise services orchestration.



1. ONAP Startup
Products, services, training (½ day, full day)
2. **Created ONAP all-in-one**
Packaged ONAP and OPNFV in one Google Cloud VM for training labs; image can also be used as a “sandbox” for developers



1. Ericsson Orchestrator and Ericsson **Network Manager** both incorporate ONAP components
2. Delivering key technology to enable Network Slicing and VoLTE.
3. Ericsson is intimately involved in driving industry alignment between ONAP and ETSI-NFV.
4. ONAP improves time to market for Ericsson and for its operator customers

ONAP Commercial Ecosystem – Early Leadership



1. **Service on Demand**
 - › Virtuora Network Controller collects E-line performance data
 - › Fujitsu microservice within ONAP manages threshold alarms to respond to needs such as add'l bandwidth
 - › Automatically resets to normal allocations when typical traffic patterns re-emerge



1. AIDO (design-time) and IES (run-time) commercial platforms based on ONAP
2. **E2E digital transformation** in progress with HKT
 - › Automating Mobile CloudVPN service
 - › Ties into backend operations systems
 - › Huawei is building a Digital Transformation service portfolio for Telcos around their ONAP-based AIDO/IES platforms



1. **ONAP on IBM Cloud Private** IBM Cloud Private is fully Kubernetes-based deployment for on-premise, bundled with capabilities from open source & IBM for core operational services¹
2. **IBM Services for ONAP**
Focus on SDN and NFV deployments & integrations worldwide, including work on ONAP for Operators. Services are augmented with IBM cloud and cognitive software and services

ONAP Commercial Ecosystem – Early Leadership



1. Inocybe Open Networking Platform - Simplifying the build, test, manage and upgrade process for open networking software (ODL, OpenSwitch, ONAP)
2. Focusing on containerized distribution of SDN-C component of ONAP
 - Use cases: Traffic Engineering, Service Function Chaining, NFVi
3. Inocybe is building a business on open source—for major operators as well as packaged solutions for enterprises

NETSIA

1. Netsia provides ONAP services and training.
2. Built custom UI in ONAP for RAN slicing with integration into DCAE and closed loop policy configuration
3. Working on full ONAP integration for leading service provider in Turkey.

Plus Several More in
Q2/Q3 2018

ODL Deployment Updates

Caltech

1. Efficiently distribute big data
 - › Lead partner with CERN to share >200 petabytes of research data among global research institutions
2. Control data, without owning the network
 - › 13 Tier 1 sites, 160 Tier 2 sites and 300+ Tier 3 sites
 - › Multiple service providers with different bandwidths and capabilities.
 - › Across geographic/jurisdictional boundaries

Tencent 腾讯

1. Support multiple apps for 500 Million monthly users
 - › One of the largest internet companies in the world
2. Using ODL since 2014
 - › Chosen for scalability and breadth of support for variety of physical and virtual infrastructure
 - › Like strong commercial ecosystem - require all vendors to work with ODL

CenturyLink™

1. Enable fully virtualized IP core + residential rollout
2. Developed virtualized Broadband Network Gateway
 - › OpenStack
 - › OpenDaylight
 - › Intel software toolkits
 - › Intel-based white boxes

ODL Deployment Updates



1. Bristol is Open smart city initiative
 - › Captures info on city energy , air quality and traffic flows, from a large number of sensors
2. ODL-based framework manages IoT traffic
 - › Portal converts networked data to show real-time pollution, journey times, energy efficiency, etc
 - › Bandwidth-on-Demand capabilities generate revenue for program from businesses such as the BBC

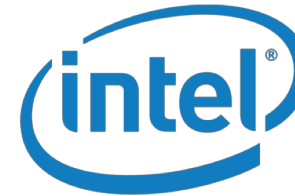
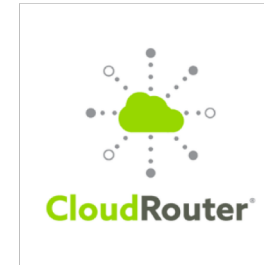


1. 800+ Million subscribers (99% of China), 2.2 M base stations
 - › Also provides cloud services to Enterprises
2. ODL - backbone of NovoNet
 - › Initially deployed in Cloud DCs and Packet Transport Networks for Enterprise customers
 - › Public cloud, virtual private cloud and telco integrated cloud (TIC) all on the same platform
 - › ONAP, OpenStack, VMware for orchestration



1. E-COMP initiative for next-gen carrier network
 - › Framework for SDN and NFV-based service delivery
2. ODL provides end-to-end control
 - › E-COMP provided key foundation for ONAP platform, ODL at core
 - › Equipment-agnostic ODL is the "global" controller; Nuage and others provide local control for specific segments

ODL Commercial ecosystem



FD.io Commercial Ecosystem



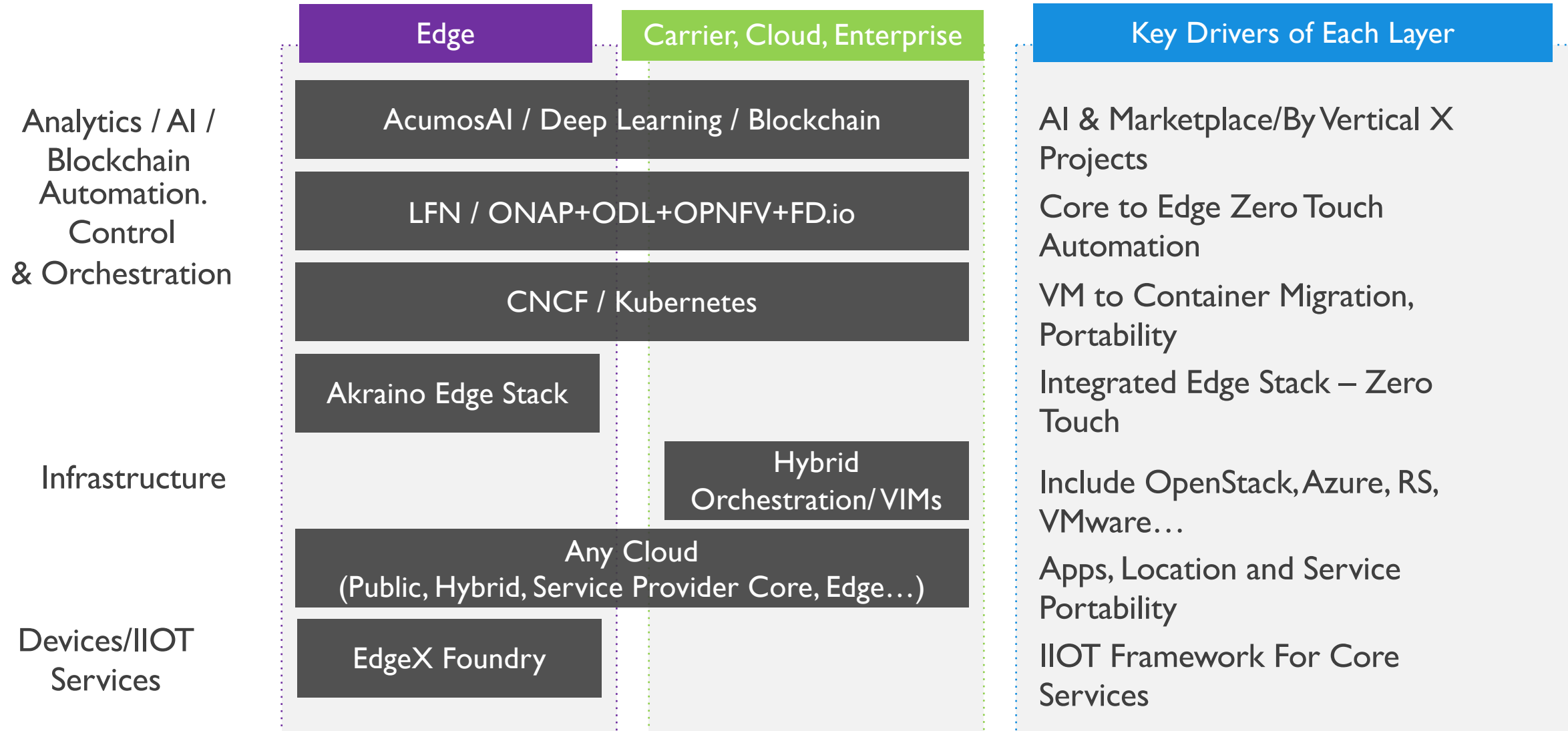
Allegro Packets
Network Software



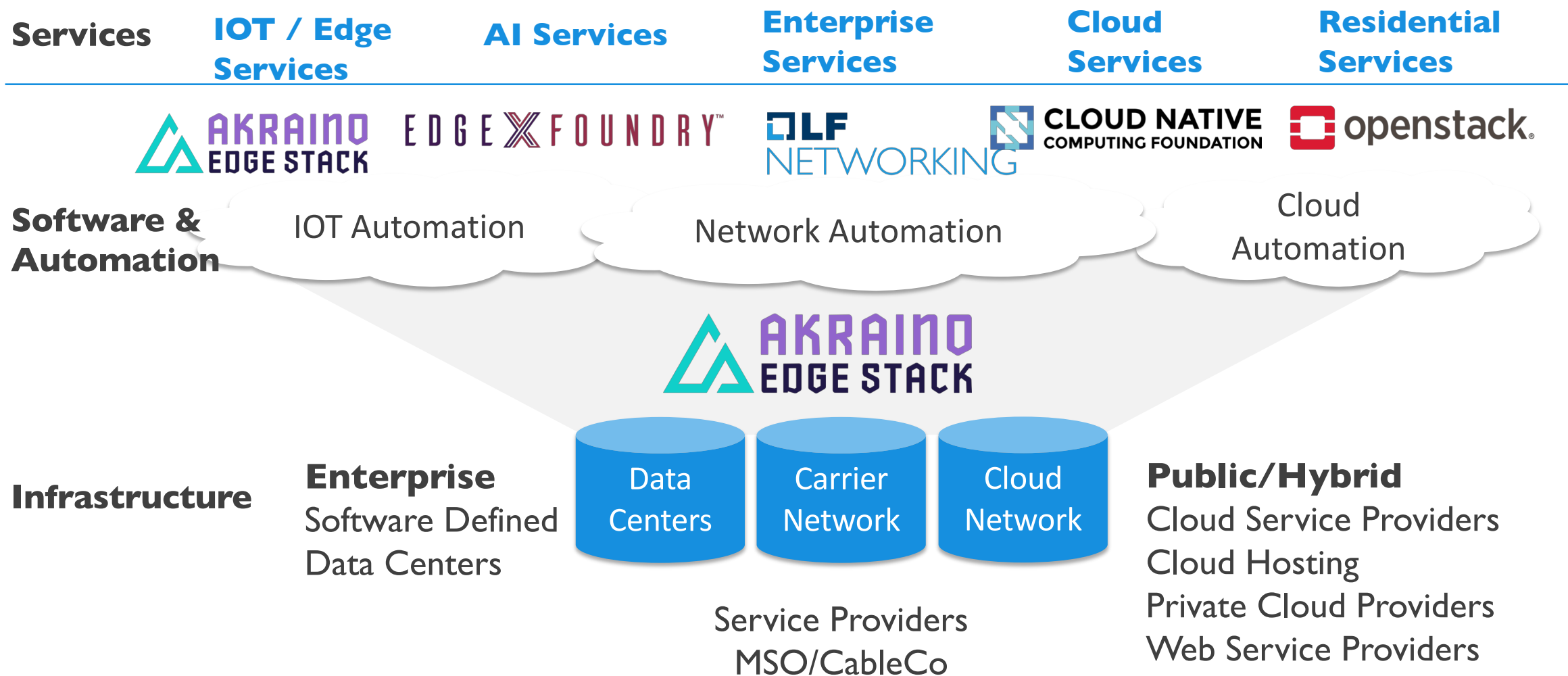
YANDEX
MISSING

Harmonization 2.0

LF Path to Open Source Harmonization 2.0

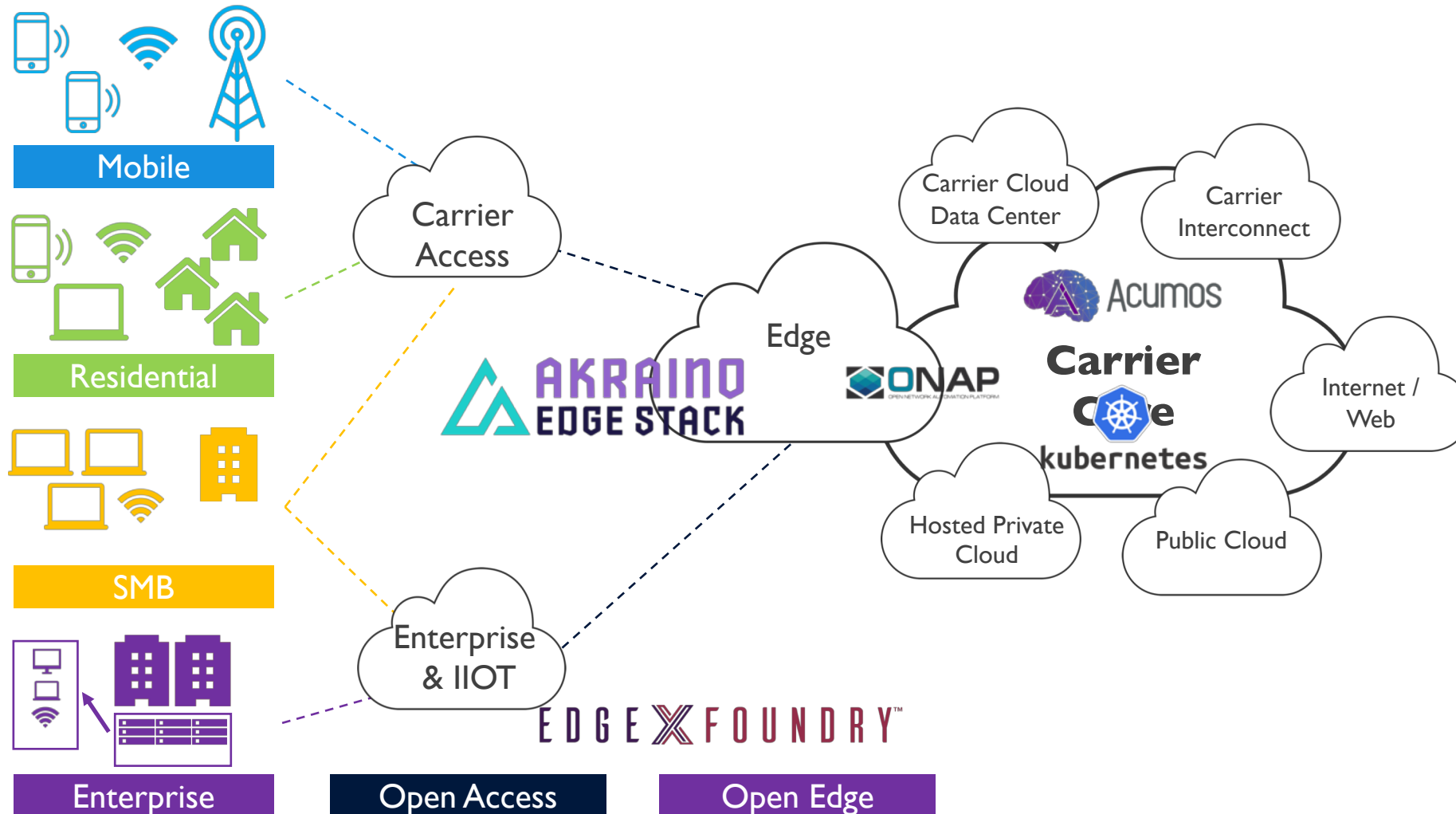


Harmonization Engine



Use Case: Cloud Bringing It All Together – LF Open Source Edge

With Complementary Standards, Ref Arch and Ref Implementations



Standards for Edge



Ref Implementation



openEDGEcomputing



IoT, Gateway &
Cloud Ref Arch

Other Edge Activities

Open Networking Ecosystem Adoption

Open Source Networking -- User Options



DIY

Use variety of small
OSS components to
develop unique
systems completely
in-house

Little/no vendor
involvement

MIXED

OSS components &
platforms + custom
tooling for network
differentiation

Several specialized
solution providers
work together as
extensions of in-
house teams

PACKAGED OPTIONS

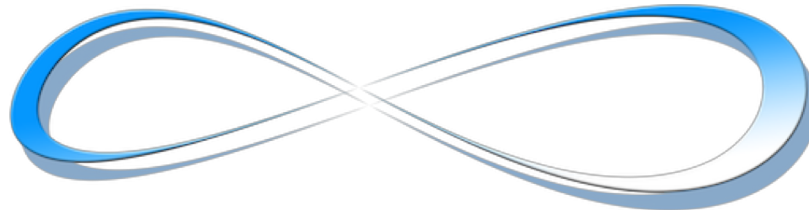
Tested, hardened
products with
support contracts

Traditional
acquisition model
with preferred
vendors

Commercialization of Open Source

Engagement across the ecosystem and commercialization of products and services are required to create and sustain a vibrant ecosystem

- › **Vendors:** Invest in the future by leveraging open source for non-differentiated R&D
- › **Integrators:** Provide end-to-end integration and deployment solutions
- › **Operators:** Consume, collaborate and help shape the supply chain
- › **Developers:** Join projects, start projects, fail fast, lead, innovate, transform



It Pays to Give Back



It is a competitive advantage for companies to allow developers to contribute.

"New research by Assistant Professor Frank Nagle, a member of the Strategy Unit at Harvard Business School, shows that paying employees to contribute to such software boosts the company's productivity from using the software by as much as 100 percent, when compared with free-riding competitors."

<https://hbswk.hbs.edu/item/the-hidden-benefit-of-giving-back-to-open-source-software>

Learn. Plan. Engage.

- › Join the Linux Foundation and LFN
- › Invest in your personnel
- › Participate in the technical communities
- › Take a training course
- › Follow best practices and develop your own
- › Empower yourself with knowledge
- › Begin Anywhere
- › LFN-info@linuxfoundation.org

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