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***

**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****

Networking
Carrier, Cloud, Enterprise

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Data Sources:
*ResearchAndMarkets.com **Zion Market Research ***Salesforce: Connected Shopper Report ****Arcluster
Linux Foundation Leads Modern Networking Innovation

- **21** Open Source Networking Projects
- **9/10** Most Important Projects
- **10/10** Networking Vendors Active
- **~70%** Global Subscribers Represented
- **$576 M** Shared Innovation
- **15 Minute** New Service Creation
The Challenge
Tsunami of Change Hitting Networks

Services
Cloud, Residential, Enterprise, IoT

Software & Automation

Hardware & Infrastructure

Networks
Carrier, Cloud, Enterprise

Bandwidth
Devices
Data Rates
Data Volume

10X
100X
100X
1000X
Challenge: Automating Cloud, Network, & IOT Services

Software & Automation
Fragmented & Disjointed Manual Tooling
Hardware & Infrastructure

Services
Cloud, Residential, Enterprise, IoT

Networks
Carrier, Cloud, Enterprise
Challenge: Automating Cloud, Network, & IOT Services

Services
Cloud, Residential, Enterprise, IoT

Mandatory Automation Before 5G & IoT

Networks
Carrier, Cloud, Enterprise

THE LINUX FOUNDATION
Building Blocks to the Journey

VIRTUALIZATION

DISAGGREGATION

AUTOMATION

CLOUD NATIVE

SOFTWARE DEFINED NETWORKING

ORCHESTRATION

NETWORK FUNCTIONS VIRTUALIZATION

Sources: Wikipedia & Techopedia
How Does Open Networking Solve the Challenge?
Revolution in the Networking Ecosystem

Proprietary
Vertically integrated, vendor-centric solutions to mix & match options at every level

Collaborative Design & Development
- Vendors and users – instant feedback
- Rapid, unified standards implementation
- Shared development of basic capabilities - supply chain efficiency

New Strategic Vendor Profile
- Broad, open portfolio
- Focus on ecosystem interop - reduce integration time and risk
- Strong implementation services & support
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

Source: ACG report: The Impact of Open Source Technologies on the Communication Service Provider Vendor Ecosystem
$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.”
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.

OPEN DAYLIGHT

Open Network Operating System

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

100 Members in Under 100 Days
LF Networking Drives X-Project Value, Ecosystem Growth
Projects crossing boundaries to interoperate and create more value
Harmonizing Open Source & Standards

Collaboration on external APIs

IPv6 Collaboration

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

Co-located Plugtest/fest with ETSI in June 2018

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

Leading Use Cases:
- SD-WAN
- Virtual Central Office (vCO)
- DC Optimization

Diagram:
- Remote Office
- Branch Office
- Private Cloud
- Main Office
- Public Cloud
- vCOaaS from ISP
- vCO to connect backends

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.
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

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 VNFM
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

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. AIDO (design-time) and IES (run-time) commercial platforms based on ONAP

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 services

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
Harmonization 2.0
LF Path to Open Source Harmonization 2.0

Key Drivers of Each Layer

AI & Marketplace/By Vertical X Projects
Core to Edge Zero Touch Automation
VM to Container Migration, Portability
Integrated Edge Stack – Zero Touch
Include OpenStack, Azure, RS, VMware…
Apps, Location and Service Portability
IIOT Framework For Core Services

Analytics / AI / Blockchain Automation, Control & Orchestration
- AcumosAI / Deep Learning / Blockchain
- LFN / ONAP+ODL+OPNFV+FD.io
- CNCF / Kubernetes
- Akraino Edge Stack
- Hybrid Orchestration/VIMs
- Any Cloud (Public, Hybrid, Service Provider Core, Edge…)
- EdgeX Foundry

Infrastructure

Devices/IIOT Services

The Linux Foundation
Harmonization Engine

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Use Case: Cloud Bringing It All Together – LF Open Source Edge
With Complementary Standards, Ref Arch and Ref Implementations

Standards for Edge

Ref Implementation

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

› 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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