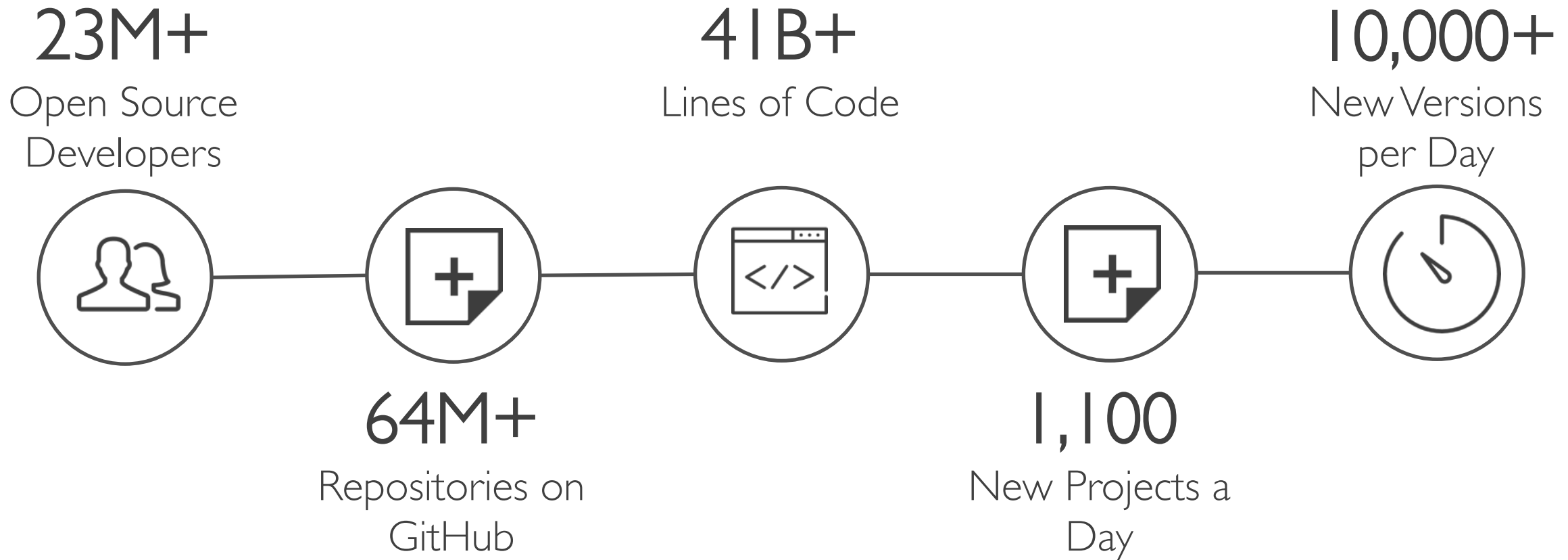# Open Source Networking

Arpit Joshipura

GM, Networking
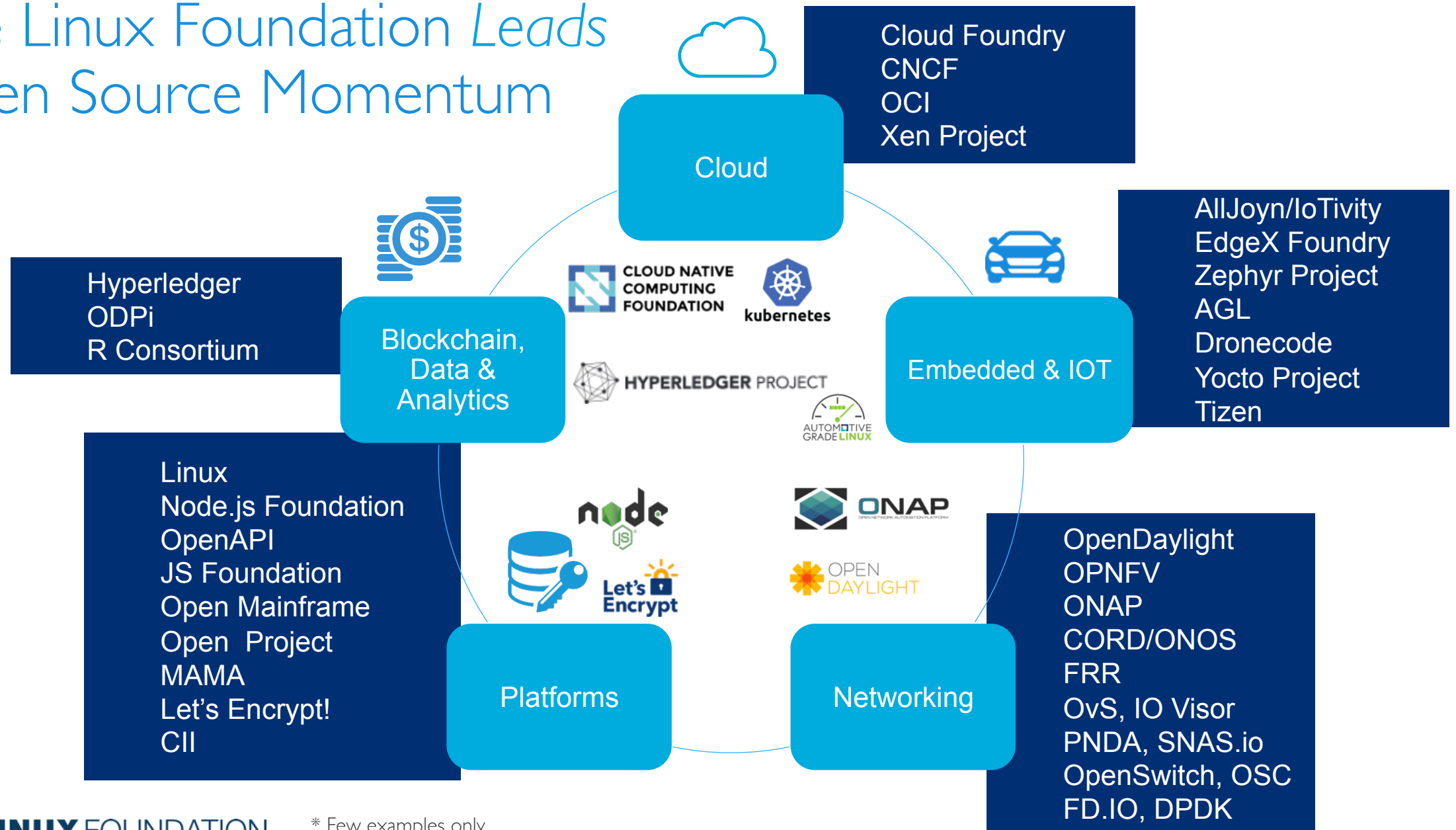
□ THE LINUX FOUNDATION

Open Source & Open Networking Vision

Open Source Development is Accelerating
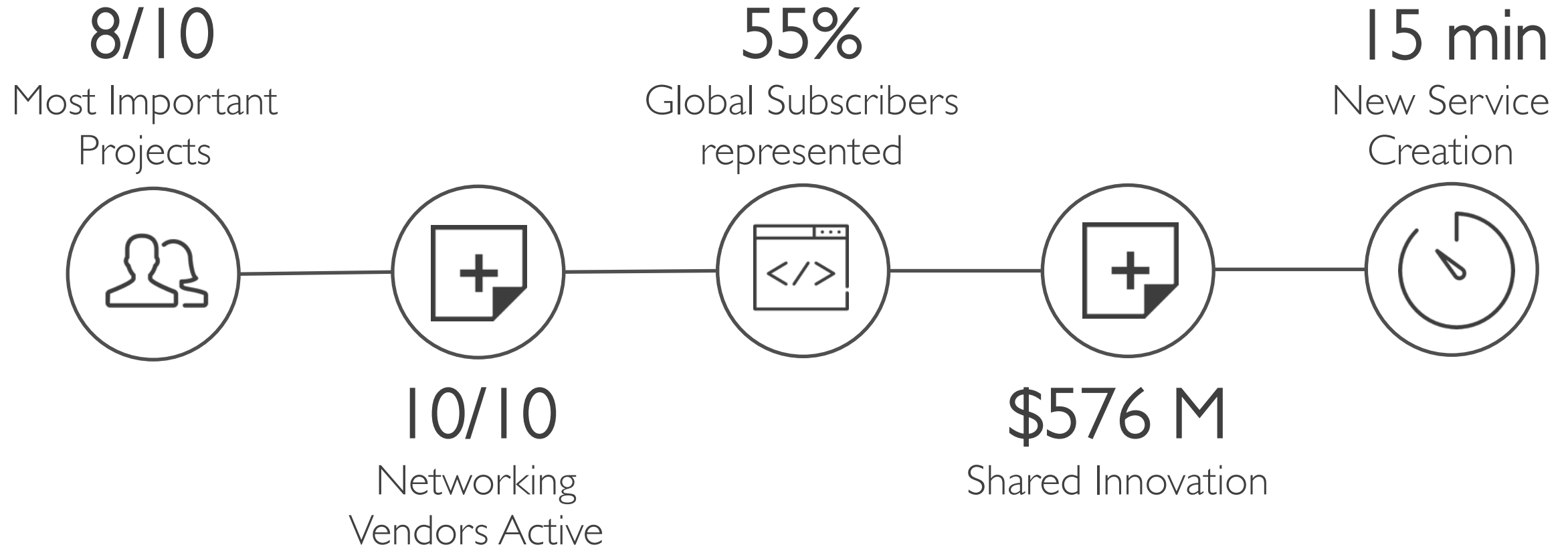
23M+
Open Source Developers

64M+
Repositories on GitHub

41B+
Lines of Code

1,100
New Projects a Day

10,000+
New Versions per Day

Sources: Sourceclear, Sonatype, Github

The Linux Foundation *Leads* Open Source Momentum

Cloud

Cloud Foundry
CNCF
OCI
Xen Project

Embedded & IOT

AllJoyn/IoTivity
EdgeX Foundry
Zephyr Project
AGL
Dronecode
Yocto Project
Tizen

Blockchain, Data & Analytics

Hyperledger
ODPi
R Consortium

Platforms

Linux
Node.js Foundation
OpenAPI
JS Foundation
Open Mainframe
Open Project
MAMA
Let's Encrypt!
CII

Networking

OpenDaylight
OPNFV
ONAP
CORD/ONOS
FRR
OvS, IO Visor
PNDA, SNAS.io
OpenSwitch, OSC
FD.IO, DPDK

CLOUD NATIVE COMPUTING FOUNDATION

kubernetes

HYPERLEDGER PROJECT

AUTOMOTIVE GRADE LINUX

node JS

Let's Encrypt

ONAP OPEN NETWORK AUTOMATION PLATFORM

OPEN DAYLIGHT

* Few examples only

4

LF Open Source Networking – Carriers, Cloud, Enterprises

8/10
Most Important
Projects

10/10
Networking
Vendors Active

55%
Global Subscribers
represented

$576 M
Shared Innovation

15 min
New Service
Creation

ONAP · OPEN DAYLIGHT · OPNFV · fd.io · OvS Open vSwitch · Open Switch · DPDK DATA PLANE DEVELOPMENT KIT · IOVISOR PROJECT · FRR · SNAS.io · pnda · CORD · ONOS · OPEN SECURITY CONTROLLER

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Telecom Transformation is Now in the 3rd Phase
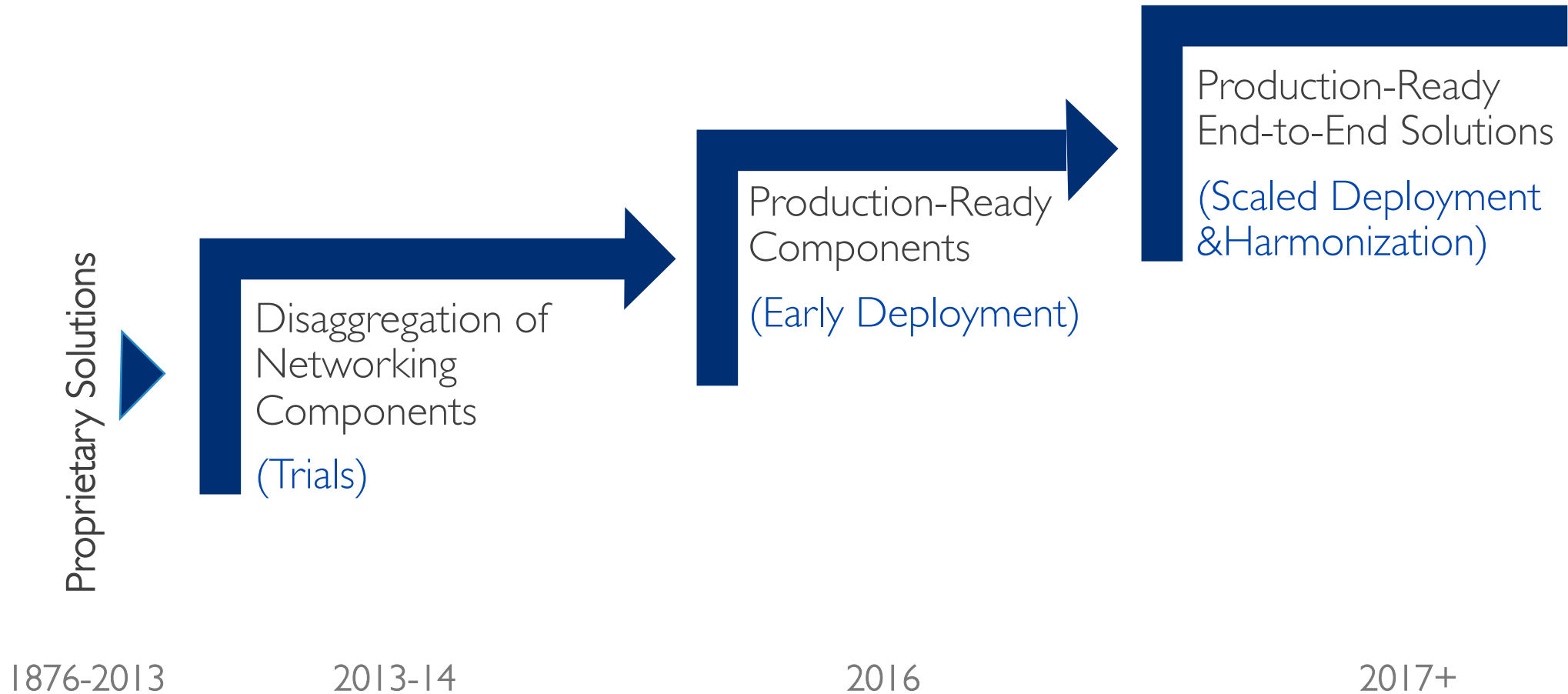
Proprietary Solutions

Disaggregation of Networking Components

(Trials)

Production-Ready Components

(Early Deployment)

Production-Ready End-to-End Solutions

(Scaled Deployment &Harmonization)

1876-2013　　　　2013-14　　　　　　2016　　　　　　　　2017+

THE LINUX FOUNDATION

Vision: Automating Cloud, Network, & IOT Services

Services   **Cloud Services**   **Residential Services**   **Enterprise Services**   **IOT Services**

Software &
Automation

Fragmented & Disjoint Manual Tooling

Infrastructure

Enterprise
Software Defined
Data Centers
(SDDC)

Data
Centers

Carrier
Network

Cloud
Network

Public/Hybrid
Cloud Service Providers
Cloud Hosting
Private Cloud Providers
Web Service Providers

Service Providers
MSO/CableCo

Vision: Automating Cloud, Network, & IOT Services

Services

Cloud Services   **Residential Services**   **Enterprise Services**   **IOT Services**

Software & Automation

Mandatory Automation before 5G

Infrastructure

Enterprise
Software Defined
Data Centers
(SDDC)

Data Centers   Carrier Network   Cloud Network

Public/Hybrid
Cloud Service Providers
Cloud Hosting
Private Cloud Providers
Web Service Providers

Service Providers
MSO/CableCo

The 5G and IOT Impact to Network

Services   **Cloud Services**   **Residential Services**   **Enterprise Services**   **IOT Services**

Software &
Automation

1000X Data Volume   100X Data Rates

100X Devices (IOT/Autos/..)

10X Bandwidth

1/5th Latency

Source: Ericsson

Infrastructure

Enterprise
Software Defined
Data Centers
(SDDC)

Data
Centers

Carrier
Network

Cloud
Network

Public/Hybrid
Cloud Service Providers
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MSO/CableCo

Vision: Automating Cloud, Network, & IOT Services

Services   **Cloud Services**   **Residential Services**   **Enterprise Services**   **IOT Services**

Software & Automation

Cloud Automation
Cloud Foundry + CNCF

Open Network Automation
ONAP+ODL+OPNFV

IOT Automation
EdgeX Foundry

Infrastructure

Enterprise
Software Defined
Data Centers
(SDDC)

Data Centers

Carrier Network

Cloud Network

Public/Hybrid
Cloud Service Providers
Cloud Hosting
Private Cloud Providers
Web Service Providers

Service Providers
MSO/CableCo

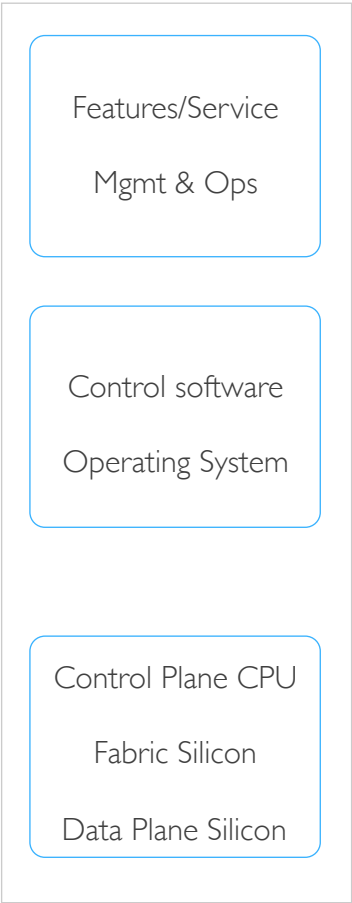# Market Disruption & Open Source Innovation

VENDOR A, B, C

Market Disruption
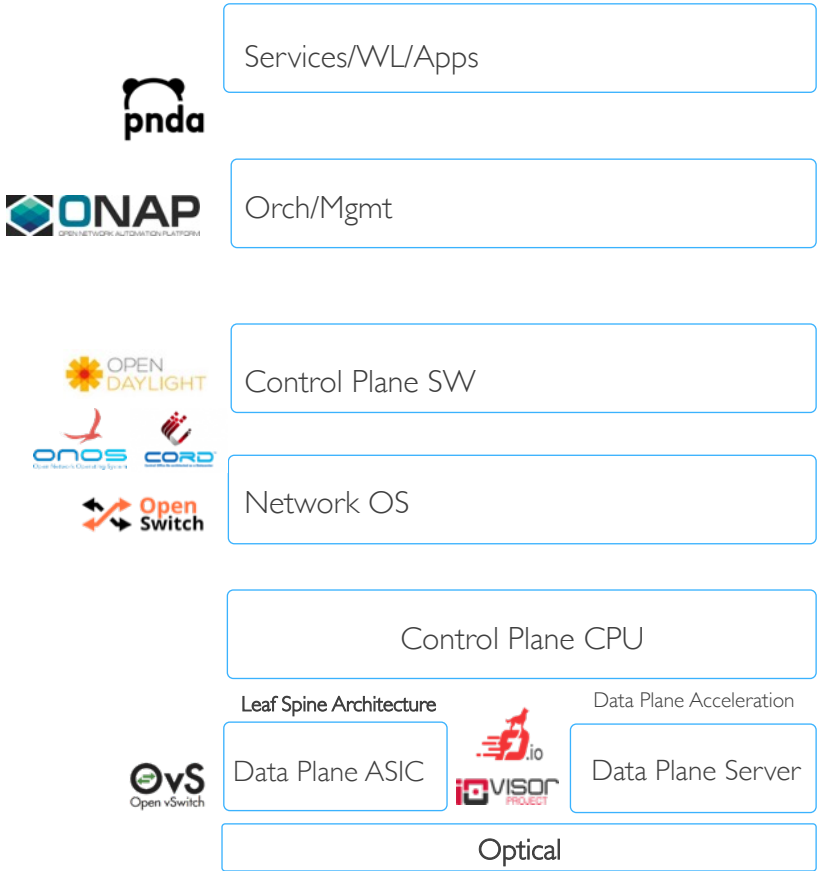
Open Source Projects

Services

Features/Service

Mgmt & Ops

Software

Control software

Operating System

Infrastructure

Control Plane CPU

Fabric Silicon

Data Plane Silicon

Virtual Functions

Software-Defined

Disaggregation

Services/WL/Apps

Orch/Mgmt

Control Plane SW

Network OS

Control Plane CPU

Leaf Spine Architecture

Data Plane Acceleration

Data Plane ASIC

Data Plane Server

Optical

OPNFV

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Open Source Networking Landscape

Linux Foundation Hosted

Outside Linux Foundation

Standards

Product, Services & Workloads

CLOUD FOUNDRY

Services

Application Layer / App Server

Network Data Analytics

Orchestration, Management, Policy

Software

Cloud & Virtual Management

Network Control

Operating Systems

Infrastructure

IO Abstraction & Data Path

Disaggregated Hardware

OPNFV System Integration & Test Automation

ONAP OPEN NETWORK AUTOMATION PLATFORM

pnda

SNAS.io

Open Source MANO

ARIA

openstack

CORD

ONOS

OPEN SECURITY CONTROLLER

OPENCONTRAIL

CLOUD NATIVE COMPUTING FOUNDATION

OPEN DAYLIGHT

FRR

Linux

Open Switch

OPEN CONTAINER INITIATIVE

OvS Open vSwitch

fd.io

io VISOR PROJECT

DPDK DATA PLANE DEVELOPMENT KIT

OpenDataPlane.org

OPEN Compute Project

TELECOM INFRA PROJECT

CI/CD

tmforum

ITU

MEF NIST

ONF OPEN NETWORKING FOUNDATION

I E T F

ETSI World Class Standards

IEEE 802 CableLabs

3GPP A GLOBAL INITIATIVE OIF OPTICAL INTERNETWORKING FORUM

THE **LINUX** FOUNDATION

Automation of Network + Infrastructure + Cloud + Apps + IOT

Linux Foundation Framework, Governance, Control
Bringing the best of both worlds together

ECOMP + OPEN-O

› 2+ years of Deployment Maturity at AT&T

› Comprehensive: Design +Orchestration + Control + Policy + Analytics

› Model-based design enabling self-serve capabilities for instantiation and closed loop automation

- Open TOSCA model

- Most Advanced Open Source Process & tool chain

- Architected for ease of VNF insertion (SDK)

Based on extensions & integration with OpenDaylight & OPNFV
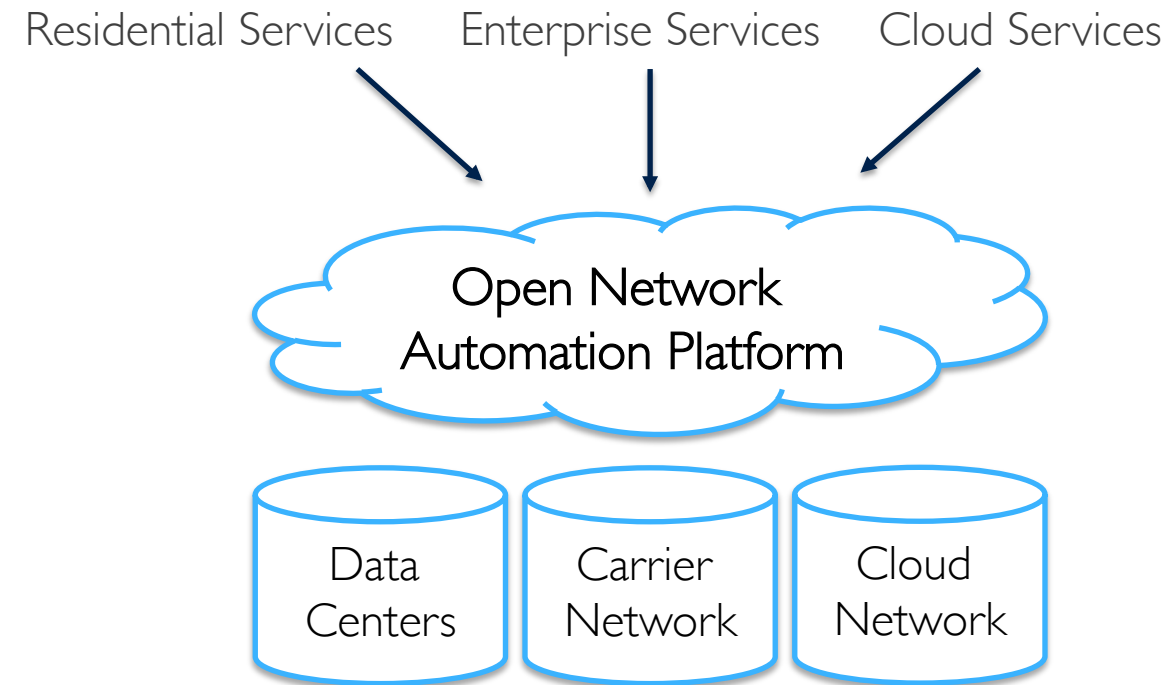
ONAP: The Business Value
Accelerate Services with Network Automation

End User Value

1. Faster Services on Demand including 4G, 5G & Business/Enterprise solutions

2. Elimination of manual steps/errors/time

3. Design, Agility & Automation enabler for 5G

Open Source Ecosystem Value

1. Harmonized shared investment in technology across Major Carriers globally

2. Neutral platform that will foster innovation on top of SDN/NFV eg Services, Virtual Functions, 5G Apps, IOT ecosystem

Residential Services   Enterprise Services   Cloud Services

Open Network Automation Platform

Data Centers   Carrier Network   Cloud Network

At Inception, ONAP enables up to 38% of Global Subscribers

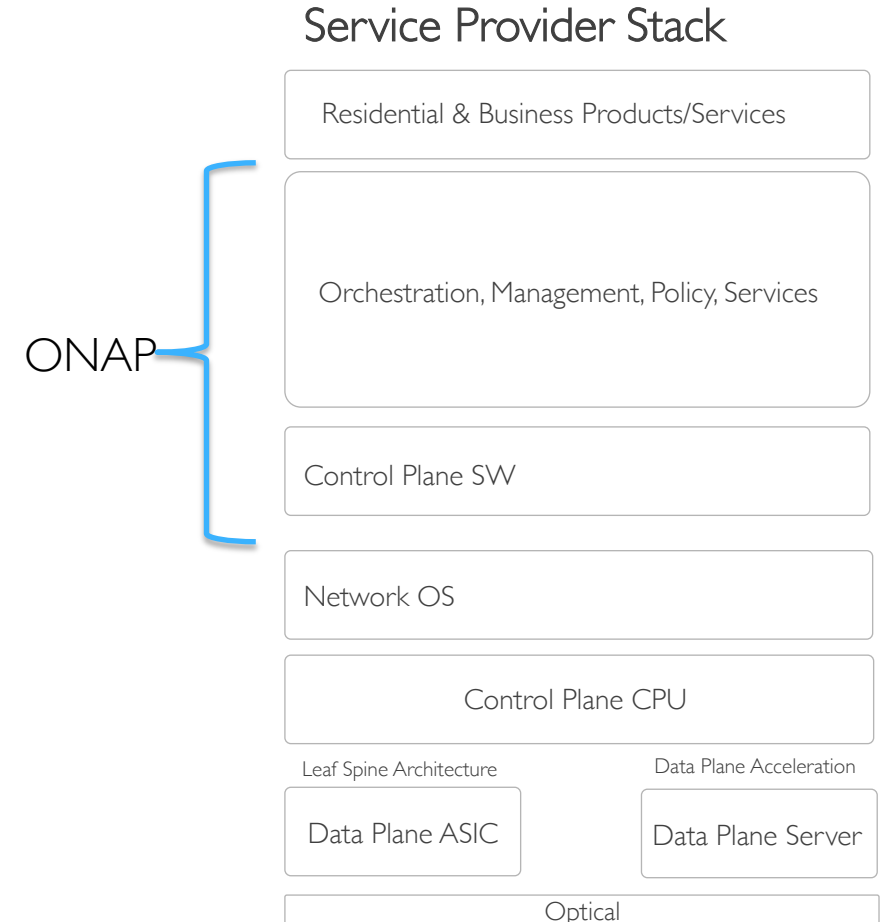**THE LINUX FOUNDATION**

15

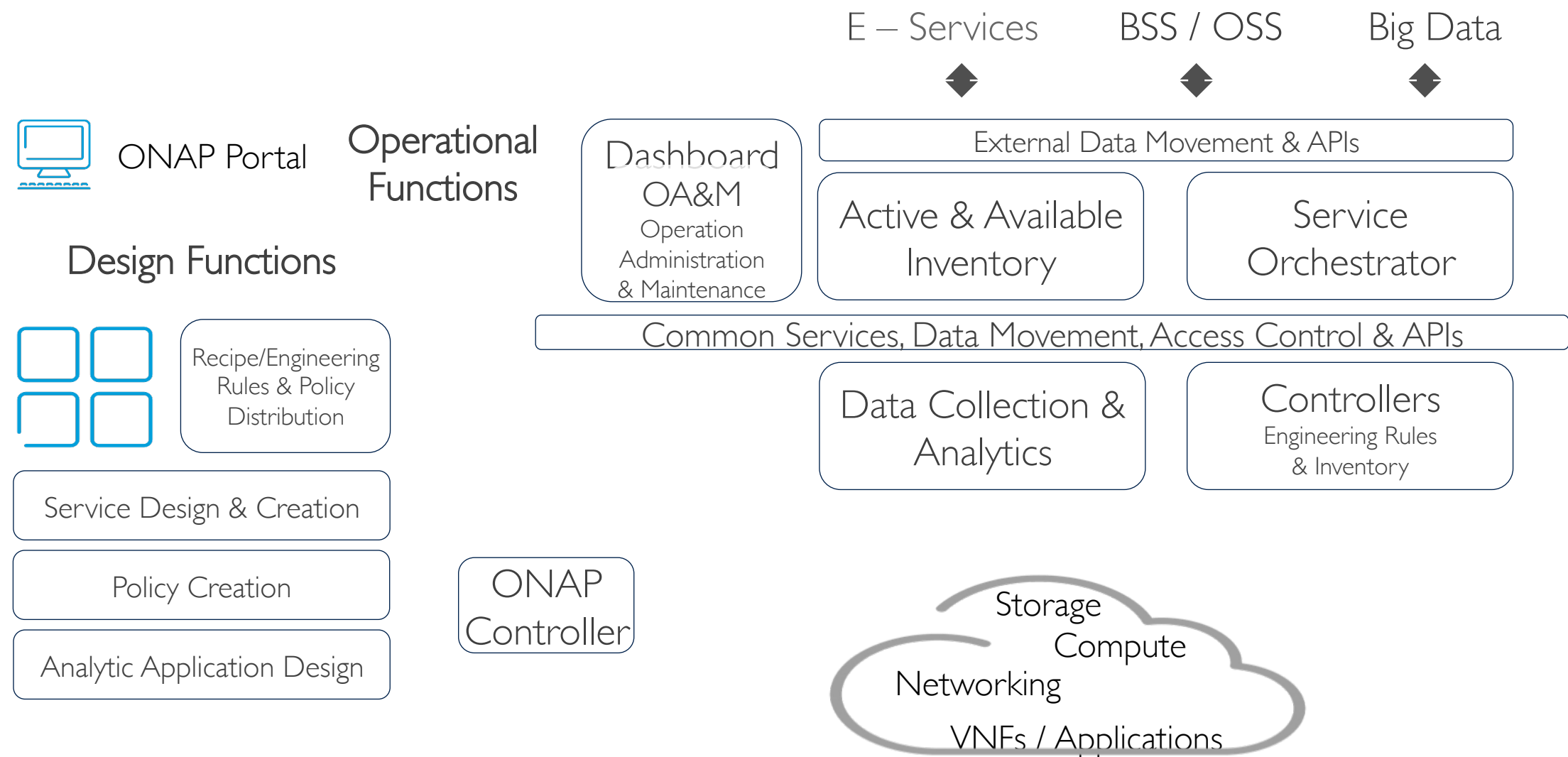# ONAP Tipping Point: 55% of Global Subscribers, 50+ Members

ONAP: Architecture Value
Design, Execute and Operate – Network Automation

1. Active and Available Inventory
2. Application Controller
3. Data Collection, Analytics, and Events
4. Design Studio
5. Service Orchestrator
6. Network Controller
7. Policy Framework
8. Portal
9. Virtual Network Function SDK
10. Virtual Function Controller
11. Modeling

Service Provider Stack
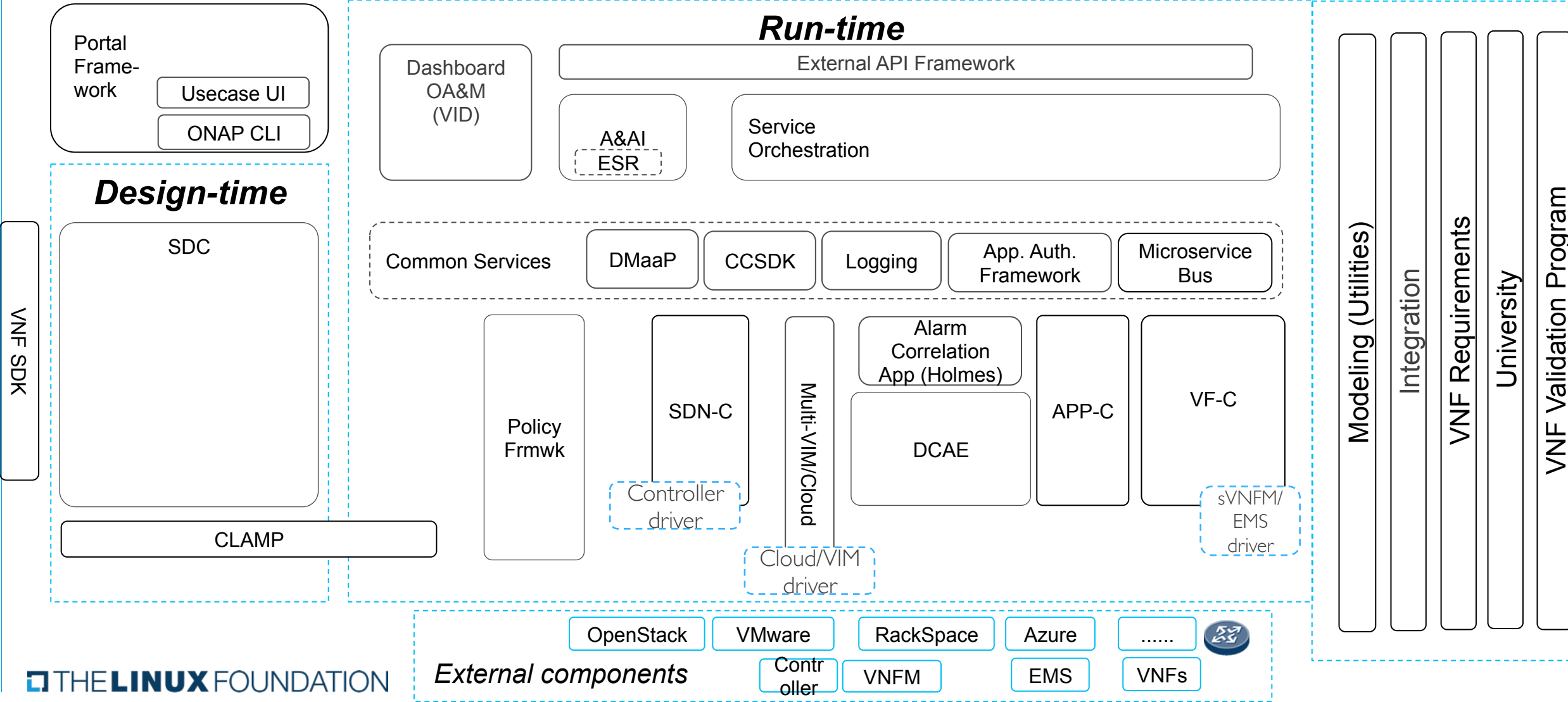
Residential & Business Products/Services

ONAP

Orchestration, Management, Policy, Services

Control Plane SW

Network OS

Control Plane CPU

Leaf Spine Architecture

Data Plane ASIC

Data Plane Acceleration

Data Plane Server

Optical

ONAP Initial Architecture

E − Services   BSS / OSS   Big Data

ONAP Portal

Operational Functions

Design Functions

Recipe/Engineering Rules & Policy Distribution

Service Design & Creation

Policy Creation

Analytic Application Design

ONAP Controller

Dashboard
OA&M
Operation Administration & Maintenance

External Data Movement & APIs

Active & Available Inventory

Service Orchestrator

Common Services, Data Movement, Access Control & APIs

Data Collection & Analytics

Controllers
Engineering Rules & Inventory

Storage
Compute
Networking
VNFs / Applications

ONAP Architecture Baseline Amsterdam (Release 1, Q417)

ONAP Operations Manager

Run-time

Portal Framework
- Usecase UI
- ONAP CLI

Dashboard OA&M (VID)

External API Framework

A&AI ESR

Service Orchestration

Design-time

SDC

VNF SDK

CLAMP

Common Services | DMaaP | CCSDK | Logging | App. Auth. Framework | Microservice Bus

Policy Frmwk

SDN-C

Controller driver

Multi-VIM/Cloud

Cloud/VIM driver

Alarm Correlation App (Holmes)

DCAE

APP-C

VF-C

sVNFM/ EMS driver

Modeling (Utilities)

Integration

VNF Requirements

University

VNF Validation Program

External components

OpenStack | VMware | RackSpace | Azure | ......

Contr oller | VNFM | EMS | VNFs

ONAP now the De-Facto Automation Platform for Carriers

Global Subscribers

- 28% Untapped, for now
- 17% Additional Wireless Subscribers (In Pipeline)
- 55%
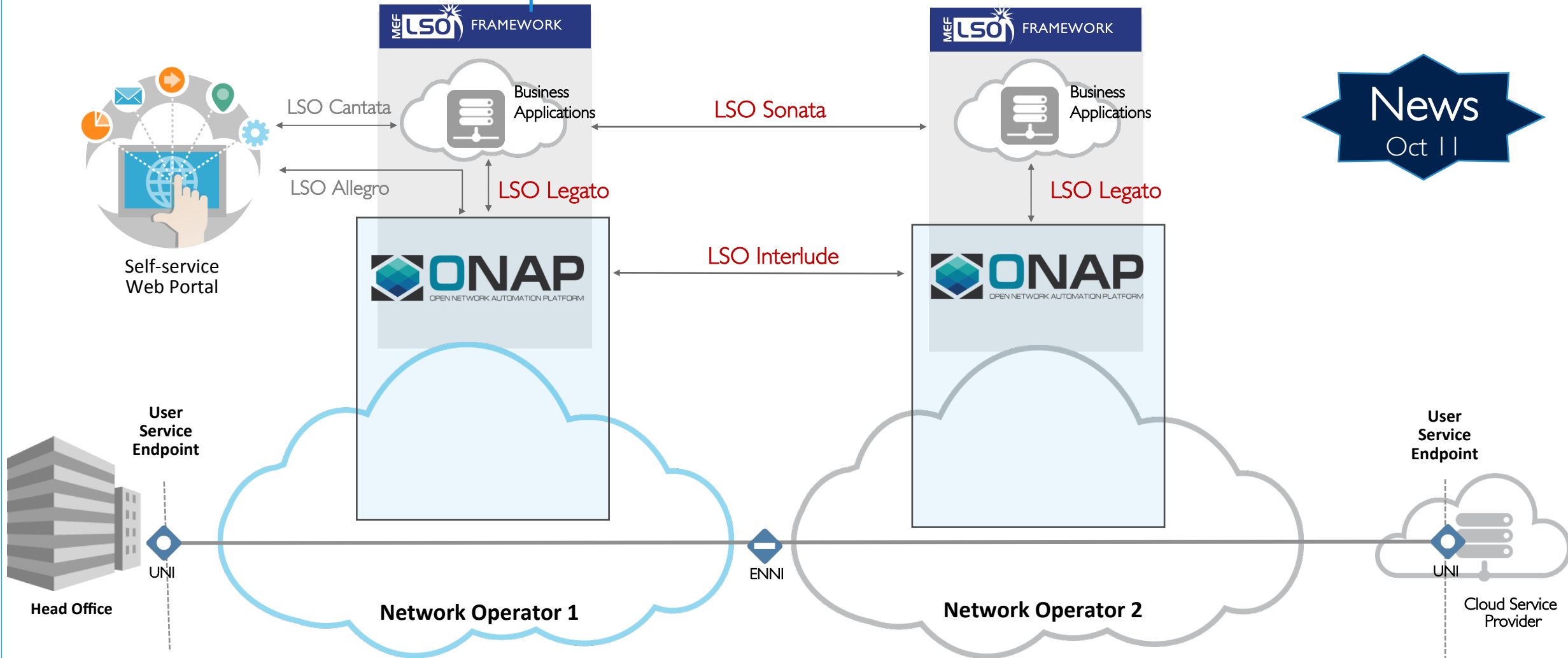
ONAP
OPEN NETWORK AUTOMATION PLATFORM
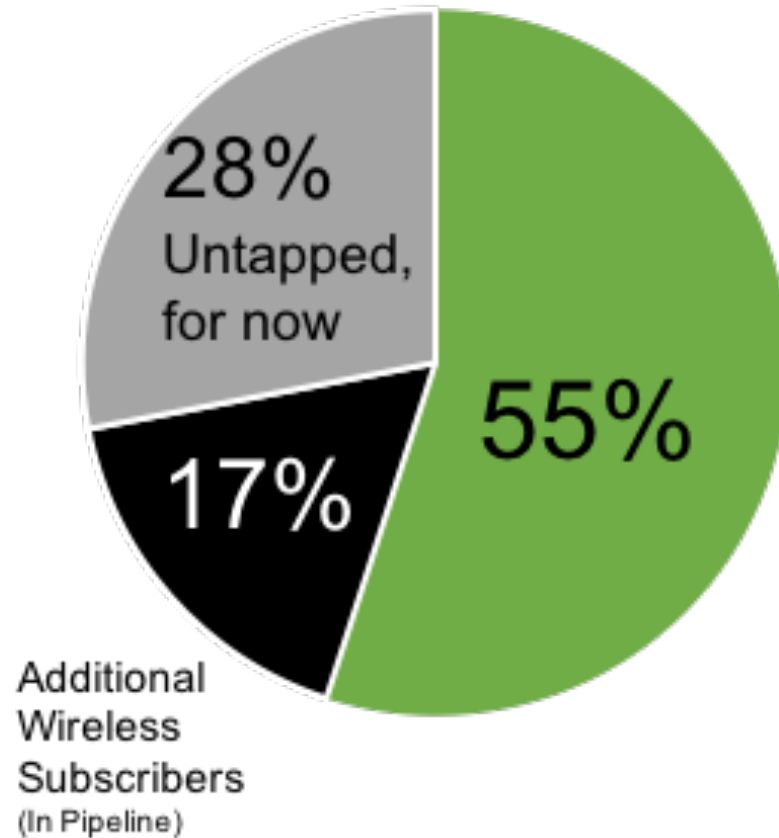
✓ Model driven service design

✓ Multivendor VNF and PNF support

✓ MultiVIM/Cloud

✓ Cross WAN DCI underlay and overlay network support

✓ Workflow driven service orchestration

✓ Multiple ONAP controllers support

✓ Closed loop automation with data collection, data analytics and policy

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ONAP Executive Metrics: YTD as of Sep 2017

ONAP Community Growth and Diversity

Legend: Total Members, Committer Companies*, Proj Team Lead Companies

Wiki Membership

Wiki-Members values: Jan 0, Feb 0, Mar 200, Apr 350, May 500, June 700, Jul 848, Aug 1019, Sept 1150
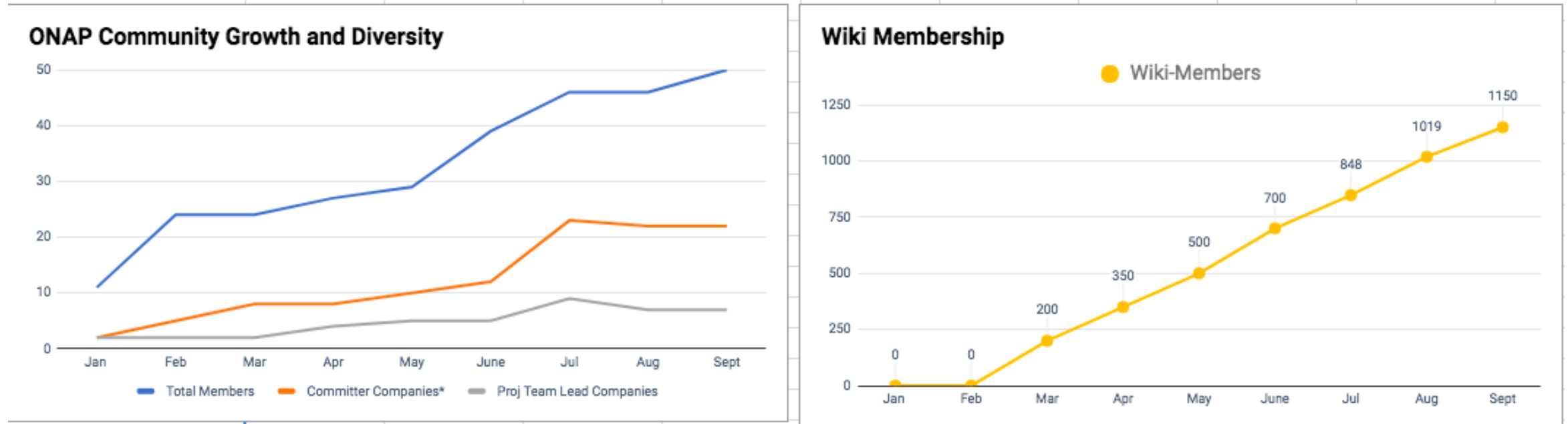
ONAP is creating the largest shared technology investment in Open Source Networking @ LF

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Key Takeaways: ONAP

› Automation is a must before 5G and IOT

› ONAP is becoming the de-facto Automation Platform
  › Global end user participation (55% subs covered)
  › Top 10 vendors & SI active
  › Vibrant community of 1100+ developers

› ONAP is leading the Industry effort on Harmonization across Open Source & Standards – starting with MEF

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Cross-Community CI: Faster Integration Upstream

Cross Community Continuous Integration

XCI

- Facilitate development & integration of open source components

- System level integration testing & creation of NFV Ref Platform

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Announcing OPNFV Euphrates

News

- Containers Support with Kubernetes orchestration engine & containerized OpenStack

- Carrier-grade network visibility and service assurance framework

- Cross-community Continuous Integration (XCI)

- Extensive new set of test tools for NFVI/VIM, VNFs and network services (eg SampleVNF, NFVbench)

- Improvements in testing, VNF-onboarding, performance and security

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https://www.opnfv.org/software

During the Euphrates Release Cycle...

- 36 Projects
- 200+ Developers
- 8K+ Commits
- 30+ Orgs Committing

4 Interns Contributing

8K+ Functional Test Runs (FuncTest)

Plus deployment of other upstream software including Kubernetes, ONAP, DPDK, FD.io, OVS, and more.

3K+ OpenDaylight Deployments

8K+ OpenStack Deployments

OPNFV EUPHRATES

THE
LINUX
FOUNDATION

Linux Foundation Networking and Orchestration White Paper:

Harmonizing Open Source and Standards in the Telecom World

A Publication of The Linux Foundation
May 2017

www.linuxfoundation.org

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