

# An Update on The Internet Infrastructure Transformation

Guru Parulkar

Honored and humbled to be in a session with  
Nandan Nilekani

# Key Takeaways

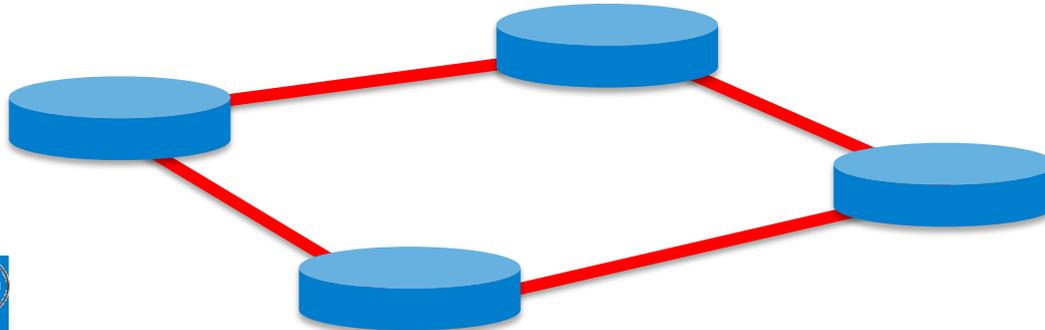
- Internet infrastructure and its industry are undergoing a major transformation
- ONF has been at the forefront of this transformation
- India and its software industry can play a big role in this transformation
  - And ONF can be their partner in this adventure

# Internet Infrastructure: What do we mean?

Google YouTube NETFLIX



Internet Infrastructure: \$300B+ per year



# Internet Infrastructure: Relative Profitability and Value

Google YouTube NETFLIX



Internet Infrastructure Providers:



AT&T



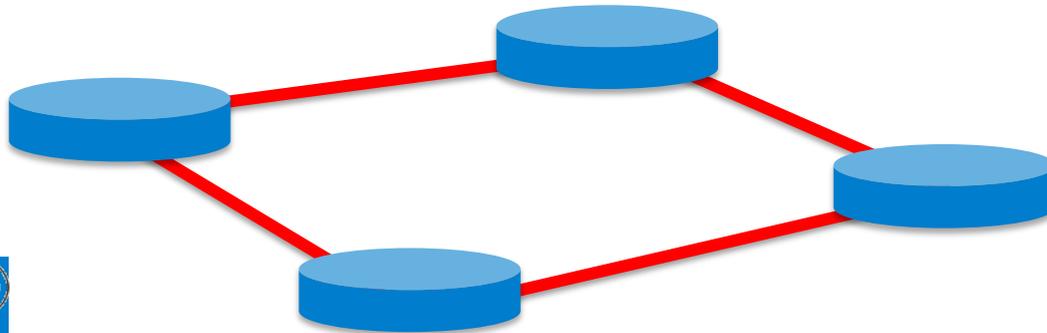
COMCAST



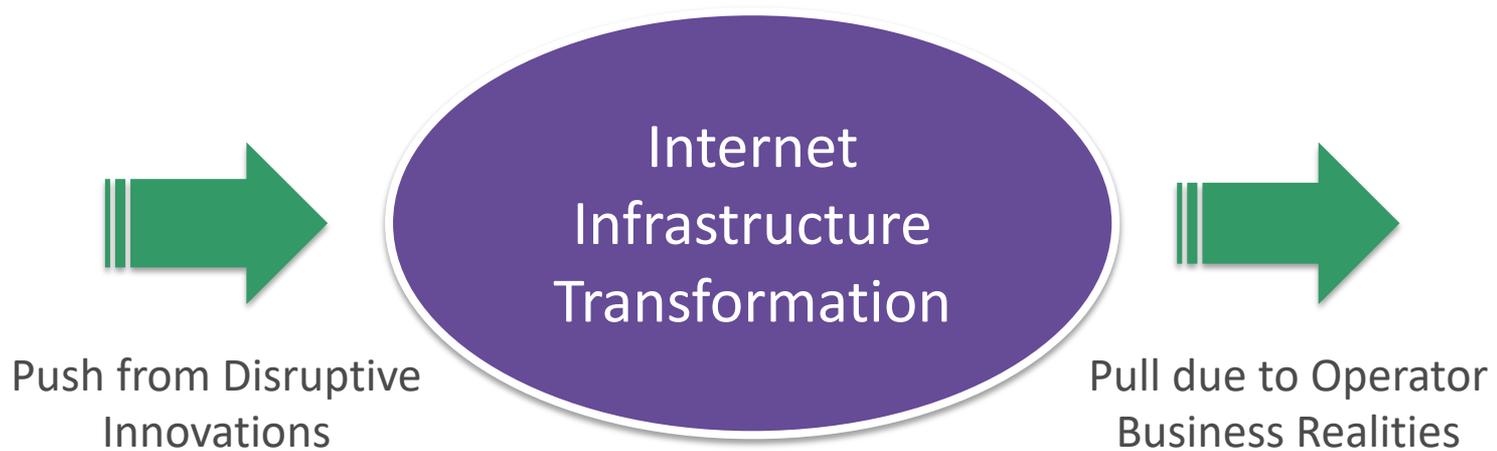
Telefonica



Jio



# Drivers for Internet Infrastructure Transformation



# Business Reality of Internet Infrastructure Providers

- Traffic growing very fast
  - "Mobile data traffic on AT&T's national wireless network increased more than 250,000% from 2007 to 2017."  
[https://about.att.com/newsroom/best\\_network\\_for\\_streaming\\_video.html](https://about.att.com/newsroom/best_network_for_streaming_video.html)
- Capex and Opex grow proportionally to traffic
- ARPU (Average Revenue Per User) is relatively flat or declining

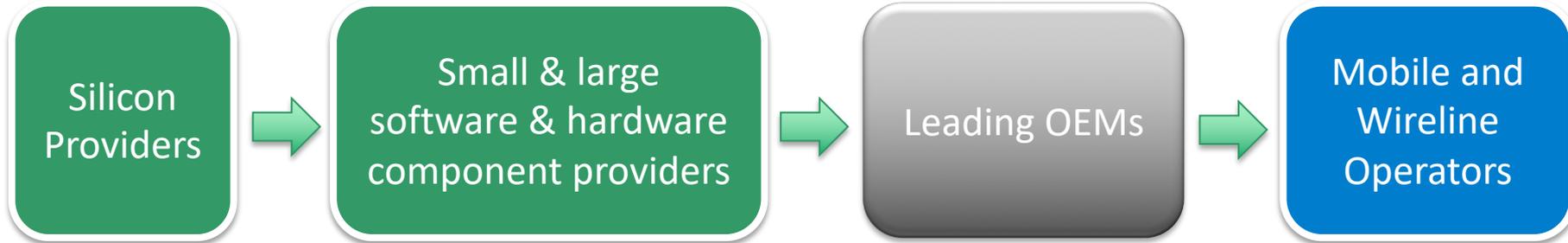
This challenges providers' business viability at the core  
and requires a fundamental paradigm shift

To make things worse, providers have to deploy 5G, Gigabit Broadband, and Edge infrastructure soon

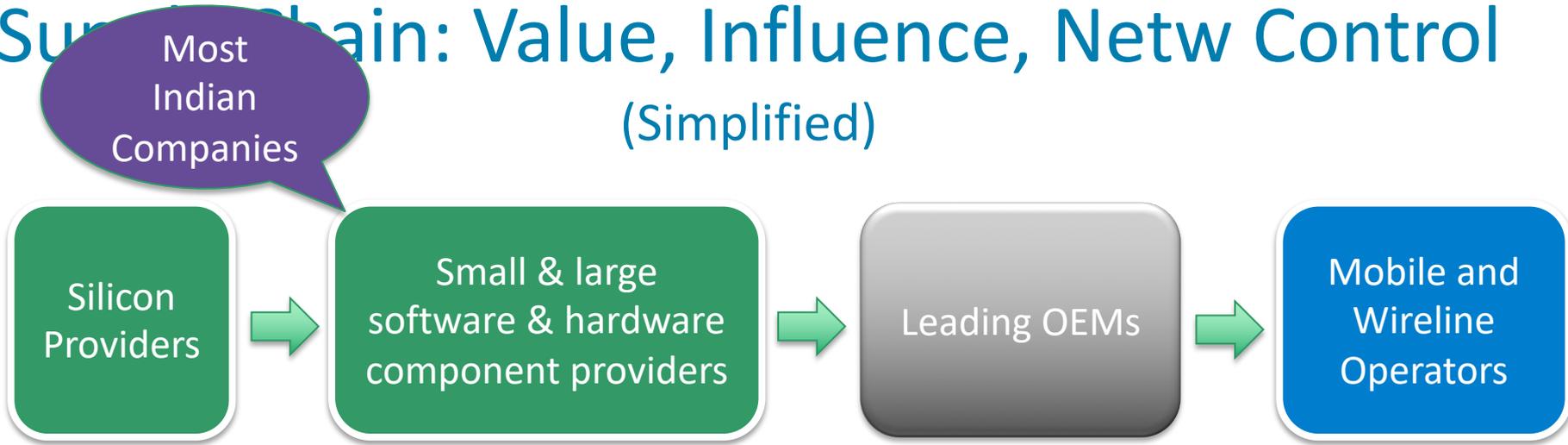
Providers cannot continue to build infrastructure with the current approach and business models

# Business Model and Supply Chain

(Simplified)



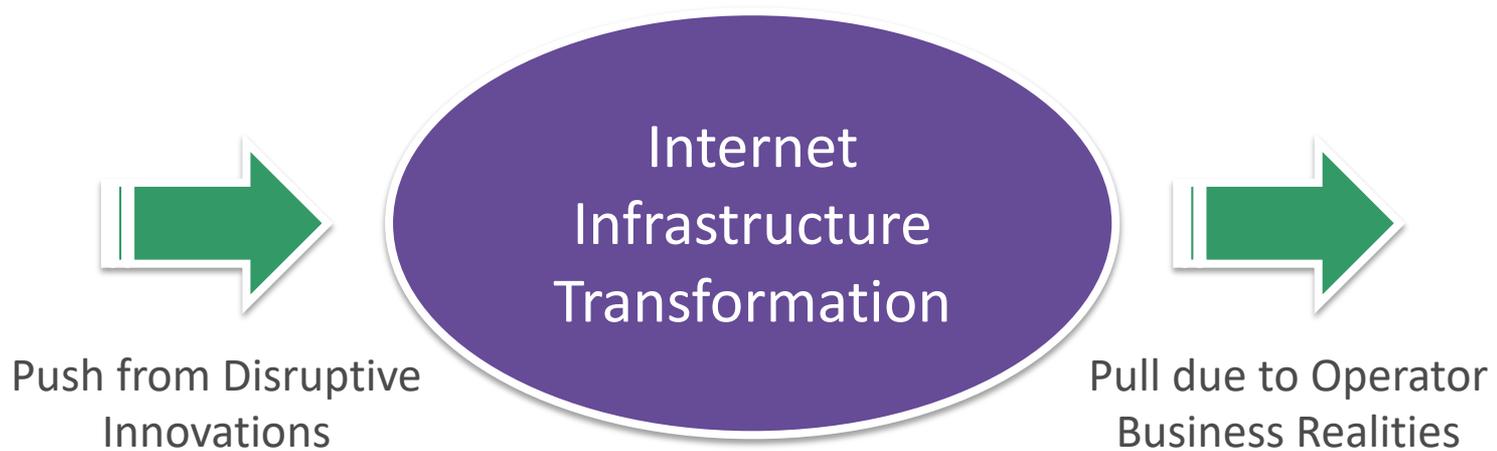
# Supply Chain: Value, Influence, Netw Control (Simplified)



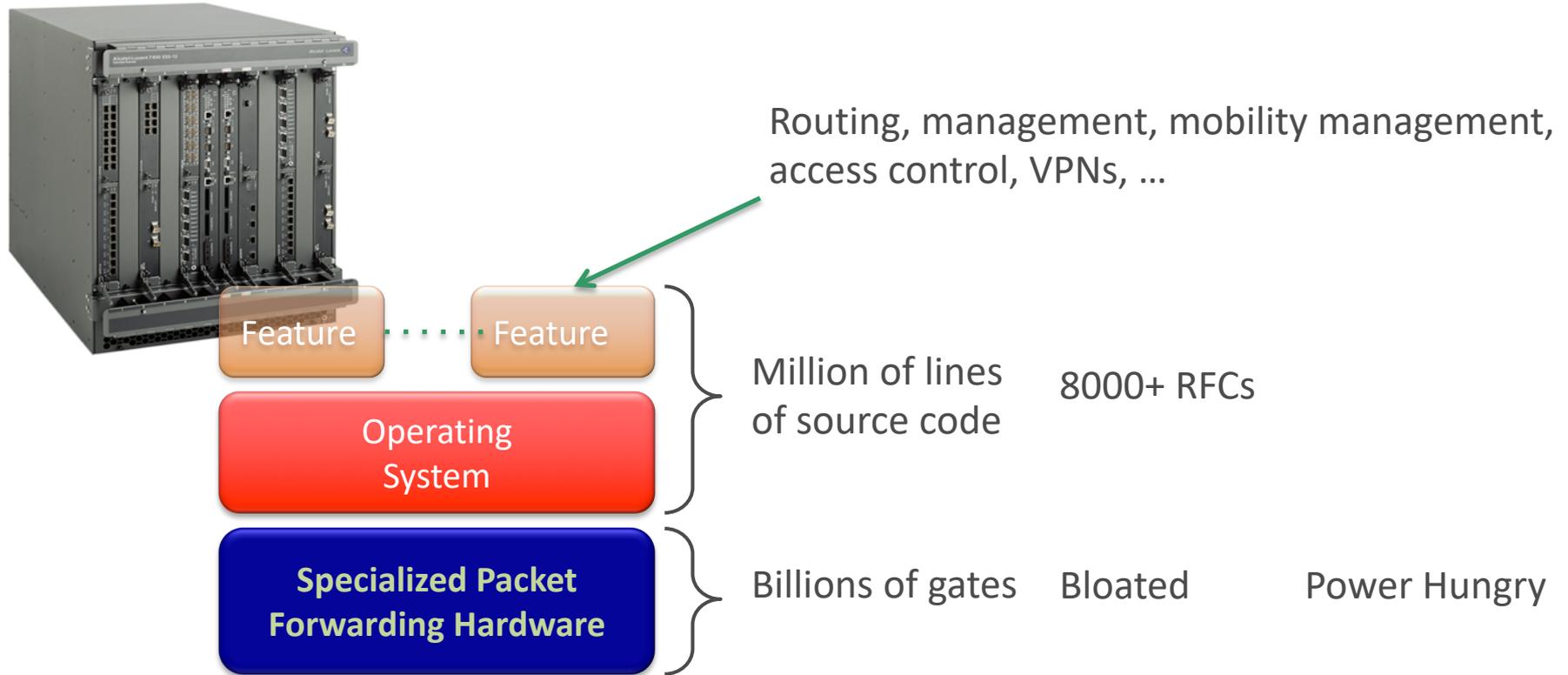
Metric	Silicon Provider	Software/Hardware Component Provider	OEM	Network Operator
Market Value	Modest	Low	High	Modest
Evolution	Modest	Low	High	Modest
Network Control	Modest	Low	High	Modest

Net Result: Low rate of innovation and high Capex & Opex for operators **ONF**

# Pull and Push Drivers for Internet Infrastructure Transformation



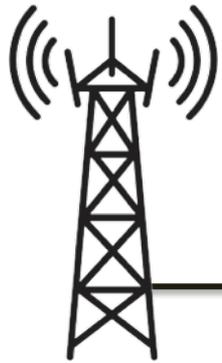
# Source of Problem: Network and Device Architecture



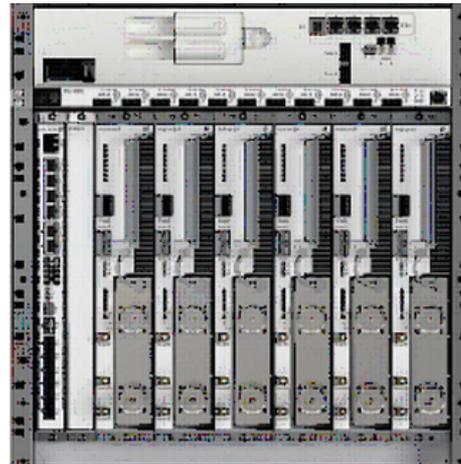
Vertically integrated, complex, closed, proprietary  
Source of high CapEx and OpEx; Not suitable for innovation;

# Situation is Even Worse for Mobile LTE Network

IETF + 3GPP Standards → More closed and proprietary



RAN



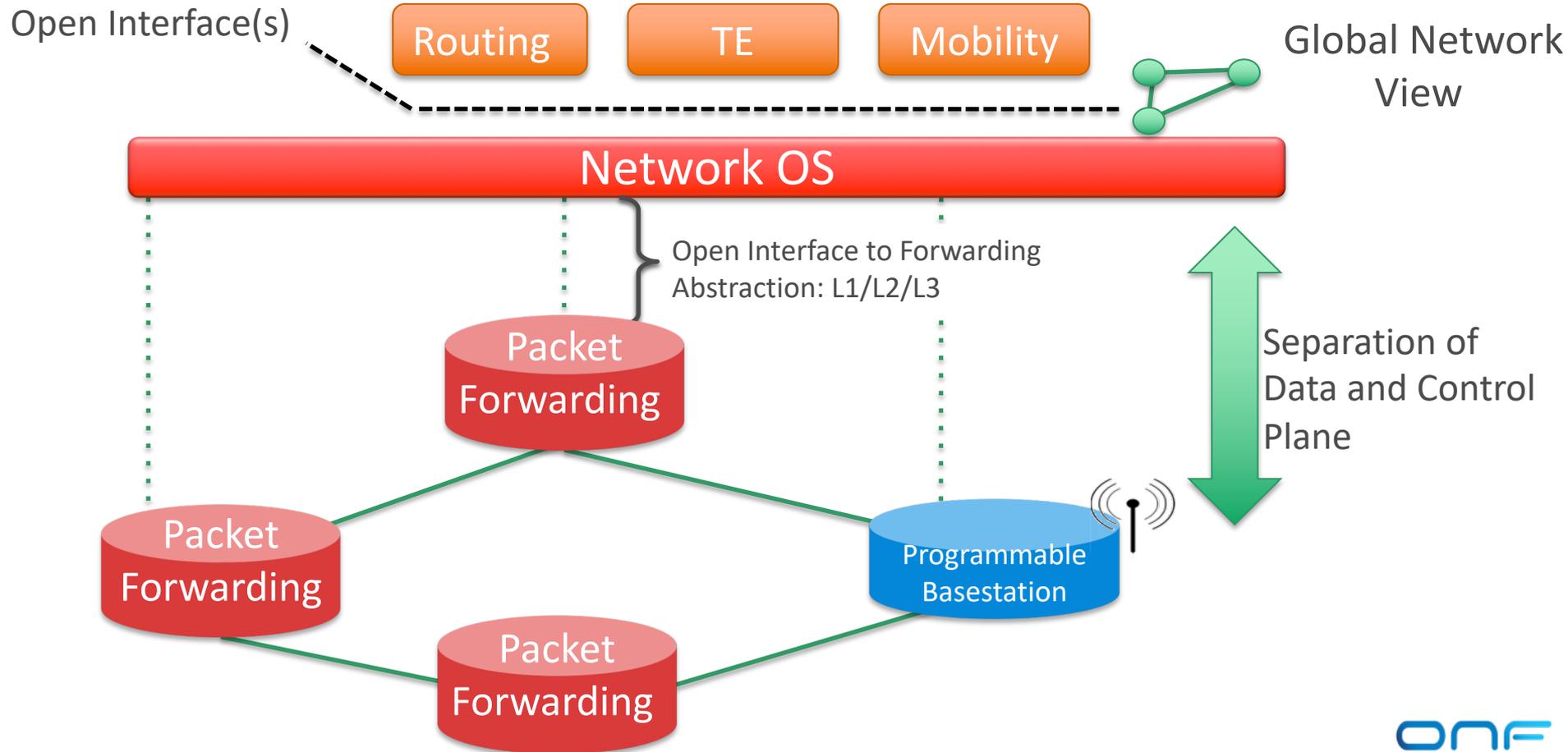
LTE eNodeB/Base Station



EPC: SGW and PGW

Mobile Core

# SDN as a New Approach to Networking



# Benefits of SDN

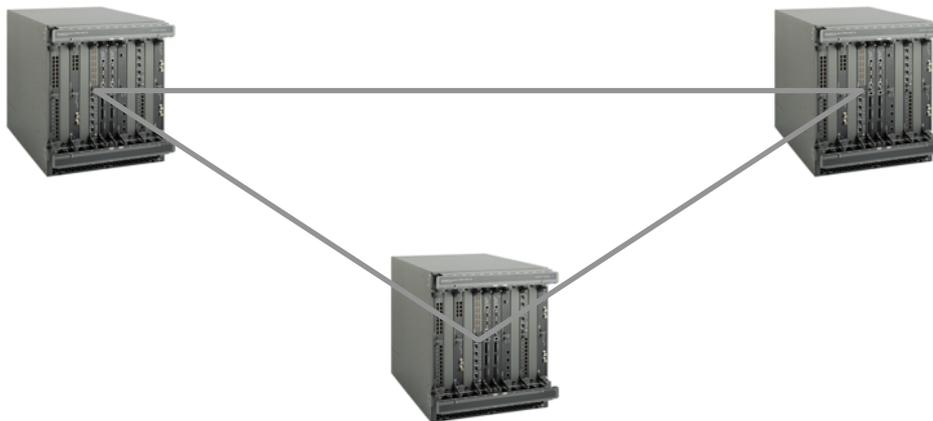
- **Help reduce Capex and Opex**
  - Disaggregation of complex proprietary boxes into simpler white boxes & (open source) software components
  - Exploit abstractions for control and management to reduce Opex
- **Enable innovation & accelerate new revenue generating services**
  - With openness and programmability of infrastructure
- **Give network operators control of their networks**
  - So they can innovate and customize and not be dependent on OEMs

Good News: Everyone in the Industry is Doing SDN!

Bad News: Many OEMs taking an “incremental” step

Network Wide Orchestration

Config and Provisioning of Devices: CLI Automation

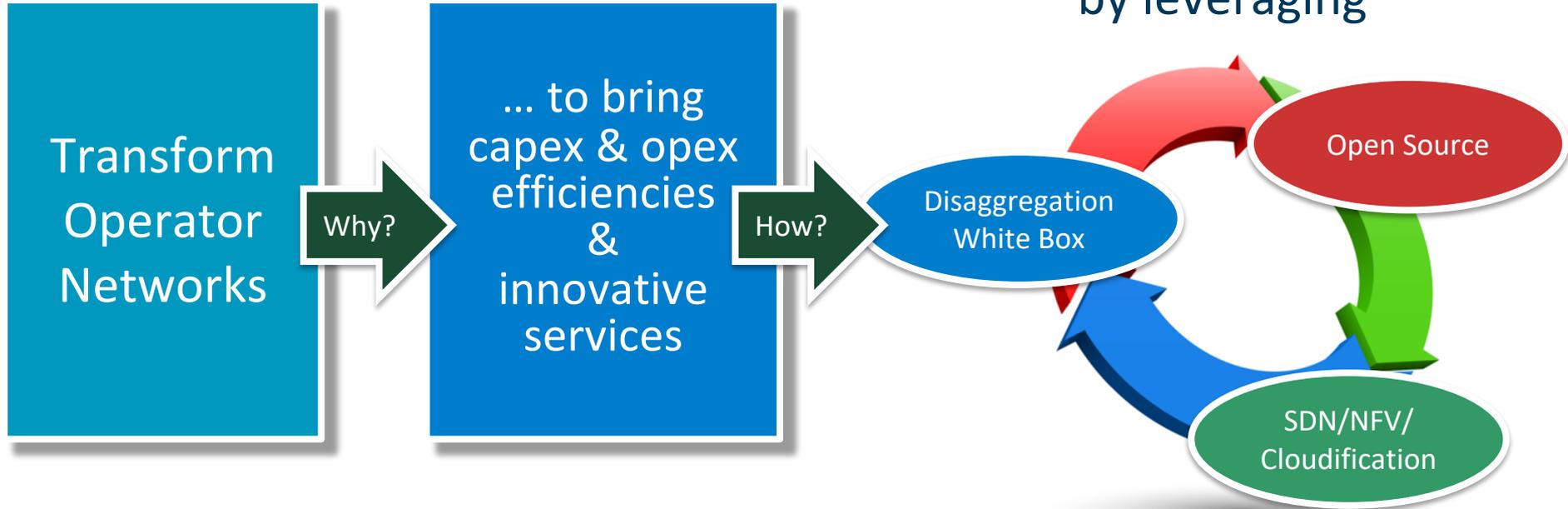


Some Opex savings but no other benefit  
No change in business model

# Key Takeaways

- Internet infrastructure and its industry are undergoing a major transformation
- ONF has been at the forefront of this transformation
- India and its software industry can play a big role in this transformation
  - And ONF can be their partner in this adventure

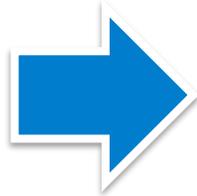
# ONF's Operator Led Mission



With the focus on Access and Edge

# ONF's Approach and Expected Outcome

Network of  
Closed Proprietary  
Boxes



Apps & Tools for  
Network Control  
& Management



**Control Plane**  
Network OS



**Forwarding**  
White boxes using  
Merchant Silicon

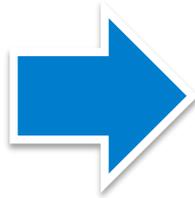


# ONF's Approach and Expected Outcome

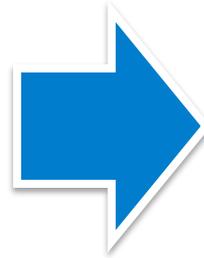
Network of  
Closed Proprietary  
Boxes



Switches, OLT,  
RU/DU, OLS/ROADM



# ONF Mission and Approach Requires New Open Source Model



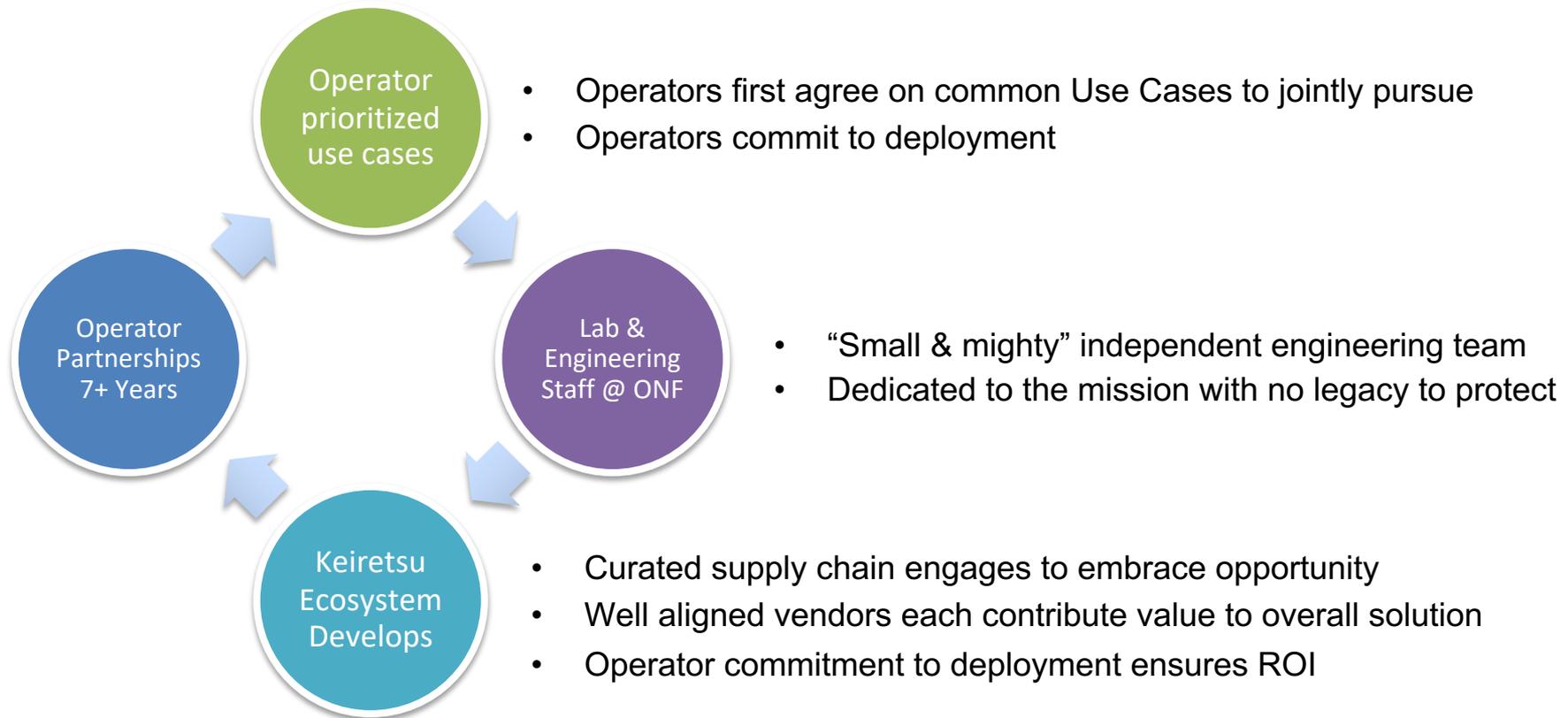
## Disruptive Innovation:

- Network Architecture
- Business Model

Difficult for existing OEMs to support & help build a developer community

ONF and its operator partners needed to invent a new open source model:  
**curated open source and curated community**

# ONF Unique Approach – Operator Led Curated Open Source

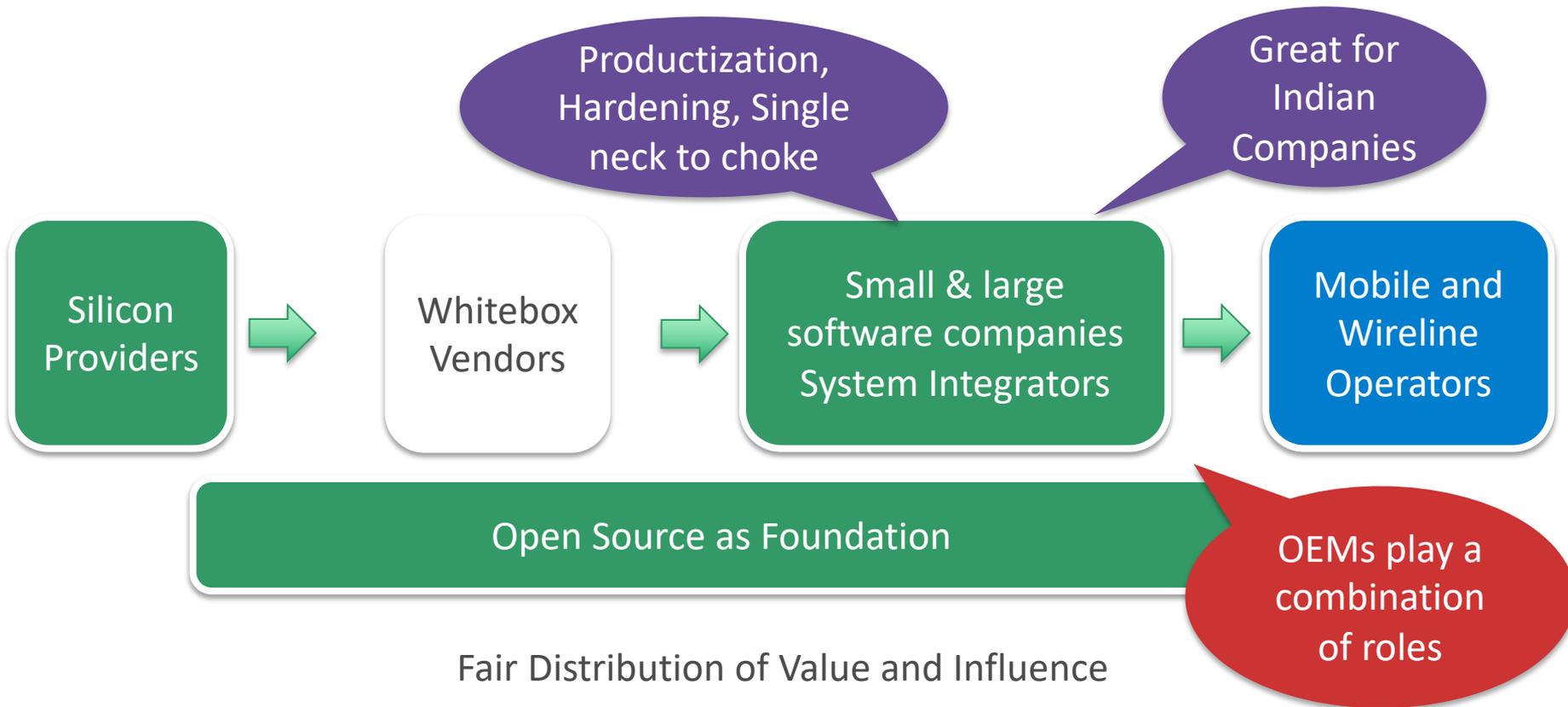


# Operator Led - Curated Open Source Community

Partners committed to disaggregation, open source and SDN/NFV/Cloudification



# NEW Supply Chain: Value, Influence, Control



Network operators have control of their networks to innovate and customize

**High rate of innovation and  
Significantly reduced Capex & Opex for operators**

# Open Source Platforms and Solutions

# ONF Open Source Components

Stratum

A Thin Switch OS supporting P4, P4RT, OpenConfig/gNMI, gNOI

Packet Switches



# ONF Open Source Components

Stratum

Packet Switches



VOLTA

OLT: Optical Line Terminator



A software layer to create OF switch abstraction

# ONF Open Source Components

XOS

A Service OS for service management, composition, orchestration

Services

A Portfolio of Mobile, Residential, & Enterprise Services

OMEC

A Disaggregated Virtualized EPC

ONOS: An SDN OS for control and config designed for scale, performance, HA

Stratum

Packet Switches



VOLTHA

OLT: Optical Line Terminator



xRAN  
Controller

RAN RU/DU



OLS/ROADM



# ONF's Ying-Yang Model for Disaggregation & Integration

**To enable innovation  
we need:**

Disaggregation and  
Open Source Components

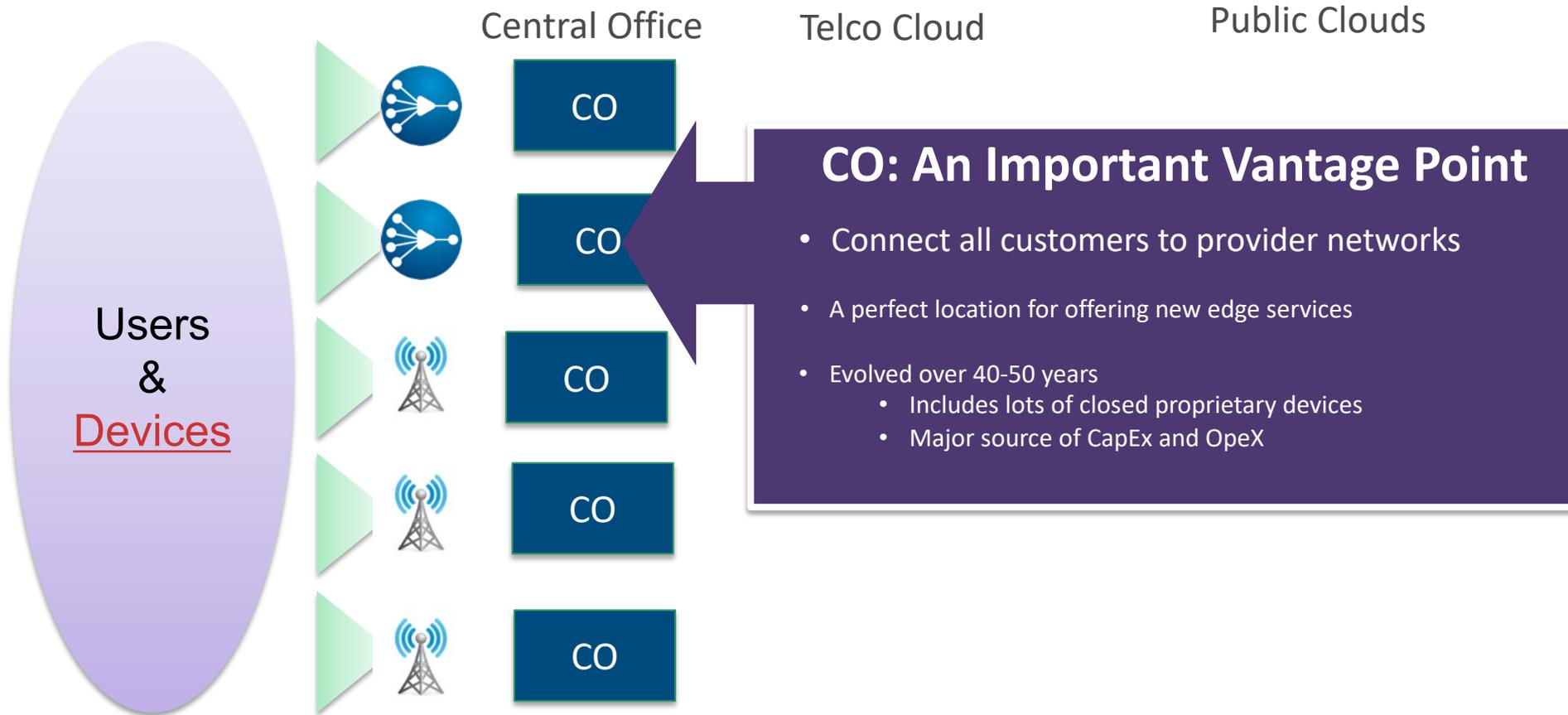


**To be able to deploy:**

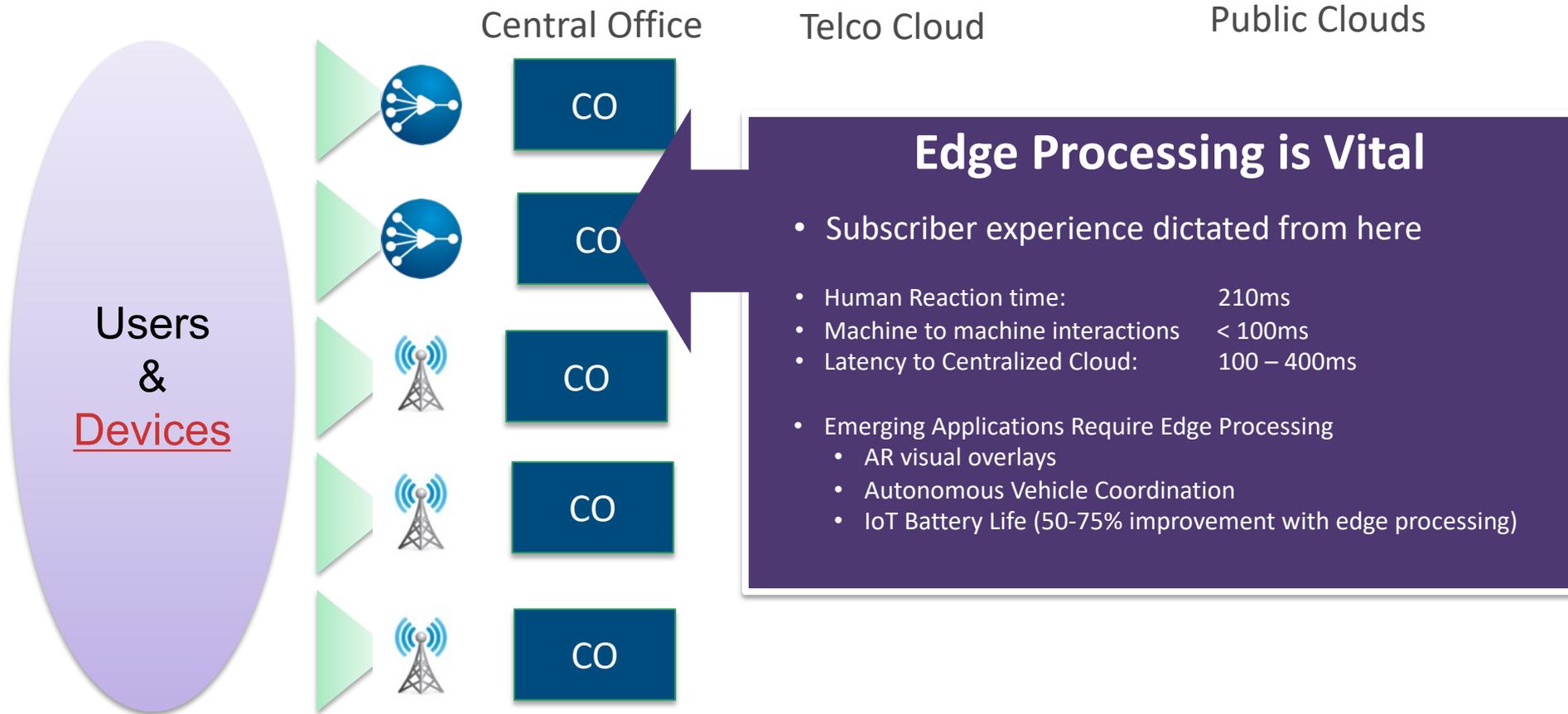
Operators Require Integrated  
Solutions Leveraging Open Source  
Disaggregated Components

ONF is unique in delivering **Integrated Solutions** leveraging open  
source **Disaggregated Components**

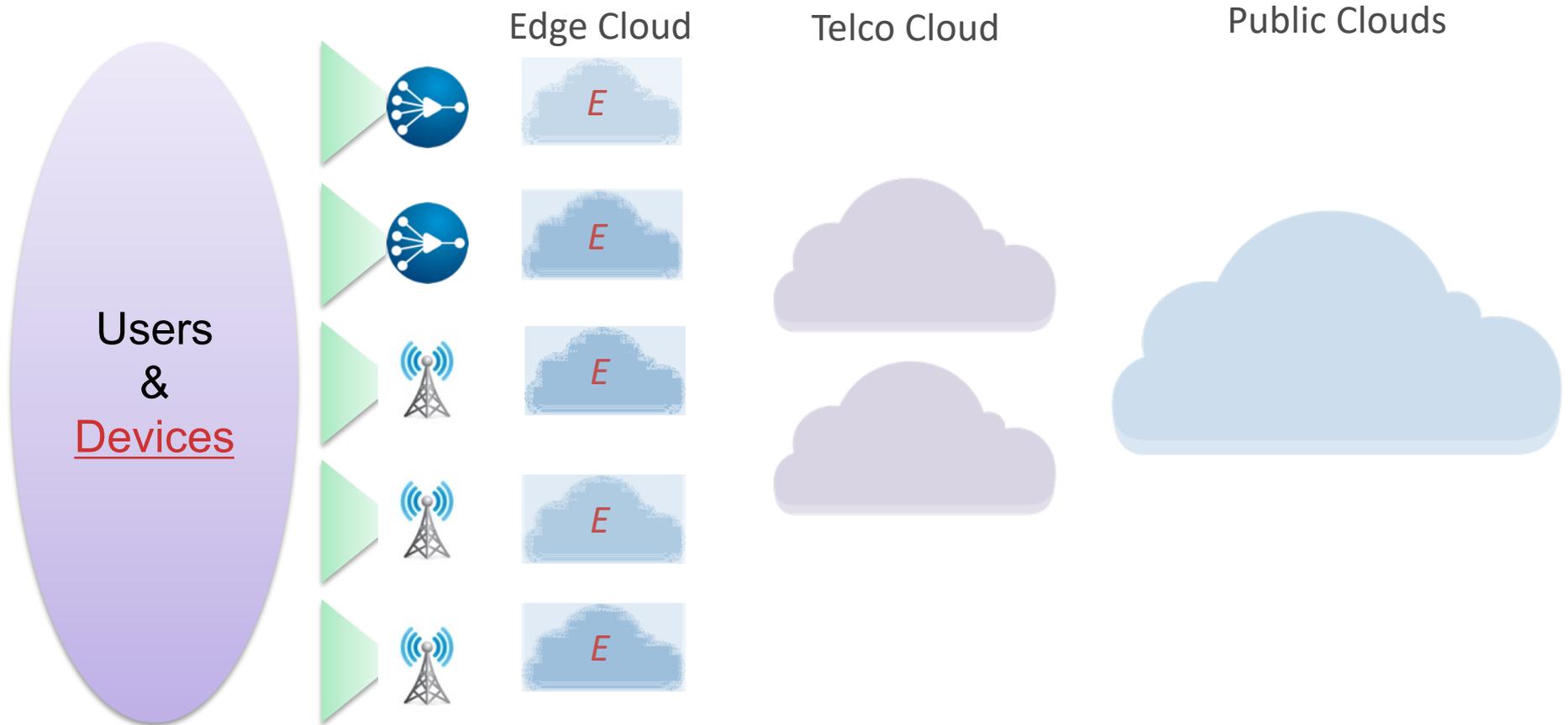
# Emerging Multi-Tier Cloud: CO Both an Asset and a Challenge



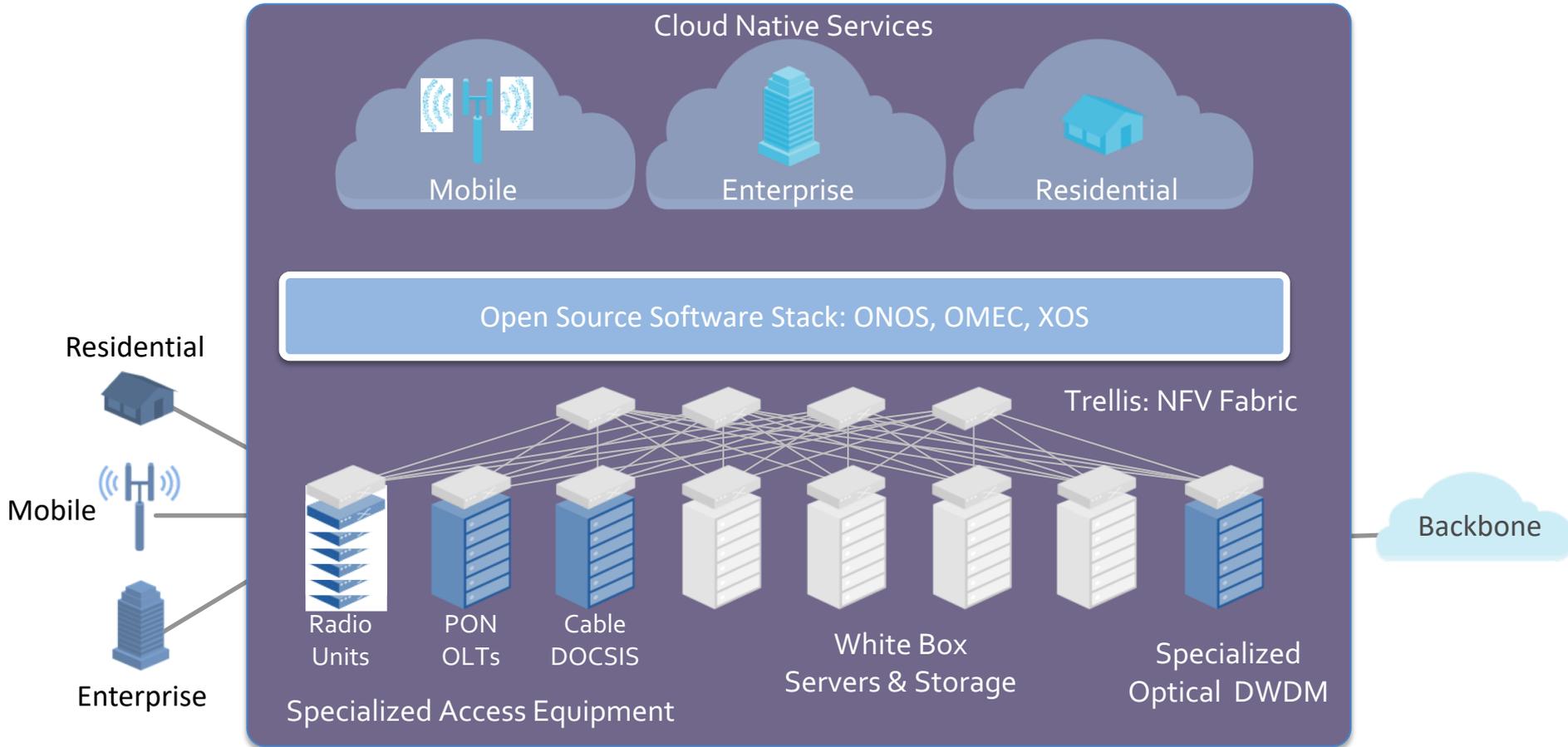
# Emerging Multi-Tier Cloud with New Edge



# Emerging Multi-Tier Cloud with New Edge Cloud



# CORD: New Edge Platform



# CORD: New Edge Platform

~25 services  
residential, mobile, &  
enterprise use cases

## Software Stack:

- OpenStack/Docker/Kubernetes
- ONOS, XOS

OCP  
Server

OCP  
Server

Ethernet

GPON OLT

XGS-PON OLT

4G/5G RAN

eNB w/ xRAN

## Trellis Switching Fabric:

- Leaf-Spine Fabric
- SDN enabled
- White Boxes
- ONOS as SDN OS
- Fabric Apps on ONOS

ROADM

Disaggregated  
ROADM

Zero-touch Provisioning  
Config & Operation  
With Helm, Docker, Kubernetes,  
XOS

# Innovative Integrated Solutions to Production



# Innovative Integrated Solutions to Production



# M-CORD POCs

## M-CORD 5.0

Architecture built on open source CORD 6.0



## ONAP Integration

Demonstrating integration with ONAP for both design-time and run-time

## P4 Fabric

Utilizing a multi-vendor p4-programmable leaf-spine fabric



## Open Source EPC

Hosting an open source, virtualized, disaggregated EPC + services

## VNF Acceleration

Showcasing VNF acceleration by offloading to P4-fabric and GPUs

## E2E Network Slicing

Exhibiting ONOS-based programmable end-to-end network slicing

## Closed Loop Analytics

Demonstrating closed loop analytics and automation

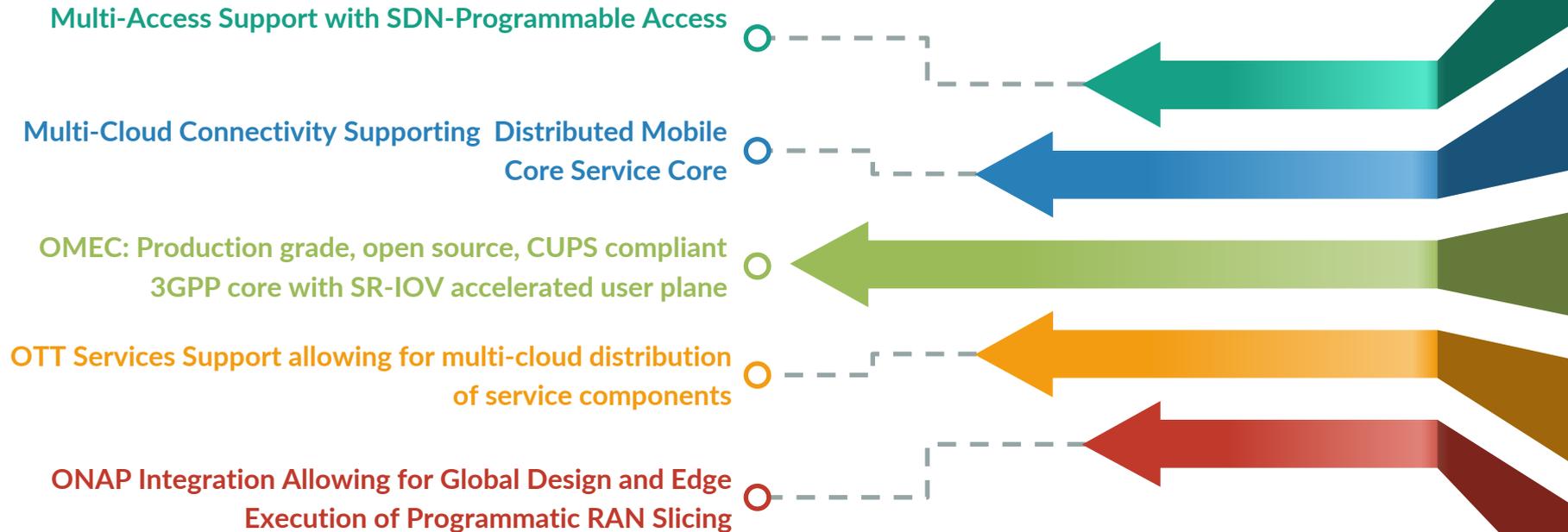


## ETSI MEC Interoperability

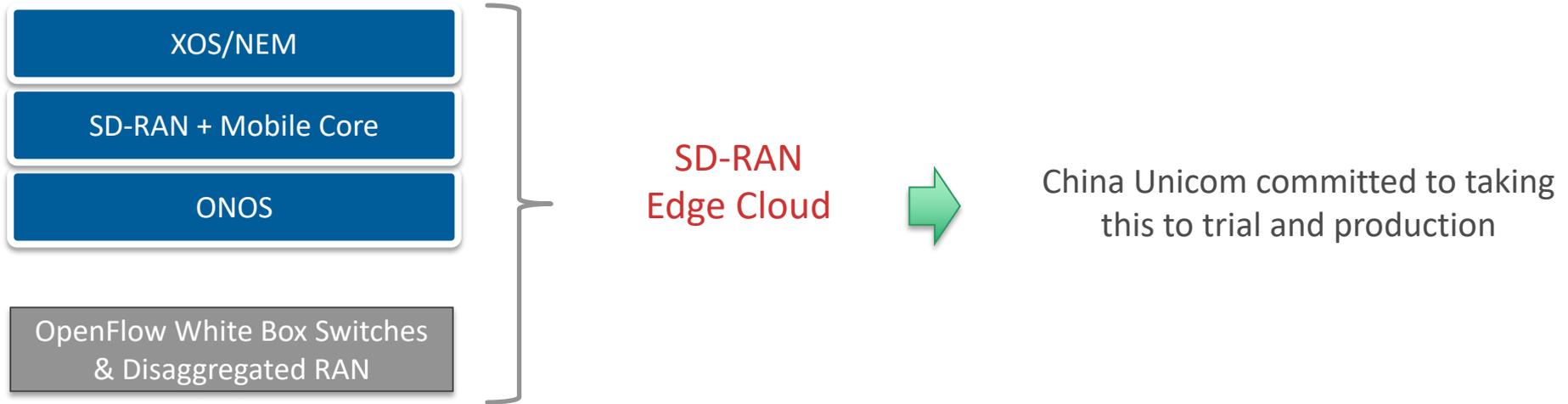
Demonstrating interoperability with legacy ETSI MEC platform

**Comprehensive, Highly Integrated Platform**  
Highlighting the Power of Open Source

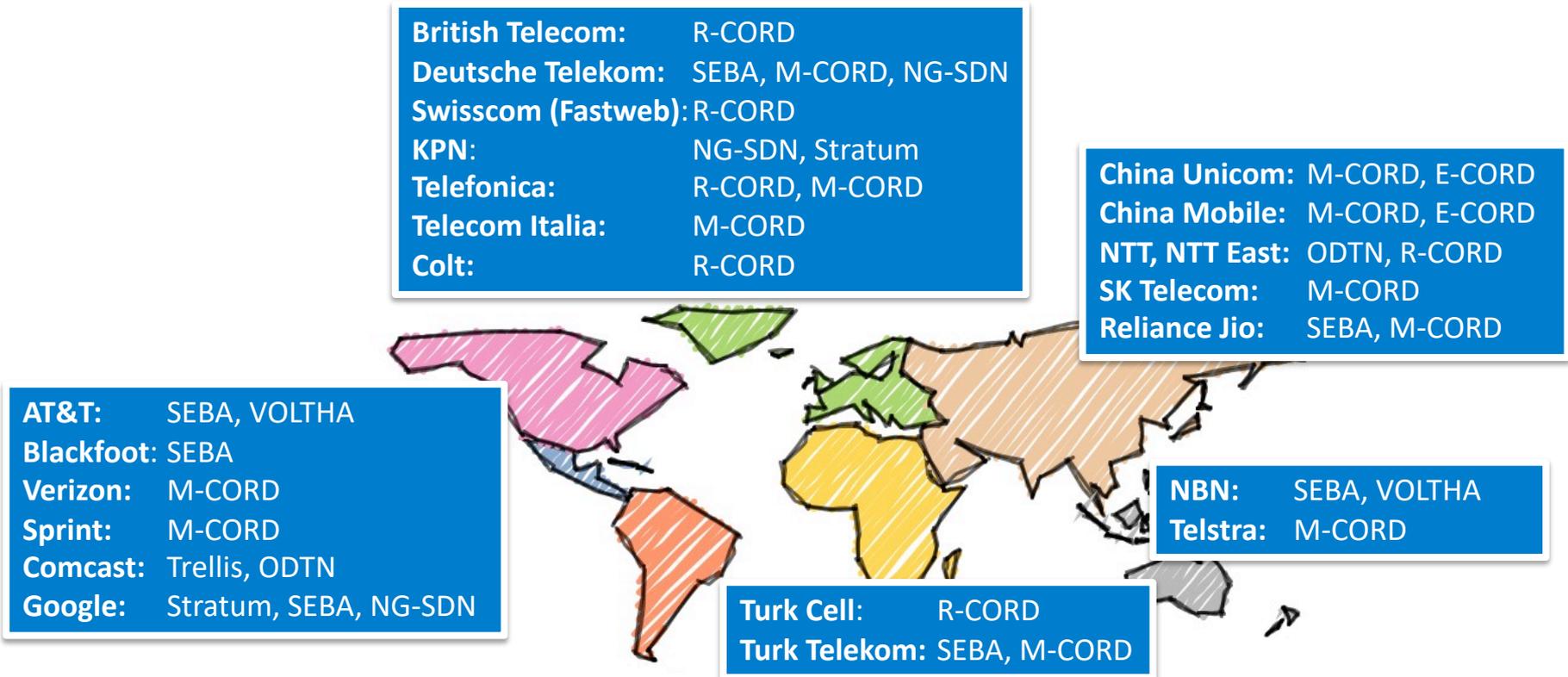
# M-CORD POC AT MWC 2019



# Innovative Integrated Solutions to Production



# Operator Traction Worldwide



# Operator Traction Worldwide

British Telecom: R-CORD  
Deutsche Telekom: SEBA, M-CORD  
Swisscom (Fastweb): R-CORD  
KPN: NG-SDN, St  
E-CORD, M  
CORD  
CORD

“70% of operators worldwide are planning to deploy CORD”



Michael Howard  
IHS Markit

“Nearly 40% of all end-customers will have service provided by ... CORD by mid-2021”



Roz Roseboro  
Heavy Reading

AT&T:  
Blackfo  
Verizon  
Sprint:  
Comcas  
Google:

Turk Cell: R-CORD  
Turk Telekom: SEBA, M-CORD

Telstra: M-CORD

E-CORD  
E-CORD  
-CORD  
-CORD

LTHA

# The New Edge

## *“The Edge Will Eat the Cloud”*

Gartner Maverick Research Report

<https://www.gartner.com/doc/reprints?id=1-4GH0FTL&ct=171004&st=sb>

## *“Return to the Edge and the End of Cloud Computing”*

Peter Levine, A16z

<https://a16z.com/2016/12/16/the-end-of-cloud-computing/>

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Software is eating the world!

Including Of course Software Defined Internet Infrastructure

Open source is the new default way to build software

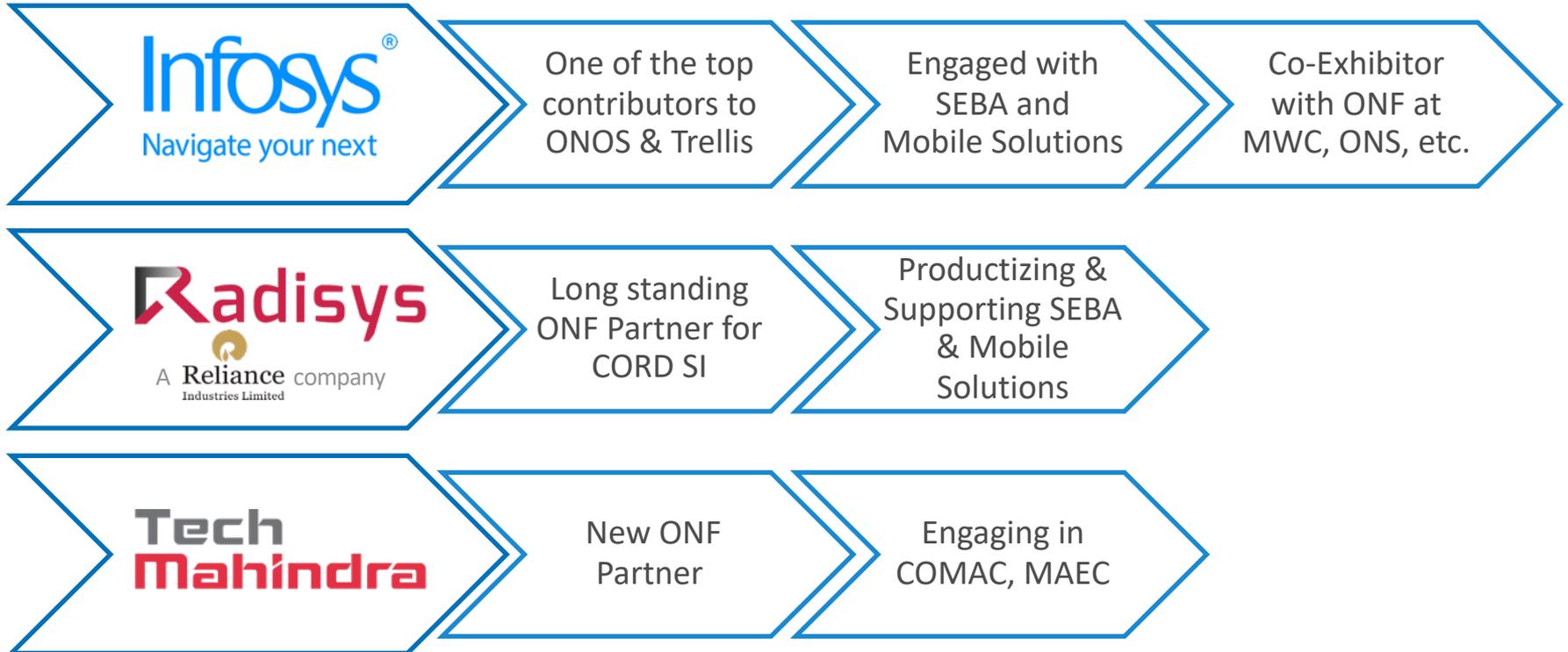
India has the largest skilled software developers



India's Opportunity to Play a Significant Role in Internet Infrastructure Transformation

# Good News: Many Indian Companies Realize the Opportunity

## ONF Partner Members based in India



# Good News: Many Indian Companies Realize the Opportunity

**ONF Partner Members with significant Eng presence in India**



**Every ONF Supply-chain Partner!**

# Good News: Many Indian Companies Realize the Opportunity

## Notable ONF Collaborative Innovator Members based in India



“A Big Thank you”

to all

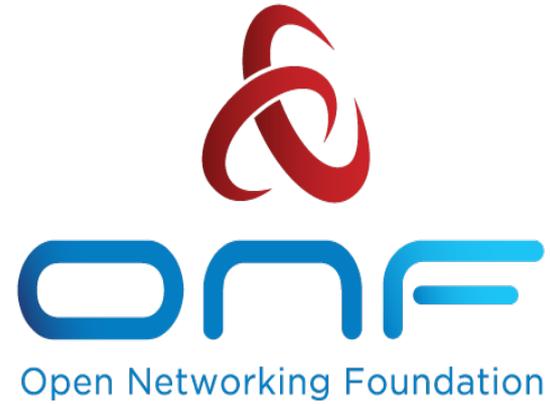
Our Indian Partners and Members

If you have been on the sidelines, it is time to join ONF and the transformation adventure!

You can be sure to get amazing ROI as this \$300B+ industry transforms

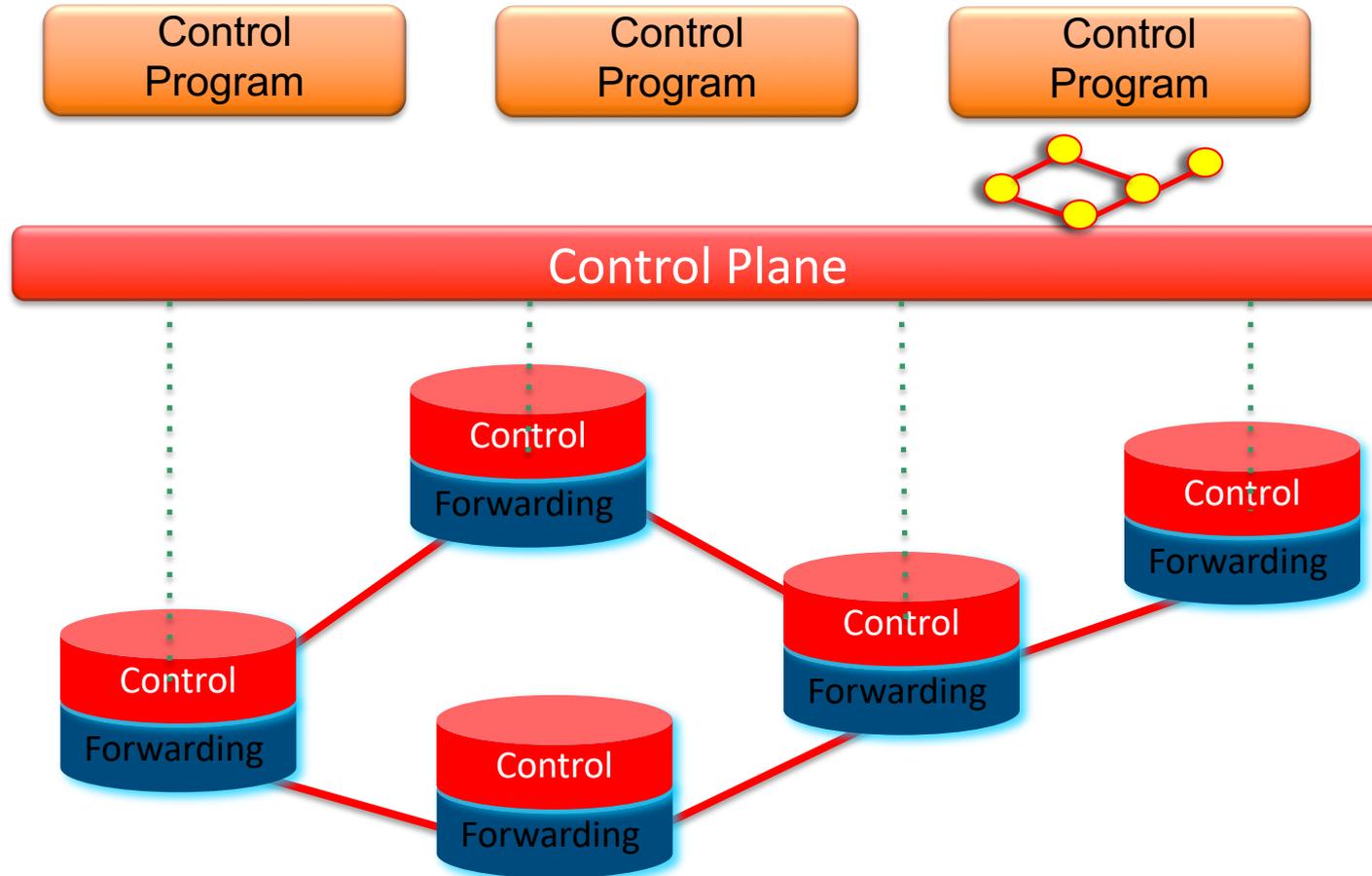
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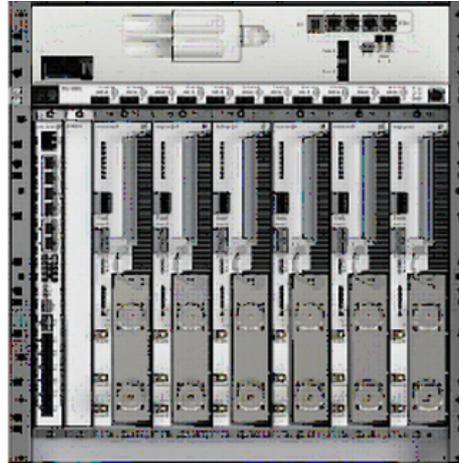
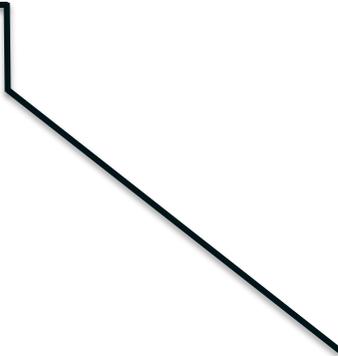


THANK YOU!

# Software Defined Networking (SDN)



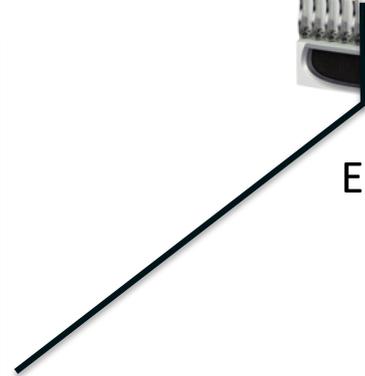
# Mobile LTE Network



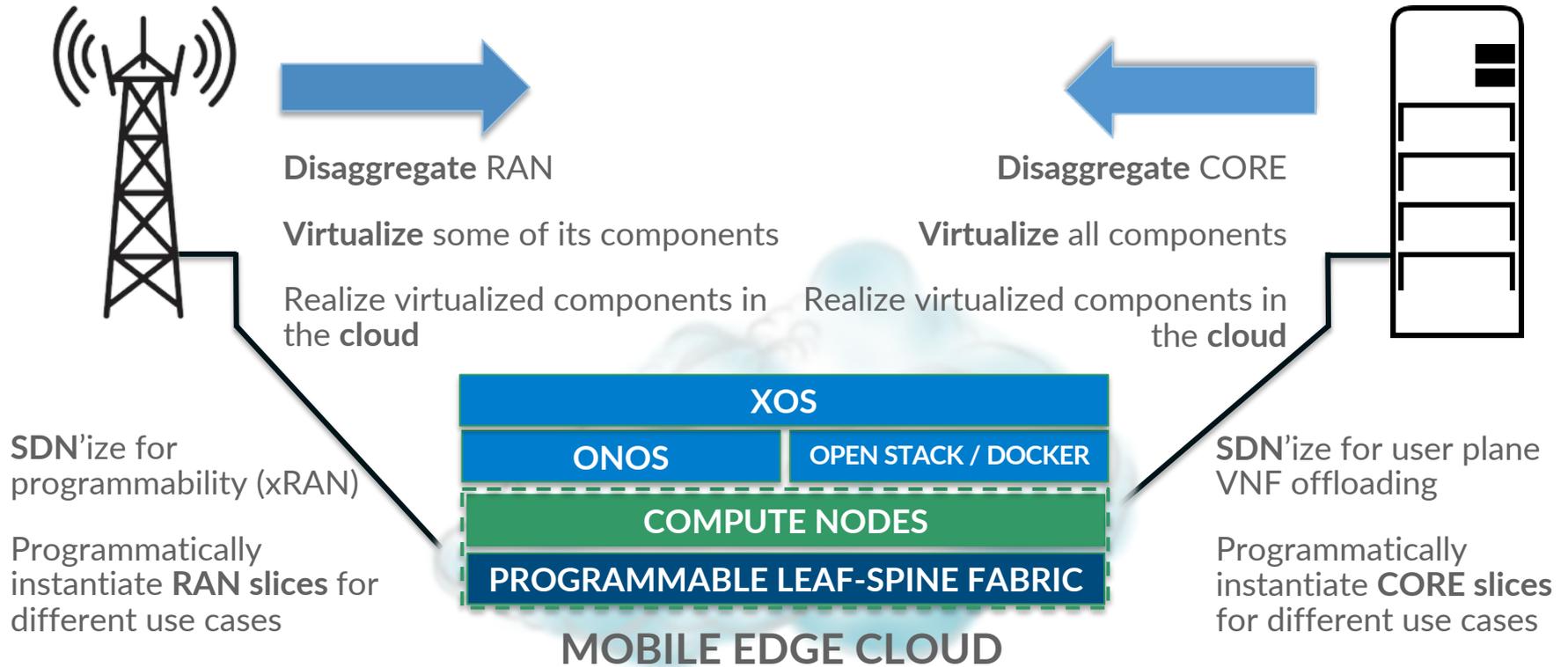
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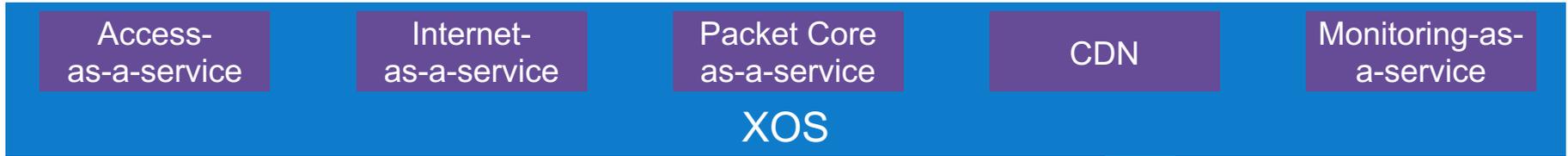
# M-CORD: Platform for 5G MOBILE EDGE



We know we are on the verge of big milestones that will take us beyond the point of no return in this transformation adventure!

We have to stay focused and continue to execute

# CORD Software Stack



All Open Source

