State of ONOS: SDN OS for Service Providers

ONOS Build
September 2017
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ONF
State of ONOS: The Key Takeaways

• ONOS is on a path to becoming a critical SDN OS platform for service providers

• Great progress on all fronts
  ▪ Platform features, functions, and maturity
  ▪ Use cases and solutions and their adoption by service providers
  ▪ Community: contributions, growth, and engagement

• We have work ahead
  ▪ We have to deliver production readiness and commercial support of ONOS
    - ONOS SDN solutions represent disruptive technology for incumbents: it takes more time
  ▪ We have to continue to strengthen our community for long term
Korea is Very Special to ONOS/CORD/ONF for Its Sustained Significant Contributions & Great Hospitality

- SONA Project
- Network virtualization subsystem
- Several SBI switch driver implementations
- Locator/Identifier Separation Protocol (LISP) subsystem
- Control Plane Management
- Several Control Plane Metrics Monitoring Tools
- Adaptive OpenFlow monitoring
- REST NBI
- gRPC northbound brigade

- P4 Fabric
- P4 INT
- Security and Performance brigade
- Security Mode ONOS
- ACTN Hierarchical Controller
- Vast amount of bug fixes
- Large scale ONOS deployment at KREONET
- Korean localization support
- Teaching brigade contributions

ETRI, KAIST, KHU, KISTI, POSTECH, Samsung, SK Telecom, ...
Agenda

- ONF – the larger context for ONOS
- Contributing to ONOS
- State of ONOS
  - Platform
  - Use cases and adoption
  - Community

As the time permits
ONF Mission

Transforming Networks into Agile Platforms for Service Delivery

Leveraging Disaggregation and Open Source to

Build Innovative Solutions for Operator Networks and

Catalyze our industry to accomplish this transformation
ONF Approach Driving the Open Transformation with A Close Partnership with Network Operators

Building Platforms Leveraging Disaggregation, White Box and Open Source

Viable Open Source Alternative

Inertia due to legacy ways of working

Operator PULL: Customize & Deploy

Operator PUSH: Vision & Funding

This impending Multi-Billion Dollar spend is prompting Industry to develop new business models
The ONF Ecosystem
Operator Led Consortium

New ONF Board

ONF (& Stanford)  
Guru Parulkar

Network Operators
AT&T  
Andre Fuetsch – CTO
China Unicom  
Shao Guanglu - SVP
Comcast  
Rob Howald – VP
DT  
Jochen Appel -- VP
Google  
Amin Vahdat – Fellow
NTT Comm  
Dai Kashiwa – Director
Turk Telekom  
Cengiz Dogan, CTO
Verizon  
Sriki Kalalapa – VP

Research & Vendor Community
Nick McKeown  
Stanford
Fabian Schneider  
NEC

Operators (8)

Innovator (110+)
Including 13 Operators:
- China Mobile
- SK Telecom
- ECI Telecom
- Facebook
- Globe Telecom
- Goldman Sachs
- Microsoft
- Swisscom
- Telecom Italia
- Telefonica
- TELUS
- Vodafone
- Yahoo

Partner

Operators (8)

Vendors (10)

Collaborator (70+)

Volunteers
100s
ONF Open Innovation Pipeline

Enabling Solution Customization

1. Different pieces can be plugged together to build solutions

2. Software Defined Standards solidify interfaces to enable easy integration of components from the broader ecosystem

3. Solutions are easier to build, customize and consume
Open Innovation Pipeline In Action
ONOS as a Foundation

ONOS and its use cases enable SDN based solutions for service providers

Disaggregated Devices
White Boxes

Programmable Forwarding Plane

ONOS

Integration & Service Creation

Open Innovation Pipeline to Deployment

Packet Switches
OLT
eNB/RAN
ROADM
Software Forwarders

ONOS

Control Plane

Leaf-Spine Fabrics
Pkt-Optical Control
xRAN Controller
SD-Access (XGS-PON)

Solution Platform(s)

VNFs
Micro-services

Packet-Optical Control

xRAN Controller

ONOS

ONOS

Packet Switches
OLT
eNB/RAN
ROADM
Software Forwarders

ONOS as a Foundation

Open Innovation Pipeline In Action
Open Innovation Pipelines

1. All ONF Members can bring value and introduce offerings anywhere along the Innovation Pipeline.

2. Vendor innovations then have an opportunity to ‘ride the pipeline’ into operators trials as ONF builds use case solutions for Operator members.
Contributing to ONOS
Idea to Impactful Contribution

The most rewarding
Make it easier
Maximize the probability

Ideas → Brigade 1 → Brigade 2 → Brigade N → ONOS → Enable → Solutions → Enrich → Part of Provider Network
Idea to Impactful Contribution

Provider Led Use Cases Steering Team

Ideas

Brigade 1
Brigade 2
Brigade N

ONOS

Enable

Solutions

Enrich

Part of Provider Network
What can you do?

- Join an on-going brigade and contribute
- Propose and lead a brigade
  - UCST will help and ensure your brigade is relevant to service providers
  - TST and community leaders will help you rally the community, assemble resources and help the brigade be successful
- Participate in ONOS regular meetings to contribute and influence
  - Weekly TST and UCST meetings
  - ONOS release and sprint planning
  - ONOS sprint demos
Share Your Feedback

One of the most important outcomes of the event

Tell us if

• Our processes are not working for you and
  How we can make them work better for you

• ONOS roadmap is missing a critical function or capability

• There is a use case or solution that is important that we are ignoring

Almost all ONF and ONOS leadership is here and we would love to hear your feedback – Don’t be shy and be candid!
State of ONOS: Platform
ONOS: SDN OS for Service Providers

- Scalability
- Performance
- High Availability
- Modular Software
- Northbound Abstraction
- Pluggable Southbound
ONOS Stack Growth: Southbound

ONOS: SDN OS Platform

- OpenFlow
- TL1
- SNMP
- PCEP
- REST
- BGP-LS
- OSPF, ISIS
- TL1 NetConf
- BGP
- PCEP
- OVSDB
- vBBU
- vOLT
- OLT
- Celestica
- Fujitsu
- Calient
- Huawei
- Ciena
- Lumentum
- Oplink
- Fujitsu T100/T200
- Ciena Waveserver
- Lumentum ROADM
- Lumentum WaveReady
- Oplink 8D ROADM
- Calient 5160
- Celestica
- MicroSemi
- Broadcom/Maple
- Tibit
- Celestica

- Trident
- Centec
- Corsa
- Dell
- HP
- Netronome
- Noviflow
- EdgeCore
- Quanta
- Pica8
- OFDPA
- SW
- HW
- OVS
- Packet Switch
- P4 Runtime
- xRAN
- OLT
- PGW-U
- Celestica
- Broadcom/Maple
- Tibit
- Broadcom/Maple
- Celestica/MicroSemi
ONOS Stack Growth: Northbound

ONOS: SDN OS Platform
ONOS Growth: Dynamic Configuration of Devices and Services

• Enable a network operator to seamlessly bring up/down and configure devices from different vendors and to verify the config

• Enable a network operator to seamlessly configure and provision a service on the network comprising many devices from many vendors

With minimal or no human intervention
Control and Config: Both Critical and Distinct

Per flow state Changes rapidly (ms)

Device state Changes slowly (minutes/hours)

ONOS

Control and Config

Both Critical and Distinct

Match | Action
---|---
Flow Table

Attribute | Value
---|---
Config State
Control and Config: Both Critical and Distinct

Service Model + Meta Info

control configuration

ONOS

control

config

Forwarding Device

<table>
<thead>
<tr>
<th>Match</th>
<th>Action</th>
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</thead>
<tbody>
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<td></td>
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</table>

<table>
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<tr>
<th>Attribute</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Flow Table

Config State
State of ONOS: Core

- Proven out its strong architecture foundation for scalability, performance, HA, modularity
- Model based dynamic configuration of devices and services
  - Late to the party compared to ODL, but now have several benefits beyond ODL
  - Ready for vendors and use case developers to start using ONOS for dynamic config
  - Will be ready for prime time in next release in Jan 2018
- In-service software upgrade (ISSU) – taking ONOS HA to the next level
  - Basic mechanisms in place
  - Will be ready for use in next release in Jan 2018
- Performance and Scalability
  - 12 consecutive releases: maintained or improved performance
  - ~3M flow ops/sec, ~225k intents/sec, less than 10ms latency to react to network events, ...

No other open source platform comes even close
State of ONOS: South Bound

- ONOS first few releases
  - Focus on OpenFlow
- ONOS subsequent releases
  - Focus (led by vendors) on legacy protocols – most legacy protocols supported
- ONOS recent and future releases – “back to the future”
  - Focus is on device disaggregation: packet switches (P4), OLT (VOLTHA), eNB/RAN (xRAN), ROADM

Validates wisdom and power of protocol and device independence of the ONOS architecture
State of ONOS: Applications

- ONOS platform now supports 125 applications
  - Small platform extensions & larger user apps
    - Contributed by ONF as well as many community members
- ONOS ready to have its “App Store”
- ONOS build will allow a user/vendor to build ONOS with specified services for a given use case or a solution

- Categories of apps include
  - Device Drivers
  - Protocols & Providers
  - Models
  - Traffic Steering
  - Monitoring
  - Security
  - Utilities
  - Test Utilities
ONOS Roadmap

• Dynamic configuration: get ready for prime time!
• In-Service software upgrade: get ready for prime time!
• gRPC API: becoming a high priority
• Code-base disaggregation: becoming a high priority
• Federation (hierarchical and peering)
• Virtualization and slicing (in progress)
• GUI scalability (in progress)
• Intent subsystem 2.0
State of ONOS: Use Cases and Adoption
ONOS Use Cases Targeting Different Parts of SP Network

- SDN/IP Peering
- Global deployment in R&E Networks
- Disaggregated ROADM
- Packet-Optical Use Case
- Traffic Engineering/PCE
- [R, E, M] CORD

Diagram shows various network components and their interconnections, including Residential, Personal, Access, Metro, Core, Central Offices, National Data Centers, and CPE.
CORD Represents Multiple Use Cases of ONOS

- **Trellis**: A leaf-spine fabric as a key building block of CORD
- **Software Defined Wireline Access**
  - SDN control of OLT devices with VOLTHA and other access services
- **Software Defined RAN and Core**
  - Disaggregation of eNB/RAN with xRAN and ONOS based xRAN controller
  - Disaggregation of EPC/core and ONOS based services
- **SDN control of (Disaggregated) ROADM**

All these use cases exist with and without CORD

Service providers taking these use cases to field trials without the entire CORD
ONOS Adoption

What use cases are moving from POC to lab trial to field trial to production?

• Trellis, SDN control of OLT, and R-CORD: from POC to lab trials to some field trials
• E-CORD: POC and lab trial (can move to field trials in early 2018)
• Software defined RAN/eNBs: POC and lab trial
• Packet-optical: POC to trials
• SDN-IP Peering: deployed in multiple R&E networks
• We don’t get visibility into what vendors and their customers are doing with ONOS

Our community emphasis has to be on productizing ONOS and moving ONOS use cases to production
Service Provider Traction for ONOS and CORD

North America
- AT&T
- Verizon
- Sprint
- Comcast
- CenturyLink
- Google

Asia & Australia
- China Unicom
- China Mobile
- NTT, NTT East
- SK Telecom
- Telstra
- Reliance Jio

Europe
- Deutsche Telecom
- Telefonica
- Telecom Italia
- Colt
- Turk Telecom
Unexpected ONOS Adoption

On Aug 17, 2017, at 22:59, GALLER Stefan <Stefan.GALLER@frequentis.com> wrote:

Dear ONOS technical steering team,

We have brought SDN to the safety-critical industry of Air Traffic Management (ATM).
We managed to do that by building our dedicated ATM product on your ONOS platform.

*It is now operational in the largest country in South America and ensures safe air travel in the region.*

We would love to utilize this achievement for both of our interests and are therefore applying as collaborator. Please find our proposal attached.

Looking forward to hearing back from you!

Best regards

Stefan Galler
State of ONOS: Community
ONOS Community Highlights

- ~70 organizations
- 100+ contributors to each release
- 10+ Brigades leading ONOS development
  - Led by other community members
  - Most have participants and contributors from outside ONF
New collaborators in Q3: Inspur and Frequentis

This chart now tracks Collaborators as well as Collaborating Innovators
## ONOS Brigade Update

<table>
<thead>
<tr>
<th>Brigade Name</th>
<th>Led By</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td>Deployment</td>
<td>ONF</td>
<td>Brigade has completed its charter and is set to spin down</td>
</tr>
<tr>
<td>Dynamic Configuration</td>
<td>Huawei</td>
<td>Recent accomplishments: OpenConfig model support, YANG RPC support, YANG “uses” augmentation support and more</td>
</tr>
<tr>
<td>Virtualization</td>
<td>Ciena</td>
<td>Transitioning to new leadership after previous ONF lead departed</td>
</tr>
<tr>
<td>GUI</td>
<td>Villa-Tech</td>
<td>Recent accomplishments: Added new developer tools, improved load performance, added more GUI diagnostics tools and more</td>
</tr>
<tr>
<td>gRPC</td>
<td>ONF</td>
<td>Recent accomplishments: First services merged, numerous internal device models merged, build problems resolved partially and more</td>
</tr>
</tbody>
</table>

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**ONF**

**Huawei**

**Ciena**

**Villa-Tech**

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**Deployment**

**Dynamic Configuration**

**Virtualization**

**GUI**

**gRPC**
## ONOS Brigade Update

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<th>Status</th>
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</thead>
<tbody>
<tr>
<td>Teaching</td>
<td>ESME-Sudria</td>
<td>Actively creating learning material and preparing to run several sessions at ONOS Build</td>
</tr>
<tr>
<td>Security &amp; Performance Analysis</td>
<td>LIP6</td>
<td>Preparing to publish their first report on ONOS security and performance</td>
</tr>
<tr>
<td>P4</td>
<td>ONF</td>
<td>Recent accomplishments: PI Framework (beta), P4Runtime support, Generic gRPC controller, General Device Provider, BMv2 driver</td>
</tr>
<tr>
<td>Localization</td>
<td>Telcaria</td>
<td>Actively working on making the UI localizable and creating the first set of translated locales (Spanish, Italian, Korean, Chinese)</td>
</tr>
<tr>
<td>In-Service Software</td>
<td>ONF</td>
<td>Recruiting for this brigade to start later in September</td>
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ONOS Community Metrics - Last Year

Overview

Top Authors

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<th>Author</th>
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<td>Thomas Git</td>
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</table>

3,827 # Commits 214 # Authors 11 # Repositories

Organizations

- ONF
- NEC
- Huawei
- Ciena
- Samsung
- Stanford University
- Fujitsu
- ZTE Corporation
- Tencent
- Radisys
- Nokia
- University of Arizona
ONOS Community Metrics - Last 2 Years
State of ONOS: The Key Takeaways

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  ▪ Community: contributions, growth, and engagement

• We have work ahead
  ▪ We have to deliver production readiness and commercial support of ONOS
    • ONOS SDN solutions represent disruptive technology for incumbents: it takes more time
  ▪ We have to continue to strengthen our community for long term
State of ONOS: SDN OS for Service Providers

ONOS Build
September 2017
ONF Unique Approach

• A strong partnership with service providers
  ▪ Complemented by rest of the ecosystem

• A small and strong independent engineering team
  ▪ For architecture shepherding and core engineering
  ▪ To pursue disruptive technologies & business models: white boxes, open source

• An open source developer community
  ▪ With the “brigade model” to scale with focus and accountability

• Focus on the virtuous cycle of platforms and solutions
  ▪ Platforms enable new solutions; and new solutions help platforms

• Work at the leading edge of technology, take risks, and demonstrate potential of innovative technologies/platforms

• A combination of open source and software defined standards (to be proven)

The approach is necessary & working to move our industry forward and we want to build on it
ONF Delivers

Artifacts
- Open source platforms
- CORD, ONOS, Trellis, VOLTHA, Mininet
- Curated solutions
- Software defined standards

Ecosystem
- Diversity
  - Network Operators
  - OEMs & ODMs
  - Software Vendors
  - Component Vendors
  - System Integrators
  - ...
- Open source communities

Institutional Transformation
- Leading Edge Technologies
- Best Practices
  - Latest techniques, tools and technologies
- Learn by Doing
  - Bring this back into your organization
ONF Impact

Artifacts

Ecosystem

Institutional Transformation

Network Industry Transformation

Operators
- New Revenues with New Services
- Reduce CapEx & OpexEx
- Transformation of Culture & Workforce

Vendors
- Reduce R&D
- Faster Time-to-Market
- New Value Creation
- Transformation of Culture & Workforce
ONF Platforms and Solutions

**Device Disaggregation**

**Packet Switch**
- ONF + ONL + OFDPA
- P4 Run Time System
- Switch OS
- Multiple target silicon

**SDN Control & Configuration Platform**

**ONOS**
- The only open source platform for control & config with scale, performance, & HA

**Leaf-Spine Fabric: Underlay + Overlay**

**Trellis**
- The only open source fabric with white boxes; underlay + overlay Hardware acceleration in overlay

**Multi-Access Edge**

**CORD**
- Integrated solutions platform
  - Supports access over XGS-PON, 4G/5G radios, metro Ethernet

**Packet-Optical Backbone**

**POB**
- The only open source solution with SDN control of packet + optical
  - Apps: bw provisioning, protection & restoration, calendaring, ...

**Use Cases and Adoption**

**Supports 120+ apps and services**
- Trellis Fabric
- R-CORD, M-CORD, E-CORD apps
- Packet-optical backbone
  - Many vendors & many providers

**Use Cases and Adoption**

**Key building block for CORD**
- Several providers using in lab
  - Field trials in fall 2017

**Key Features**

**Access & trunk VLANs**
- IPv4, IPv6, MPLS SR
- IPv4 multicast (PIM)
- DHCP relay (IPv4)
- vRouter BGP/OSPF (ext)
  - Network verification (coming)

**White boxes**
- Broadcom based & Cavium based
  - Next is Barefoot

**Service/VNF Portfolio**

- 25+ services/VNFs for [R,M,E] CORDs

**Community**

- ~70 organizations; 100s of developers

**ORCHID**

**Leading incumbent vendors, component vendors, group of 10+ service providers**
ONOS in Air Traffic Management Solutions

(Likely the most Novel Use Case which is in Production)

• ONF Collaborator : Frequentis AG, Vienna, Austria

Frequentis AG is a privately-owned company with 1,600 dedicated employees that generated 250m€ operating performance in 2016.

Frequentis is the market leader for safety-critical voice communication systems in Air Traffic Management (ATM). 90% of all passengers flying somewhere in the world are safely guided to their destinations by our customers. Our dedicated ATM-grade networks serve more than 40% of the world’s air space.
ONOS in Air Traffic Management Solutions (cont.)

- ONOS is integrated into Frequentis’ NetBroker product – a SDN controller specifically tailored to the safety- and mission-critical domain of Air Traffic Control.

- ONOS-based NetBroker is being rolled out in Brazil, a vast country that alone covers 7% of the world’s airspace.
  - ONOS/NetBroker enables a converged hybrid network for the most safety-critical applications on earth.

- For bringing SDN to the ATM industry, this project won the **IHS Janes Technology Award**, the Oscar of the Air Traffic Management industry, in March 2017.
Community Goals

• ONOS is critical for the providers
  ▪ To turn network into a platform for service delivery with significantly reduced Capex & Opex

• ONOS requires significant contributions of the community to deliver on its promise

• ONF is committed to working with the community
  ▪ Help an organization or individual to turn its/her ideas into an impactful contribution
  ▪ Lower barriers as much as possible for an organization or individual to contribute to ONOS