Agenda

- What is ONOS
- ONOSアプリ・ユースケース例
- (時間があれば)CORD関係
Evolution of SDN and ONF projects

- **OF1.0**: single table
- **OF1.3**: multiple tables
- **OF1.4+**: fixed function tables
- **TTP → (OF-DPA)**: protocol independent
- **OF1.4+**: more d-plane protocols support

**SDN** → **NFV**
What is ONOS?

Open Network Operating System (ONOS) is an open source SDN network operating system. Our mission is to enable Service Providers to build real SDN/NFV Solutions.
振返り：SDNとは何だったのか？

疑問：コンピューティング領域と比較し、ネットワーク領域は、40年に渡りあまりにも進化がなかったのはなぜか？

仮説：NW制御とステート分散の個々に難しい問題を同時に1つのプロトコルで解こうとするからではないか？

e.g., OSPF 250p specification, 10p about Dijkstra

Can we think of an architecture separating these different concerns?
先程のアーキテクチャの整理に当てはめると

NW control

State distribution

Apps: VPLS, SDN-IP, Trellis, …
distributed core
provides high-availability, scalability and performance

abstractions & models
allow applications to configure and control the network
without becoming dependent on device specifics

applications platform
allows developers to dynamically extend the base capabilities
**distributed core**
provides high-availability, scalability and performance

**abstractions & models**
allow applications to configure and control the network without becoming dependent on device specifics

**applications platform**
allows developers to dynamically extend the base capabilities
ONOS Core

Provides:
- High-availability
- Scalability
- High Performance

2 types of state
- Application State
- Network & Device State

Core manages both northbound and southbound interactions.
ONOS Core

Core is a distributed system, not a single server
ISSU - Upgrade Workflow
ISSU - Upgrade Workflow
ISSU - Upgrade Workflow
ISSU - Upgrade Workflow
distributed core
provides high-availability, scalability and performance

abstractions & models
allow applications to configure and control the network
without becoming dependent on device specifics

applications platform
allows developers to dynamically extend the base capabilities
Network Control / Programming

Abstract to concrete

Intent
- Host-Host
- Single-Point to Multi-point
- Protected Intent

Flow Objective
- OF-DPA Pipeline
- Single Table Pipeline
- P4 program Defined Pipeline

Flow Rule

Mapping through drivers
- OpenFlow
- P4Runtime
- Netconf
- TL1
ONOS: The Complete Picture

ONOS applications

ONOS networking core

ONOS distributed applications platform

OSGI / Apache Karaf
Further reading

ONOS website:
https://onosproject.org
Tutorials, documentation and general reading at:
https://wiki.onosproject.org/
ONOS is on Github at:
https://github.com/opennetworkinglab/onos
Setup Tutorial
https://wiki.onosproject.org/display/ONOS/Installing+and+Running+ONOS
Screencasts:
https://wiki.onosproject.org/display/ONOS/Screencasts
ONOS 適用例
Deployments

- **Research & Education**
  - SDN-IP, VPLS apps

- **Access network for residential customers**
  - Trials with a major US telecom providers
  - Trellis
  - CORD - SEBA (SDN Enabled Broadband Access)

- **SDN in Air-Traffic Management**
  - Safety-critical, ATM-grade deployment in Brazil (~22M km²)
  - Radar relays, remote control towers, pilot voice, etc.
  - NetBroker from Frequentis developed on ONOS
  - Brown-field & OpenFlow
Trellis is the enabling Network Infrastructure for CORD

Trellis Provides Common control over underlay & overlay networks, including
• Service Composition for Tenant Networks
• Distributed Virtual Routing
• Optimized Delivery of Multicast Traffic Streams
Trellis – Multi-purpose Leaf-Spine Fabric

ONOS Cluster

Access & Trunk VLANs
IPv4 & IPv6 & MPLS SR
IPv4 & IPv6 Multicast
DHCP L3 relay (IPv4/v6)
vRouter BGPv4/v6(ext.)
Dual-homing PWs

Multi-stage Fabrics
QinQ termination

L2 bridged
L3 routed
IP multicast
VNF Offloading

- Mobile World Congress (Feb 2018) M-CORD demo showcasing the Serving and Packet Gateway user plane functionality on P4-based fabric using multi-vendor H/W under ONOS control
- Integration of a P4 Trellis Fabric in CORD and extending VNF offloading support to R-CORD (e.g., BNG)
ONF Connect 2018
The Epicenter of Access & Edge Cloud Collaboration

Tuesday, December 4th, 2018 – Thursday, December 6th, 2018
Santa Clara, CA

https://www.opennetworking.org/onf-connect/
CORD
Umbrella project for Multi-Access Edge Cloud Platform
CORD – Next Generation Edge Cloud Platform

Cloud Native Services
- Mobile
- Enterprise
- Residential

Open Source Software Stack

Specialized Access Equipment
- Radio Units
- PON OLTs
- Cable DOCSIS

White Box Switches

White Box Servers & Storage

Specialized Optical DWDM

Backbone

Residential

Mobile

Enterprise
CORD® as Multi-Access Edge Cloud Platform

CORD

Unifying umbrella project.
Pulls together all the pieces from all the exemplar platform tracks, vehicle for MAEC research and ultimately provides a unified whole.

Mobile Services
Enterprise Services
Residential Services

XOS
Trellis
ONOS
Stratum

Edge Cloud Platform Services

Leaf-Spine Fabric
White Box Packet Switches

xRAN
VOLTHA
ODTN

Disaggregated Radio Units
Disaggregated PON OLTs
Disaggregated PON OLTs
Shared Virtualized Servers: VMs & Containers
ROADM (To Core)
SEBA: Software Enabled Broadband Access

Mobile Services

Enterprise Services

Residential Services

NEM/XOS
Network Edge Mediator
OSS mediation & FCAPS support for operationalization

Trellis

ONOS

Stratum

VOLTHA

ORAN

ODTN

Leaf-Spine Fabric
White Box Packet Switches

Disaggregated Radio Units
Disaggregated PON OLTs
Disaggregated PON OLTs
Shared Virtualized Servers: VMs & Containers
ROADM (To Core)
Trellis: A Leaf-Spine Fabric for NFV

Mobile Services
Mobile
Enterprise Services
Enterprise
Residential Services
Residential

XOS

NFV Fabric

Leaf-Spine Fabric
White Box Packet Switches

ORAN

VOLTHA

ONOS

Trellis

OF-DPA, ONL & OCP
OpenFlow Switch

Disaggregated Radio Units
Disaggregated PON OLTs
Disaggregated PON OLTs
Shared Virtualized Servers: VMs & Containers
ROADM (To Core)
SDN 2.0 Stack: Unified Programmable Autonomous Network (UPAN)

- Mobile Services
- Enterprise Services
- Residential Services

- XOS
  - Trellis 2.0
  - ONOS 2.0
  - Stratum

- UPAN
  - xRAN
  - VOLTHA
  - ODTN

- Leaf-Spine Fabric
- White Box Packet Switches

- Disaggregated Radio Units
- Disaggregated PON OLTs
- Shared Virtualized Servers: VMs & Containers
- ROADM (To Core)
VNF Offloading
Early NFV – heavy lifting & chaining
Residence

CPE
ONU

Central Office

vSG
vRouter

vOLT

OLT

Switching Fabric

ETH
AGG

BNG

Backbone Network

CPE – Customer Premises Equipment
OLT – Optical Line Termination
BNG – Broadband Network Gateway
SEBA: SDN Enabled Broadband Access

SEBA POD

Internal GE Management Switch

AGG Switch (Tomahawk 32 x 100G)

Compute Node

Compute Node

Compute Node

EdgeCore OLT

EdgeCore OLT

EdgeCore OLT

EdgeCore OLT

Up to 64 ONU+RG per PON port

Up to 16 ONU+RG per device

Up to 16 PON ports / OLT device

Up to 16 OLT devices

ONU+RG

ONU+RG

ONU+RG

AT&T External BNG

DHCP Server (subscriber RG addressing)

DHCP Server (POD addressing)

Radius Server

External OSS

Public Internet

VOLTHA, ONOS, NEM, Kubernetes, Docker registry, Gateway VM Abstract OLT
SPGW as VNF
VNF Offloading

User plane traffic is processed entirely in the HW fastpath
Trellis & P4

Same set of Trellis applications on ONOS

Enhanced with P4 program deployment and pipeline configuration

Allowing new functionality on hardware (demo at MWC ‘18)

Enabled on P4 capable hardware

ONOS

Segment Routing | DHCP L3 Relay | vRouter | Multicast | SPGW-app

OF-DPA driver

OpenFlow | OFConfig

P4Runtime | gNMI

Brcm Qumran
Brcm Tomahawk
Brcm Trident2

Barefoot Tofino
Cavium Xpliant
Mellanox

Brcm Qumran
Brcm Tomahawk
Brcm Trident2