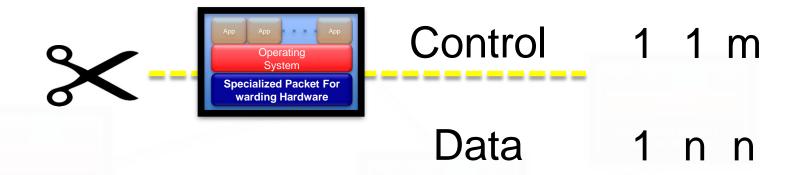# **SONA: ONOS SDN Controller based OpenStack/Kubernetes Network Management Solution**
Trellis: Multi-Purpose Leaf-Spine Fabric Solution

Feb 22, 2019

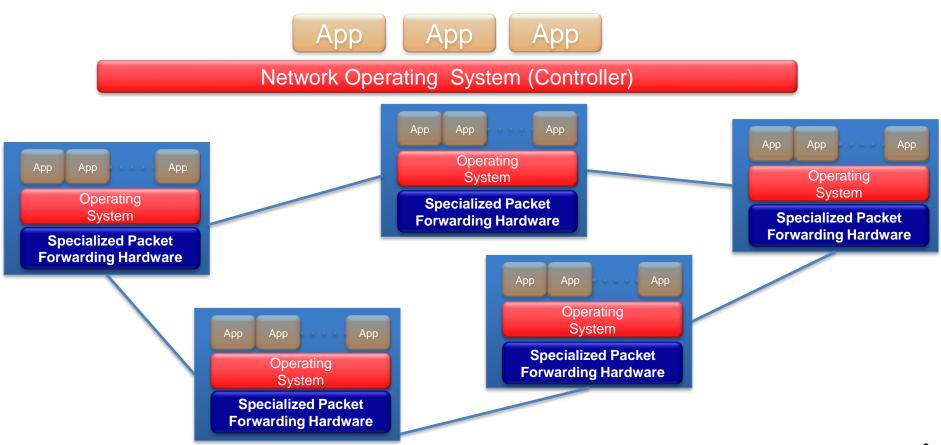## **Sangho Shin**

Introduction to SDN & ONOS

Control   1 1 m

Data   1 n n

Other aspects of SDN follow

Software-Defined Network (SDN) (2/2)

SDN Evolution and ONF

ONF

- Non-profit, carrier and vendor neutral
- Provide technical shepherding, core team
- Build community
- Many organizations supports

And Beyond

2017 – ON.Lab and ONF merger

Demonstrations

Platform Development

Deployments

Invention

2007 – Creation of SDN Concept

2007 – Ethane
2008 – OpenFlow
2009 – FlowVisor, Mininet, NOX
2010 – Beacon

2009 – Stanford
2010 – GENI started and grew to 20 universities
2013 – 20 more campuses to be added

2008-2011 – SIGCOMM
2011 – Open Networking Summit, Interop

2012 – Define SDN research agenda for the coming years
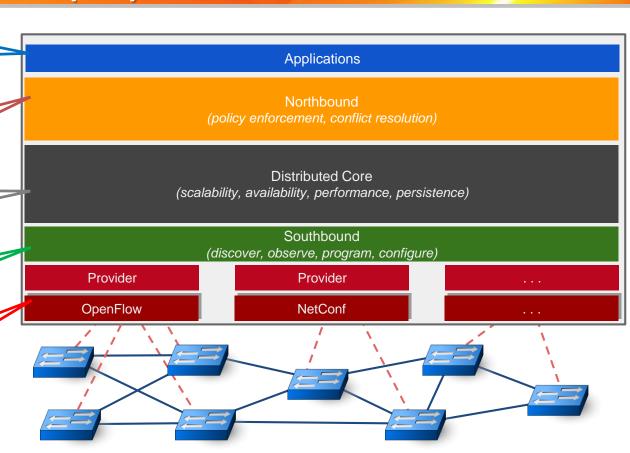
ONOS Architecture (1/2)

Contains user applications
E.g., reactive forwarding, ProxyARP, segment routing, SDN-IP, etc.

Transfer network info to app layer
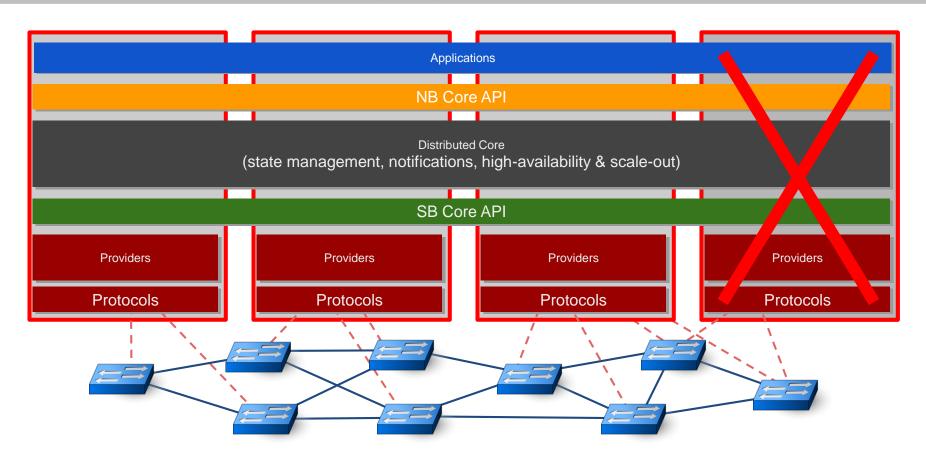Provide management interface for controlling lower layer component

Contains many core features
Provide distributed clustering func. for supporting HA and scalability

Provide an abstracted interface for controlling the network infrastructure
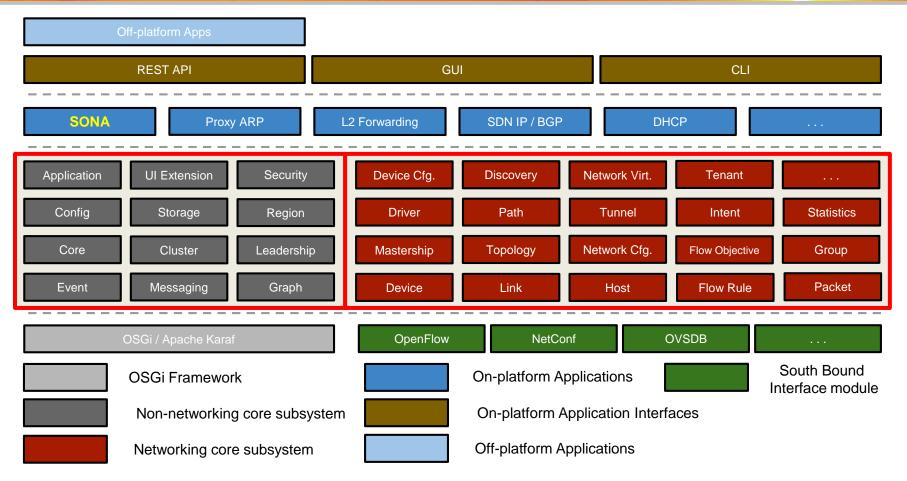
Network protocol implementation for managing network elements
E.g., OpenFlow, NetConf

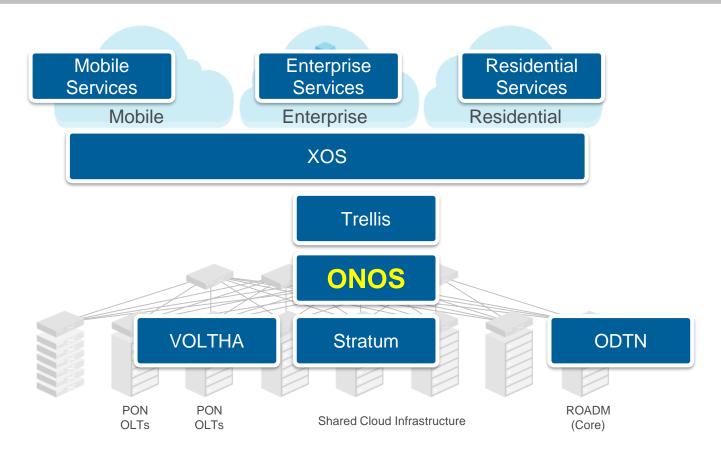Applications

Northbound
(policy enforcement, conflict resolution)

Distributed Core
(scalability, availability, performance, persistence)

Southbound
(discover, observe, program, configure)

Provider

Provider

. . .

OpenFlow

NetConf

. . .

ONOS Subsystems (Services)

Off-platform Apps

REST API	GUI	CLI

SONA	Proxy ARP	L2 Forwarding	SDN IP / BGP	DHCP	. . .

Application	UI Extension	Security
Config	Storage	Region
Core	Cluster	Leadership
Event	Messaging	Graph

Device Cfg.	Discovery	Network Virt.	Tenant	. . .
Driver	Path	Tunnel	Intent	Statistics
Mastership	Topology	Network Cfg.	Flow Objective	Group
Device	Link	Host	Flow Rule	Packet

OSGi / Apache Karaf	OpenFlow	NetConf	OVSDB	. . .

Legend:
- OSGi Framework
- Non-networking core subsystem
- Networking core subsystem
- On-platform Applications
- On-platform Application Interfaces
- Off-platform Applications
- South Bound Interface module

7

ONOS Project at ONF

ONOS Community

Partners

Collaborators

ONOS Release History

Q4/14 Avocet
Base Architecture

Q1/15 Blackbird
Performance

Q2/15 Cardinal
ONS Use Cases
SDN-IP
Packet Optical
R-CORD

Q3/15 Drake
ONF ATRIUM
Secure Mode ONOS
VxLAN
Device Configuration

Q4/15 Emu
OPNFV
SONA
AARNET
KREONET-S

Q1/16 Falcon
ONS Use Cases
{A, E, M} CORD
Disaggregated ROADM
Global R&E Deployment

Q2/16 Goldeneye
CPMan Apps
Intents using Flow Objectives
P4 DEMO support
YANG tool chain

Q3/16 Hummingbird
RabbitMQ, Kafka Message
YANG NBI, SBI CODECs
ACTN Traffic Engineering

Q4/16 Ibis
BUCK Build Tool
Trellis Fabric enhancement
LISP SBI support, REST Client,
FatTree simulator

Q1/17 Junco
TL1 SBI support
Virtualization support
Regionalization support
Dynamic conf. enhancement

Q2/17 Kingfisher
YANG Tools 2.0
OpenFlow 1.4 support
Intent F/W improment
vRouter, OpenROADM support

Q3/17 Loon
OpenFlow 1.5 SBI
gRPC NBI support
P4 runtime initial support

Q4/17 Magpie
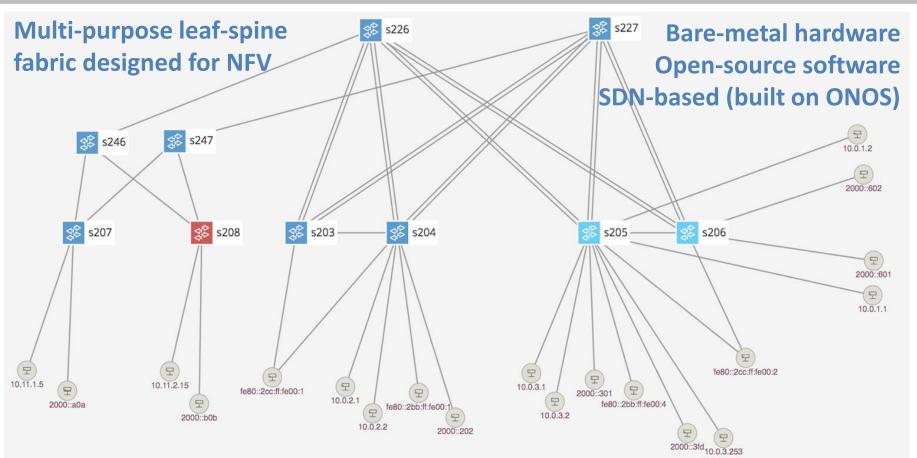Topo2 initial support
More switch driver
support

Q1/18 Nightingale
ISSU initial support
Trellis enhancement (T3)
P4 support enhancment

Q2/18 Owl
Coming soon…

Introduction to Trellis

Trellis Overview

Multi-purpose leaf-spine fabric designed for NFV

Bare-metal hardware
Open-source software
SDN-based (built on ONOS)
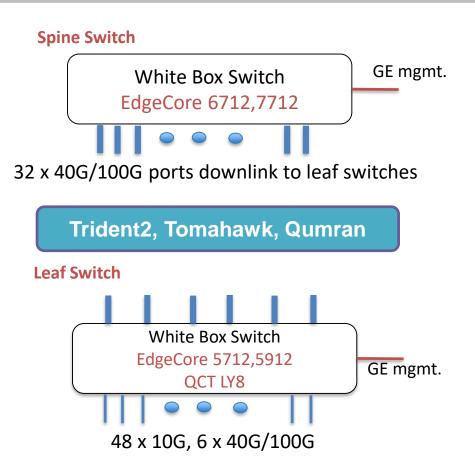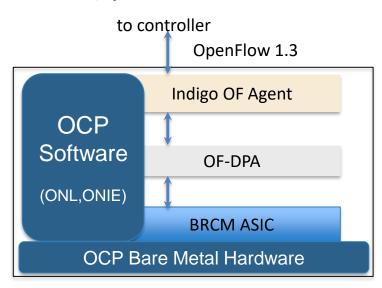
Trellis Features

- **Bridging** with Access & Trunk VLANs (within a rack)
- **Routing** (inter-rack)
  - IPv4 & IPv6 Unicast routing with MPLS Segment-Routing
  - IPv4 & IPv6 Multicast routing
- **Dual-homing** for compute-nodes and external routers
- **Multi-stage** fabrics (2 layers of spines)
- **vRouter** - entire fabric behaves as a single router
  - BGP (v4/v6) support for external (upstream) connectivity
  - Static routes, route blackholing
  - DHCP L3 relay (IPv4/v6)
- **MPLS Pseudowires**
- **QinQ termination**
- **T3** - Trellis Troubleshooting Tool
- **ASIC Support**
  - Broadcom Qumran, Tomahawk, Trident2 switches from EdgeCore & QCT
  - Preliminary support for Cavium Xpliant switches and P4-based Tofino switches
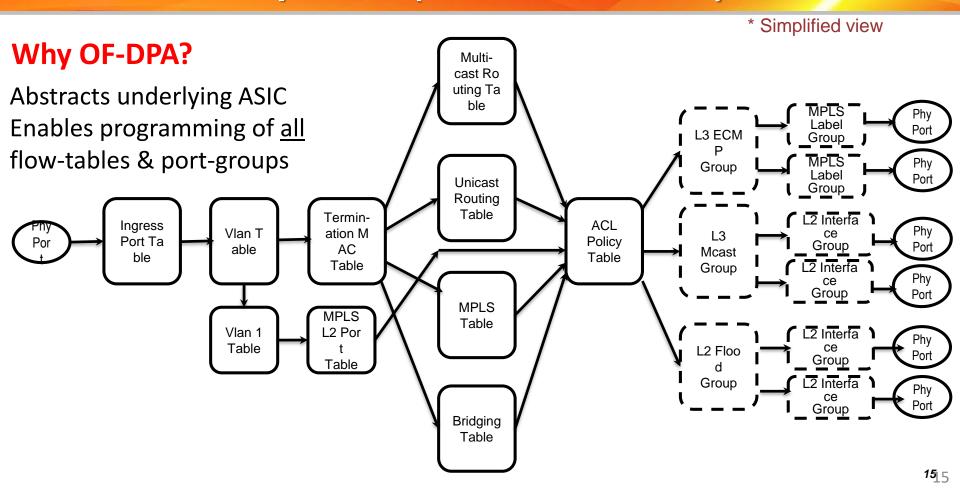
White-Box = Bare-metal hw + Open-Source sw

Spine Switch

White Box Switch
EdgeCore 6712,7712

GE mgmt.

32 x 40G/100G ports downlink to leaf switches

Trident2, Tomahawk, Qumran

Leaf Switch

White Box Switch
EdgeCore 5712,5912
QCT LY8

GE mgmt.

48 x 10G, 6 x 40G/100G

Leaf/Spine Switch Software Stack

to controller

OpenFlow 1.3

OCP Software (ONL,ONIE)

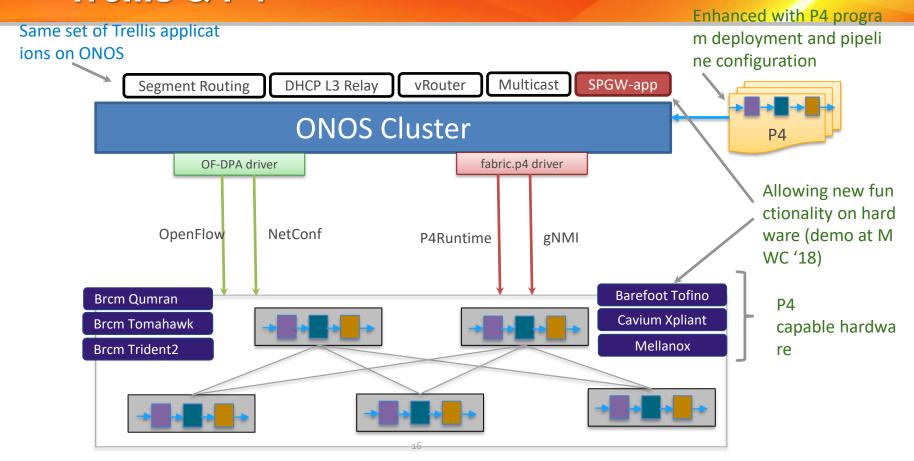Indigo OF Agent

OF-DPA

BRCM ASIC

OCP Bare Metal Hardware

OCP: Open Compute Project
ONL: Open Network Linux
ONIE: Open Network Install Environment
BRCM: Broadcom Merchant Silicon ASICs
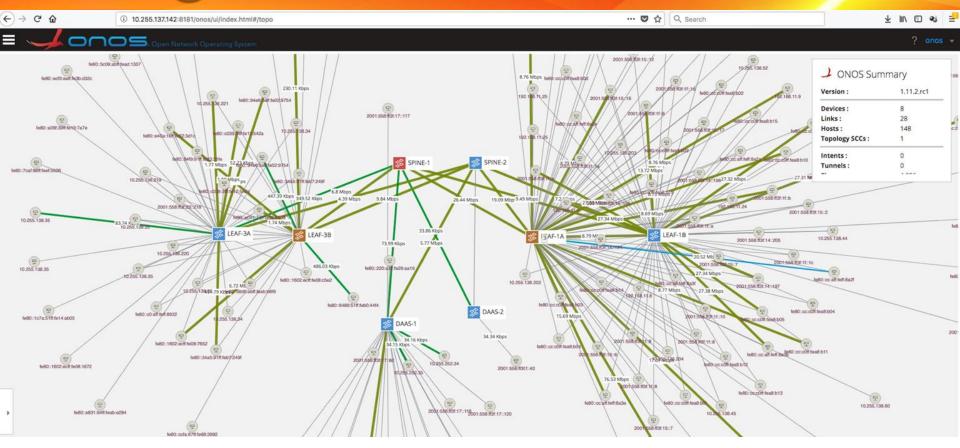OF-DPA: OpenFlow Datapath Abstraction

Fabric ASIC Pipeline* (BRCM's OF-DPA)

Why OF-DPA?

Abstracts underlying ASIC
Enables programming of <u>all</u>
flow-tables & port-groups

Trellis & P4

Same set of Trellis applicat ions on ONOS

Enhanced with P4 progra m deployment and pipeli ne configuration

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

ONOS Cluster

P4

OF-DPA driver

fabric.p4 driver

Allowing new fun ctionality on hard ware (demo at M WC '18)

OpenFlow   NetConf   P4Runtime   gNMI

P4 capable hardwa re

Brcm Qumran

Brcm Tomahawk

Brcm Trident2

Barefoot Tofino

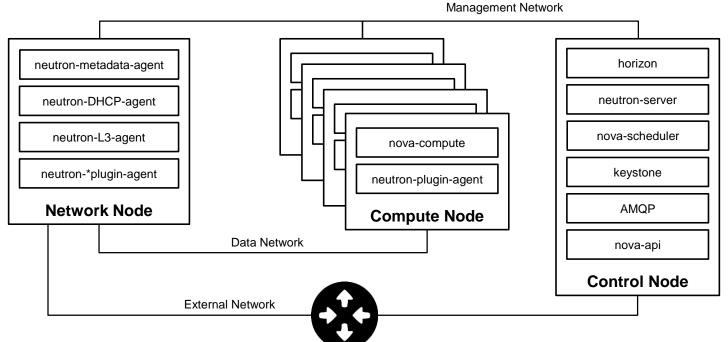Cavium Xpliant

Mellanox

16

Trellis @ Comcast

Introduction to SONA
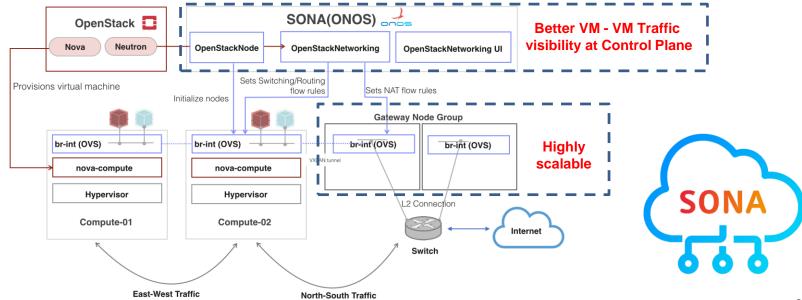
Why SONA?

- **Limitation of Neutron network**
  - Limited visibility of VM traffic
  - Limited scalability of network node
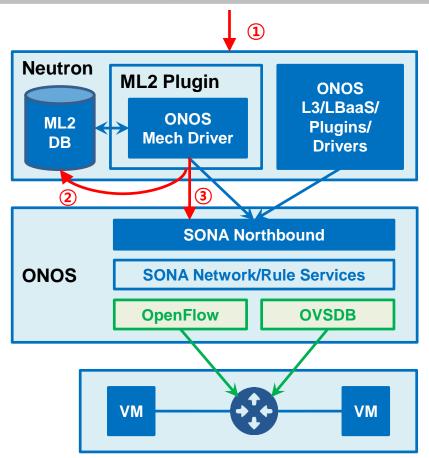
SONA (Simplified Overlay Networking Architecture)

- ## SONA: Overlay Network Management Solution for SDDC
  - ONOS based Virtual Network Management solution (support **VxLAN**, **VLAN**, **FLAT**)
  - Empowered by **SDN controller**, a better **replacement** of neutron, **scalable gateway**
  - Fully compatible with **OpenStack** (mitaka, newton, ocata, pike, queens)
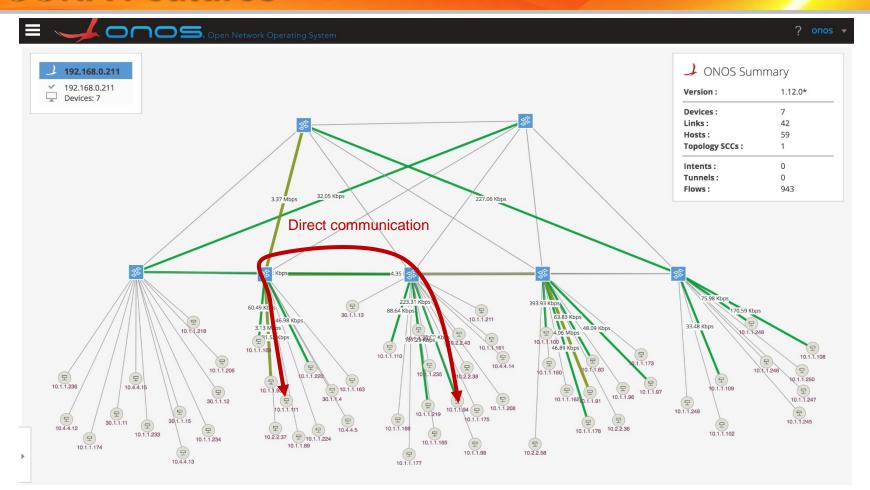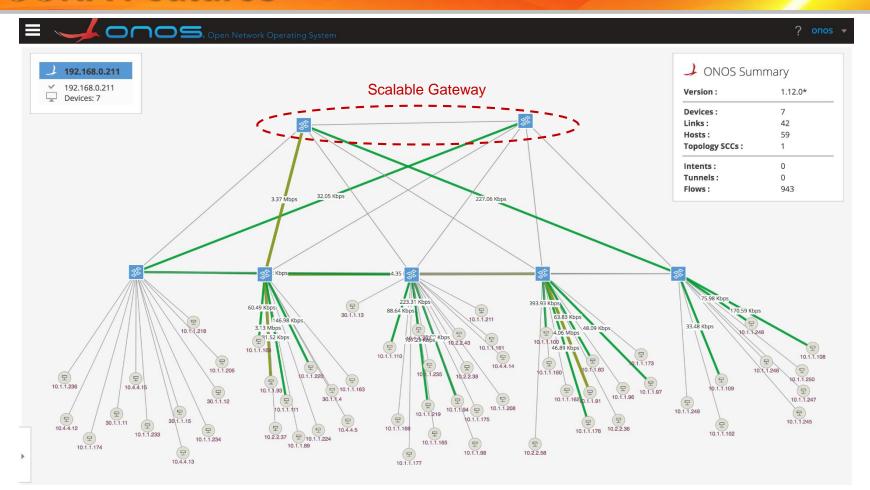
SONA (Simplified Overlay Networking Architecture)
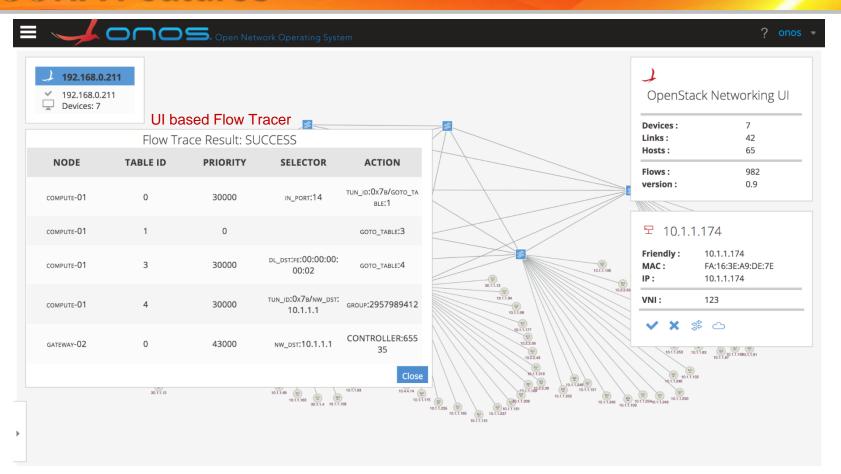
- ## Integration with OpenStack
  - OpenStack neutron
    - Plugin: modular layer 2 plugin
  - networking-onos
    - ONOS L3 plugin
    - Drivers for LBaaS, FWaaS, etc.
  - SONA
    - Northbound interacts with networking-onos
      - https://github.com/openstack/networking-onos
    - Southbound protocol
      - OpenFlow: install/uninstall flow rules
      - OVSDB: configure OpenvSwitch
        » Add/delete virtual port
        » Create/delete bridges (e.g., br-int, etc.)

SONA Features

SONA Features

SONA Features

UI based Flow Tracer

Flow Trace Result: SUCCESS

NODE	TABLE ID	PRIORITY	SELECTOR	ACTION
COMPUTE-01	0	30000	IN_PORT:14	TUN_ID:0x7B/GOTO_TABLE:1
COMPUTE-01	1	0		GOTO_TABLE:3
COMPUTE-01	3	30000	DL_DST:FE:00:00:00:00:02	GOTO_TABLE:4
COMPUTE-01	4	30000	TUN_ID:0x7B/NW_DST:10.1.1.1	GROUP:2957989412
GATEWAY-02	0	43000	NW_DST:10.1.1.1	CONTROLLER:65535

Close

OpenStack Networking UI

Devices :	7
Links :	42
Hosts :	65
Flows :	982
version :	0.9

10.1.1.174

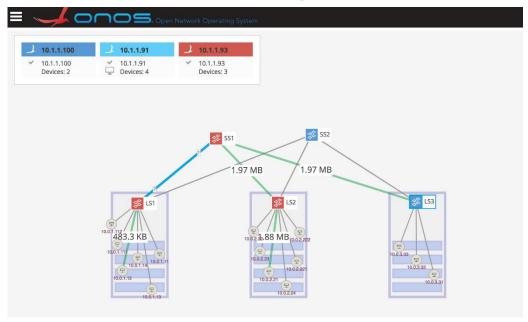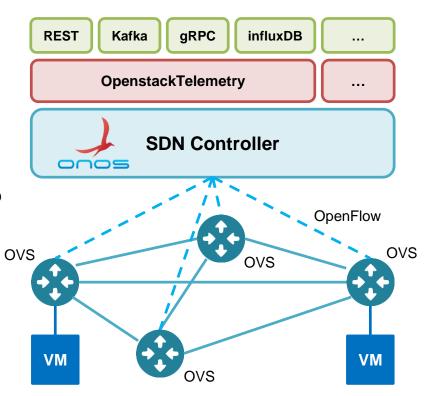| Friendly :	10.1.1.174
MAC :	FA:16:3E:A9:DE:7E
IP :	10.1.1.174
VNI :	123

SONA Features

- ## SONA Fabric
  - Pure OpenFlow based **Leaf-Spine** Fabric Solution
  - Supports **ECMP**, **Failure detection** & **auto recovery**
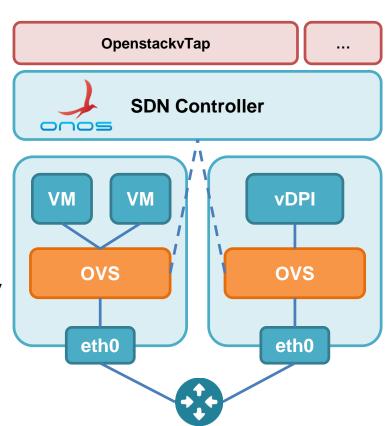 - Physical + Virtual Network **Integration**

- ## vFlow Statistics
  - Collect VM to VM **real-time flow statistic**
  - Stats collection is realized using **OpenFlow** standards protocol (no extra overhead!)
  - **Seamless integration** with monitoring systems through various NBIs
    - REST, Kafka, gRPC, influxDB, etc.
  - Realized through **OpenstackTelemetry** app
  - **No additional software installations** are required at OpenStack side
  - **No additional hardware installations** are required at compute/control node
  - **Open source!**
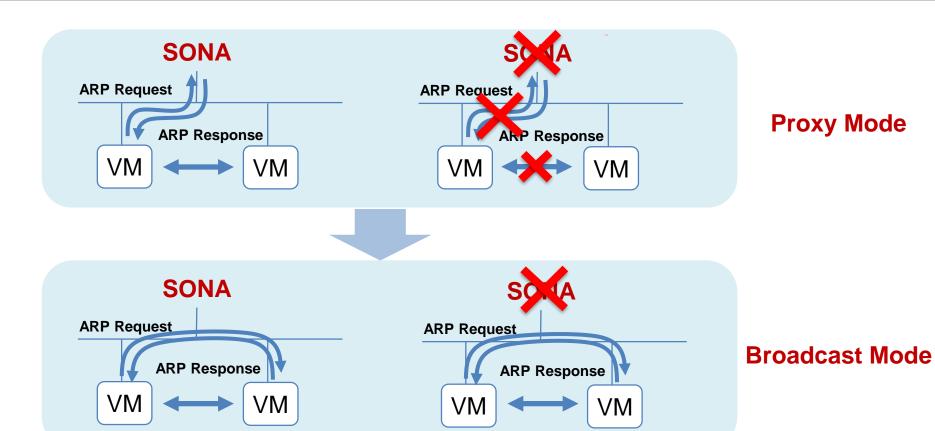
- **vTap**
  - Mirror VM to VM **real-time traffic**
  - Leverage OVS's traffic mirroring feature
  - Two traffic mirroring schemes
    - Port-based: specific to OVS
    - Flow-based: uses OpenFlow group table
  - Realized through **OpenstackTelemetry** app
  - **No additional software installations** are required at OpenStack side
  - Further **improve** the mirroring performance by leveraging data plane acceleration technology
  - **Open source!**

Proxy Mode

Broadcast Mode

SONA Features

- **Kubernetes Support**

How does SONA Process Packets?

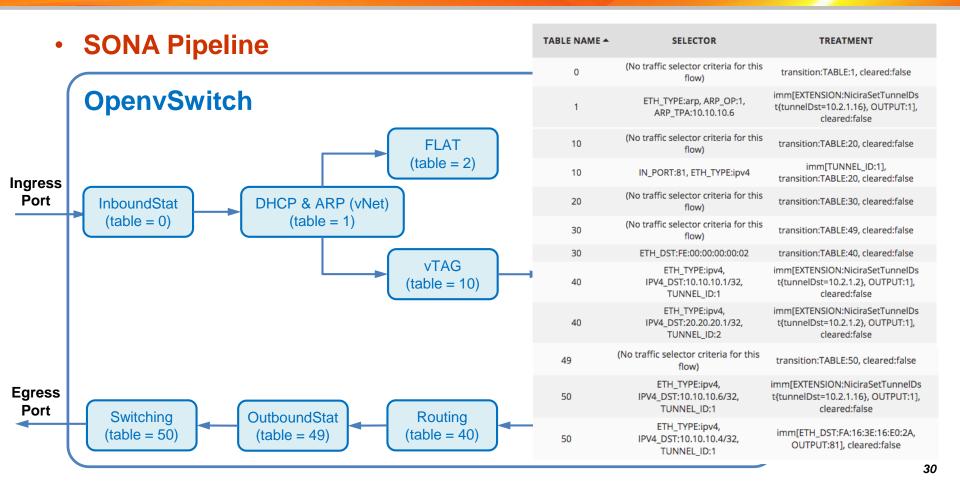- ## SONA Pipeline

OpenvSwitch

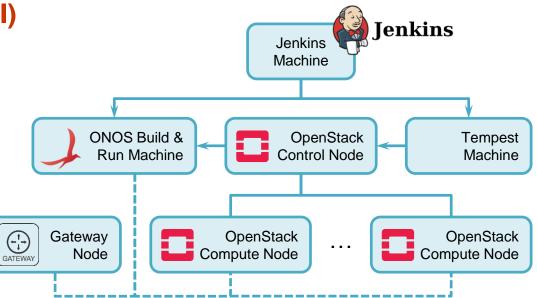| TABLE NAME ▲	SELECTOR	TREATMENT
0	(No traffic selector criteria for this flow)	transition:TABLE:1, cleared:false
1	ETH_TYPE:arp, ARP_OP:1, ARP_TPA:10.10.10.6	imm[EXTENSION:NiciraSetTunnelDst{tunnelDst=10.2.1.16}, OUTPUT:1], cleared:false
10	(No traffic selector criteria for this flow)	transition:TABLE:20, cleared:false
10	IN_PORT:81, ETH_TYPE:ipv4	imm[TUNNEL_ID:1], transition:TABLE:20, cleared:false
20	(No traffic selector criteria for this flow)	transition:TABLE:30, cleared:false
30	(No traffic selector criteria for this flow)	transition:TABLE:49, cleared:false
30	ETH_DST:FE:00:00:00:00:02	transition:TABLE:40, cleared:false
40	ETH_TYPE:ipv4, IPV4_DST:10.10.10.1/32, TUNNEL_ID:1	imm[EXTENSION:NiciraSetTunnelDst{tunnelDst=10.2.1.2}, OUTPUT:1], cleared:false
40	ETH_TYPE:ipv4, IPV4_DST:20.20.20.1/32, TUNNEL_ID:2	imm[EXTENSION:NiciraSetTunnelDst{tunnelDst=10.2.1.2}, OUTPUT:1], cleared:false
49	(No traffic selector criteria for this flow)	transition:TABLE:50, cleared:false
50	ETH_TYPE:ipv4, IPV4_DST:10.10.10.6/32, TUNNEL_ID:1	imm[EXTENSION:NiciraSetTunnelDst{tunnelDst=10.2.1.16}, OUTPUT:1], cleared:false
50	ETH_TYPE:ipv4, IPV4_DST:10.10.10.4/32, TUNNEL_ID:1	imm[ETH_DST:FA:16:3E:16:E0:2A, OUTPUT:81], cleared:false

SONA CI/CD

- **Continuous Integration (CI)**
  - Fetch latest SONA source
  - Build against stable ONOS
  - Run unit test
  - Package & deploy SONA
  - Run integration test
  - Notify the CI result via slack
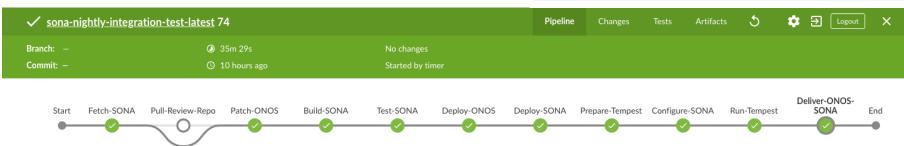 - Deliver SONA container

https://hub.docker.com/r/opensona/onos-sona-nightly-docker/

SONA CI/CD

- **Integration Test**
  - Initialize environment to spawn ONOS cluster
  - Tempest basic test
    - OpenStack API test
    - OpenStack scenario test
  - ONOS failure test
    - Terminate ONOS nodes, run tempest
  - SONA app failure test

Open Source Contribution

- **Open Source Strategy**
  - 100% open source
  - 136 commits were upstreamed in 2018 (2018.01 ~ now)
    - https://gerrit.onosproject.org/#/q/project:onos+branch:master+topic:sona
- **Helps from Community**
  - More tests and feedback from community
  - Code contributions are always welcomed :)
- **Wiki**
  - https://wiki.onosproject.org/display/ONOS/SONA%3A+DC+Network+Virtualization
- **Slack Channel**
  - #sonaproject @ onosproject.slack.com