Advances in SDN for Next Generation Data Networking

Wu Chou, Ph. D., IEEE Fellow
Global Head of Shannon (IT) Lab, Huawei

May25， 2014

敏 捷 已 来
Weaving The Future
Envision A Better Connected World

SDN (Software-defined Networks)

Fundamentally, SDN is an IT transformation of data networking. Although similar concepts being proposed before, systematically applying SDN to data networking happens only recently. It brings a paradigm change of separating the control plane and data plane, logically centralized control, open and programmable data networking, etc.

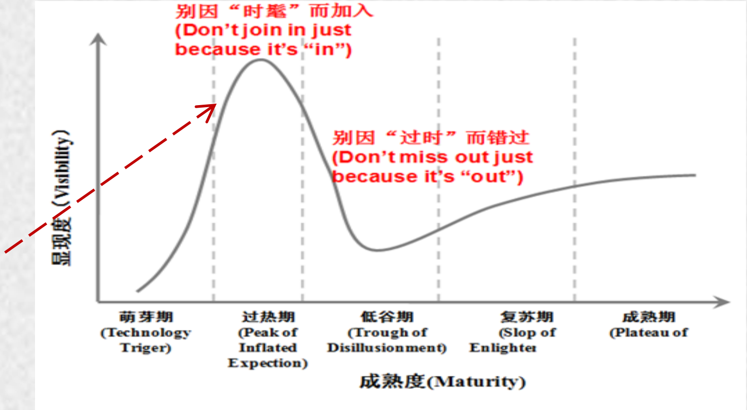


图1、Gartner光环曲线(炒作周期)

Currently, almost all network vendors and IT power houses are working on SDN, and many industry alliances are formed to guide its development

SDN and NFV（Network Function Virtualization) have become a driving force in data networking

Huawei SDN/NFV with Industry

ONF OPEN NETWORKING FOUNDATION

- Main contributor in Carrier SDN, POF, and evolution to SDN
- Chair of Migration WG
- Vice Chair of Optical Transport WG

IRTF IETF

- Visible driver for Network Service Chain BoF and "Reliable Virtualized Network Function (VNF) Pool"
- Active contributor to IETF transition towards SDN

ITU

- Leads WP2/11 (SDN and resource control) in study period 2013-2016
- Appointed as WP chair and rapporteurs, editors, set up Sup-SDN， Q.CSO and Q.SBNG
- JCA-SDN

ETSI World Class Standards NFV ISG

- Co-Chair of WG "Architecture of the Virtualization Infrastructure"
- Three editor positions in other WGs
- NFV overall Program Manager
- Most active contributor in the following areas: E2E Architecture, Use Cases, Service Chaining

broadband forum

- SIMR WG 1 co-chair
- Several editorships in SIMR WG1, E2EA WG1, Marketing
- Initiated and leads Carrier SDN E2E solution (SD-313) and Flexible Service Chaining (SD-326)

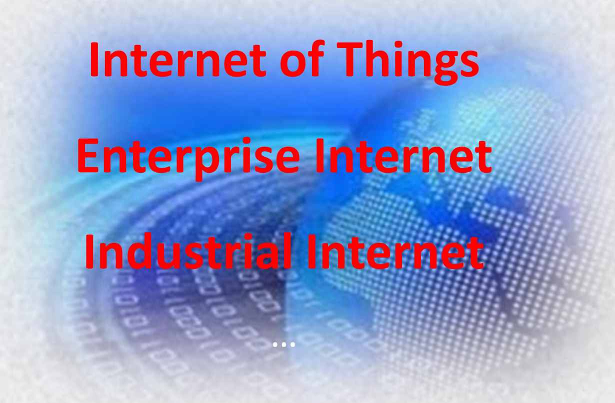
OPEN DAYLIGHT

- Joined as silver member

openstack

- Became as Gold member

WHAT IS CARRIER VALUE PROPOSITION IN NEW DIGITAL WORLD?!



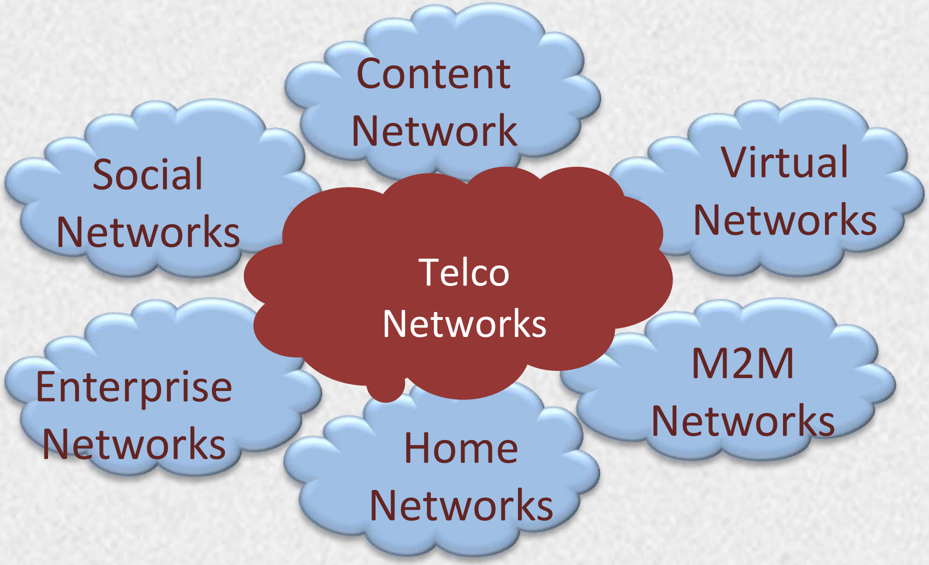
New Digital Economy:

Internet of Things

Enterprise Internet

Industrial Internet

...



Content Network

Social Networks

Virtual Networks

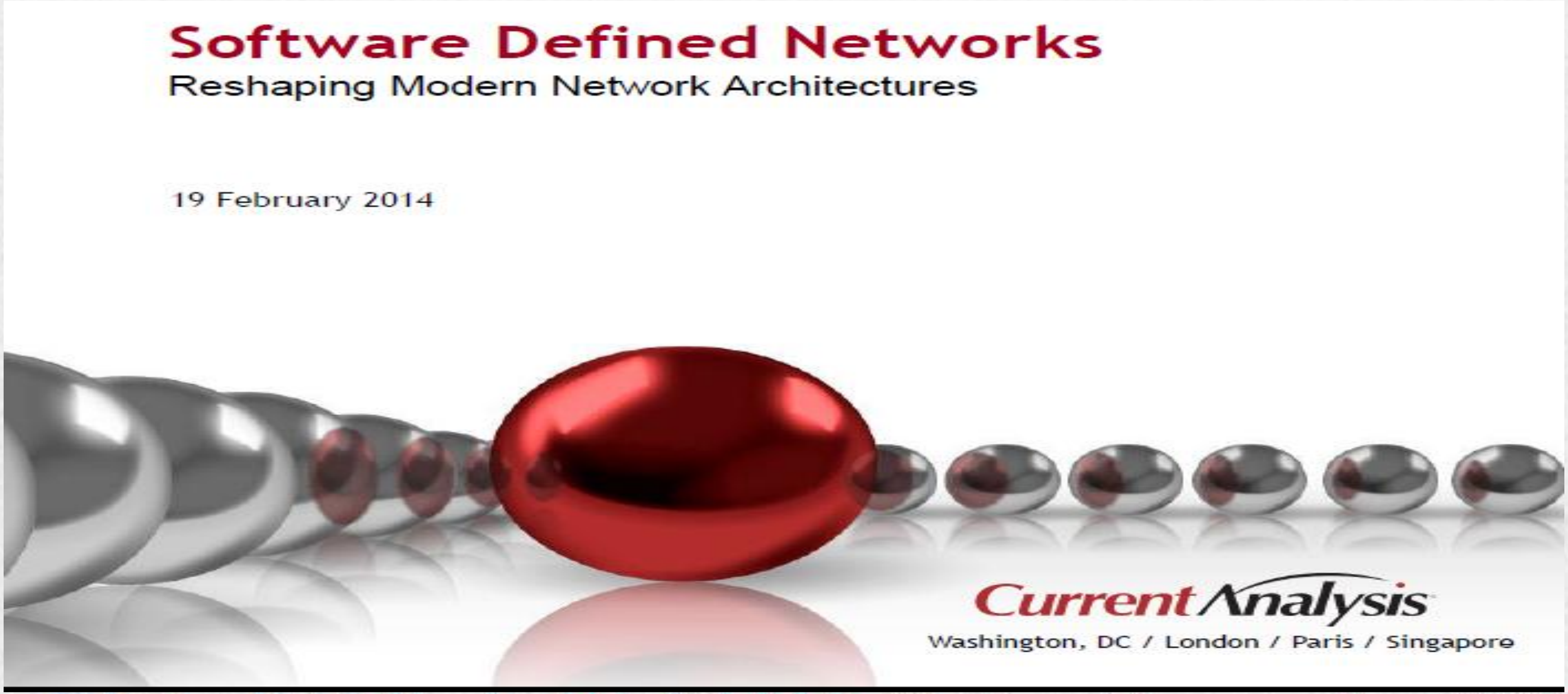
Telco Networks

Enterprise Networks

M2M Networks

Home Networks

WHAT IS CARRIER VALUE PROPOSITION IN NEW DIGITAL WORLD?!



Software Defined Networks

Reshaping Modern Network Architectures

19 February 2014

Current Analysis

Washington, DC / London / Paris / Singapore

WHAT IS CARRIER VALUE PROPOSITION IN NEW DIGITAL WORLD?!

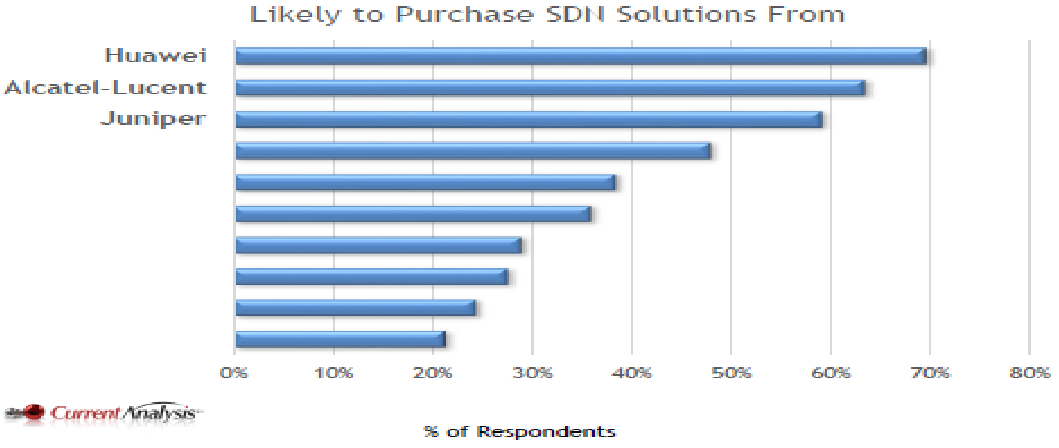
Sample of Responding Companies

Wataniya Telecom
Level (3) Communications
Deutsche Telekom
Telefonica
'yes' OPTUS
zain
Sprint
Neotel
elisa
EE
RELIANCE
MTN
JAZZTEL
bayan
orange
T-Mobile
كيوتل Qtel
Telkom
Bell
CABLEVISION
mobilicity
BT
du
اتصالات etisalat
verizon
bezeq
e-plus
ROGERS
VNPT
at&t
Virgin media
NTT
airtel
TM
SingTel
!dea
vodafone
TELUS

WHAT IS CARRIER VALUE PROPOSITION IN NEW DIGITAL WORLD?!

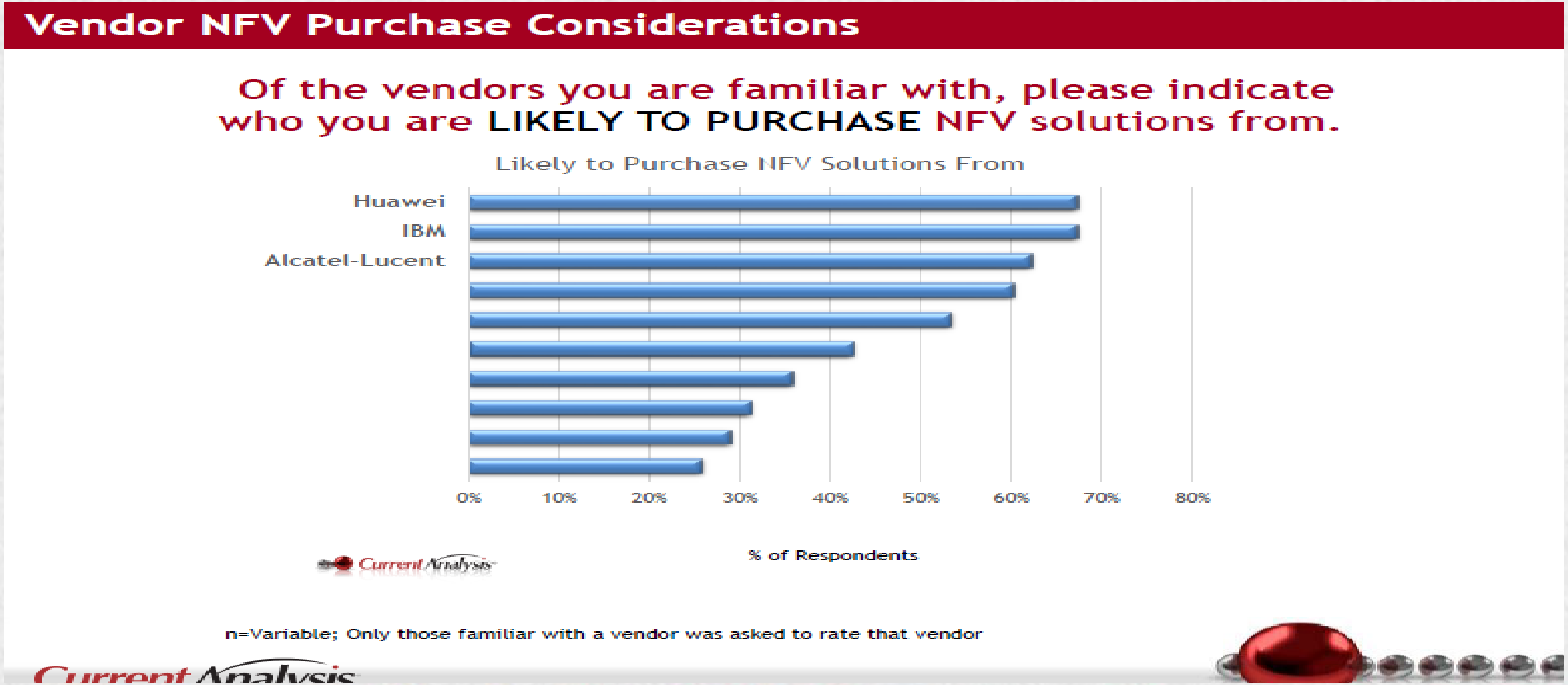
Vendor SDN Purchase Considerations

Of the vendors you are familiar with, please indicate who you are LIKELY TO PURCHASE SDN solutions from



n=Variable; Only those familiar with a vendor was asked to rate that vendor

WHAT IS CARRIER VALUE PROPOSITION IN NEW DIGITAL WORLD?!



Vendor NFV Purchase Considerations

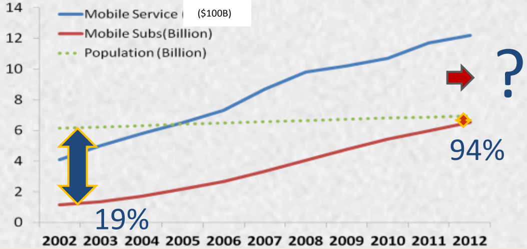
Of the vendors you are familiar with, please indicate who you are LIKELY TO PURCHASE NFV solutions from.

Likely to Purchase NFV Solutions From

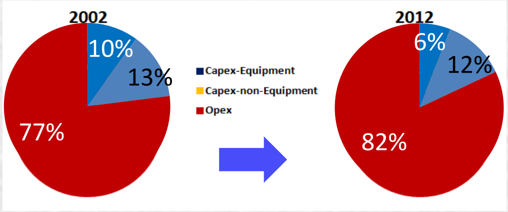
n=Variable; Only those familiar with a vendor was asked to rate that vendor

WHAT ARE FUNDAMENTALLY CHANGED IN TELCO BUSINESS

Traditional service model saturated & declining



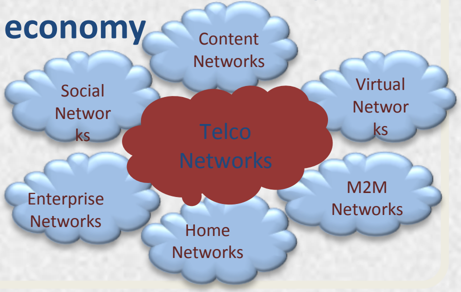
Existing TCO structure may not be sustainable



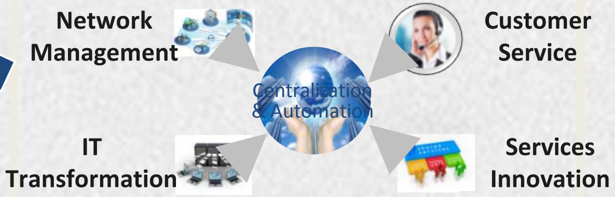
Growing New Way

Saving New Way

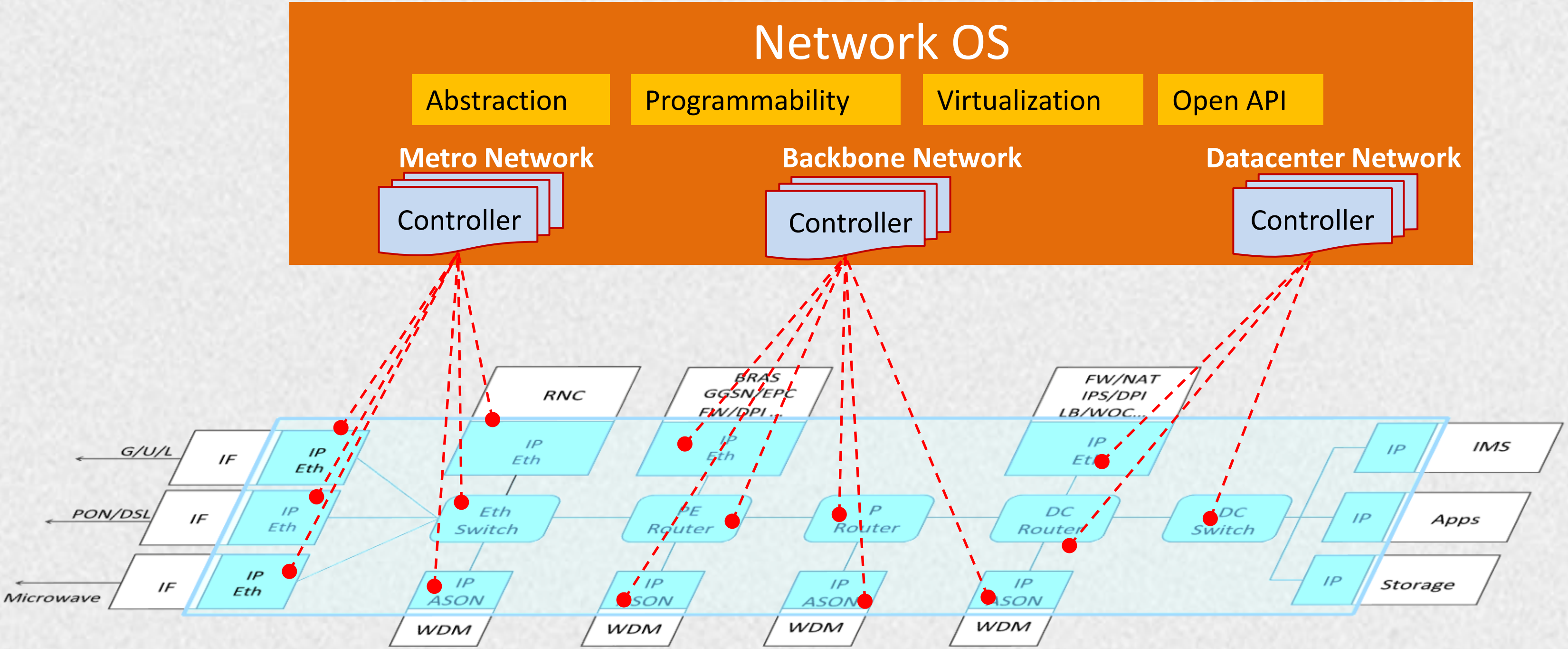
Potential opportunities huge in digital economy


Content Networks
Social Networks
Telco Networks
Virtual Networks
Enterprise Networks
M2M Networks
Home Networks

Transform to new business operation models


Network Management
Customer Service
Centralization & Automation
IT Transformation
Services Innovation

SDN IN NETWORK OS



Network OS

Abstraction | Programmability | Virtualization | Open API

Metro Network
Controller

Backbone Network
Controller

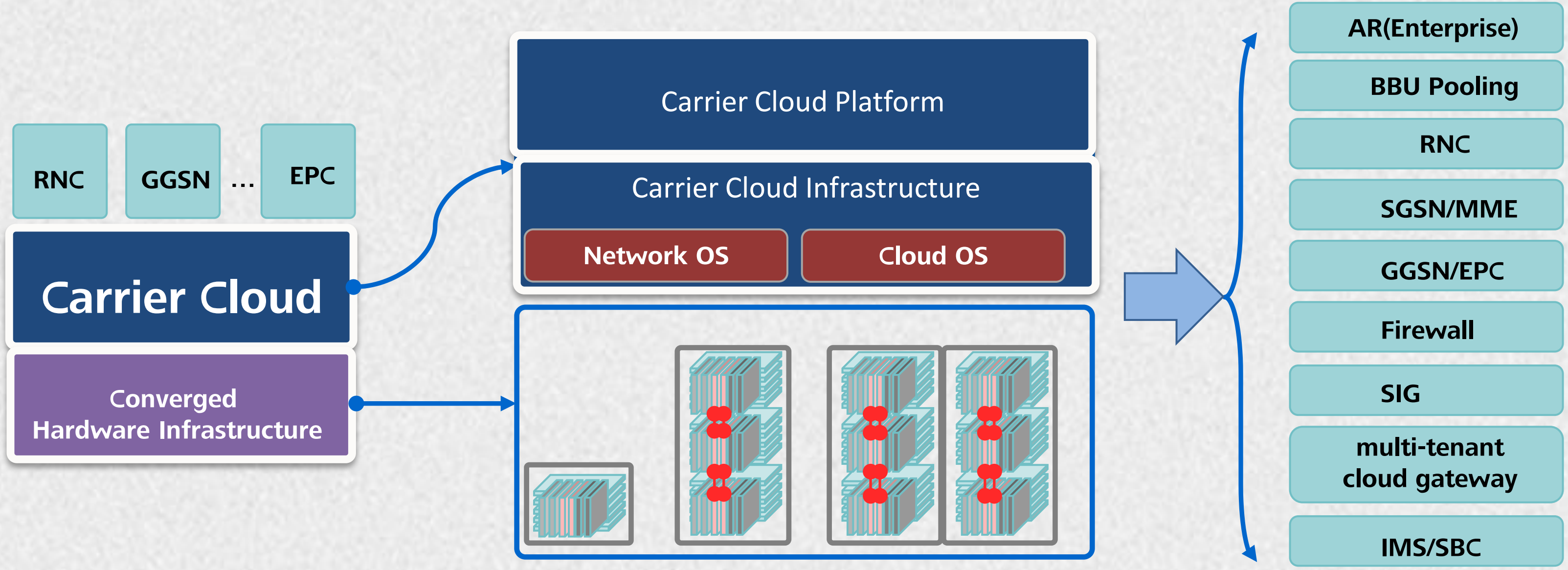
Datacenter Network
Controller

G/U/L
PON/DSL
Microwave
IF
IF
IF
IP Eth
IP Eth
IP Eth
RNC
IP Eth
Eth Switch
IP ASON
WDM
BRAS
GGSN/EPC
FW/DPI ...
IP Eth
PE Router
IP ASON
WDM
P Router
IP ASON
WDM
FW/NAT
IPS/DPI
LB/WOC...
IP Eth
DC Router
IP ASON
WDM
DC Switch
IP
IMS
IP
Apps
IP
Storage

- SDN Principle: Control Plane and Data Plane Separation
- To Structurally Optimize Networks and Simplify & Automate Control/Management

SDN+NFV FOR CLOUD EPC

- MIGRATE MOBILE NETWORK FUNCTIONS TO CLOUD-BASED SOFTWARE MODULES



RNC GGSN … EPC

Carrier Cloud

Converged Hardware Infrastructure

Carrier Cloud Platform

Carrier Cloud Infrastructure

Network OS

Cloud OS

AR(Enterprise)

BBU Pooling

RNC

SGSN/MME

GGSN/EPC

Firewall

SIG

multi-tenant cloud gateway

IMS/SBC

- Such software Modules will be managed, integrated, tested & operated in Carrier Cloud
- Becoming highly scalable, distributed and elastic with much reduced TTM & Continue Integration with SDN+NFV

SDN Research at Shannon Lab

- **Non-compatible south-bound API** (Network fragmentation problem)
  - **Industry first generalized SDN network controller (SOX) which can control and manage mixed SDN data networking with non-compatible south-bound APIs (e.g. OF1.0 and OF1.2 are not compatible),**
  - **Verified at Oct. 2012 ONF PlugFest and announced at the First World Congress on SDN, Oct. 2012, Germany and SDN interoperability evaluation at European Advanced Network Test Center (EANTC), Berlin, Germany, Feb. 2013**
- **Multi-Controller** (Network congestion problem caused by single controller)
  - **Shannon Lab SOX intelligent network controller - the first SDN controller to realize intelligent multi-controller function that passed the evaluation of ONF PlugFest, Oct. 2012**
- **East-West Network Expansion** (whole network infrastructure of SDN)
  - **SSDN（software-service-defined-network）：A software-service architecture for East-West network expansion of SDN (presented at First World Congress on SDN, Oct. 2012, Germany)**

SDN Research at Shannon Lab

- **Software Engineering Architecture of SDN**
  - ❑ MDA (model-driven-architecture) and software engineering best practice for SDN
  - ❑ Successfully applied MDA and software engineering best practice framework to the design and implementation of the industry first generalized SDN controller
  - ❑ Published the first white paper on MDA based software engineering architecture for SDN and SDN controller at the First World Congress on SDN, Oct. 2012, Germany
- **SDN Controller and Data Plan**
  - ❑ The Huawei (SOX Controller/OF1.2 switch) - the only vendor that passed the advanced test cases based on new features of OF1.2 at European Advanced Network Test Center (EANTC) SDN interoperability test, Feb. 2013 (results announced at the SDN/MPLS World Congress at Paris, March, 2013)
  - ❑ SOX Controller for SDN with mixed OpenFlow (OF1.0 - OF1.3) switches
  - ❑ Data switching based on the latest OpenFlow 1.3 standards at ONF PlugFest 2013
  - ❑ Rese[illegible] for S[illegible]N and its real[illegible]tion

SDN/OF Data Switch

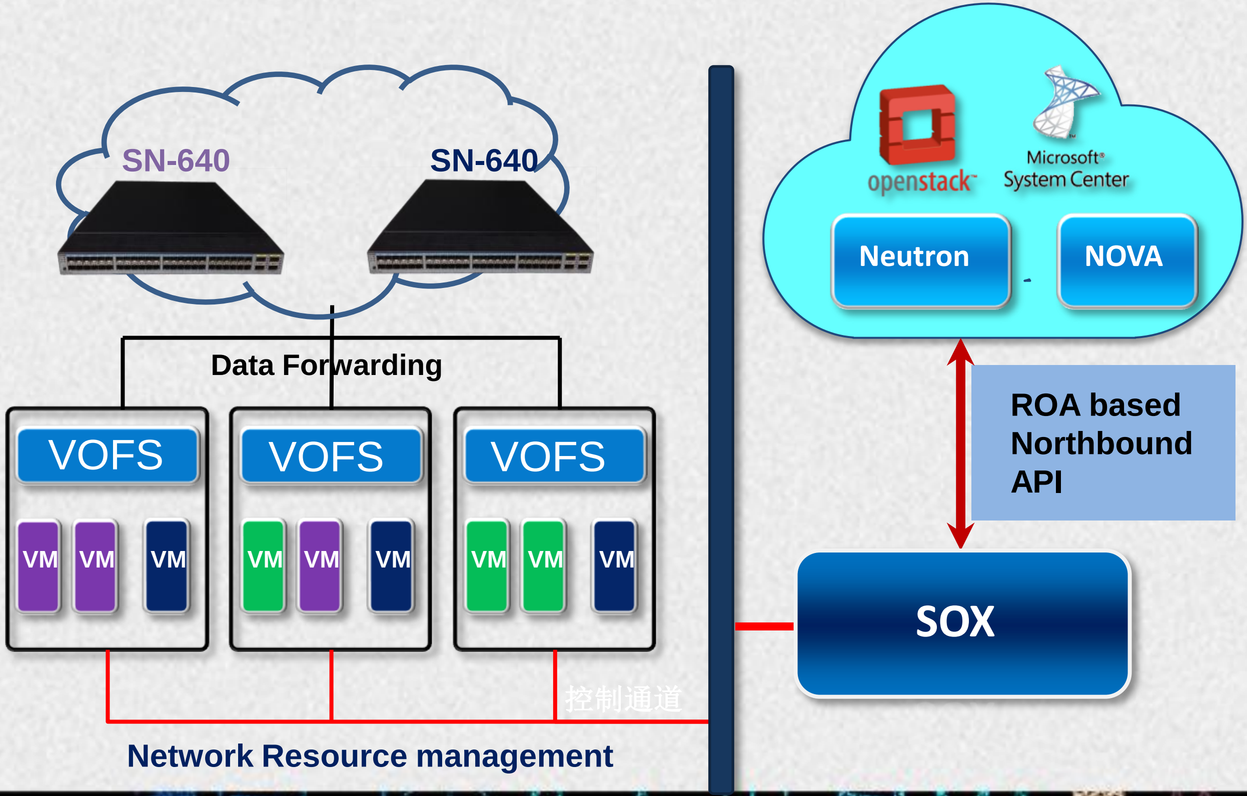
Huawei S6710 Campus/To SDN Switch
(based on SN640 of Shannon Lab)

- System Configuration
  - 48×10GE + 4 ×40GE （1U)
  - 1.28Tbps non-blocking line speed
  - Packet processing capability: 960Mpps
  - Port to port latency: 300ns
  - Industry first SDN/OpenFlow switch with hardware supporting of more than 3 flow tables（Pass ONF OF1.3 evaluation）

- SDN southbound API Protocol
  - OpenFlow 1.2/1.3
    - 9 stage pipeline with multiple flowt table
    - Each stage with 70K flow entry
    - 36 matching filed（V2 support self-defined maching elements）
    - Support 10K group table，Bucket size 80K
    - Support OF1.3 features, e.g. Meter、Queue、Counter, etc.
- Network Service Capabilities
  - Unicast：MAC forwarding、IPv4/IPv6 forwarding
  - Multicast：Layer 2, Layer 3 IPv4/IPv6 multicast
  - VLAN：4K per port
  - QoS
    - Per flow metering, with 24Kbps granularity
    - Each port with 12 queue，support queue based minimum bandwidth amd maximum bandwidth control
    - Support port based flow normalization
  - Reliability
    - Fast Failover group for link faliure
    - Alternative link to controller
    - Multi-controller
- New features in V2
  - Zero Touch Networking or Touch Free Networking
  - SDN OAM solution
  - Network virtualization solution (MPLS/VxLAN）

Shannon SDN and Cloud Solution

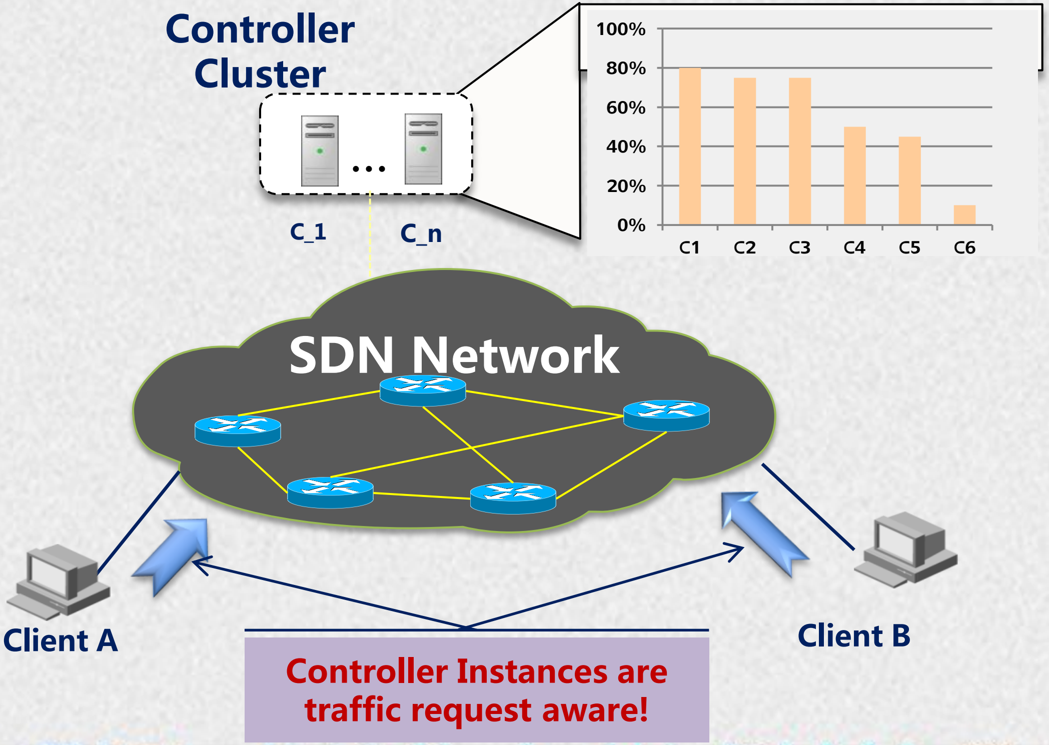
Unified control of network resources, programmable data processing platform


SN-640
SN-640
Data Forwarding
VOFS
VOFS
VOFS
VM
VM
VM
VM
VM
VM
VM
VM
VM
控制通道
Network Resource management
openstack
Microsoft System Center
Neutron
NOVA
ROA based Northbound API
SOX

SDN Controller (SOX), hardware and software based SDN/OF switches

- Integrated with OpenStack and based on SOX to support OF1.0-OF1.3 based full network control
- OF1.2/1.3 based hardware SDN switch
- High efficiency SDN softwitch VOFS
- ROA based northbound SDN API
- Maximize network resource utilization through dynamic multipath bandwidth control and load balancing
- Programmable and user defined routing policy and interface
- Hyber-link pipeline based service chaining

Multi-Controller —SDN based management engine


Controller Cluster
…
C_1
C_n
100%
80%
60%
40%
20%
0%
C1
C2
C3
C4
C5
C6
SDN Network
Client A
Client B

Controller Instances are traffic request aware!

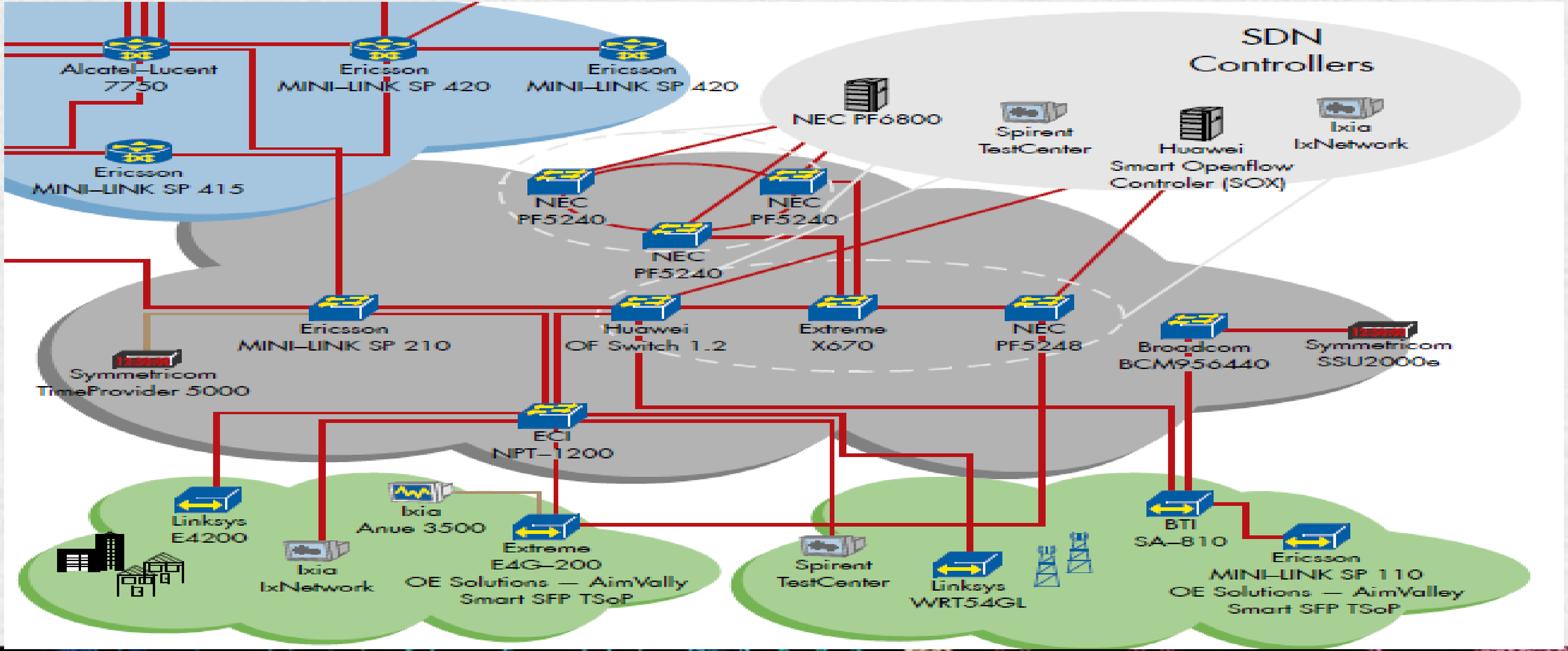
Traffic request aware controller instances

- Number of instances based on traffic load/new flow request
- More secure and reliable with multi-controller cluster

Controller load balancing

- Intelligent load balancing based on the load and traffic requests
- Scale out the capacity of the controller in a consistent way
- Integrated with ROA based northbound API

SOX: showcase in Paris, 2nd SDN Summit and 15th MPLS World Congress: Automatically transform untagged traffic with required tags (designed by EANTC)



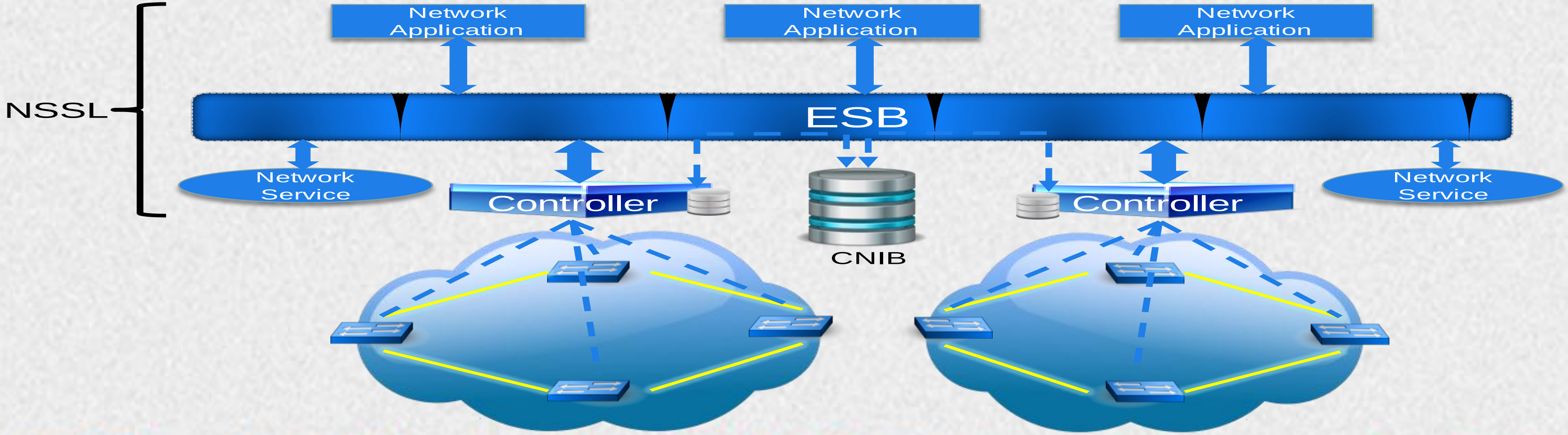
SDN Controllers
Alcatel-Lucent 7750
Ericsson MINI-LINK SP 420
Ericsson MINI-LINK SP 420
Ericsson MINI-LINK SP 415
NEC PF6800
Spirent TestCenter
Huawei Smart Openflow Controler (SOX)
Ixia IxNetwork
NEC PF5240
NEC PF5240
NEC PF5240
Ericsson MINI-LINK SP 210
Huawei OF Switch 1.2
Extreme X670
NEC PF5248
Broadcom BCM956440
Symmetricom SSU2000e
Symmetricom TimeProvider 5000
ECI NPT-1200
Linksys E4200
Ixia Anue 3500
Ixia IxNetwork
Extreme E4G-200
OE Solutions — AimValley Smart SFP TSoP
Spirent TestCenter
Linksys WRT54GL
BTI SA-810
Ericsson MINI-LINK SP 110
OE Solutions — AimValley Smart SFP TSoP

敏捷已来
Weaving The Future

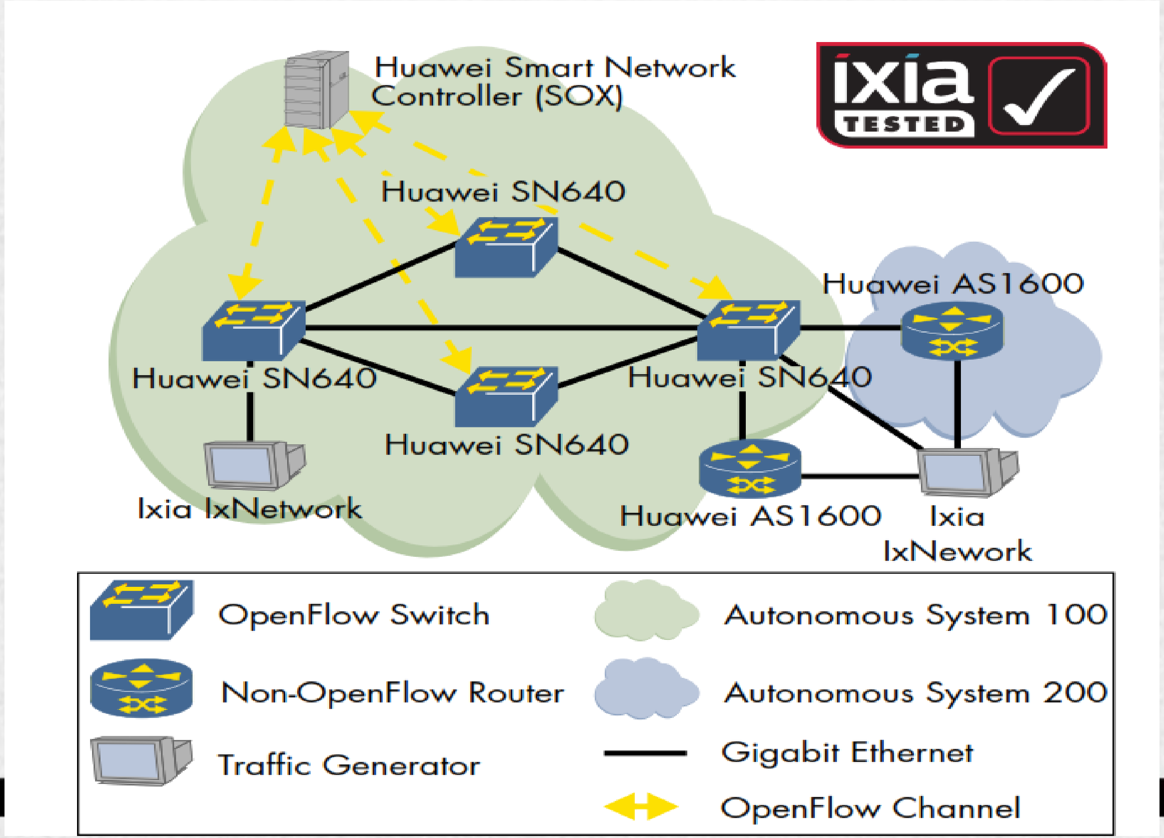
SSDN （Software-Service-Defined Networks）

SSDN - SOA based approach to data networking

- ☐ Multiple network Services can be registered on SSDN platform. They can be managed and federated to provide the mapping for crossing controller services
- ☐ Service Orchestration： including chaining and pipeline
- ☐ Develop and improve ROA based network API (NAPI)


Network Application
Network Application
Network Application
NSSL
ESB
Network Service
Controller
CNIB
Controller
Network Service

SDN/OpenFlow with Traditional Network

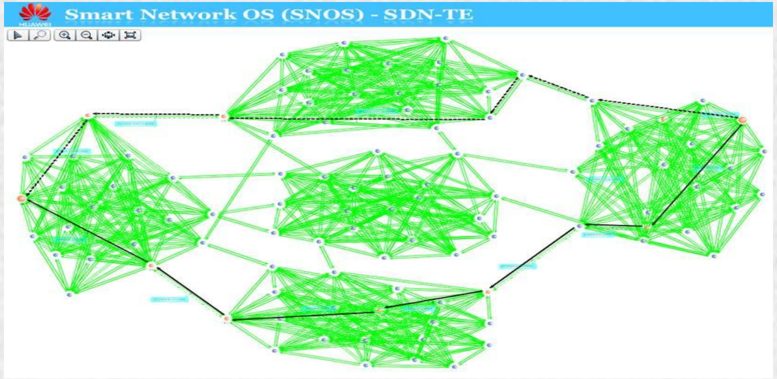


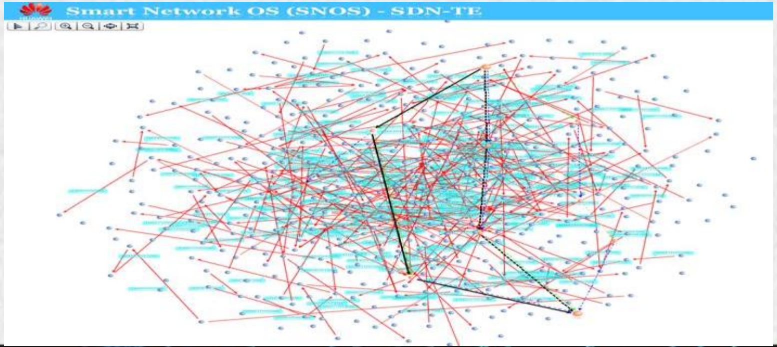
Huawei Smart Network Controller (SOX)
ixia TESTED
Huawei SN640
Huawei AS1600
Huawei SN640
Huawei SN640
Huawei SN640
Ixia IxNetwork
Huawei AS1600
Ixia IxNework
OpenFlow Switch
Autonomous System 100
Non-OpenFlow Router
Autonomous System 200
Traffic Generator
Gigabit Ethernet
OpenFlow Channel

Seamlessly inter-networking with traditional networks

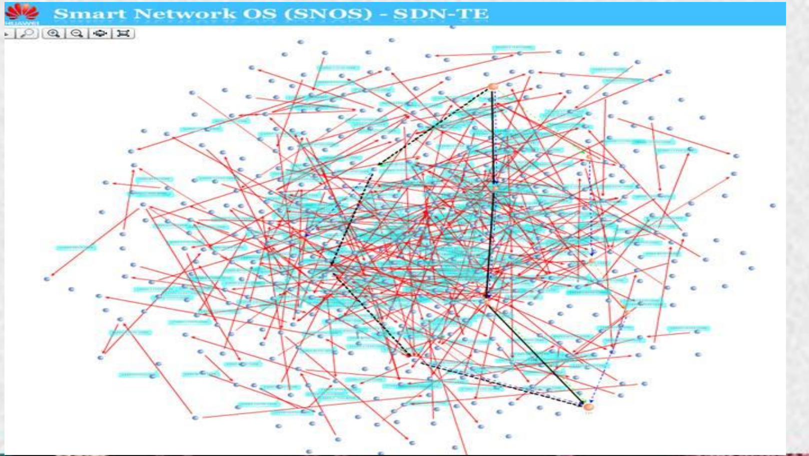
- SOX makes SDN as AS and interworking with non-SDN based existing networks
- Support E2E MPLS/TE crossing SDN/OF domain
- Support multipath data forwarding with legacy devices
- Intelligent and fast failure recovery (<50ms) required for carrier network services
- Support carrier grade differentiated QoS for different applications

Intelligent Multipath, Global Network Topology and State Aware Management Algorithms


Smart Network OS (SNOS) - SDN-TE

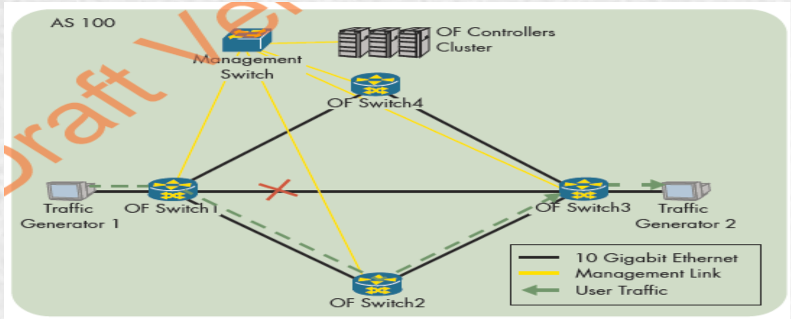

Smart Network OS (SNOS) - SDN-TE

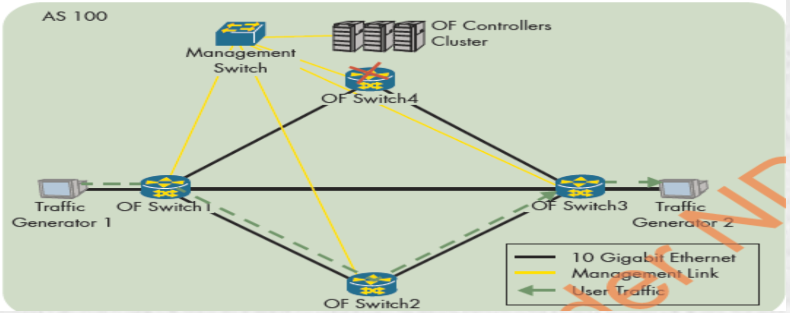
Intelligent, self-adjustable, dynamic multipath framework (ADMCF) to address the needs in large centralized network control and resource optimization problems

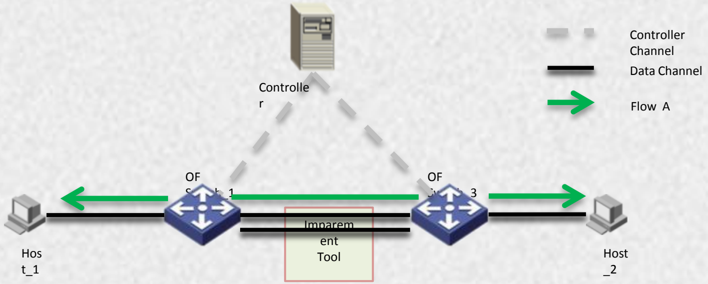

Smart Network OS (SNOS) - SDN-TE

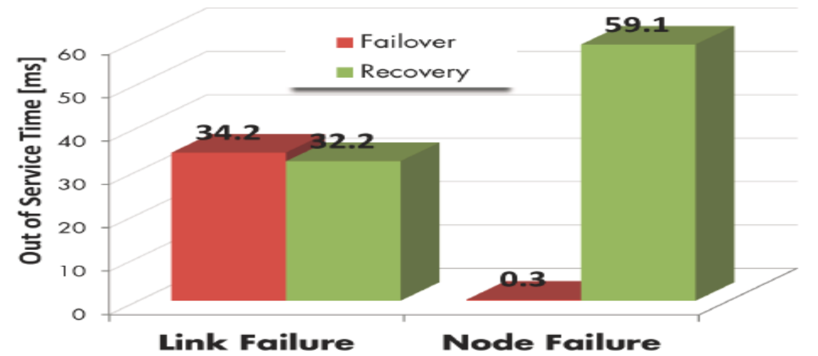
Fast Failover in SDN (EANTC-Huawei Showcase 1.3 & 1.4)

- **SDN/OF with carrier-grade resiliency (<50ms)**


AS 100
Management Switch
OF Controllers Cluster
OF Switch4
Traffic Generator 1
OF Switch1
OF Switch3
Traffic Generator 2
OF Switch2
10 Gigabit Ethernet
Management Link
User Traffic


AS 100
Management Switch
OF Controllers Cluster
OF Switch4
Traffic Generator 1
OF Switch1
OF Switch3
Traffic Generator 2
OF Switch2
10 Gigabit Ethernet
Management Link
User Traffic


Controller Channel
Data Channel
Flow A
Controlle r
OF
OF
Imparement Tool
Hos t_1
Host _2



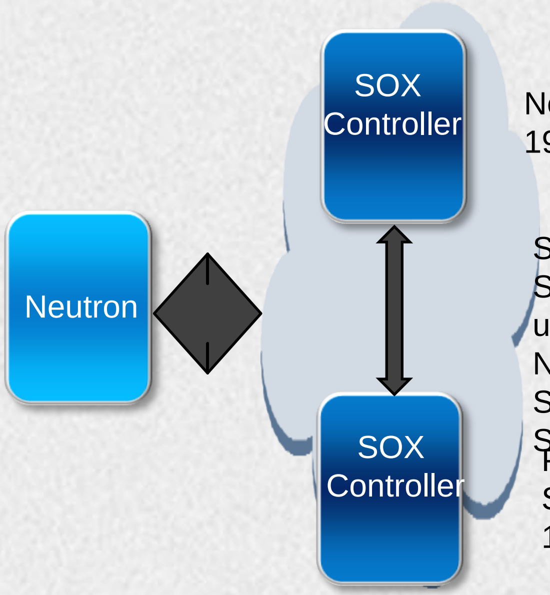
ROA（resource-oriented) based Northbound API

Current SDN Northbound API

- Fixed resource URI
- Not loosely coupled, do not support late binding, resource migration, discovery, etc.
- Resource identity and media type are tightly coupled, requiring dedicated API for each media type
- Do not support media type negotiation and discovery

ROA based SDN northbound API

- Support resource migration without impact application
- Loosely coupled and support late resource binding, resource updates, and resource discovery
- Decouple the resource identity and media type
- Support media type negotiation and discovery to maximize the resource utilization



Newer SOX Version
192.168.0.3

Seamlessly
SOX
upgrade via
NBI
SOX Migrate
Smoothly

Previous
SOX Version
192.168.0.2

Summary

- **SDN – IT transformation of data networking**
    - SDN - a growing area in data networking industry
    - SDN technology - fast advancing, being applied to data center, carrier, enterprise, family, wired line, wireless, optical network, terminal, etc.
    - SDN+NFV – changing the landscape of network hardware, software, and the architecture of next generation data networks
    - SDN+NFV – new networking and service opportunities
    - SDN+NFV – leading to a new industry ecosystem, a challenge to existing infrastructures as well as a huge opportunity for the industry

Thank you!