Technology Development Challenges for Wide-area SDx Services in the Cloud Native Era

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Introduction

- NTT Communications is transforming our service development style/process/environment through “Softwarization” to meet our customers’ requirements in the cloud-native era.

- We are tackling “Softwarization challenges” including in-house software development to provide value-added SDx services in shorter time-to-market cycle.
Agenda

- Softwarization History of NTT Communications' Network Services
- Tech-vision on the wide-area SDx Services and Active Projects
- Next Technology Development Challenges
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“SDN”-lization Step1: Inside DC(Data Center)

✓ Automation of network configuration
✓ Dynamic network management by customer portal
“SDN”-lization Step2: Between DCs

- Same IP segment
- Seam-less connectivity for Cloud/Colo/On-premise
Automated connection settings between our network services (e.g. VPN) with our cloud services
Softwarization Deployment Expansion

- Cloud exchange
- NFV-PF
- SD-WAN
- Dynamic network slicing
- Transport SDN
- SD-LAN

Cloud

WAN

LAN

IoT

Data Center

Service Network

Transport Network

SaaS

IaaS
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Customers’ Expectations for Wide-area SDx Services

- Flexible and dynamic WAN
- Value-added VxF (x: network, security, IoT, ...)

Traditional WAN: Data Center, Cloud, VPN provided by Telecom Service Provider.


Advanced Use Case (as an example)
SDx Services Architecture

(1) Next-gen WAN (Flexible and Dynamic WAN)

(2) VxF Platform
(x: network, security, IoTfunc,...)
**SDx Services Architecture**

- Micro service architecture: to achieve agility, to easily adopt technology innovation, and to achieve distributed parallel development
- API first: to achieve easier provision of various composite services and to increase extensibility

In-house development: to shorten time-to-market, to provide differentiated services
Next-gen. WAN ~ Requirements

Traditional WAN

- **Minimal traffic engineering**
- **Simple L2/L3 pipe**
- **Static control**

Today (Hybrid)

- **Fine-grained application – centric slicing and traffic engineering**
- **Simple L2/L3 pipe + Service Functions Chaining**
- **Dynamic control**

Next-gen. WAN
Next-gen. WAN ~ Basic Design

Intelligent service networks
- Slicing, SFC, Distribution
- Scalability in traffic flows
- Soft-isolation

Simple&fast transport networks
- Openness for multi-vendors/whiteboxes
- Scalability in bandwidth
- Hard-isolation

Flexible ctrlr/orchestrator
- Software-defined approach
- Automation, Centralization

Open Line System ROADM

Standard IF
- Configuration Management
- NETCONF / OpenConfig

Orchestrator
- Traffic Engineering Controller
- PCE P
Next-gen. WAN ~ Network Slicing

mMTC slice (for IoT devices)

eMBB (for ultra-high-definition video)

uRLLC (for storage access)

uRLLC: Ultra-Reliable and Low Latency Communications
eMBB: enhanced Mobile Broadband
mMTC: massive Machine Type Communication
Next-gen. WAN ~ WAN (SDN) Controller Basic Design

SDN Controller Platform

Orchestrator

REST API

Access NW App
Metro NW App
Aggregation NW App
DCN NW App
Internal NW App

Flexible
Agile
Domain-specific

In-source
Applications

Out-source
Product

Stable
Reliable
Cross-domain

CLI / NETCONF

DCN (L2, L3)
Internal (L2, L3)

Access
Metro
Aggregation

Access
Metro
Aggregation

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**VxF Platform (Network edge) Architecture**

- Decoupling control of network part and virtual server part and connecting them using matured technologies.
  - Network -> Using standardized network protocols (VXLAN/eVPN…)
  - Virtual Server -> Accommodating various kind of hypervisors (VM/Containers, …)

![Diagram of VxF Platform (Network edge) Architecture](image-url)
Examples of In-house Development Environments

Process

- Requirement Design
- Development & Unit Test
- Integration
- Release

Infrastructure

- Communication
- File Sharing
- Virtual Environment
- Development Environment
- User Management

Tools:
- Confluence
- JIRA Software
- REDMINE
- Swagger
- Test management
OOL (Okinawa Open Lab) Trial

- **RAN**
  - **<Functions>**
    - Authorization, Slicing, Location mgt
  - **<Technology>**
    - Open Air Interface

- **MultiAccess GW**
  - **<Functions>**
    - Packet manipulation
  - **<Technology>**
    - DPI, P4

- **MEC**
  - **<Functions>**
    - Packet filtering, Image processing, Image compression
  - **<Functions>**
    - FPGA, GPU, Kubernetes

- **WAN GW**
  - **<Functions>**
    - Slice mapping, Resource
  - **<Functions>**
    - SR/SRv6, Traffic engineering, Telemetry

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Practical Issues to be Resolved

- Highly hierarchical and distributed component management
  - Robust and highly automated operation scheme assuming that faults must occur in some components
  - Non-stop service provisioning against software updates
  - Reasonable quality assurance (SLA / SLO) method / mechanism including the concept of error budget

- Service monitoring and QoE/QoS management
  - Effective end-to-end service monitoring mechanism for users / operators
  - Components relationship management that enables operators to analyze fault causes
  - Proactive operation based on the QoE/QoS

- Productive and sustainable software development system
  - SRE (Site Reliability Engineering) team to improve credibility/availability/performance
  - Active utilization of cloud native software development
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Softwarization Challenges

1. OSS/Standard APIs adoption
   - Customizability
   - Faster time to market
   - Interoperability
   - CAPEX/OPEX reduction

2. Disaggregation
   - Speeding up technical innovation
   - Inventory optimization

3. DevOps & Automation
   - Fully and advanced automation & Visualization
     - Telemetry
     - AI / Deep learning

Micro Services Architectures

In-house Development
Softwarization Challenges

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Transport Networks Transformation Challenge: ODTN with

Micro Services Architectures

In-house Development
ODTN (Open Disaggregated Transport Networks)

Vendor Proprietary Network Controller
- Proprietary and closed API
- Vendor-specific data model
- Vertically integrated
- Single vendor

Open Source Network Controller
- Open and standard API
- Common data models
- Multi vendor
- Disaggregated
ODTN Members

odtn@opennetworking.org
Towards Full Open Architecture

- Existing communities are focused on each specific target
- No “Integrated Solution” in open source community

→ Build a reference implementation by using those communities outputs
Collaboration with TIP

CONVERGED ARCHITECTURES FOR NETWORK DISAGGREGATION & INTEGRATION
NTT & Telefonica

PURPOSE
- Define operator use cases in open converged packet and optical networks.
- Prove that use cases can be met with architectures based on open technologies.
- Leverage the opportunity provided by TIP to involve different players to accelerate technical developments and help operators in real-world scenarios.

The target areas expand from the edge of the network up to the VNF or Datacenter platform going through the backbone network.
ODTN / TIP Collaboration Demo
Softwarization Challenges

1. OSS/Standard APIs adoption
   - Customizability
   - Faster time to market
   - Interoperability
   - CAPEX/OPEX reduction

2. Disaggregation
   - Multi Domain Interconnect Challenge
   - Open Source

3. DevOps & Automation
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Micro Services Architectures
In-house Development
MEF Overview

Lifecycle Service Orchestration Capabilities

http://www.mef.net/lso/lifecycle-service-orchestration
MEF Collaboration Usecase (1): Multi-Vendor SD-WAN

Integrated and flexible multi-vendor SD-WAN offering using white box CPEs. (We have been providing multiple SD-WAN services based on different vendors’ solutions)
To prove an innovative concept which enables an automated uCPE based multi-vendor SD-WAN service
PoC Highlights

- **Software** (SD-WAN applications) and **hardware** (CPEs) separation by utilizing white box servers
- **Open NFVI uCPE operating system**

- **Zero touch provisioning** of uCPE platform
- **Life cycle management** of SD-WAN applications
- **Catalogue-driven service orchestration**

- **Procurement** of SD-WAN services via an **online marketplace**
- **Unified operations** of multiple SD-WAN solutions in a **self-service portal**

- **Align with** Industry-first SD-WAN service specification (MEF70)
- **Use of** Legato & Presto API for **unified management** of multiple SD-WAN solutions
MEF Collaboration Use Case (2): Mobile<->Fixed Networks Interconnect

Wire-less <-> wired slices mapping

QoS Differentiation per slice
- Best effort -> SaaS access
- Low latency -> edge computing

Multi-layer SDN provisioning

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Architecture Overview

OKINAWA Open Laboratory | NTT Communications | NTT Lab

- Orchestrator
  - SONATA
  - PRESTO

SDN controller
- Path control (L3)
- Path control (L3+L0)
- Service Function Chaining control

- Mobile Backhaul
- Mobile backhaul & MEC

RAN: Mobile backhaul & MEC

WAN: Multi-layered SDN

* Multi-Service Fabric (NTT laboratories product)
Intent-based Multi-layer SDN Provisioning

- **Path Types**
  - Dedicated path
  - L2VPN
  - L3VPN

- **Redundancy**
  - Protection
  - Restoration
  - No redundancy

- **Latency**
  - Low latency
  - Best effort

- **Bandwidth**
  - Guaranteed
  - Best effort

**Network Path Types**

**Service Order**
- Financial company
- IoT company

**Path Provision**
- Service Order
- Path Provision

**SDN controller**

**IP Layer**
- Router

**Optical Layer**
- OXC

**Virtual Path 1** (Dedicated Path)
- 1Gbps
- DC

**Virtual Path 2** (Shared Path)
- 10Mbps
- Sensor
- DC

Financial company: IoT company

NTT Lab’s Demo @NetSoft2018
Multi-grade Reliability for Network Slice

Steps of Network Slice Evolution

1. Isolation from other slices
2. QoS differentiation (e.g. ultra low latency)
3. Reliability differentiation (e.g. ultra reliability)

Slice #1 (High level reliability)
- Provide virtualized network path
- IP Protection
  - Less than 50ms switching time
- High cost

Slice #2 (Middle level reliability)
- Low cost

Slice #3 (Low level reliability)
- Optical Restoration
  - A few second switching time
- Low cost
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Micro Services Architectures

In-house Development
Experienced Issues of Micro Service Implementation (1)

Distributed development teams caused diversity of implementation method / framework / procedure.
Experienced Issues of Micro Service Implementation (2)

Hardness of root cause analysis when any fault occur

Fault → Root Cause? → Component A → Component B → Component C

Too many potential cause…
Approach 1: Commonization

- Application execution framework (->Container framework)
  - Making software developers free from infrastructure operation
  - Cutting CAPEX/OPEX by software portability
- CI/CD framework
- Deployment procedure
Approach 2: DevOps as a Service Environment

- Project Owner
  - Prioritize

- Dev & Ops Member
  - Dev env
  - pull
  - push

- Function Backlog
- Operation Backlog

- Code Repo

- DevOps as a Service Platform
- Production environment
- Test
- Deploy
- KPI

- Lab environment
- Test
- Deploy
- Operation
- Update

- User
  - Feedback

- Dev & Ops Member
  - Feedback

- Dev & Ops as a Service Environment Platform

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Operation Automation Feedback Loop

Provisioning
- NETCONF/YANG
- Model-driven atomic transaction
- In-source development

Plan
- Path computation
- Resource Optimization
- Cooperative configuration

Analysis
- Root Cause Analysis
- SLA Assurance
- Big Data analysis

Telemetry
- Real-time, high-resolution
- Fine-grained data
- Vendor-neutral model/protocol

Intent-based networking
Summary and Future Works

- NTT Communications’ “Softwarization challenges” to provide value-added SDx services in shorter time-to-market cycle.

- Next Challenges and future works
  - OSS/Standard API adoption -> from PoC level to production, reasonable collaboration with open communities that compete each other
  - Disaggregation -> Wider adoption into production environments, Difficulties in scalable management
  - DevOps & Automation -> Scalable framework for highly distributed software components, Advanced operation using AI/ Big-data?

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Hope we can move forward collaborating with audiences!