ETSI NFV Standards & Telco System Virtualization

신명기
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ETRI
KRNET2013
2013.6.25
Talk Outline

• NFV & SDN → Telco system/functions 가상화
• ETSI ISG NFV에서의 (표준)규격개발 현황
• 실 구현물 경험과 사례연구
• Wrap-up 및 My Observation
• Creates competitive supply of innovative applications by third parties

• Creates N/W abstractions to enable faster innovation

• Reduces CAPEX, OPEX
• Space & Power Consumption

Source, NFV White paper, 2012
• Creates competitive supply of innovative applications by third parties
Open Innovation Platform

Innovation Platform vision:
Support for data-intensive science

Innovation roadblocks
• One-size-fits-all approach to network data flows
• Lack of transparent performance monitoring solution
• No way to customize and optimize the network via SDN

Innovation route
• Architect a special solution to allow higher-performance data flows
• Include end-to-end performance monitoring
• Include SDN server to support programmability

Internet2

8 – 4/22/2013, © 2013 Internet2
Open Innovation Platform

Using Giga Korea TB for research
I have a great idea! The original Internet architecture was designed to connect one computer to another—but a better architecture would be fundamentally based on PEOPLE and CONTENT!

That will never work! It won’t scale! What about security? It’s impossible to implement or operate! Show me!

 Trying it out
My new architecture worked great in the lab, so now I’m going to try a larger experiment for a few months.

And so he poured his experimental software into clouds, distributed clusters, bulk-data transfer devices (faster), and wireless access devices throughout the TB auto, and started taking measurements...

Experiment turns into reality
My experiment was a real success, and my architecture turned out to be mostly compatible with today’s Internet after all—so I’m taking it off TB and spinning it out as a real company.

It turns into a really good idea
Buy! I've learned a lot. I've published papers, the architecture has evolved in major ways, and I'm even attracting real users!

Location-based social networks are really cool!
His experiment grew larger and continued to evolve as more and more real users opted in...

TB에 연결된 글로벌 오픈 커뮤니티를 통해 검증

Introduce a new capability by writing S/W programs. Creates N/W abstractions to enable faster innovation.
Open Networking

Loosely coupling
Visible behavior
Protocols, standards
Modulation
Open Source

SDN

Data and control planes separation
Programmatic/centralized controls
Network device abstraction

OpenFlow

Secure channel b/w switch and controller
Switch forwarding abstraction
SDN

Control Plane
Network OS
Data Plane (Specialized Hardware)

Control Plane
Network OS
Data Plane (Commodity Hardware)

Separation (physically or logically)
OPEN INTERFACE

POSIX-like NBAPIs
OPEN INTERFACE

Controller (logically centralized)
(e.g., OpenFlow protocol)

Apps

A Single Physical Infrastructure

Data Routing
Mobility optimization
Energy efficient forwarding ....
NFV

- Telco System Virtualization
- Easy control and management of Telco's resources (net, compute)
- Reduces CAPEX, OPEX
- Space & Power Consumption
## Comparison of SDN and NFV

<table>
<thead>
<tr>
<th>Category</th>
<th>SDN</th>
<th>NFV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reason for Being</strong></td>
<td>Separation of control and data, centralization of control and programmability of network</td>
<td>Relocation of network functions from dedicated appliances to generic servers</td>
</tr>
<tr>
<td><strong>Target Location</strong></td>
<td>Campus, data center / cloud</td>
<td>Telco networks</td>
</tr>
<tr>
<td><strong>Target Devices</strong></td>
<td>Commodity servers and switches</td>
<td>Commodity servers and switches</td>
</tr>
<tr>
<td><strong>Initial Applications</strong></td>
<td>Cloud orchestration and networking</td>
<td>Routers, firewalls, gateways, CDN, WAN accelerators, SLA assurance</td>
</tr>
<tr>
<td><strong>New Protocols</strong></td>
<td>OpenFlow</td>
<td>None yet</td>
</tr>
<tr>
<td><strong>Formalization</strong></td>
<td>Open Networking Forum(ONF)</td>
<td>ETSI NFV Working Groups</td>
</tr>
</tbody>
</table>

Source: ONS2013, Modified
NFV : Basic Concept

• 네트워크 function들을 가상화
  – Carrier의 네트워크 장비내의 function들을 standard high volume server로 분리시켜 가상화 시키는 기술
  – Network virtualization의 현실화된 Telco 버전
  – 사실, 다양한 구현 방법이 가능 (with SDN, without SDN)

• NFV as highly complementary to SDN
  – (Carrier-IDC내에 위치하는 standard high volume server의 활용)
NFV: Basic Concept

Network Functions Virtualisation Approach

Independent Software Vendors
Orchestrated, automatic remote install

Generic High Volume Servers
Generic High Volume Storage
Generic High Volume Ethernet Switches

Source, NFV White paper, 2012
NFV: Example

Carriers’ Network Functions

x86 high volume servers IN DATA CENTER @ CARRIERS

Carrier의 Network specialized HW
Telcos’ <Network functions>

• General router functions
• Mobile network node (e.g., SGSN, GGSN/PDN-GW) functions
• IPsec/SSL, VPN functions
• DPI, QoS, QoE, measure/monitoring & action
• AAA, policy control, charging
• Network optimization functions (e.g., CDNs, Cache Servers, Load Balancers, Application Accelerators)
• Security functions (e.g., Firewalls, virus scanners, intrusion detection systems, spam protection)
• Home router / set-top box functions
• Reduced equipment costs and reduced power consumption
• Increased speed of Time to Market by minimising the typical network operator cycle of innovation.
• Availability of network appliance multi-version and multi-tenancy
• Targeted service introduction based on geography or customer sets is possible. Services can be rapidly scaled up/down as required.
• Enables a wide variety of eco-systems and encourages openness.

Source, NFV White paper, 2012
왜 Telco 는 NFV 를 원하나?

• Telco의 당면 과제들 (source from DT)
  – Competitive pressure, traffic growth, cost & complexity, time to market …

• Easy control and management of Telco System
  – Dedicated appliance 들의 제어 및 관리의 어려움
  – 새로운 서비스의 도입 시간 단축
  – 이제, 몇몇 big 제조업체들만이 telco의 유일한 거래 파트너가 아니 다
  – 3rd Party S/W 협력업체의 등장
    • 특히 charging, policy, security-related functions …
NfV speeds up time to market “From 90 days to nine..."
NFV: 기술적 이슈

- Performance Trade-Off
- Migration and co-existence of legacy & compatibility with existing platforms
- Portability/Interoperability (표준)
- Management and Orchestration (서비스 제공)
- **Automation ➔ (SDN control programming)**
- Security & Resilience
- Network Stability
- Simplicity
- Integration

Source, NFV White paper, 2012 (Modified)
- Creates competitive supply of innovative applications by third parties

- Reduces CAPEX, OPEX
- Space & Power Consumption

- Creates N/W abstractions to enable faster innovation

Source, NFV White paper, 2012 (Modified)
NFV 기술의 확산 및 텔코들의 컨센서스 도출을 위한 Place필요
• ETSI 산하 ISG 결성 (2012.12)
  – Network-operator-driven ISG (13 Founding Member)
  – ETSI 멤버쉽을 가지고 있으면 누구가 조인 가능
  – 그 자체로 표준화 기구는 아님
  – 공동협력 (ONF) (예, OF규격확장)
• NFV : Network Operator Requirements
  – White paper
• NFV#01 : 2013.1.15-17, Sophia Antipolis
• NFV#02 : 2013. 4. 22-23, Santa Clara (Huawei)
Acme Packet
Allot Communications Systems Ltd
Amdocs Software Systems Ltd
AT&T
Alcatel Lucent
Benu Networks
Broadcom Corporation
BT Group PLC
Cablelabs
Ceragon Networks
Cisco Systems Belgium
Citrix Systems Inc
Deutsche Telekom AG
DOCOMO Communications Laboratories Europe GmbH
ETRI
France Telecom S.A.
Freescale Semiconductor EMEA S.A.
Fujitsu Laboratories of Europe
Hewlett-Packard
Hitachi Europe
Huawei Technologies (UK) Co. Ltd
IBM Europe
Intel Corporation (UK) Ltd
Iskratel Ltd
Italtel S.p.A
JDSU Deutschland GmbH
Juniper Networks
KT Corporation
NEC Europe Ltd
Nokia Siemens Networks GmbH & Co.KG
NTT Corporation
Oracle
Portugal Telecom SGPS SA
RadiSys Inc
Samsung Electronics
Seven Principles AG
Spirent Communications
Sprint
Swisscom SA
Tektronix GmbH Co KG
Telecom Italia S.p.A
Telefon AB LM Ericsson
Telefonica S.A.
Telekom Austria AG
Telenor ASA
Tellabs OY
UPRC
Verizon UK Ltd.
Virtela Technology Services Inc
Vodafone Group Services plc
Yokogawa Europe B.V
ZTE Corporation

51 ETSI 기관 + 58 개 participants
ETSI NFV: WG/EGs

- **Technical Steering Committee (TSC)**

- **4 WGs**
  1. Architecture of the Virtualization Infrastructure (INF)
  2. Management & Orchestration (MANO)
  3. Software Architecture for Network Functions (SWA)
  4. Reliability & Availability (REL)

- **2 EGs**
  1. Performance and Portability (PER)
  2. Security (SEC)
Technical Steering Committee
Chair: Technical Manager: Don Clarke (BT)
Vice Chair / Assistant Technical Manager: Diego Lopez (TF)
Programme Manager: TBA
NOC Chair (ISG Vice Chair) + WG Chairs + Expert Group Leaders + Others

Working Group
Architecture of the Virtualisation Infrastructure
Steve Wright (AT&T) + Yun Chao Hu (HW)
Managing Editor: Andy Reid (BT)

Working Group
Management & Orchestration
Diego Lopez (TF) + Raquel Morera (VZ)

Working Group
Software Architecture
Fred Feisullin (Sprint) + Marie-Paule Odini (HP)

Working Group
Reliability & Availability
Chair: Naseem Khan (VZ)
Vice Chair: Markus Schoeller (NEC)

Expert Group
Performance & Portability
Francisco Javier Ramón Salguero (TF)

Expert Group
Security
Bob Briscoe (BT)

Additional Expert Groups can be convened at discretion of Technical Steering Committee

HW = Huawei
TF = Telefonica
VZ = Verizon

Source, ETSI NFV ISG
NFV: Document Scope

Source, ETSI NFV ISG
<table>
<thead>
<tr>
<th>Doc</th>
<th>Group</th>
<th>Work item</th>
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<tr>
<td>NFV(13)M02028r1</td>
<td>Plenary</td>
<td>NFV(13)M02028r1_NFV_End_to_End_Architecture_Reference_Document.zip</td>
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<td>NFV(13)M02019</td>
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<td>NFV(13)M02024</td>
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<tr>
<td>NFV(13)M02025</td>
<td>INF</td>
<td>NFV(13)M02025_Proposed_WI_for_the_Partability_and_RiplicabilityCapability.zip</td>
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<td>SEC</td>
<td>NFV(13)M02031_NFV_Security__Problem_Statement.zip</td>
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</table>
Virtualisation of network function

Management and orchestration of

Source, ETSI NFV ISG
GS NFV INF.01
Part 1: Infrastructure Architecture; Sub-part 1: Overview

Source, ETSI NFV ISG
General Domain Architecture and Associated Interfaces
<table>
<thead>
<tr>
<th>Interface Type</th>
<th>Interface ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI Container Interfaces</td>
<td>4</td>
<td>This is the primary interface provided by the infrastructure to host VNFs. The applications may be distributed and the infrastructure provides virtual connectivity which interconnects the distributed components of an application.</td>
</tr>
<tr>
<td>VNF Interconnect Interfaces</td>
<td>3</td>
<td>These are the interfaces between the components of a VNF. The specification of these interfaces does not include and is transparent to the way the infrastructure provides the connectivity service between the components, however distributed.</td>
</tr>
<tr>
<td>Infrastructure Container Interfaces</td>
<td>6</td>
<td>Virtual Network Container Interface: the interface to the connectivity services, for example E-Line and E-LAN service, provided by the infrastructure. This container interface makes the infrastructure appear to the NFV applications as instances of these connectivity services.</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Virtual Machine Container Interface: the primary hosting interface on which the VNF virtual machines run. Note, NFV orchestration and management runs on this interface.</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Virtual MANO Container Interface: the interfaces that allows the VNFs to request different resources of the infrastructure, for example, request new infrastructure connectivity services, allocate more compute resources, or activate/deactivate other virtual machine components of the application.</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>The primary compute hosting interface on which the hypervisor runs.</td>
</tr>
<tr>
<td>Infrastructure Interconnect Interfaces</td>
<td>9</td>
<td>Orchestration and management interface with the infrastructure network domain.</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Orchestration and management interface with the hypervisor domain.</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Orchestration and management interface with the compute domain.</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Network interconnect between the compute equipments and the infrastructure network equipments.</td>
</tr>
<tr>
<td>Legacy Interconnect Interfaces</td>
<td>1</td>
<td>The interface between the VNF and the existing network. This is likely to be higher layers of protocol only as all protocols provided by the infrastructure are transparent to the VNFs.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Management of VNFs by existing management systems</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Management of NFV infrastructure by existing management systems</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>The interface between the infrastructure network and the existing network. This is likely to be lower layers of protocol only as all protocols provided by VNFs are transparent to the infrastructure.</td>
</tr>
</tbody>
</table>
Source, ETSI NFV ISG
<table>
<thead>
<tr>
<th>Key Issue</th>
<th>Relevant WGs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topology Validation &amp; Enforcement</td>
<td>MANO</td>
</tr>
<tr>
<td>Availability of Management Support Infrastructure</td>
<td>ArchVI, RelAv</td>
</tr>
<tr>
<td>Secure Boot</td>
<td>MANO, ArchVI</td>
</tr>
<tr>
<td>Secure Crash</td>
<td>ArchVI, MANO</td>
</tr>
<tr>
<td>Performance Isolation</td>
<td>RelAv, ArchVI</td>
</tr>
<tr>
<td>Tenant Service Accounting</td>
<td>MANO, ArchVI</td>
</tr>
<tr>
<td>Authenticated Time Service</td>
<td>ArchVI</td>
</tr>
<tr>
<td>Private Keys within Cloned Images</td>
<td>SWArch, MANO</td>
</tr>
<tr>
<td>Back-Doors via Virtualised Test Functions</td>
<td>MANO</td>
</tr>
</tbody>
</table>
• NFV Plenary meetings every quarter.
  – NFV#03: Next meeting is July 24-26 Bonn Germany
  – NFV#04: 29-31 October, USA
  – NFV#05: Jan 21-23 or Jan 28-30 2014 Europe.
  – NFV#06: April 29-May 1-2014 Asia.
  – NFV#07: July 23-25 2014 Europe.
  – NFV#08: October 2014 USA
  – The NFV closing meeting will be held in January 2015 in Sophia-Antipolis or the surrounding area.
SDN 벤더 입장에서 Telco / NFV는 중요한 고객이자 Killer 서비스!
Telco SDN (Carrier-grade SDN)

- Optical extensions to OF/SDN
- Wireless integration, characterization of wireless interfaces, flows, handover support in OF/SDN
- Evolved packet core, LTE support for OF/SDN
- New controller architectures, API, SDN “north-bound” interfaces
- End-to-end SDN and legacy interworking
- Higher level SDN abstractions, APIs, object models for carrier-grade equipment including middle box (e.g., NAT, FW, etc.)
- CCN/ICN and their relation with SDN
- Network functions Virtualization (NFV) techniques based on SDN
- SDN languages and tools, testing, and debugging
NFV Use Cases

- Software-based DPI
- CG-NAT, NAT-PT (NAT64/6RD)
- Energy-aware SDN
- Firewall, web security, IPS/IDS, WAN acceleration and optimisation, and router functions
- The virtualisation of CDN, CDNi, CCN
- Mobile network traffic optimization
- Charging …
- Crash and recovery
- (공통점) 새로운 carrier-policy의 add
BT (SDN+NFV use cases)

Research Ideas
- We need to turn them into reality

- Transport-as-a-Service (TaaS)
- SDN for content, media & broadcast
- SDN Service Chaining
- Bandwidth Allocation
- OSS Simplification
- Virtualised Ethernet Optical Fabric (vEOF)
"Software-Defined X" in SDN

Basic SDN

- SDN-aware Services/Applications/Stuff
- SDN Control Function Layer
- SDN Controller Layer
- SDN Dataplane Layer

OpenFlow
Software-Defined **EPC** in Telco System

Software-Defined **Wireless** in Telco System

Software-Defined **Optics** in Telco System

Software-Defined **Mobility** in Telco System

Software-Defined **Multicast** in Telco System

Software-Defined **Security** in Telco System

...
Open Discussion

• Network function 들의 SDN 적용 가능성
  – function 분리가 가능한지 (H/W dependency)
  – Performance
  – DPI
  – Monitoring (Northbound Interface)
  – Centralized controller

• Open Interfaces
• Service chaining (or stitching)
• Open source의 활용 여부
• Network functions Virtualization (L4-L7) 표준화
NFV & SDN

Carriers’ Network Functions

SDN Controller

Open Interface (OF + ext)

x86 high volume servers

Standard high volume storages

Service chaining

Hypervisor / Orchestration

Standard High volume Switch (Commodity)
NFV (with SDN) - 실 구현물 경험과 사례 연구
(Sources from ONS2013, SDN APAC Congress, etc.)
Telefónica & NEC & Intel: Virtual EPC

Launching Today
Open Network Platform Switch Reference Design
Telefónica & NEC & Intel: Virtual EPC

NEC and Telefónica to Collaborate on Network Virtualization

“NEC and Telefónica have produced the first real case study of virtualized EPC (Evolved Packet Core)”

Telefónica Feb 21, 2013
Verizon & Intel: Virtual N/W functions

Verizon SDN and NFV Priorities

Objectives
Better CAPEX ROI
Lower Operating Expenses
Business Agility
New ways to monetize infrastructure

Enablers (“SDN” and “Cloud”)
Implement network functions on SHV/COTS hardware
Virtualization of network functions
Application/service aware routing
Orchestration of network and cloud resources

Service
Orchestration
Hypervisor
Controller
OpenFlow
OpenFlow Switches
COTS HW = Compute & Storage
Telstra & Ericsson

Joint development with Telstra

- **Service Chaining & Virtualized Aggregation Networks**
- **Scalable to switching millions of flows and configuring 100 000s flows/sec**
- **First Ericsson Service Provider SDN application commercially available Q4 2013**

**SDN EXAMPLE**

**SERVICE CHAINING EXAMPLE**

- **Open Flow Controller**
- **Open Flow Switch**

**OFFLOADING JUMBO (VIDEO) FLOWS**

- Per subscriber service chains defines default path for all the packets & flows originated from or directed to that subscriber
- Offload selective high volume traffic once flow is admitted and no further processing required
Telefonica & Huawei: Virtual Residential G/W

**USE-CASE:** VIRTUAL RESIDENTIAL GATEWAY

**CUSTOMER TRIAL:** Deploy Virtual RGW in OLT

**CUSTOMER**
- Telefonica
- Worldwide
- $135B USD revenue
- 316M subscribers

**CHALLENGE**
- High OPEX for wireline home users (5M fixed broadband users in Spain).
- Replacement and upgrades to RGW drive high CAPEX and limit new service deployment.
Huawei: End-to-End SDN

End-to-End SDN

AVAILABLE FOR COMMERCIAL TRIAL: 13Q4

SDN-ENABLED ROUTERS
- OpenFlow 1.3 Support
- Service Chaining in SoftBNG
- IP Core Routers
  - Smart Traffic Engineering
  - Instant VPN
  - Route Reflector +

SDN-ENABLED IP RAN 2.0
- OpenFlow 1.3 Support
- Stand-Alone Controller
ETRI & 스마트인터넷
Wrap-up & My Observation

• SDN & NFV → 텔코가 나가야 할 방향 (텔코관점)
  – ETSI NFV ISG (텔코중심)
  – ONF (CP중심)
  – Open Daylight (제조업체 중심)

• NFV == Enabler of Telco-SDN (제조업체 관점)

• NFV는 새로운 개념이 아닌, 기존 Network Virtualization
  에 현실화된 개념 + 데이터 센터(클라우드) 가상화 활용

• 우리나라는 스마트노드플랫폼 + 신규SDN 과제가 이와
  연계중 (빠른개발 + Ref 사이트 + 표준화 필요)
Network Service Chaining (NSC)
IETF87@Berlin
- NFV (MANO) 중심의 텔코 요구사항 도출
- 필요한 규격은 IETF에서 작업될 가능성 많음
회의안건 및 주요이슈
- 가상화된 다양한 네트워크 L4-L7 서비스들의 연결시 연결순서, 인터페이스, 검증 이슈 등
- 시스코 등 벤더중심으로 텔코 요구사항 반영
- 이번회의는 non-forming WG BoF 회의로 일단 진행
감사합니다.

Any Questions?