SDN Initiatives

July 10, 2013

Makoto Noguchi
SDN Strategy Director
NEC Corporation
Contents

1. Introduction

2. What is SDN (Software-Defined Networking)?

3. NEC’s Initiatives for SDN (Past)

4. NEC SDN Solutions

5. Conclusion
1. Introduction
NEC Business Domains towards the Realization of the Group Vision

Realization of an affluent and equitable society which makes efficient use of resources and whose members are safe and personally secure.

Solutions for society

- Supporting the advancement of social infrastructure and systems throughout the world via ICT
- Create new business models with the understanding that social problems provide an opportunity for growth

Transformation into Social Value Innovator
(1) Innovation of Social Infrastructure via ICT(1)

Leveraging our proven results and strong position for global expansion

- From the seafloor to outer space, concentrating management resources in areas in which social infrastructure will be innovated by ICT

NEC ICT supporting social infrastructure and systems

- Next-generation network technologies
- High-performance, high-reliability core IT technologies
- Diverse sensor and human interface technologies
(1) Innovation of Social Infrastructure via ICT

Collection of large-scale data
- Diverse sensors and human interface technologies
  - Diverse sensors
  - Surveillance cameras
  - Smart devices
  - Accumulated data

Analysis and prediction
- High-performance/high-reliability core IT technologies
  - Invariant analysis
  - Heterogeneous mixture learning
  - Facial image analysis
  - Behavior analysis
  - Textual entailment recognition

Solution of social issues

Leveraging information captured by our unique and highly competitive ICT assets to become a social value innovator

* Rated as No. 1 among organizations participating in an evaluation task organized by the U.S. National Institute of Standards and Technology (NIST)
“SDN Strategic Headquarters” was established in the Business Innovation Control Unit, a BU organization for NEC’s areas of focus.
2. What is SDN?

* SDN: Software-Defined Networking
Issues with Conventional ICT systems

Current ICT systems enable easy, flexible communications anywhere and low-cost services are available.

Meanwhile, it has become more difficult to quickly and easily implement and change advanced social systems and complex ICT systems in some cases.

Can ICT systems provide convenience in the same way as car navigation systems?

- Entire route to the destination is not shown
- Traffic jams cannot be predicted
- The route cannot be changed flexibly
- Arrival time is unknown
- Whether or not the road has a high incidence of accidents is not shown

A route that avoids traffic jams or construction sites is selected in advance. The route can be changed flexibly according to the situation just by inputting the destination.
What is SDN (Software-Defined Networking)?

SDN refers to dynamically controlling networks using software and its architecture.

**Past/Present**
- Static network where network control by dedicated network equipment and data transfer processing were performed together.

**Future**
- Network control and communications processing are separated.
- Equipment that only performs communications processing is dynamically controlled by using software on a general-purpose server.

Dedicated equipment with network control function

Separated & Dynamically Controlled

Network control software
- General-purpose server

Communications processing
- Equipment that only performs communication processing.
SDN to Contribute to Enhancement of Social Infrastructure

Advance ICT systems using SDN that controls networks with software dynamically

- Suppress failure occurrence
- Visualize the entire ICT system
- Optimize ICT resource balance
- Improve efficiency of infrastructure equipment
- Improve security

Enhancement of social systems
In the event of disaster, prioritize email messages and voice calls by dynamically changing the ICT service balance when many people make calls and send email messages to confirm safety.

Normal Time

Disaster Strikes

Music distribution

Video distribution

Email

Voice call

Dynamically change the service balance using software

Music distribution

Video distribution

Email

Voice call
SDN Application Example (2): Realizing easy-to-use social infrastructure

Enable smooth utilization even when network access spikes at an online shop clearance sale or campaign by controlling networks optimally.

**Present**

Oh, no! Cannot access! The sale is almost over!

**Using SDN**

I got it!
Emergence of an IT/Network Fusion Market via SDN

Changes occurred in the IT market are also spreading in the network market rapidly.

A new market where IT and networks are merged emerged.

Moving to a value creation competition with new solutions.

To a new value creation in the IT/network fusion market.
Potential of SDN Market

Worldwide SDN market scale is expected to grow to 4.7 trillion yen by 2017

unit: trillion yen

*Calculated by NEC based on various market surveys
3. NEC’s Initiatives for SDN (Past)
NEC’s Past Initiatives

NEC leads the research and development of SDN architecture and OpenFlow*1  protocol

Participated in the Clean Slate Program of Stanford University from the beginning. Also, proactively participates in various standardization organizations and communities such as ONF, contributing to SDN promotion

<table>
<thead>
<tr>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpenFlow R&amp;D</td>
<td>World’s first OpenFlow products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open Network Consortium</td>
<td>Formulated and standardized OpenFlow specifications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDN R&amp;D</td>
<td>Open Networking Research Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSS activities for SDN software</td>
<td>SDN standardization activities by telecom carriers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Application development project for SDN</td>
<td>US Ignite*2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1 OpenFlow: Standard of network control protocol  
*2 National high-speed broadband network project of US federal government
### Reference: Trends in SDN Standardization and NEC’s Activities

*NEC activities as of July 10, 2013*

<table>
<thead>
<tr>
<th>Organization Name</th>
<th>Establishment/Objective</th>
<th>NEC Activities</th>
</tr>
</thead>
</table>
| Open Networking Foundation (ONF) | • Established by Deutsche Telekom, Facebook, Google, Microsoft, Verizon and Yahoo in March, 2011. 93 companies participate. (As of May, 2013)  
• Formulates OpenFlow standard specifications | • Participates from the establishment of the former Open Network Consortium  
• Vice chair of the architecture and configuration workgroups |
| Network Functions Virtualization (NFV) | • Established by world’s top 13 telecom carriers as a subordinate organization of ETSI (European Telecommunications Standards Institute). (October 2012)  
• Promotes the realization of functions, equivalent to the functions realized by expensive network equipment, using general-purpose servers | • NEC participates from the establishment  
• Vice chair of the reliability workgroup, editor of the management workgroup |
| OpenDaylight Project | • SDN open source project established by 18 major network-related vendors (April, 2013)  
• Participating companies donate their own SDN-related codes to the project, promoting SDN framework implementation | • Provides Virtual Tenant Networking (VTN) models and applications enabling users to create/control multi-tenant virtual networks |
| Open Networking Research Center (ONRC) | • Established by Stanford University, UC Berkeley, and others (April, 2012)  
• Leads SDN research and development, and develops software to realize SDN | • Participates from the establishment of ONRC  
• Develops OpenFlow product technologies through joint research |
NEC’s Leading SDN Products

Use SDN technologies and successful experience in the enterprise/data center market. Provide SDN products to realize simple operations

WebSAM

- Long-term experience in the enterprise/DC market
- Commitment to “Simple Operation”
- Cloud platform where know-how and expertise accumulated through cloud operations are implemented

IT

Network

Announced on May 29, 2013
The first to realize OpenFlow-based SDN on a commercial cloud platform
- Automated operations -
WebSAM vDC Automation
×
UNIVERGE PF6800

Announced on June 10, 2013
Products compatible with the latest OpenFlow 1.3 Specifications released
UNIVERGE PF Series

UNIVERGE PF Series

- Commercial experience in Japan and overseas
- Realize an open cooperation with partners
- World’s first OpenFlow products

* Best of Show Award People’s Choice Category (Product Category)
Case Study (1): Kanazawa University Hospital

- Improves the hospital network management efficiency to support 24/7 medical services
- Integrates department LANs with different policies and reduces installation costs
- Provides stable networks and reduces time and costs for the operation management and configuration modifications

### Conventional Network
- Core software
- Network appliance pool
- Servers
- Electronic records
- Anesthesia dept.
- Radiology dept.

### SDN Network
- Electronic records (Patient info)
- High resolution image transfer
- Office work LAN
- Firewall
- Network pool
- Server pool
- Electronic records
- Anesthesia dept.
- Radiology dept.
Case Study (2): Software Factory

- Implements virtual networks using OpenFlow technologies. Deploys software development environments to multiple data centers.
  - Realizes BCP (Business Continuity Plan) by disaster recovery functions
  - Developers can work without knowing the connection destination and load concentration because the loads are distributed to multiple sites

- Provides customers with stable software services through the continuous usage of software development environment
Case Study (3): NEC BIGLOBE Data Center

Proprietary developed cloud controller controls virtual servers and virtual networks collectively

- Planning Requirement definitions
- Infrastructure design (Server/network design) 5 days
- Server implementation
- Network implementation
- Connection
- Operation

Speed

Network service:
- Firewall
- Router
- Load balancer

Flexibility

IP address types:
- Global IP address
- Private IF address
- Owner specific IP address

Manage personal information securely using cloud services

Connection between cloud services and platform systems

2 weeks ⇒ Shorten to approx. 10 min
### Past Case Studies/Demonstration Examples

Employment and demonstration at companies/organizations are accelerated globally

#### Overseas

- Stanford University
- Selerity Corp (New Jersey)
- GenesisHosting (Chicago)
- Telefonica S.A. (Spain)
- Tervela (New York)
- Portugal Telecom (Portugal)

#### Japan

- NTT Communications (Biz Hosting)
- Ministries and agencies
- Manufacturing companies
- Trading companies
- Nippon Express
- Universities
- Electronic manufacturers
- Logistics companies
- Kanazawa University Hospital
- R&D
- System integrators
- Broadcasting stations

**Operating as active operation systems at various companies**
4. NEC SDN Solutions
Expanding SDN Business at NEC

**Past/Present**

- Deploy business focusing on technologies and products mainly for data centers

**Future**

- Leading to solution business based on product business experience
- Expanding the applicable market from data centers to enterprise/telecom carriers
NEC’s SDN Business Strength

In addition to the technologies and head-start experience of SDN, we deploy SDN solutions underpinned by NEC’s customer base, successful experience in IT, networking systems and SE resources.

**Worldwide: Approx. 170,000 companies**

- **Japanese companies**
  - Approx. 160,000
- **Telecom carriers**
  - Approx. 800
- **Overseas companies/JOC**
  - Approx. 10,000

**Customer base**

**IT/NW Experience/SE**

- Solution development capability
  - IT/NW solution technologies and experience (Telecom infrastructure, social infrastructure, large scale systems)
  - Sales and SE resources
  - In-house utilization, operation know-how

**Pioneering abilities of SDN Technologies**

- Products and technologies
  - Commercialized world’s first OpenFlow-compatible products
  - SDN product implementation and pioneering abilities
  - SDN advanced technology development and research organization
"NEC SDN Solutions": Solution Menu

Established SDN solution menu based on SDN products and case studies experienced before other companies

In addition to the data center market, deploy solutions to broad applicable fields of enterprises, public agencies and telecom carriers*1

<table>
<thead>
<tr>
<th>Target Market</th>
<th>Applicable Area</th>
<th>Solution</th>
<th>Product</th>
</tr>
</thead>
</table>
| NEC SDN Solutions for Enterprise  | Network optimization  | • Optimized connections between sites and data centers*2  
|                                   |                       | • LAN optimization*2                       | Integrated operation management software  
|                                   | Security              | • Access authentication*2                  | WebSAM vDC Automation               |
|                                   | Mobile                | —                                           | Cloud Network Platform  
|                                   |                       |                                             | "UNIVERGE PF Series"                |
| NEC SDN Solutions for Data Center | Operation/management | • Automated IaaS operation*2                |                                  |
|                                   | Integration           | • Data center network Integration*2         |                                  |
| NEC SDN Solutions for Telecom     | Network management    | • Integrated operations/management         |                                  |
|                                   | Network infrastructure| • Network function virtualization         |                                  |
|                                   |                       | • Transport                                |                                  |

*1: Sales timing and sales regions differ for each solution  
*2: Start sales in Japan in October 2013, then deploy to other countries
Reference: Situation at NEC and Other Companies’ Efforts (Source: NEC)

<table>
<thead>
<tr>
<th>Target Market</th>
<th>Applicable Area</th>
<th>Solution</th>
<th>Product Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEC SDN Solutions for Enterprise</td>
<td></td>
<td></td>
<td>NEC</td>
</tr>
<tr>
<td>NEC SDN Solutions for Data Center</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEC SDN Solutions for Telecom</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **NEC SDN Solutions for Enterprise**
- **NEC SDN Solutions for Data Center**
- **NEC SDN Solutions for Telecom**

**Product Group**

- Cloud Product Vendor
- NW Product Vendor
- SI Vendor
- Telecom Carrier SI Vendor
Example of SDN Solutions for Enterprises: Network optimization

- Improve business efficiency and speed up new business responses by visualizing and dynamically controlling enterprise networks
- Improve the usage efficiency of communications lines/devices and reduce ICT investment and operation management costs

Solution: “Site/data center connection optimization”

A solution to optimize the usage efficiency and routes of communication lines based on the communications line performance, which connects sites and a data center/between data centers, the communications status monitored information, and the usage time slot management functions, etc.

![Diagram of network connections and functions: Route/bandwidth control, Visualization, Flexible changes, Automated operations, Usability improvement.]

Data center
Mobile
Logistics site
Production site
Headquarters office
Branch
Solution Example for Enterprises: Access authentication solution

Improve business efficiency for information system users and administrators, and realize flexible and prompt responses to the ever-changing business environment while securing information safety and security

Solution: “Access authentication”

The use of centralized authentication information authenticates each user or each terminal and implements virtual networks separated for each group (department/project). Automates rule settings and modifications for appropriate access control.
Enhancement Policy for SDN Solution Business for Enterprises/Data Centers

Established a new dedicated SDN division fostering and enhancing engineers with IT and networking integrated skills, and developing advanced solutions through conversations, proposals and installations for customers in various industries and businesses.
Values Provided by SDN Solutions for Telecom Carriers

SDN implements flexible networks, realizes simple operations, and provides value-added networks.

- **Infrastructure**
  - Efficient resource utilization
  - Efficient resource utilization through virtualization
  - Network with high programmability, scalability and reliability
  - CAPEX reduction

- **Management & Orchestration**
  - Automated setting
  - Central control and management
  - OPEX reduction

- **Services**
  - Service promptness
  - Easy service deployment
  - New revenue

**Simple & Flexible**

**Fusion of IT technologies and network technologies**

- Mission critical computing technologies
- High-reliability network technologies
- Virtualization technologies

*: CAPEX: Capital Expenditure / OPEX: Operating Expense
SDN Solutions for Telecom Carriers

Responds to network needs of telecom carriers and focuses on three solutions

- **Integrated Operation/Management Solutions**
  - SDN Service Controller
  - OSS/BSS
  - TMS

Automate SDN integrated operations/management. Realize control optimization

- **Transport Solutions**
  - Provide efficient network resource utilization by controlling with software

- **Transport Network**

- **NFV (EPC, ••)***
  - Network Virtualization Solutions
  - Implement network functions on servers

ICT resource integration and virtualization

*: OSS/BSS: Operation Support System / Business Support System (Systems to support business operations of telecom carriers)
*: TMS: Traffic Management System (Communications management system)  
*: EPC: Evolved Packet Core (Next generation mobile core network to realize ALL-IP network)
Enhancement Policy Telecom carrier SDN Solutions

Base is located in Europe to support SDN business for telecom carriers
Enhance cooperation with leading global telecom carriers, standardization organizations and R&D institutes

Implement eco systems through standardization and open community activities

SDN Technical & Marketing Centre (NEC Europe)

SDN joint discussion with leading global telecom carriers
Telefonica S.A. (Spain)
Agreed on the joint development of network virtualization for SDN and NFV fields

Portugal Telecom (Portugal)
Agreed on becoming joint demonstration partners for SDN to be applied to networks of data centers and telecom carriers

Network Functions Virtualization (NFV)
Open Networking Research Center (ONRC)
Open Networking Research Center at Stanford University
5. Conclusion
Concept of “NEC SDN Solutions”

NEC SDN Solutions are:

NEC SDN Solutions are IT and Network integrated solutions realized through NEC’s advanced technologies

Safe, Secure, High Quality and Robust,
NEC SDN Solutions simply and flexibly support customers’ needs and the creation of new business
NEC SDN Solutions

Highly Reliable Technology

IT and Network Technology

Advanced SDN Technology

NEC SDN Solutions

Safe

Secure

High Quality

Simple & Flexible

Creation of New Business

Robust

High Quality
Review: “NEC SDN Solutions”: Lineup

Established SDN solution menu based on SDN products and case studies experienced before other companies

In addition to the data center market, deploy solutions to broad applicable fields of enterprises, public agencies and telecom carriers*1

<table>
<thead>
<tr>
<th>Target Market</th>
<th>Applicable Area</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEC SDN Solutions for Enterprises</td>
<td>Network optimization</td>
<td>• Optimized connections between sites and data centers*2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• LAN optimization*2</td>
</tr>
<tr>
<td></td>
<td>Security</td>
<td>• Access authentication*2</td>
</tr>
<tr>
<td>Mobile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEC SDN Solutions for Data Centers</td>
<td>Operation/management</td>
<td>• Automated IaaS operation*2</td>
</tr>
<tr>
<td>Integration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEC SDN Solutions for Telecoms</td>
<td>Network management</td>
<td>• Data center network integration*2</td>
</tr>
<tr>
<td>Network infrastructure</td>
<td></td>
<td>• Integrated operations/management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Network function virtualization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Transport</td>
</tr>
</tbody>
</table>

*1: Sales timing and sales regions differ for each solution

*2: Start sales in Japan in October 2013, then deploy to other countries
NEC Group Vision 2017

To be a leading global company leveraging the power of innovation to realize an information society friendly to humans and the earth
CAUTIONARY STATEMENTS:
This material contains forward-looking statements pertaining to strategies, financial targets, technology, products and services, and business performance of NEC Corporation and its consolidated subsidiaries (collectively "NEC"). Written forward-looking statements may appear in other documents that NEC files with stock exchanges or regulatory authorities, such as the Director of the Kanto Finance Bureau, and in reports to shareholders and other communications. NEC is relying on certain safe-harbors for forward-looking statements in making these disclosures. Some of the forward-looking statements can be identified by the use of forward-looking words such as "believes," "expects," "may," "will," "should," "seeks," "intends," "plans," "estimates," "targets," "aims," or "anticipates," or the negative of those words, or other comparable words or phrases. You can also identify forward-looking statements by discussions of strategy, beliefs, plans, targets, or intentions. Forward-looking statements necessarily depend on currently available assumptions, data, or methods that may be incorrect or imprecise and NEC may not be able to realize the results expected by them. You should not place undue reliance on forward-looking statements, which reflect NEC’s analysis and expectations only. Forward-looking statements are not guarantees of future performance and involve inherent risks and uncertainties. A number of important factors could cause actual results to differ materially from those in the forward-looking statements. Among the factors that could cause actual results to differ materially from such statements include (i) global economic conditions and general economic conditions in NEC’s markets, (ii) fluctuating demand for, and competitive pricing pressure on, NEC’s products and services, (iii) NEC’s ability to continue to win acceptance of NEC’s products and services in highly competitive markets, (iv) NEC’s ability to expand into foreign markets, such as China, (v) regulatory change and uncertainty and potential legal liability relating to NEC’s business and operations, (vi) NEC’s ability to restructure, or otherwise adjust, its operations to reflect changing market conditions, (vii) movement of currency exchange rates, particularly the rate between the yen and the U.S. dollar, (viii) the impact of unfavorable conditions or developments, including share price declines, in the equity markets which may result in losses from devaluation of listed securities held by NEC, and (iv) impact of any regulatory action or legal proceeding against NEC. Any forward-looking statements speak only as of the date on which they are made. New risks and uncertainties come up from time to time, and it is impossible for NEC to predict these events or how they may affect NEC. NEC does not undertake any obligation to update or revise any of the forward-looking statements, whether as a result of new information, future events, or otherwise.
The management targets included in this material are not projections, and do not represent management’s current estimates of future performance. Rather, they represent targets that management will strive to achieve through the successful implementation of NEC’s business strategies.
Finally, NEC cautions you that the statements made in this material are not an offer of securities for sale. Securities may not be offered or sold in any jurisdiction in which required registration is absent or an exemption from registration under the applicable securities laws is not granted.