The Opportunity of Software Defined Networks (SDN) from Operator's Perspective

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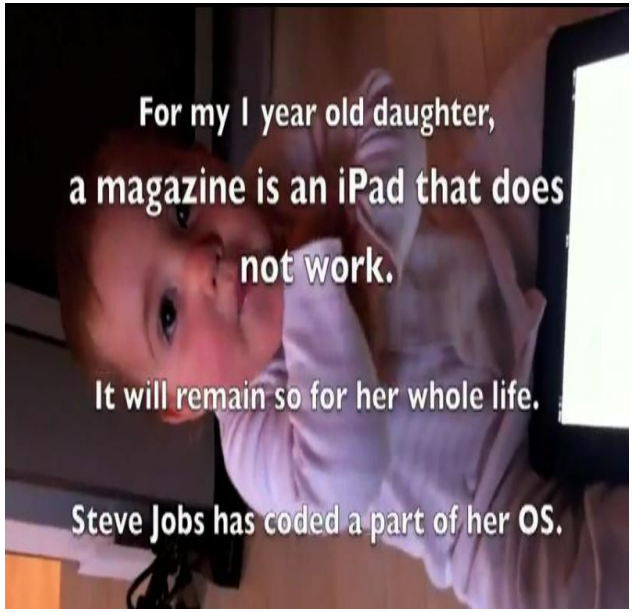
Chunghwa Telecom

09/26/2013

Outlines

- Challenge of Today's Telecom Networks
- Operator’s Expectation
- Opportunity of SDN
- SDN Activities of CHT
- Closing Remarks

Life Style with Smart Devices



Source: Good Tech, 2012

Consumer Behavior in Taiwan

Over ***95%*** of age 12-34 access online

Over ***77%*** online users visit online video

Online users take ***4hrs/day*** surfing websites

Penetration of mobile phone over ***100%***

60% visit social network through mobile phones or tablets

Smart phone penetration around ***24%***

80% Age 20-30 access online through mobile phone

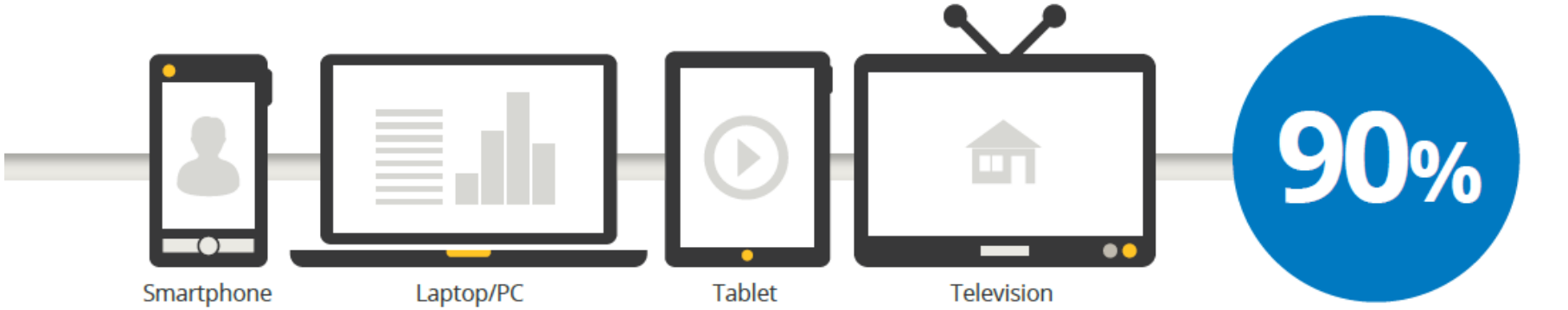
87% visit social network websites at least twice a week

Source: Dentsu Media Group Media Palette(2012); MIC(2012)

Multi-Screen Behavior

Majority of our daily media interactions are screen based

We also juggle multi-screen by using more than one device simultaneously

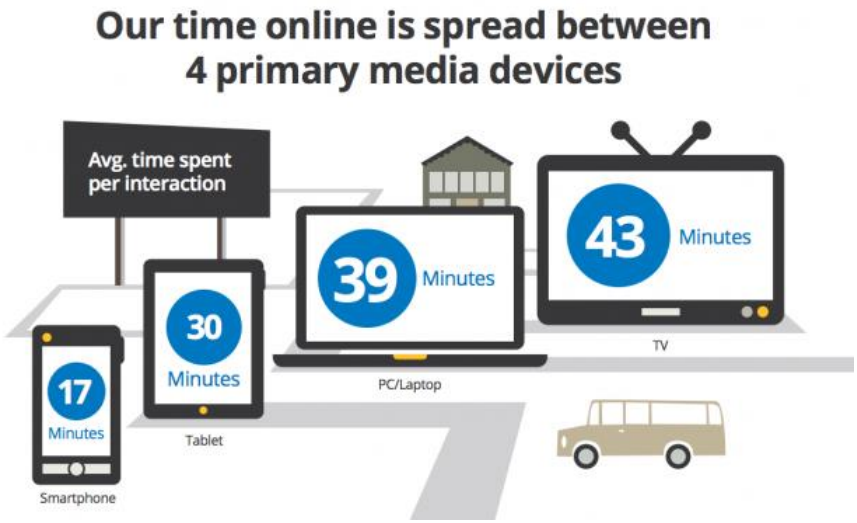


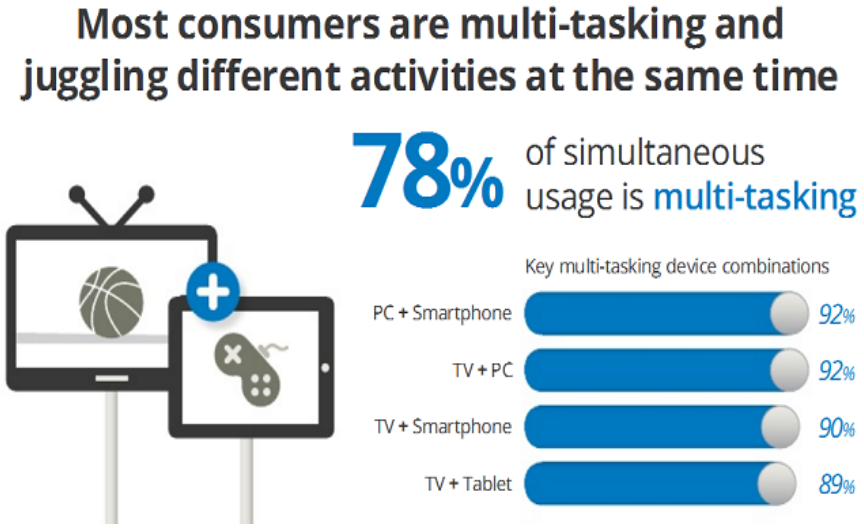
On average we spend
4.4 hours
of our leisure time in front of screens each day

*Source : Google "**The New Multi-screen World**" Aug, 2012*

中華電信 Refresh your life

Multi-Mix Media Approach



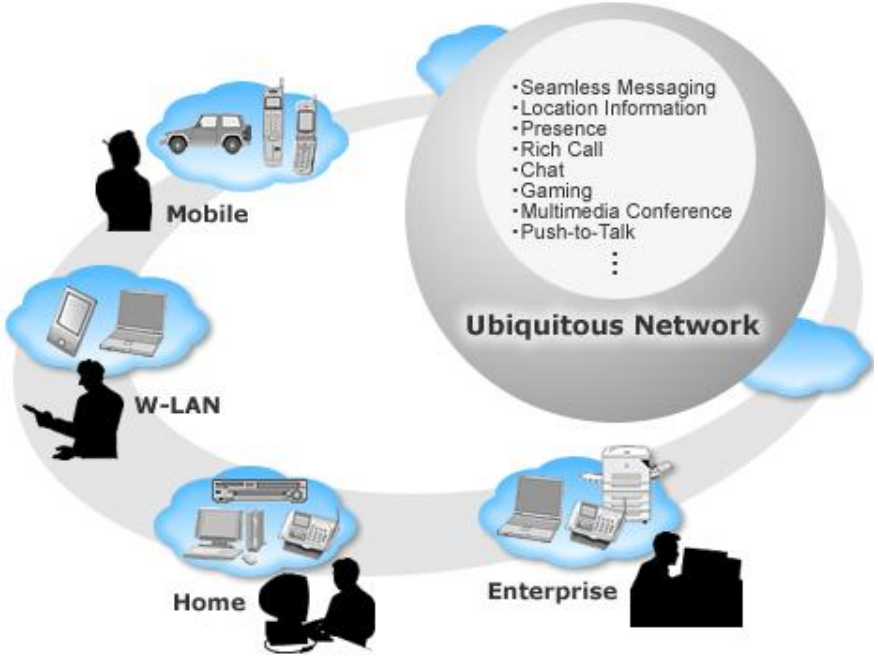


Source : Google Eyetrack 2012

*Source : Google "**The New Multi-screen World**" Aug, 2012*

Connected World, Ubiquitous Services

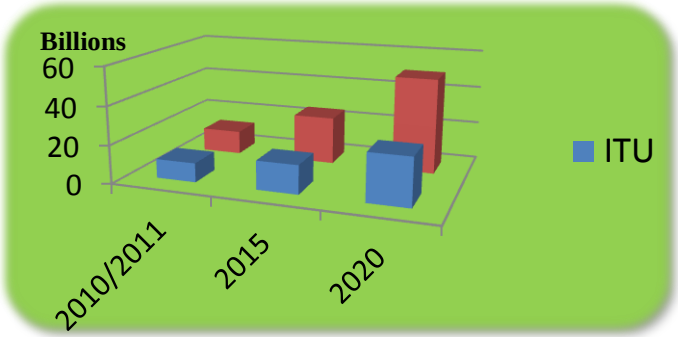
Ubiquitous services are enabled by ubiquitous network



The Connected Life

- By 2020 there will be 25B to 50B connected devices

CISCO	50B	• **6.58 devices/people** (3.47@2015, 1.84@2010)
ERICSSON	50B	• **7B phones+ 3B PCs + 3-4B electronics + others**
ITU	25B	• **6 devices/connected people**
OECD	14B in OECD	• **50 devices/household @2022** (25@2017; 10@2013)



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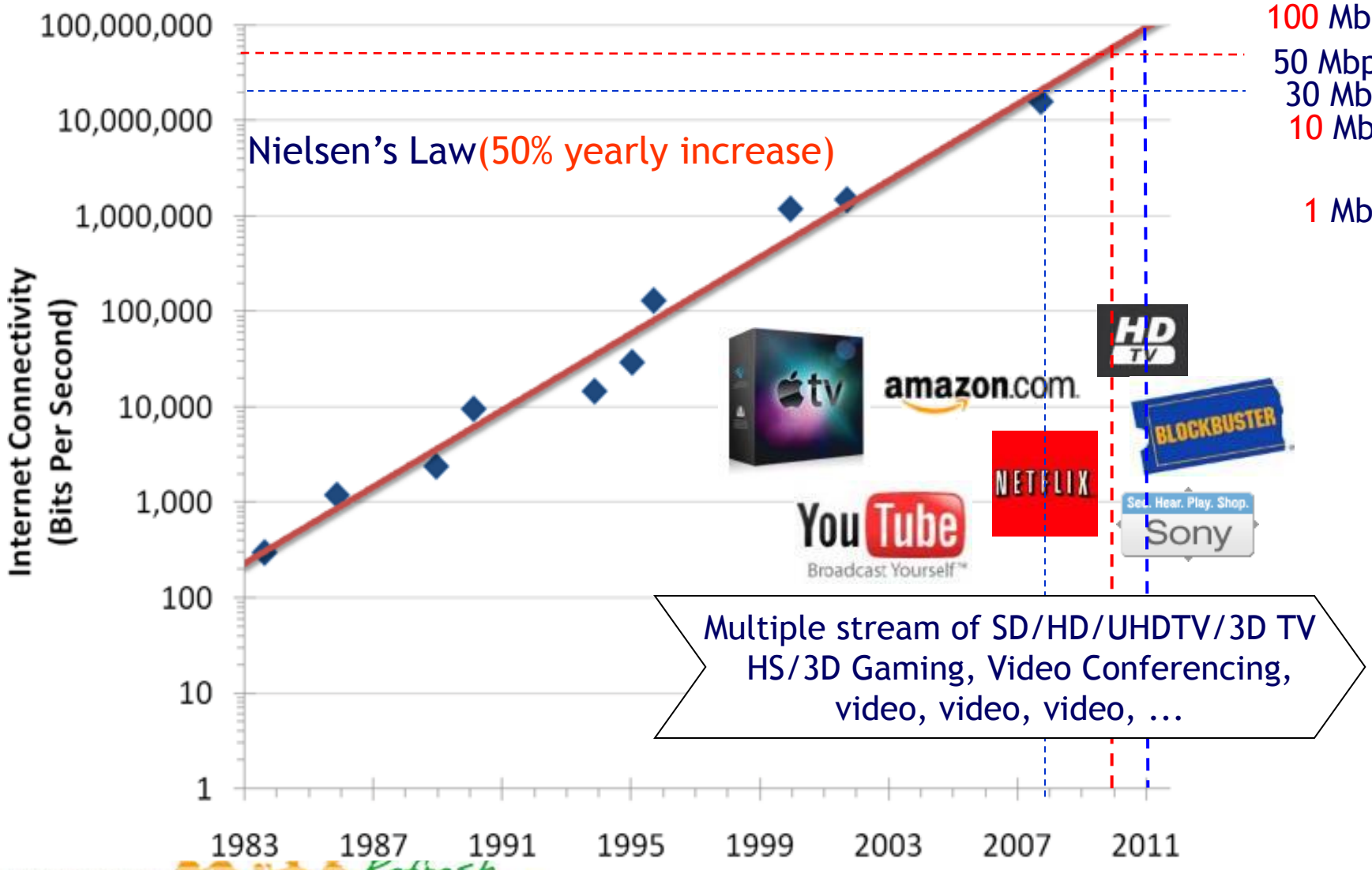
Relentless Need for Ubiquitous Bandwidth



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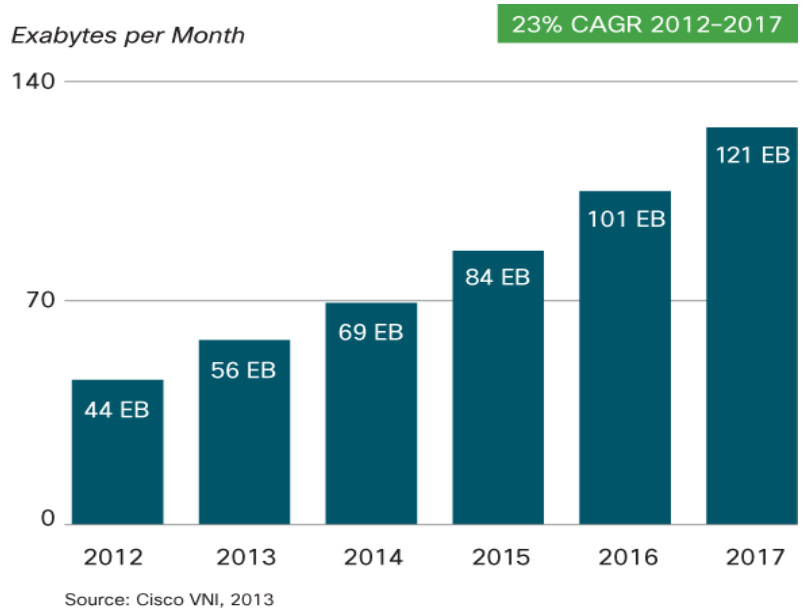
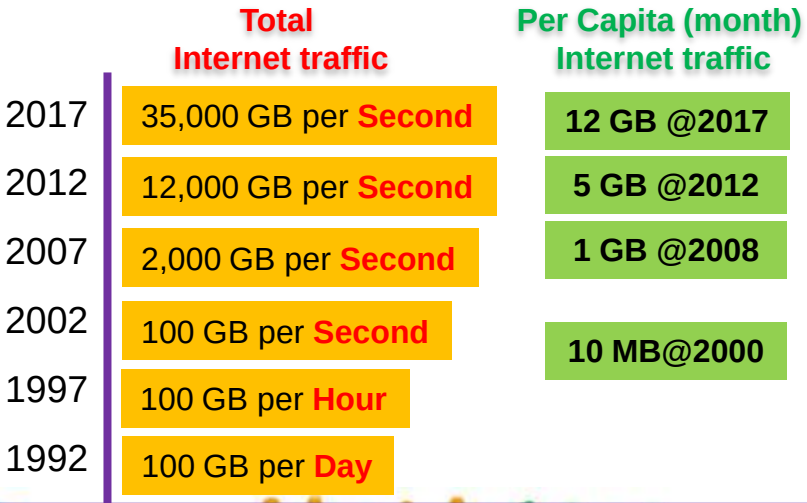
The Zettabyte Era

Source: Cisco, 2013





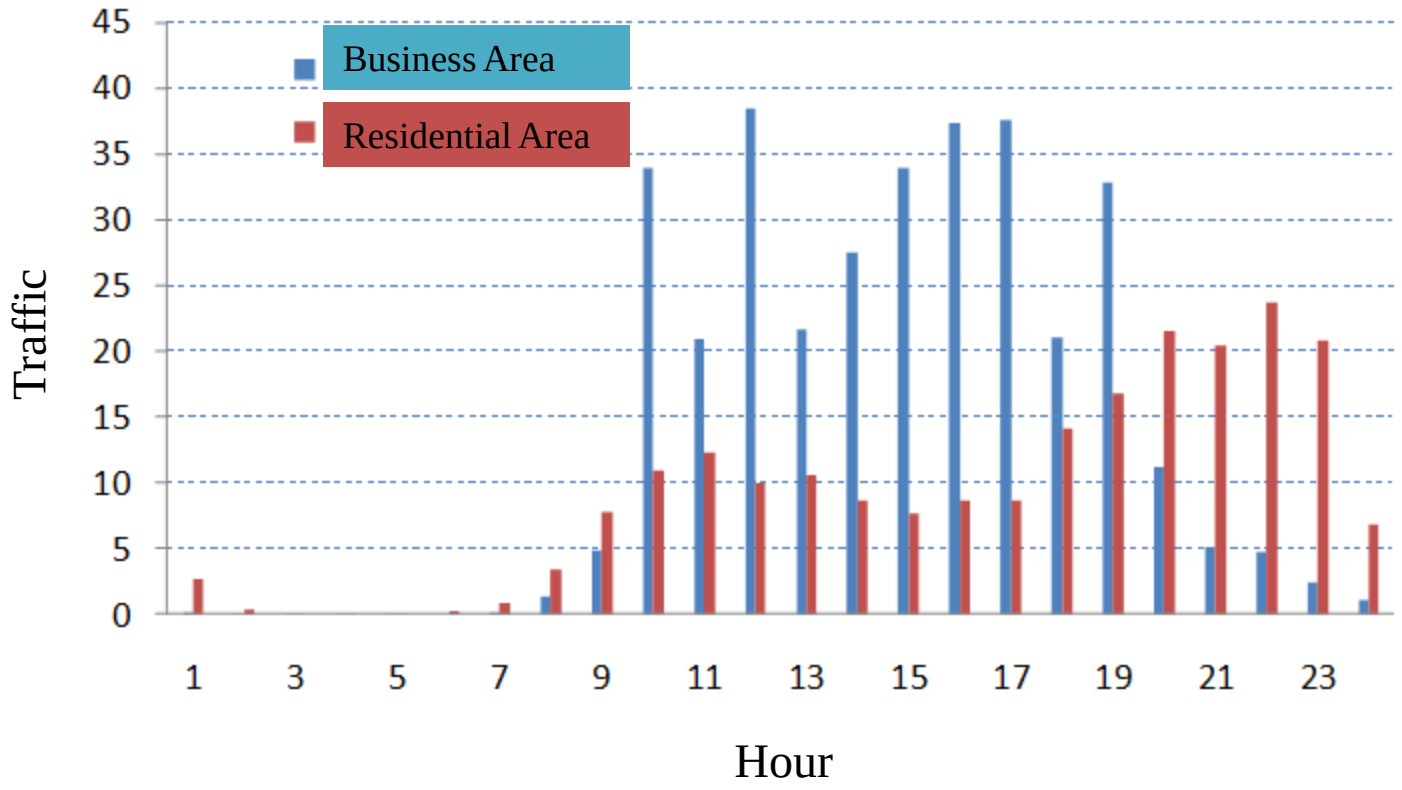
The VNI Forecast Within Historical Context

- **Growth of global IP traffic**
  - Will pass the zettabyte threshold by the end of 2015 and reach 1.4 zettabytes by 2017
  - Has increased fourfold over the past 5 years, and will increase nearly threefold over the next 5 years
  - Mobile data traffic will increase 13-fold between 2012 and 2017
- **By the end of 2017**
  - Traffic originating with non-PC devices ~1/2
  - Traffic from wireless and mobile devices will exceed traffic from wired devices
  - 42 percent of fixed and mobile devices and connections (8 billion) will be IPv6-capable
- **Other Trends**
  - Busy-hour traffic will grow faster than Average traffic
  - Metro traffic will grow faster than Long-Haul traffic

(Zetta=10^{21}, Exa=10^{18}, Peta=10^{15}, Tera=10^{12}, Giga=10^{9})

Tidal Effect of Mobile Traffic

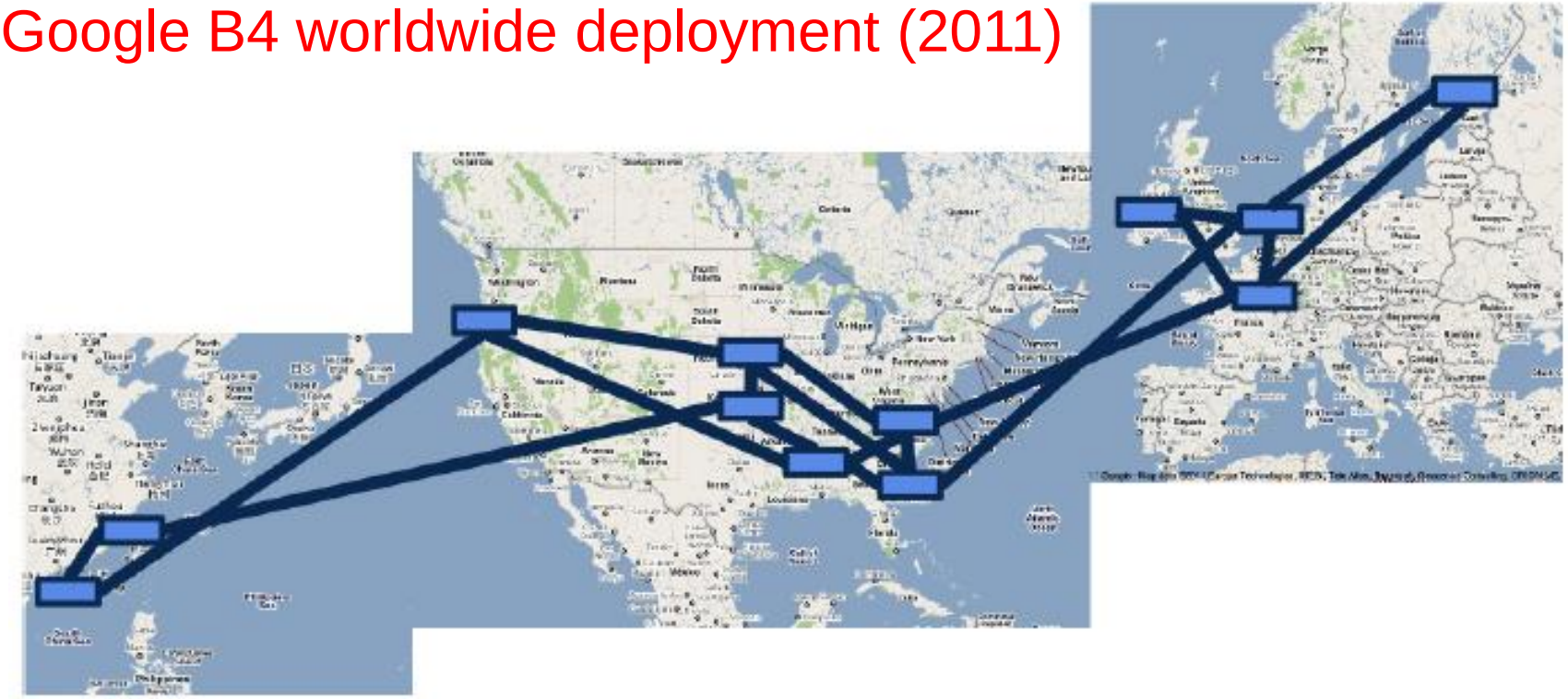
❖ Mobile network loading



Ref: China Mobile Research Institute © 2010

Emerging Cloud Data Center

Google B4 worldwide deployment (2011)

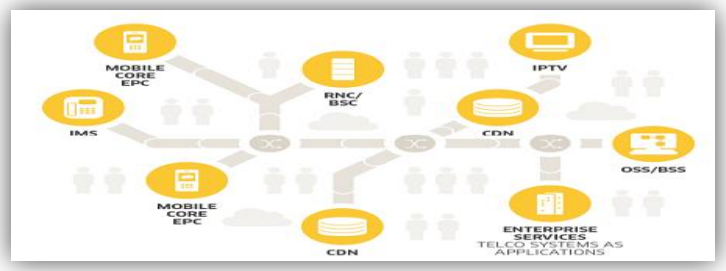


Ref: B4: Experience with a Globally-Deployed Software Defined WAN, Proceedings of the ACM SIGCOMM 2013 conference on SIGCOMM

Challenge of Today's Telecom Network

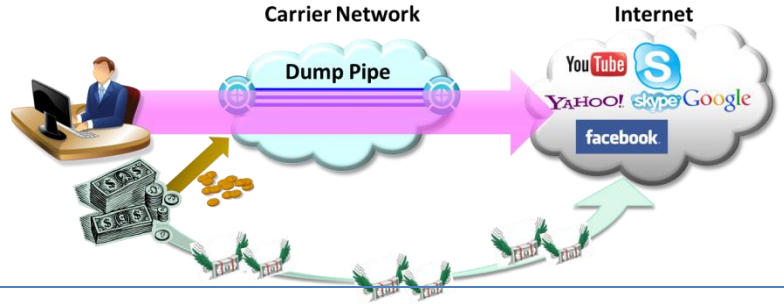
High CAPEX, OPEX

- High CAPEX: Costs for delivering increasingly more complex services
- High OPEX: Multiple management systems for different services
- Slow time to market



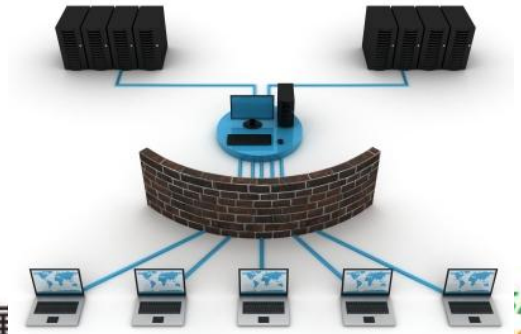
Dump Pipe

- Static provisioning, hard to scale out
- Non-real time traffic monitoring and management
- Hard to automatically troubleshooting
- Lack of context-aware capability
- Limited multipath routing capability



Lack of Security

- Current network is transparent, plug-and-play
- Easy to spoof and attack



Green Concern

- Variable services and efficiency concerns introduce increasing power consumption

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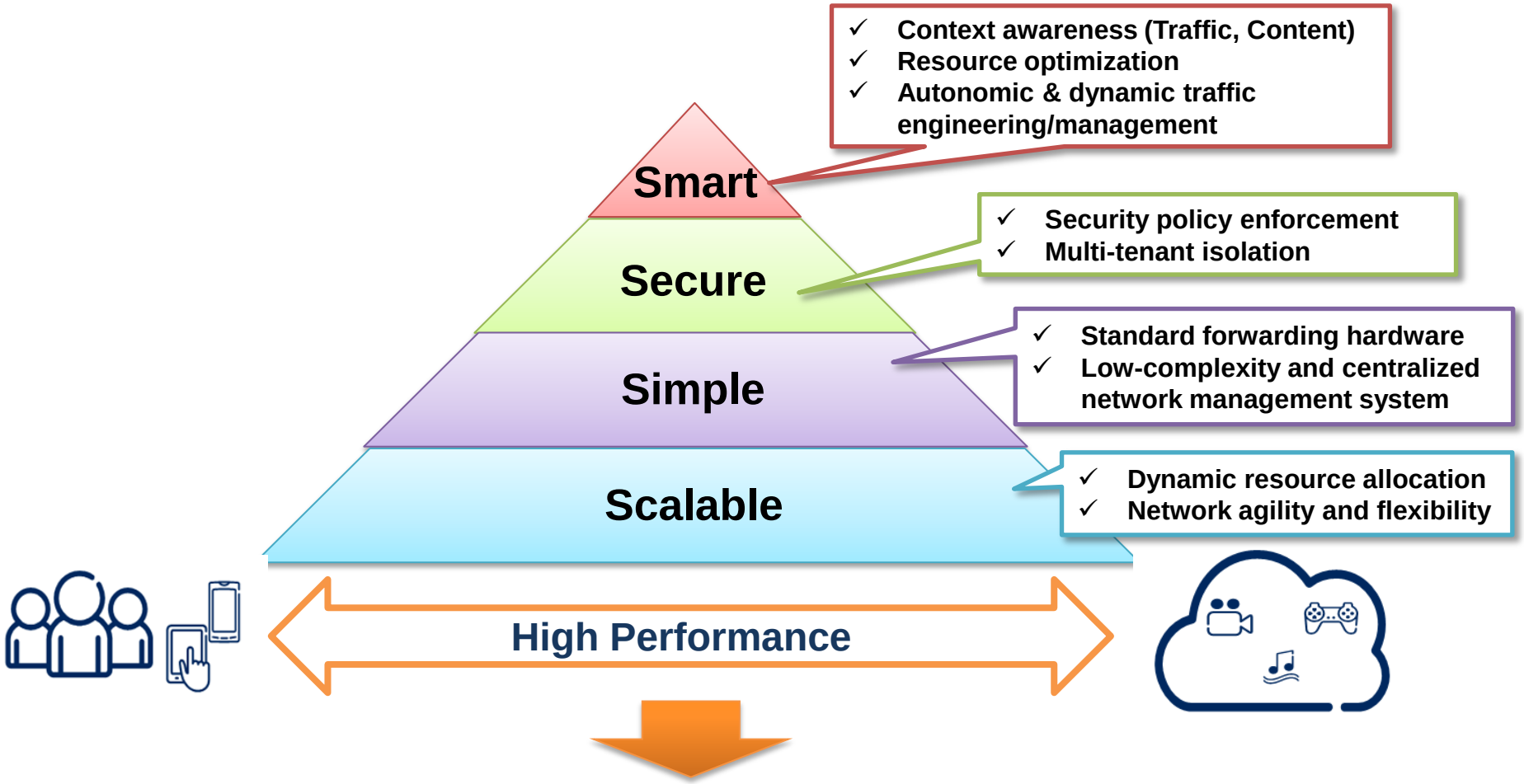
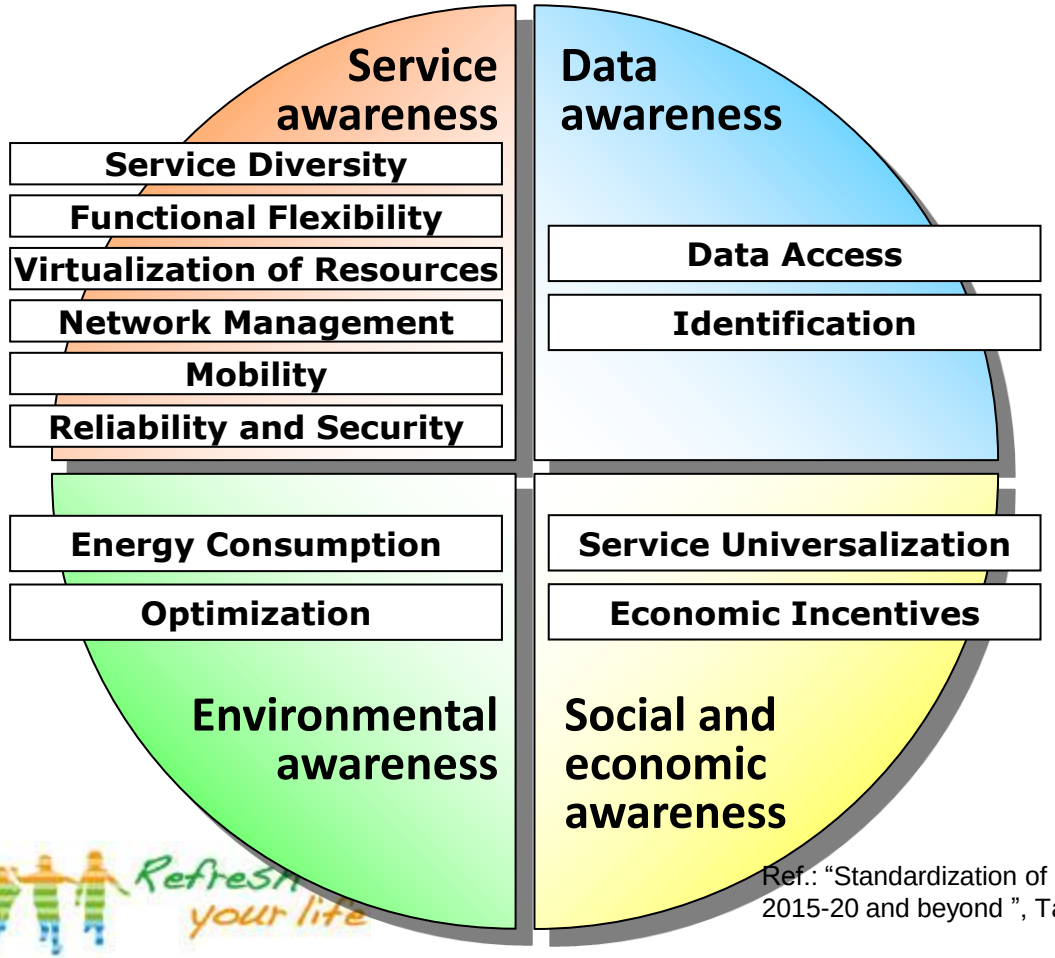
Operator's Expectation for Carrier Network



Vision of Future Networks (ITU-T Y.3001)

- **Future Networks**
  - A network able to provide services, capabilities, and facilities difficult to provide using existing network technologies.
- **Target Date: roughly 2015-2020**

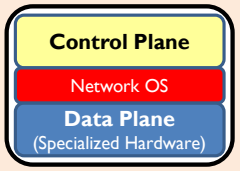


Ref.: "Standardization of Future Networks-- networks of 2015-20 and beyond ", Takashi Egawa, NEC

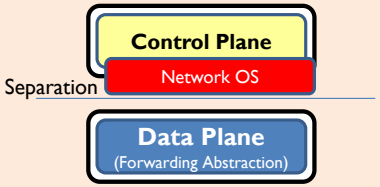
Software Defined Networks (SDN)

- **A new technology to networking which allows centralized, programmable control planes so that network operators can control and manage directly their own virtualized networks**

Separation of control from forwarding plane

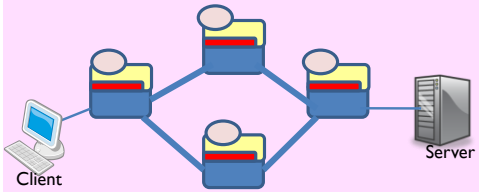


a.1 control and data planes tightly-coupled

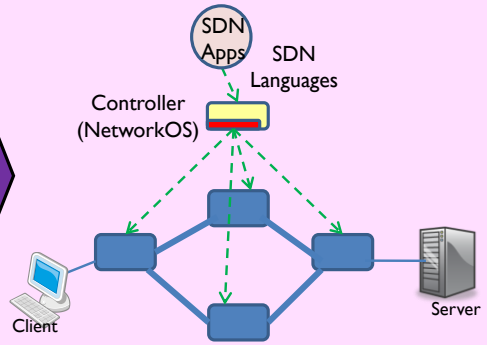


b.1 control and data planes separated

Centralized, programmable control planes

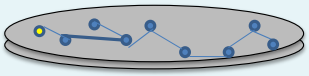


a.2 distributed control of network equipments

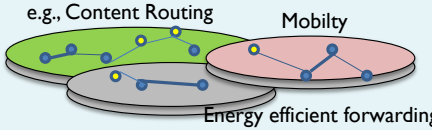


b.2 centralized, programmable control of network equipments

Network virtualization



a.3 single physical network



b.3 Multiple, isolated, virtual networks

a. Current networking technology

b. SDN networking technology

Ref.: "Network Virtualization and Service Awareness Properties of FNs in ITU-T Q.21/SG13", Myung-Ki Shin, ETRI, June 2012

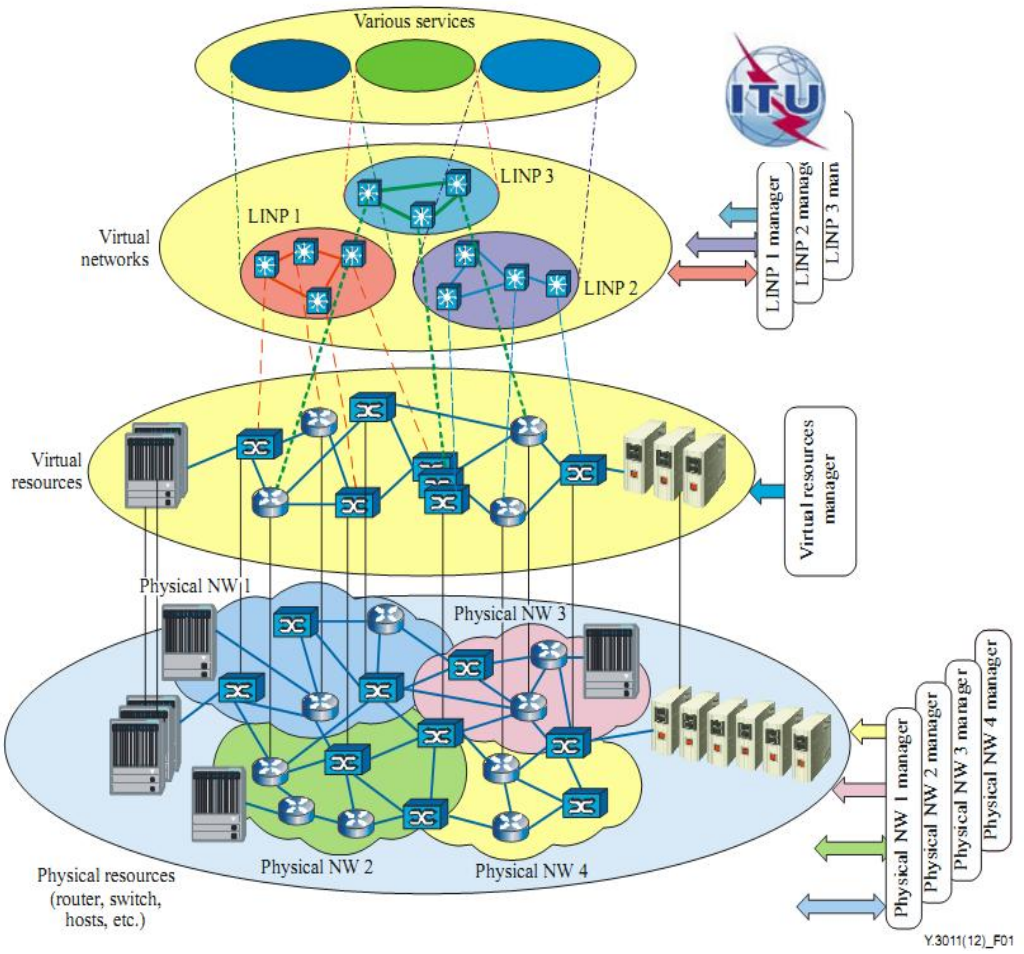
Network Virtualization
(LINP: Logically Isolated Network Partition)

- **Creation of logically isolated network partitions (LINP) over shared physical networks so that heterogeneous collection of multiple virtual networks can simultaneously coexist over the shared networks.**

- **Concepts**

  Providing multiple virtual infrastructures those are isolated each other

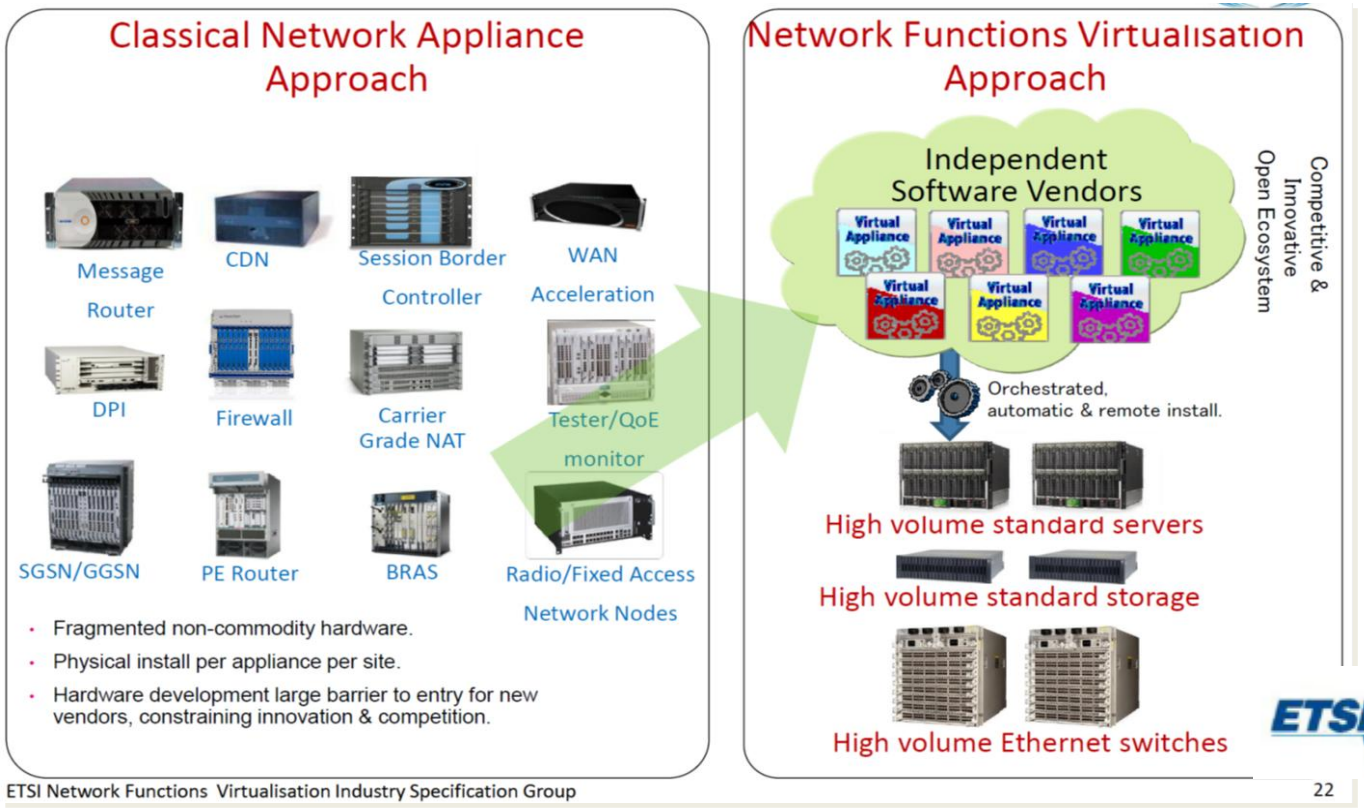
  - **Single physical infrastructure**
  - **Each virtual network is isolated each other**
  - **Programmable to satisfy the user's demand by individual manager**



Ref.: "Network Virtualization and Service Awareness Properties of FNs in ITU-T Q.21/SG13", Myung-Ki Shin, ETRI, June 2012

Network Function Virtualization (NFV)

- Transform the way that network operators architect networks
- Evolve standard IT virtualisation technology
- Consolidate many network equipment types onto industry standard high volume servers



Ref.: "Network Functions Virtualisation— Introductory White Paper". ETSI. 22 October 2012

SDN & NFV may meet Operator's Expectations

SDN&NFV Features	Operator's expectation
• Standard network devices among users and services	**Lower CAPEX**
• Centralized management • Programmability on network and operation • Efficient and automatic network management and provisioning.	**Lower OPEX**
• Network virtualization (Network as a Service) • Modular applications of different network functionality can be added and developed	**Innovative Services**

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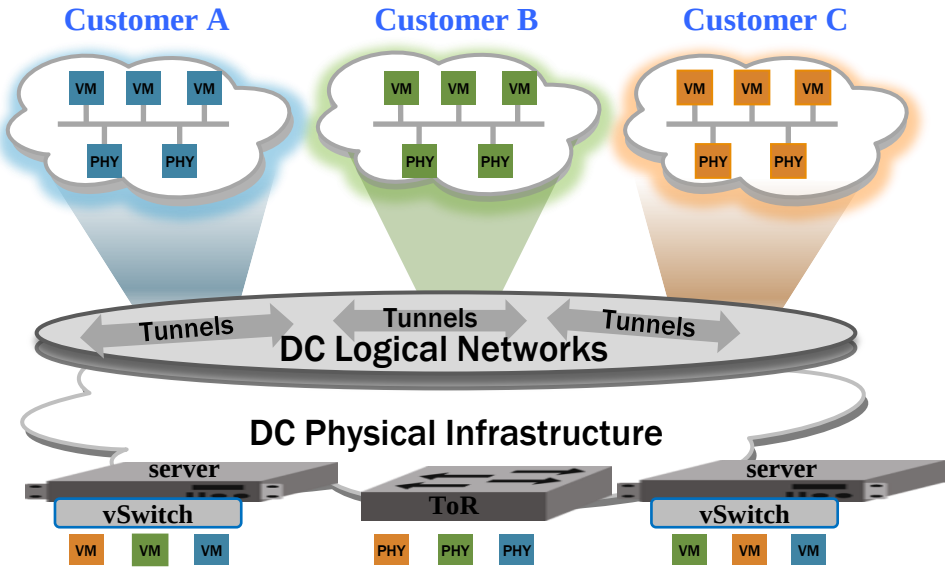
How Operators Apply SDN & NFV to Telecom Networks

- **Cloud Computing Network**
  - Data Center Network
  - WAN of Data Centers
- **Broadband Network/ Virtual Private Network (VPN)**
  - Service Aware Switching
  - Automatic threat detection & recovery
  - On-demand security services
  - Automatic network service provision
  - Automatic trouble shooting
  - Virtualized Network Device
  - Network Virtualization Architecture

Cloud Computing Network

❖ Data Center Network

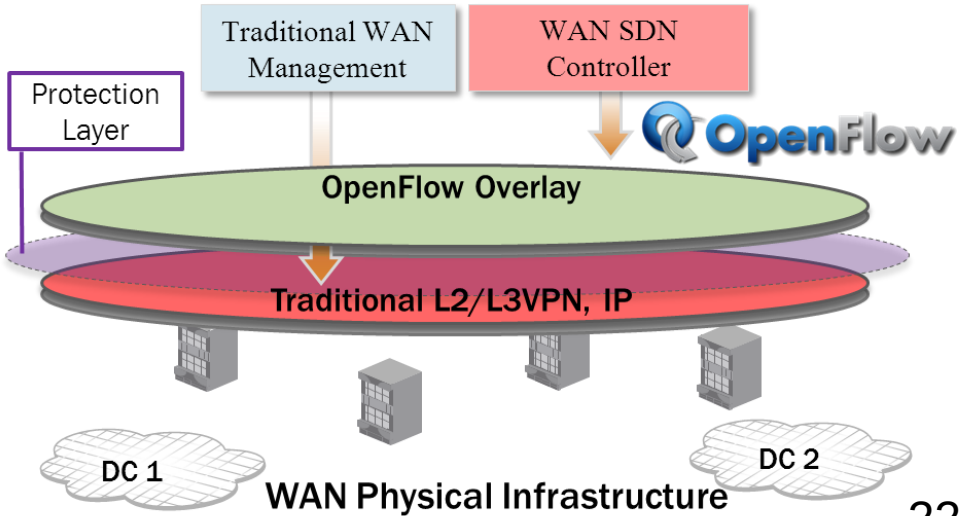
- Tunnel-based L2 network
- Multi-tenants traffic isolation
- VM live migration



❖ WAN of Data Centers

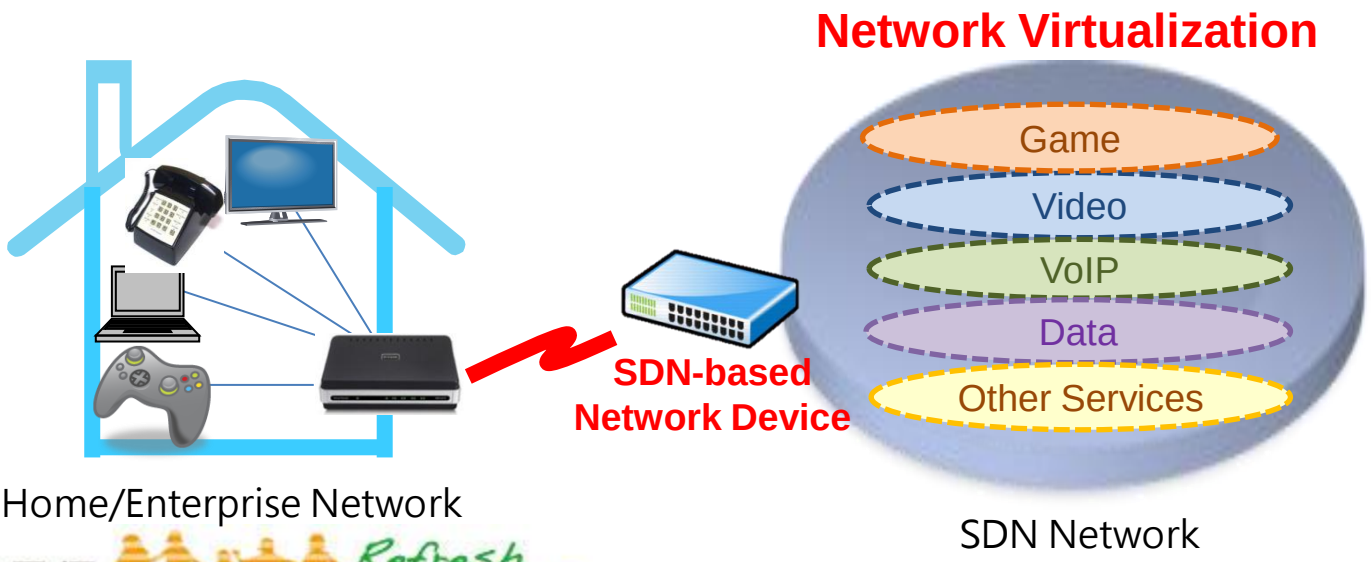
- OpenFlow as an overlay to existing network
- WAN optimization
- Centralized traffic engineering

Ex. Google's B4



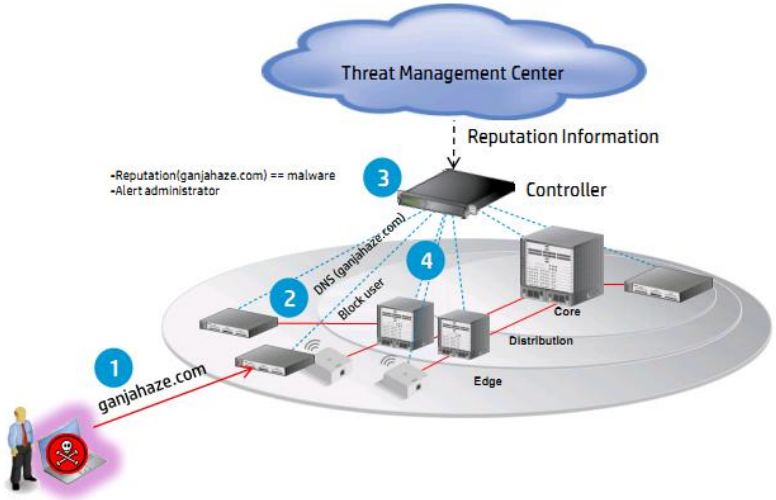
Broadband Network/ VPN (1/4)

- **Service Aware Switching**
  - **Moving customer network devices' functionality into an embedded middle box**
  - **Enabling intelligence functions on service edge device (Ex. Context-awareness to service types, Dynamic traffic management…)**
- **Benefits**
  - **Reducing the complexity of customer network devices (Ex. Home Gateway)**
  - **Providing operators with greater granularity in remote - control management**

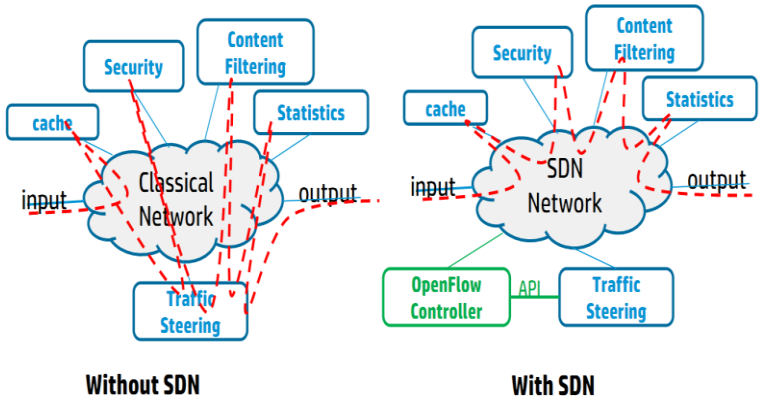


Broadband Network/ VPN (2/4)

- **Automatic threat detection & recovery**
  - ✓ **A simplified security infrastructure that enables enterprises monitor, manage, and control network traffics, also increases network visibility**



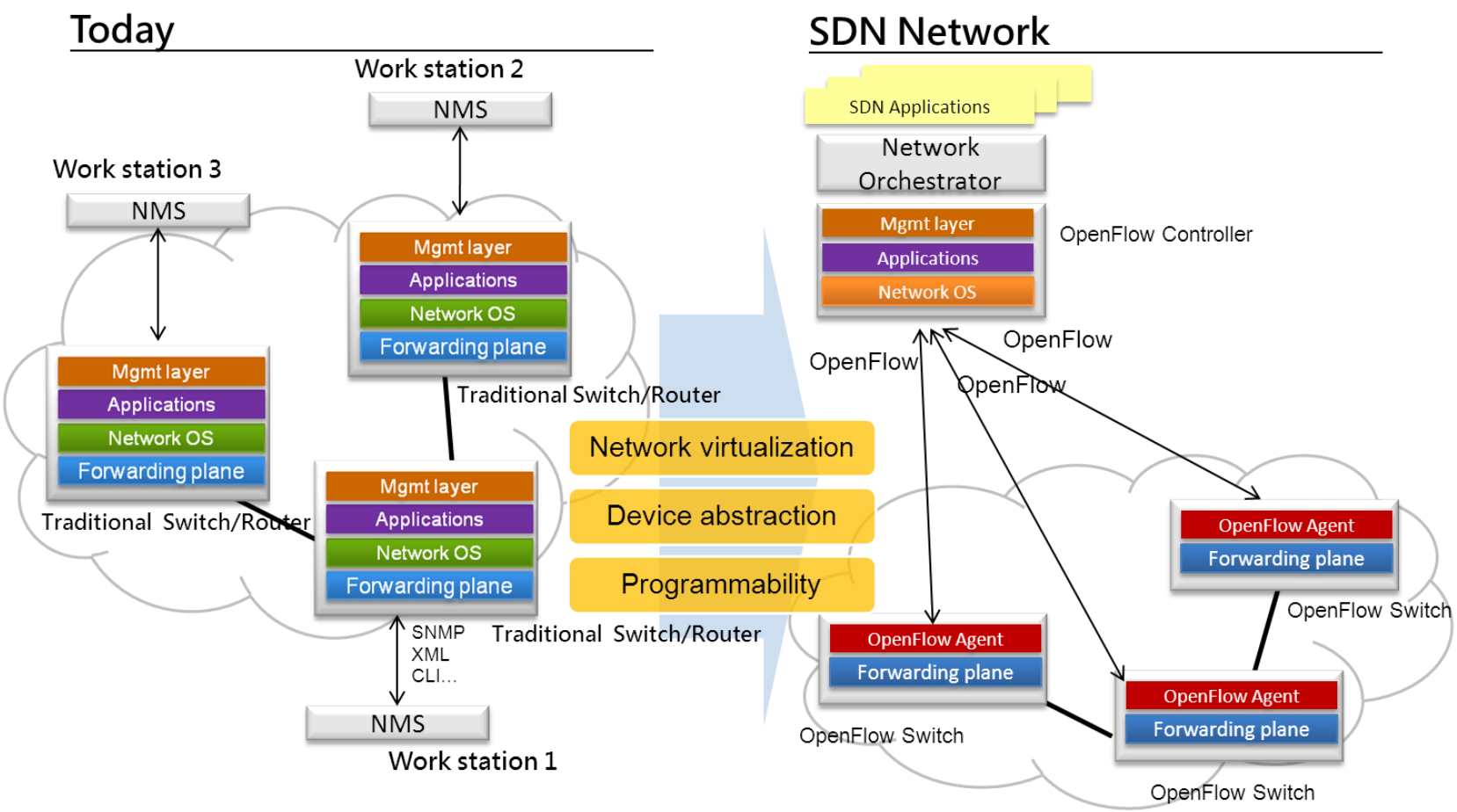
- **On-demand security services**
  - ✓ **Dynamic service chain with traffic steering**
  - ✓ **Variable services creation and insertion**
    - Security service (ex. Firewall, DDoS defender, IDS, content filter, DPI…)
    - Statistical report
    - Real-time monitoring



Ref.:"ETSI FUTURE Network: SDN and NFV for Carriers", HP Office, April 2013

Broadband Network/ VPN (3/4)

- Automatic network service provision
- Automatic trouble shooting

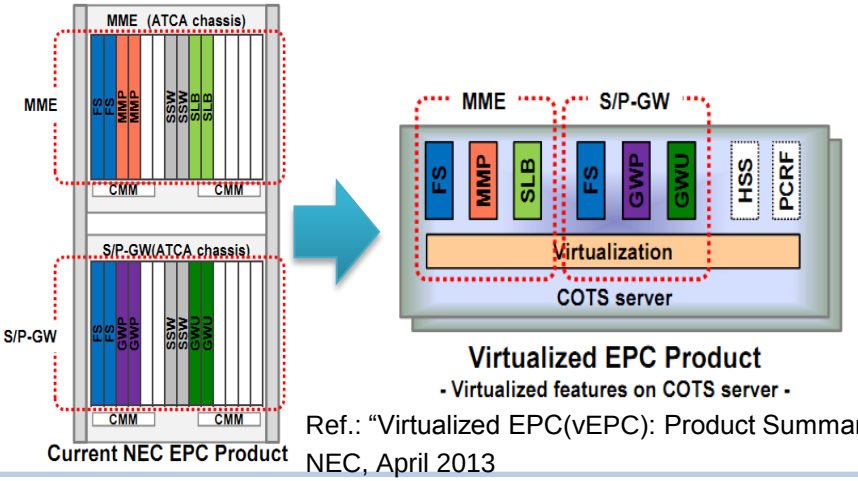


Broadband Network/ VPN (4/4)

❖ Virtualized Network Device

vEPC

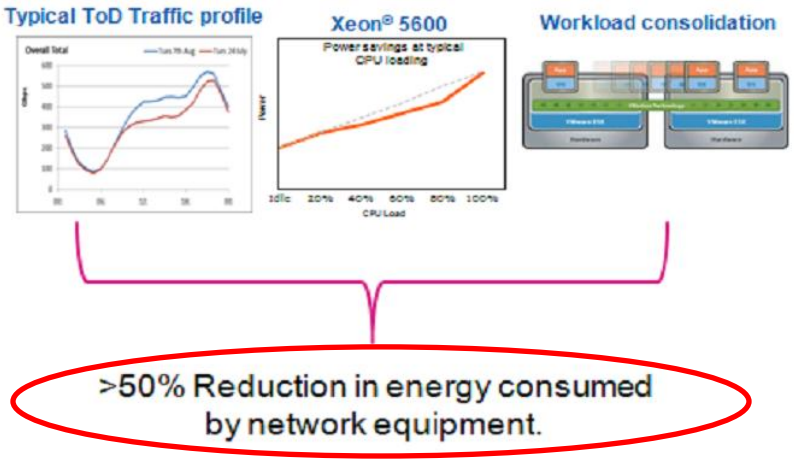
- ❖ NEC vEPC carrier-grade qualities on virtualization platform
- ❖ Cost reduction in core network



Ref.: "Virtualized EPC(vEPC): Product Summary," NEC, April 2013

vBRAS

- ❖ BT's activity shows PoC performance of vBRAS has the potential to match the performance of existing BRAS equipment
- ❖ Significant reduction in energy consumption



Ref.: "ETSI NFV ISG," Andy Reid, BT

SDN Applications & Benefits

A research by Strategy Analytics finds SDN

- Can Close Almost Half of the Forecast 'Backhaul Gap'
- Can Save Mobile Operators more than $4 Billion in Capital Expense by 2017

Five Network Applications of SDN

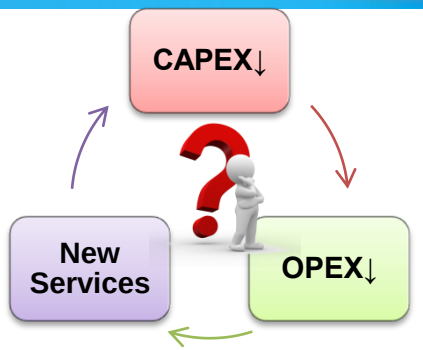
Network Elements	SDN Backhaul Optimization Application
Cloud-RAN (C-RAN) 'Fronthaul'	Remote Radio Heads(RRH) & Antennas Remotely linked to Base Station ove Fiber (w. CPRI) or Gbps microwave ('Fronthaul') can burst traffic at higher or lower speeds dynamically across Cloud RAN bandwidth
Small Cells	Small Cells managed as one or more Logical Clusters Dynamically powered up and down and Backhauled over choice of access paths to meet varying capacity demands e.g. by time of day
Metro Aggregation/ Load Redistribution	Metro- Area Network - with Partial Mesh/Ring Connectivity – improves Performance and Utilization with Congestion Control in the Aggregation network and Redirection of Traffic based on End-to-End Delivery Criteria
Local Breakout/Internet IXP	'Local breakout' of mobile broadband traffic controlled by GGSN/S-GW/P-GW allows offload of traffic directly to the Internet at the 'wireless edge' reducing backhaul overload and cost between the edge and the core e.g. for traffic not adding a significant revenue contribution like some kinds of Video. Routing/Traffic Steering both at the edge and across Internet Exchange Points (IXPs) enhances Session Management and Optimized Delivery
Wi-Fi Offload/ Video Redirect	Dynamic Offload from Mobile Broadband to Fixed Wi-Fi and Associated Backhaul Capacity based on User or Application specific Options e.g. Content Aware Streaming Video Redirection

Source: Strategy Analytics Wireless Networks and Platforms Service

Ref: http://www.tellabs.com/news/2013/index.cfm/nr/232.cfm

Challenges in SDN

- Although SDN applications already emerged in cloud computing, security domains, and in variable fields, the evolutionary path of SDN remains uncertain.
- Several issues especially about service assurance have to be resolved for telecom operators before replacing existing IP network with SDN solutions.



Benefits	Issues	Impact
OPEX↓	• The northbound and southbound APIs of SDN still need a lot of work. • Migration from existing IP networks to SDN would be a big challenge.	• Uncertainties in APIs bring higher risk, complexity, and cost in bridging SDN and existing network management systems. • After adoption of SDN, both new and old networks would co-exist for a while, resulting in limited reduction of OPEX.
CAPEX↓	• Many deployed network equipment do not support SDN.	• In the near future, CAPEX saving would be insignificant.
New Services	• There are alternative solutions for SDN applications that have already emerged.	• Traditional OSS/BSS could achieve almost the same benefits that SDN promises with few modification. The potential benefits require further validation.

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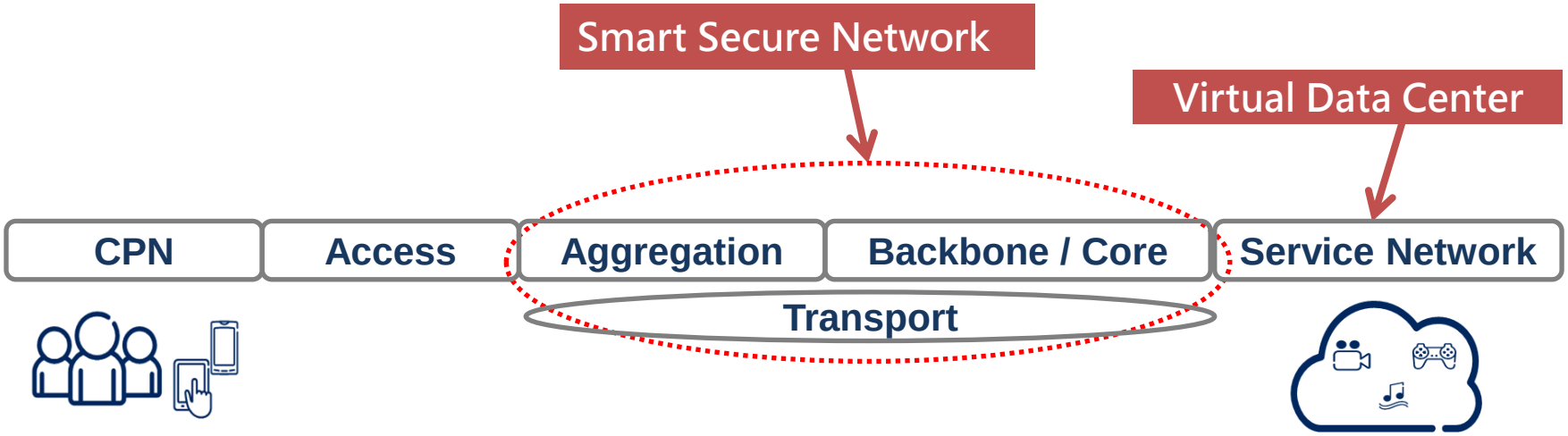
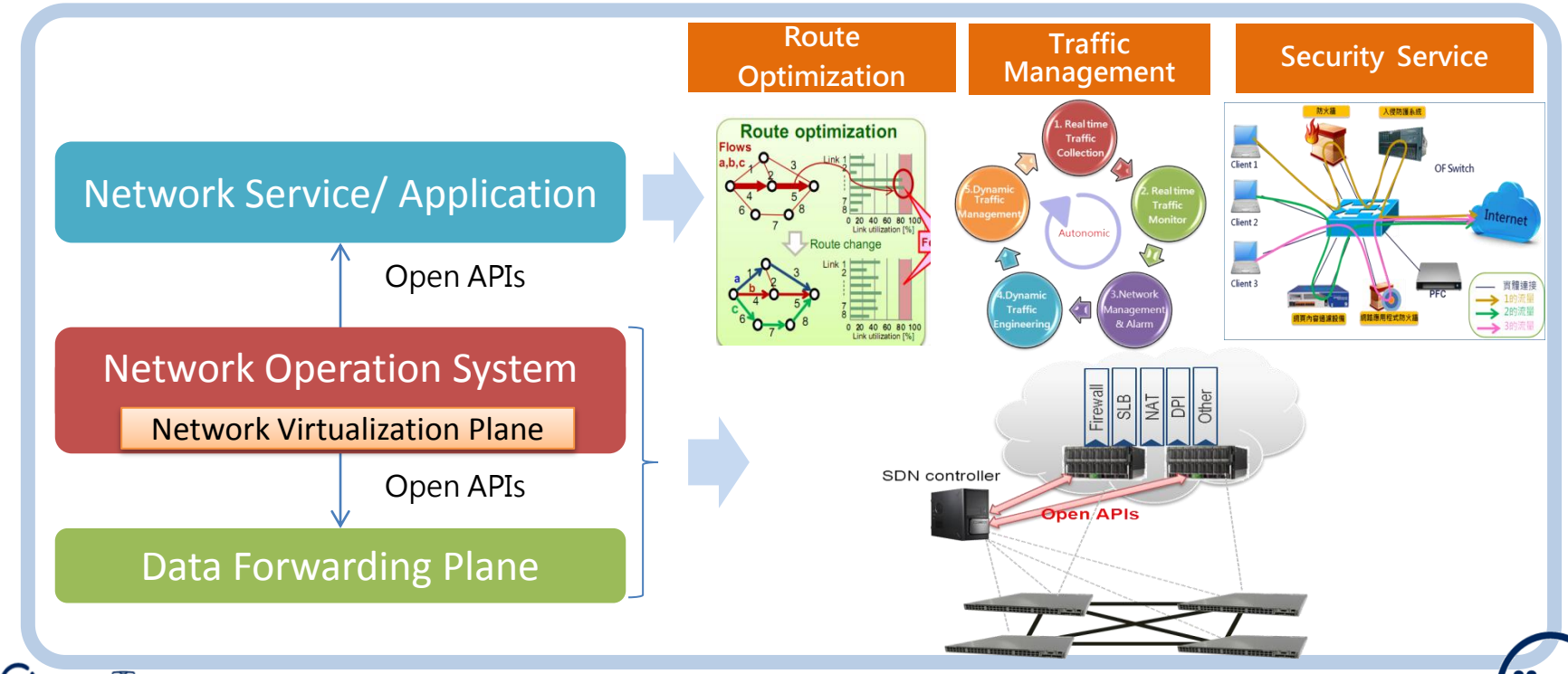
Current SDN Activities in CHT

- **Smart Secure Network**
  - Traffic Monitoring
  - Traffic Engineering
  - IP routing on SDN/OpenFlow
  - Internet Security Service
- **Virtual Data Center**



Smart Secure Network

- **Device:** Virtualization of network components
- **Architecture:** Separation of the control and data plane
- **Function:** Network intelligence + Network security

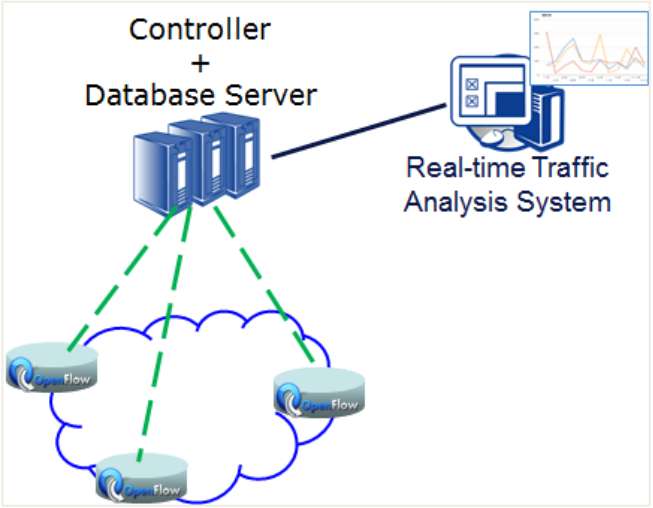


End-to-End Network

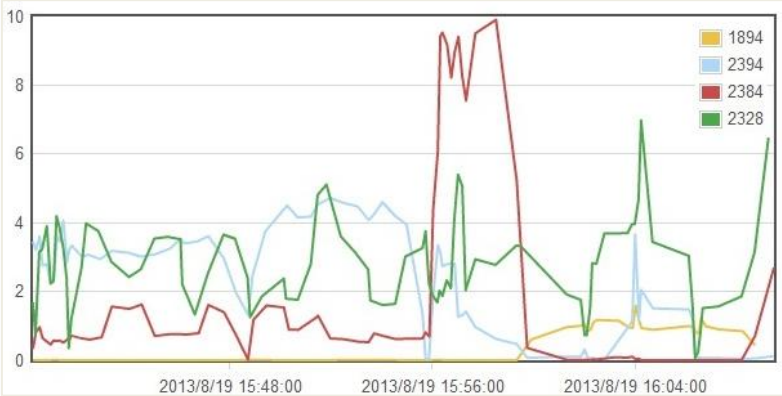
Real-time Traffic Analysis System

❖ The functions of Real-time Traffic Analysis System

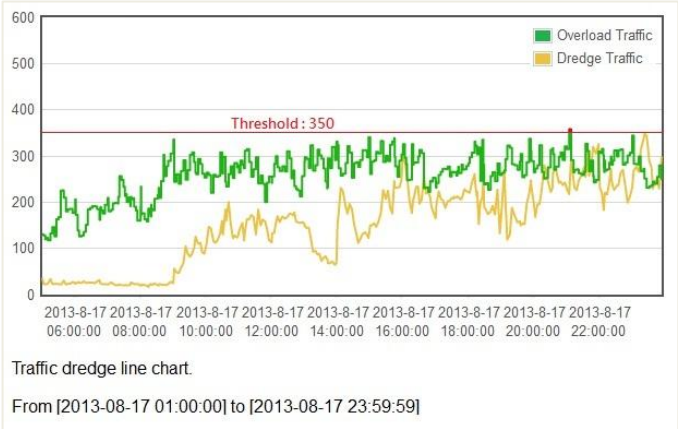
- **Monitor multiple users in the same Line Chart**
- **Monitor overloading traffic and Traffic Engineering**



Architecture



Real-time
Multi-User Traffic

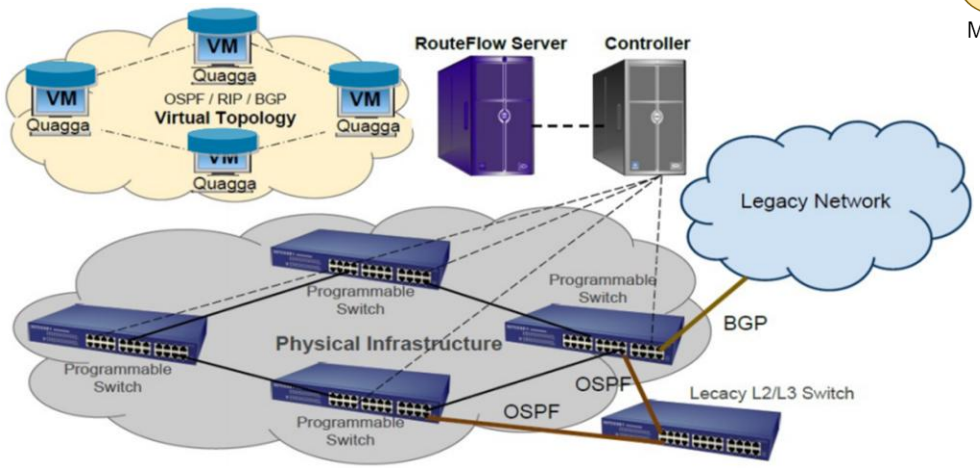


Monitoring &
Traffic Engineering

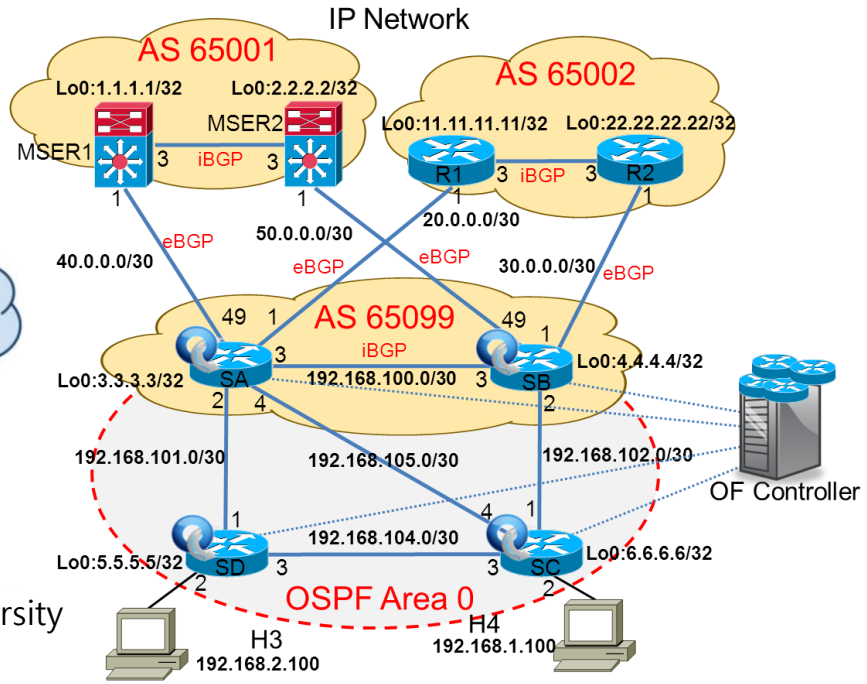
IP routing on SDN/OpenFlow

- **Apply RouteFlow (w/ Quagga) to enable SDN network to run L3 IP routing interact with existing IP network**

- **Basic IP Connection**
  - Between OpenFlow switches
  - OpenFlow switch to IP network switch/router
- **IP Routing**
  - Static routing
  - Dynamic routing (OSPF/BGP)
  - Routing convergence



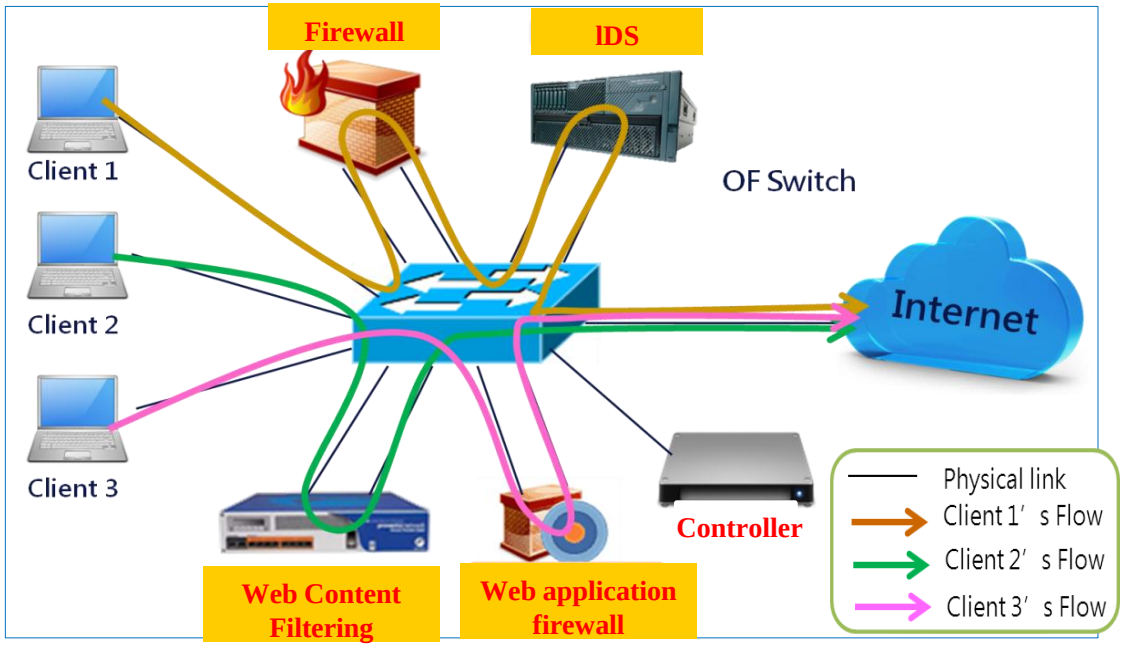
*RouteFlow is Open source project developed by Stanford University
*Ref.: https://sites.google.com/site/routeflow/



CHT Testbed

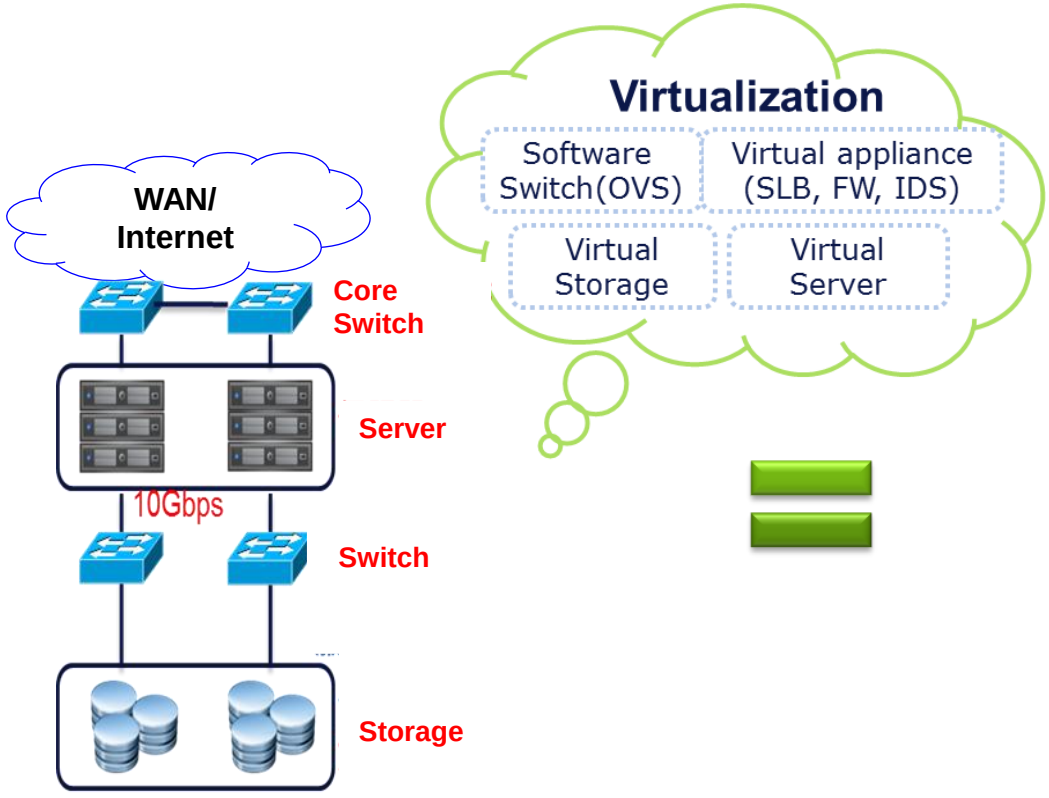
Internet Security Service

- Service Chaining: On-demand security services
- Dynamic provision and modification
- Compared to current architecture, SDN/OpenFlow architecture can **reduce 70%** cost of network devices

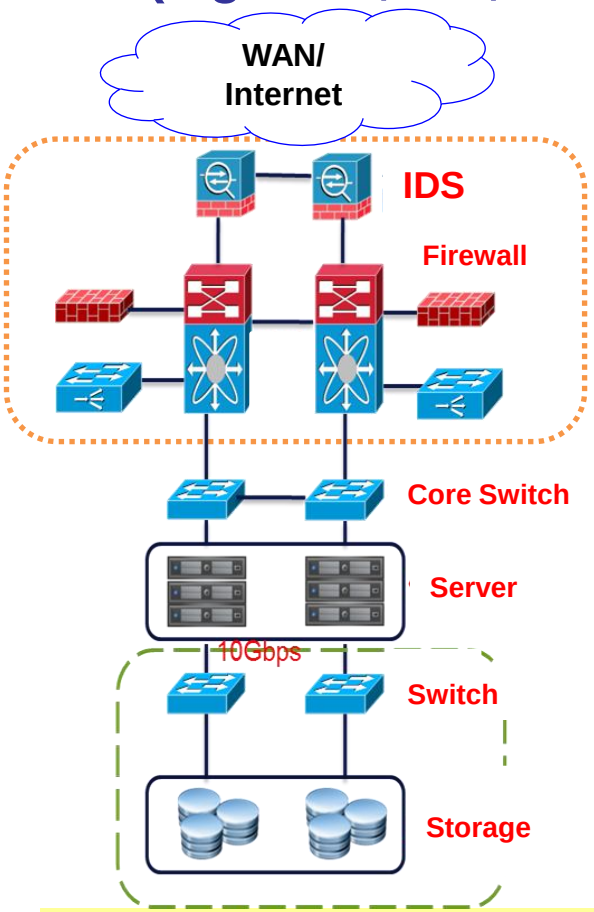


Virtual Data Center (VDC)

- SDN/OpenFlow-enabled Network
- Provide virtualized network appliance service (e.g. SLB, FW, IDS)
- Start-up costs reduction about $670,000



SDN/OpenFlow-enabled network



Traditional data center network

Closing Remarks

- Telecom operators need a dynamic and programmable approach to effectively and efficiently manage their networks to fulfill customers' requirements, and assure the end-to-end service qualities

- SDN and NFV may fulfill the dynamic service requirements and balance network resilience, QoS & QoE vs. OPEX & CAPEX

- Yet, several issues especially about Service Assurance have to be resolved for telecom operators before replacing existing IP network with SDN solutions.


CHT - Value Creator for
Investors, Customers, Employees, and Society
Thank You
for
Your Attention!