Agenda

- SDN & NFV projections
- Terminology and protocols
- Overview of SDN, NFV and NV
- CPE Evolution
- Challenges
- Summary
SDN & NFV Projections
Disruptive Innovation

Source: The Innovator’s Solution, Clayton Christensen
Disruptive Innovation - NFV

Moore’s Law:
Processor performance increases by 66% per year

Nielsen’s Law:
Bandwidth grows by 50% per year

When software only solutions running on private or public cloud infrastructure can meet the requirements of customers, the purpose-built device market disappears.
Infonetics Survey Respondents

Service Provider Type

- Incumbent: 52%
- Competitive: 26%
- Independent Wireless: 16%
- Cable operator: 6%

Geographic Distribution

- EMEA: 39%
- North America: 29%
- Asia Pacific: 32%

Source: Infonetics SDN and NFV SP Survey, March 2014
Service Providers Status with SDN/NFV

Source: Infonetics SDN and NFV SP Survey, March 2014
Excerpt 1: When Will SDN Be Widely Adopted to the Point That It Significantly Impacts the Competitive Landscape for Services?

- 2013: 2%
- 2014: 11%
- 2015: 32%
- 2016 or Later: 36%
- Not Sure: 18%
- Never: 2%

Source: Heavy Reading
Investment, Acquisition and Spin-in/Spin-out Activity

- Venture Capital money continues to flow into the industry
  - “From Q3’12 through Q2’13, SDN related startups raised nearly $416M across 35 deals” – source: CB Insights, Industry Analytics, July 2013

- July 2012 - VMware acquires Nicira for $1.05B in cash and $210M of assumed unvested equity awards.
- October 2012 – Cisco acquires vCider, maker of network overlay technology
- November 2012 - Brocade buys Vyatta, maker of networking software
- December 2012 - Juniper buys Contrail for $176M, maker of an SDN controller
- April 2013 - Alcatel-Lucent spins out fully funded Nuage Networks to build SDN/NFV solutions
- November 2013 – Cisco acquires/spins-in Insieme Networks to complete with VMware NSX (i.e. Nicira) offering
- January 2014 - Oracle buys Corente for an undisclosed amount. Corente has technology for SDN WANs
Market Projections

- **$15.6B by 2018** – Source ACG Research, January 2014
  - More than 50% of the market for SP SDN will be in Cloud Data Centers until 2016. It won't really take off outside the data center until after 2016.
  - The market for products where ADTRAN traditionally competes would be $4.2B
    - Of that, $2.94B would be revenue from software and $1.26B from hardware
    - Of the software, $1.76B would be revenue from applications and $1.18B from SDN controllers

- **$3.7B by 2016** - Source: IDC Predictions, November 2012

  * Estimate includes equipment sales that depend on SDN even if SDN isn't activated in it or available initially

- **$3.5B by 2018** - Source: Transparency Market Research, August 2013

- **$3.1B by 2017** - Source: Infonetics, December 2013
Terminology and Protocols
SDN Buzzwords

• **OpenFlow** - protocol used to configure flows, flow tables and TCAMs

• **OpenDaylight** – an open, standards-based SDN controller platform project hosted by the Linux Foundation

• **Open vSwitch** – a open source virtual switch similar to VMware’s vNetwork

• **OpenStack** – an open source “cloud operating system” used to create and manage pools of cloud resources

• **CloudStack** – an open source cloud computing software for creating managing and deploying infrastructure cloud services.

• **Orchestration** – a system to automatically create, initialize, coordinate & manage physical and virtual resources for cloud service delivery
SDN Protocols

- **OpenFlow** – a fairly low level protocol used to configure flows, flow tables and TCAMs.

- **NETCONF** – a device (physical or virtual) configuration and management protocol. Allows for configuration, data retrieval and event notification.

- **OF-Config** – The ONF specification for configuration of devices in an OpenFlow network. Specifies NETCONF over TLS with XML data models (specifically recommends YANG).

- **OVSDB** – Open vSwitch Database protocol is used to manage OVS instances, create virtual switches, attach interfaces to virtual switches, assign QoS policies, etc.

- **XMPP** – Extensible Messaging and Presence Protocol is used by some (i.e. Juniper) as an alternative to OpenFlow. Preferred by some due to its maturity as a protocol.

- **OpFlex** – A Cisco proprietary protocol proposed as an alternative to OpenFlow. Departs from a basic tenant of SDN in that control intelligence remains in the networking infrastructure.
Overview of SDN, NFV & NV
Remember when…

Someday, your network won’t be switching circuits but rather handling packets of various lengths.

Someday, your network won’t be made up of switches and routers but instead virtual machines controlling simple physical devices.
The Future of Network Applications

Compute

Highly virtualized
Concept

- Originally created by researchers and data center architects to scale and automate data center networks
- SDN separates the Control Plane (brains) from the Forwarding Plane (muscle)
- A centralized SDN Controller controls how Network Devices forward packets, & provides an abstract, centralized view of the overall network.
- **Flow Switching** is used as the new paradigm to underpin classic L2/3 switching/routing, VPNs, etc.
- Network devices move packets between ports according to policies/tables from SDN Controllers. Packets that require special handling go to the SDN controller for processing

Benefits

- Multi-Tenancy
- Automated Deployment
- Enable Innovation
- Rapidly Deploy New Applications, Services and Infrastructure
- White Box Switches/COTS IaaS
- Improved network efficiency and control
- Reduce CapEx/OpEx
What is Flow Switching?

Flow is distinguished by rule of combination through L1(port), L2(MAC), L3(IP), L4(port). Transferring method that use flow is called flow switching.
Network Functions Virtualization (NFV)

- While SDN is focused on network programmability, NFV focuses on taking network functions and converting them to software applications that run in compute resources.

- Eliminates proprietary, high-cost hardware while enabling instant activation of network services

- Virtual Network Functions (VNFs) offer great flexibility in service offerings while improving network automation

- NFV Infrastructure (NFVI) can be hosted in any IaaS environment and shared with cloud services, provided by 3rd parties
Service Chaining

- Network service chaining allows providers to define services for customers
  - Allows providers to select and link Virtual Network Functions (VNFs) from multiple vendors
  - Utilizes orchestration systems and software defined networking to automatically turn up new services
NFV Deployment Drivers

- Scale services up or down quickly: 86%
- Use software for quick revenue: 69%
- Use commercial servers, not network equipment: 62%
- Operational efficiencies: 59%
- Multi-tenancy: 45%
- Realtime network optimization: 34%
- Save energy consolidating workloads: 28%
- VNFs from small players: 14%

Source: Infonetics SDN and NFV SP Survey, March 2014
NFV Deployment Barriers

- OSS/BSS for NFV: 69%
- Integrating NFV into existing networks: 38%
- Products not carrier grade: 34%
- Incomplete standards: 34%
- Finding/training staff: 28%
- Unknown TCO: 28%
- Unknown ROI: 24%
- CIO-CTO responsibility splits: 17%
- Selecting NFV use cases: 3%

Source: Infonetics SDN and NFV SP Survey, March 2014
CPE Evolution
WT-317: Network Enhanced Residential Gateway (NERG)

• Proposed Solution
  o One box deployed at Customer Premises that can support future services – many with a “cloud” component
  o Embracing the principles of SDN and NFV
  o Centralized Management (with well defined and standard API)
  o Centralized Control, as appropriate
  o Centralized Services

• Some examples of NERG vRG services listed in WT-317 are:
  o QoS/Priority policy for different devices such as OTT media boxes, PC/laptop/ smartphone/tablets, game consoles, access to web sites, etc.
  o Parental Control of access to the Internet during a configurable period of time in the day, or to fix weekly quotas, and to limit what can be accessed on the Internet, etc.
  o DLNA - a framework for media interoperability among consumer devices in the home
WT-328: Virtual Business Gateway

- Started 3Q13; no target delivery date set yet and no working texts are available.
- The virtual business gateway architecture describes the migration of functionalities running on a business gateway to the network service provider’s infrastructure for enabling network-based features and services.
IETF NFV Group: Virtual Network Function as a Service (VNFaaS)

- Virtualization of the CPE functions (vE-CPE) into the SP’s NFV Infrastructure. This could include CPE functions such as: routing, firewall/intrusion detection, SBC, WAN Optimization, and IP-PBX.

From the ETSI NFV-001 Use Case document
Most Important NFV Use Cases: For New Revenue

- Business vE-CPE: 62%
- Service chaining: 52%
- vNPaaS: 41%
- Consumer home environment: 31%
- vPE: 24%
- vCDNs: 17%
- Consumer fixed access: 7%
- Mobile core, vEPC: 7%
- vRAN: 7%
- vBNG: 3%
- vIMS core: 3%

Source: Infonetics SDN and NFV SP Survey, March 2014
Most Important NFV Use Cases:
For Opex Reduction

Source: Infonetics SDN and NFV SP Survey, March 2014
NFV Solution Portfolio

- Different classes of CPE to provide investment protection and flexibility for evolving network architectures
  - Hybrid CPE
  - SDN-based CPE/NIDs
  - Cloud Extension Appliances

- Portfolio includes appliances ranging from simple Ethernet-in/Ethernet-out devices to advanced enterprise platforms with switching, voice and IaaS resources

- ADTRAN High Performance VNFs
  - Routing
  - eSBC
  - SIP Proxy
  - Wireless Access Point Controller
  - DPI

- Interoperability with OpenStack and other industry-leading strategic partners
• There will be some transition period from today’s networks to SDN/NFV
• Hybrid CPE can be deployed today like any current CPE solution but has the ability migrate to NFV/SDN-based architectures in the future
• When the network is ready, it allows the provider to migrate networking functions from the Hybrid CPE to the NVFI and to reuse the CPE hardware as an SDN controlled NID
• The Hybrid CPE software is architected so that the control plane is separated from the forwarding plane allowing control and network applications to easily migrate from the CPE environment to x86-based servers in the cloud
• Providers benefit by leveraging today’s CPE investment into tomorrow’s NFV architecture
SDN/NFV NID

- Provides a cost effective way to deliver a greenfield vCPE solution
- Models include simple Ethernet devices and more advanced devices with multiple UNIs and resources to support legacy analog and PRI voice interfaces
- WAN interface options range from Ethernet, to wireless, to fiber and bonded copper
Cloud Extension Appliance

- Family of edge devices based on the Intel x86 architecture
- Virtualizes both communications and cloud services at the edge
- Cloud Extension Appliances can be used:
  - as an extension of the provider’s NFVI or Cloud Services infrastructure
  - as a complete enterprise communications, compute and networking services platform
- Models with local storage or caching
- Cache only devices:
  - Use cloud storage, no primary storage in appliance
  - Centralized disaster recover
- Leverages provider orchestration and SDN controllers

Benefits

- Supports transition to SDN/NFV/Cloud at edge
- Maximum Flexibility – allows provider to deploy VNFs and applications in the optimal location
- Bolsters managed service offerings by providing for on-premises compute and storage resources
Cloud Extension Appliance

- Open software architecture supports 3rd party software and VNFs
- Multiple models to support both small and large enterprises with varying compute, throughput and storage needs
Challenges for SDN and NFV

- Evolving standards, competing schools of thought and industry politics
  - Need to ensure open standards . . .

“Open doesn’t mean simply published and available; it also means not being controlled by a single party”
- Dan Pitt, ONF Executive Director

- Migration, integration and coexistence of SDN and NFV models into existing networks
- OSS/BSS system readiness
- Virtual Network Function testing and deployment
  - Multi-vendor forwarding graph/service chaining
  - Ability to specify attributes of individual VNFs
  - Testing, measurement and validation of service performance
Summary

- SDN and NFV are game changing technologies that will impact the way we think about network and service design
- These technologies will allow service providers to automate, reduce opex and become more agile in service definition and deployment
- SDN implementations are mainly in the data center today but will find their way into broader networking applications over the next few years
- There is still a lot of work to be done but vendors and service providers are partnering together to define open standards
- ADTRAN will continue to provide leadership and innovation and will work with our customers to evolve their networks
Thank You