The promise of network Simplicity
(SDN meets NGN)

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Network simplification agenda

Towards a converged Transport architecture
  IP+optical integration and advances in routing optimizations

The SDN Evolution (not Revolution)
  real-time OSS
  The collaborative control plane

SDN modeling

Network function Virtualization
  Eliminating the need for specialized HW and OS
  Increasing the TTM and feature velocity
Network Transport Simplification
Impact of Video, Mobile, and Cloud Services
Networks in Transition

- Changing Traffic Patterns
- Exponential Traffic Growth
- TCO

- Agile Network Topologies
- 100G+ Capacity and Massive Scale
- Architectural Convergence
Convergence Requires Network Agility
Eliminating Rigid, Costly, Separate Networks

Divided Networks

1. IP Engineering requests path from transport team
2. Transport Planning researches capacity for best path
3. Transport Operations provisions network path at each node
4. IP Operations provisions VPN service

> 2 Months
Elastic Core, introducing Cisco nLight technology
Elastic, Intelligent, Programmable

- nLight Control Plane Protocol: Cisco Open Networking Environment (ONE) Programmable
- nLight Silicon for Coherent 100G+, 4000km w/o Regeneration
- nLight ROADM: Zero-Touch Optical

Up to 36% TCO Savings and over 90% Fiber CAPEX Reuse
Touchless Optical Layer – Agile DWDM
Foundation for Optical Control Plane

Complete Control in Software, No Physical Intervention Required

**Omni-Directional** – ROADM ports are not direction specific (re-route does not require fiber move)

**Tunable Laser** – Transmit laser can be provisioned to any frequency in the C-band (96 channels)

**Colorless** – ROADM ports are not frequency specific (re-tuned laser does not require fiber move)

**Tunable Receiver** – Coherent receiver can select one wavelength among a composite signal (no demux needed)

**Flex Spectrum** – Ability to provision the amount of spectrum allocated to wavelength(s) allowing for 400G and 1T channels.

**Contention-less** - Same frequency can be added/dropped from multiple ports on same device

**WSON**
Wavelength Switched Optical Network
Pre-FEC Proactive Protection

Reactive Protection

Router Bit Errors

Router Bit Errors

Time

Working route

Failure route

Protection route

FEC Limit

Pre-FEC Bit Errors

IP-over-DWDM

Router Bit Errors

Near Hitless Switch

Protection Trigger

Pre-FEC Bit Errors

Time

FEC

ROADM

ROADM

Transponder

FEC

Router

FEC

Pre-FEC

Bit Errors

Bit Errors

Router

Pre-FEC Bit Errors

Protection Trigger

Router Bit Errors
Loop Free Alternate (LFA) Link Protection

The link between $R_P$ and $R_B$ fails.

$R_P$ reroutes all traffic originally for link $R_P-R_B$ to $R_C$. This is done by pre-computing available paths that do not create loops.

Gives benefits of TE-FRR, but no configuration or design required.
Segment routing

Forwarding state (segment) is established by IGP
  Agnostic to forwarding dataplane: IPv6 or MPLS
  RSVP-TE is not required

Source Routing
  source encodes path as an ordered list of segments
  two segments: node or adjacency

IPv6 SR Routing Extension header
  includes the list of segments

Tunnelled solution
  outer header protects the SR extension header – security
  caches the active SID in the outer DA for backward compatibility
ASR 9000 Network Evolution – nV Technology
Super, Simple

**ASR 9000 “nV System”**

- **Simplify Operations**
  Reduce overall TCO
  Integrated A to Z Management

- **Multi-dimensional Scale**
  System and services scale

- **Increased Service Velocity**
  Quickly deploy new services

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Foundation for Next-Generation Edge
Moving ahead, Choice of the transport layer

L0: Photonic Layer
L1: Optical
L2: L2
L3: L3

Services:  
- IP/Packet  
- Leased Lines

- OEO switching
- IP/MPLS
- OTN

ROADM, @ 10G, 40G, 100G, 400G
Cisco Innovation:

Key Investments in multi-layer technologies

- Custom Silicon
  - New Design
    - Ultra-high density, single chip
    - Multiple applications
    - Transport services
    - Power efficient
    - Space Efficient
  - Integrated Virtualization
    - Fully modular
    - Zero Packet Loss
    - Zero Topology Loss

- NG Software
  - IOS-XR Evolved
  - IP + DWDM
    - Core Optics & Lightwire
    - Leading 40-100G (400-1T)
    - Low Cost Interconnect
    - Optimized Density / Power
    - Distance with no regeneration

- Optics
  - Low Cost Interconnect
  - Optimized Density / Power
  - Distance with no regeneration

- SDN
  - Virtualization
    - Multi Layer Control Plane
    - Flexible Routing
    - Virtualization

- Management and Orchestration
- Network Services
- Control Plane
- Forwarding Plane
- Transport
The SDN Evolution (not Revolution)
Evolution and not Revolution
SDN Network Evolution

POLICY
Orchestration
ANALYTICS

Program for Optimized Experience
Programmability
Intelligence

Network

Harvest Network Intelligence
Programmability at multiple layers of the network
Flexibility in deriving abstractions
The Cisco SDN Evolution Overview

**Today**
- Control Plane
- Data Plane

**Vendor-specific APIs**

**OF SDN Model**
- Controller
- Data Plane

**Openflow Protocol**

**Cisco Evolution Path**

**Cisco “Hybrid” Approach**
- Orchestration Provisioning
- Control

**Centralised**

**Distributed**

**Today**
- Resilient
- Scalable

**“Purist” SDN view**
- Simplified
- Logical Centralization

**Evolved Network Architecture**
- Optimized
- Best of both worlds

**Standard APIs**

**Abstraction & Programmability**
The Collaborative Control Plane
Centralized Control Example - Network Optimization

Distributed – Head End TE Path Calculation
Global topology view
Local TE requirements
Unpredictable TE tunnel placement
Overall n/w sub-optimal tunnel placement

Centralized - PCE TE Path placement
Global topology view
Global TE requirements
Predictable tunnel placement
Network wide optimized tunnel placement

“centralised optimisation enables ~30% more traffic to be supported for the same installed capacity”

Clear benefits for Centralized Control Plane
The Collaborative Control Plane
Distributed Control Example – IGP Network Convergence

Distributed – Network Convergence

Fully Centralized Control

Major failure → multiple devices will be doing this at the same time
Impulse load on controller and paths to controller, difficulty correlating of events, failure in paths to controllers

Clear benefits for Distributed Control Plane
Evolving How We Interact With Network OS

Manageability
- CLI
- SNMP
- HTML
- XML
- AAA
- CDP
- Syslog
- Netflow
- Routing Protocols
- Span

Extensibility
- IOSd
- Monitoring
- Policy
- Interface
- Discovery
- Routing
- Data Plane

Actions

Events

App
- C
- Java
- Python

Anything you can think of
onePK for Rapid Application Development

Developer Environment

Rich Service Sets

Deploy:
- On a Service Blade
- On an External Server
- Or Directly on the Device

Ubiquitous support
Providing a comprehensive environment
Flexibility to Choose – Protocols, APIs and Developer Environments

onePK Developer Environment

**Element**
- Element Capabilities
- Configuration Management
- Interface/Ports Events
- Location Information

**Utilities**
- Syslog Events and Queries
- AAA Interface
- Netflow Events
- DHCP Events

**Discovery**
- Network Element Discovery
- Service Discovery
- Topology Discovery

**Developer**
- Debug Capabilities
- Tracing Interfaces
- Management Extensions

**Policy**
- Interface Policy
- Interface Feature Policy
- Forwarding Policy
- Flow Action Policy

**Routing**
- Protocol Change Events
- RIB Table Queries

Quantum API
- Interface descriptions
- L2 network provisioning

Packet classifiers
- Marking
- Copy/Punt Inject
- Statistics

OpenFlow

Developer portal

ISVs
SDN Modeling
SDN Modeling
IP NGN Models
Infrastructure Controller based SDN

Example: Path Computation

Flow Based SDN
Example: Open Flow Controller & Agent

Virtualization associated SDN/NfV
Example: Network Virtualization

Applicability to market segment

Campus  Data Centre  IP NGN
Infrastructure Controller based SDN

Use-Case: Multi-Layer PCE with Cisco nLight

Service tunneling and setup examples:
- Setup Tunnels (PCEP)
- L3 Link Topology (BGP-LS)
- Setup λ's (PCEP)
- DWDM Topology (BGP-LS)

Network components:
- Services
- IP/MPLS
- R1, R2, R3
- O1, O2, O3, O4
- nLight
- Link Tunnel
- Service Tunnel
- IWXS
- XCON
- Setup Service Instances (OF++, IRS)
- Discovery, Status
- DWDM
- ML-PCE
Flow based SDN
Use-Case: The Gi-LAN Virtual Services Implementation

<table>
<thead>
<tr>
<th></th>
<th>Traditional Practice</th>
<th>Cloud Practice</th>
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<tbody>
<tr>
<td>Grow Capacity</td>
<td>Craft to add a service specific blade to chassis that has finite number of slots</td>
<td>Launch a VM and install the service on it – no manual operations</td>
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<tr>
<td>Reconfigure</td>
<td>Send craft to re-configure cabling</td>
<td>Use data center management and SDN to reconfigure</td>
</tr>
<tr>
<td>New Applications (MVNO, M2M, …)</td>
<td>Complex partitioning (MOCN, BSS, GWs, …)</td>
<td>Partition using virtualization and SDN</td>
</tr>
<tr>
<td>Capacity</td>
<td>Limited by slots in NE chassis</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Fault Recovery</td>
<td>HA architectures with high resiliency built-in</td>
<td>VMs can be used for quick recovery</td>
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<tr>
<td>Operations Systems</td>
<td>FCAPS model</td>
<td>Cloud Platform (NM, Orchestration,…)</td>
</tr>
<tr>
<td>Distribution of Functions</td>
<td>Complex: results in high operational expense</td>
<td>Simple via distributed computers &amp; cloud operations</td>
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Virtualization associated SDN (NfV)
Telco Cloud – Network function Virtualization

NfV = Transition of network infrastructure services to run on virtualised compute platforms – typically x86

NfV Initiative

Initiative announced at “SDN and OpenFlow World Congress”, Darmstadt, Oct 2012
Industry Specification Group (ISG) group within ETSI
Initiative should be a 2 year effort
Not defining standards - deliver white papers and liaising with standards bodies
First ETSI meeting was held in January
Inline with Cisco’s thinking – our effort is aimed at appliances

Use of cloud technology to support network functions
Management, Control and Data plane components

Not technically related to SDN
But may utilize SDN technology – APIs, Controllers

Typically uses virtual overlay technology

Extract from “Network Functions Virtualisation – Introductory White Paper
Network Function Virtualization:
Use-Case: Virtualization of Network Services, Applications, Functions onto UCS (Demo Available)

- Application/Service runs in virtual environment independent of platform (e.g., VMs)
- Plug & Play deployment of services
- Subscriber-aware service orchestration to define service paths and dynamic service routing
- Automate new service introduction and expand/contract resources on the fly
- Distributed architecture makes no assumptions about scope (free to scale up/down as needed)
- Expose Network APIs to expose the network as a service end-to-end
Virtual Network Services Taxonomy

**Centralised vs. Distributed** – where a service executes within the network?
- Centralized services – can run in centralised data centres
- Distributed services – need to be distributed further out in the network

**Control/Management plane vs. Data/User plane services**
- Control Plane Services – deal with signalling and management
  Examples include DNS, OSS, DHCP, Route Reflector
- Data Plane Services – forwarding/manipulation of user packets
  Examples include DPI, NAT, CGN, BRAS, GiLAN services

**Redirected traffic vs. routed traffic service** – how the traffic gets to the service?
- Redirected – a network device identifies a flow(s) and redirects it from its normal path
- Routed – the traffic will naturally routed through the service

**Virtual overlay + service chaining** – How the traffic gets to and is directed through the service
Network Function Virtualisation
Architectural Components

Required components and location of components will vary by use

All use cases ➔ Orchestration + Virtualized services + Service chaining
Re-direction use cases ➔ Re-direction + Policy Server + Overlay
Network Function Virtualization:
Use-Case: Virtual CPE (vCPE)

Multiple v-CPE models
1. CPE router in premises replaced by a server running virtualized router and services code
2. Very basic CPE router with services functions running in SP Datacentres (similar to a service chaining model)
3. L2 CPE with L3 function held on PE or virtualized compute
4. Cloud connector (UCS on a blade incorporated in a router) Not shown
Summary
Summary

A new era has begun in NGN network architectures

Advances in technology

TCO pressure along with traffic growth and service velocity needs

Network simplification is comprised of a number of building blocks

Network layer collapsing

IP+optical integration (Cisco nLight)

Packet protocol optimizations/simplifications

SDN capabilities

Infrastructure controller, ONE, OF, Openstack, …

Network Function Virtualization

Real-time OSS
Thank you.