SDN and Beyond
Cisco’s Application-Centric Infrastructure

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FORWARD-LOOKING STATEMENTS

This presentation contains projections and other forward-looking statements regarding future events or the future financial performance of Cisco, including future operating results. These projections and statements are only predictions. Actual events or results may differ materially from those in the projections or other forward-looking statements. Please see Cisco’s filings with the SEC, including its most recent filings on Forms 10-K and 10-Q, for a discussion of important risk factors that could cause actual events or results to differ materially from those in the projections or other forward-looking statements.
A New OPEN Operating Model is Required

TRADITIONAL NETWORK MODEL

Network of Boxes
Focus on Large, Stable, IP Networks
Network Centric
A New OPEN Operating Model is Required

TODAY’S SDN DATACENTER MODEL

Software-Based Network Virtualization
Concepts: Centralized Controller and Overlay Remains Network Centric Abstraction
A New OPEN Operating Model is Required

TODAY’S SDN DATACENTER MODEL

- **Software-Based Network Virtualization**
  - Concepts: Centralized Controller and Overlay
  - Remains Network Centric Abstraction

FUTURE OPEN MODEL

- **Application Centric Infrastructure**
  - Focus on Applications!
  - Application Centric Abstraction
  - Application Agility Across Entire Infrastructure (Compute, Storage, Network)
NETWORK VS. APPLICATIONS

APPLICATIONS

• Rapid Deployment
• Grow, Shrink, Move as Needed
• Compute, Storage, and Network

Any Application Any Time Anywhere

NETWORKS

• Scalability
• Stability
• Reliability
• Performance

Requires an Application Centric Infrastructure
Datacenter Spending (%) Over Time

Key Driver For ACI - Modern Data Centers demand agile networking

- Operating expenses represent over 80% of DC spending
- Network optimization for virtual servers is driving OpEx spending
- Increased OpEx is attributed to network optimization to VM's to deliver application SLA’s" Source: ZK Research

Source: IDC, 2011 "New Economic Model for the Datacenter"
Organizations that have implementing DevOps practices are up to five times more likely to be high-performing.

Key Metrics Shift with Automation

- Deployment Frequency
- Change Lead Time
- Change Failure Rate
- Mean Time To Recover

Build Application Aware Environments

All of the benefits of this are moot if the environments are not a perfect fit for the applications.

http://sdarchitect.wordpress.com/2013/04/12/adopting-devops-part-iii-aligning-the-dev-and-ops-teams/

Architect Environments and their projected evolution to align with that of the application.
VISION: CISCO APPLICATION CENTRIC INFRASTRUCTURE

BUILT FOR SDN AND BEYOND

NEXUS 9000 SERIES

APPLICATION POLICY INFRASTRUCTURE CONTROLLER

INDUSTRY LEADING ECOSYSTEM

APPLICATION

COMPUTE

STORAGE

NETWORK

SECURITY

CLOUD
SPOTLIGHT ON THREE GAME-CHANGING DIFFERENTIATORS

1. APPLICATION-CENTRIC POLICY MODEL
   - Operationally Simple
   - Lowest TCO
   - Zero-touch provisioning

2. PHYSICAL + VIRTUAL
   - Health Metrics
   - Visibility / Telemetry
   - Troubleshooting

3. OPEN AND SECURE
   - Open APIs / Open Source
   - Advanced Security
   - 3rd Party Integration
#1 – APPLICATION CENTRIC POLICY MODEL

Connectivity
Security
QoS
L4-7 Services

Physical Networking

Hypervisor and Virtual Networking

L4–L7 Services

Multi DC WAN and Cloud

Storage

Compute
#2: AGILITY—PHYSICAL, VIRTUAL AND CLOUD

Tenant

Health Score

Systems Telemetry 0 Packets dropped

Latency 2 2 4 8

Isolation

Application

Health Score

Systems Telemetry 25 Packets dropped

Latency 4 3 0 9

Isolation

APP VISIBILITY
#3: OPEN (AND SECURE!) FROM GROUND UP

**OPEN SOURCE**
- Daylight
- OpenStack
- Puppet
- Chef

**OPEN STANDARDS**
- NSH
- VXLAN
- OpFlex

**OPEN INTERFACES**
- JSON
- XML
- REST
- OpFlex

**WITH ADVANCED SECURITY**
- Policy
- RBAC
- Encryption
- Auditing
- Tenant Isolation
APPLICATION CENTRIC INFRASTRUCTURE & NEXUS 9000

Cisco’s Leading 10G/40G/100G Portfolio

ACI & Ecosystem

Nexus 9000 and APIC Momentum

PIPELINE ~800 CUSTOMERS AND ~40 EFT CUSTOMERS FOR APIC

CUSTOMER USE CASE AND ARCHITECTURE WINS ACROSS DIFFERENT SEGMENTS

RAPID CHANNEL PARTNER SCALE
ACI CUSTOMER USE CASES

1. Cisco IT
2. Hyperscale - 9k / 3k
3. Enterprise L2, L3, VXLAN
4. ACI Cloud Hosting
Cisco ACI / Nexus 9K
Delivering “Business Outcomes”

“Cisco ACI is an open, future-proofed data center architecture that can continue to grow as we enhance client services.”
Chuck Crane
Network and Security Architect, Axciiom

“Cisco’s open standards approach makes ACI even stronger. We conducted testing on ACI … it fully delivered everything we expected, and proved to be quite stable and mature.”
Nik Weidenbacher
Principal Engineer, SunGard

“This will enable Telstra to deliver service agility, security and performance that our customers expect from an enterprise grade cloud.”
Erez Yarkoni
Executive Director, Telstra

Greater Business Agility
- 58% Reduce Network Provisioning

Lower Capital Expenses
- 25% CAPEX Reduction

Reduced Costs/Complexity
- 21% Reduce Management Costs

Lower Operating Cost
- 45% Reduce Power and Cooling Costs

Resource Optimization
- 10-20% Compute and Storage Optimization

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CISCO IT ACI SIMPLIFIES OPERATIONS: TCO AND COST SAVINGS

**PROCESS SIMPLIFICATION**

**PRE-ACI**
- Network Operations
- Network and Policy Instantiation
- Translate Setup and Policy

**POST-ACI**

**COST SAVINGS**

**PRE-ACI**
- OPEX
- CAPEX

**POST-ACI**
- 41% Cost Savings

PRE-ACI OPEX and CAPEX vs. POST-ACI OPEX and CAPEX, showing a 41% cost savings post-ACI implementation.
USE CASE – HYPERSCALE DC – NEXUS 9000 & 40G

Technology

Nexus 9500 and Nexus 3000
• Robust and Scalable NXOS Code, feature alignment, Patching Programmability
• 9500 - 40G Wire Speed

Nexus 9500 & Nexus 3K – 10G Access and 40G Agg

Benefits
• Dev/Ops Models
• Massive Scale
• Programmability and Velocity
USE CASE – ENTERPRISE – L2, L3, & OVERLAY NETWORKS

Technology

- Nexus 9300 and 9500
- VXLAN Bridging and Routing
- Layer 2 tunnels moving over Layer 3

Benefits

- Workload mobility – Any workload any where
- Simplify the physical topology – All Layer 3
- Scaling over existing VLAN model
- Programmability & Migration to ACI
USE CASE – ACI CLOUD HOSTING

Technology
- Cloud Stack
- Xen Servers
- Xen OVS
- Nexus 9508 and Nexus 9300

Multi-Tenant Overlay with Per Hop Visibility
- 1000 of Tenants Per Leaf

Layer 2 Services
- Layer 2 and Layer 3 to traditional switching and routing

Benefits
- 100% automation of tenant overlays and networks
- Integration with CloudStack and Existing networks
- ACI scale eliminates hypervisor overlay
Data Center Market Transitions Accelerating Data Center Growth with Cisco ACI

Transitions Drive Data Center Switching Growth

Data center switching ASP
- GE → 10GE Server-Access
- 10GE → 40GE → 100GE Aggregation Transition
- Invest protection of cabling – 40G BiDi Optics

Software migration to ACI for lower TCO and OpEx

Source:
Dell’Oro LAN Switching by Vertical Report, Feb, 2014
Dell’Oro Server quarterly report – Oct, 2013
• Financial and Technical Support to Drive Transition of >70,000 EOL Catalyst 6500’s
• 10G/40G Transition Drives a Growth Opportunity for the Nexus Portfolio (40G port growth on N7k, Refresh of Nexus 2000 to 1/10/40)
• 10G/40G transitions drives higher ASPs
Early ACI Implications: CapEx AND OpEx
Cisco Driving Industry Leading TCO

ACI Network OpEx
35% OpEx savings with ACI

Before ACI

ACI vs. SDN
75% Total Cost of Ownership Savings

- Starting Level of Automation
- SW Only SDN Stops Here
- ACI = Apps.+Network+Security
- Open Source, API’s, & Open Stack
- ACI Extends to Enterprise & WAN

NETWORK VIRTUALIZATION + MERCHANT SWITCHES

APP CENTRIC CISCO

$40 OpEx*

$100 VM Tax

$14 Network

$25 OpEx

$14 Network

$15 Network

$154
NO CAPEX BENEFIT TO WHITEBOX + HIDDEN COSTS

Hidden Costs

- Cost of Integration HW, OS, Overlay
- Multiple SW release trains & Features
- Multiple Vendors / Maintenance & Support
- Troubleshooting

CAPEX Switch

NO WHITEBOX ADVANTAGE

$5,500* 27% $4,000*

Standalone Sw/Rtr SW $1,000 per year
Whitebox $2,500

Branded Switch w/ integrated HW/SW

3 Year CapEx ToR Example

Source: * Deutsche Bank 9/27/2013: "Whitebox Switches Are Not Exactly a Bargain"
### Beyond White Box – Open, Agile & Application Relevant

<table>
<thead>
<tr>
<th>Platforms</th>
<th>White Box / Cumulus Networks</th>
<th>Cisco ACI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Relevance</td>
<td>Not Applicable</td>
<td>Application Centric</td>
</tr>
<tr>
<td>Automation / SDN</td>
<td>3rd Party Only</td>
<td>Open 3rd Party</td>
</tr>
<tr>
<td>Operating System</td>
<td>Linux Model Decoupled from HW</td>
<td>Nexus</td>
</tr>
<tr>
<td>Switching</td>
<td>White Box Physical Switching Only</td>
<td></td>
</tr>
</tbody>
</table>
Application Centric Infrastructure
Moving Beyond VMware NSX – SDN LAN Emulation (LANE)

OPEN Controllers, OPEN Protocols & OPEN API’s

Hypervisor & Southbound Device Integration

Nexus 9000
NXOS
Fabric OS

OpFlex

vmware

Bare Metal
WAN & MPLS
Open Layer 4-7

Nexus 1000v

No 3rd Party Controllers

No Open Flow

3rd Party Hardware

Layer 4-7 Virtual
Closed OVSDB

APIC

Cisco Systems Advantage

Open API’s & Data Model

APIC – Policy Controller - Not SDN LANE > scale

Secure Open Device Packages for L4-L7

No VM Tax

Widest device support

Broad Partner Ecosystem

DC, Campus & WAN

Published Model for Any Device
NEXUS 9500: BREAKING PERFORMANCE RECORDS

- PERFORMANCE VERIFIED
- NON-BLOCKING MODULAR SWITCH ARCHITECTURE
- LOWEST LATENCY AMONG MODULAR DC SWITCHES
- HIGHEST 40GbE DENSITY WITH LINE RATE PERFORMANCE
- 576 x 40GbE - 100% THROUGHPUT – NOT A SINGLE DROP
- CONSISTENT UNICAST AND MULTICAST PERFORMANCE
- NO HEAD OF LINE BLOCKING
- HIGHEST POWER EFFICIENT MODULAR DC SWITCH

NEXUS 9516

NEXUS 9508

10.9W per 40G Port
(100% IMIX traffic load)
# RECENT TEST RESULTS VS DUNE BASED ARISTA 7500 MODULAR SWITCHES

## NON-BLOCKING

Nexus 9500 is line rate running in both NX-OS and ACI mode

Competition is non-line rate with oversubscribed architecture

## NEXUS 9500 IS SIGNIFICANTLY FASTER THAN COMPETITION (LATENCY)

<table>
<thead>
<tr>
<th>Frame Size (Bytes)</th>
<th>Nexus 9000</th>
<th>Dune Chipset Competitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>1.6 μs</td>
<td>182 μs*</td>
</tr>
<tr>
<td>145</td>
<td>1.6 μs</td>
<td>16 μs*</td>
</tr>
<tr>
<td>512</td>
<td>2.0 μs</td>
<td>5.3 μs</td>
</tr>
<tr>
<td>1518</td>
<td>2.5 μs</td>
<td>7.3 μs</td>
</tr>
</tbody>
</table>

Latency in microseconds, at 100% traffic load, * packet drops due to oversubscription
## Fiber infrastructure Savings with Reuse: BiDi vs other 40G optics

<table>
<thead>
<tr>
<th></th>
<th>Cisco 10G SR Multimode fiber</th>
<th>Cisco 40G BiDi Multimode fiber</th>
<th>Arista 40G SR4 Multimode fiber</th>
<th>Arista 40G LR4L Single-mode fiber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optics Price (pair)*</td>
<td>2x $995 = $1,990</td>
<td>2x $1,095 = $2,190</td>
<td>2x $1,995 = $3,990</td>
<td>2x $4,495 = $8,990</td>
</tr>
<tr>
<td>Fiber Infrastructure upgrade Price *</td>
<td>$0</td>
<td>$2,259</td>
<td>$524</td>
<td></td>
</tr>
<tr>
<td>40G upgrade Price (optics + fiber)</td>
<td>$2,190</td>
<td>$6,249</td>
<td>$9,514</td>
<td></td>
</tr>
</tbody>
</table>

Savings with BiDi (over Arista’s SR4) per 40GbE link: **$4,059**

Savings with BiDi (over Arista’s LRL4) per 40GbE link: **$7,324**

*Using Manufacturer’s list price*
Arista - Pressured Between Cisco - High End and White Box - Low End

<table>
<thead>
<tr>
<th>Platforms</th>
<th>Arista Networks</th>
<th>Cumulus Networks</th>
<th>Cisco ACI Fabric &amp; Nexus 9000</th>
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<td>Linux Model Decoupled from HW</td>
<td>• ACI Fabric OS</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• iLinux</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• NXOS - NXAPI</td>
</tr>
<tr>
<td>Switching</td>
<td>Arista Battles Cumulus &amp; White Box On the low end</td>
<td></td>
<td>SW Only Upgrade</td>
</tr>
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Data Center Automation and IT Collaboration
Common Policy Framework and Operational Model

DECENTRALIZED MANAGEMENT

Application Requirements

NETWORK

COMPUTE

STORAGE

SECURITY

POLICY-BASED AUTOMATION

STORAGE

SECURITY

APPLICATION

CLOUD

APPLICATION
EXTENDING POLICY ACROSS THE DC, WAN AND ACCESS

Network Orchestration
End-to-End

Unified Policy API
Across APIC Platform

APIC-DC
Data Center

APIC-DC
Data Center

APIC-EM
Access

APIC-EM
Access

APIC-WAN
WAN

APIC-WAN
WAN

APIC-DC
Data Center

APIC-DC
Data Center

APIC-EM
Access

APIC-EM
Access

Traditional 3-Tier Application

Unified Policy API
Across APIC Platform
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