Network Programming in a Cisco Open Network Environment
Strategy and Overview
T-SDN1/L1

Bruno Klauser
Consulting Engineer
BN EMEAR CTO Team
bklauser@cisco.com
Announcing: Cisco Open Network Environment

Industry’s Most Comprehensive Networking Portfolio

Hardware + Software  
Physical + Virtual  
Network + Compute

Applications

1. Platform APIs
One Platform Kit (onePK)
- Programmatic APIs for Network HW (IOS, IOS-XR, NX-OS)

2. Controllers And Agents
SDN:
- Controller SW (OpenFlow, onePK)
- OpenFlow 1.x support

3. Virtual Overlays
Open Clouds with Nexus 1000V
- Multi-hypervisor
- Multi-service
- Multi-cloud
- Openstack support

© 2012 Cisco and/or its affiliates. All rights reserved.
## Some Basic Definitions

### What Is Software Defined Network (SDN)?

“...In the SDN architecture, the **control and data planes are decoupled**, network intelligence and state are logically centralized, and the underlying network infrastructure is abstracted from the applications…”

Note: SDN is not mandatory for network programmability nor automation

*Source: www.opennetworking.org*

### What Is OpenFlow?

Open protocol that specifies **interactions between de-coupled control and data planes**

Note: OF is not mandatory for SDN

Note: North-bound Controller APIs are vendor-specific

### What is OpenStack?

**Opensource software** for building public and private Clouds; includes Compute (Nova), Networking (Quantum) and Storage (Swift) services.

Note: Applicable to SDN and non-SDN networks

*Source: www.openstack.org*

### What is Overlay Network?

Overlay network is created on existing network infrastructure (physical and/or virtual) using a network protocol. Examples of overlay network protocol are: GRE, VPLS, OTV, LISP and VXLAN

Note: Applicable to SDN and non-SDN networks
Software – Network Convergence

“Computer programming is an art, because it applies accumulated knowledge to the world, because it requires skill and ingenuity, and especially because it produces objects of beauty”

Donald Knuth, 1974
(Author of “The Art of Computer Programming”)
A Brief History of Network Automation & Programming
Self-Service for Human Users

Business Operations

Virtual / Overlay Networks

ICT Operations

Network
Survivability → Manageability → Automation

Wireless Controller(s) (WLC, etc, …)
Self-Service for Human Users

- Business Operations
- Wireless Controller(s) (WLC, etc, …)
- Virtual / Overlay Networks

Operations (FCAPS)
  - Resource Allocation
  - ICT Operations

Network
  - Survivability → Manageability → Automation
Self-Service for Human Users

Business Operations

Virtual / Overlay Networks

Network
Survivability → Manageability → Automation

Operations (FCAPS)

ICT Operations

1  3  5  6  7

Services (Location, Guestnet, Onboarding, …)

Resource Allocation

Wireless Controller(s) (WLC, etc, …)
Self-Service for Human Users

Business Operations

Services
(Location, Guestnet, Onboarding, …)

Wireless Controller(s) (WLC, etc, …)

ICT Operations

Overlay Networks

Survivability → Manageability → Automation

Operations (FCAPS)

Resource Allocation

Services (Location, Guestnet, Onboarding, …)

Operations (FCAPS)

Cisco Hotspot

Version: 2.8.2

Username:

Password:

Login
Inflection: Network Programming

What if the ‘User’ is a Software App?

Network
Survivability → Manageability → Automation → Autonomy
Operational Network Automation

Business Operations

Virtual / Overlay Networks

Network
Survivability → Manageability → Automation

ICT Operations

APIs and Agents
Domain Controllers

Operational Network Automation

1. Business Operations
2. Virtual / Overlay Networks
3. Network
4. Survivability
5. Manageability
6. Automation
7. ICT Operations

(a)  (b)  (c)
Operational Network Automation

Business Operations

Value to Business

Type II Automate New Task
Benefits:
- OPEX ↓
- CAPEX ↓
- Quality ↑
- Reactive → Proactive

Type I Automate Existing Task
Benefits:
- OPEX ↓
- Quality ↑

Maturity and Innovation

Network
Survivability → Manageability → Automation
Operational Network Automation – I

Type I Example: Embedded Automation Systems

Custom Failover

Custom Smart Ports

Custom Notifications

Operational Network Automation – II

Type II Example: Preventive and Proactive Automations

Real-Life → Network Workflows

Uninterruptible Power Supply

SNMP Trap – On Battery 5 Min Remaining!

Smart Call Home
Proactive Maintenance

see: www.cisco.com/go/smartcall

ICT Operations

Network
Survivability → Manageability → Automation

Business Operations

From
- Late Surprises
- Multiple Manual Escalation Steps
- Iterative Problem Isolation
- Phone, Email based Data Exchange

To
- Early Warnings
- Automated Flow
- Pinpoint Detailed Events
- Reporting and Exports
Inflection: Business-Driven Network Automations …
Inflection: Business-Driven Network Automations …

Business Operations

Value to Business

Type I – Automate Existing Task
Benefits:
- OPEX ↓
- Quality ↑

Type II – Automate New Task
Benefits:
- OPEX ↓
- CAPEX ↓
- Quality ↑
- Reactive → Proactive

Type III – Automation as Integral Part of Solution Design
Benefits:
- Revenue enabler
- OPEX ↓
- CAPEX ↓
- Quality ↑
- Reactive → Proactive
- Corporate Learning enabler

Maturity and Innovation

Network
Survivability → Manageability → Automation
What are Network Programming and SDN?

SDN Enables
Business Applications to program (parts of) the Network

SDN is Relevant when (in any combination)
The **Business** is **Software Centric**
The **Business Demands Automation**
Network **Operations** is Highly Mature

SDN Adoption across Markets and Technology Domains
2007 : ProSUMER/SMB Market Space
2009 : ESMB Routing & Switching Customizations
2010 : Network Compliance and Interop Testing
2012 : Software-Defined Data-Center SDDC
2013 : SP Network Function Virtualization, Connected Industries, Cloud-Intelligent Networks, …
Software – Network Convergence

“Computer programming is an art, because it applies accumulated knowledge to the world, because it requires skill and ingenuity, and especially because it produces objects of beauty”

Donald Knuth, 1974
(Author of “The Art of Computer Programming”)

(C) 2012 Cisco and/or its affiliates. All rights reserved.
Who is the Network Programmer – 1/2

Currently Three Main Groups:

- Network “Ponytails”
- System “Square Eyes”
- New Breed “Generation Y”
### Who is the Network Programmer – 2/2

<table>
<thead>
<tr>
<th>Works for</th>
<th>Network “Ponytails”</th>
<th>System “Square Eyes”</th>
<th>Generation Y</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typical Employers</strong></td>
<td>Vendor, Partner, large Customers</td>
<td>ISV/SI/Dev Partner, large Customer</td>
<td>Dev/SI/ISV Partner, large Customer, Education, Academia, NREN</td>
</tr>
<tr>
<td><strong>Atypical Employers</strong></td>
<td>[names omitted]</td>
<td>[names omitted]</td>
<td></td>
</tr>
<tr>
<td><strong>Network, IOS Skills</strong></td>
<td>[names omitted]</td>
<td>[names omitted]</td>
<td></td>
</tr>
<tr>
<td><strong>Scripting Skills</strong></td>
<td>[names omitted]</td>
<td>[names omitted]</td>
<td></td>
</tr>
<tr>
<td><strong>Programming Skills</strong></td>
<td>[names omitted]</td>
<td>[names omitted]</td>
<td></td>
</tr>
<tr>
<td><strong>ICT Architectural Comp</strong></td>
<td>[names omitted]</td>
<td>[names omitted]</td>
<td></td>
</tr>
<tr>
<td><strong>SW Engineering Comp</strong></td>
<td>[names omitted]</td>
<td>[names omitted]</td>
<td></td>
</tr>
<tr>
<td><strong>3rd/System Domain Comp</strong></td>
<td>PuTTY, perl, expect, Visio, mySQL, LAMP, email, wiki</td>
<td>Eclypse, JMS, TiBCO, make, perl, C, Java, Oracle, TOAD, email, wiki</td>
<td>gedit, REST, xmpp, rss, XML/XSD, IM, social, blogs, play, redmine</td>
</tr>
<tr>
<td><strong>Typical Tools</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Cisco Open Network Environment
Describing Software Architectures

4+1 View Model

Scenarios: Use Case, Who, What and Why
Examples:
Routing-for-(Dollars), Application-Flow-Manipulation, Network Slicing, SDDC Provisioning, CIN, …

Development View: SDKs, Packages, Libraries, Tools
Examples:
onePK SDK, binaries .so, Eclipse, Debugger, IOL, …

Logical View: Features, Functions, Classes, Abstractions
Examples:
onePK APIs in C, Java, Application APIs, …

Process View: Architectures, Processes, Interactions, Objects
Examples:
Agents, Controllers, Thrift IDL, Cloud Connectors, Sentinels, …

Physical View: Deployment, Hosting, Topology, Connectivity
Examples:
Virtual Containers, Blades, Endpoints, L1-2-3, Overlay

See: https://en.wikipedia.org/wiki/4+1_Architectural_View_Model
Cisco Open Network Environment – ONE

Preserve What is Working
- Resilience, Scale, Security
- Functionality and Rich Features
- Instrumentation

Evolve for New Requirements
- Operational Simplicity and Automations
- Programmability and Network-Awareness
- Upcoming Innovations

Open and Integrated Framework
- Software Defined Network concepts are a component of the Open Network Environment
- Existing APIs, Agents, Controllers and Infrastructure contribute

Open Network Environment

Development View
Logical View
Network Programming

Process View
(Software) Architectures and Patterns

Physical View
Deployment and Virtualization

Scenarios and Motivations
Cisco Open Network Environment – ONE

Preserve What is Working
- Resilience, Scale, Security
- Functionality and Rich Features
- Instrumentation

Evolve for New Requirements
- Operational Simplicity and Automations
- Programmability and Network-Awareness
- Upcoming Innovations

Open and Integrated Framework
- Software Defined Network concepts are a component of the Open Network Environment
- Existing APIs, Agents, Controllers and Infrastructure contribute

Open Network Environment

<table>
<thead>
<tr>
<th>Network Programming</th>
<th>(Software) Architectures and Patterns</th>
<th>Deployment and Virtualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>onePK</td>
<td>Controllers (ONE/Openflow PoC)</td>
<td>Nexus 1000v</td>
</tr>
<tr>
<td>developer.cisco.com, CDN, Training, Certification, Partners, EEM, EASy</td>
<td>(SBC, WLC, ++++)</td>
<td>CSR 1000v</td>
</tr>
<tr>
<td></td>
<td>CIN, CloudConnect, Sentinels, Agents</td>
<td>VSG and vFW/ASA, vWAAS, vNAM, …</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cisco Openstack Ed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blade Hosting (UCS-E, …), Virtual Containers (AirVision, Cat, ISR, ASR, …)</td>
</tr>
</tbody>
</table>

Scenarios and Motivations
Cisco Open Network Environment – ONE

Preserve What is Working
- Resilience, Scale, Security
- Functionality and Rich Features
- Instrumentation

Evolve for New Requirements
- Operational Simplicity and Automations
- Programmability and Network-Awareness
- Upcoming Innovations

Open and Integrated Framework
- Software Defined Network concepts are a component of the Open Network Environment
- Existing APIs, Agents, Controllers and Infrastructure contribute

Open Network Environment

<table>
<thead>
<tr>
<th>Network Programming</th>
<th>(Software) Architectures and Patterns</th>
<th>Deployment and Virtualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>onePK</td>
<td>Controllers (ONE/Openflow PoC) (SBC, WLC, +++), CIN, CloudConnect, Sentinels, Agents</td>
<td>Nexus 1000v CSR 1000v VSG and vFW/ASA, vWAAS, vNAM, …</td>
</tr>
<tr>
<td>developer.cisco.com, CDN, Training, Certification, Partners, EEM, EASy</td>
<td></td>
<td>Cisco Openstack Ed</td>
</tr>
</tbody>
</table>

Scenarios and Motivations
Cisco ONE – Virtual Networking / Cloud Networking

- Nexus 1000V
  - Distributed switch
  - NX-OS consistency
  - 6000+ Customers
- VSG
  - VM-level controls
  - Zone-based FW
- ASA 1000V
  - Edge firewall, VPN
  - Protocol Inspection
- vWAAS
  - WAN optimization
  - Application traffic
- CSR 1000V (Cloud Router)
  - WAN L3 gateway
  - Routing and VPN
  - Limited Availability: CQ4'12
  - Full Availability: CQ1'13
- Ecosystem Services
  - Citrix NetScaler VPX virtual ADC
  - Imperva Web App. Firewall

Virtualized/Cloud Data Center

Multi-Hypervisor
Multi-Services
Multi-Cloud

WAN Router
Switches
Servers

Tenants
Zone A
Zone B

Virtualized/Cloud Data Center

Imperva SecureSphere WAF
Citrix NetScaler VPX
vWAAS
ASA 1000V Cloud Firewall
Cisco Virtual Security Gateway
Cloud Services Router 1000V
Nexus 1000V
vPath
VXLAN

6000+ Customers
Shipping
Shipping
Shipping
Shipping
2013
Cisco Open Network Environment – ONE

Preserve What is Working
- Resilience, Scale, Security
- Functionality and Rich Features
- Instrumentation

Evolve for New Requirements
- Operational Simplicity and Automations
- Programmability and Network-Awareness
- Upcoming Innovations

Open and Integrated Framework
- Software Defined Network concepts are a component of the Open Network Environment
- Existing APIs, Agents, Controllers and Infrastructure contribute

**Open Network Environment**

<table>
<thead>
<tr>
<th>Network Programming</th>
<th>(Software) Architectures and Patterns</th>
<th>Deployment and Virtualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>onePK</td>
<td>Controllers (ONE/Openflow PoC) (SBC, WLC, ++++)</td>
<td>Nexus 1000v CSR 1000v VSG and vFW/ASA, vWAAS, vNAM, …</td>
</tr>
<tr>
<td>developer.cisco.com, CDN, Training, Certification, Partners, EEM, EASy</td>
<td>CIN, CloudConnect, Sentinels, Agents</td>
<td>Cisco Openstack Ed Blade Hosting (UCS-E, …), Virtual Containers (AirVision, Cat, ISR, ASR, …)</td>
</tr>
</tbody>
</table>

Scenarios and Motivations
Example: Controller Architectures

Open Daylight Controller Provides

Open-Source, Community-Driven Architecture and Platform for SDN Applications

Cisco are
Co-Founder
Platinum Member
Active Steering and Technical Member

Initial Controller Download available from 2013-04-08
http://www.opendaylight.org
http://wiki.opendaylight.org
Example: Controller Architectures

Cisco ONE Controller Provides

Platform for generic control functions – state consolidation across multiple entities

Current Use Cases

Flexible Network Partitioning and Provisioning ("Campus Slicing")
Network Troubleshooting
Custom Routing

Software Product, Java, Beta: 1H CY13

Cisco ONE Controller Anatomy

onePK and Openflow support
Modular Architectures
Extensibility and Manageability (UI and API)
**Example: Flexible Monitoring Matrix Solution – 1/2**

**Problem:** How to build a flexible, programmable and cost-effective monitoring matrix solution?

**Challenge:** Traditional implementations tend to be inflexible, closed, expensive

- Specialized high-density, high-throughput Switch
- Static rules and configurations
- Closed systems, limited adaptability, tool compatibility
- Expensive, not scalable
Example: Flexible Monitoring Matrix Solution – 2/2

**Problem:** How to build a flexible, programmable and cost-effective monitoring matrix solution?

**Solution:** Use Network Programming based on Cisco ONE Controller:

- Agent enabled Nexus 3000 Switches (Openflow)
- Cisco ONE Controller and Matrix Application
- Open UI (Controller and Application) and API (Agent and Controller)
- Cost-effective, scalable, extensible
Example: Cloud Connectors for ISR G2 and beyond

Cloud Connectors Provide
- Network-Awareness to Cloud Services
- Cloud Service-Awareness to Network
- Improved Quality and Experience
- Simplified Deployment and Operations

Cloud Connector Anatomy
- Deployed into Branch on ASR/ISR
- Native (in Network OS) or Hosted (on SRE, UCS-E Blade)
- Abstractions on top of Network OS

Some Examples

Available Now
- Scansafe Connector
- HCS Connector
- Webex Cloud Connect Audio

Future
- Backup/Storage Connector
- Identity Services Connector
- Securelogix / UC Services Connector
- VXI Connector
Cisco Cloud Intelligent Network
Delivering Optimal Experience, Pervasive Security, and Simplified Operations
Cloud Connectors
Bringing Network Intelligence to the Cloud

Cloud Connector – a network service that improves the performance, security or availability of cloud applications. Cisco Cloud Connectors provide Optimal Experience, Pervasive Security, and Simplified Operations when utilizing Private, Public or Hybrid Clouds over the WAN or Internet.

Cloud Intelligent Platforms
- ISR
- ASR
- CSR

Users

Cloud Services

Branch

Private/Public/Hybrid

Visibility
Optimization
Security
Collaboration
App Hosting
Types of Cloud Connectors

- **Native** Connectors
  - Hosted Collaboration Solution (ESRST)
  - WebEx Cloud Connected Audio (CUBE)
  - ScanSafe Connector

- **Hosted** Connectors
  - Run on UCS-E and use OnePK, UC Services or No API
  - May not always run everything on UCS-E

- **Scripted** Connectors
  - Uses OnePK API, Python scripting environment
  - Rapid Development and Deployment
  - Takes advantage of Cisco infrastructure (hosting environment to run)

**Example: Fleet Management and Telemetry**

**Problem:** Fleet Management and public transport telemetry information

**Solution:** Use an ISR 819 to aggregate and communicate relevant onboard data

1. Provide onboard network via 819
2. Aggregate relevant data on 819 using custom Fleet Management Connector
3. Fleet/Bus state defines use of uplinks to Fleet Management Center
Cisco Open Network Environment – ONE

Preserve What is Working
- Resilience, Scale, Security
- Functionality and Rich Features
- Instrumentation

Evolve for New Requirements
- Operational Simplicity and Automations
- Programmability and Network-Awareness
- Upcoming Innovations

Open and Integrated Framework
- Software Defined Network concepts are a component of the Open Network Environment
- Existing APIs, Agents, Controllers and Infrastructure contribute

### Open Network Environment

<table>
<thead>
<tr>
<th>Network Programming</th>
<th>(Software) Architectures and Patterns</th>
<th>Deployment and Virtualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>onePK</td>
<td>Controllers (ONE/Openflow PoC)</td>
<td>Nexus 1000v</td>
</tr>
<tr>
<td>developer.cisco.com, CDN, Training, Certification, Partners, EEM, EASy</td>
<td>(SBC, WLC, +++), CIN, CloudConnect, Sentinels, Agents</td>
<td>CSR 1000v, VSG and vFW/ASA, vWAAS, vNAM, …</td>
</tr>
</tbody>
</table>

Scenarios and Motivations

<table>
<thead>
<tr>
<th>Deployment and Virtualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco Openstack Ed</td>
</tr>
<tr>
<td>Blade Hosting (UCS-E, …), Virtual Containers (AirVision, Cat, ISR, ASR, …)</td>
</tr>
</tbody>
</table>
### Device Manageability Instrumentation Has Evolved Significantly

#### Network Automation and Manageability

<table>
<thead>
<tr>
<th>Fault</th>
<th>Configuration</th>
<th>Performance</th>
<th>Accounting</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP OAM—Ping, Trace, BFD, ISG per session</td>
<td>Config CLI—diff, logging, lock, replace, rollback</td>
<td>Auto IP SLA—delay, jitter, loss probability</td>
<td>Flexible NetFlow—IETF IPFIX</td>
<td>Auto Secure—one-touch device hardening</td>
</tr>
<tr>
<td>802.3ah—Link monitoring and remote fault indication</td>
<td>E-LMI—parameter and status signaling</td>
<td>CBQoS MIB—class-based QoS</td>
<td>BGP policy accounting—includes AS information</td>
<td>LDP Auth—message authentication</td>
</tr>
<tr>
<td>802.1 ag—Continuity check, L2 ping, trace, AIS</td>
<td>E-DI—Enhanced Device Interface, CLI, Perl, IETF Netconf</td>
<td>NBAR</td>
<td>Routing Auth—MD5 authentication, BGP, OSPF</td>
<td></td>
</tr>
<tr>
<td>MPLS OAM—LSP ping, LSP trace, VCCV</td>
<td>EMM — Embedded Menu Manager</td>
<td>RMON</td>
<td>…</td>
<td></td>
</tr>
<tr>
<td>EEM—Embedded Event Manager</td>
<td>NETCONF—IETF NETCONF XML PI</td>
<td>EPC — Embedded Packet Capture</td>
<td>…</td>
<td></td>
</tr>
<tr>
<td>EVENT-MIB—OID-based triggers, events, or SNMP Set, IETF DISMON</td>
<td>CNS and WSMA</td>
<td>ERM—Embedded Resource Manager</td>
<td>…</td>
<td></td>
</tr>
<tr>
<td>EXPRSSION-MIB—OID expression-based triggers, IETF DISMON</td>
<td>TR-069</td>
<td>GOLD—Generic Online Diagnosis</td>
<td>…</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>KRON—command scheduler</td>
<td>Smart Call Home—preventive maintenance</td>
<td>…</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>AutoInstall—bootstrapping</td>
<td>VidMon—Video Monitoring</td>
<td>…</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>IOS.sh —IOS Shell</td>
<td>...</td>
<td>…</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>SmartInstall</td>
<td>...</td>
<td>…</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>Auto SmartPorts</td>
<td>...</td>
<td>…</td>
<td></td>
</tr>
</tbody>
</table>
Embedded Event Manager (EEM)
Network Automation spans across full Life Cycle

- Is it built to Specification?
- Does it meet Requirements?
- How to configure?
- Is it working as specified?
- How to take out of service?

Pre-Operational Era: Manufacturing Test, Vendor Approval, Service Planning
- Is there room for yet another service?

Operational Era: Deployment & Activation, Testing & Verification, Troubleshooting & Optimization, Service Assurance
- What if something goes wrong?
- Are we meeting SLA?

Post-Operational Era: Decommissioning, Replanning, Post-Mortem
...
Example: EEM Applets – Loops, Variables

**Problem:** None in Particular

**Solution:** Have fun exploring EEM Applet capabilities

```
event manager applet 99-bob
  description written by bklauser inspired by http://www.99-bottles-of-beer.net
  event none
    action 100 set b 99
    action 110 while $b gt 1
    action 120 puts "$b bottles of beer on the wall, $b bottles of beer."
    action 130 decrement b
    action 140 puts "Take one down, pass it around, "
    action 150 puts "$b bottles of beer on the wall.\n"
    action 160 end
    action 170 puts "$b bottle of beer on the wall, $b bottle of beer."
    action 180 puts "Take one down, pass it around, "
    action 190 puts "no more bottles of beer on the wall.\n"
    action 200 puts "No more bottles of beer on the wall, "
    action 210 puts "no more bottles of beer."
    action 220 puts "Go to the store and buy some more, "
    action 230 puts "99 bottles of beer on the wall.\n"
! alias exec sing event manager run 99-bob
```

Packaging Network Automations

**Problem:** Cisco IOS Embedded Automation Systems often include multiple configuration items, files, checks and procedures – how to ensure they are deployed consistently?

**Solution:** Cisco EASy provides a simple packaging mechanism and open-source EASy Installer. A developer guide is available online to assist with the creation of EASy packages.

- Package Description
- Pre-Requisite Verification
- Pre-Installation Config
- Pre-Installation Exec
- Environment Variables
- Configuration
- Files
- Post-Requisite Verification
- Post-Installation Config
- Post-Installation Exec
- Uninstall

EASy Installer + MyPackage.tar = Menu Guided Installation

Router# easy-installer tftp://10.1.1.1/mypackage.tar flash:/easy

-----------------------------------------------------------------
Configure and Install EASy Package 'mypackage-1.03'
-----------------------------------------------------------------
1. Display Package Description
2. Configure Package Parameters
3. Deploy Package Policies
4. Exit

Enter option: 2

See: [http://www.cisco.com/go/easy](http://www.cisco.com/go/easy)
Cisco ONE Platform Kit (onePK)

Network Programming Environment to:
- Innovate
- Extend
- Automate
- Customize
- Enhance
- Modify

Any Cisco Router or Switch
Cisco ONE Platform Kit (onePK)

onePK Provides

- Abstractions (Service Sets)
- Programmatic Interfaces (C, Java, (REST) …)
- Software Development Kit (SDK)

Anatomy of a onePK Application

- Software Application (currently C and Java)
- Interfaces and Abstractions (Service Sets)
- Communication Bus (Thrift IDL)
- Connected-Apps Agent in Network OS
- Network OS Features and Embedded Automations

Service Set | Description | Version v.6.0.5 EFT 2012/2013
--- | --- | ---
Data Path | Provides packet delivery service to application: Copy, Punt, Inject | v.6.0.5 EFT 2012/2013
Policy | Provides filtering (NBAR, ACL), classification (Class-maps, Policy-maps), actions (Marking, Policing, Queueing, Copy, Punt) and applying policies to interfaces on network elements | v.6.0.5 EFT 2012/2013
Routing | Read RIB routes, add/remove routes, receive RIB notifications | v.6.0.5 EFT 2012/2013
Element | Get element properties, CPU/memory statistics, network interfaces, element and interface events | v.6.0.5 EFT 2012/2013
Discovery | L3 topology and local service discovery | v.6.0.5 EFT 2012/2013
Utility | Syslog events notification, Path tracing capabilities (ingress/egress and interface stats, next-hop info, etc.) | v.6.0.5 EFT 2012/2013
Developer | Debug capability, CLI extension which allows application to extend/integrate application’s CLIs with network element | v.6.0.5 EFT 2012/2013

Write once run anywhere
Portfolio of API, Languages and Abstractions

Network Programming with onePK and Embedded Network Automation

<table>
<thead>
<tr>
<th>Native Network OS Embedded Automation</th>
<th>Advanced Network OS Embedded Scripting</th>
<th>Structured API</th>
<th>Object Oriented API</th>
<th>Higher-Level Abstractions / Interfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event-/Expression- MIB, PfR, IPSLA Thresholds, Embedded Event Manager Applets, …</td>
<td>Tcl, Python, Embedded Event Manager, EASY, …</td>
<td>onePK C</td>
<td>onePK Java</td>
<td>onePK Libraries REST, XMPP, Design Patterns, OMNI Controllers, …</td>
</tr>
</tbody>
</table>

Network Programming – SDN

Network Automation – Embedded Automations

Choice and Flexibility of Implementation
Cisco ONE – Current Key Components …

Network
Survivability → Manageability → Automation → Autonomy

CloudConnectors
UCS-E
Virtual Containers

APIs and Agents
Virtual / Overlay Networks
Nexus 1000v
CSR 1000v
ASA 1000v
VSG
vWAAS
++

APIs and Agents
Domain Controllers

ONE Controller
Open Daylight Controller

For Your Reference
Cisco ONE
Openflow
Cisco Openstack Edition
ONE Controller
Cisco ONE stack Edition

For Your Reference
Resources and References
References – Programmable and Cloud-Intelligent

Cisco ONE – Open Network Environment: http://www.cisco.com/go/one
Cisco Developer Network: http://developer.cisco.com/web/onepk

Cisco EASy – Embedded Automation Solutions: http://www.cisco.com/go/easy
Cisco Scripting Community: www.cisco.com/go/ciscobeyond

Network Programming Hands-On Lab

At CiscoLive: Join us for TECNMS-3601 Advanced Network Automation or

1. Walk up to the WISP Labs
2. Book a seat for:
   - Network Automation – The Basics
   - Network Automation – Intermediate
   - Network Automation – Advanced
   - Network Automation – Smart Call Home
   - Network Programming – The Basics
   - Network Programming – Intermediate
   - Network Programming – Advanced

Partners via PEC (currently being updated):

1. Navigate to http://www.cisco.com/go/pec
2. Click on >Launch
3. Search for ‘%Network Programming%’
4. Enjoy!
Master Class Network Programming and Automation
Sustainable Innovation and Differentiation with Cisco Embedded Automation and onePK

How can I successfully use Network Programming?
Step-by-step introduction and adoption strategies

Where do I start – can I do this?
Practical Examples and Hands-on Lab

What have other Customers and Partners done?
Real-Life Examples and Case Studies

What are Cisco ONE and onePK anyhow?
Illustration in the bigger SDN and Automation Context

Join us for the Network Programming Master Class Series
References – Instrumentation and Automation

Device Manageability Instrumentation (DMI) [www.cisco.com/go/instrumentation]

- Embedded Event Manager (EEM): [www.cisco.com/go/eem]
- Cisco Beyond – EEM Community: [www.cisco.com/go/ciscobeyond]
- Embedded Packet Capture (EPC): [www.cisco.com/go/epc]
- Flexible NetFlow: [www.cisco.com/go/netflow] and [www.cisco.com/go/fnf]
- IPSLA (formerly SAA, formerly RTR): [www.cisco.com/go/ipsla]
- Network Analysis Module: [http://www.cisco.com/go/nam]
- Network Based Application Recognition (NBAR): [www.cisco.com/go/nbar]
- Smart Call Home: [www.cisco.com/go/smartcall]
- Cisco Configuration Engine (CCE): [www.cisco.com/go/ciscoce]

- Feature Navigator: [www.cisco.com/go/fn]
- MIB Locator: [www.cisco.com/go/mibs]
Embedded Automation Systems (EASy)

1. Browse and Download EASy Packages
   www.cisco.com/go/easy

2. Make Sure to also download EASy Installer

3. Browse Other Embedded Automations
   www.cisco.com/go/ciscobeyond

4. Learn About The Technology Under The Hood
   www.cisco.com/go/instrumentation
   www.cisco.com/go/eem
   www.cisco.com/go/pec

5. Discuss, Ask Questions, Suggest Answers
   supportforums.cisco.com
   supportforums.cisco.mobi

6. Upload your own Examples to CiscoBeyond
   www.cisco.com/go/ciscobeyond

7. Engage via ask-easy@cisco.com
Network Programming in a Cisco Open Networking Environment …

… provides Choice and Flexibility of
- APIs and Abstractions
- Architectures
- Deployment Models

… closes the gap between Business Applications and Networks

… enables Operational Savings and New Opportunities

… puts YOU in control

What will YOU Program?
Prosíme, ohodnoťte tuto přednášku.
Děkujeme za pozornost.