Cisco DevNet Series

1. Intro to Software & Programmability
   Intent Networks: How to be a Network Engineer in a Programmable Age

2. Intro to Coding
   Fast Lane: Where Code (Apple) Meets Network Infrastructure (Cisco)

3. APIs with Cisco Spark


5. Network Programmability with YANG/NETCONF/RESTCONF – March 15

All Series Details can be Found @ http://bit.ly/DevNetSeries
Network Programmability & APIC-EM
Cisco DevNet Webinar Series

Speaker: Matt DeNapoli | DevNet Developer Evangelist
Hostess: Kara Sullivan | Cisco Networking Academy
18 January 2018
Welcome to the 6th session of the Cisco DevNet webinar series

- Use the Q and A panel to ask questions.
- Use the Chat panel to communicate with attendees and panelists.
- A link to a recording of the session will be sent to all registered attendees.
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Cisco DevNet Series

1. Intro to Software & Programmability
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6. Network Programmability & APIC-EM
7. Network Programmability with YANG/NETCONF/RESTCONF – March 15

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Joining You Today:

Matt Denapoli
Developer Evangelist
DevNet, Cisco

Recommended knowledge to follow along today:

- CCNA2
- Basic Programming Skills
Module 03

Network Programmability and APIC-EM

Matthew DeNapoli
DevNet Developer Evangelist
https://learninglabs.cisco.com/tracks/devnet-beginner

- **Networking 101 Basics and Software Defined Networks**
  https://learninglabs.cisco.com/tracks/devnet-beginner/network-programmability/networking-101-the-basics/step/1

- **What is Network Programmability?**
  https://learninglabs.cisco.com/tracks/devnet-beginner/network-programmability/02-dna-02-what-is-network-prog/step/1

- **Controller Basics and APIC-EM**

- **APIC-EM Applications and Use Cases**
  https://learninglabs.cisco.com/tracks/devnet-beginner/network-programmability/05-apic-02-apic-em-applications-and-use-cases/step/1

- **Coding 101 - REST API Basics**
- **APIC-EM APIs with Python: Part I - The Basics**
  https://learninglabs.cisco.com/tracks/devnet-beginner/network-programmability/apic-em-1-3-basic/step/1

- **APIC-EM APIs with Python: Part II - Path Trace**
  https://learninglabs.cisco.com/tracks/devnet-beginner/network-programmability/apic-em-1-3-path-trace/step/1

- **APIC-EM APIs with Python: Part III - Policy Labs**
  https://learninglabs.cisco.com/tracks/devnet-beginner/network-programmability/apic-em-1-3-policy/step/1
Network Programmability, DNA, Controllers
Digital Network Architecture

Digital Network Architecture (DNA) Vision

Open and Software-Driven
Common Policy Model from Branch to Data Center

**POLICY**

**DATA CENTER**
- Application Network Flow Profile
  - SLA, Security, QoS, Load Balancing
- Cloud
- Data Center

**WAN AND ACCESS**
- User and Things Network Profile
  - QoS, Security, SLA, Device, Location, Role
- WAN
- Access

**CISCO® ADVANTAGE**
- BROWNFIELD AND GREENFIELD
- END TO END
- POLICY FRAMEWORK: FOCUS ON APPLICATION AND USER ENABLEMENT

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Network-Wide Abstractions Simplify the Network

The SDN Ideal: Controller as the Application Platform

Applications
- Orchestration
- Automation
- Collaboration
- Security
- Virtualization

REST API

SDN CONTROLLER

SOUTHBOUND ABSTRACTION LAYER
- CATALYST®
- CISCO NEXUS®
- ISR
- ASR
- ASA
- WIRELESS
- OTHER

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# What's New: DNA Innovations

## Cloud
- Cloud Web Security

## Controllers
- APIC-EM
  - IWAN | Path Trace
  - REST API for Ecosystem

## Virtualization
- ISR 4000 with UCS E Series

## New Innovations
- **CMX Cloud**
- **Lancope**
- **APIC EM Apps**
  - Plug and Play | Enterprise Service Automation | Easy QoS
- **Evolved IOS XE**
  - Programmable and Extensible | Model-driven API | App Hosting
  - Enterprise NFV
Introduction to APIC-EM
APIC-EM - Platform Architecture

APIC-EM Applications
- Network PnP
- IWAN
- Path Trace
- Network Inventory
- Advanced Topology Visualizer

APIC-EM Controller
- Northbound REST APIs

APIC-EM Services
- Inventory Manager
- RBAC
- Policy Analysis
- Policy Programmer
- Topology Services
- Data Access Service
- Network PnP
- IWAN Services

Grapevine
- Elastic Service Infrastructure

Addresses Scale Out and HA Requirements

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APIC-EM – Log in
# APIC-EM Device Inventory

<table>
<thead>
<tr>
<th>Device Name</th>
<th>IP Address</th>
<th>Reachability Status</th>
<th>Up Time</th>
<th>Last Updated Time</th>
<th>Last Inventory Collection Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHEC-2960C1</td>
<td>165.10.1.39</td>
<td>Reachable</td>
<td>16:11:38.76</td>
<td>20 Minutes</td>
<td>DEV-UNREACHED</td>
</tr>
<tr>
<td>AP7961-050F19ca</td>
<td>10.1.14.3</td>
<td>Reachable</td>
<td>NA</td>
<td>23 Minutes</td>
<td>Managed</td>
</tr>
<tr>
<td>Branch-Access1</td>
<td>10.2.1.17</td>
<td>Reachable</td>
<td>219 days, 21:09:28:84</td>
<td>19 Minutes</td>
<td>DEV-UNREACHED</td>
</tr>
<tr>
<td>Branch-Router1</td>
<td>10.2.2.1</td>
<td>Reachable</td>
<td>174 days, 23:37:05.58</td>
<td>23 Minutes</td>
<td>DEV-UNREACHED</td>
</tr>
<tr>
<td>Branch-Router2</td>
<td>10.2.2.2</td>
<td>Reachable</td>
<td>174 days, 23:49:53:28</td>
<td>16 Minutes</td>
<td>DEV-UNREACHED</td>
</tr>
<tr>
<td>Branch2-Router.yourdomain.com</td>
<td>218.1.100.100</td>
<td>Reachable</td>
<td>354 days, 0:18:52:75</td>
<td>12 Minutes</td>
<td>DEV-UNREACHED</td>
</tr>
<tr>
<td>CAMPUS-Access1</td>
<td>10.1.12.1</td>
<td>Reachable</td>
<td>175 days, 0:00:54.84</td>
<td>10 Minutes</td>
<td>DEV-UNREACHED</td>
</tr>
<tr>
<td>CAMPUS-Core1</td>
<td>10.1.7.1</td>
<td>Reachable</td>
<td>109 days, 8:08:47.24</td>
<td>12 Minutes</td>
<td>DEV-UNREACHED</td>
</tr>
<tr>
<td>CAMPUS-Core2</td>
<td>10.1.10.1</td>
<td>Reachable</td>
<td>226 days, 23:38:02:60</td>
<td>18 Minutes</td>
<td>DEV-UNREACHED</td>
</tr>
<tr>
<td>CAMPUS-Dist1</td>
<td>10.255.1.5</td>
<td>Reachable</td>
<td>115 days, 19:22:08:43</td>
<td>28 Minutes</td>
<td>DEV-UNREACHED</td>
</tr>
</tbody>
</table>
APIC-EM Topology
APIC-EM: Path Trace
APIC-EM REST APIs
What is so great about REST?

Cisco APIC-EM REST APIs

- Hosts
- Devices
- Users
- + more

How does this work?

Easy to use:

- In mobile apps
- In console apps
- In web apps
How does this work?

APIC-EM → Request → 3rd Party App → Response

APIC-EM → Get Hosts → 3rd Party App → List of Hosts
APIC-EM Example: Get Host

Application Policy Infrastructure Controller (APIC) Enterprise Module (EM)

GET http://{APIC-EMController}/api/v1/host

Request
List of Hosts returned in JSON
Response

3rd Party App
Anatomy of a REST Request

**Method**
- GET, POST, PUT, DELETE

**URL**
- Example: http://{APIC-EMController}/api/v1/host

**Authentication**
- Basic HTTP, OAuth, none, Custom

**Custom Headers**
- HTTP Headers
  - Example: Content-Type: application/json

**Request Body**
- JSON or XML containing data needed to complete request
And what is in the Response?

HTTP Status Codes
- [http://www.w3.org/Protocols/HTTP/HTRESP.html](http://www.w3.org/Protocols/HTTP/HTRESP.html)
- 200 OK
- 201 Created
- 500 Internal Error

Headers

Body
- JSON
- XML
Using the API Reference Documentation

Inventory

APIC-EM Service API based on the Swagger™ 1.2 specification

Terms of service
Cisco DevNet

device-credential : Device Credential API

ShowHide | List Operations | Expand Operations | Raw

discovery : Discovery API

ShowHide | List Operations | Expand Operations | Raw

host : host API

GET /host
Retrieve hosts

GET /host/count
Gives total number of hosts

GET /host/(id)
Retrieves host based on id

interface : Interface API

ShowHide | List Operations | Expand Operations | Raw

location : Location API

ShowHide | List Operations | Expand Operations | Raw

network-device : network-device API

ShowHide | List Operations | Expand Operations | Raw

network-device-config : Network Device Configuration API

ShowHide | List Operations | Expand Operations | Raw

tag : Tag API

ShowHide | List Operations | Expand Operations | Raw
Using Postman to get the Service Ticket

**Method:** POST

**URL:** https://sandboxapic.cisco.com/api/v1/ticket

**Authorization:**

- Headers 1: Content-Type = application/json

**Body:**

```json
{
  "username": "devnetuser",
  "password": "Cisco1231"
}
```
Using Postman to get the Service Ticket

- **POST**: https://sandboxapic.cisco.com/api/v1/ticket

**Response body**

```
{
  "response": {
    "serviceTicket": "ST-4772-a5w9z510TA7LQ5IRDWr-g-cas",
    "idleTimeout": 1800,
    "sessionTimeout": 21600
  },
  "version": "1.0"
}
```

**Authentication Token**: ST-4772-a5w9z510TA7LQ5IRDWr-g-cas
Using Postman to get Network Hosts
What about authentication?

- **Basic HTTP:** The username and password are passed to the server in an encoded string.

- **OAuth:** Open standard for HTTP authentication and session management. Creates an access token associated to a specific user that also specifies the user rights. The token is used to identify the user and rights when making APIs calls in order to verify access and control.

- **Token:** A token is created and passed with each API call, but there is no session management and tracking of clients which simplifies interaction between the server and client.

→ APIC-EM uses **Token** for authentication management.
Github Collection

Introduction

To use these examples, you need the latest version of postman (3.2.0). It has free Jetpacks support. This is required for linking requests.

Importing

You need to import the collection as well as the environment. You can import the raw git files using the From URL option, as seen below. You can also download them and import from file/folder.
APIC-EM Applications
APIC-EM Applications

Plug-and-Play (PnP)
The APIC-EM Controller’s PnP (Plug and Play) application delivers on ZTD (Zero Touch Deployment) for Cisco Enterprise Network routers, switches and wireless controllers.

Easy QoS
The APIC-EM Controller’s Easy Quality of Service application provides a simple way to classify and assign application priority.

Intelligent WAN (IWAN) Application
The APIC-EM Controller’s Intelligent WAN (IWAN) application automates the configuration of advanced IWAN features on Cisco 4000 Series Integrated Service Routers.

Path Trace
The APIC-EM Controller’s Path Visualization application greatly eases and accelerates the task of connection troubleshooting.
Plug and Play

Network Plug and Play (PnP)
Plug and Play

Network Plug and Play (PnP) – Components

- **PnP Helper App**
  [Optional]
  Delivers bootstrap, status and troubleshooting checks

- **Cloud Redirect Service**
  [Optional]
  Roadmap Phase 2

- **PnP Server**
  Central Server on APIC-EM
  Manages sites, devices, images, licenses, workflow
  Provides Northbound REST APIs

- **PnP Protocol**
  Runs between Agent and Server
  Open Schema

- **PnP Agent**
  Runs on Cisco® switches, routers, and wireless access points
  Automates the deployment process
# Plug and Play

## PnP – Discovery Options

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1    | DHCP with options 60 and 43  
PnP string: 5A1D:B2;K4;l172.19.45.222;J80 |
| 2    | DNS lookup  
pnpserver.localdomain ---- 172.19.45.222 (PnP Server) |
| 3    | Cloud Redirect Service – roadmap (Q2CY2016)  
https://devicehelper.cisco.com/device-helper re-directs to 172.19.45.22  
(PnP Server) |
| 4    | USB-based bootstrapping |
| 5    | Manual - using the Cisco® Installer App  
iPhone, iPad, Android, (roadmap - Windows mobile and PC) |
| X    | Others  
Any other manual or automated discovery method – Scripting, AN, EEM, NAP, etc. |
Plug and Play

PnP – Simple & Secure & Consistent
Easy QoS

Policy Service: EasyQoS

Select from Predefined Policies
Automated Deployment of QoS config
Optimized for Any Infrastructure

Implements QoS in 250 ms

Enhance Collaboration Experience
300% Reduction in voice jitter
50% Video quality improves

Improved Application Experience with No Operator Intervention

“The EasyQoS App reduces deployment times for network-wide QoS dramatically. We can now respond to changing application needs via policy-based automation within minutes or even seconds.”

Edeka

Cisco ONE Foundation
March 2016
General Availability in Cisco ONE May 2016
Easy QoS

EasyQoS Solution

Network Operators can create Business Relevant QoS Policies in APIC-EM’s UI

Applications can interact with APIC-EM via Northbound APIs, informing the network of application-specific and dynamic QoS requirements

Southbound APIs translate business-intent to platform-specific configurations

Wireless AP Trust Boundary PEP 4Q (WMM)

Catalyst 4500 1P7Q1T

Nexus 7700 F3: 1P7Q1T

ASR/ISR/ MOC

Catalyst 2960-X Trust Boundary PEP 1P3Q3T

Wireless AP Trust Boundary PEP 4Q (WMM)

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Easy QoS

Application-Driven Dynamic Policy

Client A calls client B

Client sends call setup info to App server

App Server calls APIC-EM to setup policy

QoS policy enabled on network device

Call ends

Client sends call teardown info to App Server

App Server calls APIC-EM to delete policy

QoS policy removed from network device
IWAN

• **Plug and Play** - The network is used to deploy Cisco 4000 Series Integrated Services Routers (ISRs) in new sites.

• Centralized policy automation

• Public-key-infrastructure (PKI) certificate

• Centralized hybrid WAN management

• QoS deployment and change of management

• Network wide visibility and segmentation with Application Visibility and Control (AVC) -

• DMVPN deployment and change of management

• Cisco Validated Designs based IWAN deployment workflows
PathTrace (Flow Analysis)

- APIC-EM Flow Analysis – UI

5 Tuple Input

Source IP
Destination IP
Source Port
Destination Port
Protocol
PathTrace (Flow Analysis)

APIC-EM Flow Analysis – UI

Task Overview
APIC-EM provides status of Flow Analysis Tasks
- In Progress
- Active (periodic)
- Completed
Path Trace (Flow Analysis)

APIC-EM Flow Analysis – UI
Path Trace (Flow Analysis)

APIC-EM Flow Analysis – UI

Topology View
Flow Analysis
Overlay on Topology
Path Trace (Flow Analysis)

APIC-EM Flow Analysis – UI
Path Trace (Flow Analysis)

APIC-EM Flow Analysis – UI

Reverse Path
Side-by-Side Comparison
Path Trace (Flow Analysis)

APIC-EM Flow Analysis – UI

Reverse Path
Side-by-Side Comparison

Locate Issue
In our case: on the reverse path
Path Trace (Flow Analysis)

APIC-EM Flow Analysis
Accurate 5-tuple path flow-analysis – available via GUI and REST APIs

```
"response": {
  "request": {
    "sourceIP": "65.1.1.83",
    "destIP": "212.1.10.20",
    "lastUpdate": "Thu Apr 23 01:23:21 UTC 2015",
    "properties": [],
    "networkElementsInSo": [
      { "id": "42462ba-d2b4-4d42-ad16-92d4d5c19fa4", "type": "Wired", "ip": "418.110.20", "linkInformationSource": "Wired" },
      { "id": "0b3a2e-c247-421d-941f-3ba42696c489", "name": "CAMBUS-Acces1", "type": "SWITCH", "ip": "212.1.10.1", "interface": "" }
  }
}
```
Get your hands dirty with ... The Mission!

Networking Academy | DEVNET
Wrap-Up
What you learned in this Module…

- Network Programmability
- APIC-EM
- APIC-EM Northbound APIs
Save the Date

NEXT SESSION:

Network Programmability with YANG/NETCONF/RESTCONF

15 March – 9:00 A.M. PT

This is the Digital Transformation

Introduction to IoT

Learn how the Internet of Things (IoT) and the digital transformation of business create new value and new job opportunities.

Self-enroll today to learn more @ http://bit.ly/intro2iot