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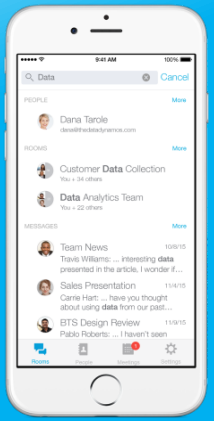

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Spark rooms will be available until Friday 17 November 2017

Python for the Enterprise

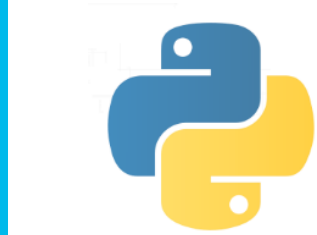
Kevin Kuhls, TME EISG

DEVNET-2449

Cisco live!

Agenda

- Programmability
- YANG
- NETCONF



Who is this guy?

…and should I listen or look at my phone?

Kevin Kuhls

1998 – Cisco Router

2002 – PIX Firewall

BIG LULL “honing skills”

2012 – DC Tech (UCS, Nexus, VMWare)

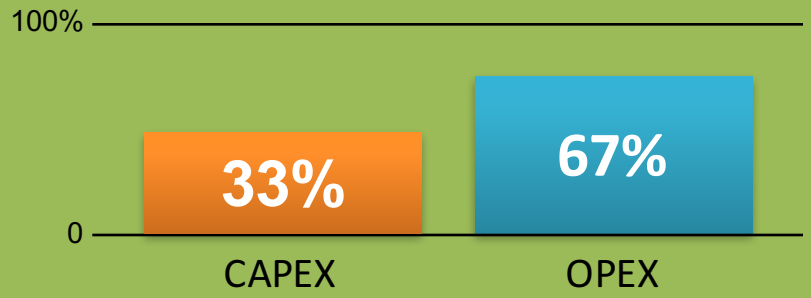
2014 – OpenStack, ACI

2015 – Network Programmability, SDN

Old Dog learning new tricks

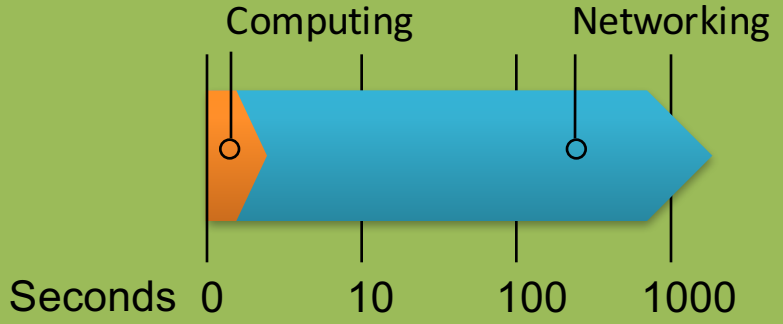
Why Network Programmability Matters

Network Expenses



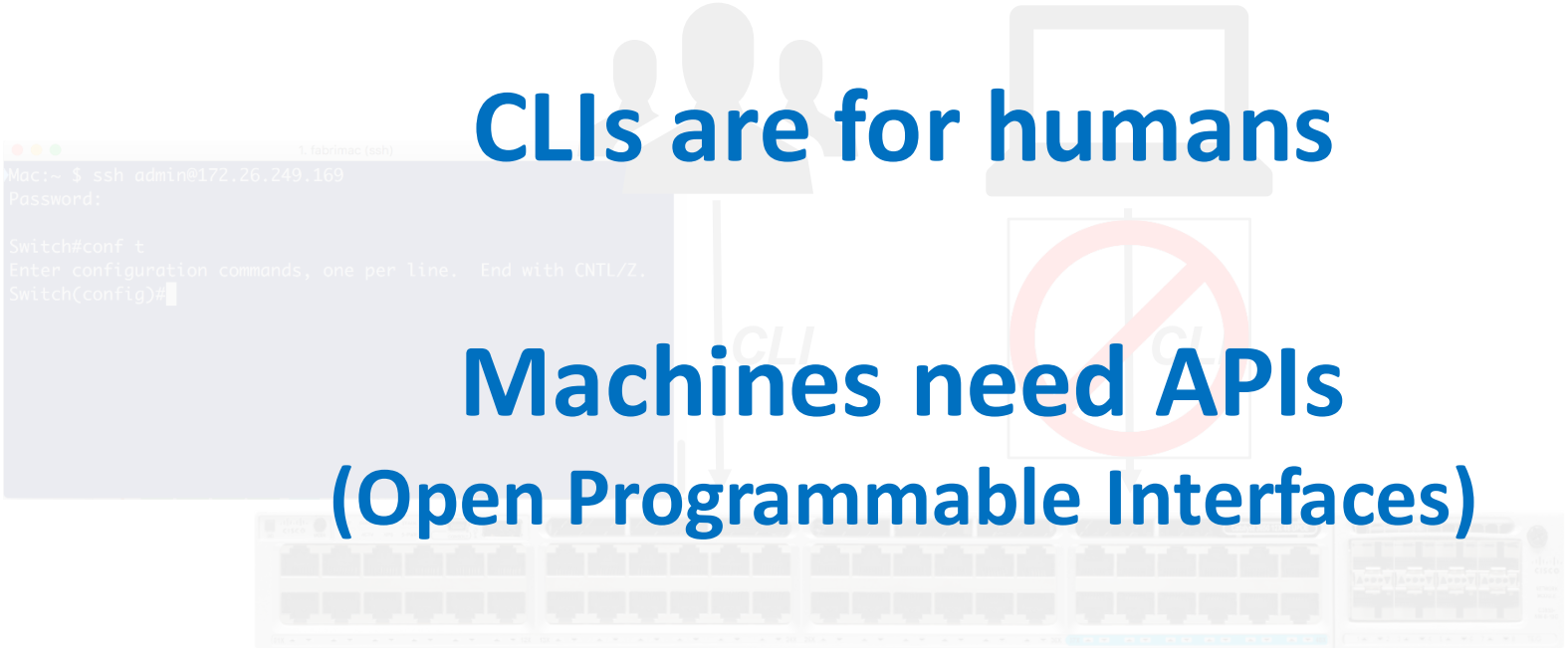
Source: Forrester

Deployment Speed



Source: Open Compute Project

Configuration Management Today



CLIs are for humans

Machines need APIs

(Open Programmable Interfaces)

Configuration Management Today: CLI

- Human Friendly
- Task Oriented
- Easy To Replay
- No Special Tools

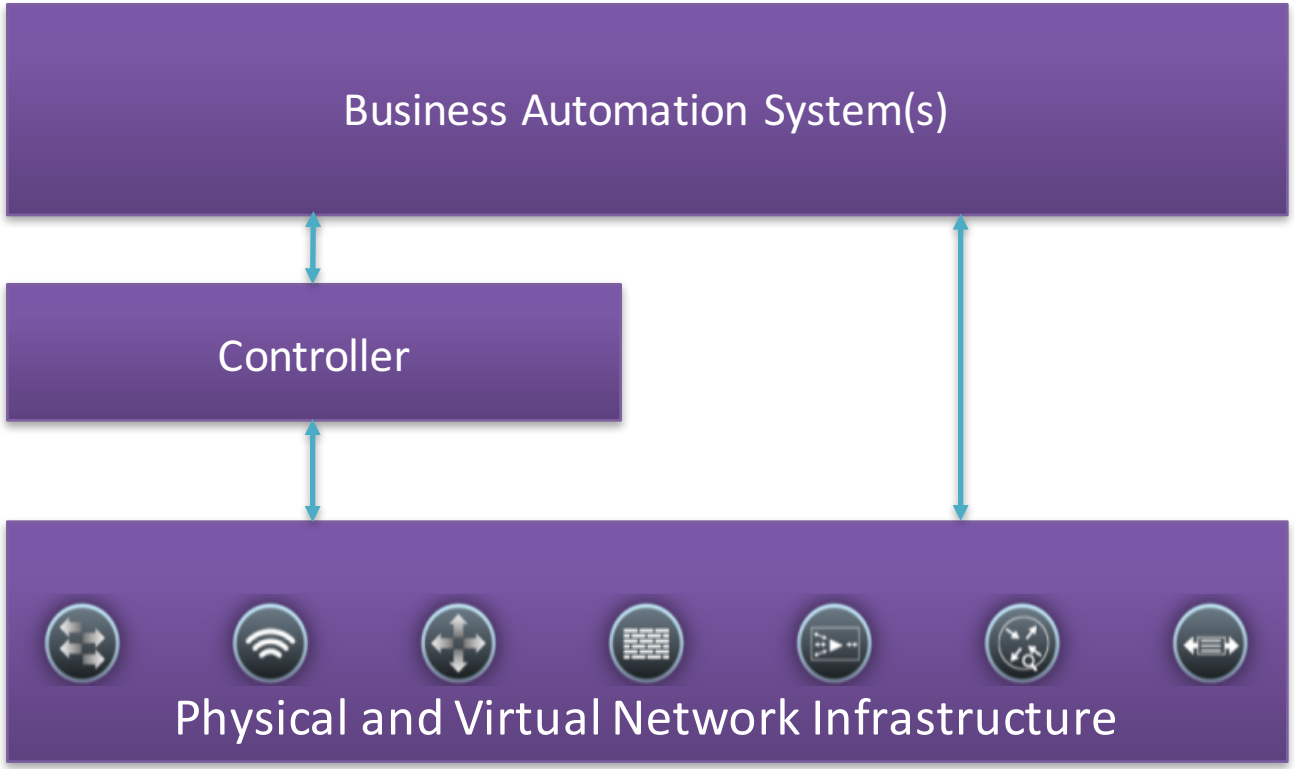
- Syntax format changes
- No Structured output
- No Error Reporting
- No Transaction

APIs – Application Programming Interfaces

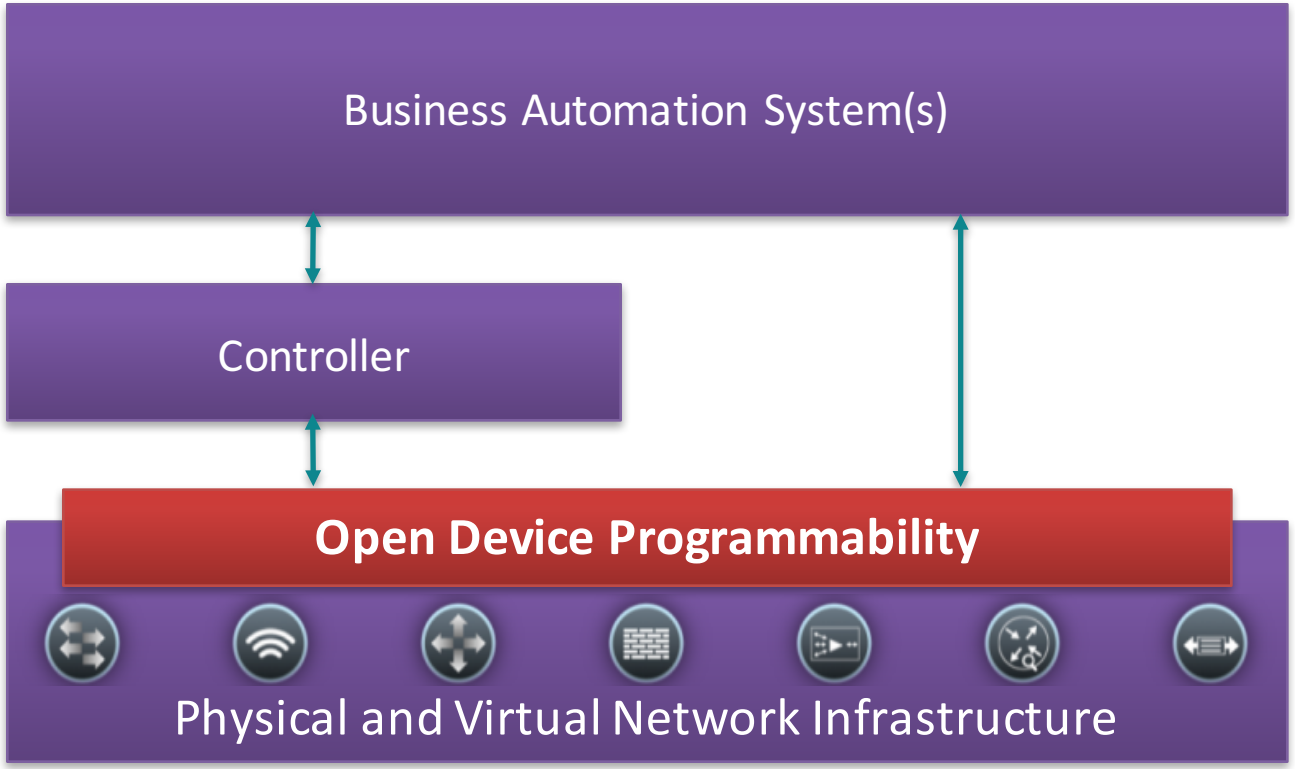
*"A **set of Function Calls** that allow talking to a system"*

- Programming Building block
- APIs can have various **Properties**
  - **Transport** (SSH, HTTP)
  - **Encoding** (XML, JSON, ProtoBuffer)
  - **Data structure** (Data Models)
- Some **Examples** of APIs
  - The Twitter API
  - The Java API

Network Programmability



Network Programmability

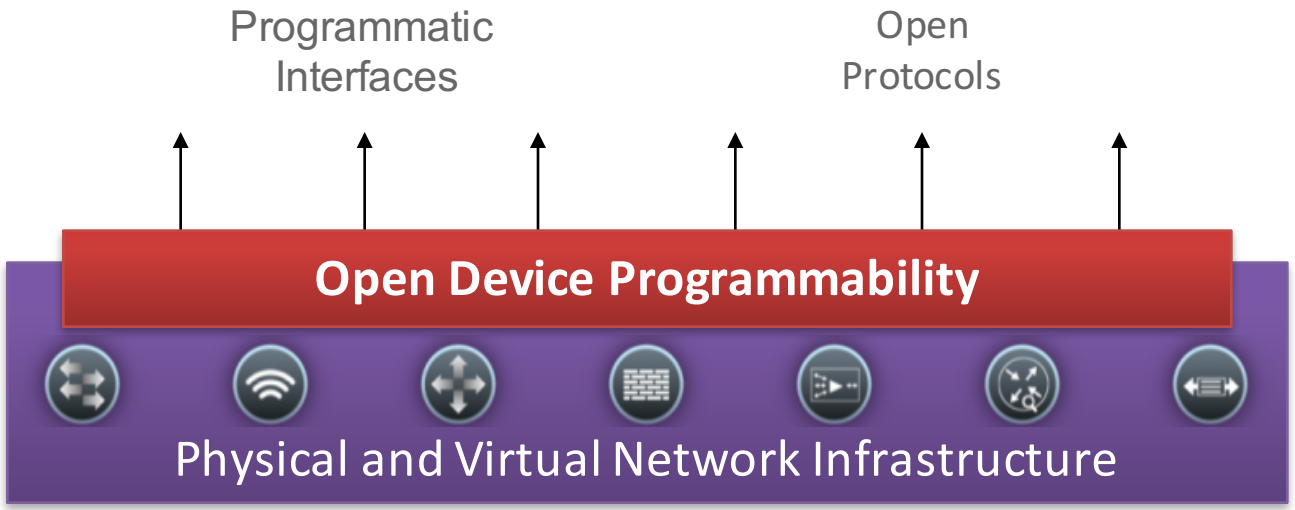


Network Programmability

Configuration Management

Operational State

Traffic Engineering



Implementation

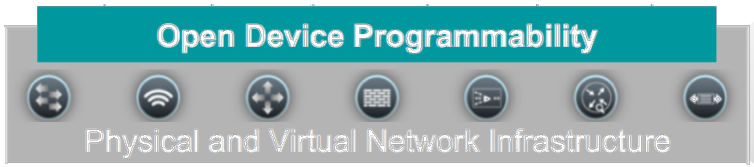
IETF

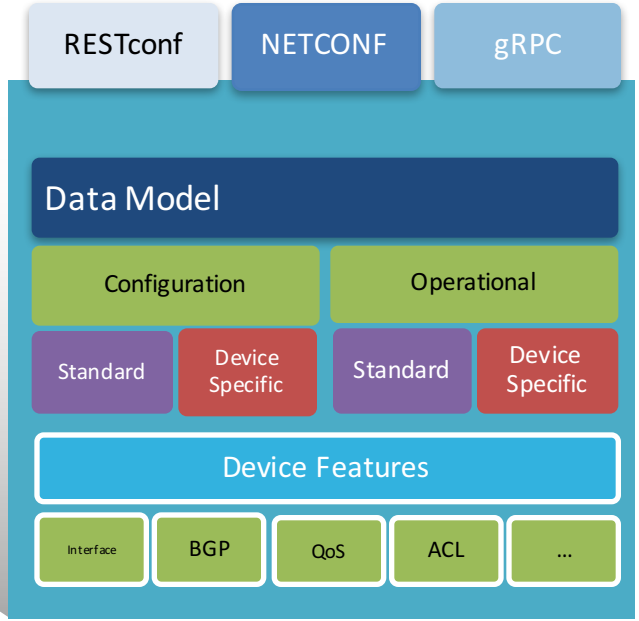
ITU International Telecommunication Union

OpenConfig

CISCO

Other vendors





Why Data Models?

- Devices are self-describing
  - Including definition of constraints
- We can apply tool chains
- New protocols and encodings
- Explicitly and precisely **defines Data**
  - **Structure**
  - **Syntax**
  - **Semantics**
- Consistent and complete

Use Cases

SDN Controller Integration

cisco
Open SDN Controller

OPENDAYLIGHT

Configuration Mgmt

Access Control

Inventory / Topology

Application Integration

Custom Application

puppet labs

Chef

SALTSTACK

ANSIBLE

CFEngine

Script Automation

DevOps

OSS / BSS Integration

SevOne

DonRiver

ARTIN

SIGMA

NETWORKMINING

Configuration Mgmt

Service Provisioning

Fault Mgmt

YANG

Data Models

- Explicitly and precisely **defines Data**
  - **Structure**
  - **Syntax**
  - **Semantics**

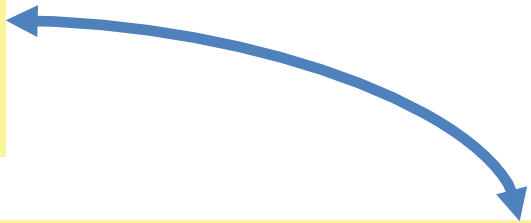
- Consistent and complete

Interface Model **definition**

```
list interface {
    key "interface-name";
    leaf interface-name {
        type string;
    }
    leaf speed {
        type string;
    }
    leaf duplex {
        type string;
    }
}
```

YANG Data Model Structure

```
!
interface GigabitEthernet0/0/0
 description whatever
 ip address 1.1.1.1 255.255.255.0
 shutdown
 negotiation auto
end
```



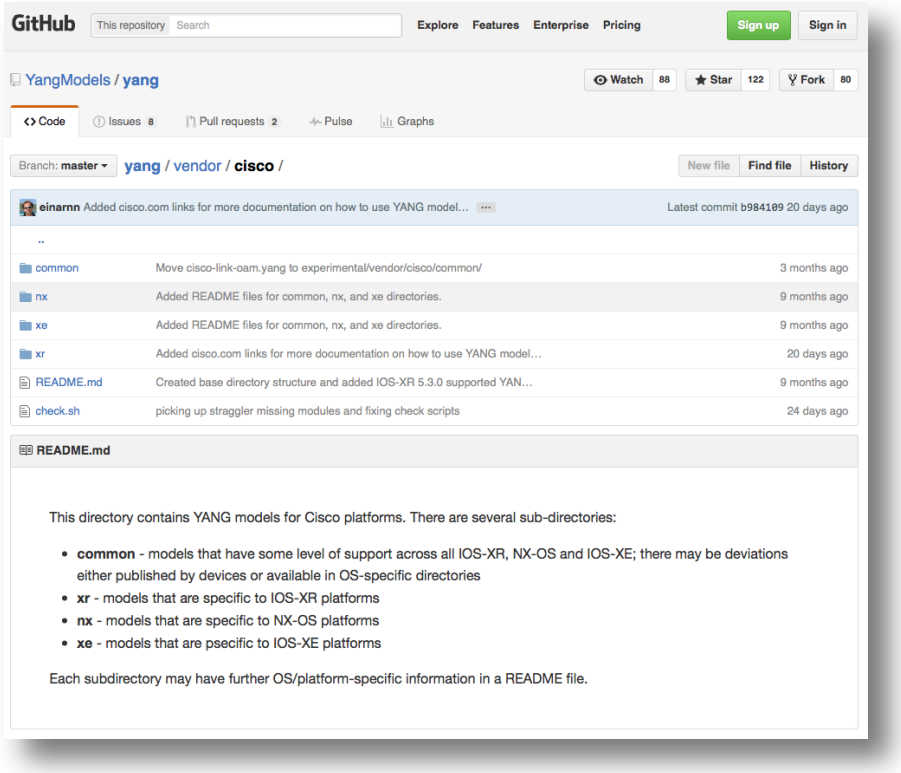
- Look familiar?
  - Description of all interfaces
    - Can be named, described, typed, enabled (or not), set for traps

```
module: ietf-interfaces
   +--rw interfaces
   |  +--rw interface* [name]
   |     +--rw name                          string
   |     +--rw description?                  string
   |     +--rw type                          identityref
   |     +--rw enabled?                      boolean
   |     +--rw link-up-down-trap-enable?     enumeration {if-mib}?
```

Where to get the Models?

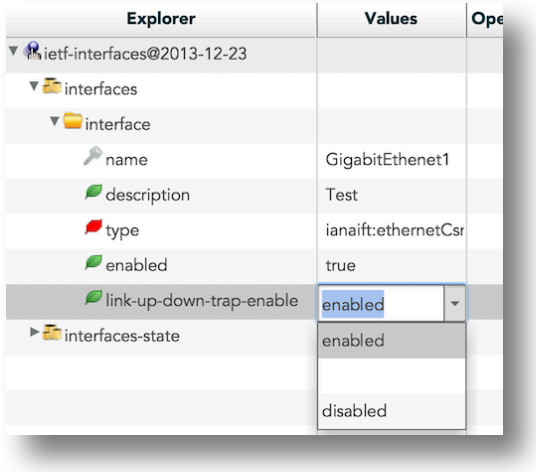
https://github.com/YangModels/yang

"YANG modules from standard organizations such as the IETF, open source such as Open Daylight or vendor specific modules"
https://github.com/CiscoDevNet/xe-netconf-yang **
During a lab, like here ☺



Tools to work with YANG Models

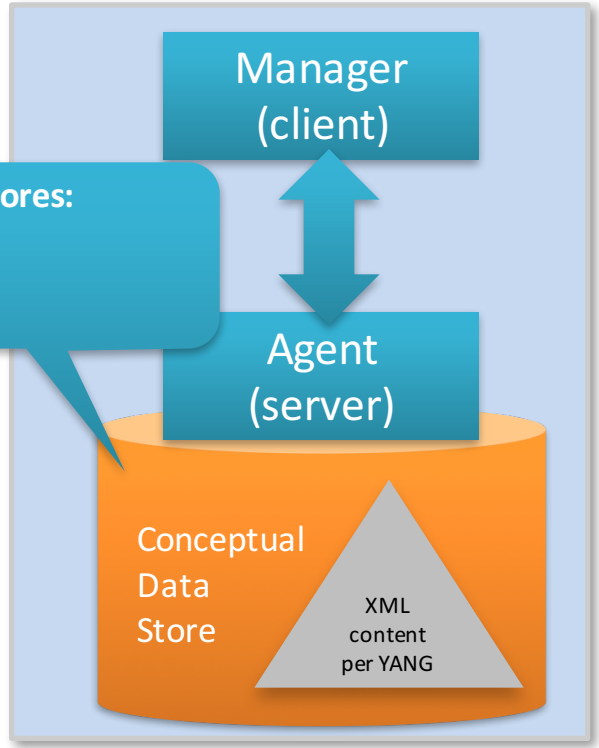
- **pyang** 'An extensible YANG validator and converter in python'
  - https://github.com/mbj4668/pyang
  - Via PyPi: `pyang - A YANG (RFC 6020) validator and converter`
  - Mandatory tool ☺
- **YANG Explorer** 'An open-source YANG Browser and RPC Builder Application'
  - https://github.com/CiscoDevNet/yang-explorer
  - Web Based GUI
  - More difficult to get started with



NETCONF

NETCONF Overview

Management info (definition)	e.g., YANG modules
Management info (instantiated/payload)	XML-encoded content
Management Services	NETCONF operations <edit-config>, <get-config>, <get>
Remote Operations	Netconf RPC <rpc>, <rpc-reply>
Transport	TLS, SSH



NETCONF Highlights

- **Transactional**
  - Either **all** configuration is applied **or nothing**
  - Avoids **inconsistent state**
  - Both at **Single Device** and **Network-wide** level

- **Error** Management
  - OK or error code

- **Capability Exchange**

```
ssh -p 830 admin@172.26.249.169 -s netconf
```

- **Models Download** from a Device

NETCONF Capabilities

- How do I know what a box can support?

```
ssh -p 830 admin@o22-4451-1 -s netconf
```

  - Many other ways too.
  - This is the capabilities exchange defined by the RFC

- Can I download all these models to help me code?

```
<get-schema
xmlns="urn:ietf:params:xml:ns:yang:ietf-netconf-
monitoring">
</get-schema>
```

  - This is great for integrating.

NETCONF Datastores – Target of Operations

*"A Datastore holds **a copy of the configuration data** that is required to get a device from its initial default state into a desired operational state"*

Running is the **only mandatory** Datastore

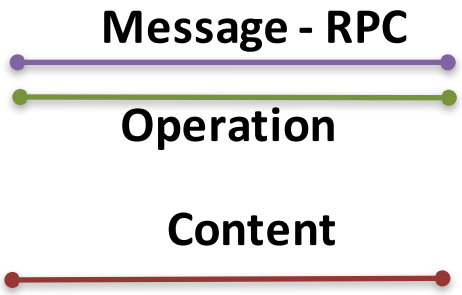
NETCONF Operations

Main Operations		Description
<get>	(close to 'show ?')	Retrieve running configuration and device state information
<get-config>	(close to 'show run')	Retrieve all or part of specified configuration datastore
<edit-config>	(close to 'conf t')	Loads all or part of a configuration to the specified configuration datastore

Other Operations	Description
<copy-config>	Replace an entire configuration datastore with another
<delete-config>	Delete a configuration datastore
<commit>	Copy candidate datastore to running datastore (ex: XR)
<lock> / <unlock>	Lock or unlock the entire configuration datastore system
<close-session>	Graceful termination of NETCONF session
<kill-session>	Forced termination of NETCONF session

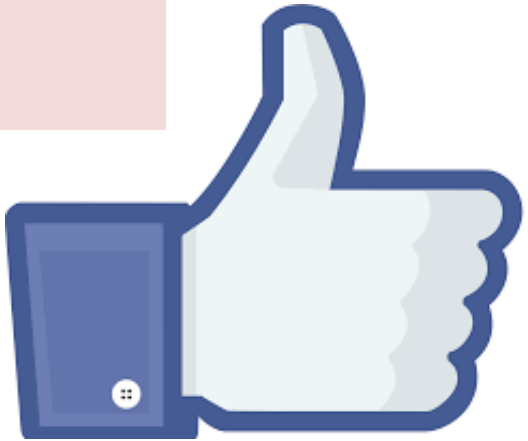
NETCONF Stack

```
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <get>
    <filter>
      <interfaces  xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
        <interface>
          <name>GigabitEthernet1/0/1</name>
        </interface>
      </interfaces>
    </filter>
  </get>
</rpc>
```



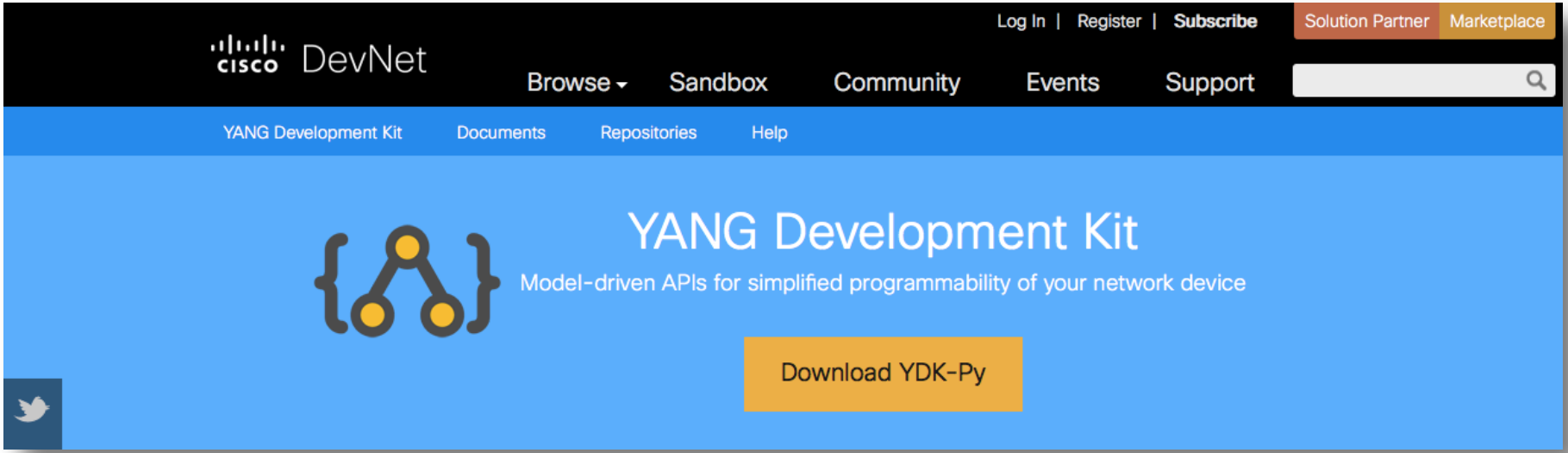
Three Things to Like about NETCONF

1. Capability discovery, model download
2. Transactions
3. Notifications

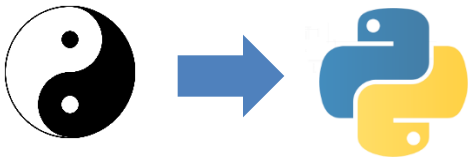


YDK – The YANG Development Kit

https://developer.cisco.com/site/ydk/



YDK turns YANG models in Python classes



Example Configure IPSLA

Using YDK

```
from ydk.models.ned import ned
from ydk.services import CRUDService
from ydk.providers import NetconfServiceProvider
from ydk.types import Empty

cs = CRUDService()

ne = NetconfServiceProvider(address="127.0.0.1", port=830, username="admin", password="cisco")
ipsla_cfg = ned.Native.Ip.Sla()

ipsla_entry = ned.Native.Ip.Sla.Entry()
icmp_echo = ned.Native.Ip.Sla.Entry.IcmpEcho()
icmp_echo.destination = "8.8.8.8"
ipsla_entry.number = 2
ipsla_entry.icmp_echo = icmp_echo

schedule = ned.Native.Ip.Sla.Schedule()
schedule.entry_number = 2
schedule.life = ned.Native.Ip.Sla.Schedule.LifeEnum.FOREVER
start_time = ned.Native.Ip.Sla.Schedule.StartTime()
start_time.now = Empty()
schedule.start_time = start_time

ipsla_cfg.entry.append(ipsla_entry)
ipsla_cfg.schedule.append(schedule)

cs.create(ne, ipsla_cfg)
```

All the model XML becomes Python object code

Creates the XML…

…Performs the NETCONF `<edit-config>`

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https://www.ciscolive.com/latam/attend-es/attendee-info/#mobile-app (Español)

➢ or from the Session Catalog on CiscoLive.com/latam.

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Thank you

Building the Environment

This is a rough guideline how to bring up / prepare the entire environment.

- Git client
- VirtualBox 5.0.28
- Docker 1.13.1
- Vagrant 1.8.7 (be aware of this issue)
- cdrtools (in particular mkisofs)
- a build environment (e.g. compiler, make, ...), suggest to use MacPorts or Brew if running on a Mac
- Clone the iso-xrv-x64-vbox repository from GitHub
- IOS XE image from Cisco.com (e.g. here, then go to *IOS XE Software* and download the Denali-16.5.2 .iso file in the *Latest* tree branch, ~350MB in size)

Building the Environment (cont)

Building the Vagrant Box

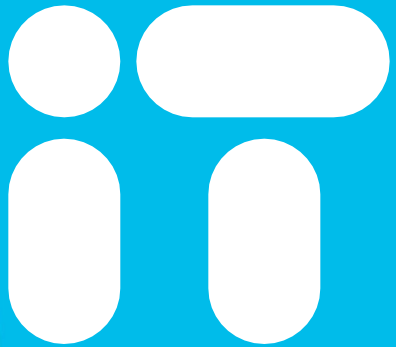
- Go to the directory where you cloned the iso-xrv-x64-vbox repository. Start the Vagrant box image build by running the following command
- iosxe_iso2vbox.py -v ~/Downloads/csr1000v-universalk9.16.05.02.iso
- This will take a while. When done, you need to install the resulting box into Vagrant:
- vagrant box add --name iosxe csr1000v-universalk9.16.05.02.box
- (See the output at the end of the script. It has the exact location of the generated box file and also the command to add / replace the Vagrant box file).

Configure and Start Routers

The next steps are required to prepare configuration disks for the routers

- Clone this repo from GitHub into a new directory: https://github.com/kuhlskev/devnet1002
- Make sure that the Vagrant box name matches the one configured in the Vagrant file
- Ensure you have the required tools installed
- run make to create the ISO files with the router configurations
- Bring up the routers using vagrant up (brings up both) or vagrant up rtr1 to only start rtr1

You're



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