NetDevOps for the Network Dude
How to get started with API's, Ansible and Python

Agenda

- Introduction
- Automation Motivation
- Tools: Ansible for CLI automation
- API's: better machine communication with NETCONF
- Configuration Abstraction
- Conclusion

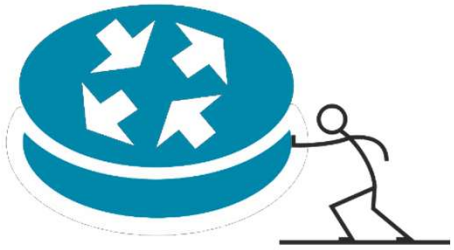
Motivators for Automation

Cloud-scale:

- Lots of Equipment:
  1000 Network Devices
- Multiple Operating Systems:
  - IOS, IOSXR, IOSXE, NXOS, ASA OS
  - Multivendor Security Appliances (WAF, DDoS, LB)
- Small team: 6 people
- Rapid Deployment
  - Several new Datacenters per year
  - Several Service Deployments requiring changes

Enterprise-scale:

- Daily repetitive tasks:
  - New device configuration
  - 3rd party NMS config
  - Change one config line on all your devices (NF collector,…)
- Monitoring:
  - Be alerted when a route goes away



What is Ansible

Ansible, an open source community project sponsored by Red Hat, is the simplest way to automate IT.

Ansible is the only automation language that can be used across entire IT teams – from systems and network administrators to developers and managers.

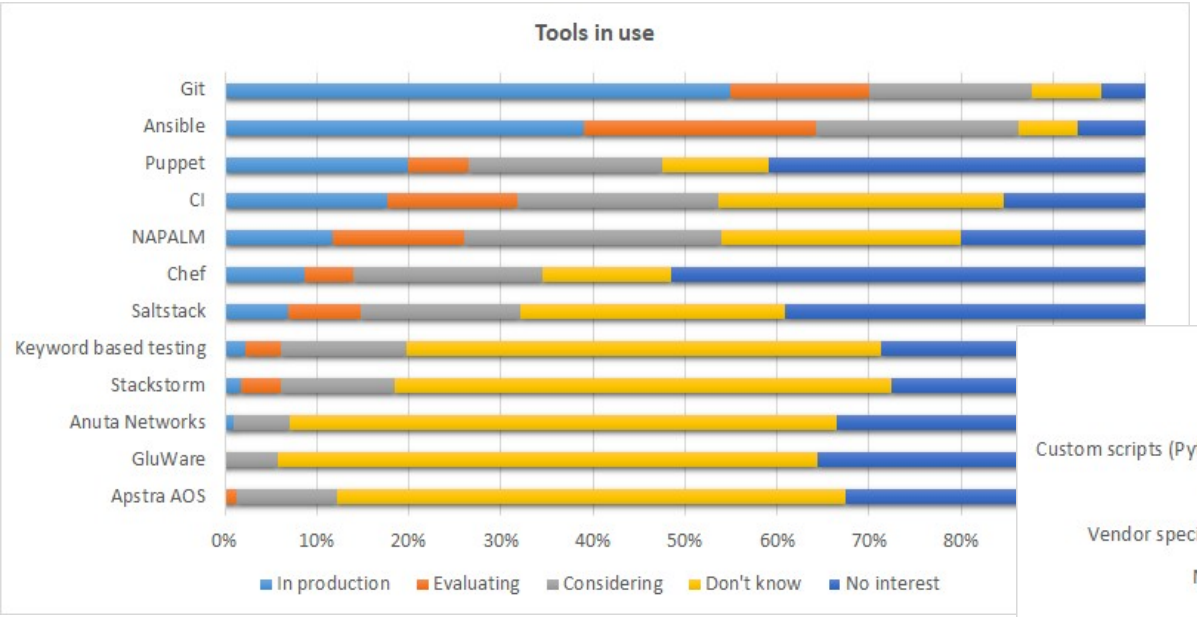
Ansible by Red Hat provides enterprise-ready solutions to automate your entire application lifecycle – from servers to clouds to containers and everything in between.

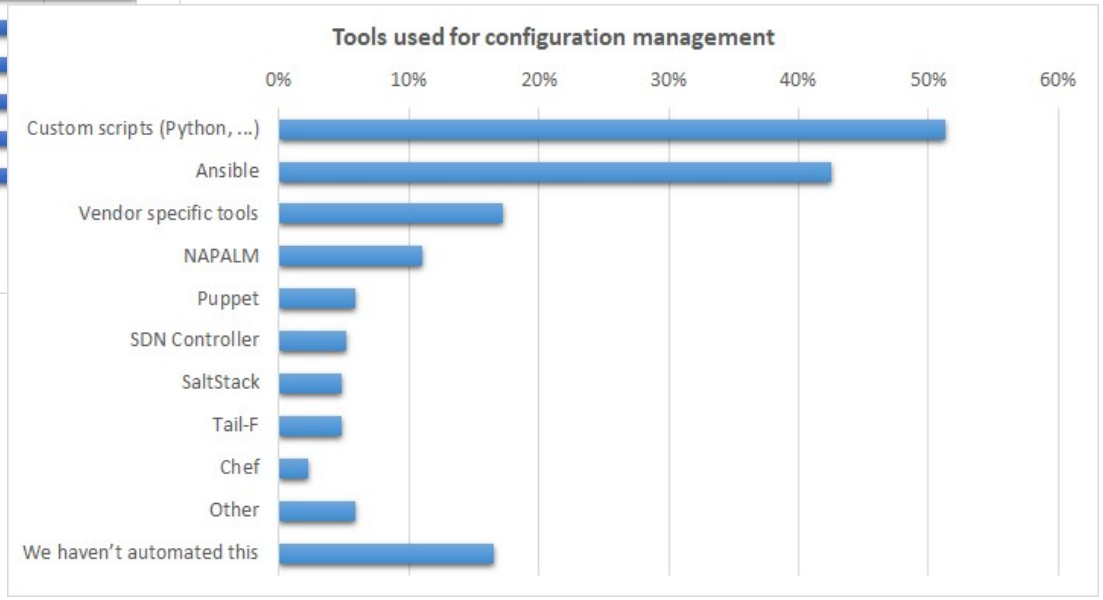
It uses no agents and no additional custom security infrastructure, so it's easy to deploy - and most importantly, it uses a very simple language (YAML, in the form of Ansible Playbooks) that allow you to describe your automation jobs in a way that approaches plain English.

Why choose Ansible?

- Agentless
- Server and support teams already using Ansible
- Infrastructure as code
- Simple to use and learn
- Community and vendor driven
- Modular framework, easily modified
- Leverage many common programming languages

DevNet Survey

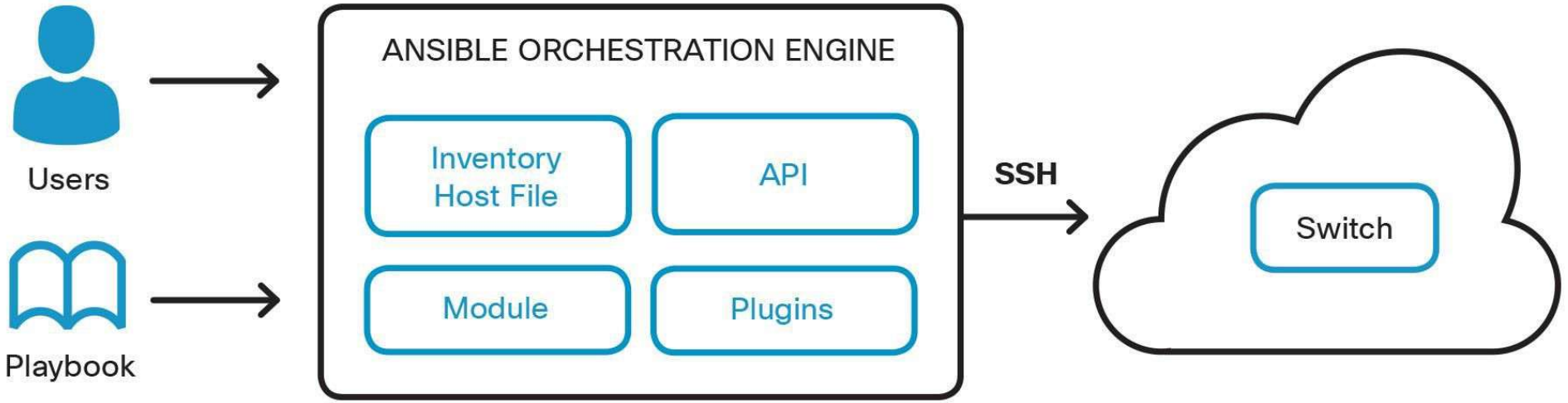




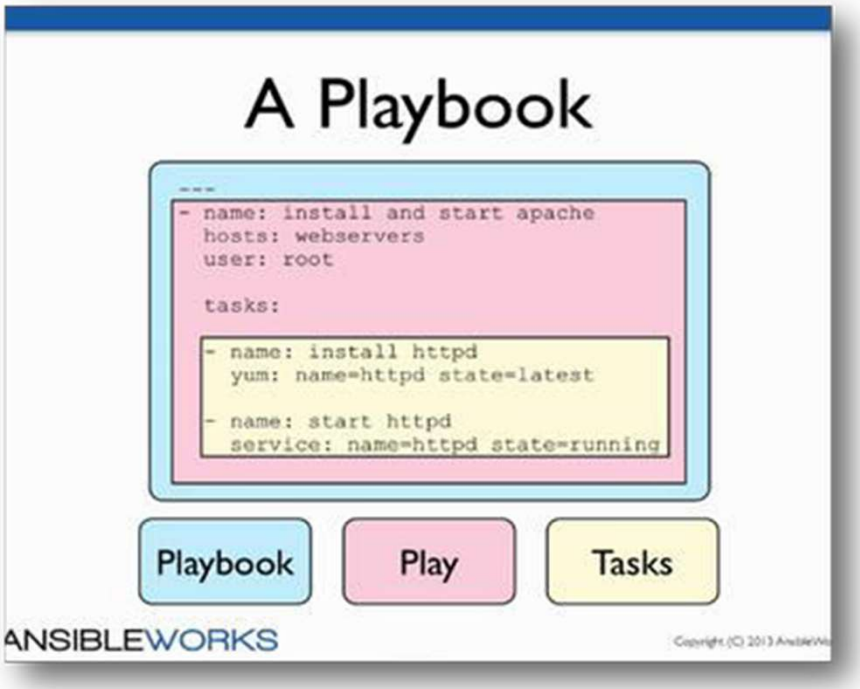
Source:

https://interestingtraffic.nl/2017/03/27/insights-from-the-netdevops-fall-2016-survey/

Ansible Configuration Management Workflow



Ansible Terms




```
kekuhls (master *) devnet1002 $ tree devnet1002/
devnet1002/
├── inventory
├── ios_example.yaml
├── ios_template.yaml
├── library
|   ├── netconf_config_kev.py
|   └── netconf_config_new.py
├── nc_example.yaml
├── nc_template.yaml
├── passwords.yml
├── requirements.txt
├── roles
|   └── iosv_config
|       ├── tasks
|       |   └── main.yml
|       ├── templates
|       |   └── router_full.j2
|       └── vars
|           └── main.yml
└── vars.yaml

6 directories, 13 files
```

Ansible for Networking


```
- name: load new acl into device
  ios_config:
    lines:
    - 10 permit ip host 1.1.1.1 any log
      - 20 permit ip host 2.2.2.2 any log
      - 30 permit ip host 3.3.3.3 any log
      - 40 permit ip host 4.4.4.4 any log
    - 50 permit ip host 5.5.5.5 any log
    parents: ip access-list extended test
    before: no ip access-list extended test
    match: exact
    provider: "{{ cli }}"
```

Jinja Template

Contains **variables** and/or **expressions** which get replaced with values when *rendered*

 # Simple Variable Replacment
hostname {{sitecode}}-fw

 # Variable Replacement based on Dictionary
route outside 0.0.0.0 0.0.0.0 {{config['vlan101']['ip'][1]}}

 # Variable Replacement by Filter
route outside 0.0.0.0 0.0.0.0 {{ external_net_cidr | ipaddr('1') | ipaddr('address') }}"

 # Loop Through set of data to create multiple lines
{%for route in config['routes'] %}
route oob-vpn {{config['routes'][route]['network']}} {{config['routes'][route]['mask']}} {{config['vlan90']['ip'][1]}}
{% endfor %}

 # Conditional Statements
{% if config['vlan41'] is defined %}
route dmzext {{config['vlan41']['ip'][0]}} {{config['vlan41']['ip'].netmask}} {{config['vlan102']['ip'][1]}}
{endif %}

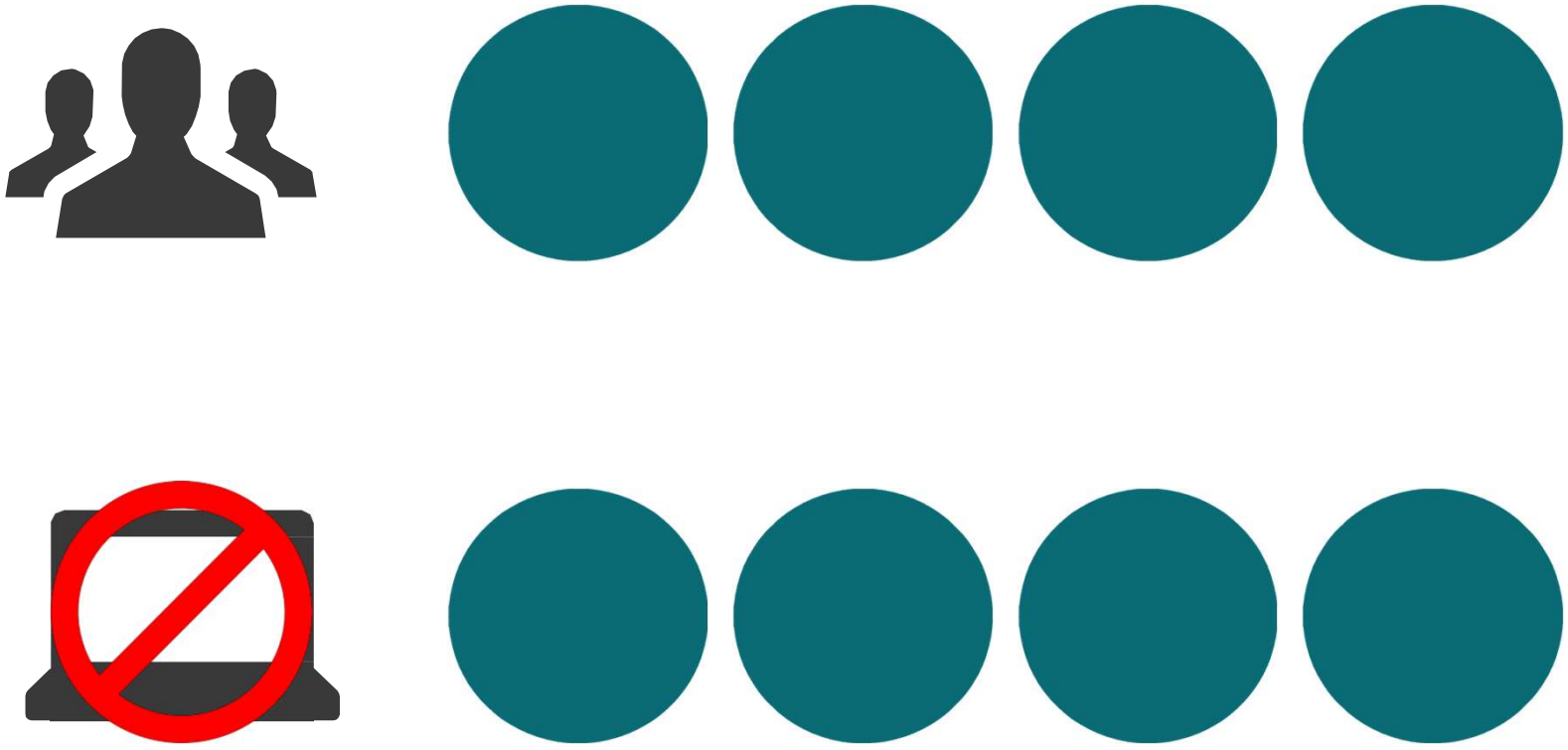
Yaml

- Structure to define:
  - dictionary (unordered set of key value pairs, lists)
  - list of items
  - key value pair

```
# A sample employee record
name: Francois Caen
job: Systems Engineer
employed: True
languages:
    French: Native
    English: Fluent
    German: Novice
    python: Novice
education: Maitrise
favorite drinks:
    - beer
    - gin
```

Ansible 2.x Exercise

Configuration Management Today: CLI

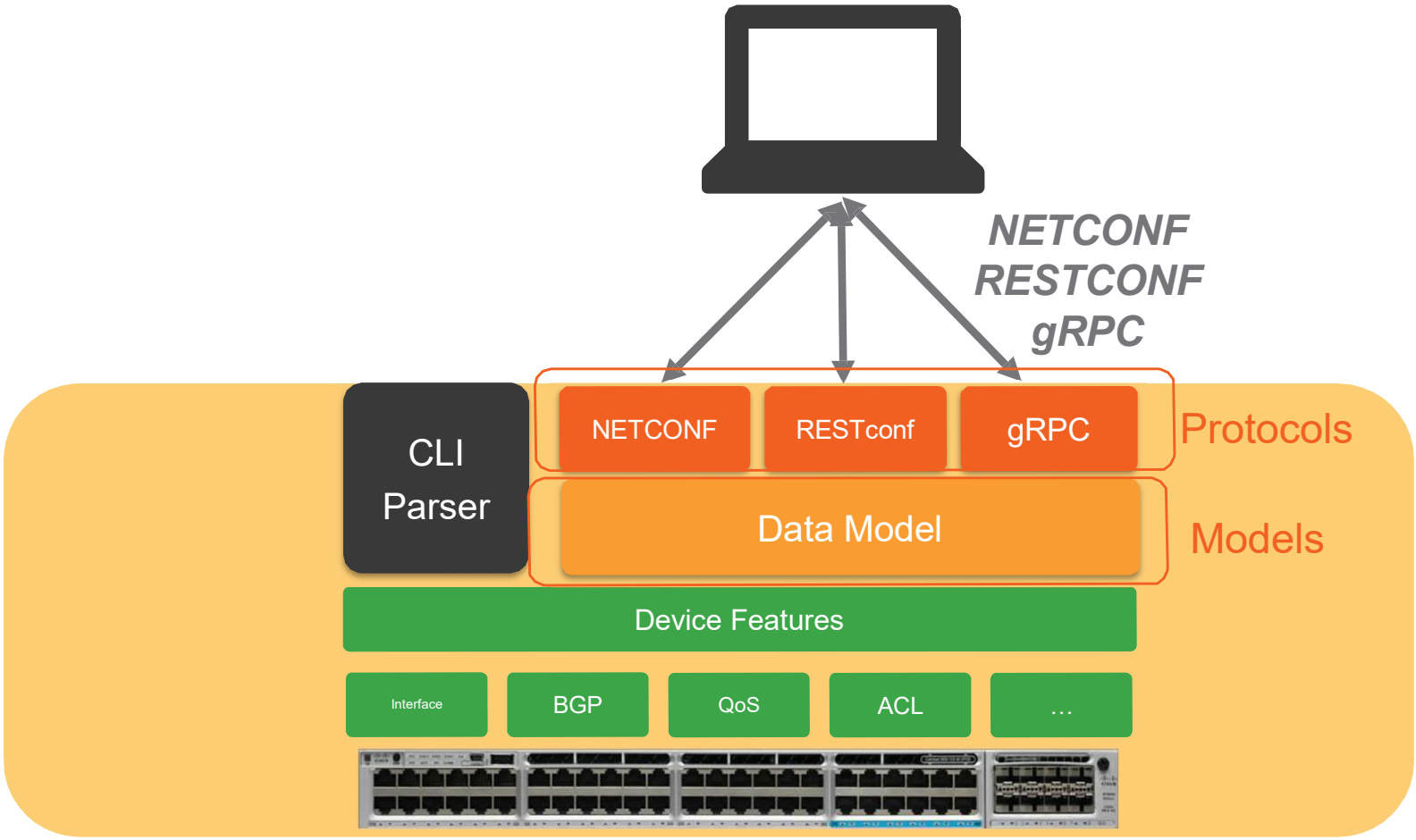


APIs – Application Programming Interfaces

"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

Open Programmable Interface



NETCONF definition

*"NETCONF is **a protocol defined by the IETF** to **install**, **manipulate**, and delete the **configuration of network devices**"*

V 1.0	V 1.1	Extensions
• RFC 4741 1.0 Base NETCONF Protocol • RFC 4742 NETCONF over SSH	• RFC 6241 – 1.1 Base NETCONF Protocol • RFC 6242 – NETCONF over SSH	• RFC 5277 Notifications • RFC 5717 Partial Locking • RFC 6243 With defaults • RFC 6020 YANG

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

<get-config>

```
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <get-config>
    <source>
      <running/>
    </source>
    <filter>
      <interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
        <interface>
          <name>GigabitEthernet0</name>
        </interface>
      </interfaces>
    </filter>
  </get-config>
</rpc>
```

<get-config> Response

```
<rpc-reply message-id="urn:uuid:bdb1189e-4480-11e6-8507-fa163e2846a4"
xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0">
  <data>
    <interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
      <interface>
        <name>GigabitEthernet0</name>
        <type xmlns:ianaift="urn:ietf:params:xml:ns:yang:iana-if-type">ianaift:ethernetCsmacd</type>
        <enabled>true</enabled>
        <ipv4 xmlns="urn:ietf:params:xml:ns:yang:ietf-ip">
          <address>
            <ip>172.26.170.253</ip>
            <netmask>255.255.254.0</netmask>
          </address>
        </ipv4>
        <ipv6 xmlns="urn:ietf:params:xml:ns:yang:ietf-ip"/>
      </interface>
    </interfaces>
  </data>
</rpc-reply>
```

<edit-config>

```
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
        <interface>
          <name>GigabitEthernet0/0/0</name>
          <ipv4 xmlns="urn:ietf:params:xml:ns:yang:ietf-ip">
            <address>
              <ip>1.1.1.1</ip>
              <netmask>255.255.255.255</netmask>
            </address>
           </ipv4>
        </interface>
      </interfaces>
    </config>
  </edit-config>
</rpc>
```

<edit-config> Response

```
<rpc-reply message-id="urn:uuid:d5fa0c22-4484-11e6-9132-fa163e2846a4"
xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0">
  <ok/>
</rpc-reply>
```

Ansible for Networking


```
- name: configure new ntp server
  netconf_config:
  xml: |
  <config xmlns:xc="urn:ietf:params:xml:ns:netconf:base:1.0">
    <system xmlns="urn:ietf:params:xml:ns:yang:ietf-system">
      <ntp>
        <enabled>true</enabled>
          <server>
            <name>ntp1</name>
            <udp><address>127.0.0.1</address></udp>
          </server>
        </ntp>
      </system>
    </config>
```

NETCONF Exercise

Three Things to Like about NETCONF

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

Configuration Abstraction

Infrastructure as Code Example

Variable structure to represent SD-Access

```
fabric:
  - tenant_name: DEVELOPMENT
    tenant_id: 103
    ints:
      - vlan_id: 3240
        name: "10_103_240_0-DATA"
        subnet: " 10.103.240.0/24"
  - tenant_name: EMPLOYEE
    tenant_id: 101
    ints:
      - vlan_id: 1240
        name: "10_101_240_0-DATA"
        subnet: " 10.103.240.0/24”
      - vlan_id: 1241
        name: "10_101_241_0-VOICE"
        subnet: " 10.101.241.0/24”
```

Building the Environment

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

- Git client
- VirtualBox 5.2.6
- Vagrant 2.0.1
- Docker 17.12
- 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 Everest-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