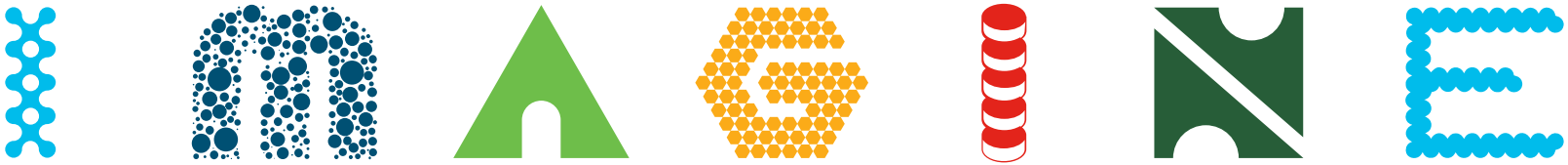

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#CLUS

Network Automation using YANG Models & DevOps Tools across IOS-XE, IOS-XR, & NX-OS

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LTRSDN-2260

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Agenda

- Dockerized Dev Environment
- Model Driven Programmability Foundations
- NETCONF YANG with Ansible
- NETCONF YANG using ncclient
- Python YANG Development Kit (YDK)
- RESTCONF YANG with Python Requests
- (Bonus) Introduction to Cisco NSO
- (Bonus) YDK-Gen
- Lab Overview
- Additional References

Cisco Webex Teams

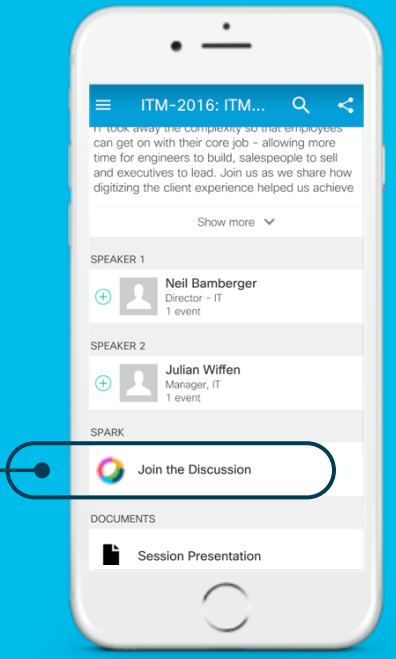
Questions?

Use Cisco Webex Teams (formerly Cisco Spark) to chat with the speaker after the session

How

1. Find this session in the Cisco Events App
2. Click “Join the Discussion”
3. Install Webex Teams or go directly to the team space
4. Enter messages/questions in the team space

Webex Teams will be moderated by the speaker until June 18, 2018.

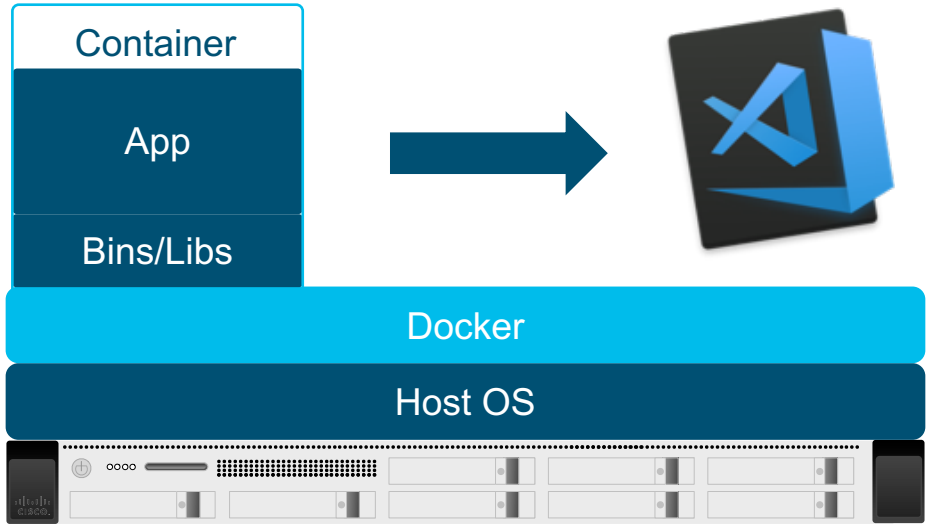


cs.co/ciscolivebot#LTRSDN-2260

Dockerized Dev Environment

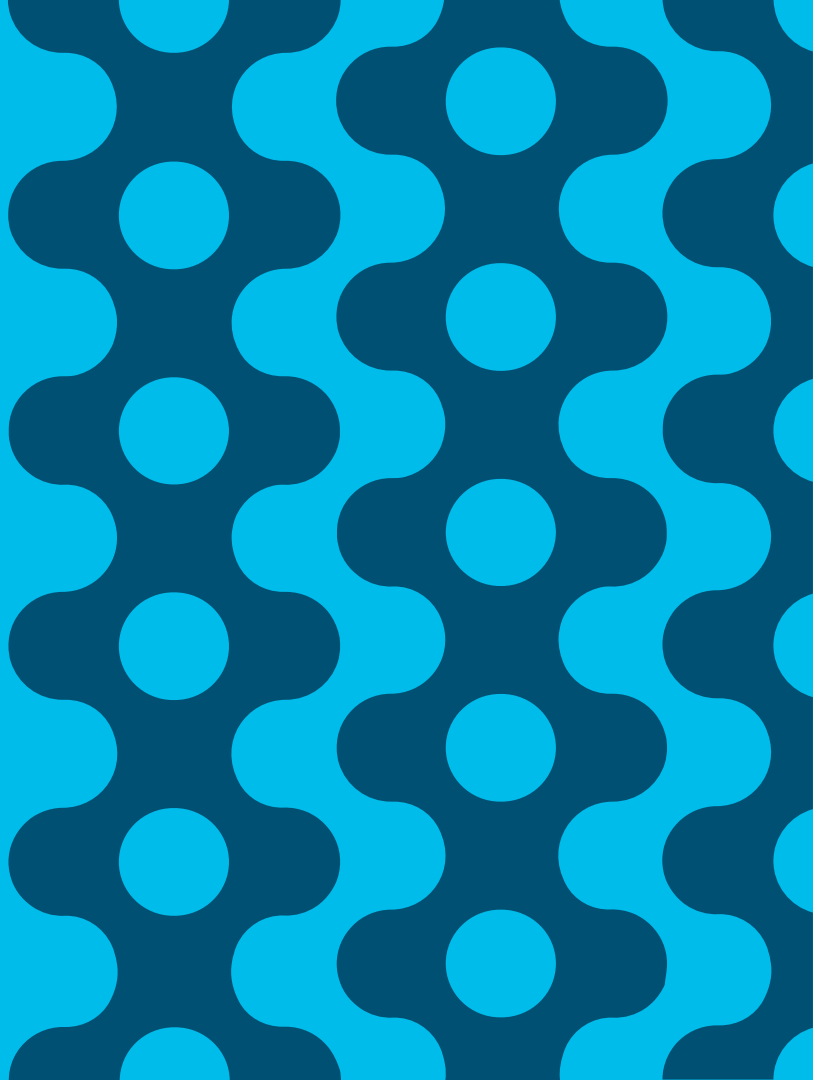
Docker Dev Environment

- CentOS Host
- Docker Container with libraries and packages pre-installed
- Python executed in Docker Container
- Development done on local CentOS using VS Code
- Container/Host OS share workspace folder

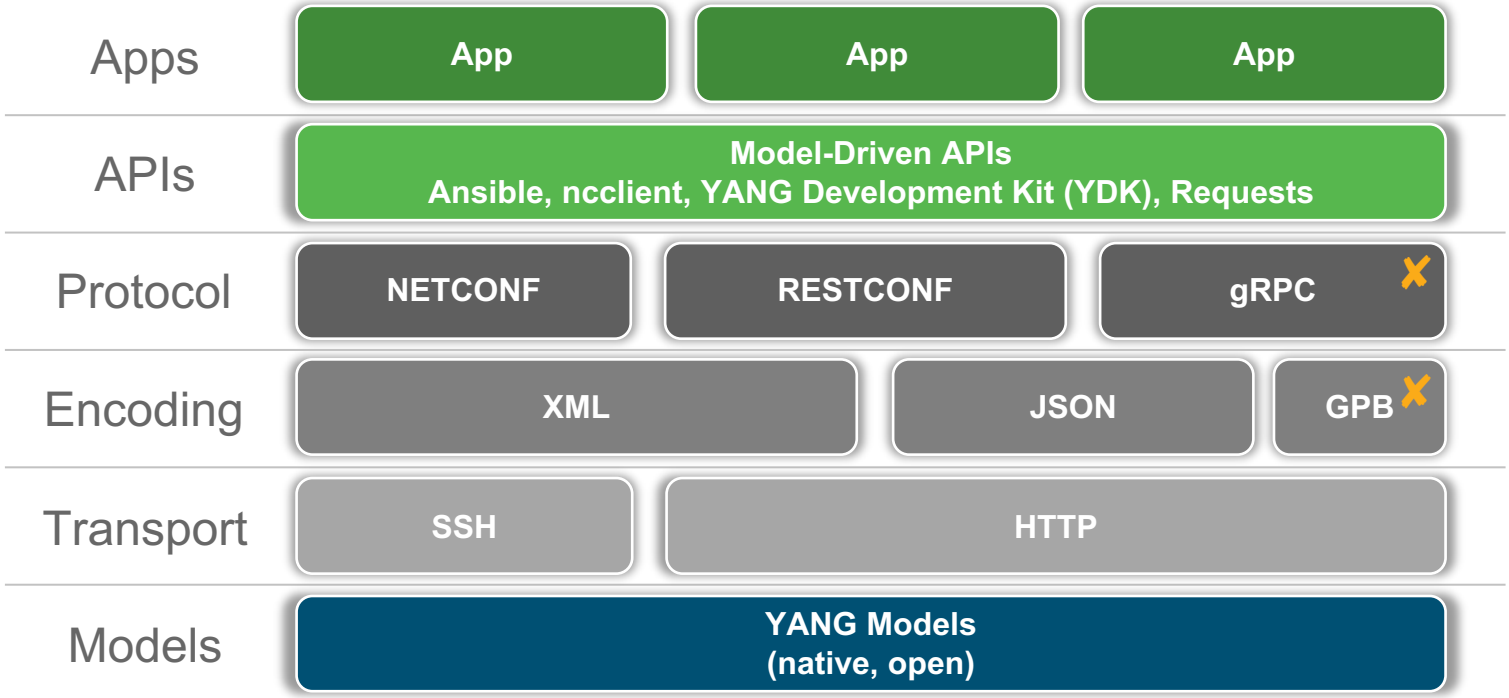



```
[root@ciscolive-pod-centos Devel]# docker ps -a
CONTAINER ID      IMAGE                                          COMMAND          CREATED             STATUS              PORTS          NAMES
b2d920ff6763    ciscolive-docker-registry-2:5000/ltrsdn-2260   "bash"           10 seconds ago      Up 9 seconds                       ltrsdn-2260
```

Model Driven Programmability

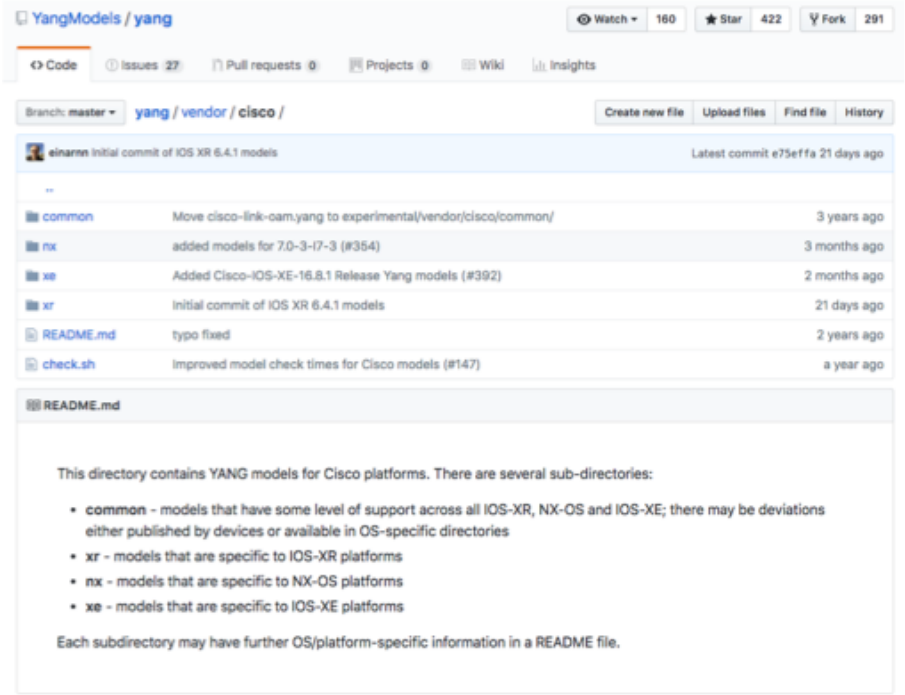


Model-Driven Programmability



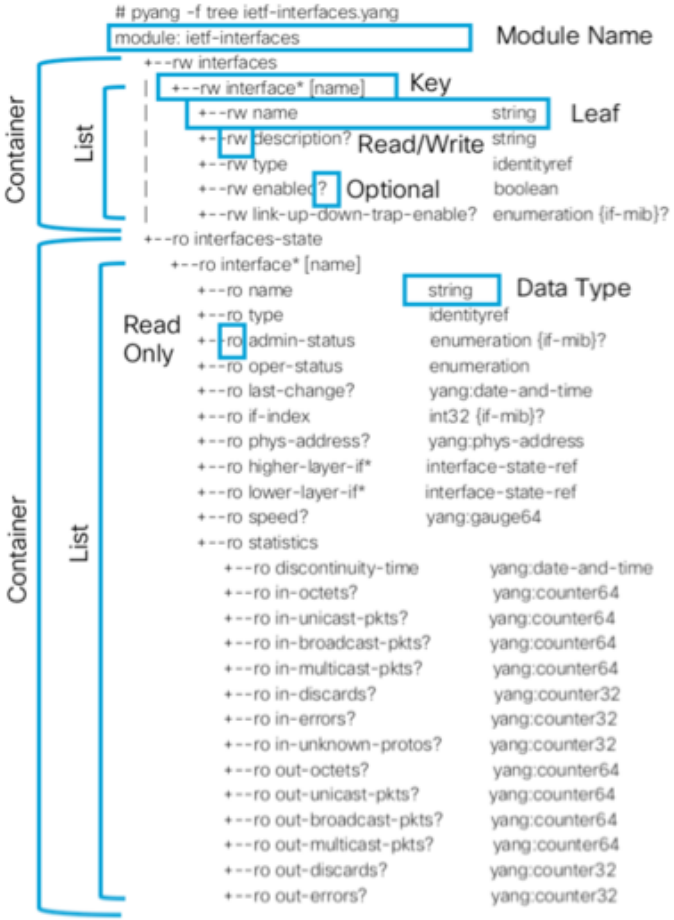
Where are YANG Models Found?

- GitHub is the primary source
- YANG models from SDOs: https://github.com/YangModels/yang
- YANG models from OpenConfig: https://github.com/openconfig/public
- Vendor housed YANG models in respective repos



YANG

- Industry standardized structured data modeling language
- Top-level module that is self-contained hierarchy of nodes
- Containers used to group related nodes
- Lists of nodes that are stored in sequence
- Nodes are represented by a leaf
- Each leaf must have an associated type



YANG Augmentations & Deviations

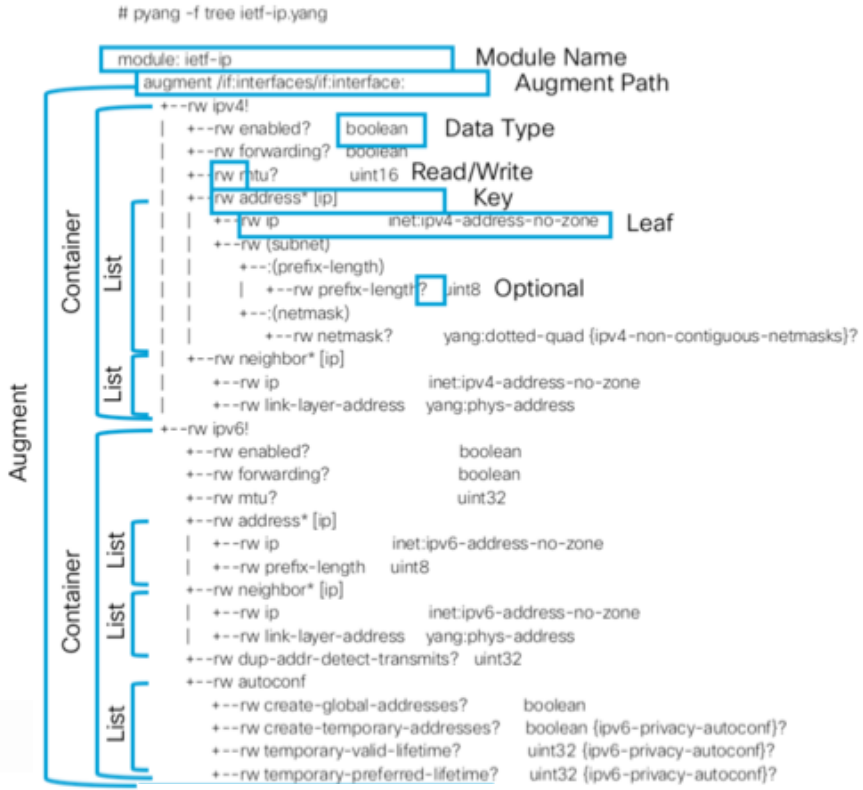
Augmentations

- Expansion of existing data model to add feature/functionality
- Done using augment keyword

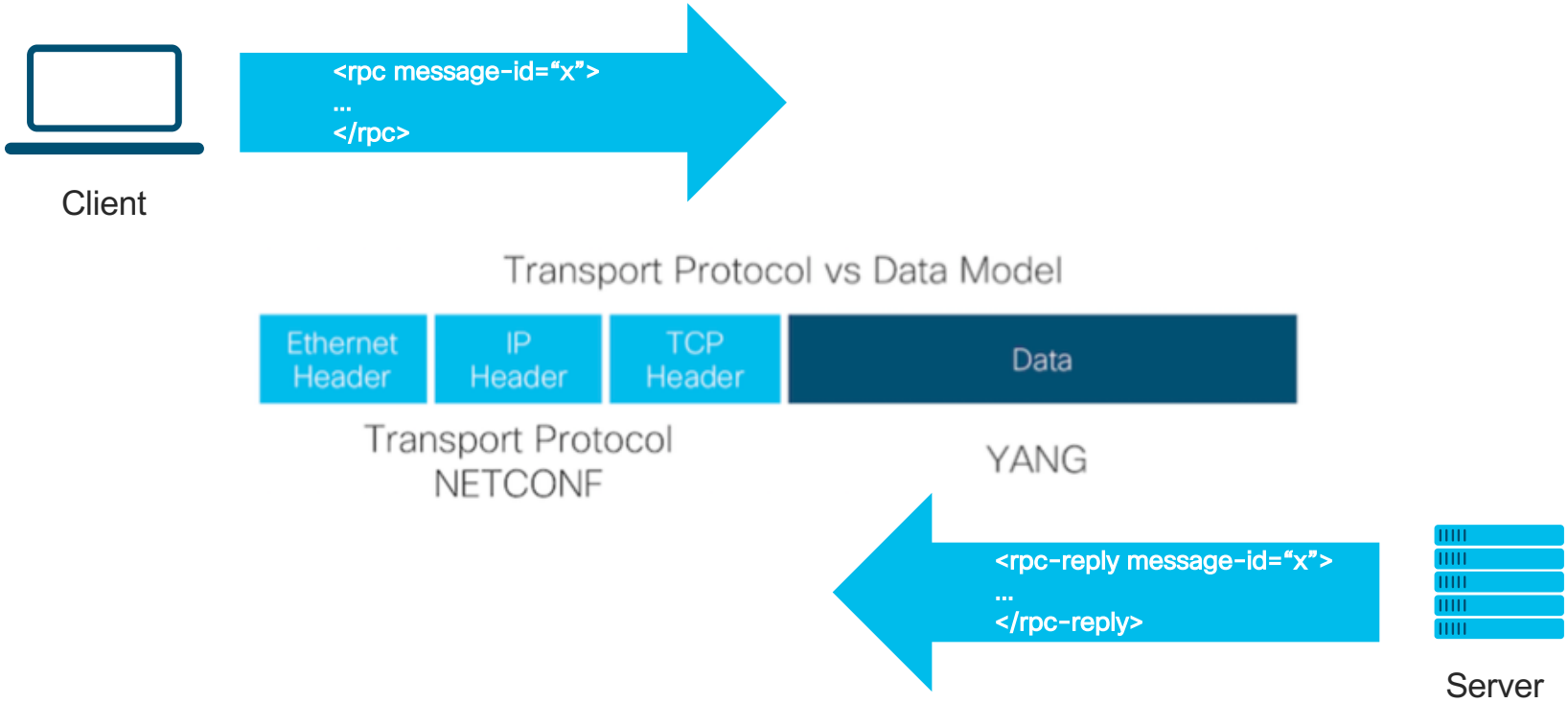
Deviations

- The world isn't perfect…
- Used to annotate when model is different, lacks support, etc

```
deviation /if:interfaces/if:interface/ip:ipv4/ip:mtu {
    deviate not-supported;
    description  "Not supported in IOS-XE 3.17 release.";
}
```



NETCONF (Network Configuration Protocol)

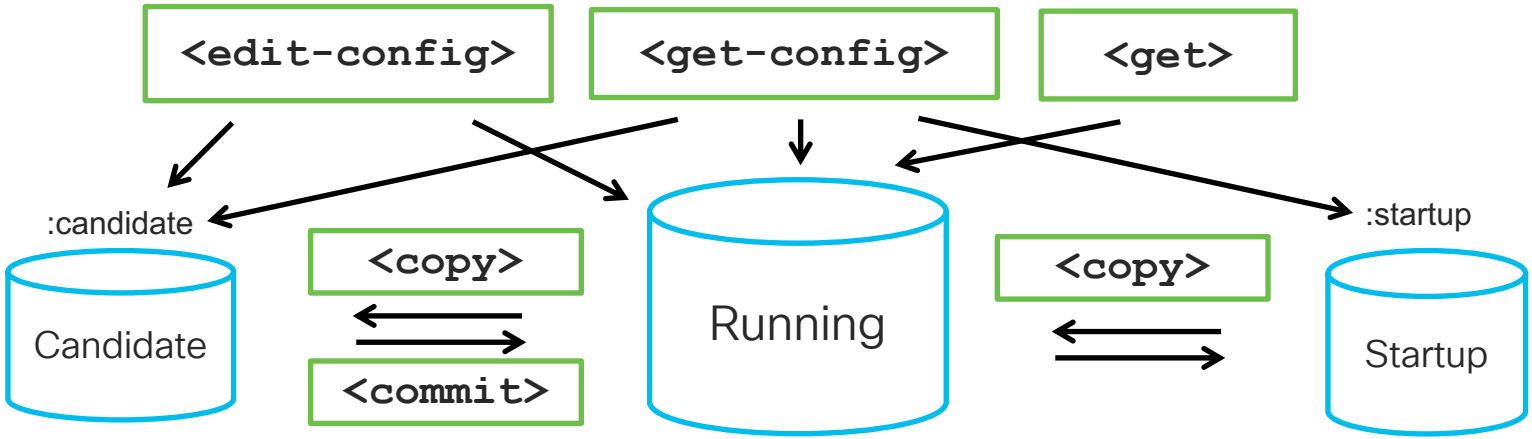


NETCONF Operations

Operation	Description
<get>	Retrieve running configuration and device state information
<get-config>	Retrieve all or part of specified configuration data store
<edit-config>	Loads all or part of a configuration to the specified data store
<copy-config>	Replace an entire configuration data store with another
<delete-config>	Delete a configuration data store
<commit>	Copy candidate data store to running data store
<lock> / <unlock>	Lock or unlock the entire configuration data store system
<close-session>	Graceful termination of NETCONF session
<kill-session>	Forced termination of NETCONF session

NETCONF Datastore Capabilities

Additional operations and content supported on a device

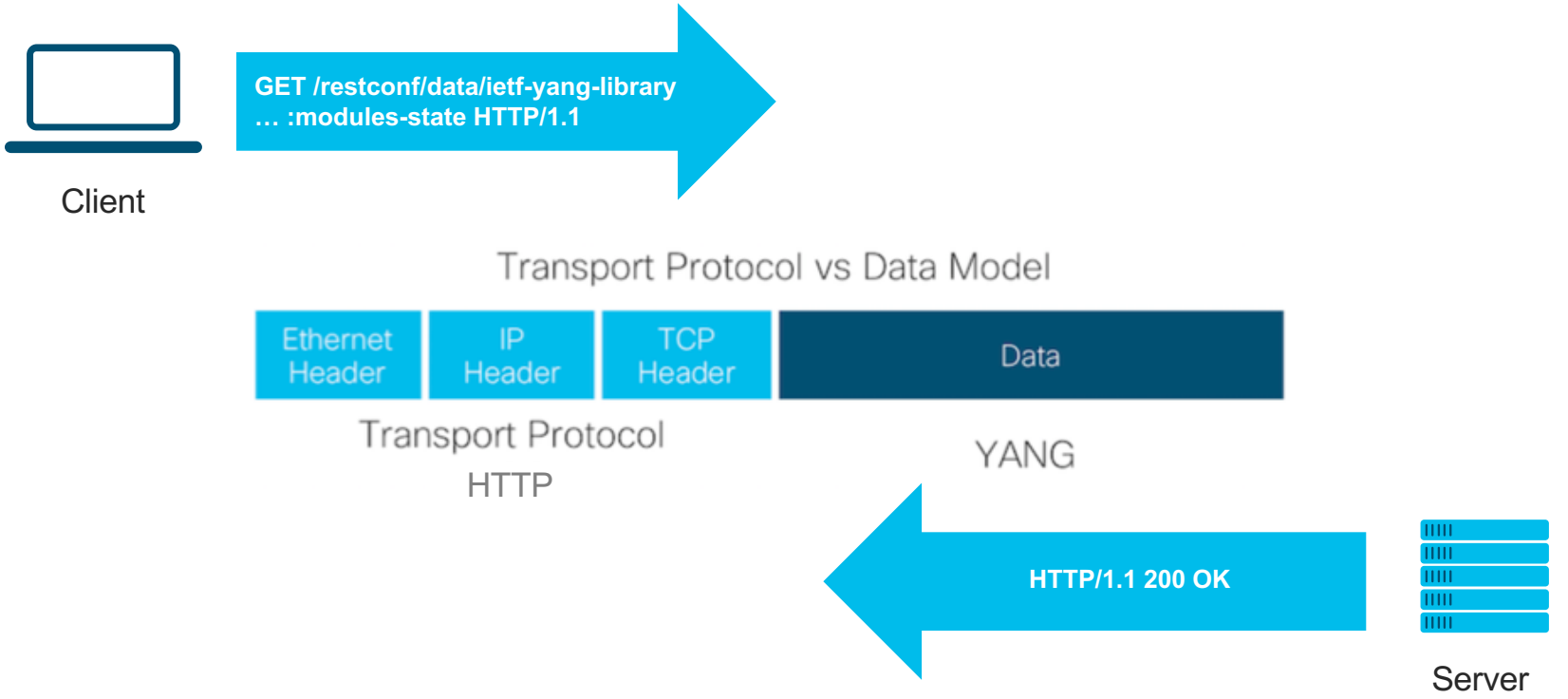


Working copy to manipulate with no impact on current configuration

Complete and active configuration and operations data

Configuration loaded at startup

RESTCONF (REST Configuration Protocol)



RESTCONF Operations (CRUD)

Operation	Description
GET	<get>, <get-config>
POST	<edit-config> (operation="create")
PUT	<edit-config> (operation="create/replace")
PATCH	<edit-config> (operation=”merge")
DELETE	<edit-config> (operation=”delete")

```
CRUD: Create, Read, Update, Delete
REST: Representative State Transfer
```

RESTCONF versus NETCONF: Summary

- RESTCONF: no notion of transaction
- RESTCONF: no notion of lock
- RESTCONF: no notion of candidate config and commit
- RESTCONF: no notion of two phase commit
- RESTCONF: no <copy-config>
- RESTCONF: some more granularity for query => "config", "nonconfig“, "all".
- RESTCONF: XML or JSON (while NETCONF is XML only)

NETCONF might be better for router and switches
RESTCONF might be better for controller north-bound interface

Lab Tasks

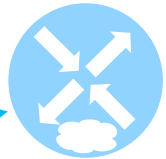
Enable MDP using Ansible

/playbook/roles/**<role>**/

role:
enable-xe-mdp
enable-xr-mdp
enable-nx-mdp

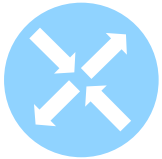
CLI Automation using
platform specific modules
to enable:
NETCONF
RESTCONF*

XE



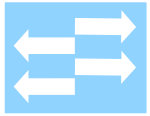
```
-name:ENABLE MDP FEATURES
 ios_config:
   lines:
     -netconf-yang
     -restconf
     -ip http secure-server
```

XR



```
-name:ENABLE NETCONF FEATURE
 iosxr_netconf:
   netconf_vrf:management
   netconf_port:830
   state:present
```

NX



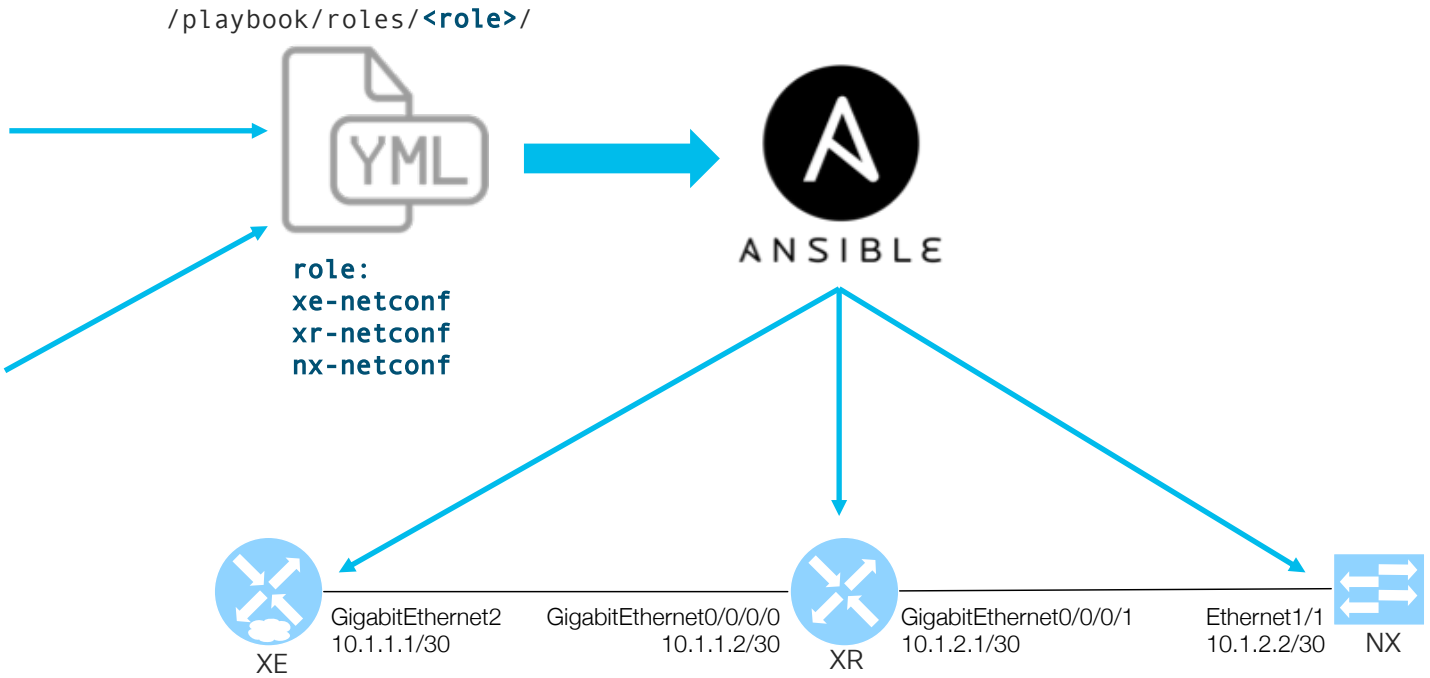
```
-name:ENABLE MDP FEATURES
 nxos_feature:
   feature:'{{ item }}'
   state:enabled
 loop:'{{ features }}'
```

*(where supported)

Ansible NETCONF

```
- name: THIS IS EXAMPLE 1
  netconf_config:
    look_for_keys: False
    hostkey_verify: False
    allow_agent: False
    datastore: running
    src: ./rpc.xml
```

```
- name: THIS IS EXAMPLE 2
  netconf_config:
    look_for_keys: False
    hostkey_verify: False
    allow_agent: False
    datastore: candidate
    xml: |
        <config>
        </config>
```



ncclient Manager

- Full NETCONF Manager implementation in Python
  - https://ncclient.readthedocs.io
- Simplifies connection and communication instantiation
- Deals in raw XML

```
with manager.connect(
    host='a.b.c.d',         # IP address of device
    port=830,               # Port to connect to
    username='user',        # SSH Username
    password='pass',        # SSH Password
    hostkey_verify=False  # Allow unknown hostkeys not in local store
    device_params={'name':<device type>} # Device connection parameters
)as m:                      # Context manager reference, i.e. instance of connected manager
```

ncclient – Get Configuration


```
with manager.connect(
   host='a.b.c.d',          # IP address of device
   port=830,                # Port to connect to
   username='user',   # SSH Username
   password='pass',   # SSH Password
   hostkey_verify=False     # Allow unknown hostkeys not in local store
   device_params={'name':<device type>} # Device connection parameters
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ncclient – Get Configuration


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   password='pass',   # SSH Password
   hostkey_verify=False     # Allow unknown hostkeys not in local store
   device_params={'name':<device type>} # Device connection parameters
)as m:                      # Context manager reference, i.e. instance of connected manager
```

```
int_filter='''
            <interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
                <interface>
                    <name>GigabitEthernet2</name>
                </interface>
            </interfaces>
           '''
```

ncclient – Get Configuration


```
with manager.connect(
   host='a.b.c.d',          # IP address of device
   port=830,                # Port to connect to
   username='user',   # SSH Username
   password='pass',   # SSH Password
   hostkey_verify=False     # Allow unknown hostkeys not in local store
   device_params={'name':<device type>} # Device connection parameters
)as m:                      # Context manager reference, i.e. instance of connected manager
```

```
    int_filter='''
                <interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
                    <interface>
                        <name>GigabitEthernet2</name>
                    </interface>
                </interfaces>
               '''
    reply=m.get_config('running',filter=('subtree',int_filter))
```

ncclient – Edit Configuration


```
with manager.connect(host='a.b.c.d', port=830, username='user', password='pass',
hostkey_verify=False, device_params={'name':<device type>})as m:
```

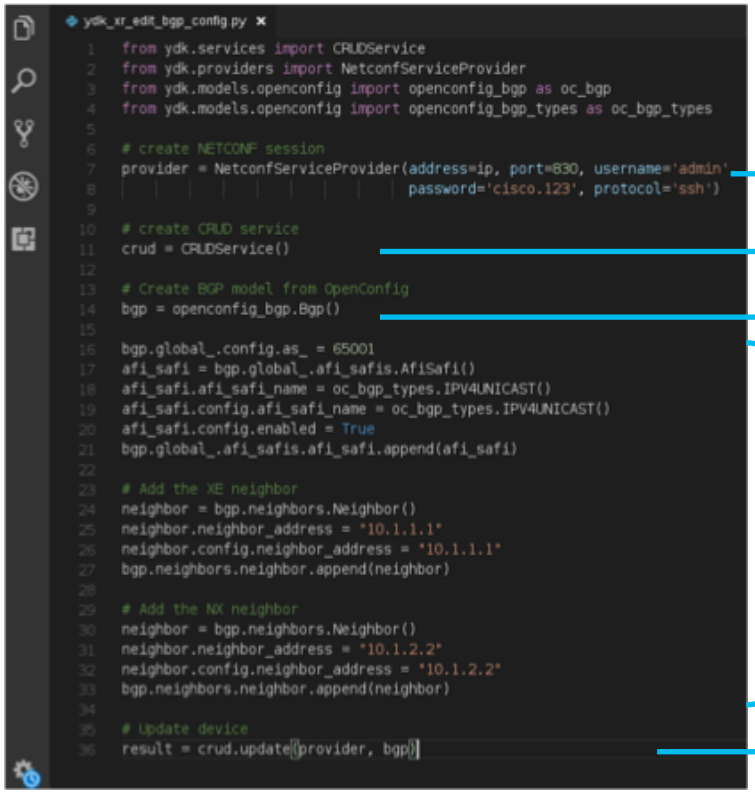
ncclient – Edit Configuration


```
with manager.connect(host='a.b.c.d', port=830, username='user', password='pass',
hostkey_verify=False, device_params={'name':<device type>})as m:
      rpc='''
          <config>
              <native xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-native">
                   <router>
                                <ospf xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-ospf">
                                    <id>100</id>
                                    <router-id>1.1.1.1</router-id>
                                    <network>
                                        <ip>10.1.1.0</ip>
                                        <mask>0.0.0.3</mask>
                                        <area>0</area>
                                    </network>
                                </ospf>
                           </router>
                      </native>
                 </config>
             '''
```

ncclient – Edit Configuration


```
with manager.connect(host='a.b.c.d', port=830, username='user', password='pass',
hostkey_verify=False, device_params={'name':<device type>})as m:
      rpc='''
          <config>
              <native xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-native">
                   <router>
                                <ospf xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-ospf">
                                    <id>100</id>
                                    <router-id>1.1.1.1</router-id>
                                    <network>
                                        <ip>10.1.1.0</ip>
                                        <mask>0.0.0.3</mask>
                                        <area>0</area>
                                    </network>
                                </ospf>
                           </router>
                      </native>
                 </config>
             '''
      reply=m.edit_config(rpc,target='running')
```

YANG Development Kit (YDK)



Device Information

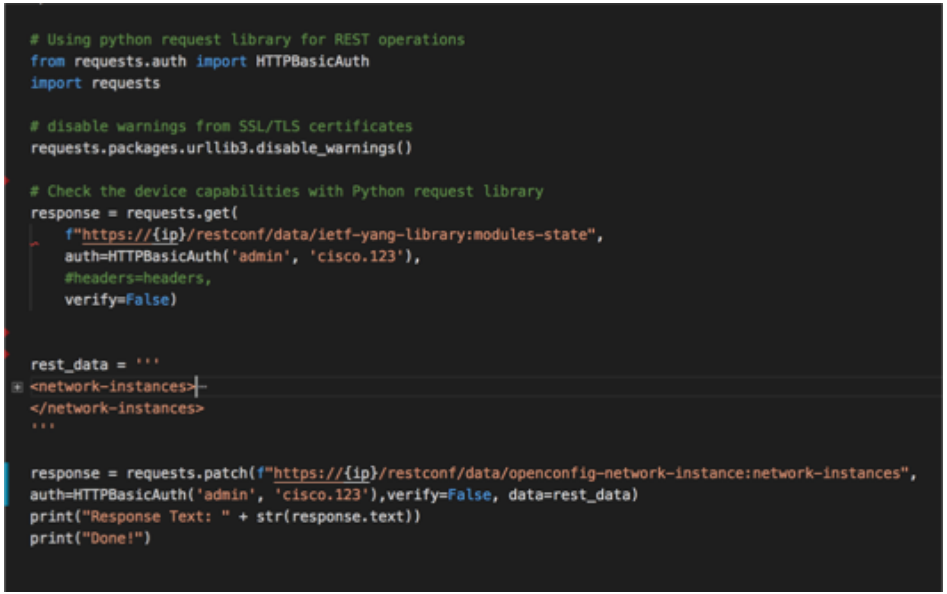
Manger Class Object

Top-Level BGP Object

YANG containers, leafs, etc
as objects/classes

NETCONF Operation:
<edit-config> == edit_config()

RESTCONF + YANG



```
# Using python request library for REST operations
from requests.auth import HTTPBasicAuth
import requests

# disable warnings from SSL/TLS certificates
requests.packages.urllib3.disable_warnings()

# Check the device capabilities with Python request library
response = requests.get(
    f"https://{ip}/restconf/data/ietf-yang-library:modules-state",
    auth=HTTPBasicAuth('admin', 'cisco.123'),
    #headers=headers,
    verify=False)


rest_data = '''
<network-instances>
</network-instances>
'''

response = requests.patch(f"https://{ip}/restconf/data/openconfig-network-instance:network-instances",
auth=HTTPBasicAuth('admin', 'cisco.123'),verify=False, data=rest_data)
print("Response Text: " + str(response.text))
print("Done!")
```

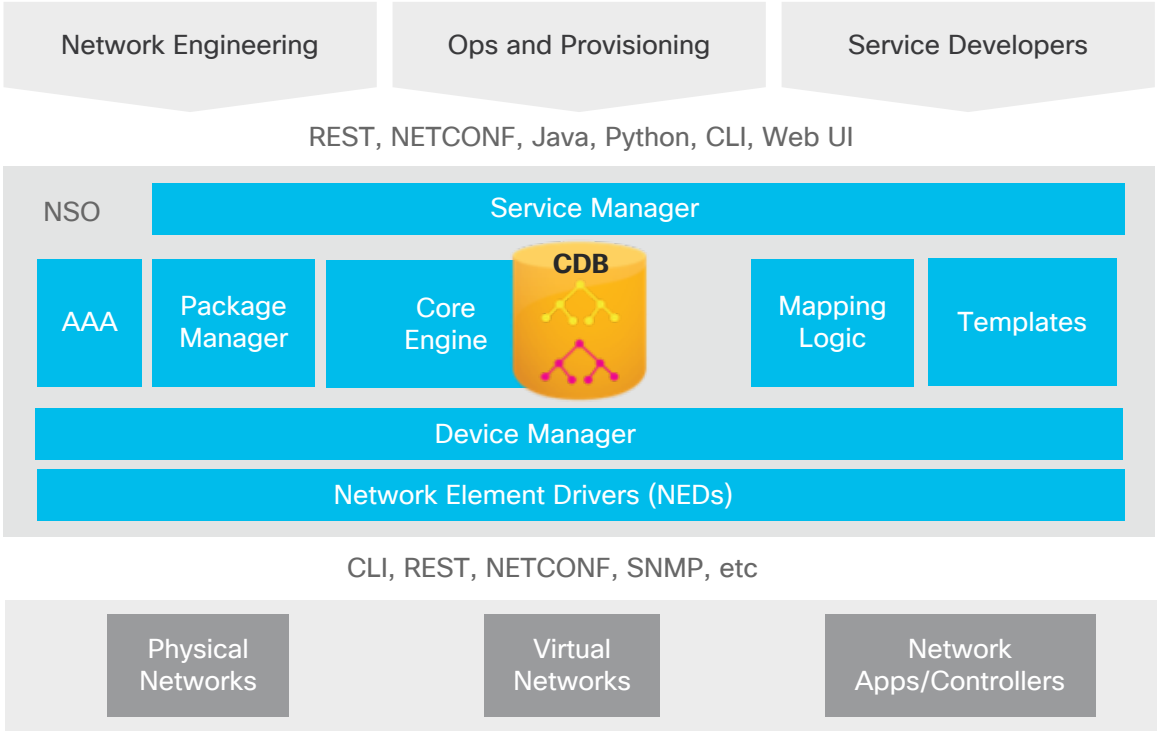
Python Requests Library

GETS/POSTS/PUTS/DELETES

YANG Model Data Payload

Config Merge / Patch Operations

Putting together: Network Services Orchestrator

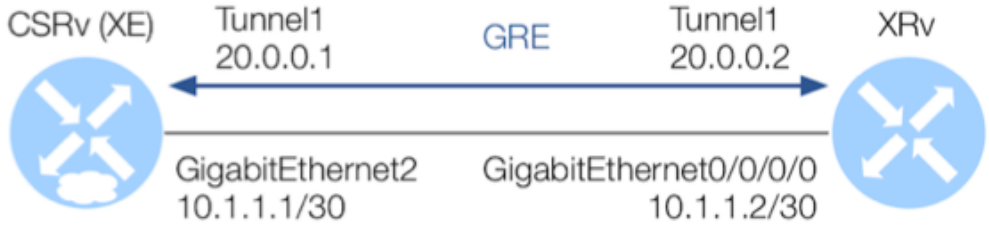


- Logically centralized network services
- Data models in YANG for data structures:
  - Service instances
  - Network configuration and state
- Mapping service operations to network configuration changes
- Transactional integrity
- Multiprotocol and multivendor support

NSO in the Lab

```
module buildgre {
  namespace "http://com/example/buildgre";
  prefix buildgre;
  ...
  import tailf-ncs {
    prefix ncs;
  }
  ...
  augment /ncs:services {
    list buildgre {
      key name;
      leaf name {
        tailf:info "Service Instance Name";
          type string;
      }
      ...
      leaf device1 {
        tailf:info "Tunnel Router #1";
        mandatory true;
        type leafref {
          path "/ncs:devices/ncs:device/ncs:name";
        }
      }
      leaf tunnel-inf-ip1 {
        tailf:info "Tunnel Router #1 Interface IP";
        mandatory true;
        type inet:ipv4-address {
          pattern "20\.0\.0\.[0-9]+";
        }
      }
```

services buildgre CSRv-XRv-GRE device1 CSRv tunnel-number 1 tunnel-inf-ip1 20.0.0.1 tunnel-inf-mask1 255.255.255.0 tunnel-src-ip1 10.1.1.1 tunnel-dest-ip1 10.1.1.2 device2 XRv tunnel-inf-ip2 20.0.0.2 tunnel-inf-mask2 255.255.255.0 tunnel-src-ip2 10.1.1.2 tunnel-dest-ip2 10.1.1.1



YDK-Gen: From .yang to .py

```
cd /workspace/ydk-gen
python3.6 generate.py --adhoc-bundle-name openconfig-interfaces-lab --adhoc-bundle ../openconfig-extensions.yang ../
```

YDK code generator

User supplied models

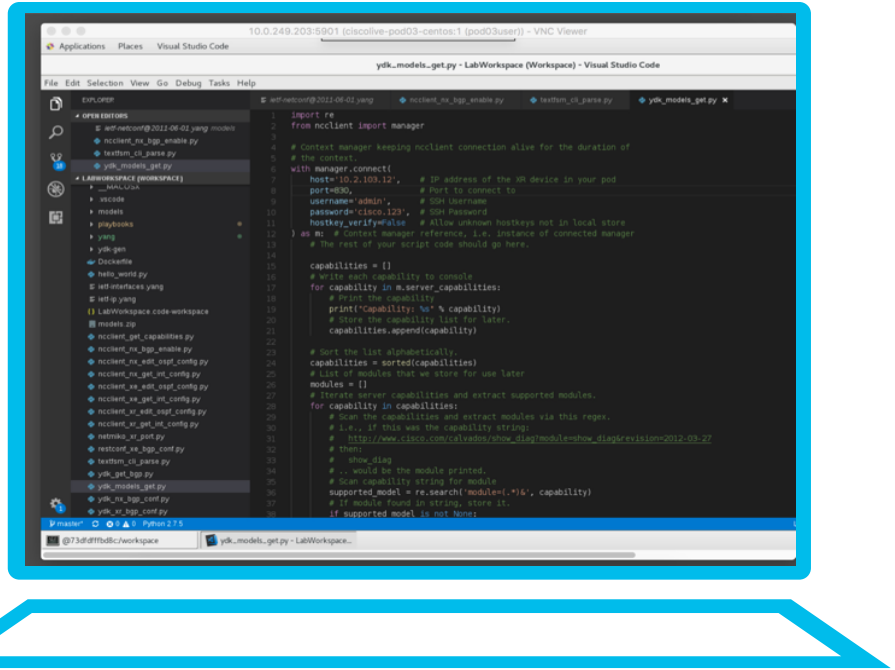
```
Successfully created source distribution at /workspace/ydk-gen/gen-api/python/openconfig_interfaces_lab-bundle/dist
================================================
Successfully generated Python YDK at /workspace/ydk-gen/gen-api/python/openconfig_interfaces_lab-bundle
Please refer to the README for information on how to install the package in your environment
Code generation and installation completed successfully!
Total time taken:  14 seconds
```

Custom Python Package from Source *.yang

Lab Overview

Lab Overview

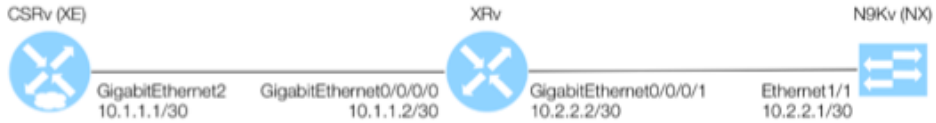
- Cisco AnyConnect VPN back to SVS RTP DMZ
- VNC is used to access the lab from your workstations at Cisco Live
- Each customer has a specific POD
- Connection information on tent card in front of you



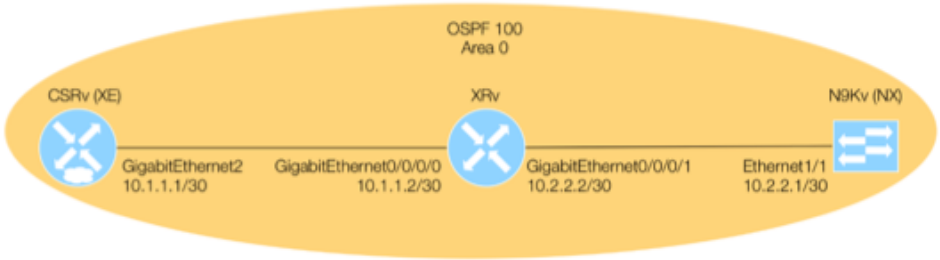
Lab Overview

- Leverage virtual platforms:
  - CSR1000v
  - XRv
  - Nexus 9000v (N9Kv)
- Each customer get their own topology!
- Shortcut aliases in container
  - xe, xr, nx

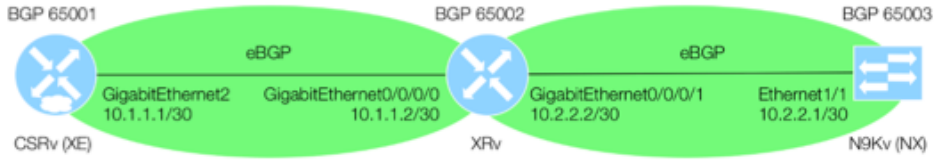
Physical Connection Topology



OSPF Topology



BGP Topology



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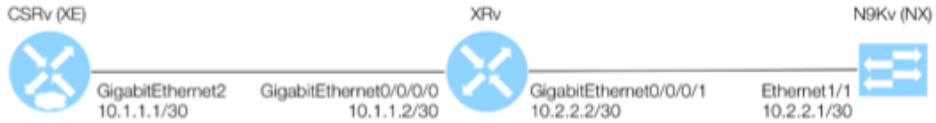

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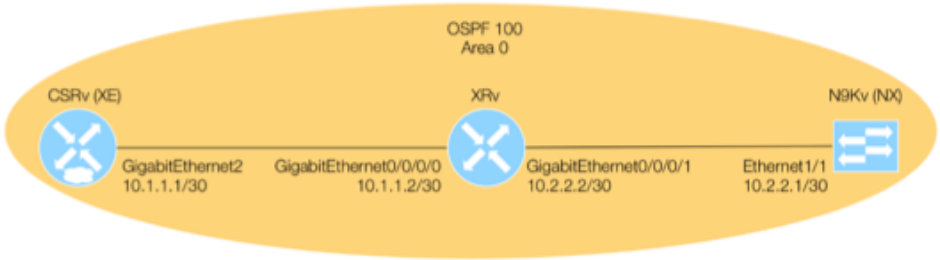

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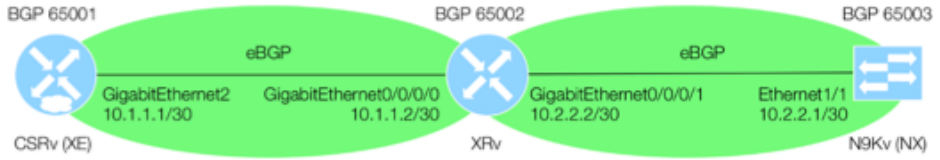

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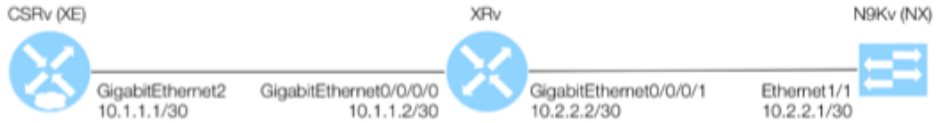
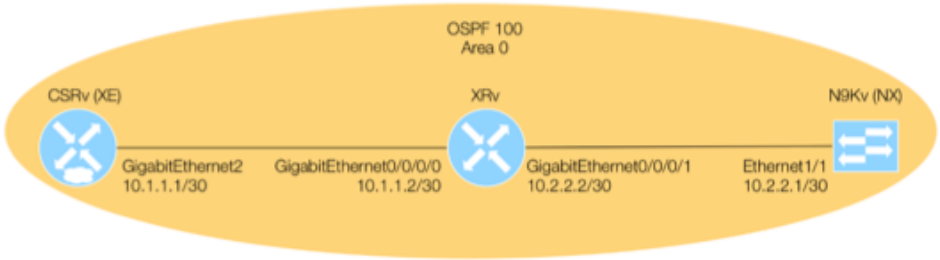


OSPF Topology



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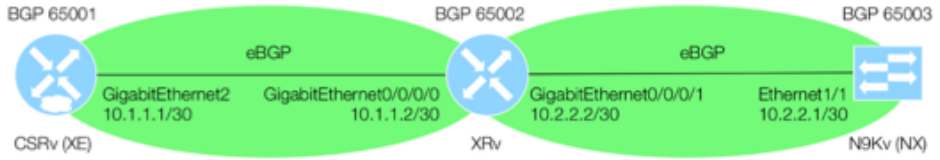
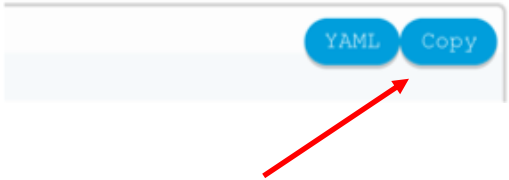


Lab Overview

- Copy blocks – feel free to type everything if you wish!



- RED – DO NOT copy or type
  - Indicates something done for you or verification

```
feature nxapi
```

- BLUE – Text meant to be copied or typed into Terminal or Visual Studio Code

```
1  import json
2  import requests
3
```

Lab Overview

- Web-based lab guide
- Make sure you select and work in the correct POD
- Available publicly on the web

Complete your online session evaluation

Give us your feedback to be entered into a Daily Survey Drawing.

Complete your session surveys through the Cisco Live mobile app or on www.CiscoLive.com/us.

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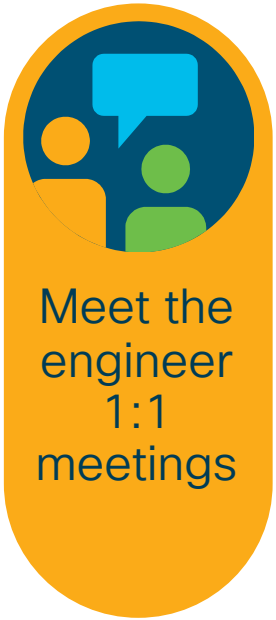

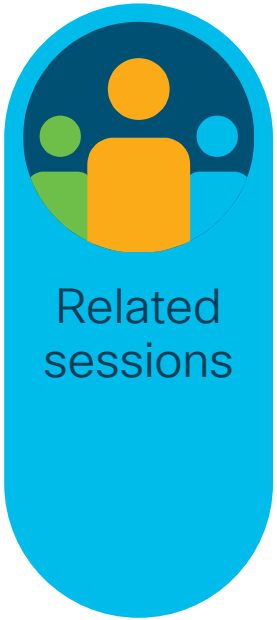

Thank you

INTUITIVE

R&S related Cisco education offerings

Course	Description	Cisco Certification
CCIE R&S Advanced Workshops (CIERS-1 & CIERS-2) plus Self Assessments, Workbooks & Labs	Expert level trainings including: instructor led workshops, self assessments, practice labs and CCIE Lab Builder to prepare candidates for the CCIE R&S practical exam.	CCIE® Routing & Switching
• Implementing Cisco IP Routing v2.0 • Implementing Cisco IP Switched Networks V2.0 • Troubleshooting and Maintaining Cisco IP Networks v2.0	Professional level instructor led trainings to prepare candidates for the CCNP R&S exams (ROUTE, SWITCH and TSHOOT). Also available in self study eLearning formats with Cisco Learning Labs.	CCNP® Routing & Switching
Interconnecting Cisco Networking Devices: Part 2 (or combined)	Builds on ICND1 to provide capabilities needed to configure, implement and troubleshoot a small enterprise network. Including: understanding of Quality of Service (QoS), how virtualized and cloud services interact and impact enterprise networks, along with an overview of network programmability and the related controller types and tools that are available to support software-defined network architectures. Also available in self study eLearning format with Cisco Learning Lab.	CCNA® Routing & Switching
Interconnecting Cisco Networking Devices: Part 1	Understand layer 2 and layer 3 networking fundamentals needed to install, configure, and provide basic support of small/branch networks. Covers network device security and IPv6 basics. Also available in self study eLearning format with Cisco Learning Lab.	CCENT® Routing & Switching

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Design Cisco education offerings

Course	Description	Cisco Certification
Designing Cisco Network Service Architectures (ARCH) Version 3.0	Provides learner with the ability to perform conceptual, intermediate, and detailed design of a network infrastructure that supports desired capacity, performance, availability required for converged Enterprise network services and applications.	CCDP® (Design Professional) (Available Now)
Designing for Cisco Internetwork Solutions (DESGN) Version 3.0	Instructor led training focused on fundamental design methodologies used to determine requirements for network performance, security, voice, and wireless solutions. Prepares candidates for the CCDA certification exam.	CCDA® (Design Associate) (Available Now)

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Wireless Cisco education offerings

Course	Description	Cisco Certification
• Designing Cisco Wireless Enterprise Networks • Deploying Cisco Wireless Enterprise Networks • Troubleshooting Cisco Wireless Enterprise Networks • Securing Cisco Wireless Enterprise Networks	Professional level instructor led trainings to prepare candidates to conduct site surveys, implement, configure and support APs and controllers in converged Enterprise networks. Focused on 802.11 and related technologies to design, deploy, troubleshoot as well as secure Wireless infrastructure. Course also provide details around Cisco mobility services Engine, Prime Infrastructure and wireless security.	CCNP® Wireless
Implementing Cisco Unified Wireless Network Essential	Prepares candidates to design, install, configure, monitor and conduct basic troubleshooting tasks of a Cisco WLAN in Enterprise installations.	CCNA® Wireless
Deploying Basic Cisco Wireless LANs (WDBWL)	Understanding of the Cisco Unified Wireless Networking for enterprise deployment scenarios. In this course, you will learn the basics of how to install, configure, operate, and maintain a wireless network, both as an add-on to an existing wireless LAN (WLAN) and as a new Cisco Unified Wireless Networking solution.	1.2
Deploying Advanced Cisco Wireless LANs (WDAWL)	The WDAWL advanced course is designed with the goal of providing learners with the knowledge and skills to successfully plan, install, configure, troubleshoot, monitor, and maintain advanced Cisco wireless LAN solutions such as QoS, “salt and pepper” mobility, high density deployments, and outdoor mesh deployments in an enterprise customer environment.	1.2
Deploying Cisco Connected Mobile Experiences (WCMX)	WCMX will prepare professionals to use the Cisco Unified Wireless Network to configure, administer, manage, troubleshoot, and optimize utilization of mobile content while gaining meaningful client analytics.	2.0

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Cybersecurity Cisco education offerings

Course	Description	Cisco Certification
Understanding Cisco Cybersecurity Fundamentals (SFUND)	The SECFND course provides understanding of cybersecurity's basic principles, foundational knowledge, and core skills needed to build a foundation for understanding more advanced cybersecurity material & skills.	CCNA® Cyber Ops
Implementing Cisco Cybersecurity Operations (SECOPS)	This course prepares candidates to begin a career within a Security Operations Center (SOC), working with Cybersecurity Analysts at the associate level.	CCNA® Cyber Ops
Cisco Security Product Training Courses	Official deep-dive, hands-on product training on Cisco's latest security products, including NGFW, ASA, NGIPS, AMP, Identity Services Engine, Email and Web Security Appliances, and much more.	

For more details, please visit: www.cisco.com/go/securitytraining or http://learningnetwork.cisco.com
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Cybersecurity Cisco education offerings

Course	Description	Cisco Certification
CCIE Security 5.0		CCIE® Security
Implementing Cisco Edge Network Security Solutions (SENSS) Implementing Cisco Threat Control Solutions (SITCS) v1.5 Implementing Cisco Secure Access Solutions (SISAS) Implementing Cisco Secure Mobility Solutions (SIMOS)	Configure Cisco perimeter edge security solutions utilizing Cisco Switches, Cisco Routers, and Cisco Adaptive Security Appliance (ASA) Firewalls Implement Cisco's Next Generation Firewall (NGFW), FirePOWER NGIPS (Next Generation IPS), Cisco AMP (Advanced Malware Protection), as well as Web Security, Email Security and Cloud Web Security Deploy Cisco's Identity Services Engine and 802.1X secure network access Protect data traversing a public or shared infrastructure such as the Internet by implementing and maintaining Cisco VPN solutions	CCNP® Security
Implementing Cisco Network Security (IINS 3.0)	Focuses on the design, implementation, and monitoring of a comprehensive security policy, using Cisco IOS security features	CCNA® Security

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Data Center / Virtualization Cisco education offerings

Course	Description	Cisco Certification
Introducing Cisco Data Center Networking (DCICN) Introducing Cisco Data Center Technologies (DCICT)	Get job-ready foundational-level certification and skills in installing, configuring, and maintaining next generation data centers.	CCNA® Data Center
Implementing Cisco Data Center Unified Computing (DCUCI) Implementing Cisco Data Center Infrastructure (DCII) Implementing Cisco Data Center Virtualization and Automation (DCVAI) Designing Cisco Data Center Infrastructure (DCID) Troubleshooting Cisco Data Center Infrastructure (DCIT)	Obtain professional level skills to design, configure, implement, troubleshoot next generation data center infrastructure.	CCNP® Data Center
Product Training Portfolio:DCAC9K, DCINX9K, DCMDS, DCUCS, DCNX1K, DCNX5K, DCNX7K, CACND, DSACI, HFLEX UCSDF, UCSDACI, DCUCCEN	Gain hands-on skills using Cisco solutions to configure, deploy, manage and troubleshoot unified computing, policy-driven and virtualized data center infrastructure.	
Designing the FlexPod® Solution (FPDESIGN) Implementing and Administering the FlexPod® Solution (FPIMPADM)	Learn how to design, implement and administer FlexPod® solutions	Cisco and NetApp Certified FlexPod® Specialist
Designing the VersaStack Solution (VSDESIGN) Implementing and Administering the VersaStack Solution (VSIMP)	Learn how to design, implement and administer VersaStack solutions	

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Network Programmability Cisco education offerings

Course	Description	Cisco Certification
Developing with Cisco Network Programmability (NPDEV)	Provides Application Developers with comprehensive curriculum to develop infrastructure programming skills; Addresses needs of software engineers who automate network infrastructure and/or utilize APIs and toolkits to interface with SDN controllers and individual devices	Cisco Network Programmability Developer (NPDEV) Specialist Certification
Designing and Implementing Cisco Network Programmability (NPDESI)	Provides network engineers with comprehensive soup-to-nuts curriculum to develop and validate automation and programming skills; Directly addresses the evolving role of network engineers towards more programmability, automation and orchestration	Cisco Network Programmability Design and Implementation (NPDESI) Specialist Certification
Programming for Network Engineers (PRNE)	Learn the fundamentals of Python programming – within the context of performing functions relevant to network engineers. Use Network Programming to simplify or automate tasks	Recommended pre-requisite for NPDESI and NPDEV Specialist Certifications
Cisco Digital Network Architecture Implementation Essentials (DNAIE)	This training provides students with the guiding principles and core elements of Cisco's Digital Network Architecture (DNA) architecture and its solution components including; APIC-EM, NFV, Analytics, Security and Fabric.	

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Cloud Cisco education offerings

Course	Description	Cisco Certification
Understanding Cloud Fundamentals (CLDFND) Introducing Cloud Administration (CLDADM)	Learn how to perform foundational tasks related to Cloud computing, and the essentials of Cloud infrastructure, administration and operations	CCNA® Cloud
Implementing and Troubleshooting the Cisco Cloud Infrastructure (CLDINF) Designing the Cisco Cloud (CLDDES) Automating the Cisco Enterprise Cloud (CLDAUT) Building the Cisco Cloud with Application Centric Infrastructure (CLDACI)	Obtain professional level skills to design, automate, secure, provision and manage private and hybrid Clouds	CCNP® Cloud
Product Training Portfolio: CloudCenter: CLDCTR* UCS Director: UCSDF, UCSDACI Prime Service Catalog: PSCF, PSCI, PSCD MetaPod: MPODF20	Gain in-depth hands-on skills using Cisco solutions to configure, deploy, manage and troubleshoot Cloud deployments	

*Available Q3FY18

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Collaboration Cisco education offerings

Course	Description	Cisco Certification
CCIE Collaboration Advanced Workshop (CIEC)	Gain expert-level skills to integrate, configure, and troubleshoot complex collaboration networks	CCIE® Collaboration
Implementing Cisco Collaboration Applications (CAPPS)	Understand how to implement the full suite of Cisco collaboration applications including Jabber, Cisco Unified IM and Presence, and Cisco Unity Connection.	CCNP® Collaboration
Implementing Cisco IP Telephony and Video Part 1 (CIPTV1) Implementing Cisco IP Telephony and Video Part 2 (CIPTV2) Troubleshooting Cisco IP Telephony and Video (CTCOLLAB)	Learn how to implement Cisco Unified Communications Manager, CUBE, and audio and videoconferences in a single-site voice and video network. Obtain the skills to implement Cisco Unified Communications Manager in a modern, multisite collaboration environment. Troubleshoot complex integrated voice and video infrastructures	CCNP® Collaboration
Implementing Cisco Collaboration Devices (CICD) Implementing Cisco Video Network Devices (CIVND)	Acquire a basic understanding of collaboration technologies like Cisco Call Manager and Cisco Unified Communications Manager. Learn how to evaluate requirements for video deployments, and implement Cisco Collaboration endpoints in converged Cisco infrastructures.	CCNA® Collaboration

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Service Provider Cisco education offerings

Course	Description	Cisco Certification
Deploying Cisco Service Provider Network Routing (SPROUTE) & Advanced (SPADVROUTE) Implementing Cisco Service Provider Next-Generation Core Network Services (SPCORE) Edge Network Services (SPEDGE)	SPROUTE covers the implementation of routing protocols (OSPF, IS-IS, BGP), route manipulations, and HA routing features; SPADVROUTE covers advanced routing topics in BGP, multicast services including PIM-SM, and IPv6; SPCORE covers network services, including MPLS-LDP, MPLS traffic engineering, QoS mechanisms, and transport technologies; SPEDGE covers network services, including MPLS Layer 3 VPNs, Layer 2 VPNs, and Carrier Ethernet services; all within SP IP NGN environments.	CCNP Service Provider®
Building Cisco Service Provider Next-Generation Networks, Part 1&2 (SPNGN1), (SPNGN2)	The two courses introduce networking technologies and solutions, including OSI and TCP/IP models, IPv4/v6, switching, routing, transport types, security, network management, and Cisco OS (IOS and IOS XR).	CCNA Service Provider®
Implementing Cisco Service Provider Mobility UMTS Networks (SPUMTS); Implementing Cisco Service Provider Mobility CDMA Networks (SPCDMA); Implementing Cisco Service Provider Mobility LTE Networks (SPLTE)	The three courses (SPUMTS, SPCDMA, SPLTE) cover knowledge and skills required to understand products, technologies, and architectures that are found in Universal Mobile Telecommunications Systems (UMTS) and Code Division Multiple Access (CDMA) packet core networks, plus their migration to Long-Term Evolution (LTE) Evolved Packet Systems (EPS), including Evolved Packet Core (EPC) and Radio Access Networks (RANs).	Cisco Service Provider Mobility CDMA to LTE Specialist; Cisco Service Provider Mobility UMTS to LTE Specialist
Implementing and Maintaining Cisco Technologies Using IOS XR (IMTXR)	Service Provider/Enterprise engineers to implement, verification-test, and optimize core/edge technologies in a Cisco IOS XR environment.	Cisco IOS XR Specialist

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Internet of Things (IoT) Cisco education offerings

Course	Description	Cisco Certification
Managing Industrial Networks for Manufacturing (IMINS2)	An associate level instructor led lab based training focuses on common industrial application protocols, security, wireless and troubleshooting designed to prepare you for the CCNA Industrial certification	CCNA® Industrial
Managing Industrial Networks with Cisco Networking Technologies (IMINS)	This instructor led lab based training addresses foundational skills needed to manage and administer networked industrial control systems for today's connected plants and enterprises. It helps prepare plant administrators, control system engineers and traditional network engineers for the Cisco Industrial Networking Specialist certification.	Cisco Industrial Networking Specialist
Control Systems Fundamentals for Industrial Networking (ICINS)	For IT and Network Engineers, provides an introduction to industry IoT verticals, automation environment and an overview of industrial control networks (E-Learning)	Pre-learning for IMINS, IMINS2 training & certifications
Networking Fundamentals for Industrial Control Systems (INICS)	For Industrial Engineers and Control System Technicians, covers basic IP and networking concepts, and introductory overview of Automation industry Protocols.	Pre-learning for IMINS, IMINS2 training & certifications

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Data and Analytics Cisco education offerings

Course	Description
ANDMB – Data Management, Architecture and Applications	Provides hands on training with a technical mix of application, compute, storage and networking topics concerning the deployment of Big Data clusters.
ANDMA – Advanced Data Management, Architecture and Applications	Covers major architecture design to cater to different needs of the application, data center or deployment requirements. It provides architectural designs and advanced hands-on training on topics covering Scaling of cluster to thousands of nodes and management, Data Life Cycle management with HDFS tiered storage, and different approaches for Multi-tenant Hadoop cluster deployments with Openstack

Data and Analytics training page: http://www.cisco.com/c/en/us/training-events/resources/learning-services/technology/data-analytics.html
For more details, please visit: http://learningnetwork.cisco.com
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Digital Business Transformation Cisco education offerings

Course	Description	Cisco Certification
For Technology Sellers:		
Adopting the Cisco Business Architecture Approach	Builds skills to discover and address technology needs using a business-focused, consultative sales approach, broadly applicable and targeted to prepare for the digital transformation journey that is demanded across the business world.	Cisco Business Architecture Analyst
Applying Cisco Business Architecture Techniques	Provides tools and skills training to prepare the learner to use a business led approach to technology solutions sales and deployments. This continues the journey begun with the Adopting the Cisco Business Architecture Approach above	Cisco Business Architecture Specialist
Mastering the Cisco Business Architecture Discipline	Builds skills, and proven, real-world techniques to prepare for a Business architect leadership role in the sales and deployment of transformative technology solutions.	Cisco Business Architecture Practitioner
Cisco Customer Success Manager Specialist	Prepares for the crucial role that drives adoption and enablement, ensuring that customers achieve their expected business outcomes, and reduces churn/increases renewal for services and subscription based products.	Cisco Certified Customer Success Manager

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