



Network Automation using Python

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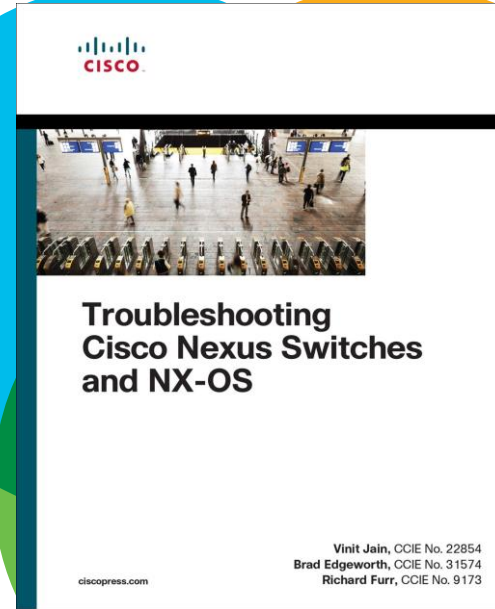


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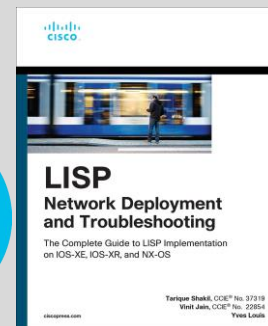
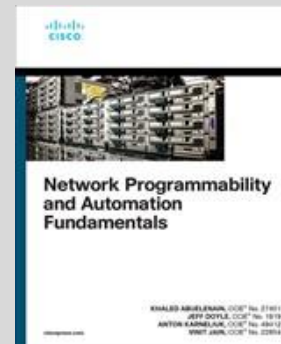
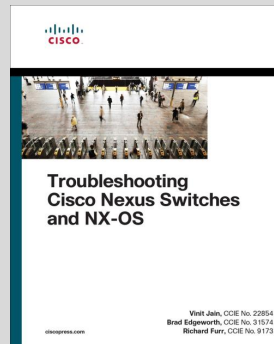
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Co-author Cisco Press books and Educational material!



Network Automation using Python

Vinit Jain, Sr. Technical Leader, CCIE #22854

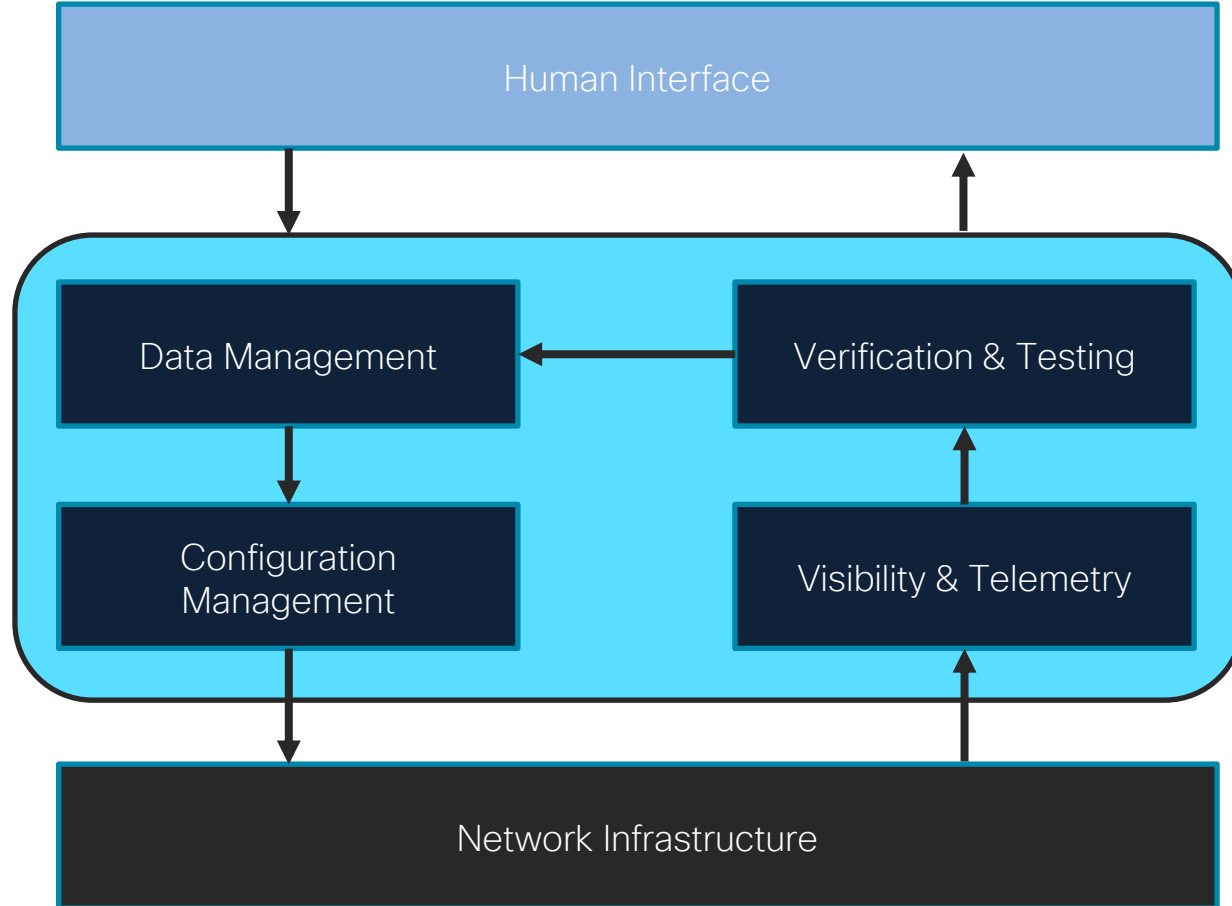


Network Automation

- Process of using software to automate network provisioning, testing, deployment and network management
 - To help maximize network efficiency and functionality
- Networks are complex and bulky in nature
 - Manual operations – more delays
- Automation makes the networks more agile and responsive to changes
- Benefits:
 - Improved operational efficiency
 - Reduced errors
 - Lower OPEX



Network Automation Architecture



Network Programmability

- It's a set of tools to deploy, manage and troubleshoot a network device
- Network engineer perspective – interacting with a device or group of devices
- Software developer perspective – abstracting the network. Seeing the whole network as a single device and manipulating it with software



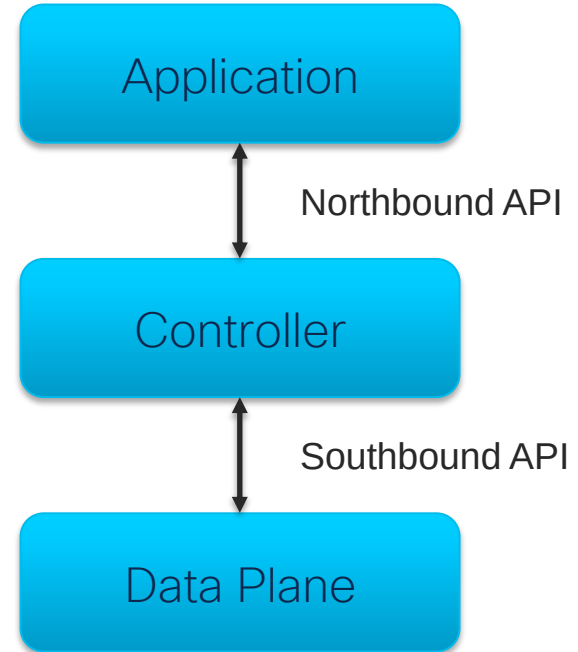
Benefits of Network Programmability

- Reduced OPEX
- Customization
- Reduced human error
- Operational flexibility
- Increased opportunity for innovation



Application Programming Interface (API)

- APIs are mechanisms used to communicate with applications and other software.
- An API may perform different functions based on where they are located in the flow
 - Used to communicate with various components of the network through software
- APIs are usually RESTful APIs



Representational State Transfer (REST) APIs

- An API that uses REST is often referred to a RESTful API.
- RESTful APIs use Hypertext Transfer Protocol (HTTP) methods to gather and manipulate data.

HTTP Function	Action
GET	Read
POST	Create
PATCH	Update / Modify
PUT	Update / Replace
DELETE	Delete



HTTP Status Codes

HTTP STATUS CODE	RESULT	COMMON REASON
200	Ok	Using GET or POST to exchange data with an API
201	Created	Creating resources by using a REST API call
400	Bad Request	Request failed due to client-side issue
401	Unauthorized	Client not authenticated to access site or API call
403	Forbidden	Access not granted based on supplied credentials
404	Not Found	Page at HTTP URL location does not exist or is hidden



Netmiko

Netmiko Overview

- Netmiko – Python library used extensively to interact with network devices
- Multi-vendor library
 - Cisco IOS/IOS-XE, NX-OS, firewalls, etc.
- Extended support of Paramiko library's SSH functionality
 - Going into configuration modes
 - Sending commands
 - Retrieving outputs
 - Taking care of yes/no prompts



NAPALM

NAPALM Overview

- NAPALM – Network automation and programmability abstraction layer with multi-vendor support
- Provides functions that allows:
 - Configuration operations (commit or rollback)
 - Retrieve state data from network devices
- Contains methods to establish connection to network devices
 - Can work in conjunction with automation tools – Ansible
- Has support for various network OS:
 - IOS, IOS-XR, NX-OS, JunOS, EOS, etc.



NAPALM Operations

- **Replace** – Allows users to replace the existing running configuration with an entirely new configuration.
- **Merge** – Allows users to merge configuration changes from a file to the running configuration on the device.
- **Compare** – Compare the newly proposed configuration with the existing one. Only applies to replace operation and not for merge operation.
- **Discard** – Resets the merge configuration file to an empty file. Thus, not allowing the new configuration to be applied on the device.
- **Commit** – Commits the proposed configuration to the network device. In other words, used to deploy a staged configuration.
- **Rollback** – Rollback (revert back) the running configuration to the saved configured prior to the last commit.



Jinja



Templating with Jinja2

- Jinja is a modern templating language for Python – Modelled after Django templates
- Allows user to easily interact with Python program
 - Use data to quickly generate dynamic content
- Benefits:
 - Template inheritance
 - Optimal just-in-time compilation
 - Easy debuggability
 - Configurable syntax
- Commonly used with web frameworks such as Flask
- Configuration management tools – Ansible, Nornir, etc.



Delimiters

- `{% . . . %}` – for statements
- `{{ . . . }}` – for expressions (used to print template output)
- `{# . . . #}` – for Comments. Comments are not included in template output
- `# . . . ###` – for line statements



Nornir

Nornir Overview

- Python based automation framework
- Manage network and host inventory and provide common framework to write plugins for the network devices and hosts
- Requires minimum Python version 3.6.2
- Multi-threaded – Defaults to 20 worker threads
- Initialized using config file – references couple other files
 - Host inventory file
 - Group file
- All these files are written in YAML format



Nornir Advantages

- Python or Golang (Gornir)
- Reuse existing libraries – napalm, netmiko
- Quick host filtering based on any attribute or combination of attributes
- Very fast due to use of threads
- Can be used to build highly flexible and extensible automation tools using Flask, Django, etc.
- Automatically performs caching and closes open connections



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Extra Resources and References

Cisco Press News

Network Programmability and Automation Fundamentals [[Learn more](#)]

CCNP and CCIE Security Core SCOR 350-701 Official Cert Guide

<https://www.ciscopress.com/store/ccnp-and-ccie-security-core-scor-350-701-official-cert-9780135971970>

Cisco DevNet Professional DEVCOR 350-901 Study Guide

<https://www.ciscopress.com/store/cisco-devnet-professional-devcor-350-901-study-guide-9780137500048>

Other useful resources:

Interview with Vinit Jain, Cisco's Top Events Contributor

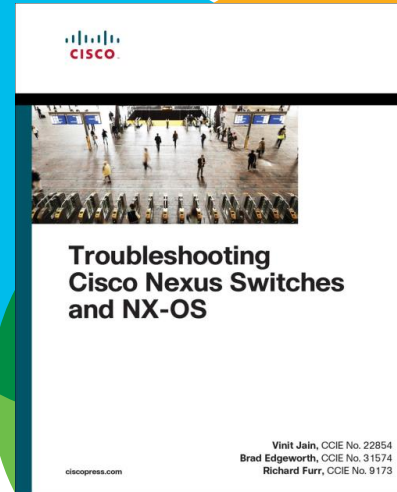
<https://community.cisco.com/t5/networking-documents/interview-with-vinit-jain-cisco-s-top-events-contributor/ta-p/3156059>

Vinit's publications

<http://www.ciscopress.com/authors/bio/255ee209-1418-4938-9a42-d3bece2b46c6>



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