IOS XE Zero Touch Provisioning

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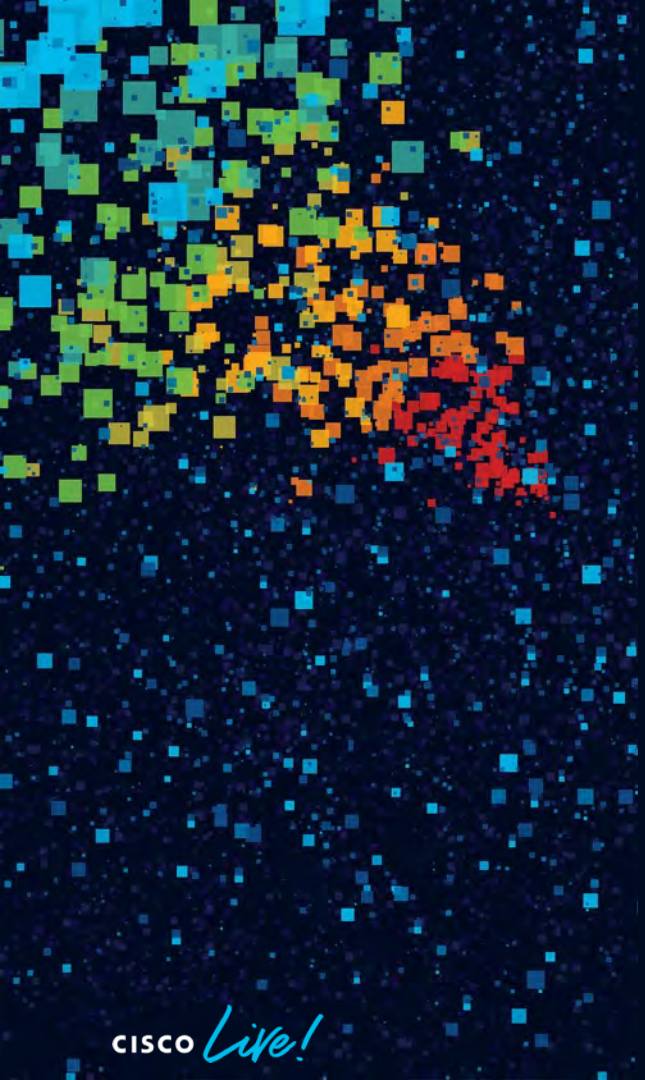

Agenda

- Overview of ZTP
- Demo
- Resources

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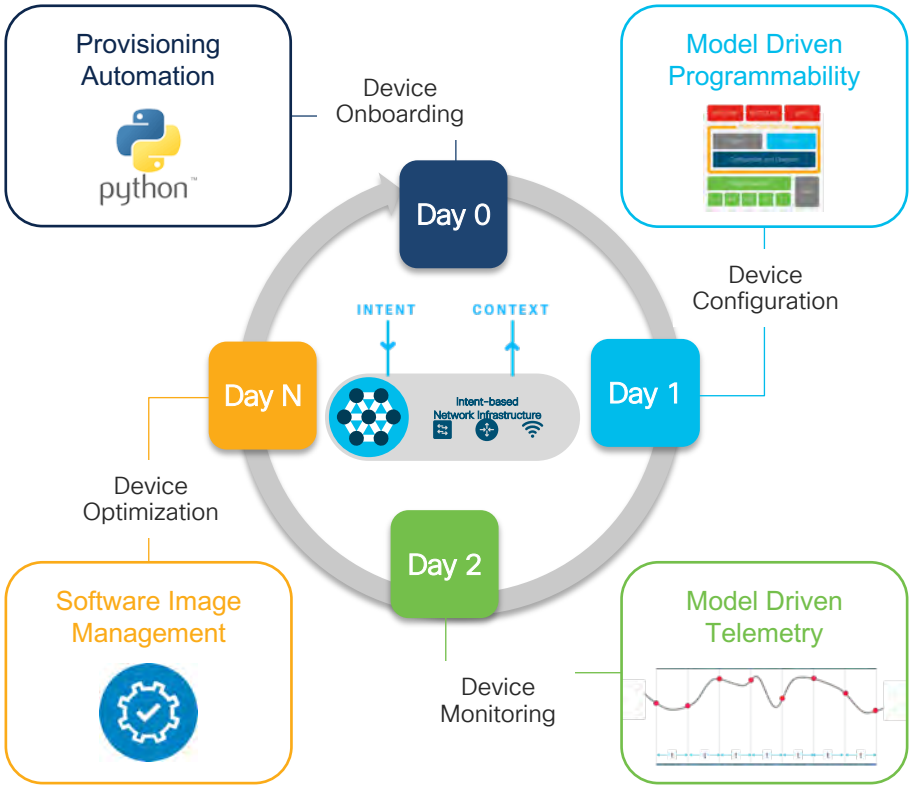
IOS XE Programmability

VMWare/KVM run script

Zero Touch Provisioning

DHCP Auto Install, PnP



Network Configuration Protocols (NETCONF)

RESTCONF, gNMI

YANG Data Models, OpenConfig

Guest Shell

On-Box Python API

Application Hosting with Docker

gRPC Dial Out Configured

gNMI Dial-In

NETCONF Dial-In

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ZTP Overview

The ZTP feature is used to programmatically configure new devices

When an XE device boots and there is no config

+

When DHCP provides option 67 with python file

The Python file is executed within the Guest Shell

https://www.youtube.com/watch?v=EAXnftG6odg
https://blogs.cisco.com/developer/device-provisioning-with-ios-xe-zero-touch-provisioning
https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/prog/configuration/172/b_172_programmability_cg.html

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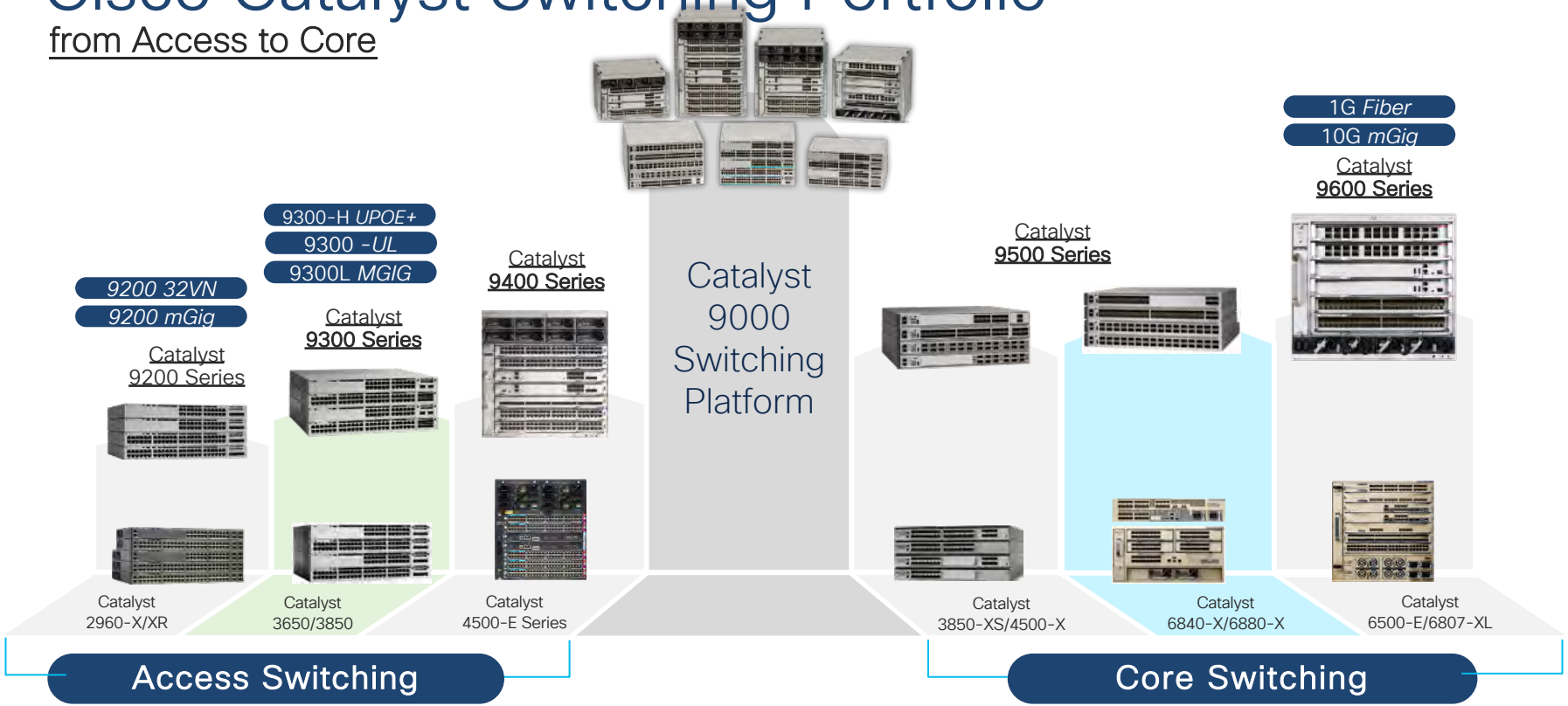
Cisco Catalyst Switching Portfolio

from Access to Core



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Cisco Enterprise Routing Portfolio

Branch

ISR 1000

- Integrated wired and wireless access
- PoE/PoE+

ISR 4000

- WAN and voice module flexibility
- Compute with UCS E
- Integrated Security stack
- WAN Optimization

Aggregation

ASR 1000

- Hardware and software redundancy
- High-performance service with hardware assist

Virtual and Cloud

CSR 1000V

- Cisco DNA virtualization
- Extend enterprise routing, security & management to cloud

SD-WAN

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Catalyst 9800 Series Wireless Controllers

DNA Center

Translate business intent into network policy and capture actionable insights with DNA Center

Catalyst 9800-80

Catalyst 9800-40

Catalyst 9800-L

Catalyst 9800-CL for Cloud

Catalyst 9800 embedded wireless

for Cat 9k Switch

Aironet and Catalyst Access Points

Works with Cisco Aironet 802.11ac Wave 1 and Wave 2 and 802.11ax Catalyst 9100 Access Points

ZTP Overview

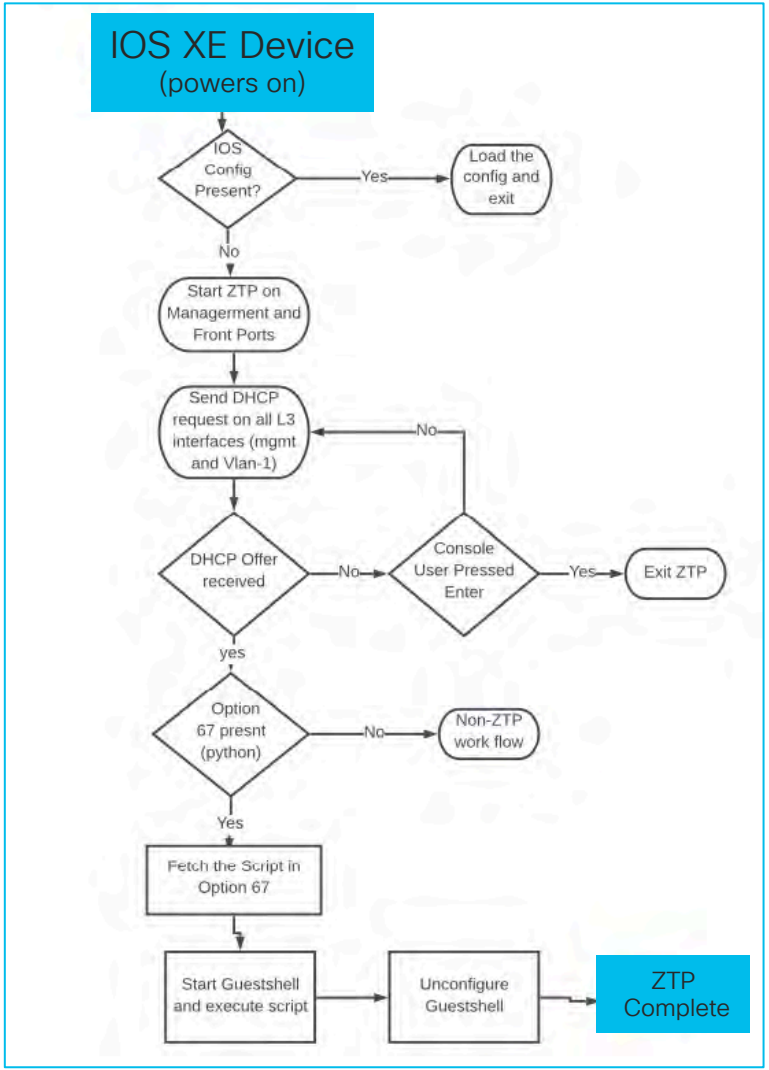
How and when does ZTP happen?

1. When an IOS XE device boots and no configuration is present, the device will issue a DHCP request on the management port and on the front panel port.

2. If the DHCP response contains option 67 then ZTP is initiated and the device will retrieve and execute the python script from within the Guest Shell

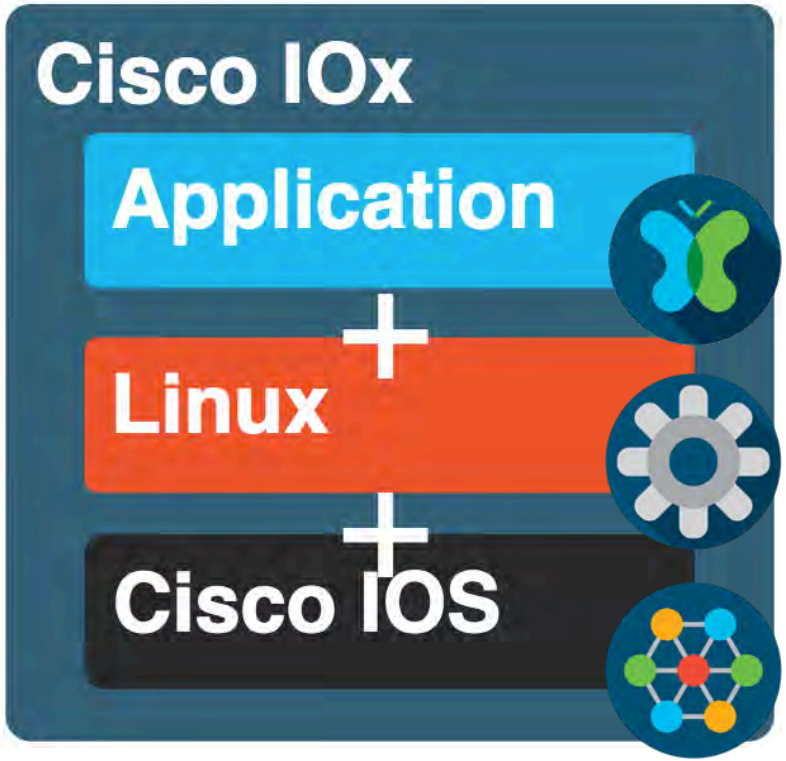
3. Guest Shell is started and networking is automatically configured

The Python API within Guest Shell enables complete device configuration



Guest Shell– Cisco IOS + Linux OS (IOX)

- 64 bit application environment running on IOS XE
- Isolated user space - Fault isolation, Resource isolation
- Access to bootflash.
- Linux Commands - Integrate into existing Linux workflows
- Bundled with **Python** Cisco CLI python library for CLI operations and automated output collection.



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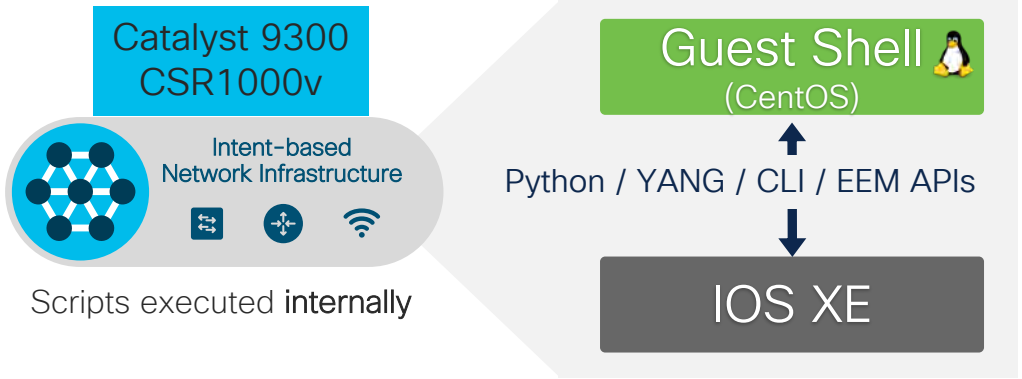
Guestshell

- Fault/resource isolation
- Secure Linux shell environment
- Python interpreter, Bash shell
- PIP Package Manager
- Integrated with ZTP and EEM
- Disabled by default
- Enabled then disabled after ZTP completes

```
iosxe# guestshell enable
iosxe# guestshell run bash
```



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Python Modules - API

3 Python modules are available that are the API between Guest Shell and the IOS XE device:

- cli.cli, cli.clip
- cli.execute, cli.executep
- cli.configure, cli.configurep

```
print "\n\n *** Sample ZTP Day0 Python Script *** \n\n"
# Importing cli module
import cli

print "Configure vlan interface, gateway, aaa, and enable netconf-yang\n\n"
cli.configurep(["int vlan 1", "ip address 10.5.123.27 255.255.255.0", "no shut", "end"])
cli.configurep(["ip default-gateway 10.5.123.1", "end"])
cli.configurep(["username admin privilege 15 secret 0 Cisco123"])
cli.configurep(["aaa new-model", "aaa authentication login default local", "end"])
cli.configurep(["aaa authorization exec default local", "aaa session-id common", "end"])
cli.configurep(["netconf-yang", "end"])

print "\n\n *** Executing show ip interface brief  *** \n\n"
cli_command = "sh ip int brief"
cli.executep(cli_command)

print "\n\n *** ZTP Day0 Python Script Execution Complete *** \n\n"
```

1. cli.cli(command) —This function takes an IOS command as an argument, runs the command through the IOS parser, and returns the resulting text.

2. cli.execute(command) —This function executes a single EXEC command and returns the output; however, does not print the resulting text. No semicolons or newlines are allowed as part of this command. Use a Python list with a for-loop to execute this function more than once.

3. cli.configure(command) —This function configures the device with the configuration available in commands. It returns a list of named tuples that contains the command and its result

4, 5, 6: cli.{cli, execute, configure}p (command) — This function works exactly the same as the other functions, except that it prints the resulting text to *stdout* rather than returning it .

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Python 2 to 3 transition

IOS XE 16.12	Python 2 only	python3 can be installed via pip
IOS XE 17.1	Python2 default	python3 installed

Cisco CLI, EEM, and NETCONF client Python libraries already support Python 3.0

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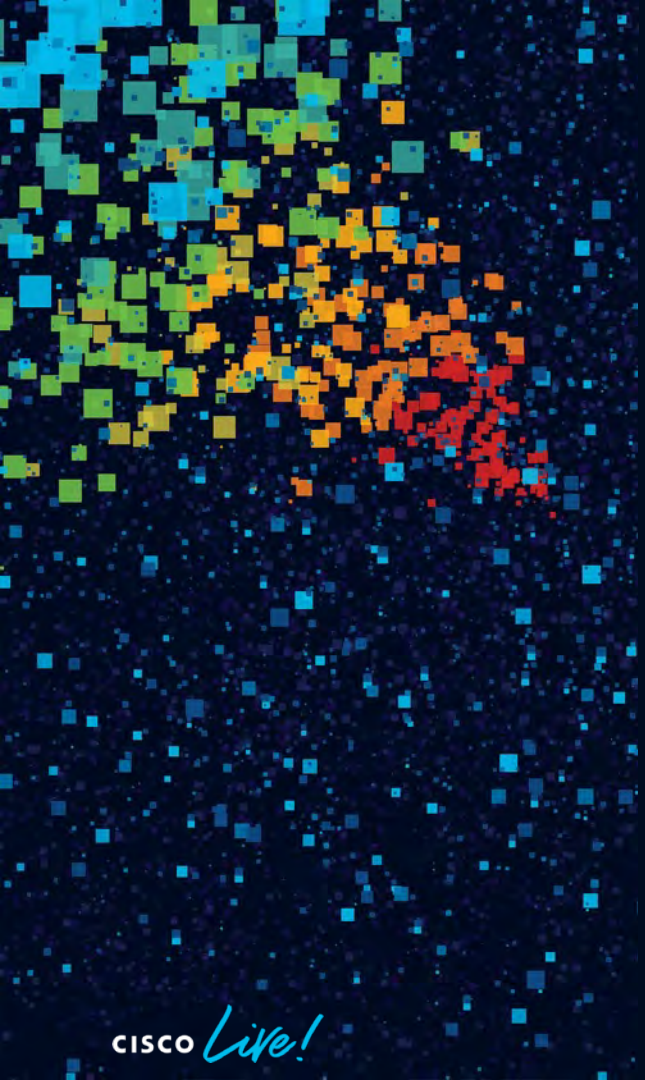

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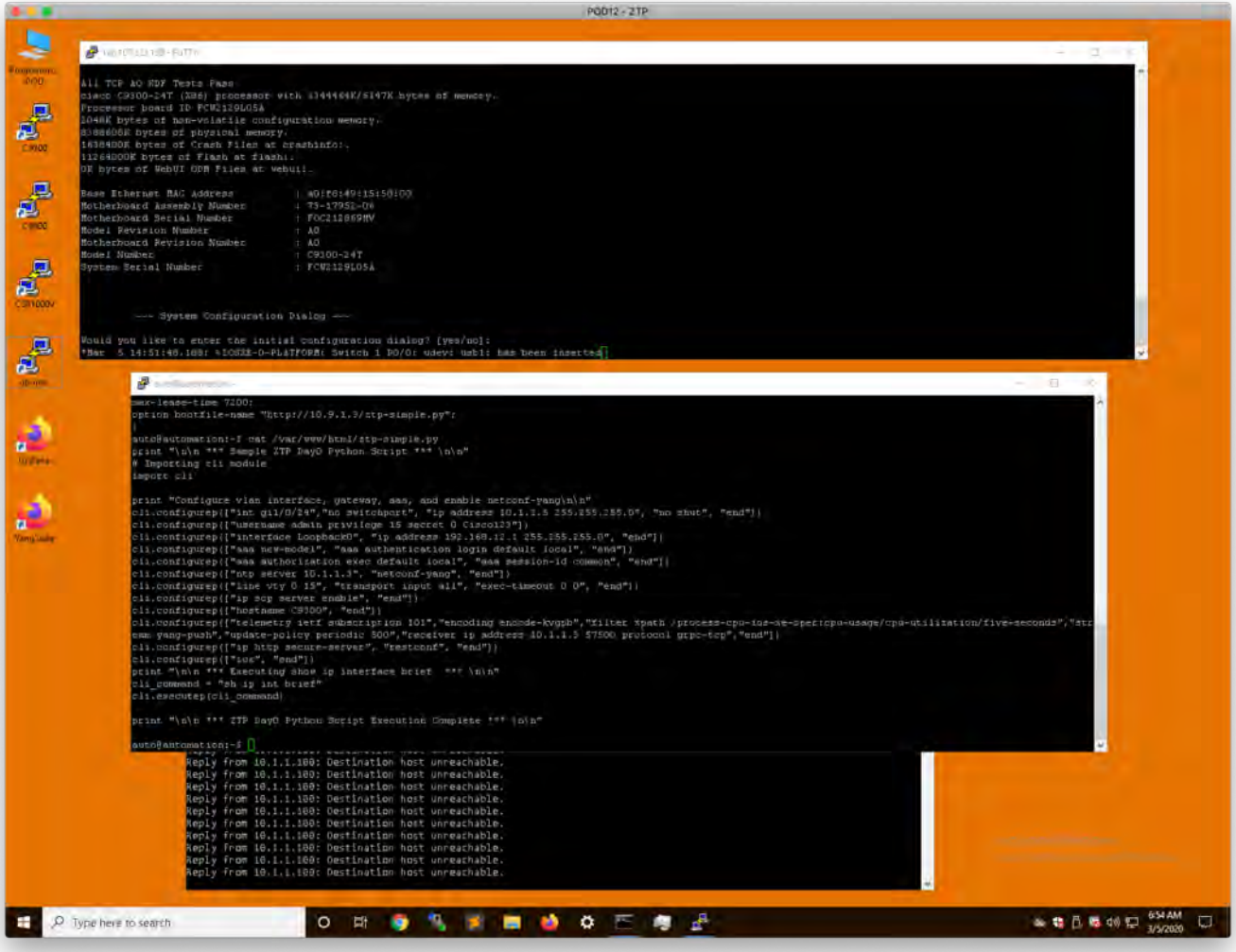

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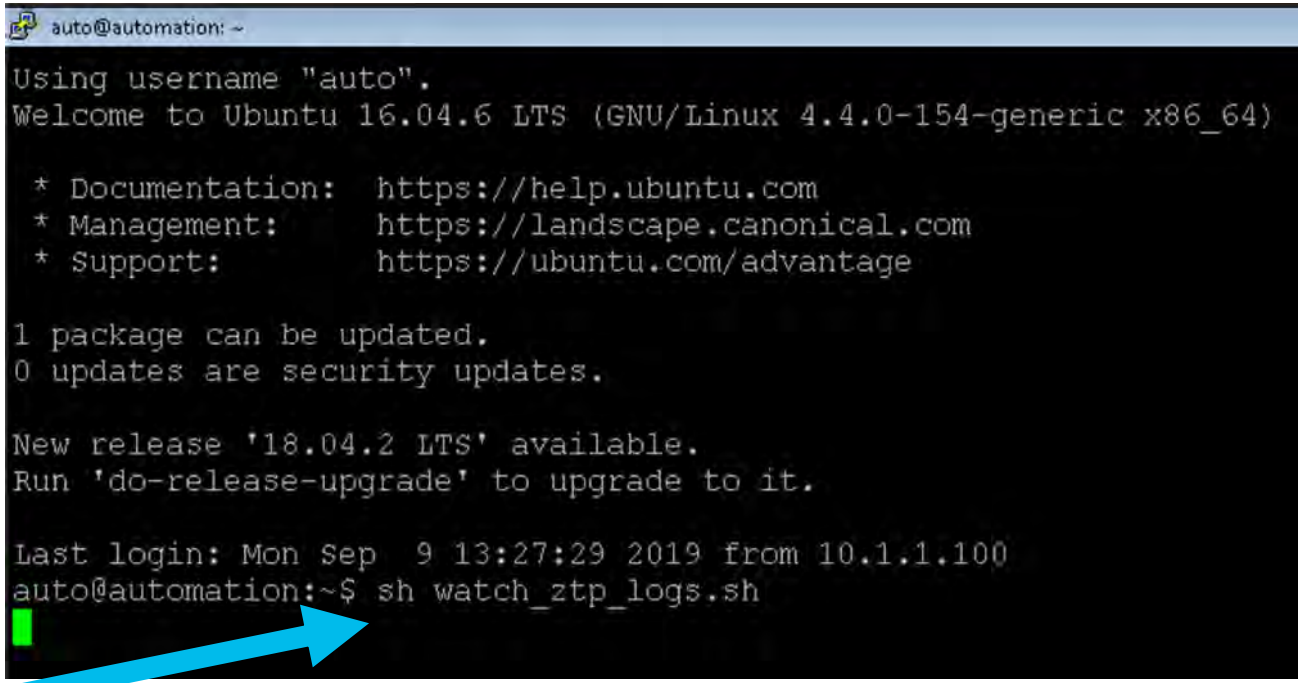
watch_ztp_logs.sh

Login to Ubuntu and run this script

$ sh watch_ztp_logs.sh

When the device gets DHCP and downloads the Python file the logs will be seen



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Example Python ZTP Script (ztp-simple.py)

```
1  print "\n\n *** Sample ZTP Day0 Python Script *** \n\n"
2  # Importing cli module
3  import cli
4
5  print "Configure vlan interface, gateway, aaa, and enable netconf-yang\n\n"
6  cli.configurep(["int vlan 1", "ip address 10.5.123.27 255.255.255.0", "no shut", "end"])
7  cli.configurep(["ip default-gateway 10.5.123.1", "end"])
8  cli.configurep(["username admin privilege 15 secret 0 XXXXXXXXXXXXX"])
9  cli.configurep(["aaa new-model", "aaa authentication login default local", "end"])
10 cli.configurep(["aaa authorization exec default local", "aaa session-id common", "end"])
11 cli.configurep(["netconf-yang", "end"])
12
13 print "\n\n *** Executing show ip interface brief  *** \n\n"
14 cli_command = "sh ip int brief"
15 cli.executep(cli_command)
16
17 print "\n\n *** ZTP Day0 Python Script Execution Complete *** \n\n"
```

https://github.com/jeremycohoe/c9300-ztp

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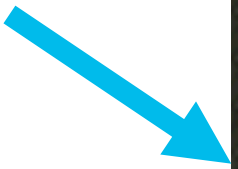
ISC DHCP Configuration Example (dhcpd.conf)

```
option domain-name "gold-programmability-lab.cisco.com";
default-lease-time 600;
max-lease-time 7200;
ddns-update-style none;
authoritative;

# Pod Network
# interface has IP 10.1.1.x
subnet 10.1.1.0 netmask 255.255.255.0 {
range 10.1.1.150 10.1.1.159;
option domain-name "gold-programmability-lab.cisco.com";
option subnet-mask 255.255.255.0;
option broadcast-address 10.1.1.255;
default-lease-time 600;
max-lease-time 7200;
option bootfile-name "http://10.1.1.3/ztp-simple.py";
}
```

option 67



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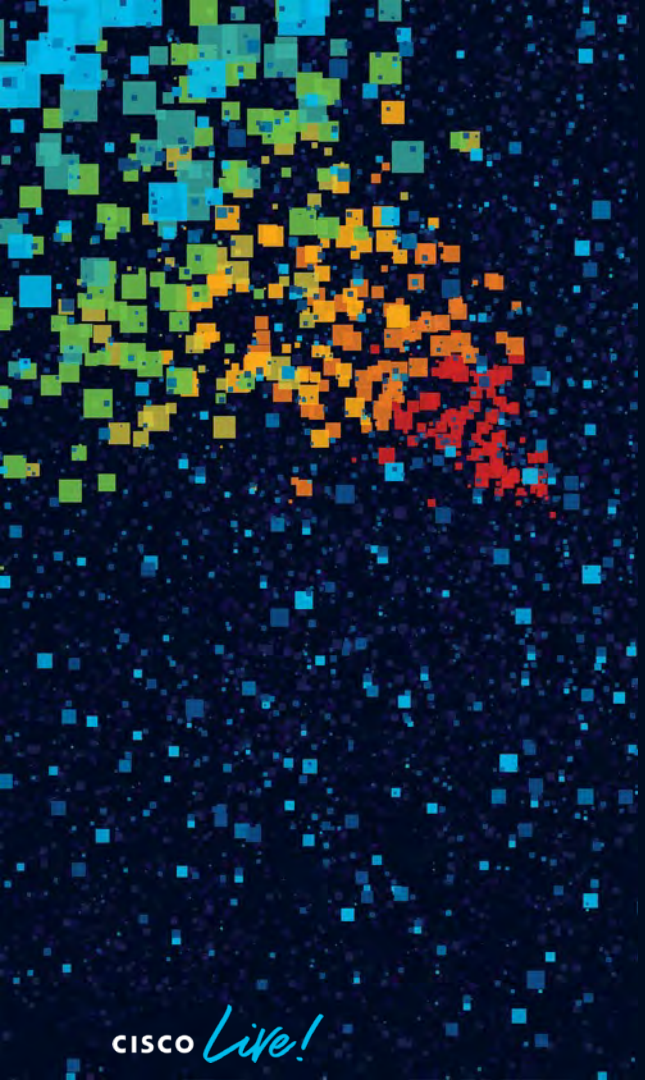

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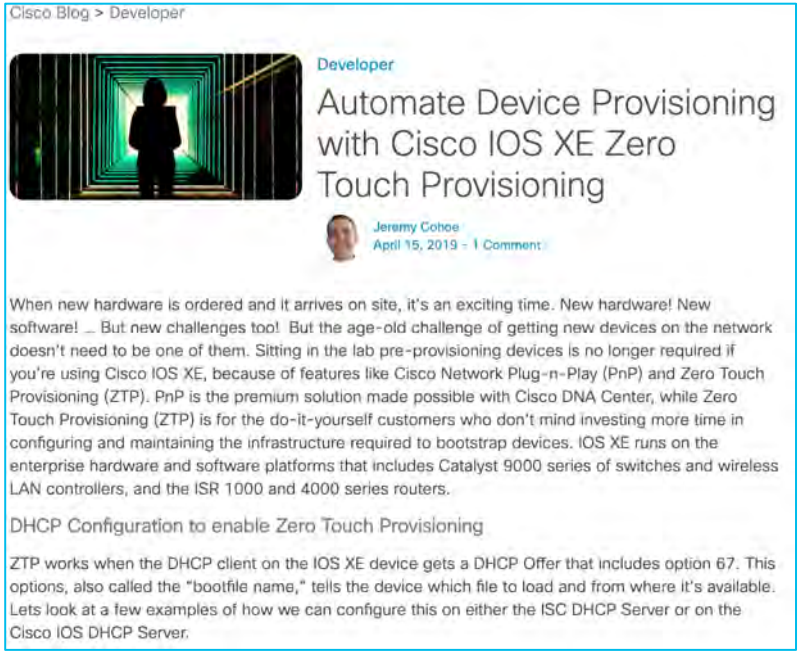
Cisco Blog resources



https://blogs.cisco.com/developer/look-mom-no-hands-automating-device-deployment-with-ios-xe
https://blogs.cisco.com/developer/device-provisioning-with-ios-xe-zero-touch-provisioning

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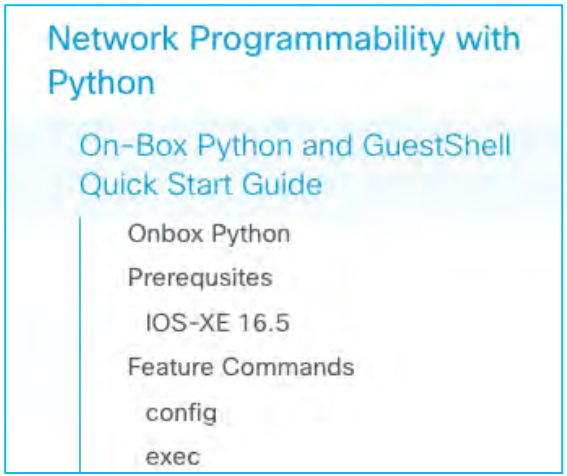
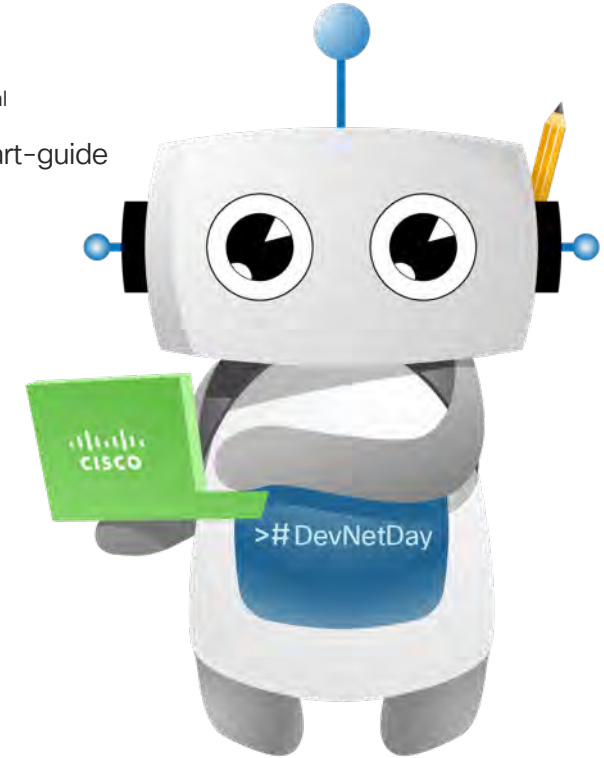
Explore More

- Cisco IOS XE Programmability Configuration Guide – Guest Shell
  - https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/prog/configuration/172/b_172_programmability_cg.html
- https://developer.cisco.com/docs/ios-xe/#!on-box-python-and-guestshell-quick-start-guide





- DEVNET Learning Lab and Sandbox for ZTP … coming soon !

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Thank you

Possibilities

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