

IOS XE Zero Touch Provisioning

Jeremy Cohoe
Technical Marketing Engineer
Cisco Systems



jcohoe@cisco.com



[@jeremycohoe](https://twitter.com/jeremycohoe)



github.com/jeremycohoe





Agenda

- Overview of ZTP
- Demo
- Resources

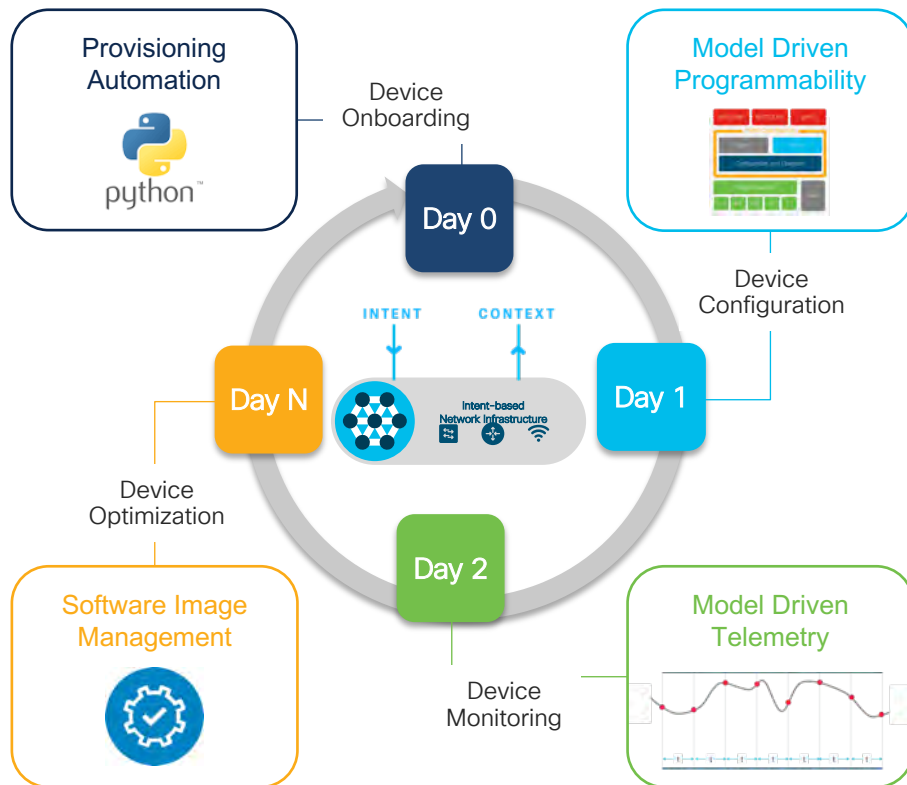
IOS XE Programmability

VMWare/KVM run script

Zero Touch Provisioning

DHCP Auto Install, PnP

Guest Shell
On-Box Python API
Application Hosting
with Docker



Network Configuration
Protocols (NETCONF)

RESTCONF, gNMI

YANG Data Models,
OpenConfig

gRPC Dial Out Configured

gNMI Dial-In

NETCONF Dial-In

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



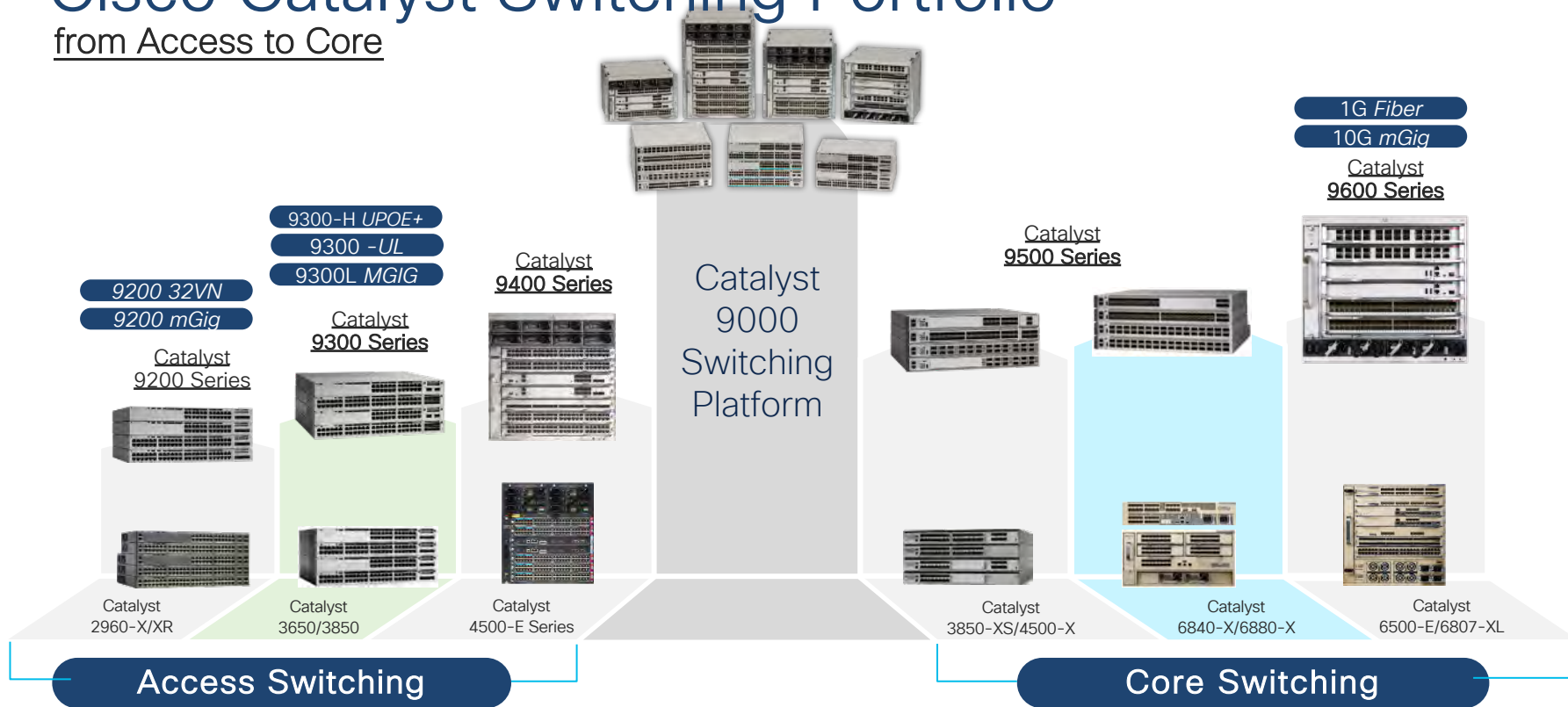
<https://www.youtube.com/watch?v=EAXnftG6odg>

<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

Cisco Catalyst Switching Portfolio

from Access to Core



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



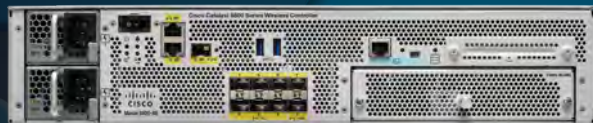
- Cisco DNA virtualization
- Extend enterprise routing, security & management to cloud

SD-WAN

Catalyst 9800 Series Wireless Controllers



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



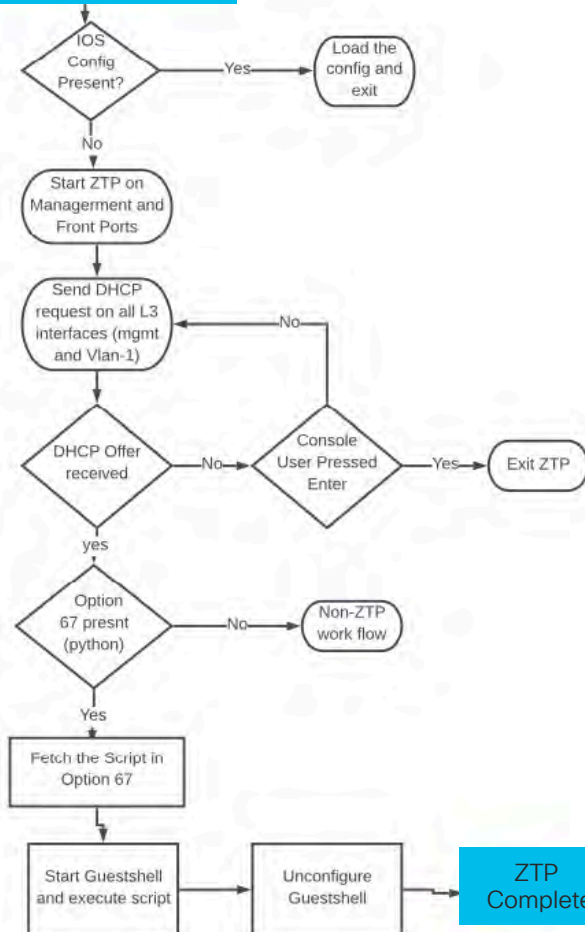
ZTP Overview

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

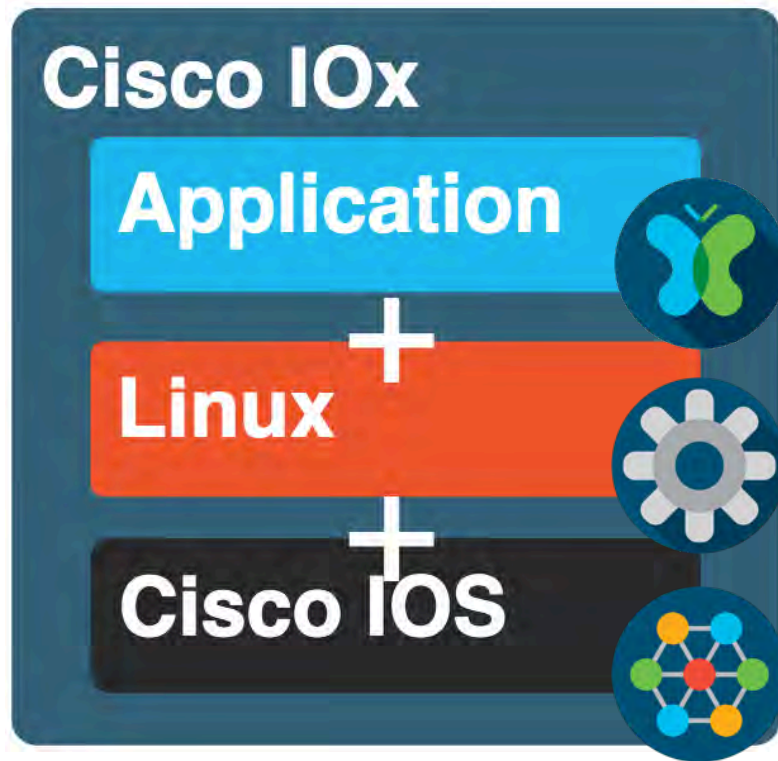
The Python API within Guest Shell enables complete device configuration

IOS XE Device
(powers on)



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.

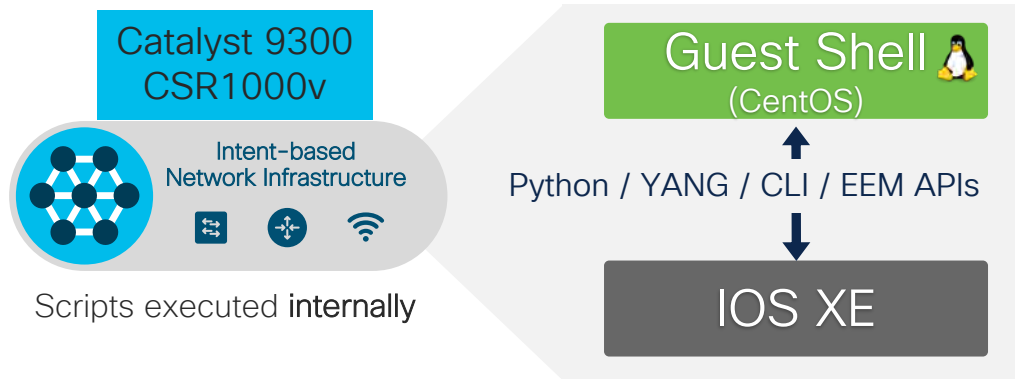


Guestshell

- 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
```



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 .

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

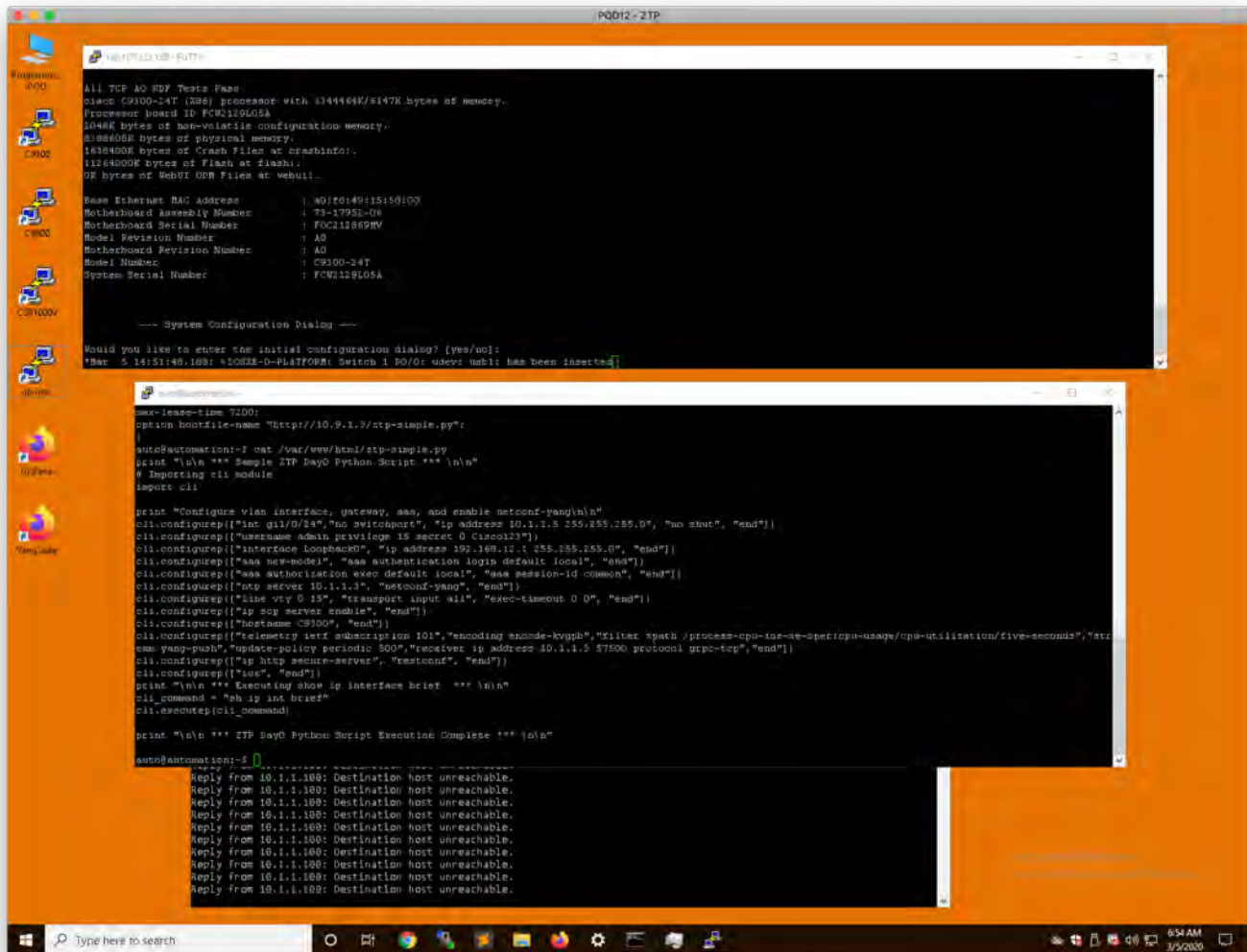


Cisco CLI, EEM, and NETCONF client Python libraries already support Python 3.0



Agenda

- Overview of ZTP
- Demo
- Resources



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

```
auto@automation: ~  
Using username "auto".  
Welcome to Ubuntu 16.04.6 LTS (GNU/Linux 4.4.0-154-generic x86_64)  
  
* Documentation:  https://help.ubuntu.com  
* Management:    https://landscape.canonical.com  
* Support:        https://ubuntu.com/advantage  
  
1 package can be updated.  
0 updates are security updates.  
  
New release '18.04.2 LTS' available.  
Run 'do-release-upgrade' to upgrade to it.  
  
Last login: Mon Sep  9 13:27:29 2019 from 10.1.1.100  
auto@automation:~$ sh watch_ztp_logs.sh  
█
```

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 XXXXXXXXXXXXXXXX"])
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>

ISC DHCP Configuration Example (dhcpcd.conf)

```
1 option domain-name "gold-programmability-lab.cisco.com";
2 default-lease-time 600;
3 max-lease-time 7200;
4 ddns-update-style none;
5 authoritative;
6
7 # Pod Network
8 # interface has IP 10.1.1.x
9 subnet 10.1.1.0 netmask 255.255.255.0 {
10 range 10.1.1.150 10.1.1.159;
11 option domain-name "gold-programmability-lab.cisco.com";
12 option subnet-mask 255.255.255.0;
13 option broadcast-address 10.1.1.255;
14 default-lease-time 600;
15 max-lease-time 7200;
16 option bootfile-name "http://10.1.1.3/ztp-simple.py";
17 }
```

option 67





Agenda

- Overview of ZTP
- Demo
- Resources

Cisco Blog resources

 Cisco Blogs

All BlogsTechnologiesIndustriesPartnersFor the Tech ExpertGet to Know Cisco

Cisco Blog > Developer



Developer


Look Mom...No Hands!
Automating Device
Deployment with IOS XE

 Adam Radford
August 21, 2017 - 9 Comments

For those of you who have followed earlier blogs, you will have seen the major enhancements we have been making in open [IOS XE](#). Jeff McLaughlin mentioned Day Zero deployment in [his recent blog](#).


Day Zero is a critical step in automation. In the past, in order to install a new network device, a highly skilled network engineer would go out on site, connect and configure the device. This process was quite manual (cut/paste) and hence error prone. A great opportunity for automation.

Cisco Blog > Developer



Developer

Automate Device Provisioning
with Cisco IOS XE Zero
Touch Provisioning

 Jeremy Cohoe
April 15, 2019 - 1 Comment

When new hardware is ordered and it arrives on site, it's an exciting time. New hardware! New software! ... But new challenges too! But the age-old challenge of getting new devices on the network doesn't need to be one of them. Sitting in the lab pre-provisioning devices is no longer required if you're using Cisco IOS XE, because of features like Cisco Network Plug-n-Play (PnP) and Zero Touch Provisioning (ZTP). PnP is the premium solution made possible with Cisco DNA Center, while Zero Touch Provisioning (ZTP) is for the do-it-yourself customers who don't mind investing more time in configuring and maintaining the infrastructure required to bootstrap devices. IOS XE runs on the enterprise hardware and software platforms that includes Catalyst 9000 series of switches and wireless LAN controllers, and the ISR 1000 and 4000 series routers.

DHCP Configuration to enable Zero Touch Provisioning

ZTP works when the DHCP client on the IOS XE device gets a DHCP Offer that includes option 67. This options, also called the "bootfile name," tells the device which file to load and from where it's available. Lets look at a few examples of how we can configure this on either the ISC DHCP Server or on the Cisco IOS DHCP Server.

<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>

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>

Network Programmability with Python

On-Box Python and GuestShell Quick Start Guide

- Onbox Python
- Prerequisites
 - IOS-XE 16.5
- Feature Commands
 - config
 - exec

Zero Touch Provisioning (ZTP)

IOS XE also supports Zero Touch Provisioning. The ZTP process is similar to PoP, but it is designed to work with standard servers and uses protocols like TFTP and SCP. ZTP is not a turnkey solution like PoP, but is offered for greater compatibility with other device types. Nexus Power-On Auto-Provisioning (PoAP) is very similar to ZTP.

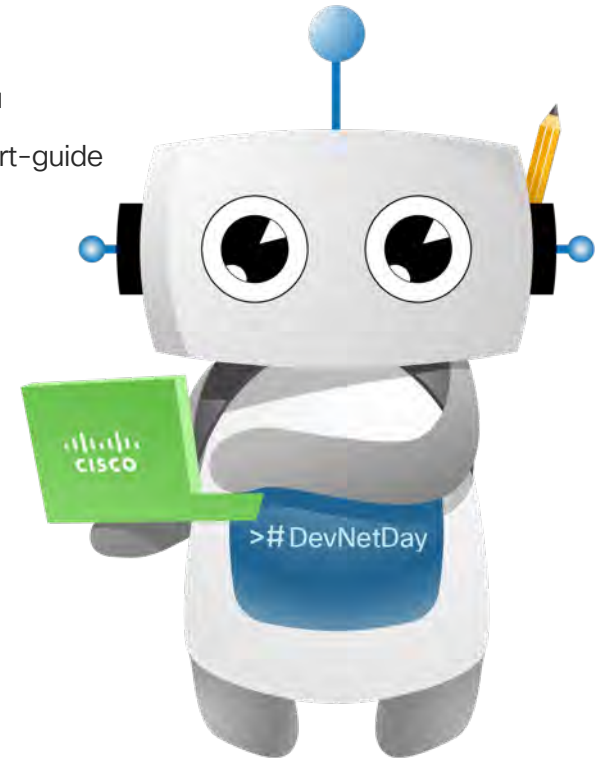
When a device that supports Zero-Touch Provisioning boots up, and does not find the startup configuration (during fresh install on Day Zero), the device enters the Zero-Touch Provisioning mode. The device locates a Dynamic Host Control Protocol (DHCP) server, bootstraps itself with its interface IP address, gateway, and Domain Name System (DNS) server IP address, and enables Guest Shell. The device then obtains the IP address or URL of a TFTP server, and downloads the Python script to configure the device.

Guest Shell provides the environment for the Python script to run. Guest Shell executes the downloaded Python script and configures the device for Day Zero. After Day Zero provisioning is complete, Guest Shell remains enabled.

The following is an example of the DHCP configuration required for ZTP:

CODE SNIPPET

```
ip dhcp pool ztp_device_pool          ← Name of DHCP pool
vrf Mgmt-vrf                          ← Management VRF
network 10.1.1.0 255.255.255.0         ← Range of client IP addresses
default-router 10.1.1.1                ← Gateway address
option 150 ip 203.0.113.254            ← Script server
option 67 ascii /sample_python_dir/python_script.py ← Python script name
```



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

Thank you



Possibilities

#CiscoLive | #DevNetDay