

Network Configuration Example

Configuring Zero Touch Provisioning in Branch Networks



Modified: 2017-01-18

Juniper Networks, Inc.
1133 Innovation Way
Sunnyvale, California 94089
USA
408-745-2000
www.juniper.net

Copyright © 2017, Juniper Networks, Inc. All rights reserved.

Juniper Networks, Junos, Steel-Belted Radius, NetScreen, and ScreenOS are registered trademarks of Juniper Networks, Inc. in the United States and other countries. The Juniper Networks Logo, the Junos logo, and JunosE are trademarks of Juniper Networks, Inc. All other trademarks, service marks, registered trademarks, or registered service marks are the property of their respective owners.

Juniper Networks assumes no responsibility for any inaccuracies in this document. Juniper Networks reserves the right to change, modify, transfer, or otherwise revise this publication without notice.

Network Configuration Example Configuring Zero Touch Provisioning in Branch Networks

Copyright © 2017, Juniper Networks, Inc.
All rights reserved.

The information in this document is current as of the date on the title page.

YEAR 2000 NOTICE

Juniper Networks hardware and software products are Year 2000 compliant. Junos OS has no known time-related limitations through the year 2038. However, the NTP application is known to have some difficulty in the year 2036.

END USER LICENSE AGREEMENT

The Juniper Networks product that is the subject of this technical documentation consists of (or is intended for use with) Juniper Networks software. Use of such software is subject to the terms and conditions of the End User License Agreement ("EULA") posted at <http://www.juniper.net/support/eula.html>. By downloading, installing or using such software, you agree to the terms and conditions of that EULA.

Table of Contents

Chapter 1	Configuring Zero Touch Provisioning in Branch Networks	5
	About This Network Configuration Example	5
	Use Case for Configuring Zero Touch Provisioning	5
	Example: Configuring Zero Touch Provisioning in Branch Networks	6
	Conclusion	22

CHAPTER 1

Configuring Zero Touch Provisioning in Branch Networks

- [About This Network Configuration Example on page 5](#)
- [Use Case for Configuring Zero Touch Provisioning on page 5](#)
- [Example: Configuring Zero Touch Provisioning in Branch Networks on page 6](#)
- [Conclusion on page 22](#)

About This Network Configuration Example

The objective of this document is to demonstrate some of the Zero Touch Provisioning (ZTP) capabilities available in Juniper Networks switches. This document defines a typical customer use case and provides a step-by-step process to address the requirement.

This document covers the basic ZTP process and specific device configuration for the Juniper Networks® EX3300 switch running Junos® OS Release 12.3R6. This document does not show the capabilities of enhanced ZTP, which is available on newer platforms like QFX5100 and EX4300.

Use Case for Configuring Zero Touch Provisioning

When bringing up a new network device in a remote office or branch, it can be costly to dispatch resources to provision equipment. With ZTP, all new devices that are connected to the ZTP environment are able to function without any manual CLI or GUI intervention. The network device simply only needs to be connected and turned on. This is useful when technical staff is limited or unavailable.

This example shows how to configure ZTP. Maintenance tasks such as the following can be performed by nontechnical staff:

- Deploying new access switches in branch offices
- Replacing access switches in branch offices

With ZTP, a new device has its port configuration and its IP address automatically provisioned based on the requirements of its location. Also, when an inoperable switch is swapped out, the replacement switch will automatically be configured correctly. All newly added switches register with Network Director.

ZTP allows for lower operational overhead and saves time. Customers can reliably bring up network services throughout their environment.

**Related
Documentation**

- [Example: Configuring Zero Touch Provisioning in Branch Networks on page 6](#)

Example: Configuring Zero Touch Provisioning in Branch Networks

Zero Touch Provisioning (ZTP) allows automatic provisioning of new switches without any manual intervention. This example configuration shows how to configure ZTP in a typical branch network environment.

- [Requirements on page 6](#)
- [Overview on page 6](#)
- [Configuration on page 8](#)
- [Verification on page 19](#)

Requirements

This example uses the following hardware and software components:

- EX3300 24-port switch
- EX3300 48-port switch
- Network Director 1.6
- CentOS DHCP server
- FileZilla FTP server

Before you configure ZTP, ensure that you have completed the following tasks:

- Make sure that devices are physically cabled properly. Confirm that each ZTP device can connect to the DHCP server, the file server, and Network Director.
- Make sure that devices to be provisioned are plugged into power, but switched OFF. The devices should not be switched to ON before configuring ZTP. Devices can be powered ON after the ZTP environment has been configured.

In this example configuration, the network devices that are provisioned by ZTP are referred to as the *ZTP device*. For example, the EX3300 24-port switch at the branch site in this topology is the ZTP device. Network Director is used as the *ZTP server*.

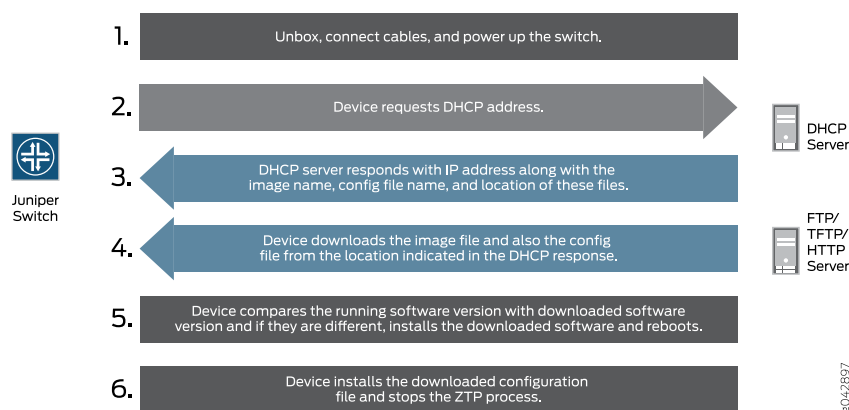
Overview

When a switch is connected to the network and powered up with its factory default configuration, the ZTP process on the switch downloads the appropriate software and also the configuration file for the device. The basic ZTP process provides a standard configuration file based on the type of device. For example, all EX3300 switches must have a specified Junos OS software version and a standardized configuration file intended for EX3300 switches.

When bringing up a new device on a network with ZTP, there are two phases. The first phase is the basic ZTP process that includes general provisioning, such as downloading of the proper software and configuration files to the ZTP device. After the configuration file has been downloaded, the basic ZTP process is completed. The second phase is device-specific, taking advantage of Juniper Networks built-in automation capabilities. During the second phase, the device automatically installs a device-specific configuration based on its location.

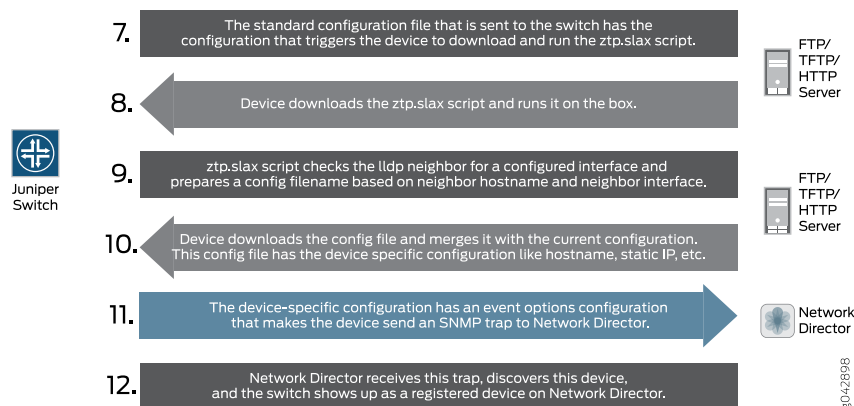
Figure 1 on page 7 shows the basic ZTP process.

Figure 1: Phase One - Basic ZTP Process



When the basic ZTP process is complete, the ZTP device has the correct OS for that model and also has a configuration file that is common for that type of platform in a site. ZTP solutions from most other vendors stop there. However, Juniper Networks devices can go on further. Figure 2 on page 7 shows the next part of the process.

Figure 2: Phase Two - Device-Specific Provisioning



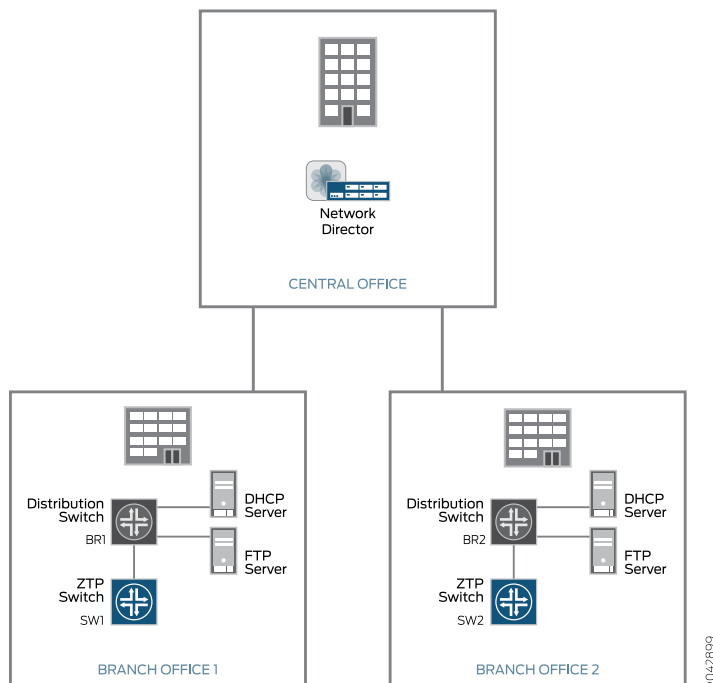
After the device is connected and powered up, there is no need for any additional CLI or GUI intervention to configure the device. The device has the necessary configuration for

the location. Note that there is no need to identify the MAC address/Serial number of the device. The device gets a specific configuration based on where the device is plugged into the network. If this device is removed and another device gets plugged in at this location, that device gets the same specific configuration irrespective of the MAC address or serial number of the device. This is a truly “Zero Touch” provisioning solution.

Topology

The topology as illustrated in [Figure 3 on page 8](#) is used for this example.

Figure 3: Network Topology for ZTP



Configuration

The network environment requires some preparation to support the ZTP process. This section includes procedures that show how to set up the environment to support ZTP, as well as how to actively deploy ZTP in this example. It shows how network administrators can use Junos Space Network Director to prepare the environment to support the ZTP process. The network administrators can also manually prepare these tasks separately if desired. To configure ZTP involves performing these tasks:

- [Configuring the DHCP Server \(Manually\) on page 9](#)
- [Configuring Network Director for ZTP on page 11](#)
- [Configuring ZTP for Device-Specific Configuration File on page 17](#)

Configuring the DHCP Server (Manually)

Step-by-Step Procedure The DHCP server should be configured to identify the type of device (in this case, the EX3300) requesting the DHCP address and to send back the following information along with the DHCP response. The DHCP server can be configured separately, or Network Director can be used to configure DHCP as well.

- Software image file name
- Configuration file name
- File transfer mode
- Server IP address where these files are located

To configure the DHCP server manually:

1. Set the DHCP options within the **dhcpcd.conf** file on the DHCP server.

The screenshot in [Figure 4 on page 10](#) provides an example **dhcpcd.conf** file.

Figure 4: Set DHCP Options Screenshot

```
ddns-update-style interim;
set vendor-string = option vendor-class-identifier;
ignore client-updates;
option space NEW_OP;
option NEW_OP.image-file-name code 0 = text;
option NEW_OP.config-file-name code 1 = text;
option NEW_OP.image-file-type code 2 = text;
option NEW_OP.transfer-mode code 3 = text;
option NEW_OP-encapsulation code 43 = encapsulate NEW_OP;
option NEW_OP.image-file-type "symlink";
option option-150 code 150 = ip-address;

class "ex3300-48p-clients" {
    match if substring (option vendor-class-identifier, 0,18) = "Juniper-ex3300-48p";
}

subnet 10.105.5.0 netmask 255.255.255.0 {
    range 10.105.5.240 10.105.5.246;
    option domain-name-servers 8.8.8.8, 8.8.4.4;
    option routers 10.105.5.1;
    default-lease-time 600;
    max-lease-time 7200;
    authoritative;
    pool {
        allow members of "ex3300-48p-clients";
        range dynamic-bootp 10.105.5.98 10.105.5.198;
        option NEW_OP.transfer-mode "ftp";
        option option-150 10.92.70.224;
        option NEW_OP.image-file-name "/pub/jinstall-ex-3300-13.2X50-D19.2-domestic-signed.tgz";
        option NEW_OP.config-file-name "/pub/default-ex3300-48p.config";
    }
}
```

Network administrators can prepare this configuration manually or they can use Network Director to generate this configuration.

This example configuration file can be used for your DHCP server.

```
ddns-update-style interim;
set vendor-string = option vendor-class-identifier;
ignore client-updates;
option space NEW_OP;
option NEW_OP.image-file-name code 0 = text;
option NEW_OP.config-file-name code 1 = text;
option NEW_OP.image-file-type code 2 = text;
option NEW_OP.transfer-mode code 3 = text;
option NEW_OP-encapsulation code 43 = encapsulate NEW_OP;
option NEW_OP.image-file-type "symlink";
option option-150 code 150 = ip-address;

class "ex3300-48" {
    match if (
        (substring (option vendor-class-identifier,0,18) =
"Juniper-ex3300-48p")
        or
        (substring (option vendor-class-identifier,0,18) =
"Juniper-ex3300-48t")
    );
}

subnet 10.105.5.0 netmask 255.255.255.0 {
    option domain-name-servers 8.8.8.8, 8.8.4.4;
    option routers 10.105.5.1;
    default-lease-time 600;
```

```

max-lease-time 7200;
authoritative;
pool {
    allow members of "ex3300-48t";
    range dynamic-bootp 10.105.5.98 10.105.5.198;
    option NEW_OP.transfer-mode "ftp";
    option OPTION-150 10.92.70.224;
    option NEW_OP.config-file-name "/3300/3300-base-network.conf";
    option NEW_OP.image-file-name
"/3300/jinstall-ex-3300-13.2X50-D19.2-domestic-signed.tgz";
}
}

```

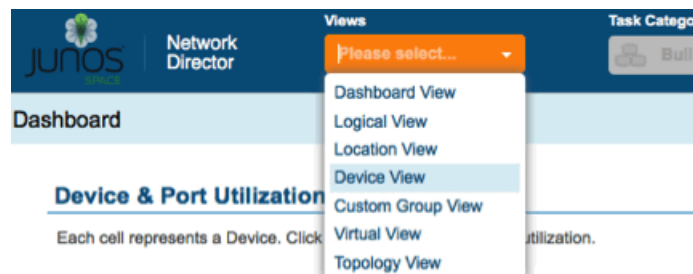
Configuring Network Director for ZTP

Step-by-Step Procedure

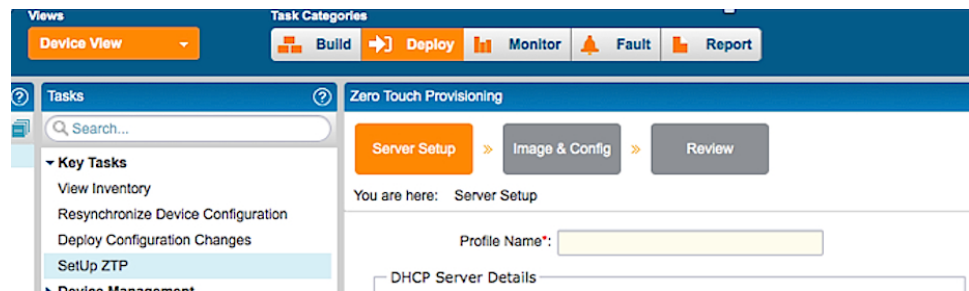
To use Network Director to populate the `dhcpd.conf` file as well as prepare the rest of the ZTP environment:

1. Log in to the Network Director Dashboard and select **Device View**.

Figure 5: Selecting Device View



2. Select the **Deploy** task category and then choose the **Set up ZTP** task.



3. Set up the DHCP server on Network Director.

Figure 6 on page 12 shows example settings to provision DHCP.

Set the following DHCP server information details:

- DHCP server type
- DHCP server IP address
- DHCP server username and password



NOTE: This user must have write permission for the `dhcpd.conf` file.

Figure 6: DHCP Server Setup

The screenshot shows the 'Zero Touch Provisioning' configuration page. The left sidebar lists tasks under 'Zero Touch Provisioning', with 'SetUp ZTP' selected. The main content area shows the 'Server Setup' step, which includes a 'Profile Name' field set to 'True_ZTP_Profile_BR1'. Below this is a 'DHCP Server Details' section with a 'DHCP Server Type' dropdown set to 'CentOS'. There is a checkbox for 'Manually Configure Server'. Below the checkbox are input fields for 'DHCP Server' (10.105.5.150), 'DHCP User' (dhcpadmin), 'DHCP Password' (masked with asterisks), and 'Confirm Password' (masked with asterisks).

4. Set up the file server on Network Director.

Once you have set up the DHCP server details, continue to populate the information for the file server details.

Set the following file server information:

- File server type
- File server IP address
- Directory path to software images and configuration file storage

Figure 7: Network Director ZTP Configuration - File Server Setup

Zero Touch Provisioning

Server Setup » Image & Config » Review

You are here: Server Setup

Profile Name*: True_ZTP_Profile_BR1

DHCP Server Details

DHCP Server Type*: CentOS

☒ Manually Configure Server

DHCP Server*: 10.105.5.150

DHCP User*: dhcpadmin

DHCP Password*: *****

Confirm Password*: *****

File Server Details

☒ FTP File Server ☐ HTTP File Server ☐ TFTP File Server

File Server*: 10.92.70.224

File Server Root Dir*: /pub

Optional Settings

Syslog Server IP:

NTP Server IP:

5. Configure the software image and configuration.

Once you have completed the DHCP server setup and file server setup, click **Next** to enter device-specific image and configuration details.

Configure the root password for the ZTP device. This is the password that is used by the root user in the configuration file that the ZTP device downloads during the ZTP process.



NOTE: Network Director uses this password to discover and manage the device once it is registered. If you decide not to use the default configuration generated by Network Director, make sure that you use the same root password used in your configuration file so the ZTP device can be managed by Network Director after the device completes ZTP.

Figure 8: Network Director ZTP Configuration - Image and Config

Zero Touch Provisioning

Server Setup » **Image & Config** » Review

You are here: Image & Config

ZTP Devices root user password*:

Confirm Password*:

Configure Settings

+ Add Delete Export DHCP Config

Device Model	Image File	Config File	Default Config	Upload	Subnet	From IP
EX3300-48p	jinstall-ex-3300-13.2X50-D19.2-domestic-signed.tgz	default-ex3300-48p.config	View	Upload Config	10.105.5.0/255.255.255.0	10.105.5.98

Add the type of device for which the ZTP environment should be prepared.

Be sure to include the following details:

- Device model
- Software image



NOTE: You can upload images to Network Director under **Image Management > Manage Image Repository**.

- Configuration file



NOTE: Network Director generates a default configuration file or you can use your own. If you are using your own, upload your file to Network Director by clicking **Upload Config**.

This is an example custom configuration file that you would upload to Network Director for your ZTP device.

```
system {
  host-name ex_autoi;
  root-authentication {
    encrypted-password;
  }
  services {
    rsh;
    ssh {
      max-sessions-per-connection 32;
    }
    netconf {
      ssh;
    }
    dhcp {
```

The root password of the device will not appear in cleartext, it will be encrypted

```

        traceoptions {
            file dhcp_logfile;
            level all;
            flag all;
        }
    }
}
syslog {
    user * {
        any emergency;
    }
    file messages {
        any notice;
        authorization info;
    }
    file interactive-commands {
        interactive-commands any;
    }
    file default-log-messages {
        any any;
        match "(requested 'commit' operation)|(copying configuration
to juniper.save)|(commit complete)|ifAdminStatus|(FRU power)|(FRU
removal)|(FRU insertion)|(link
UP)|transitioned|Transferred|transfer-file|(license add)|(license
delete)|(package -X update)|(package -X delete) | cm_device|(Master
Unchanged, Members Changed)|(Master Changed, Members Changed)|(Master
Detected, Members Changed)|(vc add)|(vc delete)|(Master detected)|(Master
changed)|(Backup detected)|(Backup changed)|(interface vcp-) |
(AIS_DATA_AVAILABLE)";
        structured-data;
    }
}
}
interfaces {
    interface-range first24 {
        member-range ge-0/0/0 to ge-0/0/28;
        unit 0 {
            family ethernet-switching {
                vlan {
                    members v200;
                }
            }
        }
    }
}
vme {
    unit 0 {
        family inet {
            dhcp {
                vendor-id Juniper-ex3300-48p;
            }
        }
    }
}
}
event-options {
    generate-event {
        ztp-autoi time-interval 60;
    }
    policy ztp-autoi {
        events ztp-autoi;
        then {

```

```
        execute-commands {
            commands {
                "op url ftp://10.92.70.224/ztp.slax interface ge-0/0/0
server 10.92.70.224 SWVER 13.2X51";
            }
        }
    }
}
protocols {
    igmp-snooping {
        vlan all;
    }
    rstp;
    lldp {
        interface all;
    }
    lldp-med {
        interface all;
    }
}
ethernet-switching-options {
    storm-control {
        interface all;
    }
}
vlans {
    v200 {
        vlan-id 200;
    }
}
poe {
    interface all;
}
```

- DHCP subnet
- DHCP range

DHCP information that was specified in the **dhcpd.conf** file loaded in Network Director is automatically displayed. You can add a new subnet through this user interface if desired.

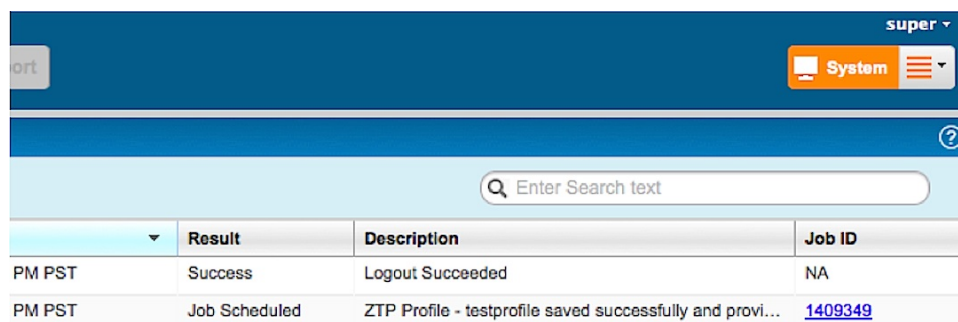
6. Review the ZTP configuration.

Once you have completed configuring the device software image and configuration details, you can click **Next** to review your work. You can click the **Back** button to modify any configuration details before you finish.

7. Finish the ZTP configuration.

Click **Finish** after you have fully reviewed your configuration and are ready to push the image file and configuration file to the ftp server. On the upper right corner of the browser window, click **System** to check the job status of ZTP Profile creation. You can click the **Job ID** for further details.

Figure 9: Network Director ZTP Configuration - System Status Check



	Result	Description	Job ID
PM PST	Success	Logout Succeeded	NA
PM PST	Job Scheduled	ZTP Profile - testprofile saved successfully and provi...	1409349

Configuring ZTP for Device-Specific Configuration File

Step-by-Step Procedure

In this example, a customer wants a device-specific configuration file installed with a device-specific hostname and static IP address configured on the device. To achieve this, use the on-box automation capabilities available in Juniper Networks switches.

To configure ZTP for a device-specific configuration file:

1. Configure event options on the ZTP device.

Using the **event-options** configuration, generate an event that triggers the switch to download a slax script and run the slax script on the box. This slax script can be the **ztp.slax** script that is used in this example or any other slax script that is specific to your environment.

You can download the **ztp.slax** script from

<https://github.com/spkrishnan/ztp/blob/master/ztp.slax>.

```
event-options {
  generate-event {
    ztp-autoi time-interval 60;
  }
  policy ztp-autoi {
    events ztp-autoi;
    then {
      execute-commands {
        commands {
          "op url ftp://10.92.70.224/ztp.slax interface ge-0/0/0 server 10.92.70.224
          SWVER 12.3R6.6";
        }
      }
    }
  }
}
```

The **ztp.slax** script that is used in this example checks the LLDP neighbor information for the interface that is provided as input to the script. Based on the LLDP neighbor hostname and neighbor interface name, the script prepares the name of the device-specific configuration file that should be downloaded for this device. For

example, if the LLDP neighbor hostname is BR1 and the neighbor interface name is ge-0/0/7, the script generates the filename the **JUNOS-BR1-ge-0_0_7.conf**.

The script downloads this file from the file server provided as input to the script and merges the configuration in the file with the device configuration. In this example, **JUNOS-BR1-ge-0_0_7.conf** configuration file was already created by the network administrator and posted on the ftp server. In this example, the device-specific configuration file has the device-specific hostname for the device and a static IP address for the device. But, depending on the requirements of your environment, this configuration file can have any valid configuration.

2. Configure device auto registration with Network Director.

```
system {
  root-authentication {
    encrypted-password <PASSWORD>; ## SECRET-DATA
  }
}
event-options {
  policy target_add_test {
    events snmpd_trap_target_add_notice;
    then {
      raise-trap;
    }
  }
}
snmp {
  trap-group networkdirector_trap_group {
    version all;
    destination-port <ND Port>;
    categories {
      authentication;
      link;
      services;
    }
    targets {
      <ND IP Address>;
    }
  }
}
```

This configuration is necessary for the device to automatically register with Network Director after the ZTP process is complete.

Be sure to specify the following parameters in your configuration properly:

- ND IP address
- ND port (by default this port is 10162)
- Password



NOTE: If it is desired to have the device auto register with Network Director after completing the ZTP process, the following requirements must be met:

- The device should send the trap `snmpd_trap_target_add_notice` to the Network Director.
- There should be a profile on Network Director for ZTP.
- The IP address of the device must be from the pool of IP addresses defined in the ZTP profile.
- The root password of the device must be the same password that is defined in the ZTP profile.

Verification

Confirm that the configuration is working properly.

- [Verifying the ZTP Configuration on page 19](#)
- [Verifying the Custom Configuration for a Device Using the ZTP Device-Specific Configuration on page 21](#)

Verifying the ZTP Configuration

Purpose Confirm that the ZTP configuration is properly configured.

- Action**
1. Physically connect cables and power up the ZTP device (switch) to enter ZTP.

If the ZTP device was already in use, you can restore the device to factory default settings.

`root# request system zeroize`
Reboot system to enter ZTP.
 2. Verify DHCP.

Figure 10: Verifying ZTP - DHCP

```

U-Boot 1.1.6 (Aug 21 2011 - 01:45:26)

Board: EX3300-48P 4.10
EPLD: Version 03.110621 (0x02)
DRAM: Initializing (1GB)
Flash: 8 MB
NAND: 1024 MiB

Firmware Version: --- 01.00.00 ---
USB: scanning bus for devices...
Root Hub 0: 2 USB Device(s) found
Root Hub 1: 1 USB Device(s) found
       scanning bus for storage devices... 1 Storage Device(s) found

ELF file is 32 bit
Consoles: U-Boot console

FreeBSD/arm U-Boot loader, Revision 1.1
(builder@dagmath.juniper.net, Sun Aug 21 01:24:12 UTC 2011)
Memory: 1024MB
bootsequencing is enabled
bootsuccess is set
new boot device = disk0s1:
Loading /boot/defaults/loader.conf
/kernel data=0x8c3440+0xff83c \

```

After the switch completes booting, it starts broadcasting DHCP discover packets. If a DHCP server on the network responds with a DHCP ACK packet with DHCP vendor options set with the necessary values to initiate ZTP, then ZTP proceeds.

3. Verify the image upgrade.

Figure 11: Verifying ZTP - Auto Image Upgrade

```

Broadcast Message from root@
(no tty) at 9:47 UTC...

Auto-image upgrade started successfully

Broadcast Message from root@
(no tty) at 9:47 UTC...

Auto-image upgrade started successfully

Broadcast Message from root@
(no tty) at 9:47 UTC...

ALERT:Auto-image upgrade will start. This can terminate config          CLI sess
ion(s). Modified configuration will be lost. To stop Auto-image, in CLI do the
following: 'edit; delete chassis auto-image-upgrade; commit'.

Broadcast Message from root@
(no tty) at 9:47 UTC...

ALERT:Auto-image upgrade will start. This can terminate config          CLI sess
ion(s). Modified configuration will be lost. To stop Auto-image, in CLI do the
following: 'edit; delete chassis auto-image-upgrade; commit'.

```

To disable the ZTP process, manually delete the **auto-image-upgrade** statement located in the **[edit chassis]** hierarchy. If ZTP completes without errors, the **auto-image-upgrade** is automatically deleted.

The device downloads the configuration file and the image file from the file server indicated in the DHCP vendor options. The device compares the downloaded image file with the installed software version. If the downloaded image file is different from the installed software version, the downloaded software image is installed and the switch reboots automatically.

After the software installation, the downloaded configuration file is installed and the basic ZTP process is completed. The **auto-image-upgrade** statement in **[edit chassis]** hierarchy is deleted. This completes the basic ZTP process.

The device now has the correct software image and configuration file intended for that device type.

Meaning The ZTP device was able to automatically download the correct software image and configuration file without any manual intervention.

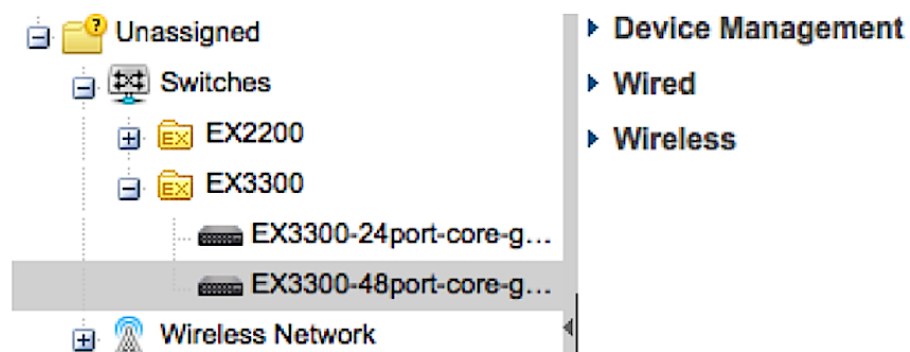
Verifying the Custom Configuration for a Device Using the ZTP Device-Specific Configuration

Purpose Verify that the ZTP device has registered with Network Director from the customized configuration file.

Action 1. After the ZTP device automatically registers with Network Director, go to the **Unassigned** location in the **Location** view.

The device can then be moved to the appropriate location.

Figure 12: Network Director ZTP Configuration - Device Auto Registration



2. Verify the IP address of the ZTP device.

The IP address of the device must be from the pool of IP addresses defined on the ZTP profile for the device in Network Director.

3. Verify the password of the ZTP device.

The root password matches in the configuration file and the ZTP setup in Network Director if the device was able to successfully acquire the expected IP address.

Meaning The ZTP device was able to register with Network Director and properly download a custom configuration.

Related Documentation

- [Use Case for Configuring Zero Touch Provisioning on page 5](#)

Conclusion

The ZTP process and the Junos OS scripting capabilities demonstrated in this document are available on all Juniper Networks switching platforms. Newer platforms like EX4300 and QFX5100 support an enhanced ZTP solution where the ability to download and execute additional scripts during the basic ZTP process is provided. We plan to provide more details on this solution in future documentation.