Introduction to JUNOS Software

9.b

Student Guide

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Introduction to JUNOS Software Student Guide, Revision 9.b

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YEAR 2000 NOTICE

Juniper Networks hardware and software products do not suffer from Year 2000 problems and hence are Year 2000 compliant. The JUNOS Software has no known time-related limitations through the year 2038. However, the NTP application is known to have some difficulty in the year 2036.

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Contents

Course Overview

This course provides students with the foundational knowledge required to work with JUNOS Software and to configure JUNOS devices. This one-day course provides a brief overview of the JUNOS device families and discusses the key architectural components of the software. Additional key topics include user interface options with a heavy focus on the command-line interface (CLI), configuration tasks typically associated with the initial setup of devices, interface configuration basics with configuration examples, secondary system configuration, and the basics of operational monitoring and maintenance of JUNOS devices.

Through demonstrations and hands-on labs, you will gain experience in configuring and monitoring the JUNOS Software and monitoring basic device operations.

Objectives

After successfully completing this course, you should be able to:

- Describe the basic design architecture of JUNOS Software.
- Identify and provide a brief overview of JUNOS devices.
- Navigate within the JUNOS Software CLI.
- Perform tasks within the CLI operational and configuration modes.
- Restore a JUNOS device to its factory-default state.
- Perform initial configuration tasks.
- Configure and monitor network interfaces.
- Describe user configuration and authentication options.
- Perform secondary configuration tasks for features and services such as system logging (syslog) and tracing, Network Time Protocol (NTP), configuration archival, and SNMP.
- Monitor basic operation for JUNOS Software and devices.
- Identify and use network utilities.
- Upgrade the JUNOS Software.
- Perform file system maintenance and password recovery on a JUNOS device.

Intended Audience

This course benefits individuals responsible for configuring and monitoring devices running JUNOS Software.

Course Level

The Introduction to JUNOS Software course is a one-day introductory course.

Prerequisites

Students should have basic networking knowledge and an understanding of the OSI model and the TCP/IP protocol suite.

Course Agenda

Day 1

Chapter 1: Course Introduction

Chapter 2: JUNOS Software Fundamentals

Chapter 3: User Interface Options

- Lab 1: User Interface Options

Chapter 4: Initial Configuration

- Lab 2: Initial Configuration

Chapter 5: Secondary System Configuration

- Lab 3: Secondary System Configuration

Chapter 6: Operational Monitoring and Maintenance

- Lab 4: Operational Monitoring

Appendix A: Interface Configuration Examples

Document Conventions

CLI and GUI Text

Frequently throughout this course, we refer to text that appears in a command-line interface (CLI) or a graphical user interface (GUI). To make the language of these documents easier to read, we distinguish GUI and CLI text from chapter text according to the following table.

Style	Description	Usage Example
Franklin Gothic	Normal text.	Most of what you read in the Lab Guide and Student Guide.

`Courier New`	Console text:
	• Screen captures
	• Noncommand-related syntax
		`commit complete`
		`Exiting configuration mode`

	GUI text elements: • Menu names • Text field entry	Select `File > Open`, and then click `Configuration.conf` in the `Filename` text box.

Input Text Versus Output Text

You will also frequently see cases where you must enter input text yourself. Often this will be shown in the context of where you must enter it. We use bold style to distinguish text that is input versus text that is simply displayed.

Style	Description	Usage Example
`Normal CLI`	No distinguishing variant.	`Physical interface:fxp0, Enabled`
`Normal GUI`		View configuration history by clicking `Configuration > History`.
`CLI Input`	Text that you must enter.	`lab@San_Jose>` **`show route`**
`GUI Input`		Select `File > Save`, and enter **`config.ini`** in the `Filename` field.

Defined and Undefined Syntax Variables

Finally, this course distinguishes between regular text and syntax variables, and it also distinguishes between syntax variables where the value is already assigned (defined variables) and syntax variables where you must assign the value (undefined variables). Note that these styles can be combined with the input style as well.

Style	Description	Usage Example
CLI Variable *GUI variable*	Text where variable value is already assigned.	policy *my-peers* Click on *my-peers* in the dialog.
CLI Undefined *GUI Undefined*	Text where the variable's value is the user's discretion and text where the variable's value as shown in the lab guide might differ from the value the user must input.	Type **set policy *policy-name***. **ping 10.0.*1.1*** Select File > Save, and enter ***filename*** in the Filename field.

Additional Information

Education Services Offerings

You can obtain information on the latest Education Services offerings, course dates, and class locations from the World Wide Web by pointing your Web browser to: http://www.juniper.net/training/education/.

About This Publication

The *Introduction to JUNOS Software Student Guide* was developed and tested using software Release 9.6R1.13. Previous and later versions of software might behave differently so you should always consult the documentation and release notes for the version of code you are running before reporting errors.

This document is written and maintained by the Juniper Networks Education Services development team. Please send questions and suggestions for improvement to training@juniper.net.

Technical Publications

You can print technical manuals and release notes directly from the Internet in a variety of formats:

- Go to http://www.juniper.net/techpubs/.
- Locate the specific software or hardware release and title you need, and choose the format in which you want to view or print the document.

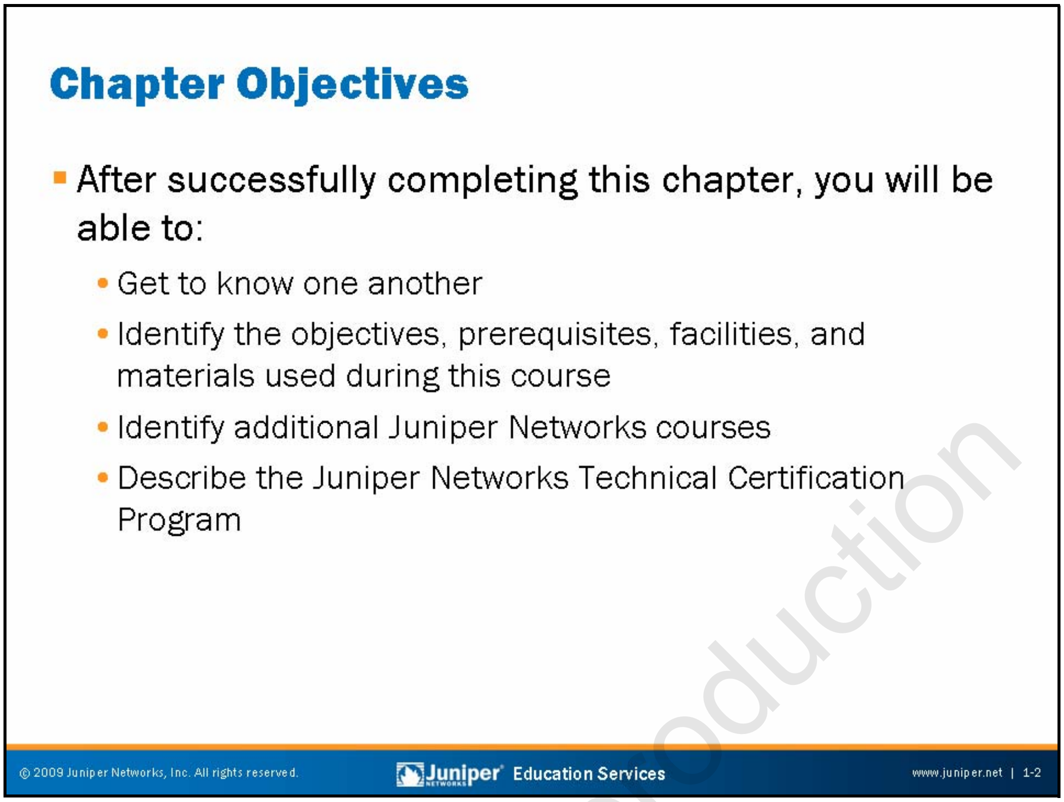
Documentation sets and CDs are available through your local Juniper Networks sales office or account representative.

Juniper Networks Support

For technical support, contact Juniper Networks at http://www.juniper.net/customers/support/, or at 1-888-314-JTAC (within the United States) or 408-745-2121 (from outside the United States).

Introduction to JUNOS Software

Chapter 1: Course Introduction



Chapter Objectives

- After successfully completing this chapter, you will be able to:
  - Get to know one another
  - Identify the objectives, prerequisites, facilities, and materials used during this course
  - Identify additional Juniper Networks courses
  - Describe the Juniper Networks Technical Certification Program

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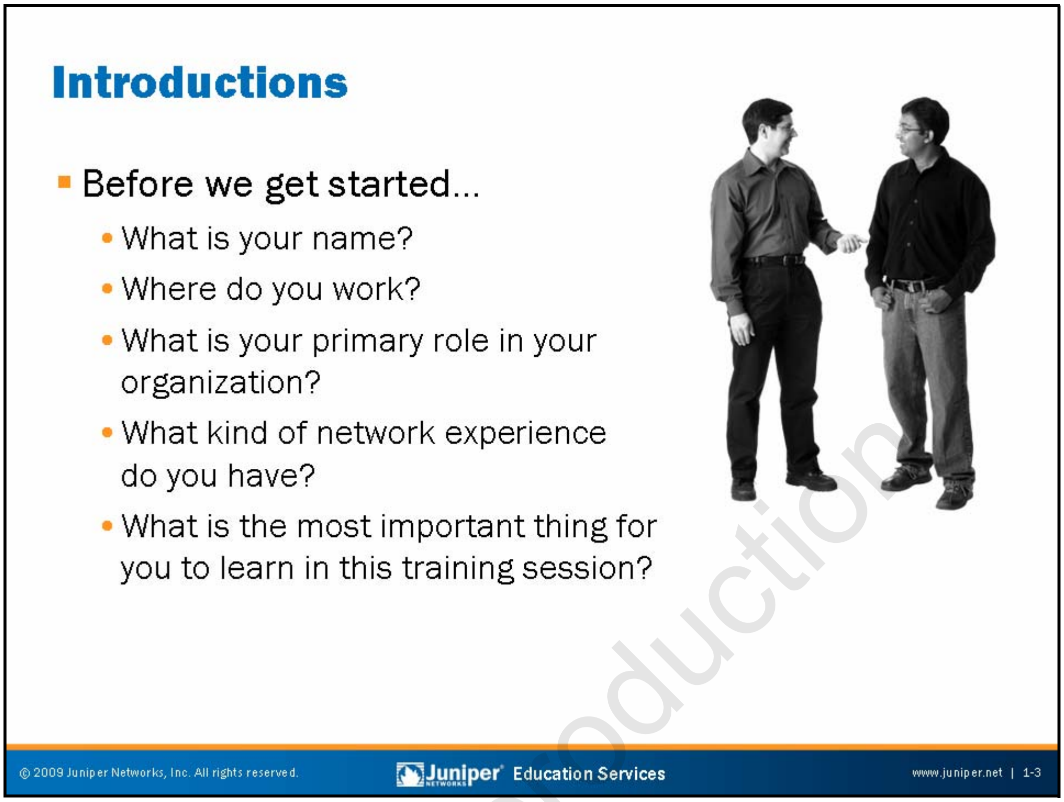
This Chapter Discusses:

- Objectives and course content information;
- Additional Juniper Networks, Inc. courses; and
- Juniper Networks Technical Certification Program (JNTCP).



Introductions

- Before we get started…
  - What is your name?
  - Where do you work?
  - What is your primary role in your organization?
  - What kind of network experience do you have?
  - What is the most important thing for you to learn in this training session?

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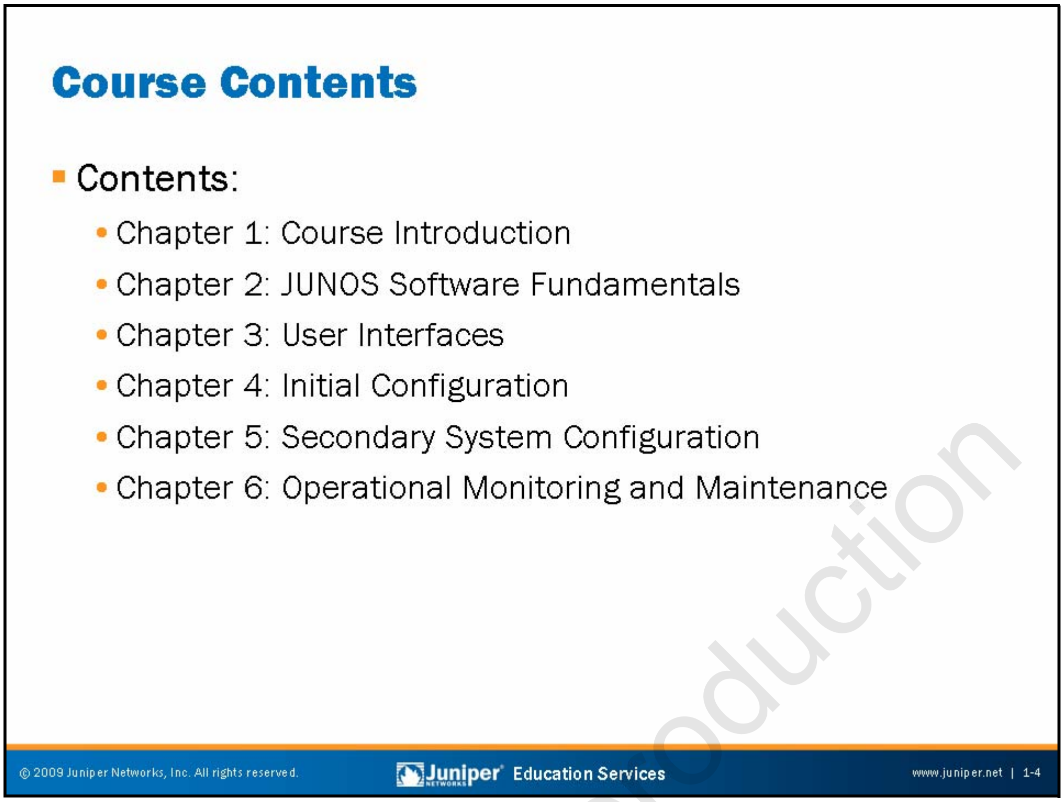
Introductions

This slide asks several questions for you to answer during class introductions.



Course Contents

- Contents:
  - Chapter 1: Course Introduction
  - Chapter 2: JUNOS Software Fundamentals
  - Chapter 3: User Interfaces
  - Chapter 4: Initial Configuration
  - Chapter 5: Secondary System Configuration
  - Chapter 6: Operational Monitoring and Maintenance

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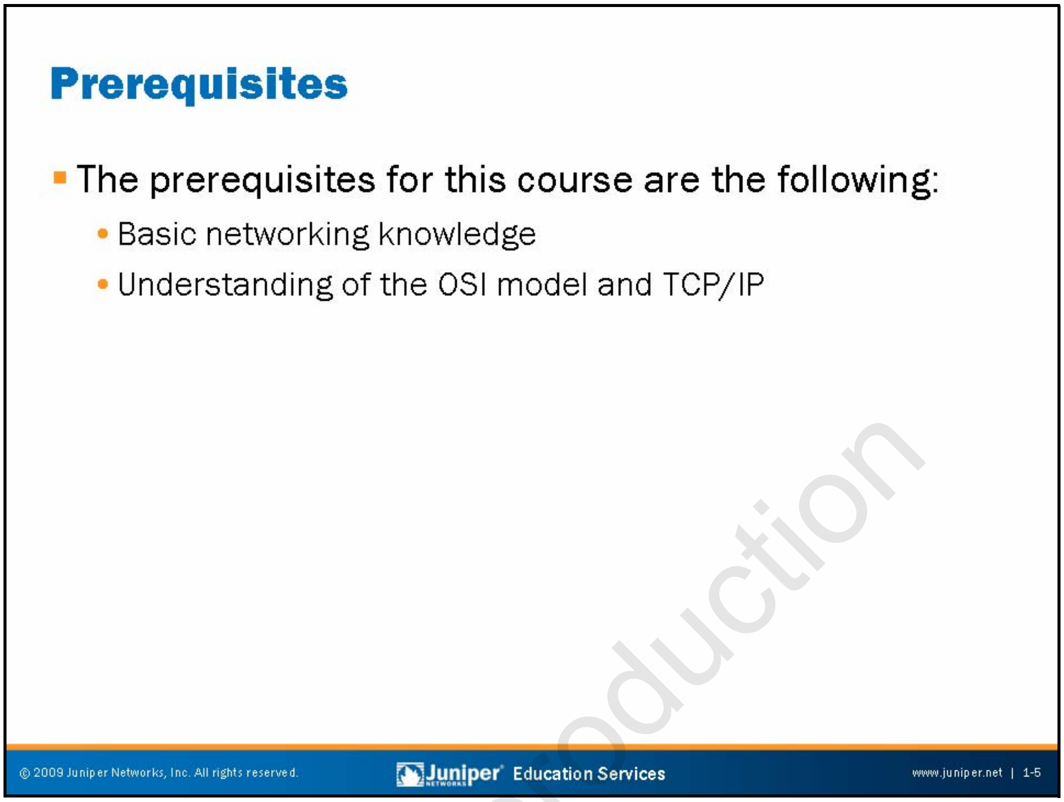
Course Contents

This slide lists the topics we discuss in this course.



Prerequisites

- The prerequisites for this course are the following:
  - Basic networking knowledge
  - Understanding of the OSI model and TCP/IP

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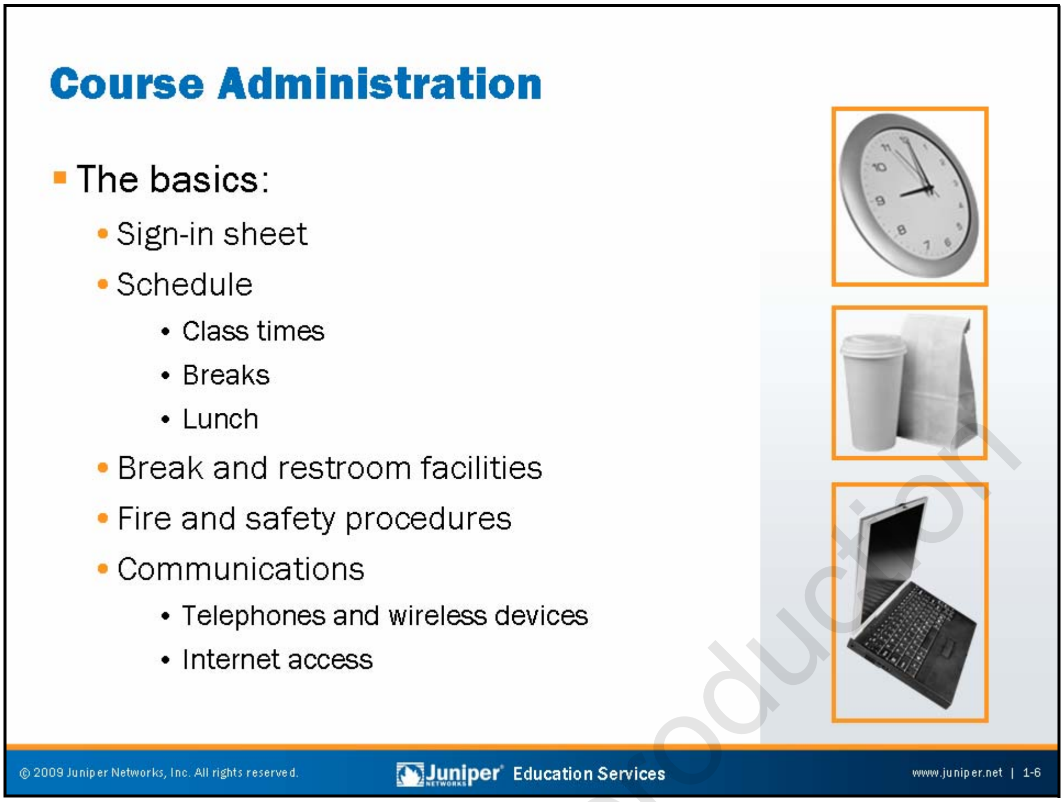
Prerequisites

This slide lists the prerequisites for this course.



Course Administration

- The basics:
  - Sign-in sheet
  - Schedule
    - Class times
    - Breaks
    - Lunch
  - Break and restroom facilities
  - Fire and safety procedures
  - Communications
    - Telephones and wireless devices
    - Internet access

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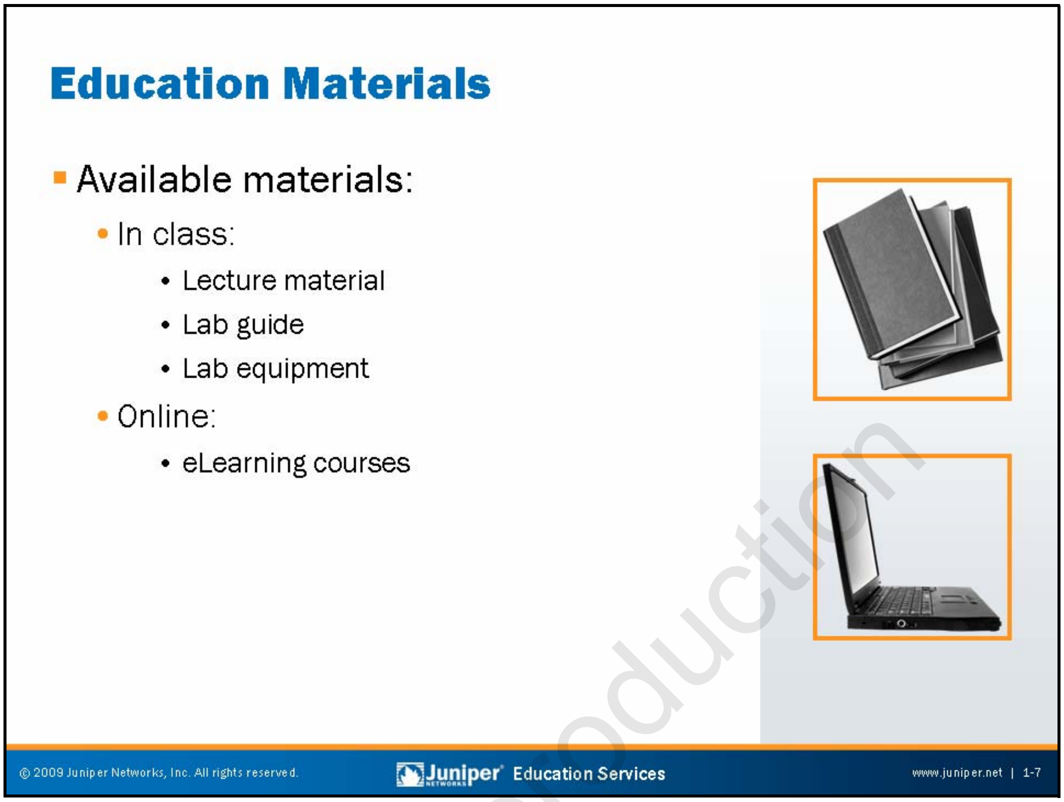
General Course Administration

This slide documents general aspects of classroom administration.



Education Materials

- Available materials:
  - In class:
    - Lecture material
    - Lab guide
    - Lab equipment
  - Online:
    - eLearning courses

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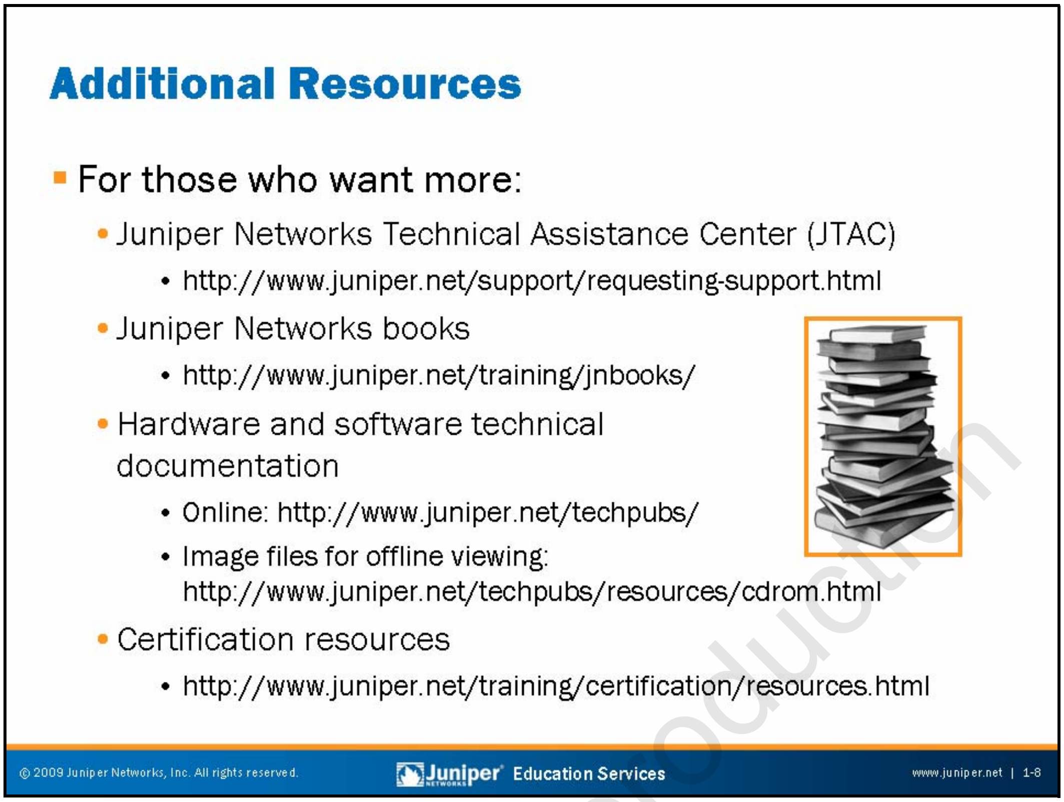
Training and Study Materials

This slide describes Education Services materials that are available for reference both in the classroom and online.



Additional Resources

- For those who want more:
  - Juniper Networks Technical Assistance Center (JTAC)
    - http://www.juniper.net/support/requesting-support.html
  - Juniper Networks books
    - http://www.juniper.net/training/jnbooks/
  - Hardware and software technical documentation
    - Online: http://www.juniper.net/techpubs/
    - Image files for offline viewing: http://www.juniper.net/techpubs/resources/cdrom.html
  - Certification resources
    - http://www.juniper.net/training/certification/resources.html

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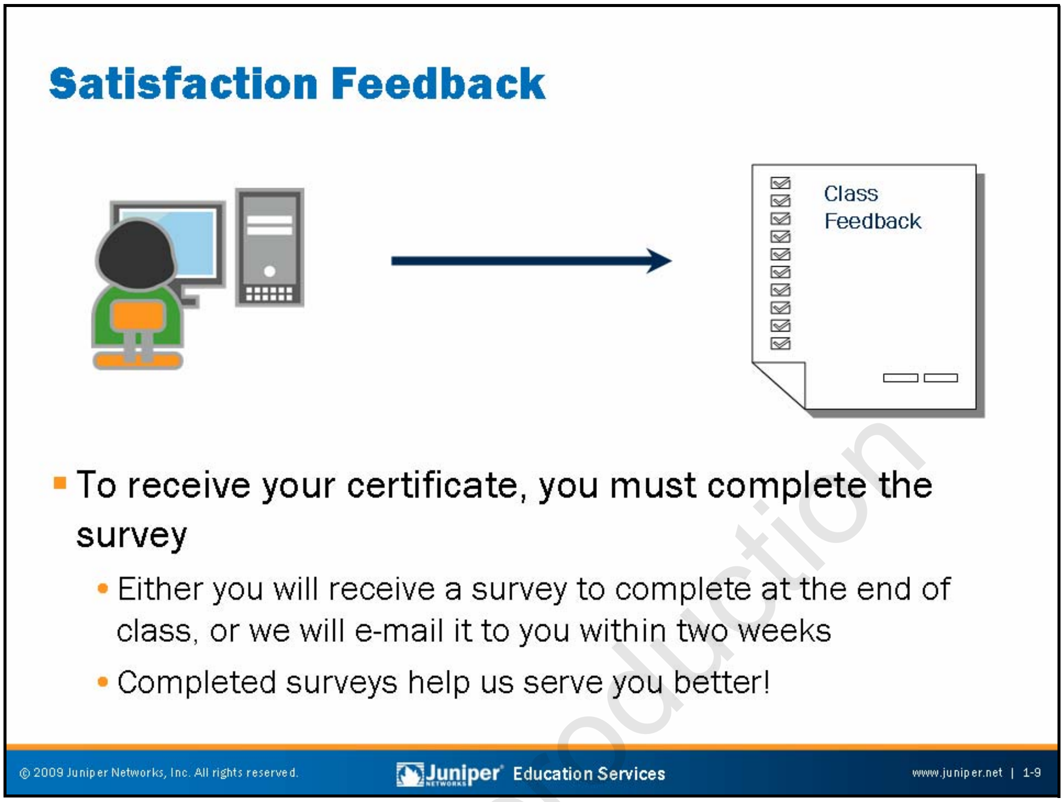
Additional Resources

This slide describes additional resources available to assist you in the installation, configuration, and operation of Juniper Networks products.



Satisfaction Feedback

Class
Feedback

- To receive your certificate, you must complete the survey
  - Either you will receive a survey to complete at the end of class, or we will e-mail it to you within two weeks
  - Completed surveys help us serve you better!

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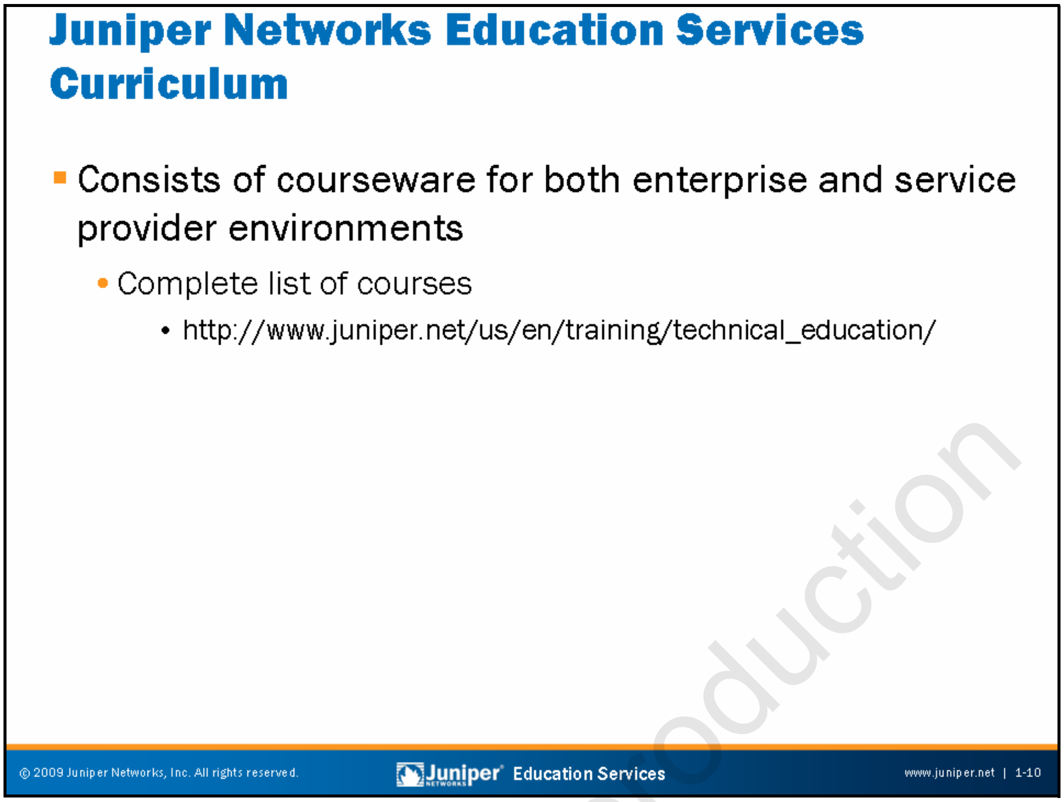
Satisfaction Feedback

Juniper Networks uses an electronic survey system to collect and analyze your comments and feedback. Depending on the class you are taking, please complete the survey at the end of the class, or be sure to look for an e-mail about two weeks from class completion that directs you to complete an online survey form. (Be sure to provide us with your current e-mail address.)

Submitting your feedback entitles you to a certificate of class completion. We thank you in advance for taking the time to help us improve our educational offerings.



Juniper Networks Education Services Curriculum

- Consists of courseware for both enterprise and service provider environments
  - Complete list of courses
    - http://www.juniper.net/us/en/training/technical_education/

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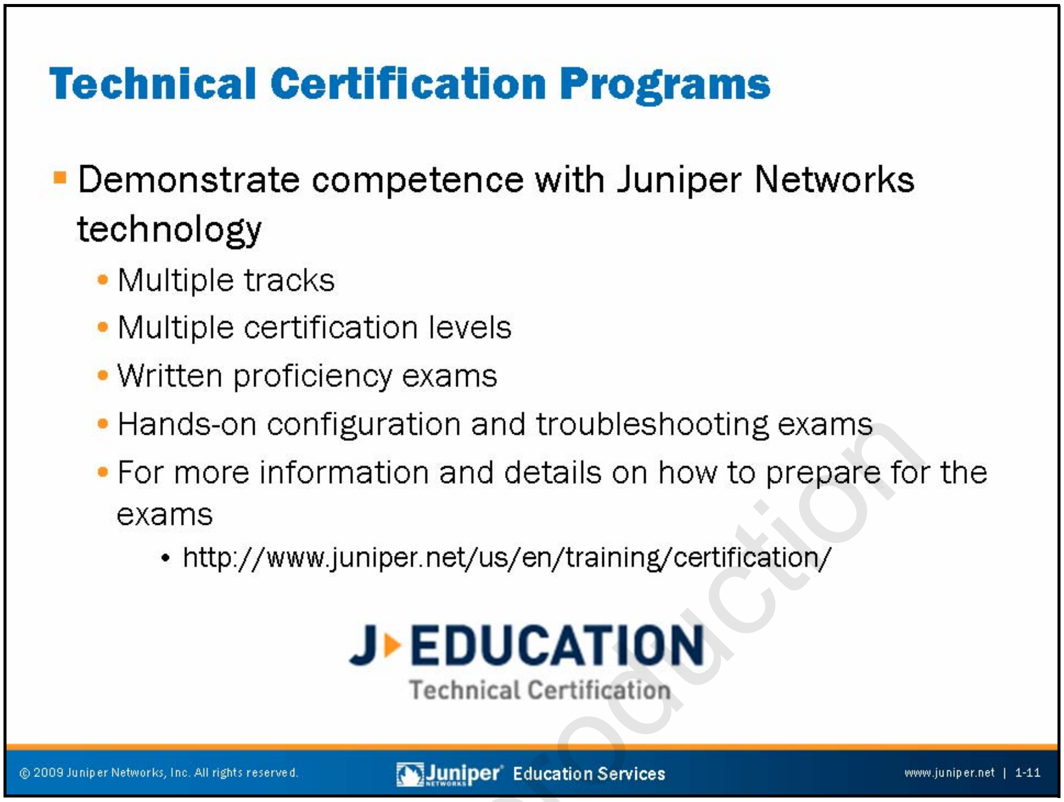
Juniper Networks Education Services Curriculum

Juniper Networks Education Services can help ensure that you have the knowledge and skills to deploy and maintain cost-effective, high-performance networks for both enterprise and service provider environments. We have expert training staff with deep technical and industry knowledge, providing you with instructor-led hands-on courses as well as convenient, self-paced eLearning courses.

You can access the latest Education Services offerings covering a wide range of platforms at http://www.juniper.net/us/en/training/technical_education/.



Technical Certification Programs

- Demonstrate competence with Juniper Networks technology
  - Multiple tracks
  - Multiple certification levels
  - Written proficiency exams
  - Hands-on configuration and troubleshooting exams
  - For more information and details on how to prepare for the exams
    - http://www.juniper.net/us/en/training/certification/

J EDUCATION
Technical Certification

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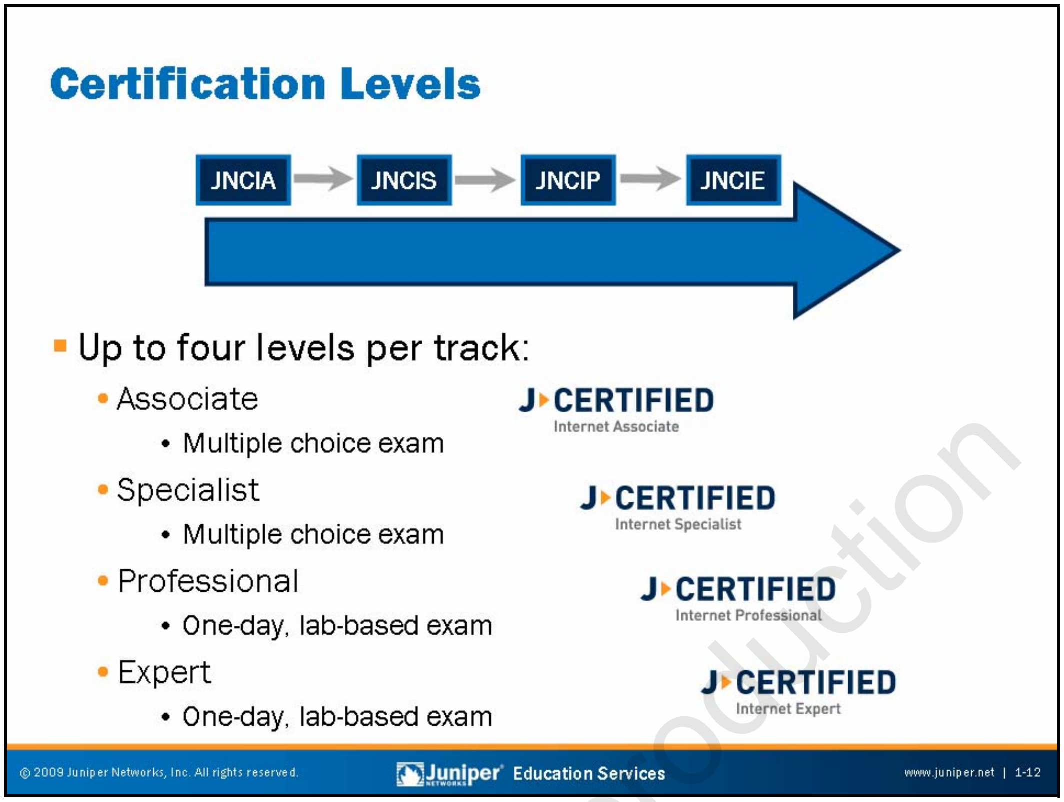
JNTCP

The Juniper Networks Technical Certification Program (JNTCP) consists of platform-specific, multitiered tracks that enable participants to demonstrate, through a combination of written proficiency exams and hands-on configuration and troubleshooting exams, competence with Juniper Networks technology. Successful candidates demonstrate thorough understanding of Internet and security technologies and Juniper Networks platform configuration and troubleshooting skills. You can learn more information about the JNTCP at http://www.juniper.net/training/certification/.



Certification Levels

JNCIA → JNCIS → JNCIP → JNCIE

- Up to four levels per track:
  - Associate
    - Multiple choice exam
  - Specialist
    - Multiple choice exam
  - Professional
    - One-day, lab-based exam
  - Expert
    - One-day, lab-based exam

J CERTIFIED Internet Associate

J CERTIFIED Internet Specialist

J CERTIFIED Internet Professional

J CERTIFIED Internet Expert

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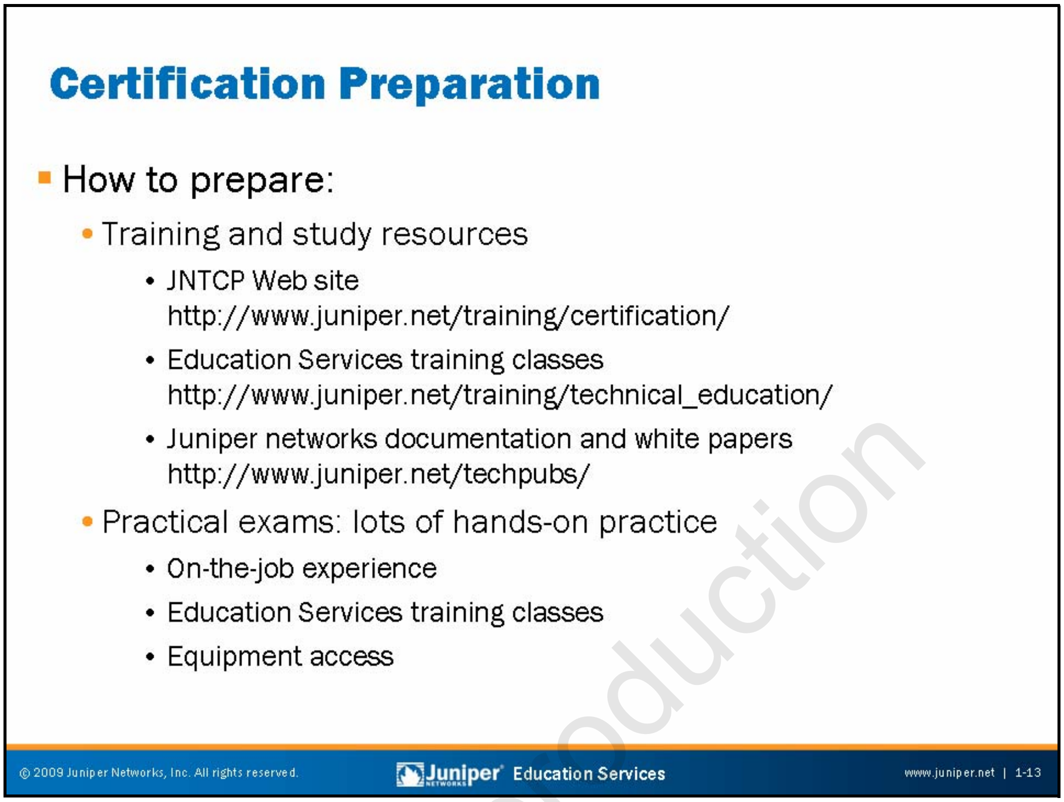
Certification Levels

Each JNTCP track has one to four certification levels. Associate-level and Specialist-level exams are computer-based exams composed of multiple choice questions. These computer-based exams are administered at Prometric testing centers worldwide and have no prerequisite certification requirements.

Professional-level and Expert-level exams are composed of hands-on lab exercises that are administered at select Juniper Networks testing centers. Professional-level and Expert-level exams require that you first obtain the next lower certification in the track. Please visit the JNTCP Web site at http://www.juniper.net/training/certification/ for detailed exam information, exam pricing, and exam registration.



Certification Preparation

- How to prepare:
  - Training and study resources
    - JNTCP Web site
      http://www.juniper.net/training/certification/
    - Education Services training classes
      http://www.juniper.net/training/technical_education/
    - Juniper networks documentation and white papers
      http://www.juniper.net/techpubs/
  - Practical exams: lots of hands-on practice
    - On-the-job experience
    - Education Services training classes
    - Equipment access

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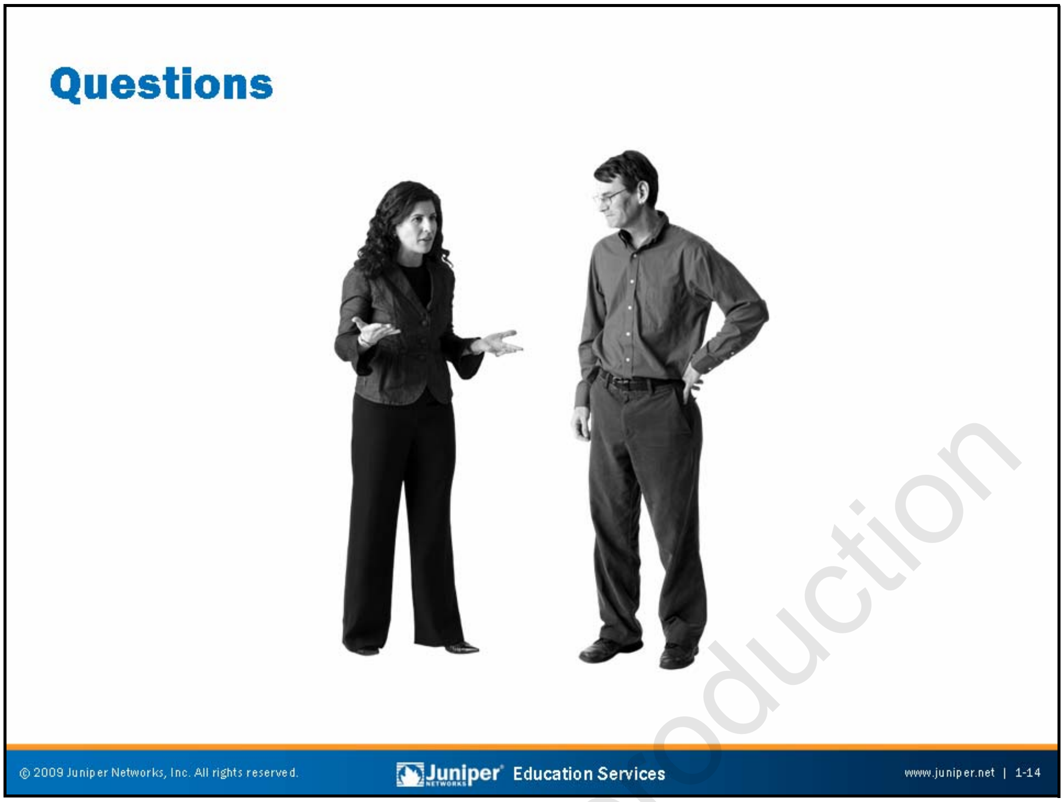
Prepping and Studying

This slide lists some options for those interested in prepping for Juniper Networks certification.



Questions

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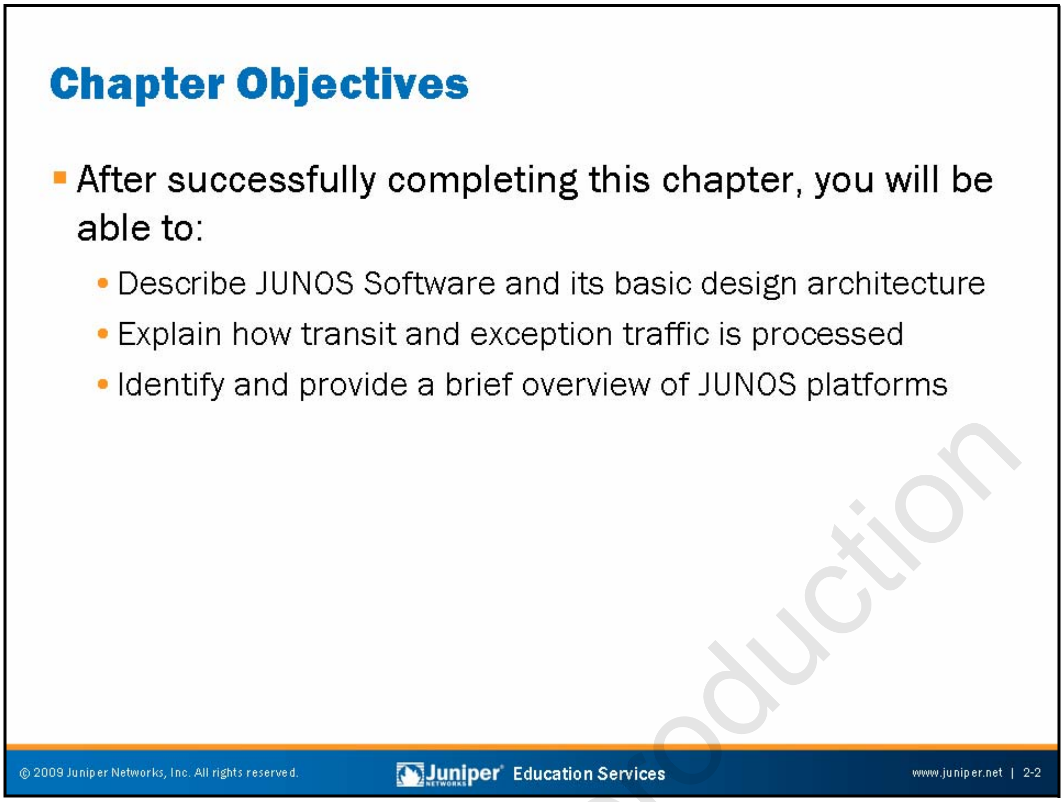
Any Questions?

If you have any questions or concerns about the class you are attending, we suggest that you voice them now so that your instructor can best address your needs during class.

Introduction to JUNOS Software

Chapter 2: JUNOS Software Fundamentals



Chapter Objectives

- After successfully completing this chapter, you will be able to:
  - Describe JUNOS Software and its basic design architecture
  - Explain how transit and exception traffic is processed
  - Identify and provide a brief overview of JUNOS platforms

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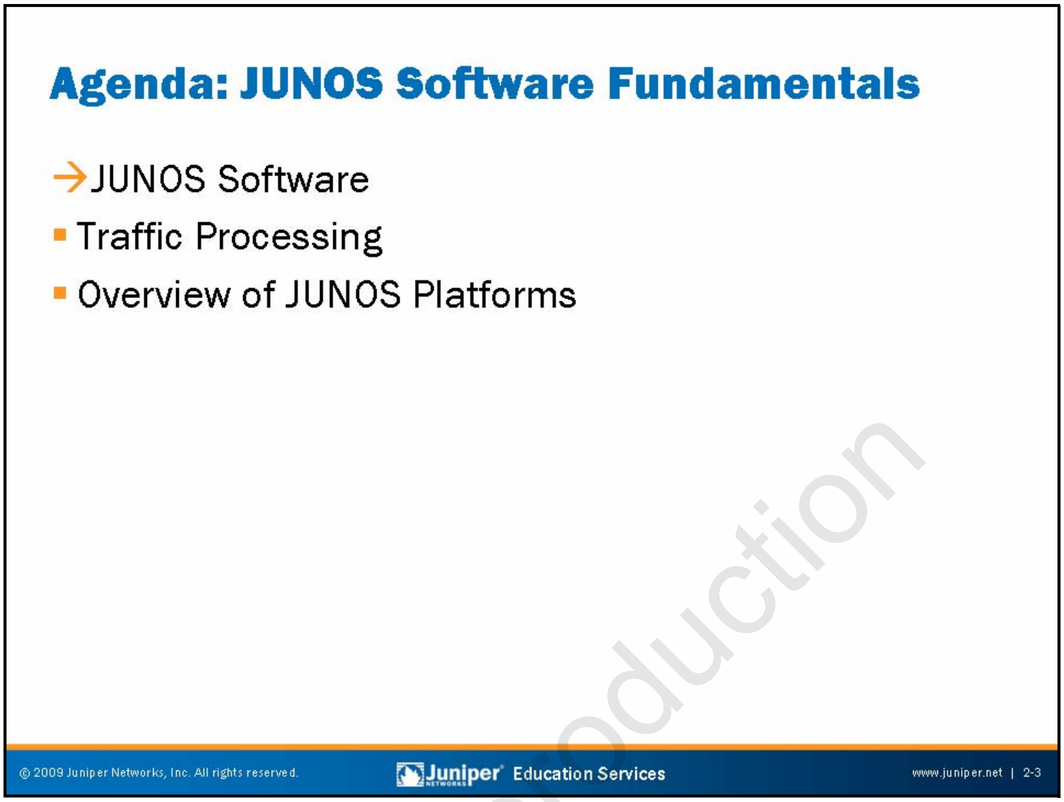
This Chapter Discusses:

- JUNOS Software and its basic design architecture;
- Traffic processing for transit and exception traffic; and
- JUNOS platforms.



Agenda: JUNOS Software Fundamentals

→JUNOS Software

- Traffic Processing
- Overview of JUNOS Platforms

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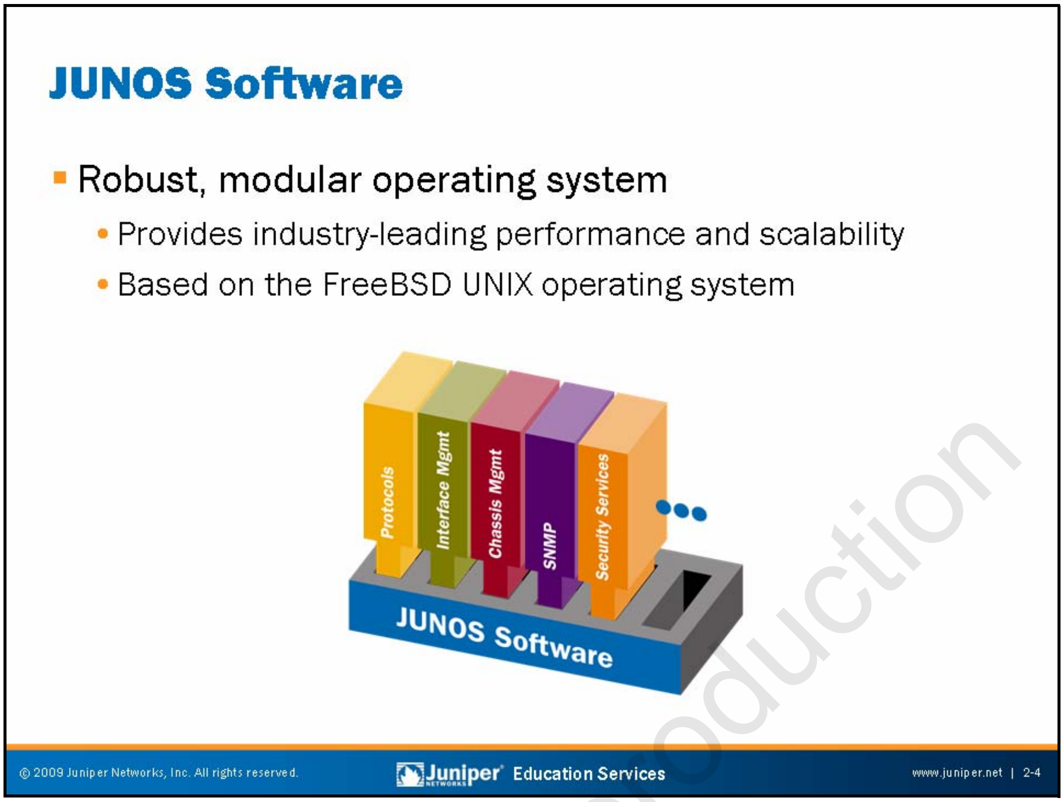
JUNOS Software

The slide lists the topics we cover in this chapter. We discuss the highlighted topic first.



JUNOS Software

- Robust, modular operating system
  - Provides industry-leading performance and scalability
  - Based on the FreeBSD UNIX operating system

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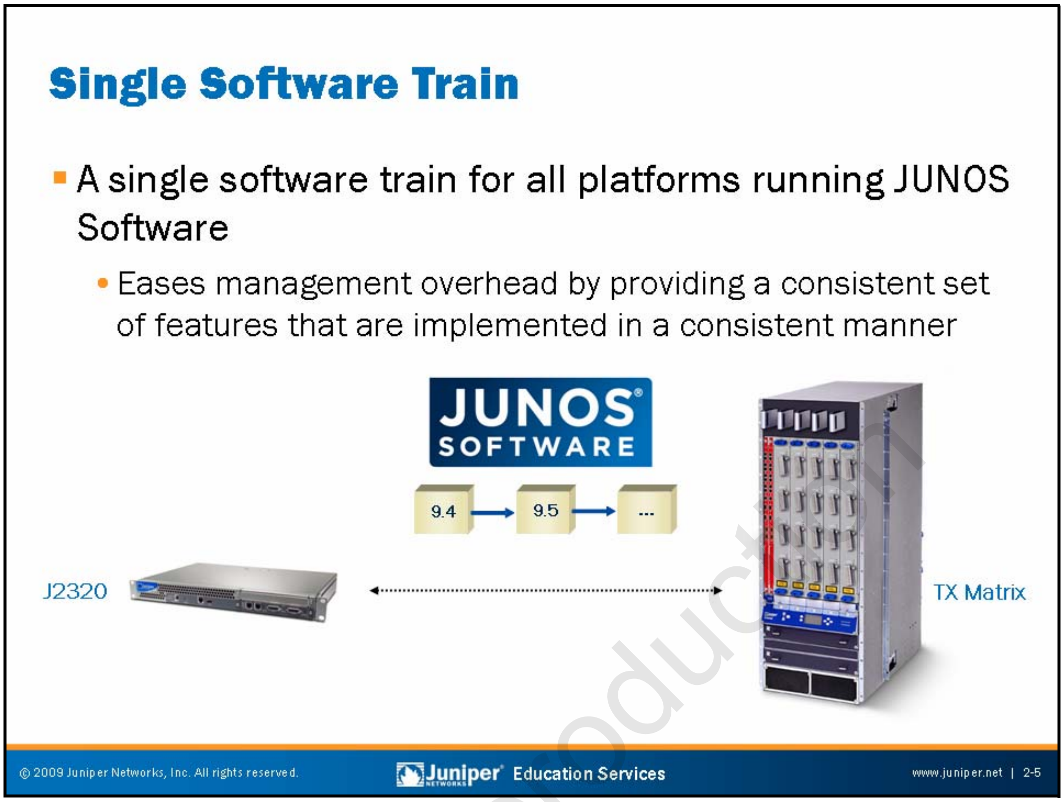
Robust, Modular, and Scalable

JUNOS Software functionality is compartmentalized into multiple software processes. Each process handles a portion of the device's functionality. Each process runs in its own protected memory space, ensuring that one process cannot directly interfere with another. When a single process fails, the entire system does not necessarily fail. This modularity also ensures that new features can be added with less likelihood of breaking current functionality.

JUNOS Software is the trusted, secure network operating system powering the high-performance network infrastructure offered by Juniper Networks. The JUNOS kernel is based on the FreeBSD UNIX operating system, which is an open source software system.



Single Software Train

- A single software train for all platforms running JUNOS Software
  - Eases management overhead by providing a consistent set of features that are implemented in a consistent manner

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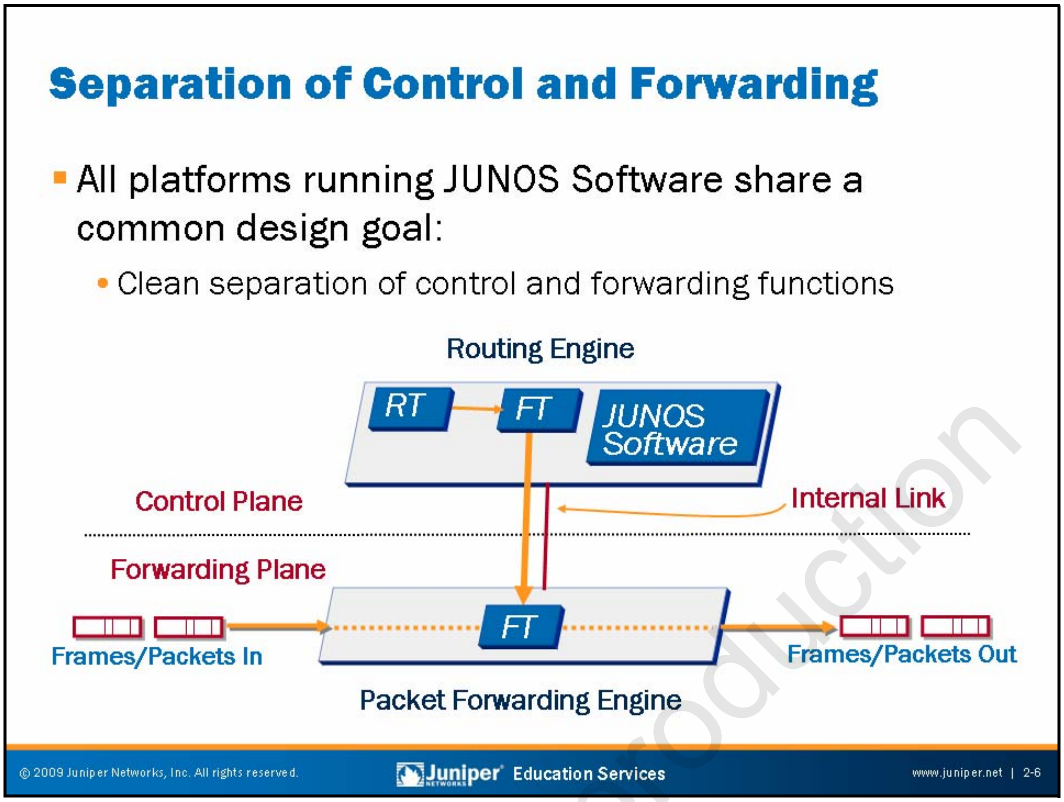
Single Software Source Code Base

All platforms running JUNOS Software use the same source code base within their platform-specific images. This design ensures that core features work in a consistent manner across all platforms running JUNOS Software. Because many features and services are configured and managed the same way, the setup tasks and ongoing maintenance and operation within your network is simplified.



Separation of Control and Forwarding

- All platforms running JUNOS Software share a common design goal:
  - Clean separation of control and forwarding functions

Routing Engine

RT

FT

JUNOS Software

Control Plane

Internal Link

Forwarding Plane

Frames/Packets In

FT

Frames/Packets Out

Packet Forwarding Engine

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Separate Control and Forwarding Planes

Another aspect of the JUNOS Software's modularity is the separation of the control plane and the forwarding or data plane. The processes that control routing and switching protocols are cleanly separated from the processes that forward frames, packets, or both through the device running JUNOS Software. This design allows you to tune each process for maximum performance and reliability. The separation of the control and forwarding planes is one of the key reasons why JUNOS Software can support many different platforms from a common code base.

The slide illustrates a basic view of the JUNOS architecture and highlights the control and forwarding planes. The control plane, shown above the dashed line on the slide, runs on the Routing Engine (RE). The RE is the brain of the platform; it is responsible for performing protocol updates and system management. The RE runs various protocol and management software processes that reside inside a protected memory environment. The RE is based on an X86 or PowerPC architecture, depending on the specific platform running JUNOS Software. The RE maintains the routing tables, bridging table, and primary forwarding table and connects to the Packet Forwarding Engine (PFE) through an internal link. Although all JUNOS platforms share this common design goal, the actual components that make up the control and forwarding planes vary between the different JUNOS platforms. For additional details about a specific JUNOS platform, see the technical publications at http://www.juniper.net/techpubs/.

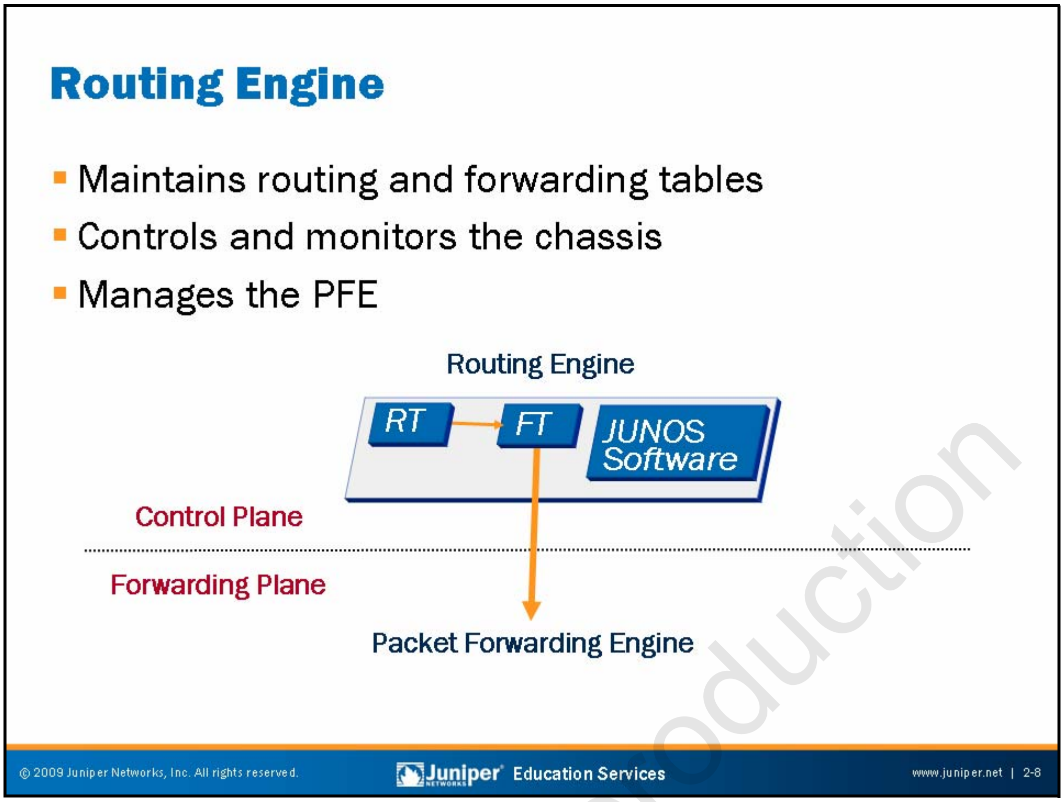
Continued on next page.

Separate Control and Forwarding Planes (contd.)

The PFE, shown below the dashed line on the slide on the previous page, usually runs on separate hardware and is responsible for forwarding transit traffic through the device. In many platforms running JUNOS Software, the PFE uses application-specific integrated circuits (ASICs) for increased performance. Because this architecture separates control operations—such as protocol updates and system management—from forwarding operations, platforms running JUNOS Software can deliver superior performance and highly reliable deterministic operation.

The PFE receives the forwarding table (FT) from the RE by means of an internal link. FT updates are a high priority for the JUNOS Software kernel and are performed incrementally.

Because the RE provides the *intelligence* side of the equation, the PFE can simply perform as it is instructed—that is, it forwards frames, packets, or both with a high degree of stability and deterministic performance. This architectural design also makes possible the incorporation of high-availability features like graceful Routing Engine switchover (GRES), nonstop active routing (NSR), and in-service software upgrades (ISSUs).



Routing Engine

- Maintains routing and forwarding tables
- Controls and monitors the chassis
- Manages the PFE

Routing Engine

RT

FT

JUNOS Software

Control Plane

Forwarding Plane

Packet Forwarding Engine

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Maintains Routing Engine Intelligence

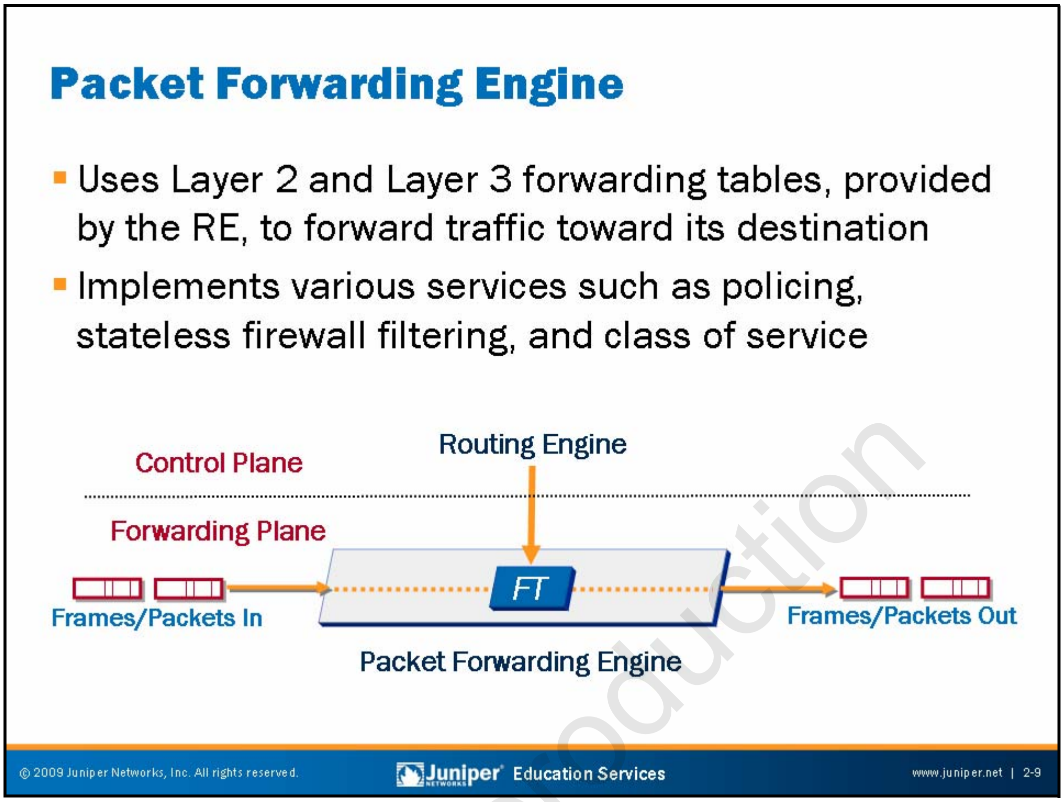
The RE handles all protocol processes in addition to other software processes that control the device's interfaces, the chassis components, system management, and user access to the device. These software processes run on top of the JUNOS kernel, which interacts with the PFE. The software directs all protocol traffic from the network to the RE for the required processing.

Controls and Monitors Chassis

The RE provides the CLI in addition to the J-Web GUI. These user interfaces run on top of the JUNOS kernel and provide user access and control of the device. We discuss user interfaces in a subsequent chapter in this course.

Manages Packet Forwarding Engine

The RE controls the PFE by providing accurate, up-to-date Layer 2 and Layer 3 forwarding tables and by downloading microcode and managing software processes that reside in the PFE's microcode. The RE receives hardware and environmental status messages from the PFE and acts upon them as appropriate.



Packet Forwarding Engine

- Uses Layer 2 and Layer 3 forwarding tables, provided by the RE, to forward traffic toward its destination
- Implements various services such as policing, stateless firewall filtering, and class of service

Control Plane

Routing Engine

Forwarding Plane

FT

Frames/Packets In

Frames/Packets Out

Packet Forwarding Engine

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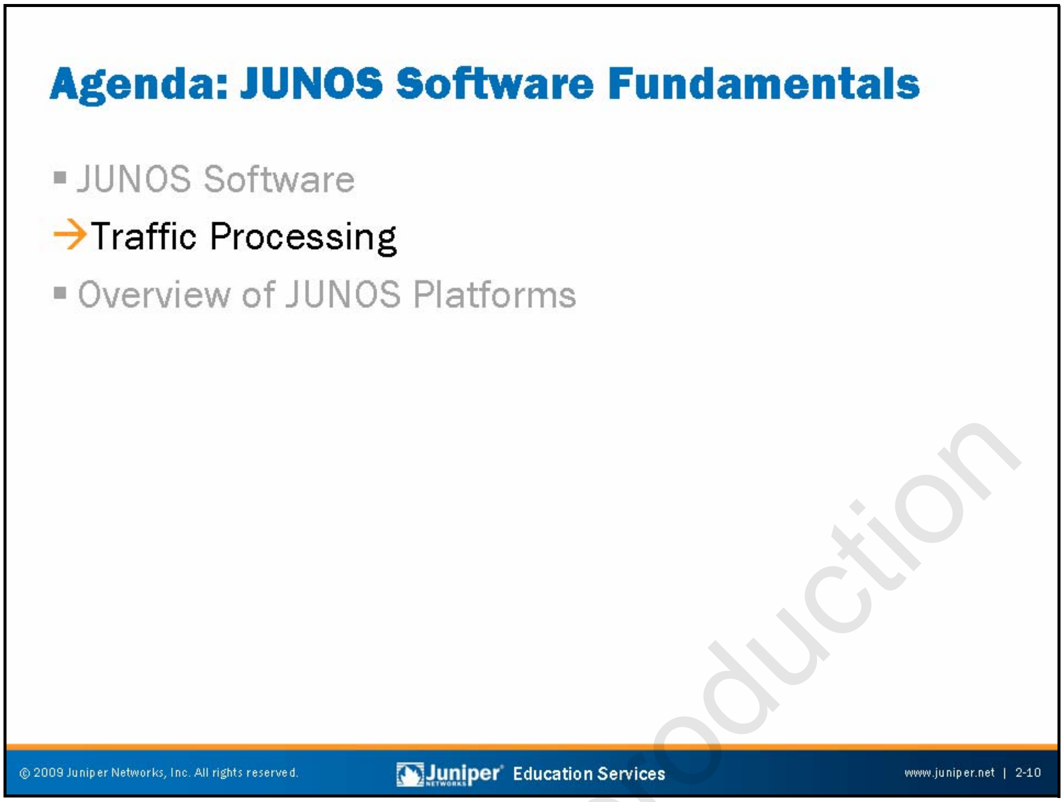
Forwards Traffic

The PFE is the central processing component of the forwarding plane. The PFE systematically forwards traffic based on its local copy of the forwarding table. The PFE's forwarding table is a synchronized copy of the information created on and provided by the RE. Storing and using a local copy of the forwarding table allows the PFE to forward traffic more efficiently and eliminates the need to consult the RE each time a packet needs to be processed. Using this local copy of the forwarding table also allows platforms running JUNOS Software to continue forwarding traffic during control plane instabilities.

Implements Services

In addition to forwarding traffic, the PFE also implements a number of advanced services. Some examples of advanced services implemented through the PFE include policers that provide rate limiting, stateless firewall filters, and class of service (CoS). Other services are available through special interface cards that you can add to the PFE complex. We cover interfaces in a subsequent chapter.



Agenda: JUNOS Software Fundamentals

- JUNOS Software
- → Traffic Processing
- Overview of JUNOS Platforms

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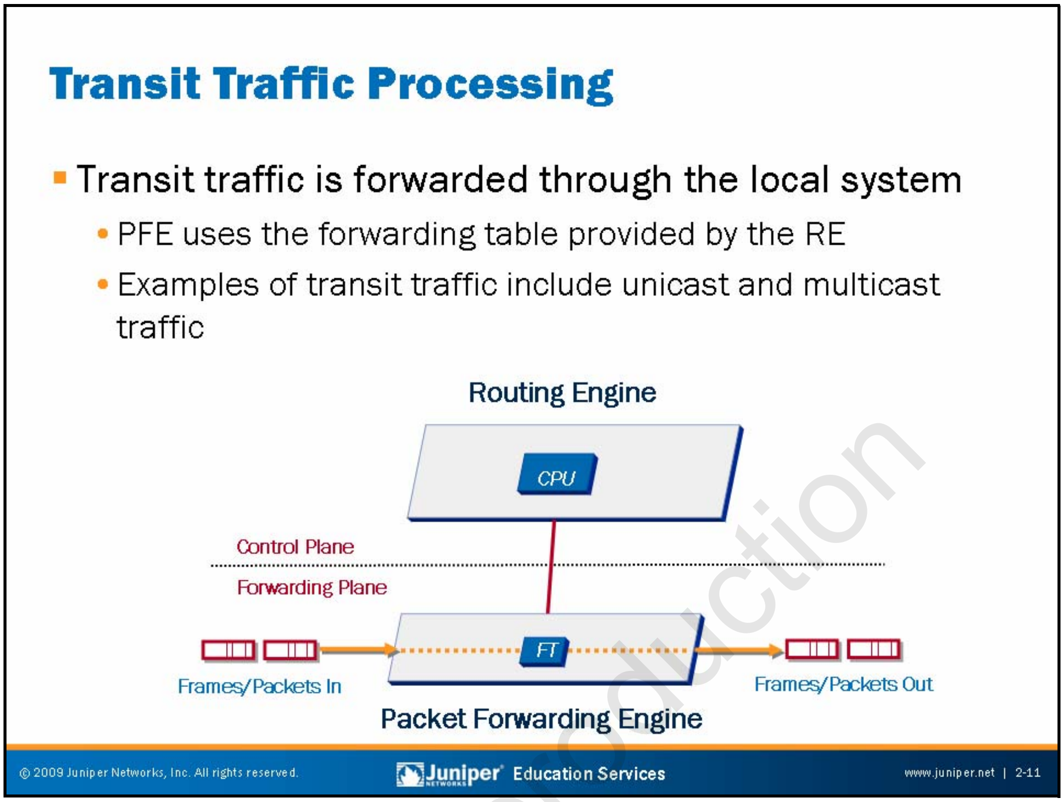
Traffic Processing

The slide highlights the topic we discuss next.



Transit Traffic Processing

- Transit traffic is forwarded through the local system
  - PFE uses the forwarding table provided by the RE
  - Examples of transit traffic include unicast and multicast traffic

Routing Engine

CPU

Control Plane

Forwarding Plane

FT

Frames/Packets In

Frames/Packets Out

Packet Forwarding Engine

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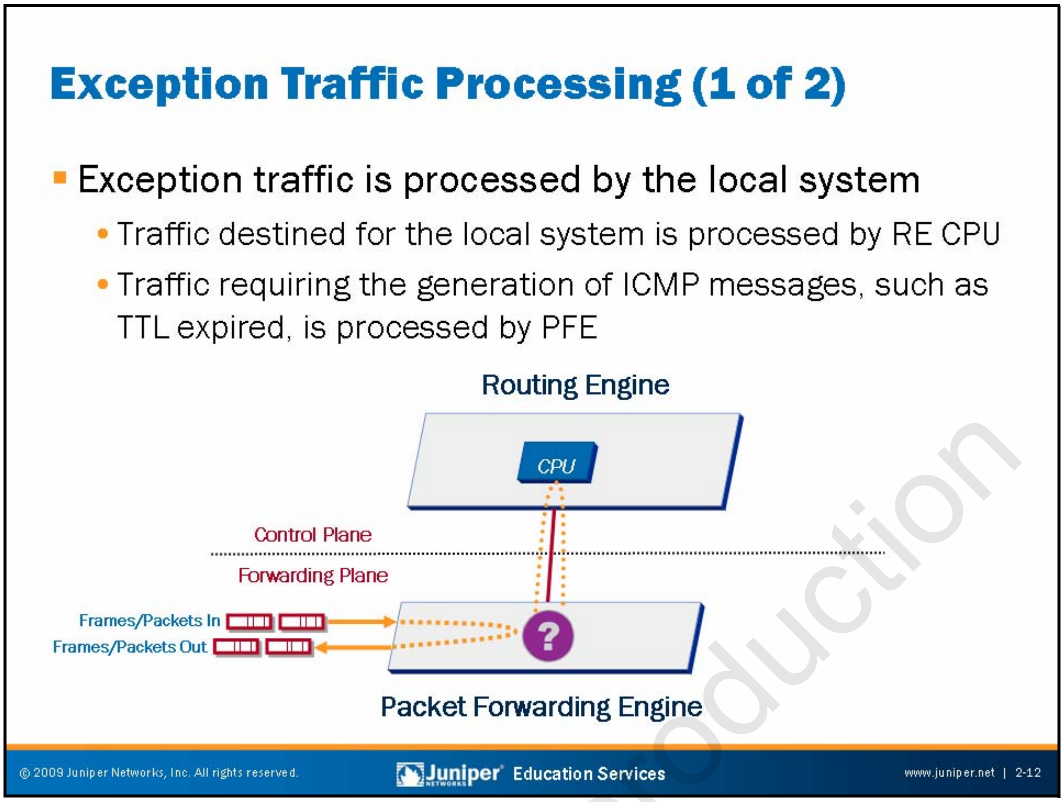
Transit Traffic

Transit traffic consists of all traffic that enters an ingress network port, is compared against the forwarding table entries, and is finally forwarded out an egress network port toward its destination.

A forwarding table entry for a destination must exist, for a device running JUNOS Software to successfully forward transit traffic to that destination. Transit traffic only passes through the forwarding plane and is never sent to or processed by the control plane. By processing transit traffic through the forwarding plane, platforms running JUNOS Software can achieve predictably high performance rates.

Transit traffic can be both unicast and multicast traffic. Unicast transit traffic enters one ingress port and is transmitted out exactly one egress port toward its destination. Although multicast transit traffic also enters the transit device through a single ingress port, it can be replicated and sent out multiple egress ports depending on the number of multicast receivers and the network environment.



Exception Traffic Processing (1 of 2)

- Exception traffic is processed by the local system
  - Traffic destined for the local system is processed by RE CPU
  - Traffic requiring the generation of ICMP messages, such as TTL expired, is processed by PFE

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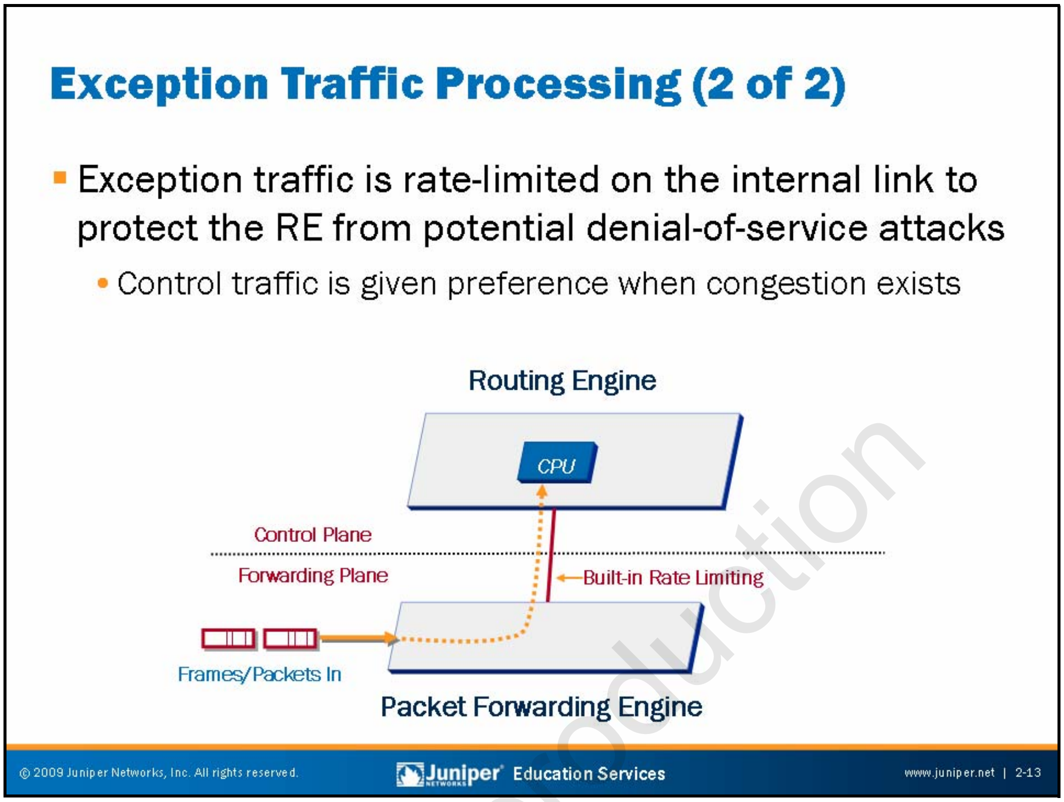
Exception Traffic: Part 1

Unlike transit traffic, exception traffic does not pass through the local device but rather requires some form of special handling. Examples of exception traffic include the following:

- Packets addressed to the chassis, such as routing protocol updates, Telnet sessions, pings, traceroutes, and replies to traffic sourced from the RE;
- IP packets with the IP options field (Options in the packet's IP header are rarely seen, but the PFE was purposely designed not to handle IP options; packets with IP options must be sent to the RE for processing); and
- Traffic that requires the generation of Internet Control Message Protocol (ICMP) messages.

ICMP messages are sent to the packet's source to report various error conditions and to respond to ping requests. Examples of ICMP errors include destination unreachable messages, which are sent when there is no entry in the forwarding table for the packet's destination address, or time-to-live (TTL) expired messages, which are sent when a packet's TTL is decremented to zero. In most cases, the PFE process handles the generation of ICMP messages.



Exception Traffic Processing (2 of 2)

- Exception traffic is rate-limited on the internal link to protect the RE from potential denial-of-service attacks
  - Control traffic is given preference when congestion exists

Routing Engine

CPU

Control Plane

Forwarding Plane

Built-in Rate Limiting

Frames/Packets In

Packet Forwarding Engine

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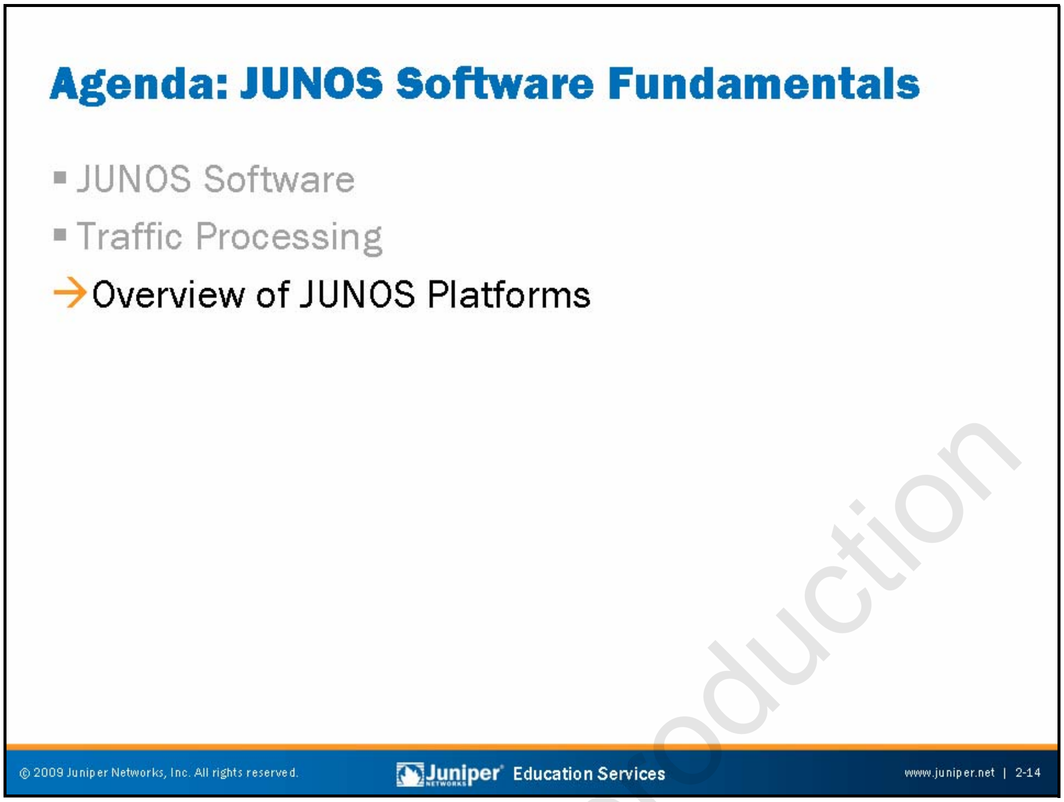
Exception Traffic: Part 2

JUNOS Software sends all exception traffic destined for the RE over the internal link that connects the control and forwarding planes. JUNOS Software rate limits exception traffic traversing the internal link to protect the RE from denial-of-service (DoS) attacks. During times of congestion, the JUNOS Software gives preference to the local and control traffic destined for the RE. The built-in rate limiter is not configurable.



Agenda: JUNOS Software Fundamentals

- JUNOS Software
- Traffic Processing

→ Overview of JUNOS Platforms

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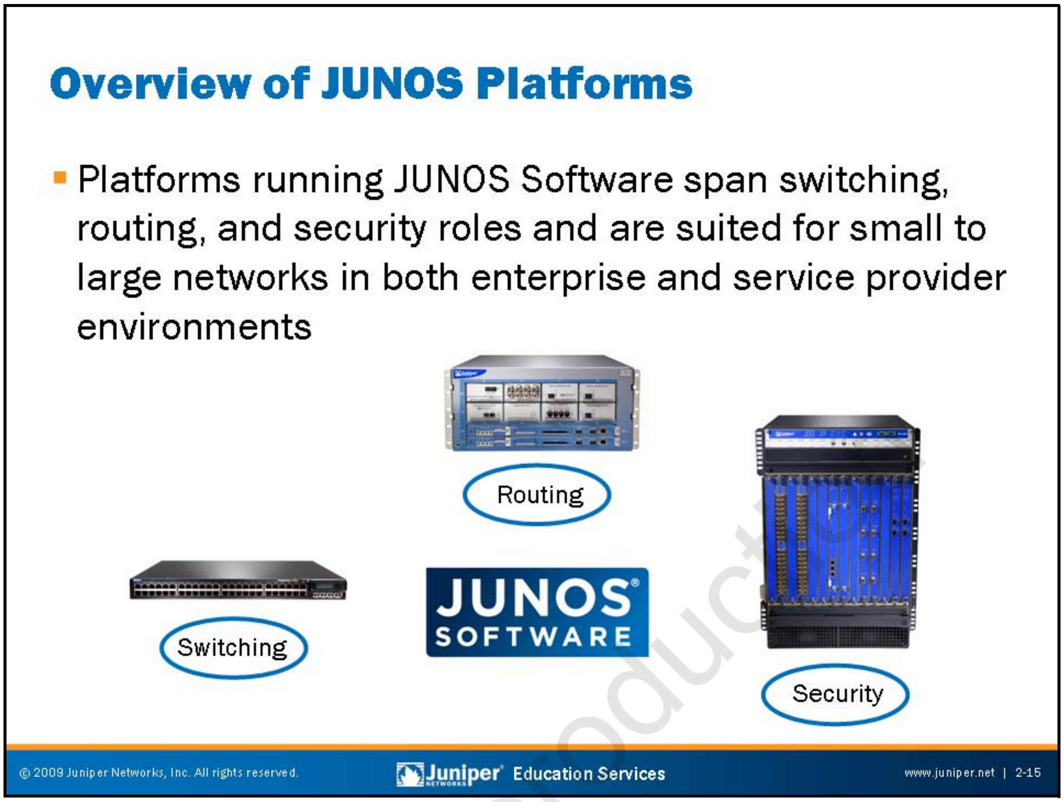
Platforms Running JUNOS Software

The slide highlights the topic we discuss next.



Overview of JUNOS Platforms

- Platforms running JUNOS Software span switching, routing, and security roles and are suited for small to large networks in both enterprise and service provider environments

Routing

Switching

JUNOS SOFTWARE

Security

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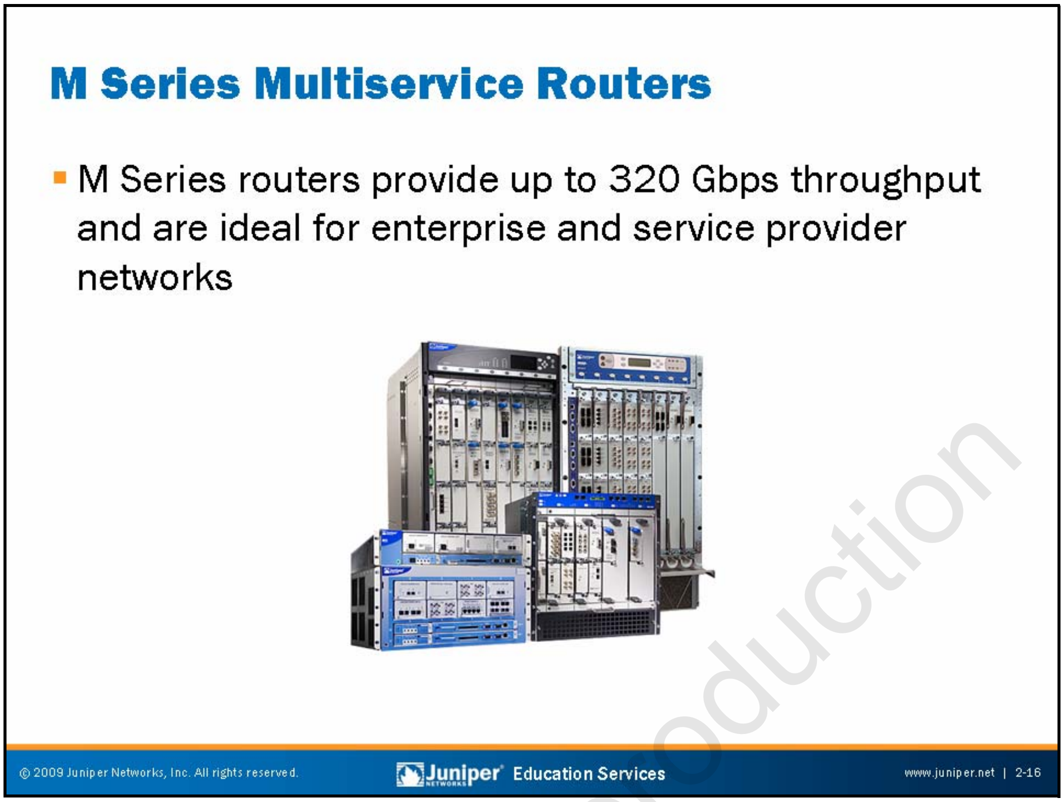
Platforms Running JUNOS Software

Platforms running JUNOS Software come in many shapes and sizes and are targeted for a number of deployment scenarios. The platforms running JUNOS Software span switching, routing, and security and are well suited for a variety of network environments. As the heart of all these platforms, the JUNOS Software provides a consistent end-to-end IP infrastructure in small enterprise environments and the largest service provider networks alike. The subsequent slides introduce and provide some details for each product family.



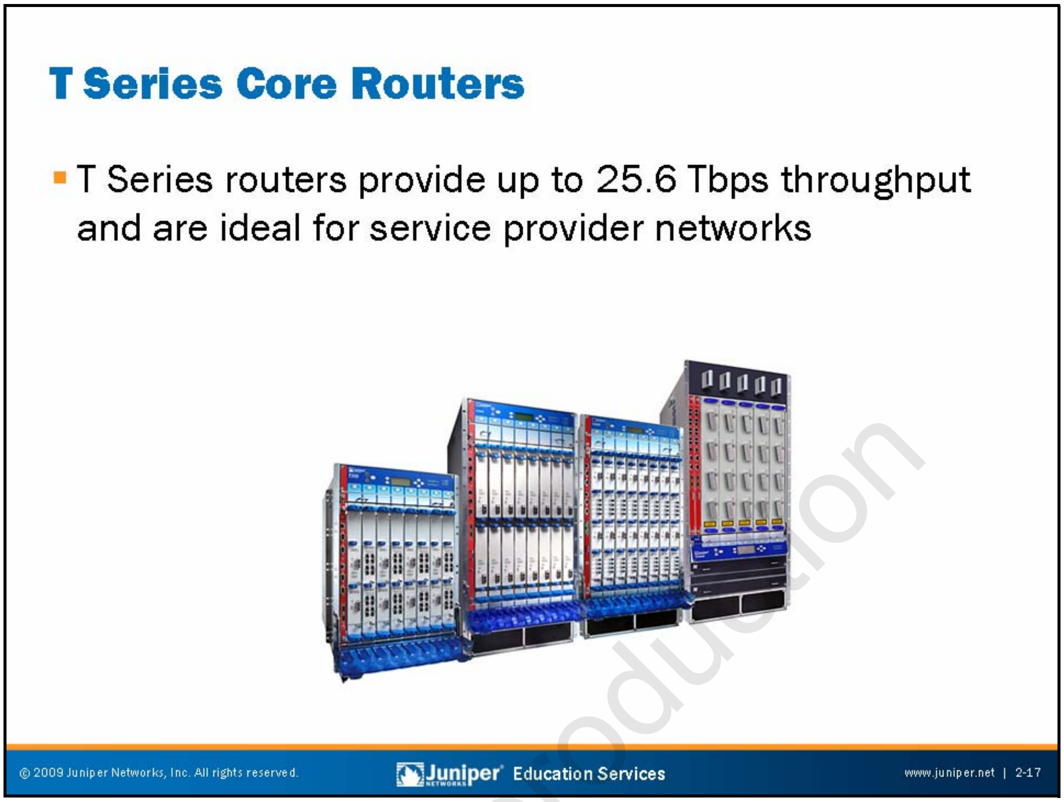
M Series Multiservice Routers

- M Series routers provide up to 320 Gbps throughput and are ideal for enterprise and service provider networks

M Series Multiservice Routers

The M Series multiservice routers provide up to 320 Gbps of aggregate half-duplex throughput. You can deploy the M Series family can be deployed in both high-end enterprise and service-provider environments. Large enterprises deploy M Series routers in a number of different roles, including Internet gateway router, WAN connectivity router, campus core router, and regional backbone and data center routers. In service-provider environments, the M Series router operates predominantly as a multiservice edge router, but you can also deploy it in small and medium cores, and in peering, route reflector, multicast, mobile, and data-center applications.

For additional, in-depth details on the M Series multiservice routers, go to http://www.juniper.net/products_and_services/m_series_routing_portfolio/index.html.



T Series Core Routers

- T Series routers provide up to 25.6 Tbps throughput and are ideal for service provider networks

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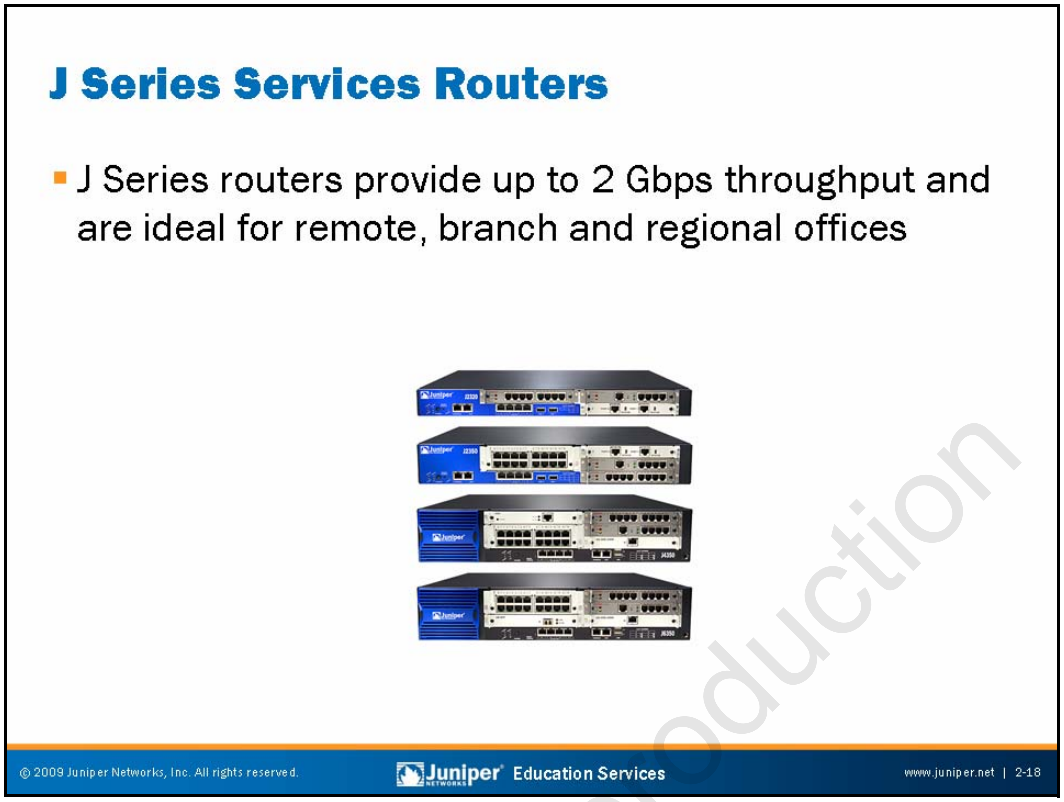
T Series Core Routers

The T Series core routers provide up to 25.6 Tbps of throughput. The T Series family is ideal for service provider environments and is deployed within the core of those networks.

For additional, in-depth details on the T Series core routers, go to http://www.juniper.net/products_and_services/t_series_core_platforms/index.html.



J Series Services Routers

- J Series routers provide up to 2 Gbps throughput and are ideal for remote, branch and regional offices

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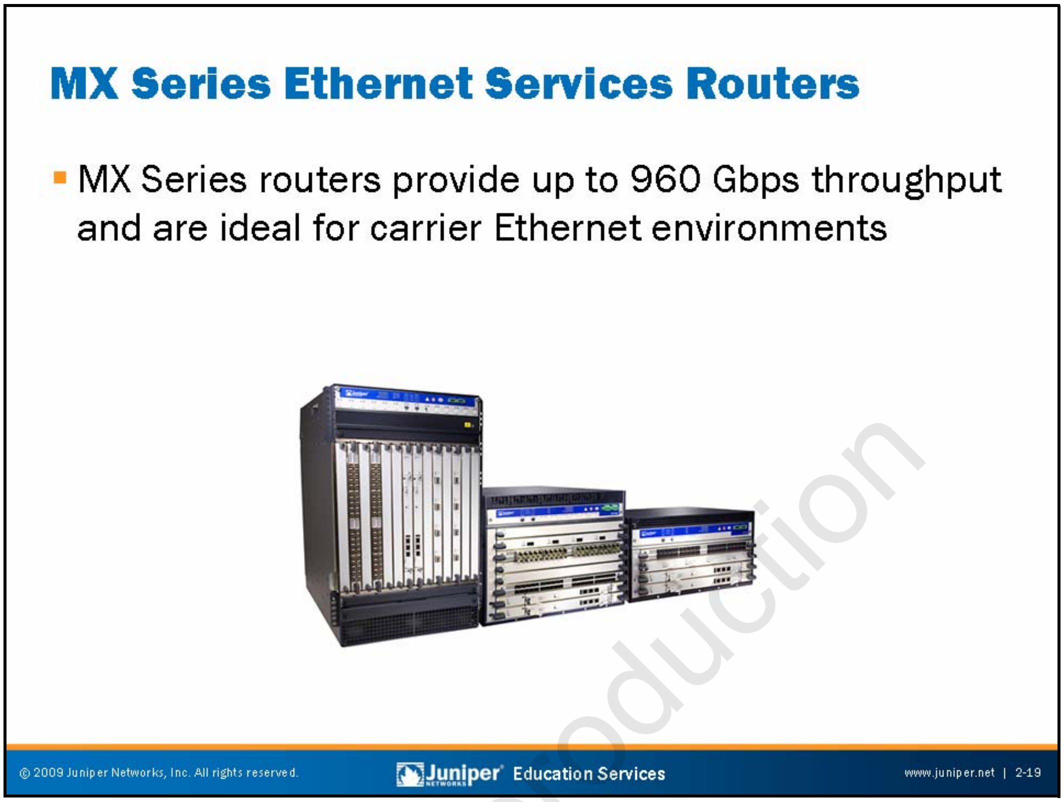
J Series Services Routers

The J Series services routers provide up to 2 Gbps of throughput. The J Series services routers are deployed at branch and remote locations in the network to provide all-in-one secure WAN connectivity, IP telephony, and connection to local PCs and servers through integrated Ethernet switching.

For additional, in-depth details on the J Series services routers, go to http://www.juniper.net/products_and_services/j_series_services_routers/index.html.



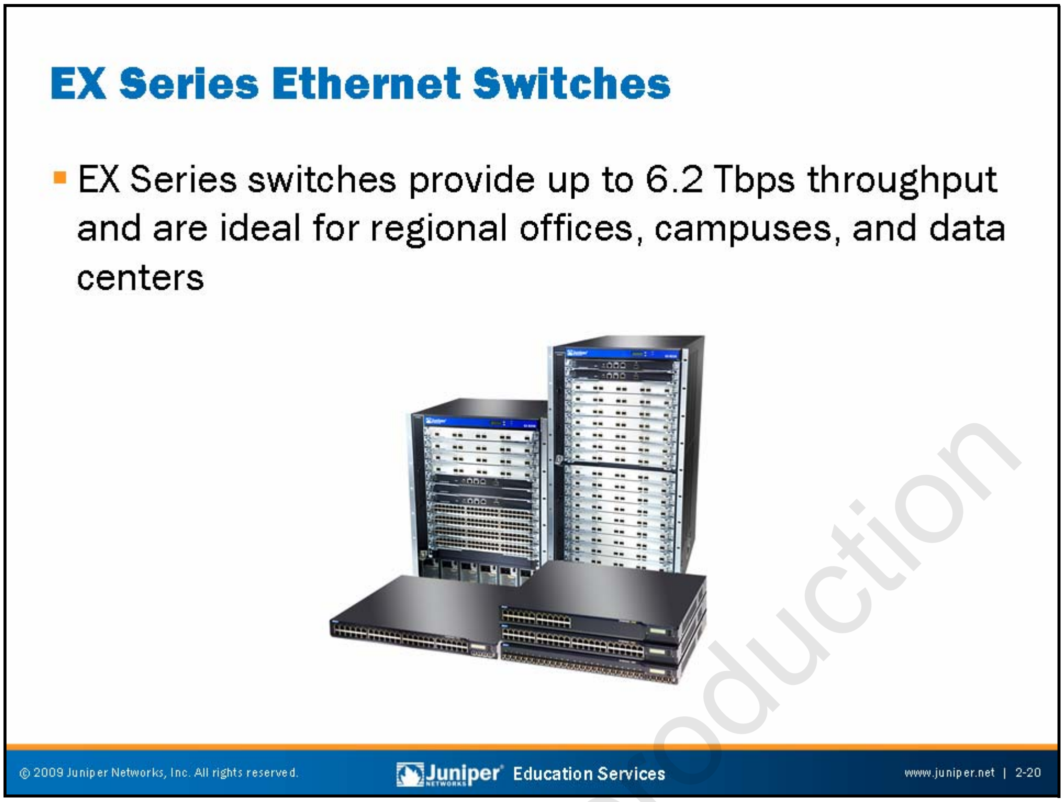
MX Series Ethernet Services Routers

- MX Series routers provide up to 960 Gbps throughput and are ideal for carrier Ethernet environments

MX Series Ethernet Services Routers

The MX Series Ethernet services routers provide up to 960 Gbps of aggregate half-duplex throughput. The MX Series family is targeted for dense dedicated access aggregation and provider edge services in medium and large point of presence (POPs). Large enterprise environments and service providers can leverage MX Series Ethernet services routers for a variety of network functions including Ethernet transport, aggregation, and offering new Ethernet-based services.

For additional, in-depth details on the MX Series Ethernet services routers, go to http://www.juniper.net/products_and_services/mx_series/index.html.



EX Series Ethernet Switches

- EX Series switches provide up to 6.2 Tbps throughput and are ideal for regional offices, campuses, and data centers

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EX Series Ethernet Switches

The EX Series Ethernet switches provide up to 6.2 Tbps of throughput. The EX Series switches are designed for access, aggregation, and core deployments and are well suited for low-density to high-density enterprise and data center environments.

For additional, in-depth details on the EX Series Ethernet switches, go to http://www.juniper.net/products_and_services/ex_series/index.html.

SRX Series Services Gateways

- SRX Series services gateways provide up to 120 Gbps throughput and are ideal for enterprise and service provider networks

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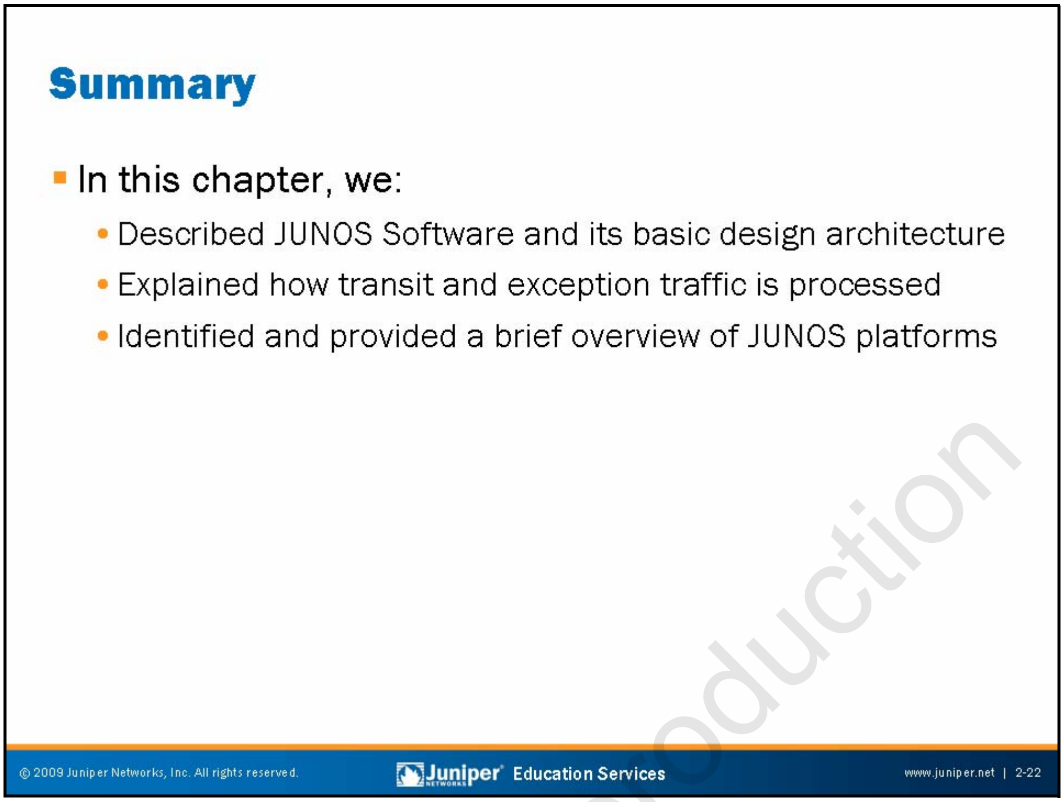
SRX Series Services Gateways

The SRX Series services gateways provide up to 120 Gbps of throughput. The SRX Series family is designed to meet the network and security requirements for consolidated data centers, managed services deployments, and aggregation of security services in both enterprise and service provider environments.

For additional, in-depth details on the SRX Series services gateways, go to http://www.juniper.net/products_and_services/srx_series/index.html.



Summary

- In this chapter, we:
  - Described JUNOS Software and its basic design architecture
  - Explained how transit and exception traffic is processed
  - Identified and provided a brief overview of JUNOS platforms

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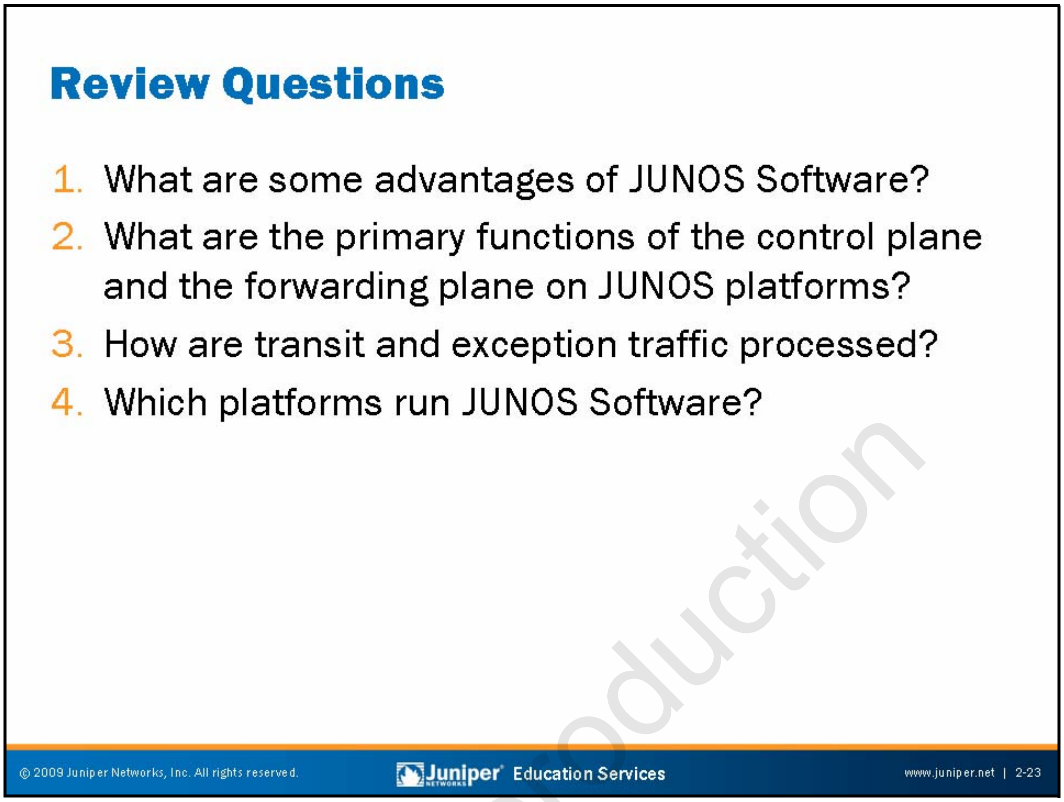
This Chapter Discussed:

- JUNOS Software and its basic design architecture;
- Traffic processing for transit and exception traffic; and
- JUNOS platforms.



Review Questions

1. What are some advantages of JUNOS Software?
2. What are the primary functions of the control plane and the forwarding plane on JUNOS platforms?
3. How are transit and exception traffic processed?
4. Which platforms run JUNOS Software?

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Review Questions

1.

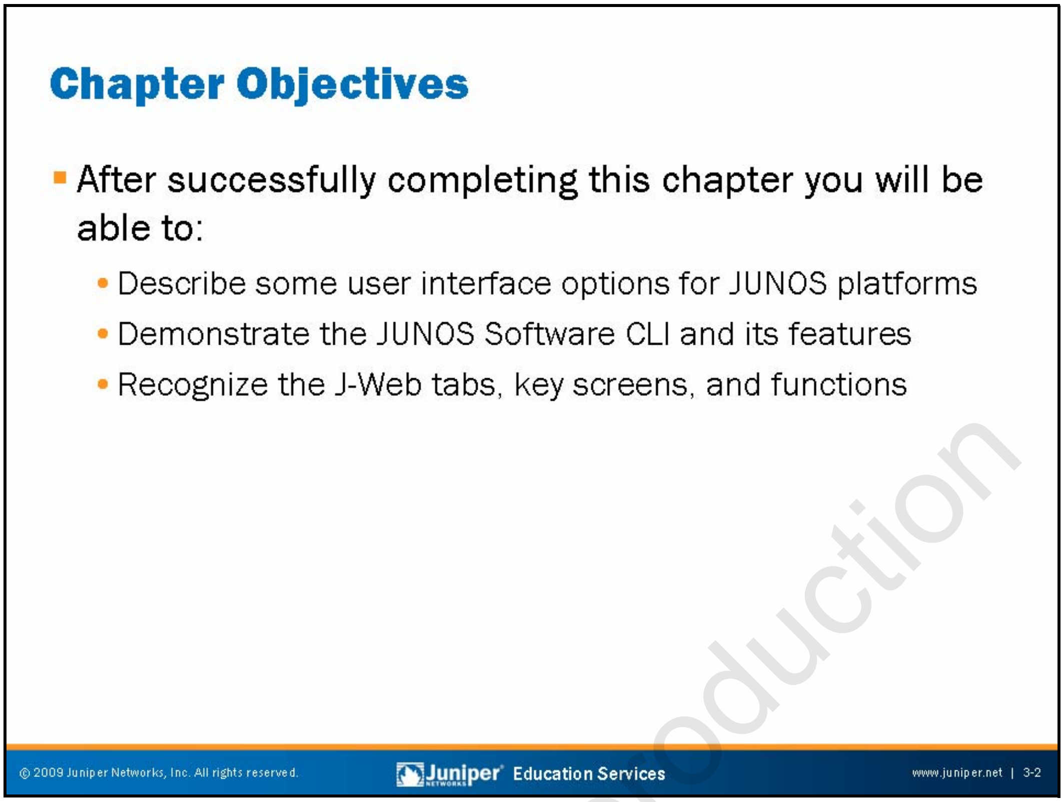
2.

3.

4.

Introduction to JUNOS Software

Chapter 3: User Interface Options



Chapter Objectives

- After successfully completing this chapter you will be able to:
  - Describe some user interface options for JUNOS platforms
  - Demonstrate the JUNOS Software CLI and its features
  - Recognize the J-Web tabs, key screens, and functions

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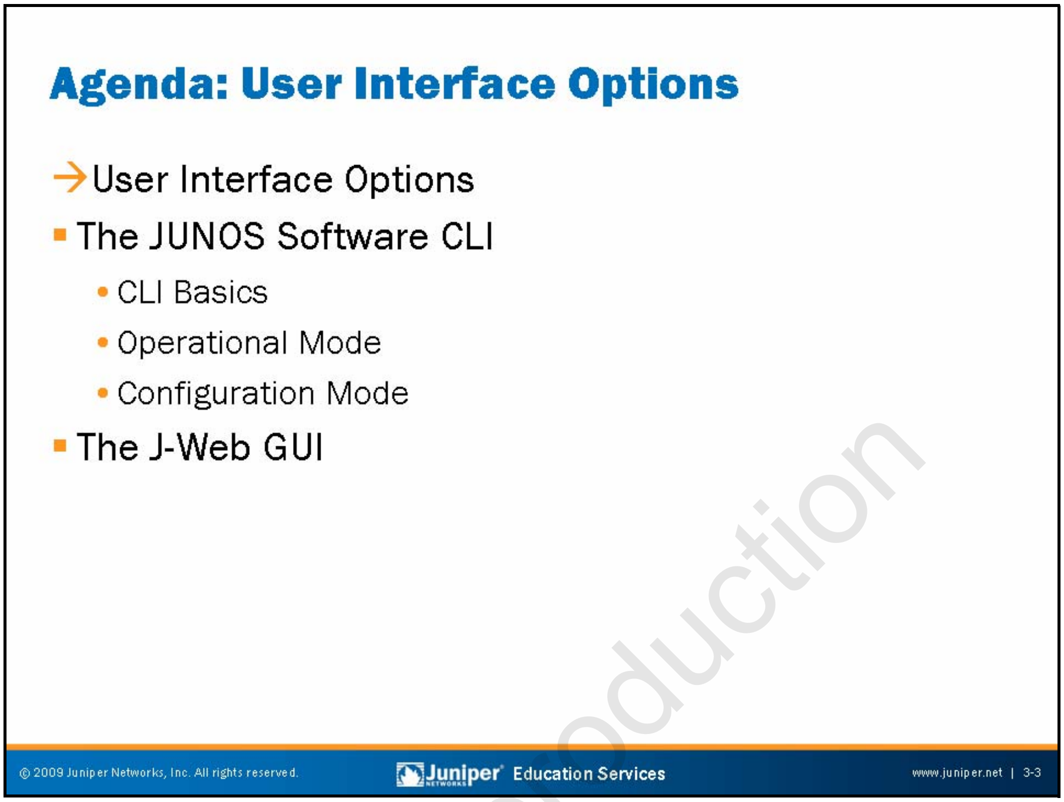
This Chapter Discusses:

- Common user interface options available for platforms running JUNOS Software;
- The JUNOS Software CLI and its related modes and features; and
- The J-Web GUI and its tabs, key screens, and functions.



Agenda: User Interface Options

→User Interface Options

- The JUNOS Software CLI
  - CLI Basics
  - Operational Mode
  - Configuration Mode
- The J-Web GUI

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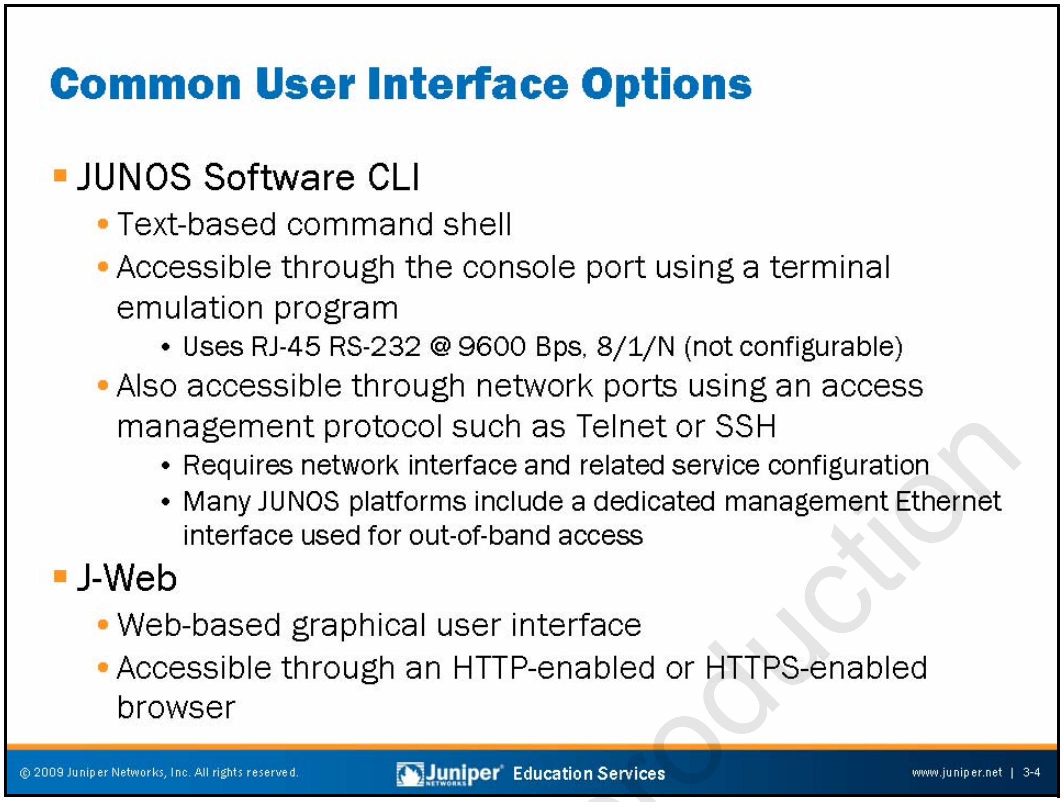
User Interface Options

The slide lists the topics we cover in this chapter. We discuss the highlighted topic first.



Common User Interface Options

- JUNOS Software CLI
  - Text-based command shell
  - Accessible through the console port using a terminal emulation program
    - Uses RJ-45 RS-232 @ 9600 Bps, 8/1/N (not configurable)
  - Also accessible through network ports using an access management protocol such as Telnet or SSH
    - Requires network interface and related service configuration
    - Many JUNOS platforms include a dedicated management Ethernet interface used for out-of-band access
- J-Web
  - Web-based graphical user interface
  - Accessible through an HTTP-enabled or HTTPS-enabled browser

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JUNOS Software CLI

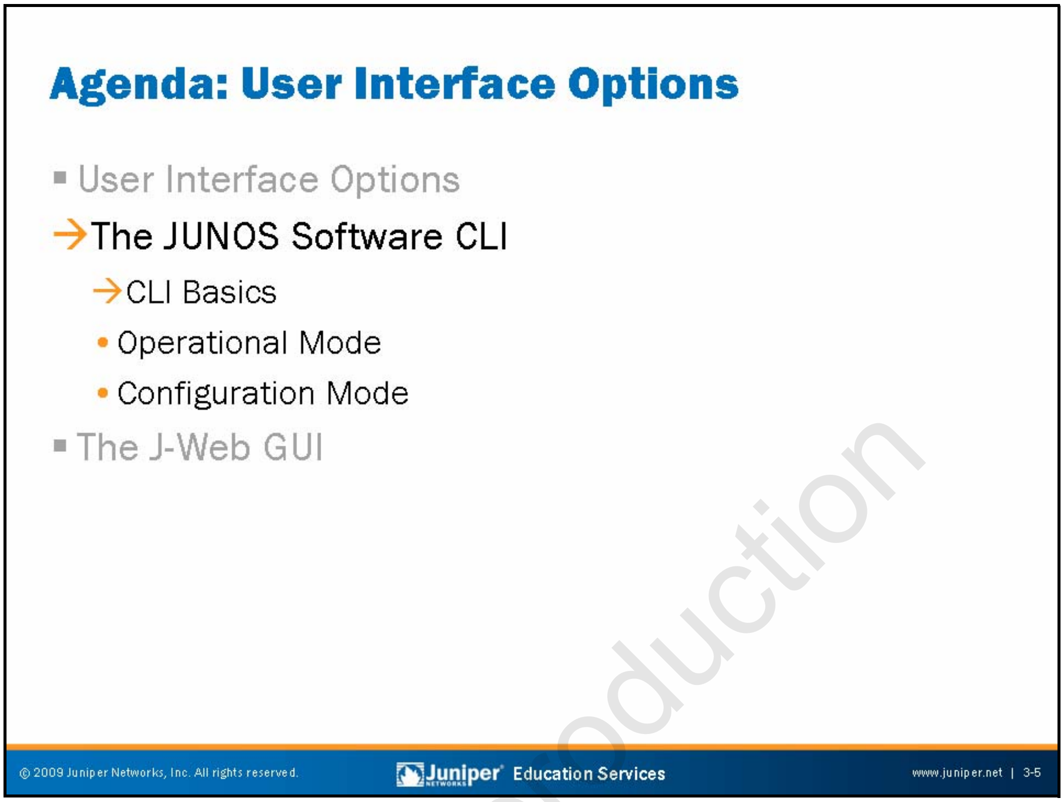
The JUNOS Software CLI is a text-based command shell. One option for accessing the CLI is through the out-of-band (OoB) serial console connection. The console port settings, shown on the slide, are predefined and are not user configurable.

A second option for accessing the CLI is over the network (in band) using access protocols such as Telnet or SSH. Unlike the console connection, these access options require configuration for a network port and the access protocol.

Many platforms running JUNOS Software also offer a dedicated management Ethernet port. This management port provides OoB access; therefore, the software cannot forward transit traffic through this management port. The actual name of the dedicated management Ethernet port varies between platforms. For details on your specific platform, refer to http://www.juniper.net/techpubs/ for the technical publications.

J-Web Interface

The J-Web is a Web-based graphical user interface (GUI) that you access by using either Hypertext Transfer Protocol (HTTP) or HTTP over Secure Sockets Layer (HTTPS). It provides quick configuration wizards to simplify the most common configuration tasks. For more complicated configurations, the J-Web GUI allows you to directly edit the system's text configuration file. The J-Web GUI is installed and enabled by default on most platforms running JUNOS Software.



Agenda: User Interface Options

- User Interface Options
- →The JUNOS Software CLI
  - →CLI Basics
  - Operational Mode
  - Configuration Mode
- The J-Web GUI

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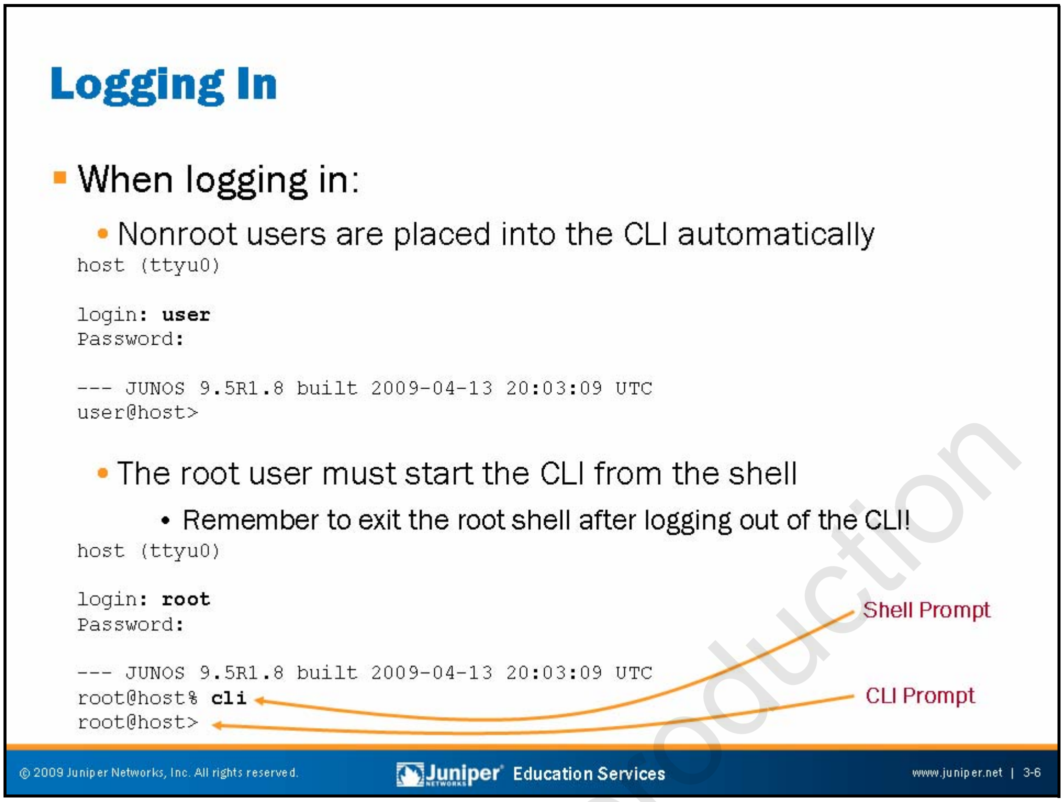
The JUNOS Software CLI: CLI Basics

The slide highlights the topic we discuss next.



Logging In

- When logging in:
  - Nonroot users are placed into the CLI automatically

```
host (ttyu0)

login: user
Password:

--- JUNOS 9.5R1.8 built 2009-04-13 20:03:09 UTC
user@host>
```

  - The root user must start the CLI from the shell
    - Remember to exit the root shell after logging out of the CLI!

```
host (ttyu0)

login: root
Password:

--- JUNOS 9.5R1.8 built 2009-04-13 20:03:09 UTC
root@host% cli
root@host>
```

Shell Prompt
CLI Prompt

Logging In

JUNOS Software requires a username and a password for access. The administrator creates user accounts and assigns permissions. All platforms running JUNOS Software have only the root user configured by default, without any password.

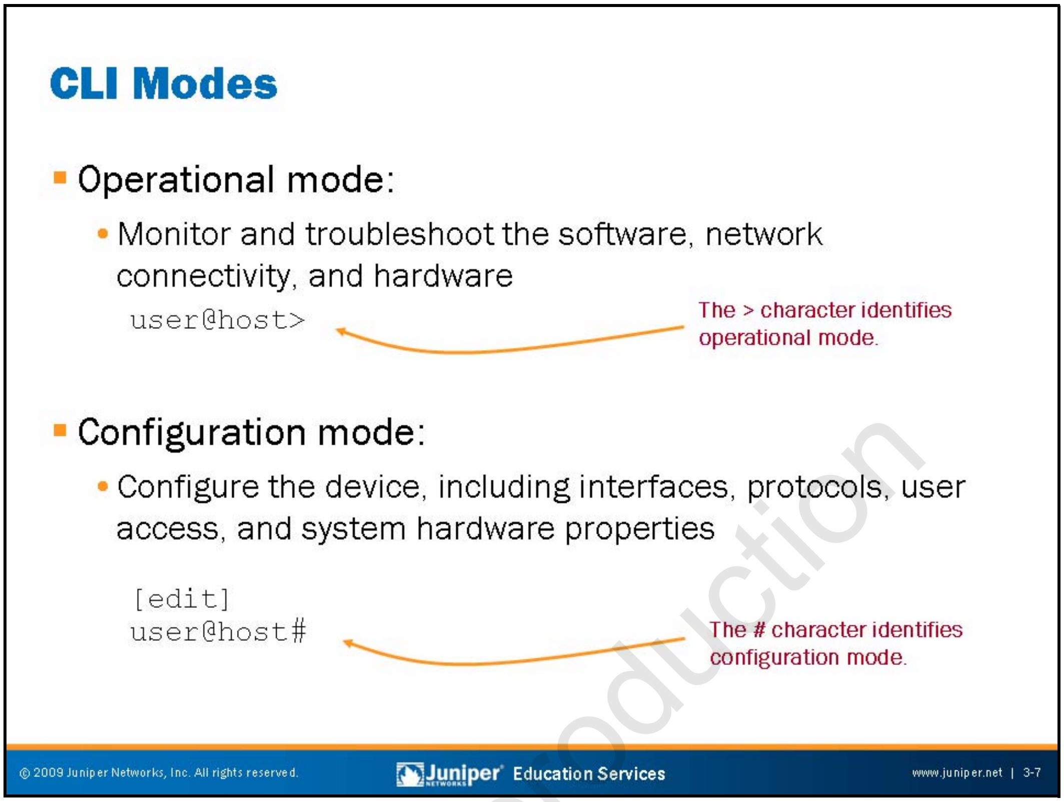
When configured, the console login displays the hostname of the device. When you have not configured a hostname, as is the case with a factory-default configuration, the software displays `Amnesiac` in place of the hostname:

```
Amnesiac (ttyu0)

login: root

--- JUNOS 9.5R1.8 built 2009-04-13 20:03:09 UTC
root@%
```

The root user has complete access and control of the device. When you log in as the root user, the software places you at the UNIX shell. You must start the CLI by typing the **`cli`** command. When you exit the CLI, you return to the UNIX shell. For security reasons, ensure that you also log out of the shell by using the **`exit`** command.



CLI Modes

- Operational mode:
  - Monitor and troubleshoot the software, network connectivity, and hardware

```
user@host>
```

The > character identifies operational mode.

- Configuration mode:
  - Configure the device, including interfaces, protocols, user access, and system hardware properties

```
[edit]
user@host#
```

The # character identifies configuration mode.

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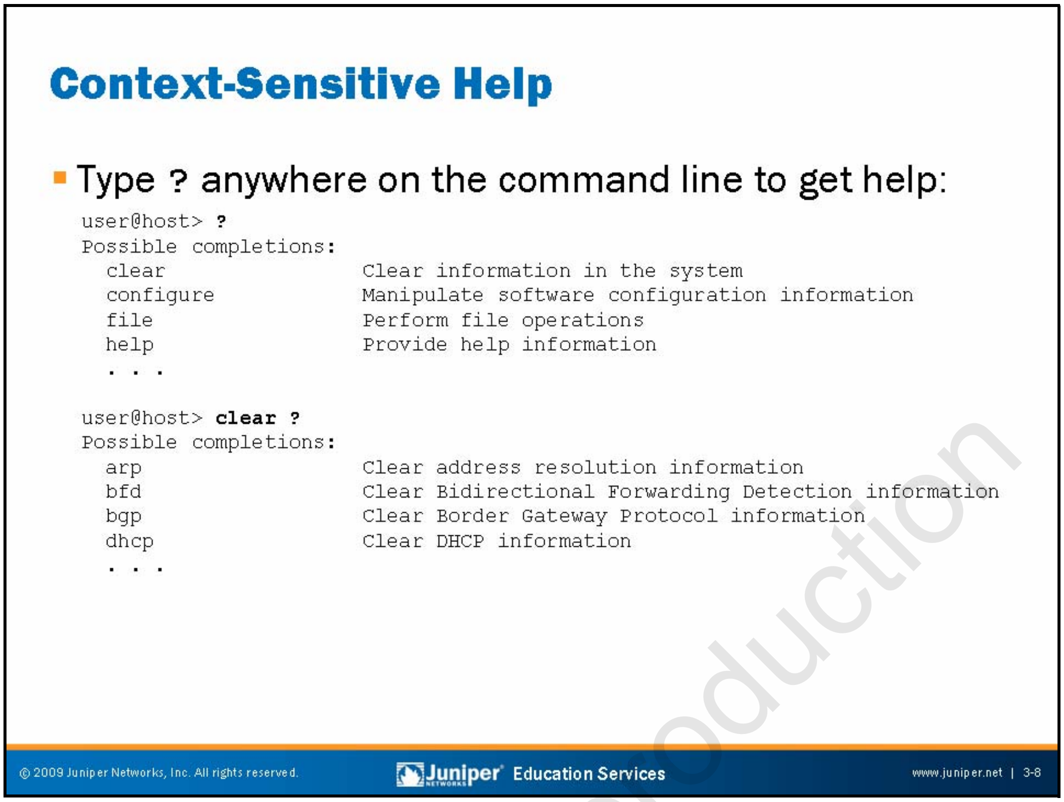
Operational Mode

In operational mode, you use the CLI to monitor and troubleshoot the device. The **`monitor`**, **`ping`**, **`show`**, **`test`**, and **`traceroute`** commands let you display information and test network connectivity for the device.

Configuration Mode

In configuration mode, you can configure all properties of JUNOS Software, including interfaces, protocols, and user access, as well as several system hardware properties.



Context-Sensitive Help

- Type ? anywhere on the command line to get help:

```
user@host> ?
Possible completions:
  clear                Clear information in the system
  configure            Manipulate software configuration information
  file                 Perform file operations
  help                 Provide help information
  . . .

user@host> clear ?
Possible completions:
  arp                  Clear address resolution information
  bfd                  Clear Bidirectional Forwarding Detection information
  bgp                  Clear Border Gateway Protocol information
  dhcp                 Clear DHCP information
  . . .
```

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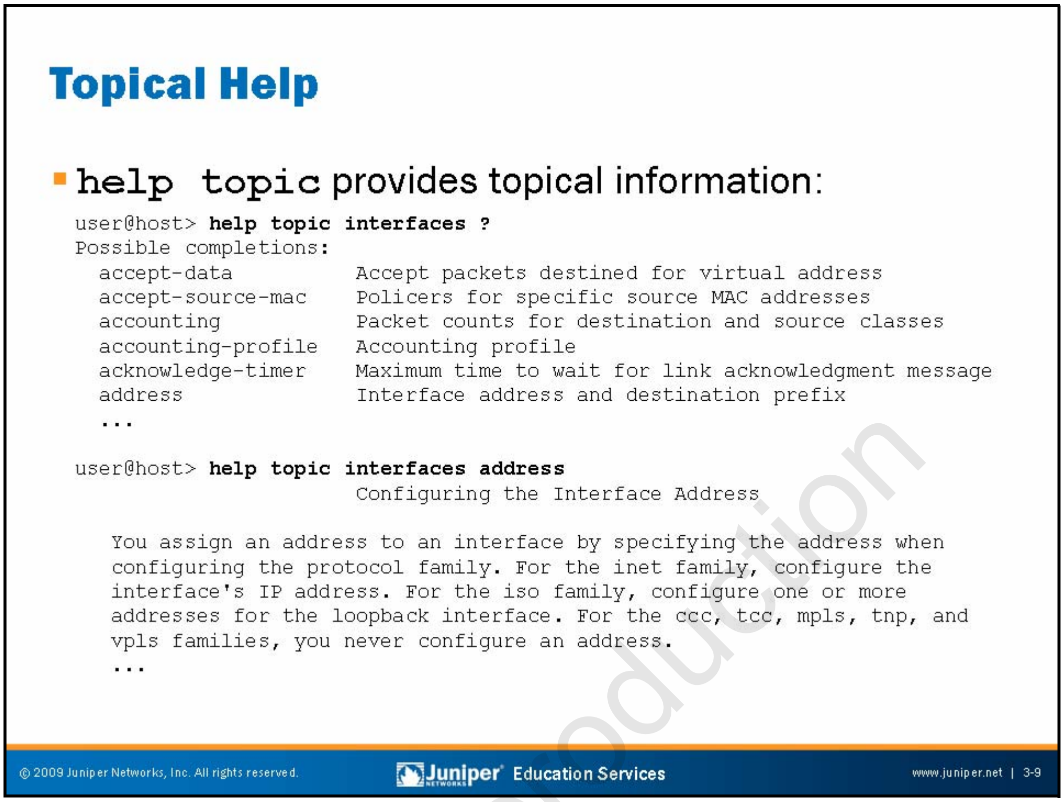
Need Help?

The CLI provides context-sensitive help at any point in a command line. Help tells you which options are acceptable at the current point in the command and provides a brief description of each command or command option.

To receive help at any time while in the JUNOS CLI, type a question mark (**?**). You do not need to press Enter. If you type the question mark at the command-line prompt, the CLI lists the available commands and options including user-defined variables at the appropriate context. If you type the question mark after entering the complete name of a command or an option, the CLI lists the available commands and options and then redisplays the command name and options that you typed. If you type the question mark in the middle of a command name, the CLI lists possible command completions that match the letters you have entered so far and then redisplays the letters that you typed.



Topical Help

- **help topic** provides topical information:

```
user@host> help topic interfaces ?
Possible completions:
  accept-data          Accept packets destined for virtual address
  accept-source-mac    Policers for specific source MAC addresses
  accounting           Packet counts for destination and source classes
  accounting-profile   Accounting profile
  acknowledge-timer    Maximum time to wait for link acknowledgment message
  address              Interface address and destination prefix
  ...

user@host> help topic interfaces address
                       Configuring the Interface Address

   You assign an address to an interface by specifying the address when
   configuring the protocol family. For the inet family, configure the
   interface's IP address. For the iso family, configure one or more
   addresses for the loopback interface. For the ccc, tcc, mpls, tnp, and
   vpls families, you never configure an address.
   ...
```

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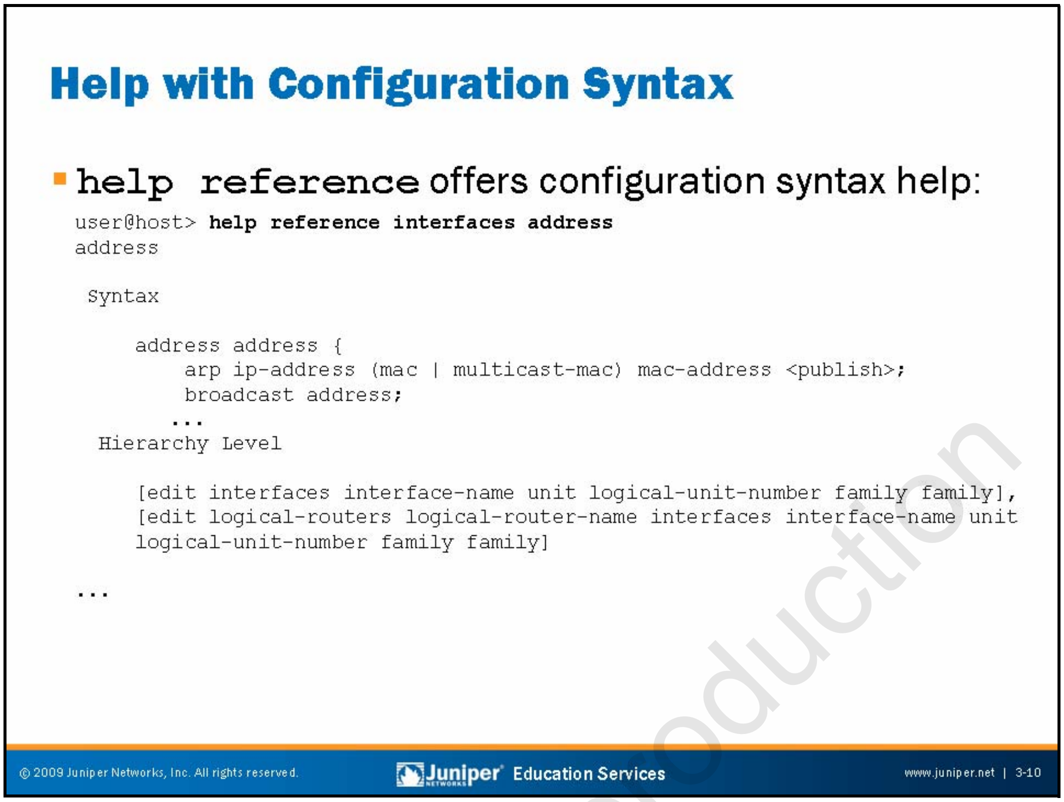
Help on General Concepts

You can use the **help** command in various ways. The **help topic** command displays usage guidelines for the statement. In the example on the slide, we receive information on configuring an interface address.



Help with Configuration Syntax

- **help reference** offers configuration syntax help:

```
user@host> help reference interfaces address
address

 Syntax

     address address {
         arp ip-address (mac | multicast-mac) mac-address <publish>;
         broadcast address;
        ...
  Hierarchy Level

     [edit interfaces interface-name unit logical-unit-number family family],
     [edit logical-routers logical-router-name interfaces interface-name unit
     logical-unit-number family family]

...
```

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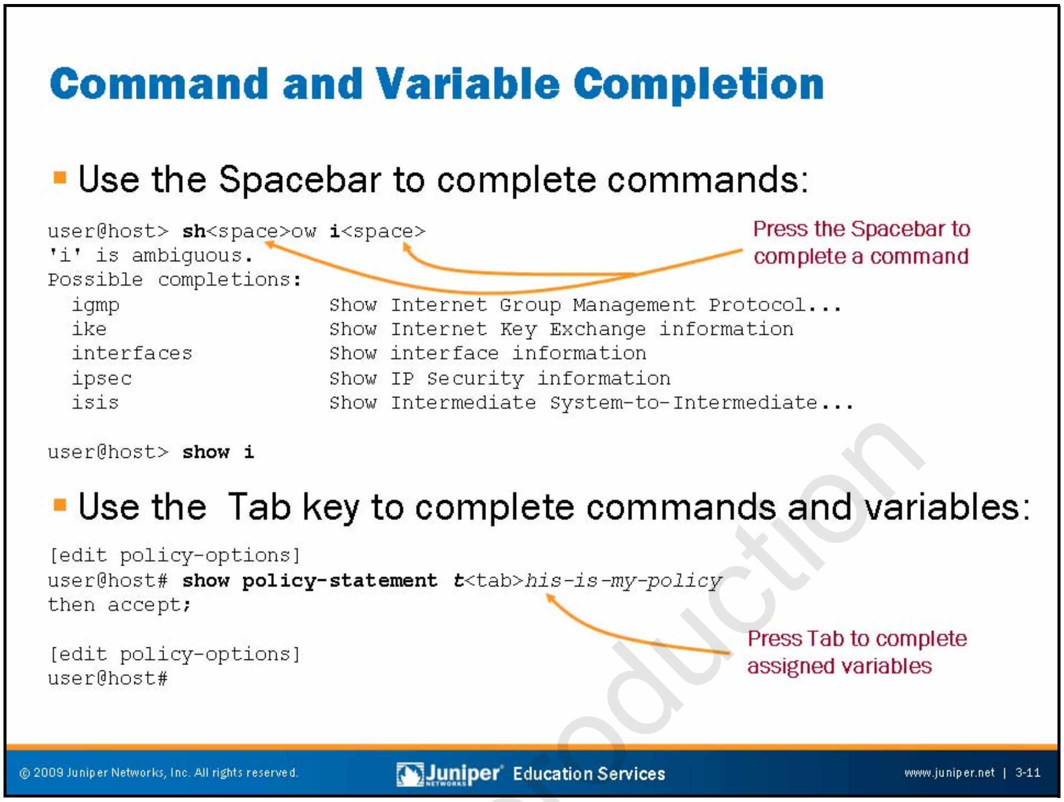
Help with JUNOS Software Configuration

The **help reference** command displays summary information for the referenced configuration statement. In the example on the slide, once again, we are seeking help with interface addressing. Although not shown on the slide, the **help reference** command displays a complete list of related configuration options along with several other details specific to the referenced command statement.

In addition to the **help topic** and **help reference** commands, JUNOS Software also offers the **help apropos** command. The **help apropos** command displays the contexts (typically **set** commands) that reference a specified variable. The following is an example of the **help apropos** command:

```
[edit system archival configuration]
user@host# help apropos archive
set archive-sites
    List of archive destinations
set archive-sites <url> password <password>
    Password for login into the archive site
```

The **help apropos** command only displays contexts that are relevant to the configuration hierarchy level at which you are currently positioned. In other words, if you entered the sample command shown, at the `[edit]` hierarchy level you would see all possible references rather than just those that are applicable to the `[edit system archival configuration]` hierarchy level.



Command and Variable Completion

- Use the Spacebar to complete commands:

```
user@host> sh<space>ow i<space>
'i' is ambiguous.
Possible completions:
  igmp                   Show Internet Group Management Protocol...
  ike                    Show Internet Key Exchange information
  interfaces             Show interface information
  ipsec                  Show IP Security information
  isis                   Show Intermediate System-to-Intermediate...

user@host> show i
```

Press the Spacebar to complete a command

- Use the Tab key to complete commands and variables:

```
[edit policy-options]
user@host# show policy-statement t<tab>his-is-my-policy
then accept;

[edit policy-options]
user@host#
```

Press Tab to complete assigned variables

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Spacebar Completion for Commands

The CLI provides a completion function. Therefore, you are not always required to type the full command or the command option name for the CLI to recognize it.

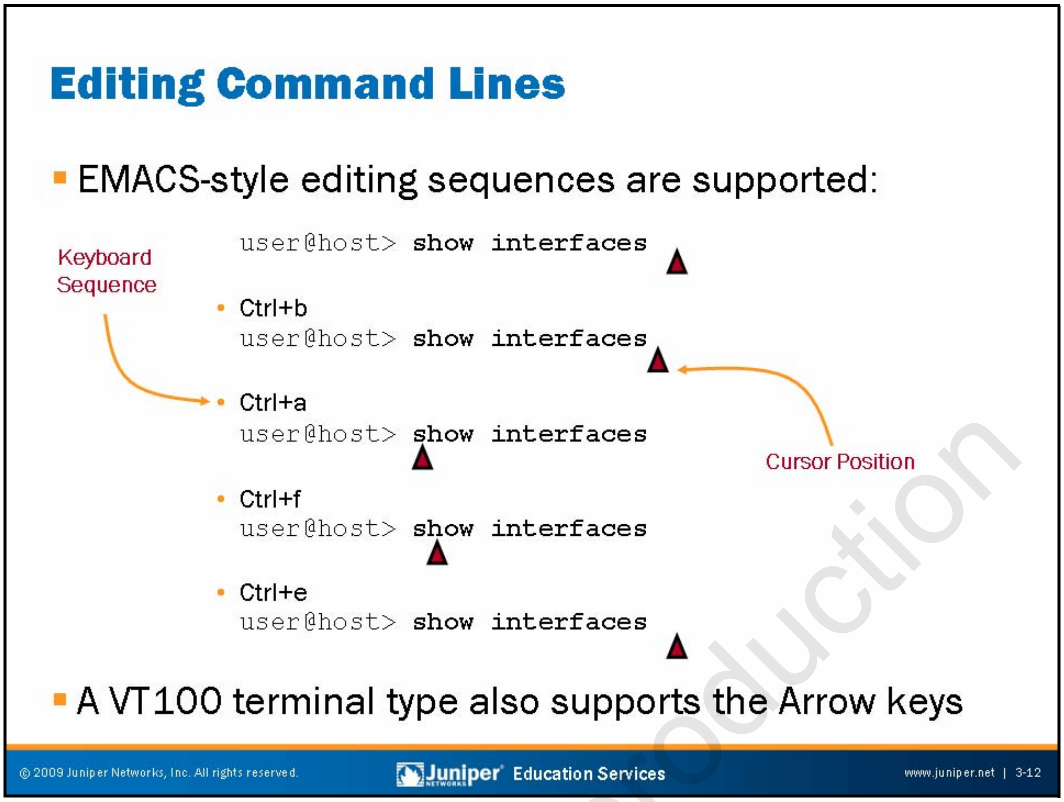
To complete a command or option that you have partially typed, press the Spacebar. If the partially typed letters begin a string that uniquely identifies a command, the CLI displays the complete command name. Otherwise, the CLI beeps to indicate that you have entered an ambiguous command, and it displays the possible completions.

The command completion option is on by default, but you can turn it off. To disable command completion for an individual user’s session, issue the **set cli complete-on-space off** command as follows:

```
user@host> set cli complete-on-space off
Disabling complete-on-space
```

Tab Completion for Commands and Variables

You can use the Tab key to complete system commands and user-defined variables. Examples of variables include policy names, AS paths, community names, and IP addresses. The Tab key also offers a list of possible completions if multiple, ambiguous options exist. Command completion allows you to save time by reducing your keystrokes, and prevents errors by accurately referencing the desired user-defined variables.



Editing Command Lines

- EMACS-style editing sequences are supported:

```
user@host> show interfaces
```

- Ctrl+b

```
user@host> show interfaces
```

- Ctrl+a

```
user@host> show interfaces
```

- Ctrl+f

```
user@host> show interfaces
```

- Ctrl+e

```
user@host> show interfaces
```

- A VT100 terminal type also supports the Arrow keys

EMACS-Style Control Keys

The CLI supports EMACS-style keyboard sequences that allow you to move the cursor on a command line and delete specific characters or words. The following are supported sequences:

- *Ctrl+b*: Moves the cursor left one character;
- *Ctrl+a*: Moves the cursor to the beginning of the command line;
- *Ctrl+f*: Moves the cursor right one character;
- *Ctrl+e*: Moves the cursor to the end of the command line;
- *Delete* and *Backspace*: Deletes the character before the cursor;
- *Ctrl+d*: Deletes the character over the cursor;
- *Ctrl+k*: Deletes from the cursor to the end of the line;
- *Ctrl+u*: Deletes all characters and negates the current command;
- *Ctrl+w*: Deletes the entire word to the left of the cursor;
- *Ctrl+l*: Redraws the current line; and
- *Ctrl+p*, *Ctrl+n*: Repeats the previous and next command in the command history, respectively.

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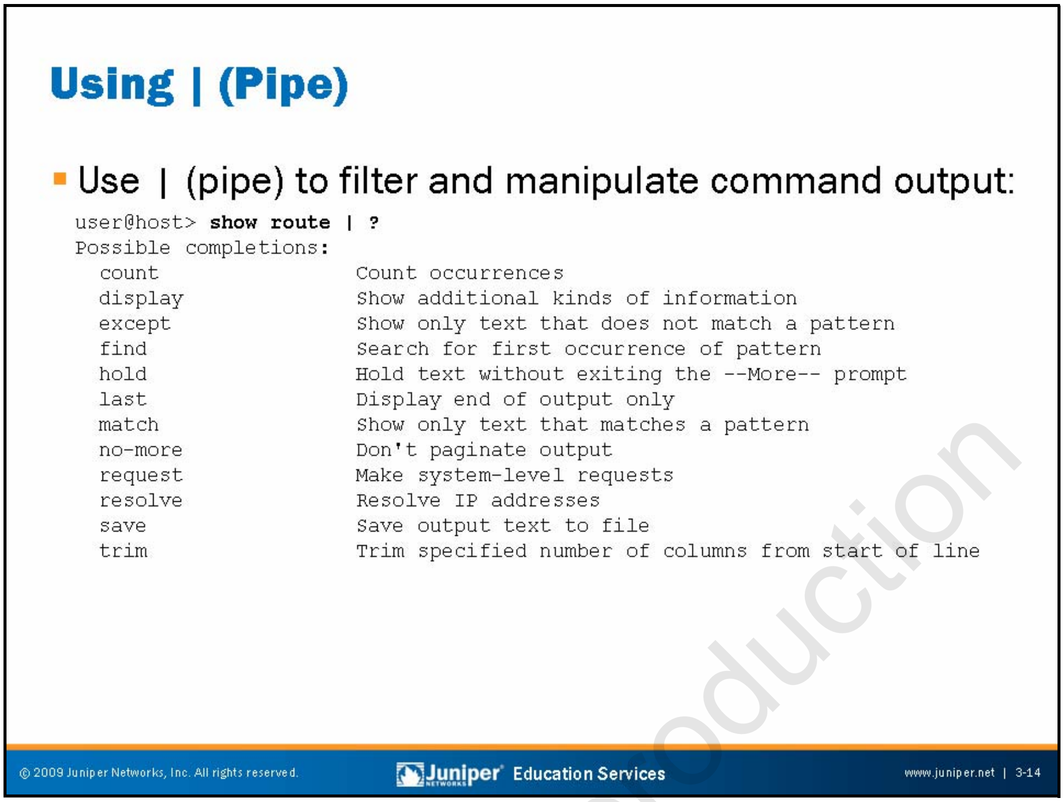
VT100 Terminal Type

JUNOS Software defaults to a VT100 terminal type. This terminal type enables the use of keyboard Arrow keys without any additional session or configuration modification.



Using | (Pipe)

- Use | (pipe) to filter and manipulate command output:

```
user@host> show route | ?
Possible completions:
  count                  Count occurrences
  display                Show additional kinds of information
  except                 Show only text that does not match a pattern
  find                   Search for first occurrence of pattern
  hold                   Hold text without exiting the --More-- prompt
  last                   Display end of output only
  match                  Show only text that matches a pattern
  no-more                Don't paginate output
  request                Make system-level requests
  resolve                Resolve IP addresses
  save                   Save output text to file
  trim                   Trim specified number of columns from start of line
```

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Using Pipe

For operational and configuration commands that display output, such as the **show** commands, you can filter the output. When help is displayed for these commands, one of the options listed is |, called a pipe, which allows the command output to be filtered. To filter the output of an operational mode or a configuration mode command, add a pipe and an option to the end of the command. The following are available options:

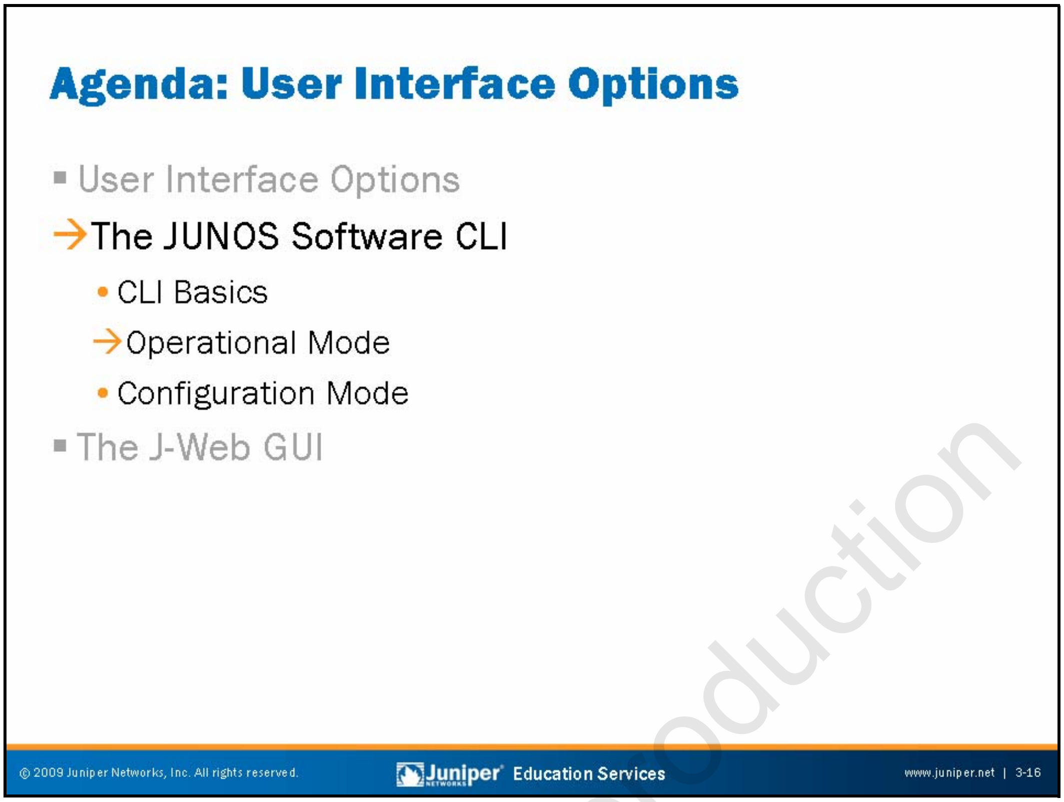
- **compare** (***filename*** **| rollback** ***n***): Available in configuration mode using only the **show** command. Compares configuration changes with another configuration file;
- **count**: Displays the number of lines in the output;
- **display changed**: Available in configuration mode only. Tags changes with junos:changed attribute only for XML use;
- **display commit-scripts**: Shows data after JUNOS Software applies commit scripts;
- **display detail**: Available in configuration mode only. Displays additional information about the contents of the configuration;

Continued on next page.

Using Pipe (contd.)

- **`display inheritance`**: Available in configuration mode only. Displays inherited configuration data and source group;
- **`display omit`**: Available in configuration mode only. Omits configuration statements with the **`omit`** option;
- **`display set`**: Available in configuration mode only. Shows **`set`** commands that created configuration statements;
- **`display xml`**: Displays the output in JUNOScript XML format;
- **`except`** ***`regular-expression`***: Ignores text matching a regular expression when searching the output. If the regular expression contains spaces, operators, or wildcard characters, you must enclose it in quotation marks;
- **`find`** ***`regular-expression`***: Displays the output starting at the first occurrence of text matching a regular expression. If the regular expression contains spaces, operators, or wildcard characters, you must enclose it in quotation marks;
- **`hold`**: Holds text without exiting the `--(more)--` prompt;
- **`last`**: Displays the last screen of information;
- **`match`** ***`regular-expression`***: Searches for text matching a regular expression. If the regular expression contains spaces, operators, or wildcard characters, you must enclose it in quotation marks;
- **`no-more`**: Displays output all at once rather than one screen at a time;
- **`request message`**: Displays output to multiple users;
- **`resolve`**: Converts IP addresses to Domain Name System (DNS) names. Truncates to fit original size unless you specify **`full-names`**;
- **`save`** ***`filename`***: Saves the output to a file or URL; and
- **`trim`**: Trims specified number of columns from the start line.

You can cascade multiple instances of the CLI's pipe functionality, which can be very beneficial when you must search extensive outputs displayed through the CLI for specific information. In a subsequent chapter, we highlight the required syntax to evoke logical AND and logical OR searches within extensive outputs and files.



Agenda: User Interface Options

- User Interface Options
- → The JUNOS Software CLI
  - CLI Basics
  - → Operational Mode
  - Configuration Mode
- The J-Web GUI

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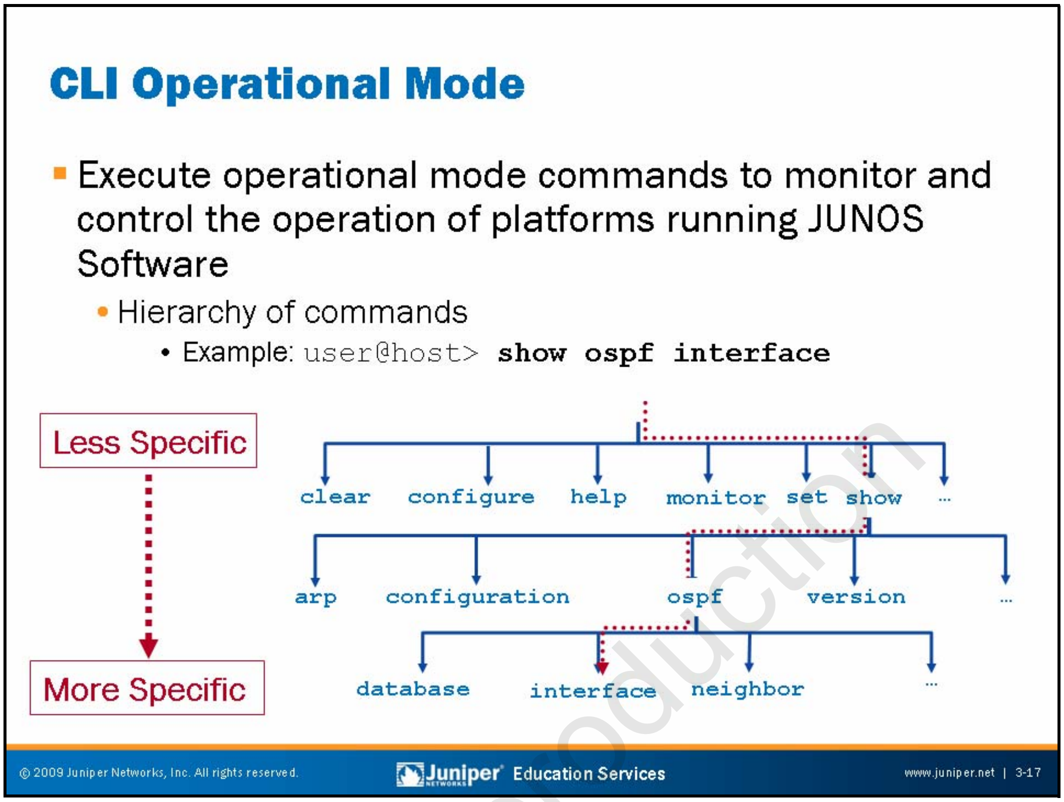
The JUNOS Software CLI: Operational Mode

The slide highlights the topic we discuss next.



CLI Operational Mode

- Execute operational mode commands to monitor and control the operation of platforms running JUNOS Software
  - Hierarchy of commands
    - Example: `user@host>` **`show ospf interface`**

Less Specific

More Specific

clear configure help monitor set show …

arp configuration ospf version …

database interface neighbor …

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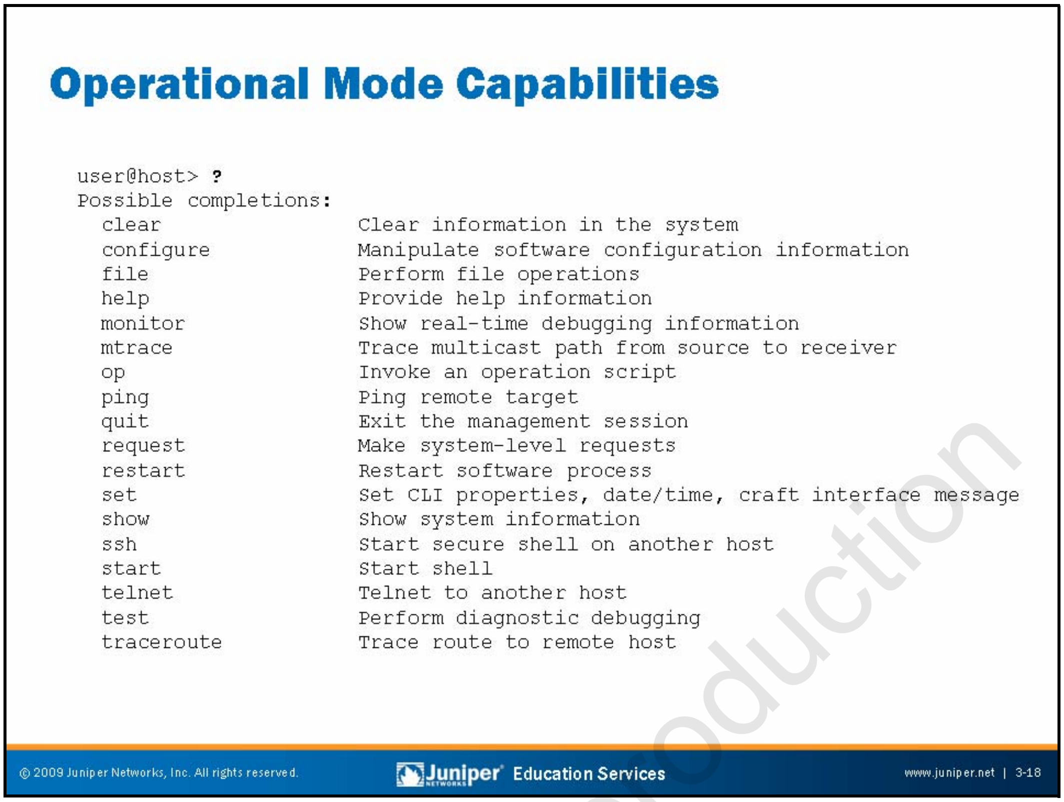
Operational Mode

You use operational mode CLI commands to monitor and control the operation of a device running JUNOS Software. The operational mode commands exist in a hierarchical structure, as shown on the slide. For example, the **show** command displays various types of information about the system and its environment. One of the possible options for the **show** command is **`ospf`**, which displays information about the Open Shortest Path First (OSPF) protocol. Specifying the **`interface`** option, as in the **`show ospf interface`** command, outputs information on OSPF interfaces.

The JUNOS Software also adds additional flexibility through the **`run`** command, which allows you to issue operational mode commands while in configuration mode. We cover the **`run`** command in detail later in this chapter.



Operational Mode Capabilities

```
user@host> ?
Possible completions:
  clear                 Clear information in the system
  configure             Manipulate software configuration information
  file                  Perform file operations
  help                  Provide help information
  monitor               Show real-time debugging information
  mtrace                Trace multicast path from source to receiver
  op                    Invoke an operation script
  ping                  Ping remote target
  quit                  Exit the management session
  request               Make system-level requests
  restart               Restart software process
  set                   Set CLI properties, date/time, craft interface message
  show                  Show system information
  ssh                   Start secure shell on another host
  start                 Start shell
  telnet                Telnet to another host
  test                  Perform diagnostic debugging
  traceroute            Trace route to remote host
```

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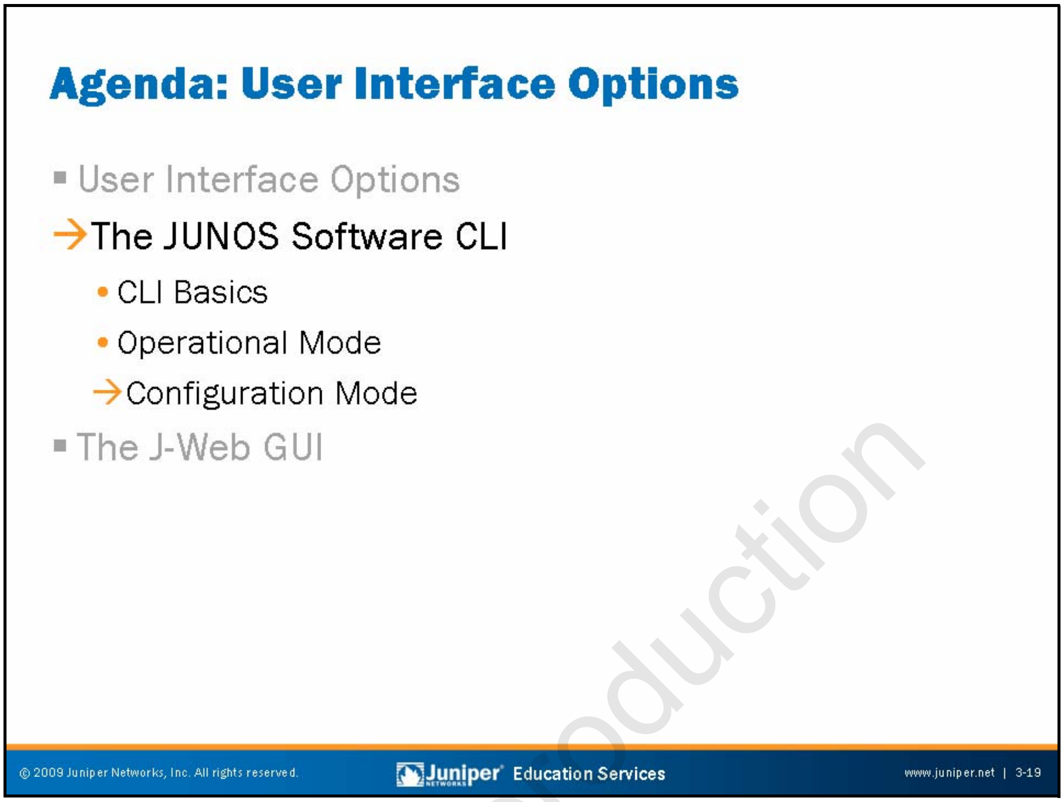
Operational Mode Capabilities

Key operational mode capabilities include the following:

- Entering configuration mode;
- Controlling the CLI environment;
- Exiting the CLI;
- Monitoring and troubleshooting:
  - **clear**
  - **monitor**
  - **mtrace**
  - **ping**
  - **show**
  - **test**
  - **traceroute;**
- Connecting to other network systems;
- Copying files;
- Restarting software processes; and
- Performing system-level operations.



Agenda: User Interface Options

- User Interface Options
- →The JUNOS Software CLI
  - CLI Basics
  - Operational Mode
  - →Configuration Mode
- The J-Web GUI

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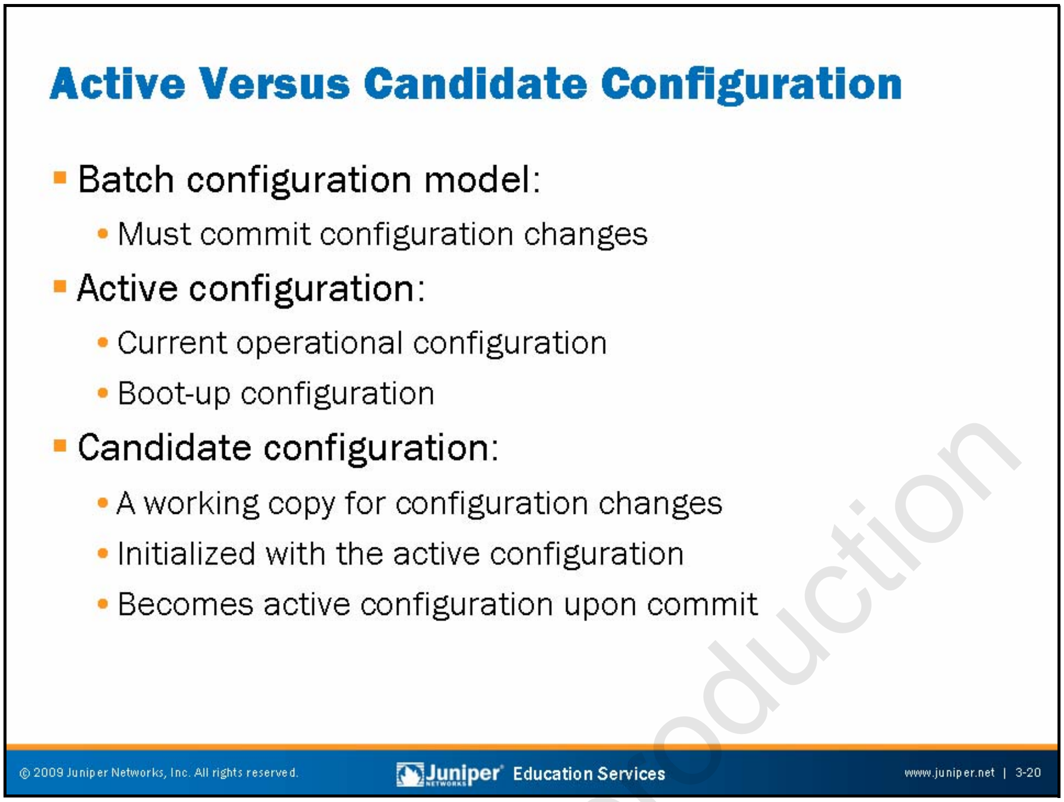
The JUNOS Software CLI: Configuration Mode

The slide highlights the topic we discuss next.



Active Versus Candidate Configuration

- Batch configuration model:
  - Must commit configuration changes
- Active configuration:
  - Current operational configuration
  - Boot-up configuration
- Candidate configuration:
  - A working copy for configuration changes
  - Initialized with the active configuration
  - Becomes active configuration upon commit

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Batch Configuration Changes

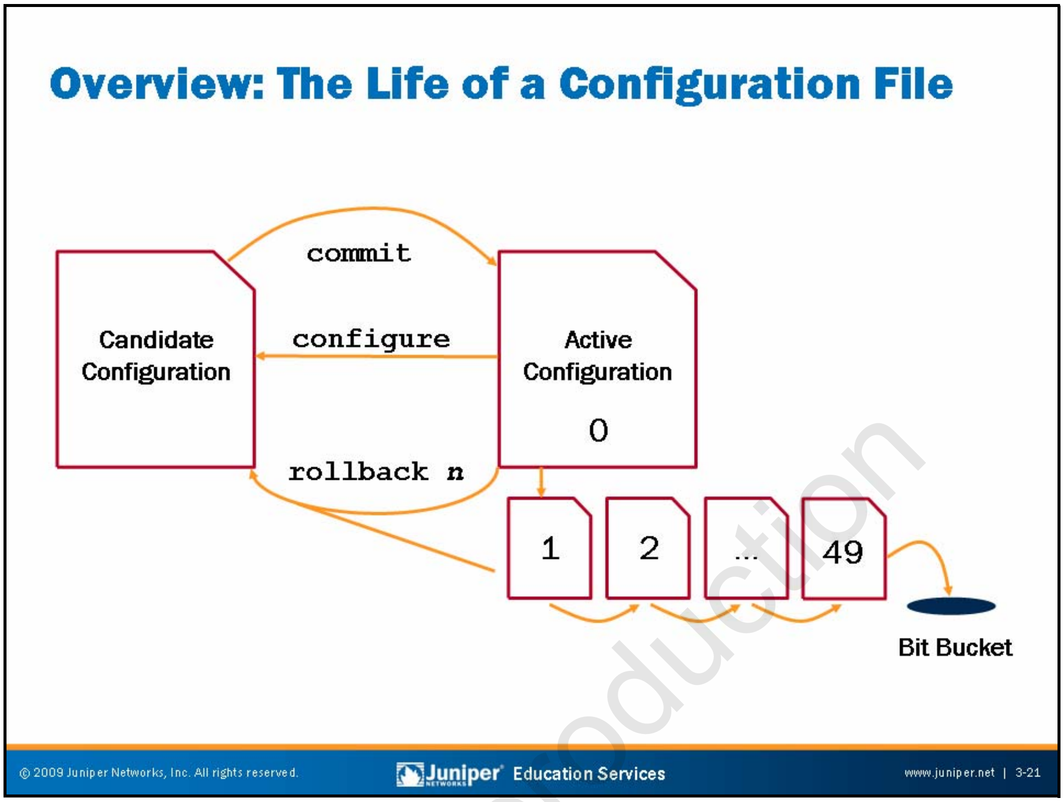
Unlike software from other vendors, configuration changes made in the JUNOS Software do not take effect immediately. This design feature allows you to group together and apply multiple configuration changes to the running configuration as a single unit.

Active Configuration

The active configuration is the configuration currently operational on the system and is the configuration the system loads during the boot sequence. This concept is analogous to both the *running configuration* and *startup configuration* in software from other vendors.

Candidate Configuration

The candidate configuration is a temporary configuration that might possibly become the active configuration. When you configure a device running JUNOS Software, the software creates a candidate configuration and initially populates it with the active configuration running on that device. You then modify the candidate configuration. Once satisfied with your modifications, you can commit the changes. This action causes the candidate configuration to become the active configuration.



Overview: The Life of a Configuration File

Candidate Configuration

commit

configure

rollback *n*

Active Configuration

0

1

2

...

49

Bit Bucket

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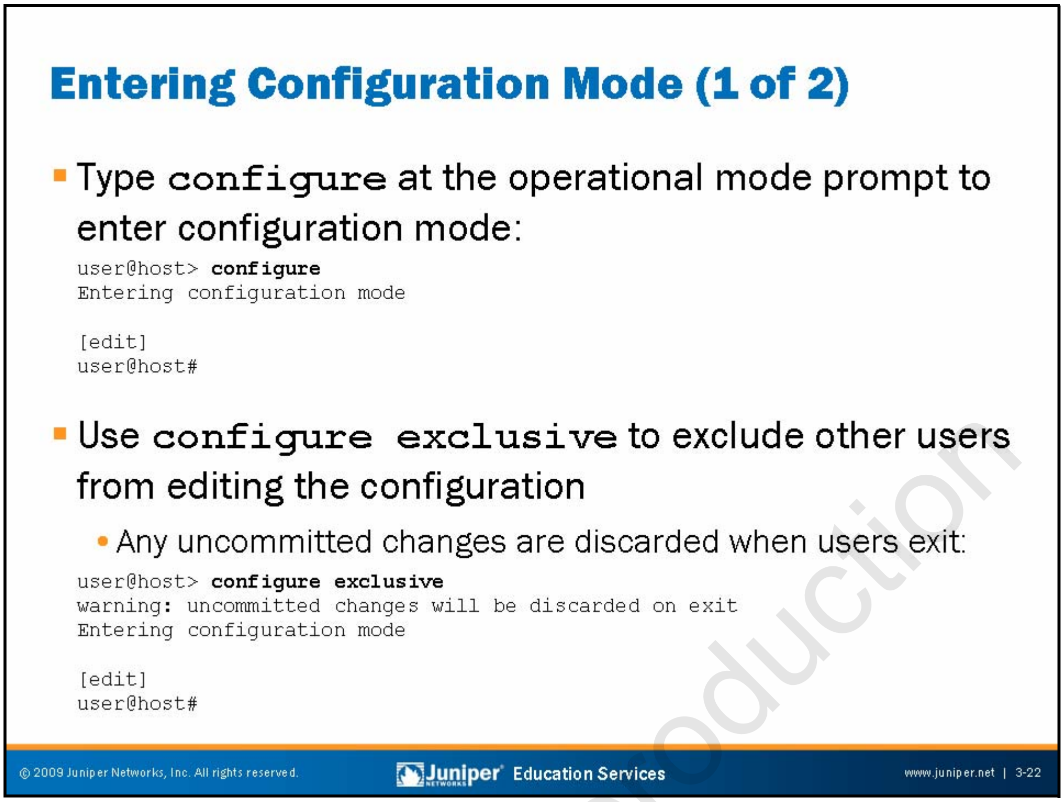
The Life of a Configuration File: An Overview

The **`configure`** command causes a candidate configuration to be created and populated with the contents of the active configuration. You can then modify the candidate configuration with your changes.

To have a candidate configuration take effect, you must commit the changes. At this time, JUNOS Software checks the candidate configuration for proper syntax and it installs it as the active configuration. If the syntax is not correct, an error message indicates the location of the error, and the software does not activate any part of the configuration. You must correct the errors before recommitting the configuration.

You can easily recover previous configurations by using a **`rollback`** ***n*** command. JUNOS Software maintains a configuration history by storing previously active configurations. The software saves a maximum of 50 configurations. This number includes the current active configuration, which is also known as `rollback 0`, and up to 49 previously active configurations. If you perform a rollback operation, keep in mind that the related configuration does not become active until you issue a **`commit`**. When you issue a **`commit`** and there are 50 rollback configurations, the software purges the last rollback configuration—rollback 49.

We cover these details more thoroughly on the following pages.



Entering Configuration Mode (1 of 2)

- Type `configure` at the operational mode prompt to enter configuration mode:

```
user@host> configure
Entering configuration mode

[edit]
user@host#
```

- Use `configure exclusive` to exclude other users from editing the configuration
  - Any uncommitted changes are discarded when users exit:

```
user@host> configure exclusive
warning: uncommitted changes will be discarded on exit
Entering configuration mode

[edit]
user@host#
```

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Starting Configuration Mode

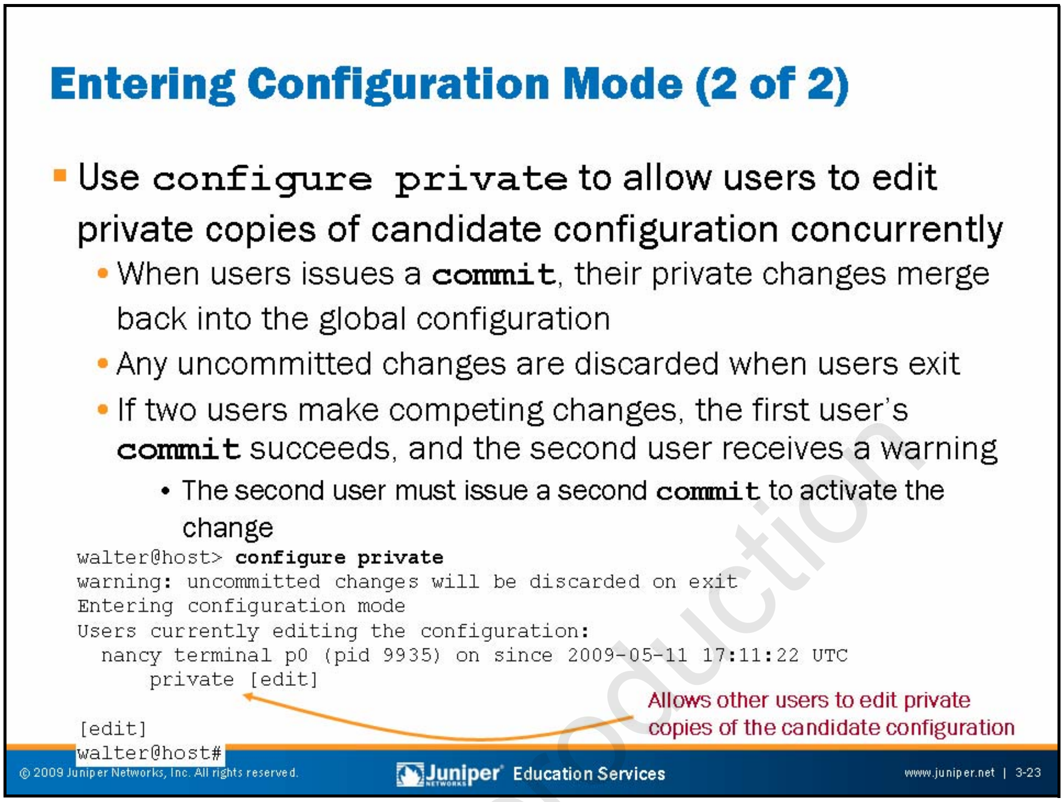
You enter configuration mode by issuing the **`configure`** command from the CLI's operational mode. If, when you enter configuration mode, another user is also in configuration mode, a message indicates who the user is and what portion of the configuration the user is viewing or editing.

In configuration mode, the prompt changes from the angle bracket (>) of operational mode to the pound sign (#), preceded by the name of the user and the name of the device.

The portion of the prompt in brackets, such as `[edit]`, is a banner indicating that you are in configuration mode and specifying your location within the configuration hierarchy.

Exclusive Configuration

By default, multiple users can enter configuration mode and commit changes. Use the **`configure exclusive`** command to allow only a single user to edit the configuration. Uncommitted changes are always discarded when you use the **`configure exclusive`** command. In contrast, uncommitted changes are retained when you use the standard **`configure`** command.



Entering Configuration Mode (2 of 2)

- Use **configure private** to allow users to edit private copies of candidate configuration concurrently
  - When users issues a **commit**, their private changes merge back into the global configuration
  - Any uncommitted changes are discarded when users exit
  - If two users make competing changes, the first user's **commit** succeeds, and the second user receives a warning
    - The second user must issue a second **commit** to activate the change

```
walter@host> configure private
warning: uncommitted changes will be discarded on exit
Entering configuration mode
Users currently editing the configuration:
  nancy terminal p0 (pid 9935) on since 2009-05-11 17:11:22 UTC
      private [edit]

[edit]
walter@host#
```

Allows other users to edit private copies of the candidate configuration

Private Configuration

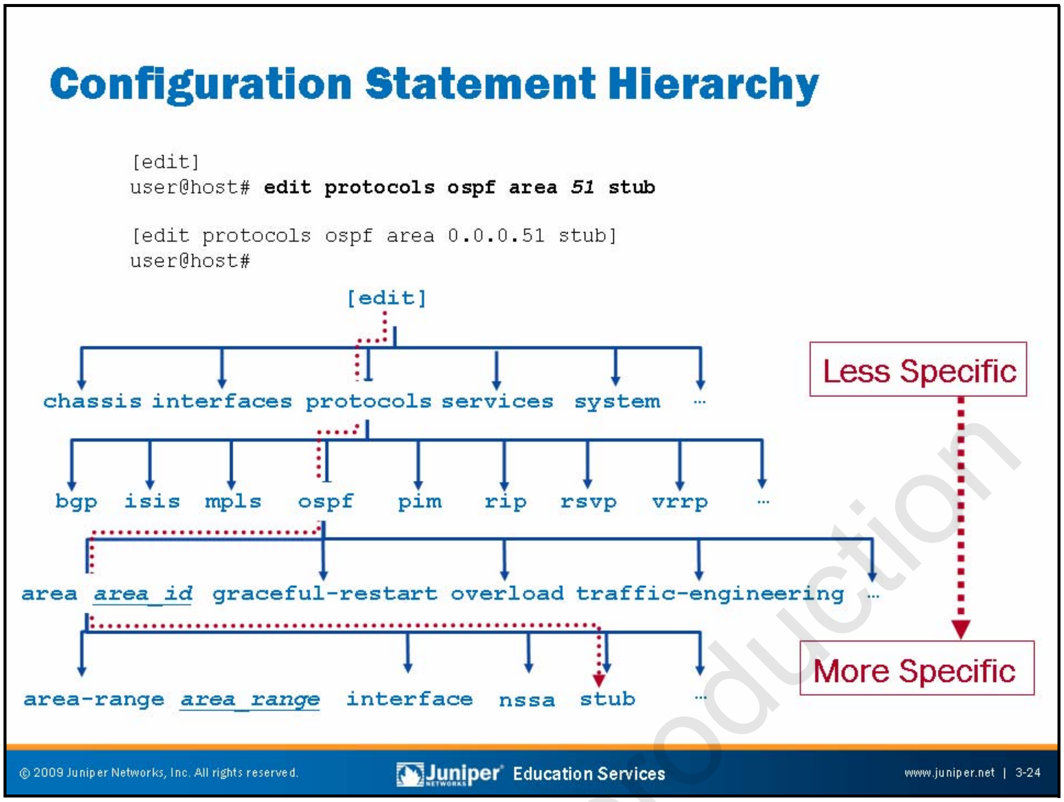
Entering configuration mode using the **configure private** command allows multiple users to edit the configuration while committing only their private changes. (You must issue a **commit** command from the [edit] hierarchy.) If private users issue a **rollback 0** command, the software discards only their changes.

When a user is in private mode, other users must enter private mode or use **configure exclusive** to become the master, or they cannot modify the candidate configuration. Exiting private configuration without committing changes results in the loss of any modifications made to the private candidate configuration.

If two users are in private mode and both make the same change (For example, User 1 changes the system hostname to *apples* while User 2 sets the hostname to *oranges*), the second **commit** will fail with an error message to avoid configuration conflicts. The software places the second user's changes into effect if User 2 issues a second **commit** command.

When chassis clustering is in effect, the **configure private** command is automated. In some other environments, you might want to require users to only use **configure private**. When creating user accounts, it is possible to limit the commands available to users through the assigned properties. We discuss user accounts and their assigned properties later in this course.

If a user is in configuration mode and has altered the candidate configuration, other users cannot enter confguration mode using the **exclusive** or **private** options. The changes made by the first user must be committed or cancelled prior to any other users entering configuration mode with the **exclusive** or **private** options.



Configuration Statement Hierarchy

```
[edit]
user@host# edit protocols ospf area 51 stub

[edit protocols ospf area 0.0.0.51 stub]
user@host#
```

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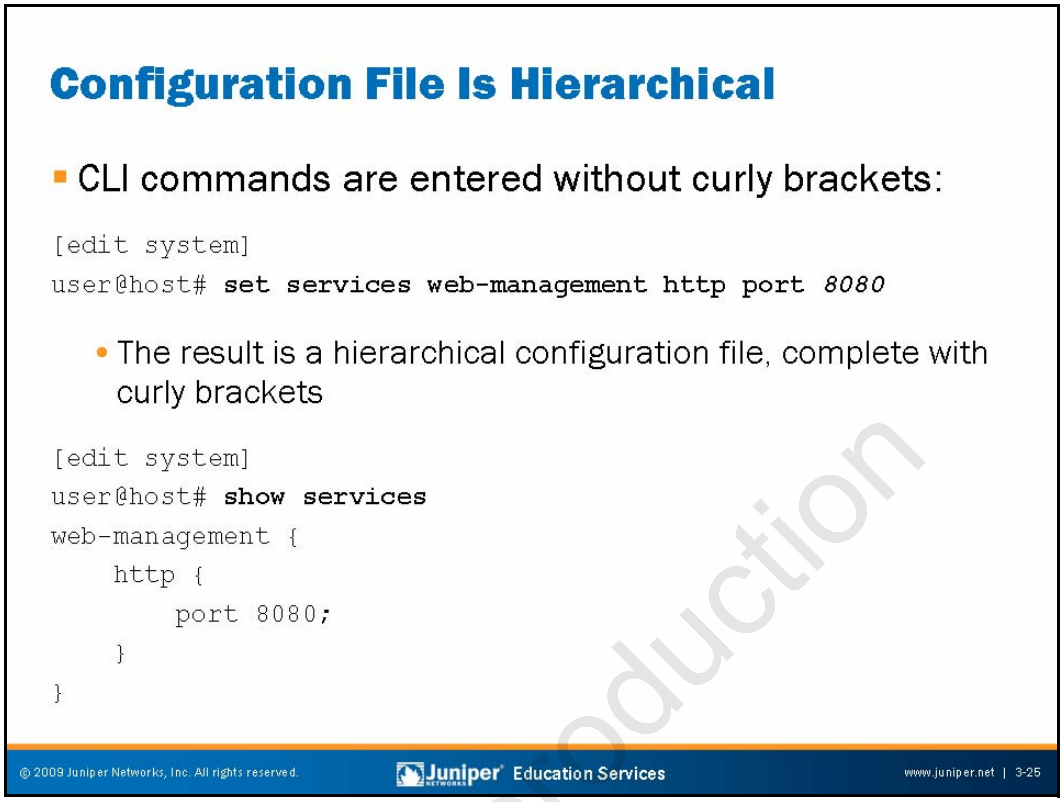
Statement Hierarchy

In configuration mode, you enter commands that affect the statement hierarchy. The statement hierarchy stores configuration information and is independent of the CLI operational mode command hierarchy. The commands available in configuration mode are also independent of the commands available in operational mode. For example, CLI operational mode includes a **show** command to display specific operational information, while the CLI configuration mode provides a **show** command to display the statement hierarchy. The two commands are independent of each other.

The software organizes the statement hierarchy in a tree structure similar to Windows folders or UNIX directories, grouping related information into a particular branch of the tree.



Configuration File Is Hierarchical

- CLI commands are entered without curly brackets:

```
[edit system]
user@host# set services web-management http port 8080
```

  - The result is a hierarchical configuration file, complete with curly brackets

```
[edit system]
user@host# show services
web-management {
    http {
        port 8080;
    }
}
```

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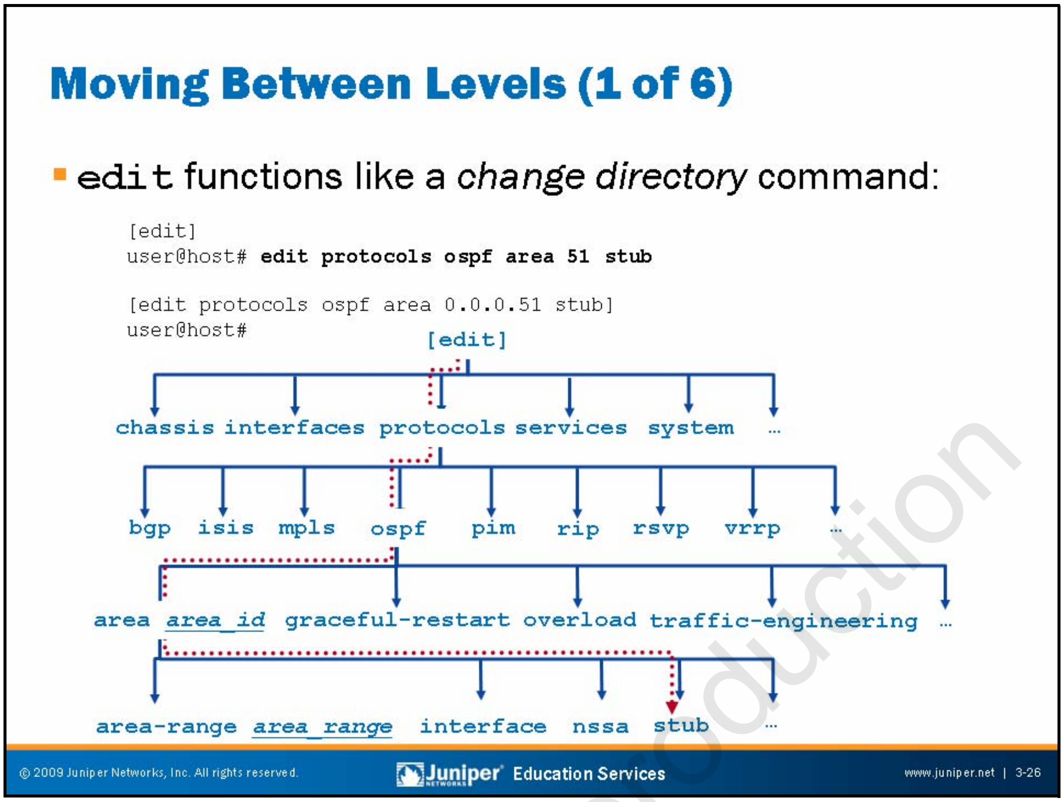
Hierarchical Configuration

Use **set** commands in the CLI configuration mode to modify the candidate configuration. Use the **show** command to display the candidate configuration. Both commands are relative to the current configuration hierarchy, shown by the `[edit]` prompt.

Configuration files use curly brackets (`{}`) and indentation to visually display the hierarchical structure of the configuration. Terminating—or leaf—statements in the configuration hierarchy are displayed with a trailing semicolon (`;`). You enter neither the curly brackets nor the semicolons as part of the **set** command.



Moving Between Levels (1 of 6)

- `edit` functions like a *change directory* command:

```
[edit]
user@host# edit protocols ospf area 51 stub

[edit protocols ospf area 0.0.0.51 stub]
user@host#
```

[edit]

chassis interfaces protocols services system …

bgp isis mpls ospf pim rip rsvp vrrp …

area *area_id* graceful-restart overload traffic-engineering …

area-range *area_range* interface nssa stub …

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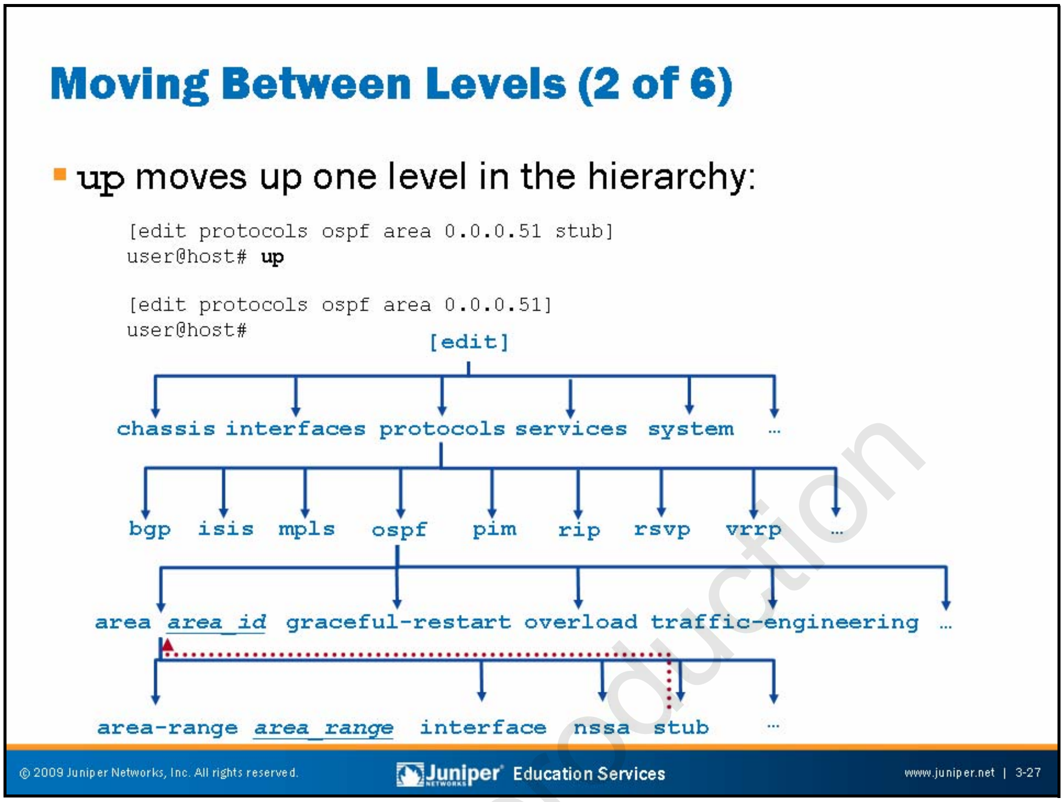
Moving Between Levels Is Like Changing Directories

To move down through an existing configuration statement hierarchy or to create a hierarchy and move down to that level, use the **`edit`** command, specifying your desired hierarchy level. After you issue an **`edit`** command, the configuration mode banner changes to indicate your current level in the hierarchy.



Moving Between Levels (2 of 6)

- up moves up one level in the hierarchy:

```
[edit protocols ospf area 0.0.0.51 stub]
user@host# up

[edit protocols ospf area 0.0.0.51]
user@host#
```

[edit]

chassis interfaces protocols services system …

bgp isis mpls ospf pim rip rsvp vrrp …

area *area_id* graceful-restart overload traffic-engineering …

area-range *area_range* interface nssa stub …

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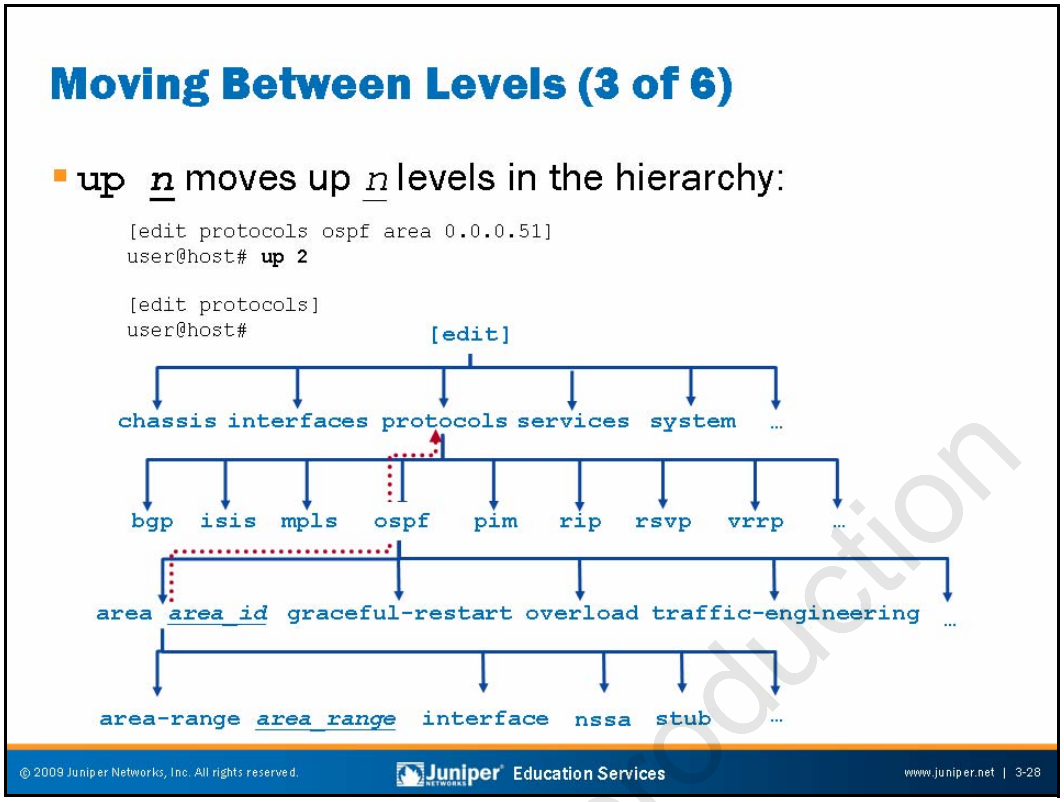
Moving Up One Level

To move up one level from the current position in the hierarchy, use the **up** command.



Moving Between Levels (3 of 6)

- **up** *n* moves up *n* levels in the hierarchy:

```
[edit protocols ospf area 0.0.0.51]
user@host# up 2

[edit protocols]
user@host#
```

[edit]
chassis interfaces protocols services system …
bgp isis mpls ospf pim rip rsvp vrrp …
area area_id graceful-restart overload traffic-engineering …
area-range area_range interface nssa stub …

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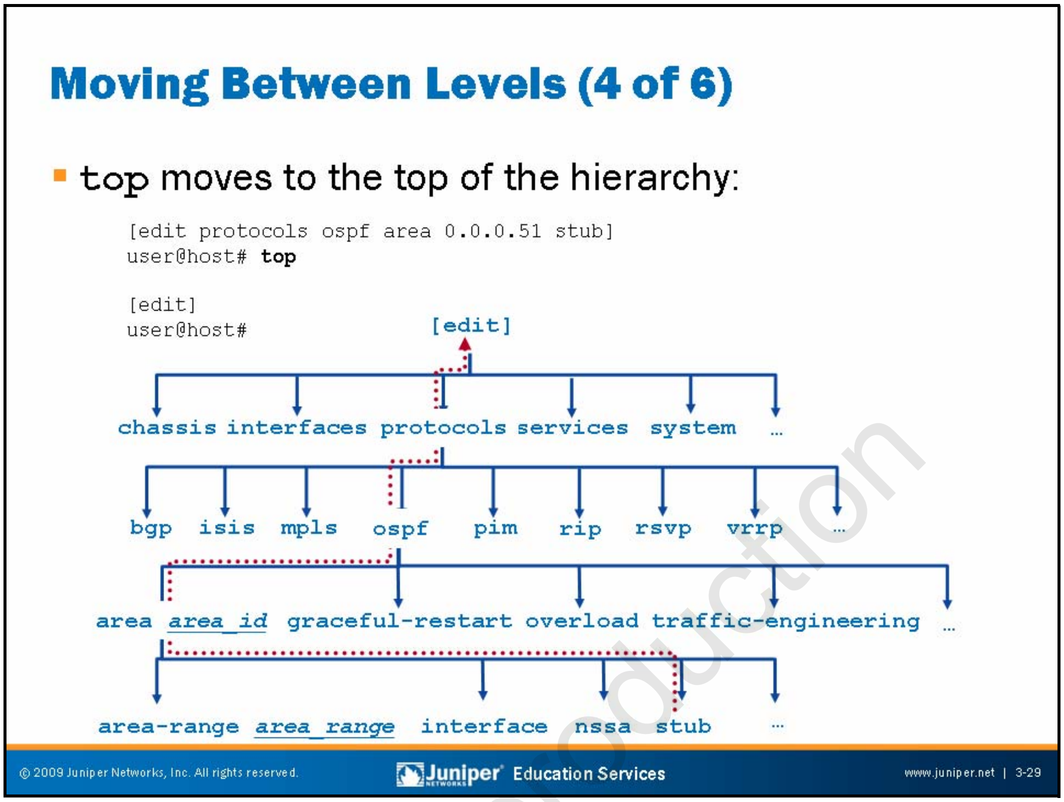
Moving Up More Than One Level

To move up more than one level from the current position in the hierarchy, supply an optional count to the **up** command. The software moves you up the specified number of levels or to the top of the hierarchy if there are fewer levels than specified.



Moving Between Levels (4 of 6)

- top moves to the top of the hierarchy:

```
[edit protocols ospf area 0.0.0.51 stub]
user@host# top

[edit]
user@host#
```

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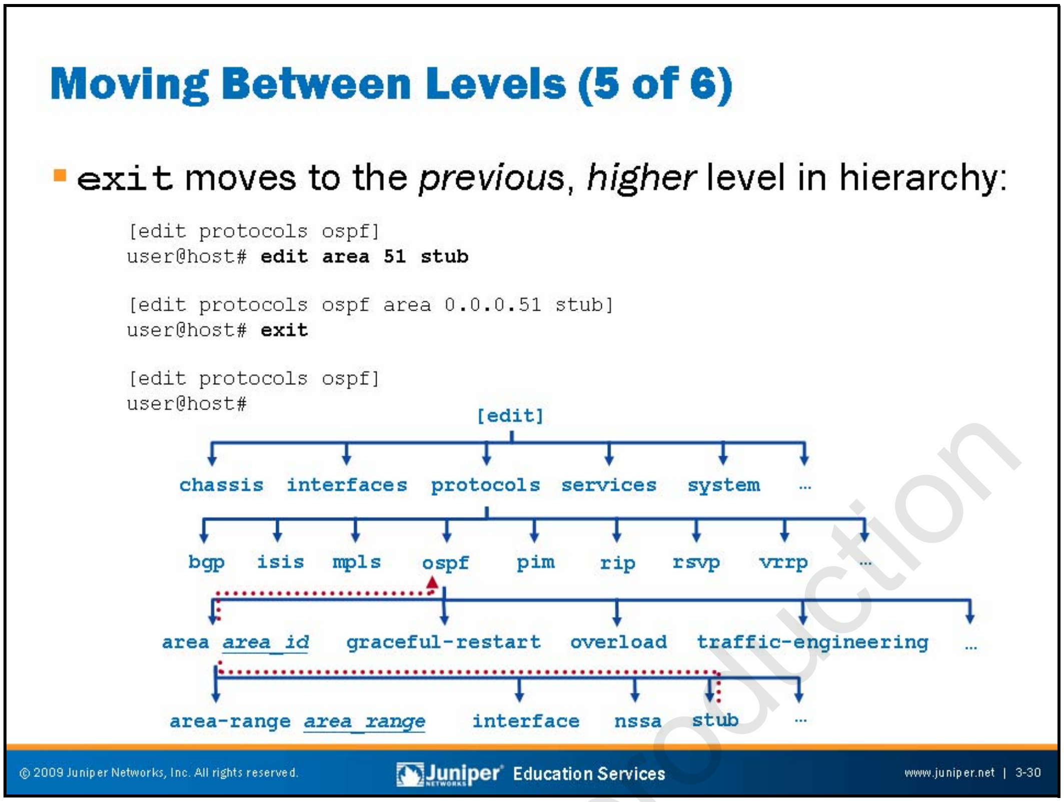
Take Me to the Top

The **top** command quickly moves you to the top of the configuration hierarchy. You can combine **top** with **edit** to move quickly to a different hierarchy or with **show** to display the configuration details for a different hierarchy, as in the following example:

```
[edit protocols ospf area 0.0.0.0 interface ge-0/0/0.0]
user@host# top edit system login

[edit system login]
user@host# top show system services
ftp;
ssh;
```



Moving Between Levels (5 of 6)

- `exit` moves to the *previous*, *higher* level in hierarchy:

```
[edit protocols ospf]
user@host# edit area 51 stub

[edit protocols ospf area 0.0.0.51 stub]
user@host# exit

[edit protocols ospf]
user@host#
```

[edit]

chassis interfaces protocols services system ...

bgp isis mpls ospf pim rip rsvp vrrp ...

area *area_id* graceful-restart overload traffic-engineering ...

area-range *area_range* interface nssa stub ...

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Back to Where I Was Before

As the example on the slide illustrates, the **`exit`** command returns the user to the most recent, higher level of the hierarchy. Entering **`exit`** at the top level of the hierarchy exits configuration mode, as follows:

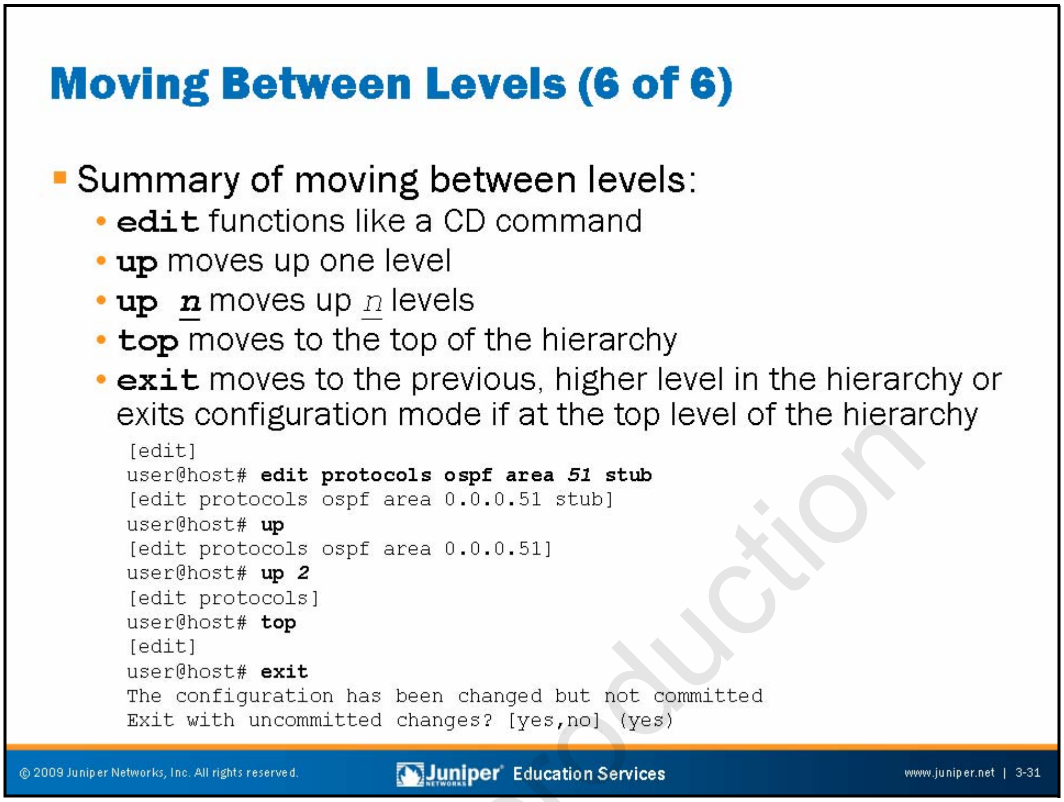
```
[edit]
user@host# exit
Exiting configuration mode

user@host>
```

Entering **`exit configuration-mode`** from any level of the hierarchy also allows you to exit configuration mode, as in the following example:

```
[edit protocols ospf area 0.0.0.0 interface ge-0/0/0.0]
user@host# exit configuration-mode
Exiting configuration mode

user@host>
```



Moving Between Levels (6 of 6)

- Summary of moving between levels:
  - **edit** functions like a CD command
  - **up** moves up one level
  - **up *n*** moves up *n* levels
  - **top** moves to the top of the hierarchy
  - **exit** moves to the previous, higher level in the hierarchy or exits configuration mode if at the top level of the hierarchy

```
[edit]
user@host# edit protocols ospf area 51 stub
[edit protocols ospf area 0.0.0.51 stub]
user@host# up
[edit protocols ospf area 0.0.0.51]
user@host# up 2
[edit protocols]
user@host# top
[edit]
user@host# exit
The configuration has been changed but not committed
Exit with uncommitted changes? [yes,no] (yes)
```

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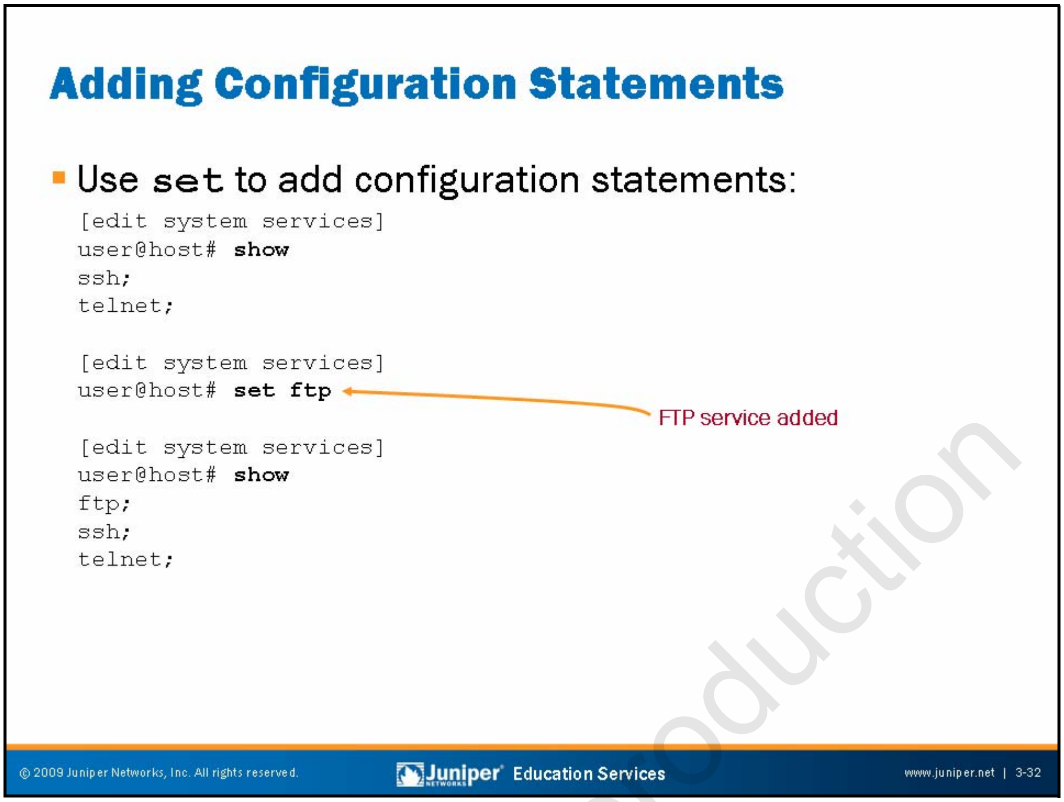
In Summary

You can quickly navigate between levels of the configuration hierarchy using the **edit**, **up**, **top**, and **exit** commands.



Adding Configuration Statements

- Use **set** to add configuration statements:

```
[edit system services]
user@host# show
ssh;
telnet;

[edit system services]
user@host# set ftp

[edit system services]
user@host# show
ftp;
ssh;
telnet;
```

FTP service added

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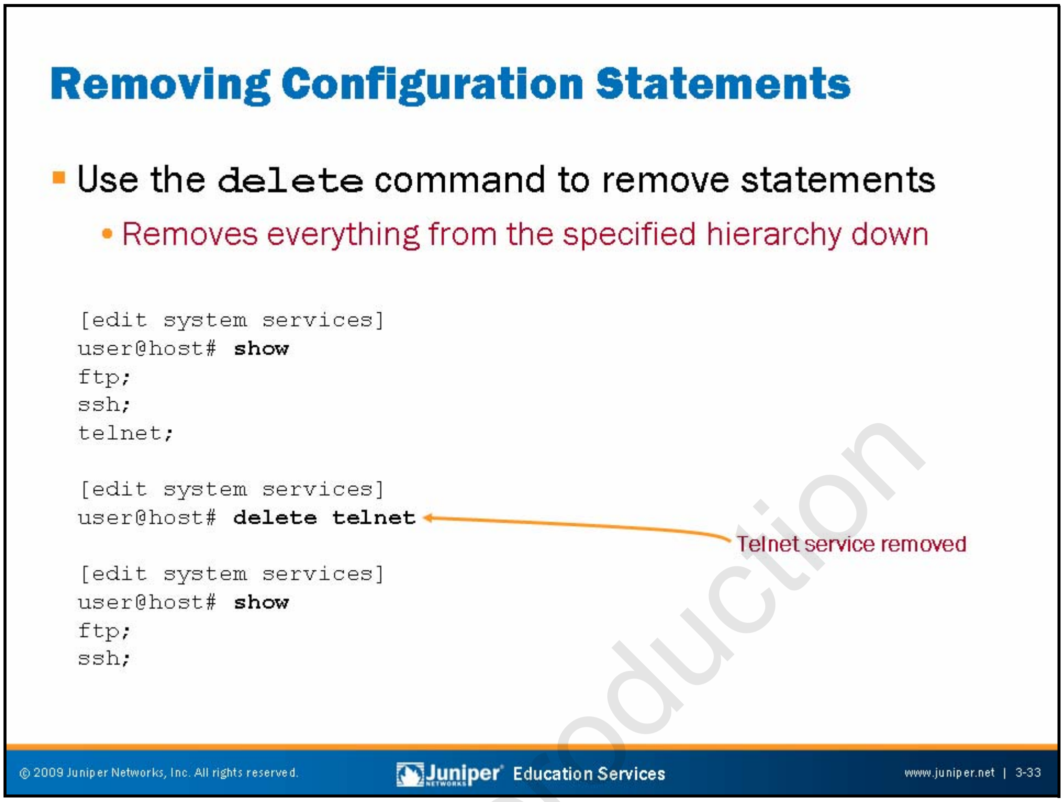
Adding Configuration Statements

Use **set** commands in the CLI configuration mode to modify the candidate configuration.



Removing Configuration Statements

- Use the `delete` command to remove statements
  - Removes everything from the specified hierarchy down

```
[edit system services]
user@host# show
ftp;
ssh;
telnet;

[edit system services]
user@host# delete telnet

[edit system services]
user@host# show
ftp;
ssh;
```

Telnet service removed

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Removing Configuration Statements

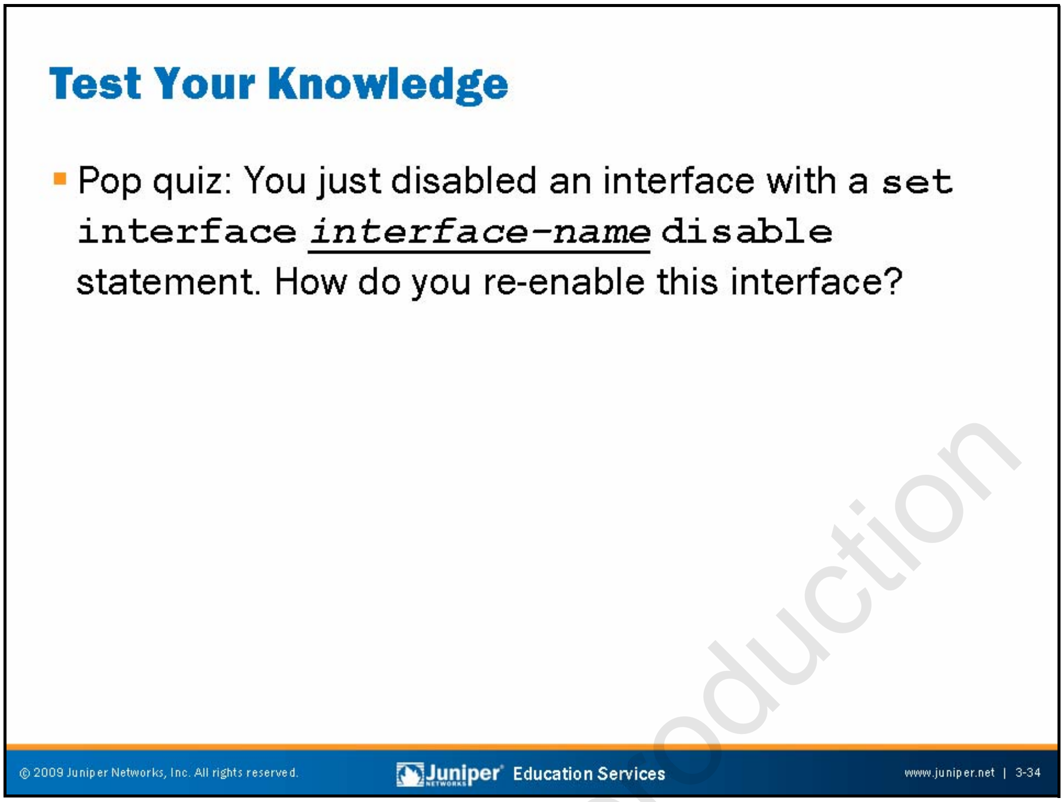
Use the configuration mode **`delete`** command to remove statements that you previously added to the configuration with a **`set`** command. This command deletes the statement and all its subordinate statements and identifiers. Deleting a statement or an identifier effectively unconfigures the functionality associated with that statement or identifier, returning that functionality to its default condition.

Consider using the **`wildcard delete`** function when deleting individual statements is too arduous and deleting an entire configuration subhierarchy lacks the granularity that you need. The following example shows sample syntax for a **`wildcard delete`**:

```
[edit]
user@host# wildcard delete interfaces ge-1/*
  matched: ge-1/0/0
  matched: ge-1/0/1
Delete 2 objects? [yes,no] (no) yes

[edit]
user@host#
```

In addition to deleting configuration statements, you should also consider the use of the **`deactivate`** command to cause the specified portion of the configuration hierarchy to be ignored while still retaining the original configuration. Issue an **`activate`** command to place the configuration back into effect. We provide an example of the **`deactivate`** and **`activate`** commands on a subsequent page.



Test Your Knowledge

- Pop quiz: You just disabled an interface with a `set interface` ***interface-name*** `disable` statement. How do you re-enable this interface?

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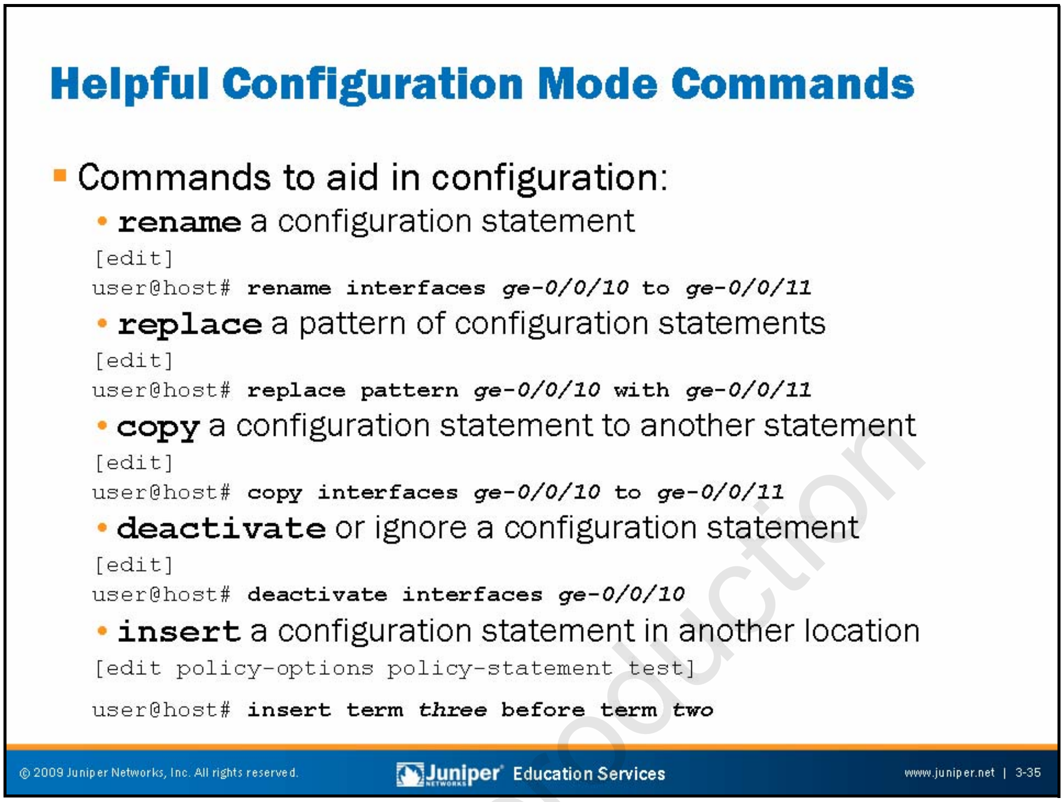
Pop Quiz!

Issue a **`delete interface`** ***interface-name*** **`disable`** command to delete the `disable` statement placed into effect with the referenced **`set`** command. Note that the double negative in this syntax is correct.



Helpful Configuration Mode Commands

- Commands to aid in configuration:
  - **rename** a configuration statement

```
[edit]
user@host# rename interfaces ge-0/0/10 to ge-0/0/11
```

  - **replace** a pattern of configuration statements

```
[edit]
user@host# replace pattern ge-0/0/10 with ge-0/0/11
```

  - **copy** a configuration statement to another statement

```
[edit]
user@host# copy interfaces ge-0/0/10 to ge-0/0/11
```

  - **deactivate** or ignore a configuration statement

```
[edit]
user@host# deactivate interfaces ge-0/0/10
```

  - **insert** a configuration statement in another location

```
[edit policy-options policy-statement test]
user@host# insert term three before term two
```

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Using Configuration Mode Efficiently

Using the configuration commands shown on the slide can increase efficiency. The following output illustrates the full list of configuration mode commands:

```
[edit]
user@host# ?
Possible completions:
  <[Enter]>            Execute this command
  activate             Remove the inactive tag from a statement
  annotate             Annotate the statement with a comment
  commit               Commit current set of changes
  copy                 Copy a statement
  deactivate           Add the inactive tag to a statement
  delete               Delete a data element
  edit                 Edit a sub-element
  exit                 Exit from this level
  extension            Extension operations
  help                 Provide help information
  insert               Insert a new ordered data element
  load                 Load configuration from ASCII file
  quit                 Quit from this level
```

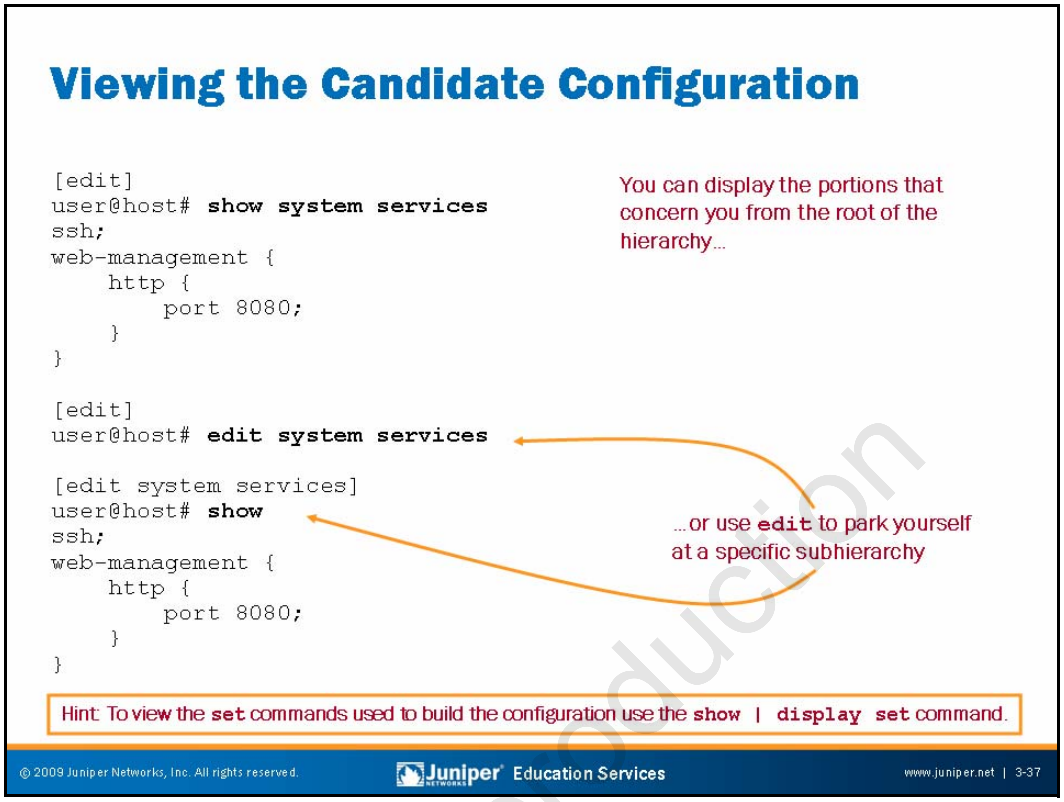
Continued on next page.

Using Configuration Mode Efficiently (contd.)

```
  rename                Rename a statement
  replace               Replace character string in configuration
  rollback              Roll back to previous committed configuration
  run                   Run an operational-mode command
  save                  Save configuration to ASCII file
  set                   Set a parameter
  show                  Show a parameter
  status                Show users currently editing configuration
  top                   Exit to top level of configuration
  up                    Exit one level of configuration
  wildcard              Wildcard operations
[edit]
user@host#
```

Regardless of the method and commands you use to update your configuration file, you must issue the **commit** command to activate changes. The following example shows the **deactivate**, **activate**, and **commit** commands and their output:

```
[edit]
user@host# deactivate interfaces ge-0/0/0

[edit]
user@host# commit
commit complete

[edit]
user@host# show interfaces ge-0/0/0
##
## inactive: interfaces ge-0/0/0
##
unit 0 {
    family inet {
        address 10.210.11.177/28;
    }
    family inet6;
}

[edit]
user@host# activate interfaces ge-0/0/0

[edit]
user@host# commit
commit complete

[edit]
user@host# show interfaces ge-0/0/0
unit 0 {
    family inet {
        address 10.210.11.177/28;
    }
    family inet6;
}
```



Viewing the Candidate Configuration

```
[edit]
user@host# show system services
ssh;
web-management {
    http {
        port 8080;
    }
}

[edit]
user@host# edit system services

[edit system services]
user@host# show
ssh;
web-management {
    http {
        port 8080;
    }
}
```

You can display the portions that concern you from the root of the hierarchy...

...or use **edit** to park yourself at a specific subhierarchy

Hint: To view the **set** commands used to build the configuration use the **show | display set** command.

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Viewing the Candidate Configuration

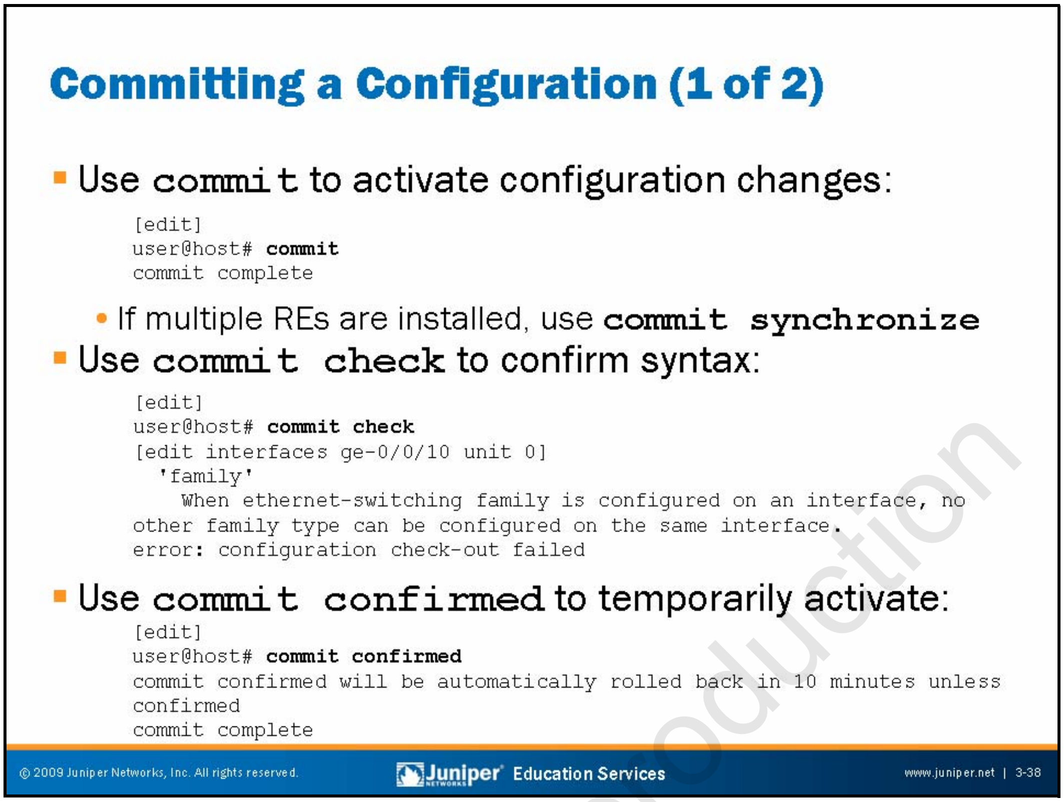
Use the configuration mode **show** command to display the candidate configuration. This command displays the configuration at the current hierarchy level or at the specified level below the current location.

The **show** command has the following syntax: **show *statement-path***. When displaying the configuration, the CLI indents each subordinate hierarchy level, inserts curly brackets to indicate the beginning and end of each hierarchy level, and places a semicolon at the end of statements that are at the lowest level of the hierarchy. The display format is the same format you use when creating an ASCII configuration file and it is also the same format that the CLI uses when saving a configuration to an ASCII file.

In cases where an empty statement leads to an invalid configuration because it is incomplete or meaningless, the **show** command does not display any of the statement path.

You can display the individual set commands used to create the existing configuration file using the **show | display set** command. The following is an example of this command and its resulting output:

```
[edit]
user@host# show system services | display set
set system services ssh
set system services web-management http port 8080
```



Committing a Configuration (1 of 2)

- Use `commit` to activate configuration changes:

```
[edit]
user@host# commit
commit complete
```

  - If multiple REs are installed, use **commit synchronize**

- Use `commit check` to confirm syntax:

```
[edit]
user@host# commit check
[edit interfaces ge-0/0/10 unit 0]
  'family'
    When ethernet-switching family is configured on an interface, no
other family type can be configured on the same interface.
error: configuration check-out failed
```

- Use `commit confirmed` to temporarily activate:

```
[edit]
user@host# commit confirmed
commit confirmed will be automatically rolled back in 10 minutes unless
confirmed
commit complete
```

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Remember to Commit

Remember, JUNOS devices do not automatically apply your configuration changes. You must use the **commit** command to activate your candidate configuration. You can typically perform the commit operation from any hierarchy level. The exception is when users enter configuration mode using the **configure private** option, which requires the **commit** command to be issued at the top hierarchy level.

On devices with redundant routing engines, you can perform a **commit synchronize**, which activates and synchronizes the configuration on both routing engines, as shown in the following capture:

```
{master:0}[edit]
user@host# commit s?
Possible completions:
  synchronize          Synchronize commit on both Routing Engines
```

Alternatively, you can configure the system to automatically perform the synchronize operation when a standard **commit** is issued through the **set system commit synchronize** command.

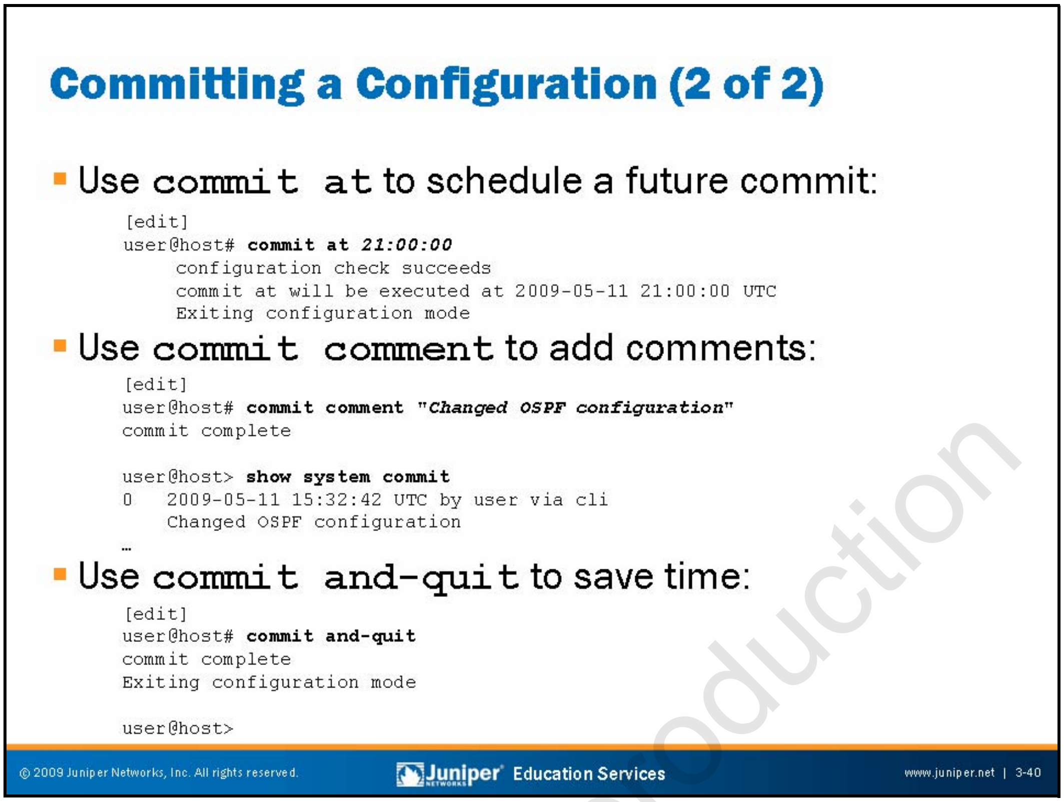
Checking Configuration Syntax

When you commit a candidate configuration, the software activates the entire configuration in its current form. Use the **commit check** command to validate the syntax of a candidate configuration without actually placing it into effect.

Continued on next page.

Remote Configuration Is Risky

Of course, **`commit check`** cannot catch logical errors in your configuration. What happens when you are configuring a device remotely and make a mistake that leaves that device inaccessible to remote connections? You can solve this scenario by using the **`commit confirmed`** command. When you issue a **`commit confirmed`** ***time-out*** command, the system starts a timer, during which time it expects to see another **`commit`**. If a second **`commit`** does not occur within the time-out value specified (the software supports a range of 1 to 65,535 minutes, with 10 minutes being the default), the system performs a **`rollback`** ***1***, **`commit`** sequence on your behalf. After the automatic rollback, you can load the `rollback 1` file to look for your mistake. We discuss the **`rollback`** command and operation in detail later in this chapter.



Committing a Configuration (2 of 2)

- Use `commit at` to schedule a future commit:

```
[edit]
user@host# commit at 21:00:00
    configuration check succeeds
    commit at will be executed at 2009-05-11 21:00:00 UTC
    Exiting configuration mode
```

- Use `commit comment` to add comments:

```
[edit]
user@host# commit comment "Changed OSPF configuration"
commit complete

user@host> show system commit
0   2009-05-11 15:32:42 UTC by user via cli
    Changed OSPF configuration
…
```

- Use `commit and-quit` to save time:

```
[edit]
user@host# commit and-quit
commit complete
Exiting configuration mode

user@host>
```

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Scheduled Commits

You can also schedule a commit that occurs at a specific time using the **`commit at`** ***`time`*** command. To view and clear pending commits, use the **`show system commit`** and **`clear system commit`** commands:

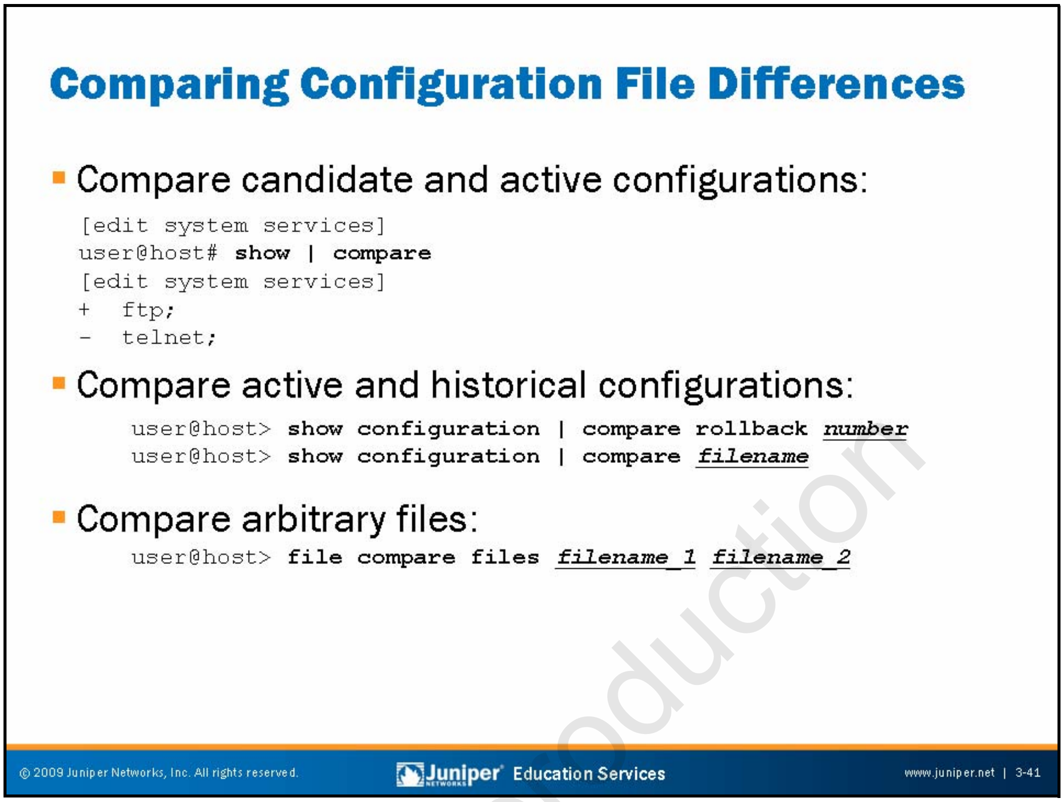
```
user@host> show system commit
commit requested by user via cli at 2009-05-11 21:00:00 UTC
0   2009-05-11 15:32:42 UTC by user via cli
...

user@host> clear system commit
Pending commit cleared
```

Adding a Log Entry to Your Commit

You can also add a log entry to your commit using the **`commit comment`** *“`comment-string`”* option. As illustrated on the slide, these logs are visible in the output of the **`show system commit`** command.

Exiting Configuration Mode

You can add the **`and-quit`** option to the **`commit`** command to activate your changes and exit configuration mode in a single step.



Comparing Configuration File Differences

- Compare candidate and active configurations:

```
[edit system services]
user@host# show | compare
[edit system services]
+   ftp;
-   telnet;
```

- Compare active and historical configurations:

```
    user@host> show configuration | compare rollback number
    user@host> show configuration | compare filename
```

- Compare arbitrary files:

```
    user@host> file compare files filename_1 filename_2
```

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Viewing Differences

Using **show | compare** displays the differences between the candidate configuration and the active configuration, also known as `rollback 0`. Configuration comparison is patch-like. Thus, instead of showing the entire configuration, the display shows only the actual changes.

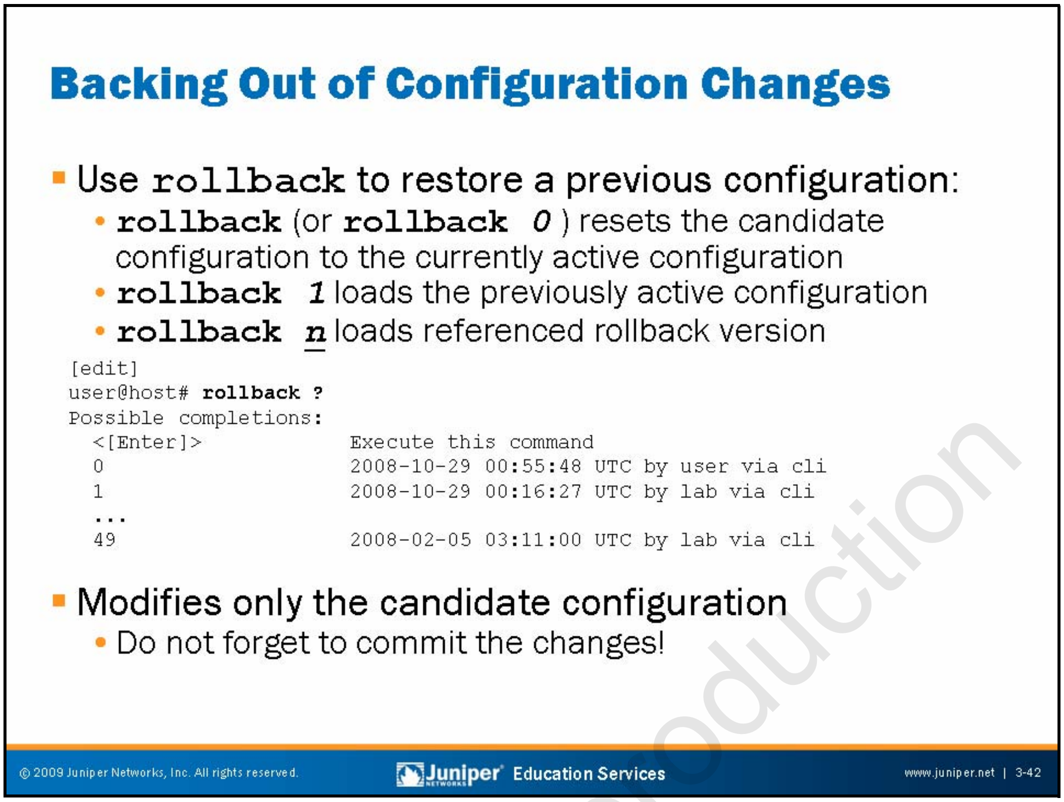
Comparing Active and Rollback Configurations

Using the operational mode **show configuration | compare rollback *number*** command, as shown on the slide, allows you to view differences between the active configuration and the rollback configurations. The JUNOS Software can store up to forty-nine additional rollback configurations in addition to `rollback 0`, which is the active configuration.

Similarly, the **show configuration | compare *filename*** command allows you to compare the active configuration to an arbitrary file. You can also use **show | compare rollback *number*** and **show | compare *filename*** in configuration mode to compare the candidate configuration with rollback configurations and arbitrary files, respectively.

Viewing Differences in Other Files

The operational mode **file compare files** command allows you to view differences between any two text files, including log files. The output of this command is in the same patch-like format as the **show | compare** command.



Backing Out of Configuration Changes

- Use `rollback` to restore a previous configuration:
  - **`rollback`** (or **`rollback`** *0*) resets the candidate configuration to the currently active configuration
  - **`rollback`** *1* loads the previously active configuration
  - **`rollback`** *n* loads referenced rollback version

```
[edit]
user@host# rollback ?
Possible completions:
  <[Enter]>            Execute this command
  0                    2008-10-29 00:55:48 UTC by user via cli
  1                    2008-10-29 00:16:27 UTC by lab via cli
  ...
  49                   2008-02-05 03:11:00 UTC by lab via cli
```

- Modifies only the candidate configuration
  - Do not forget to commit the changes!

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Restoring a Previous Configuration

The software saves the last 50 committed versions of the configuration. To overwrite the candidate configuration with one of these previously committed versions, use the CLI configuration **`rollback`** command. By default, the system returns to the most recently committed configuration—the active configuration.

To return to a version prior to the configuration most recently committed, include the version number in the **`rollback`** command.

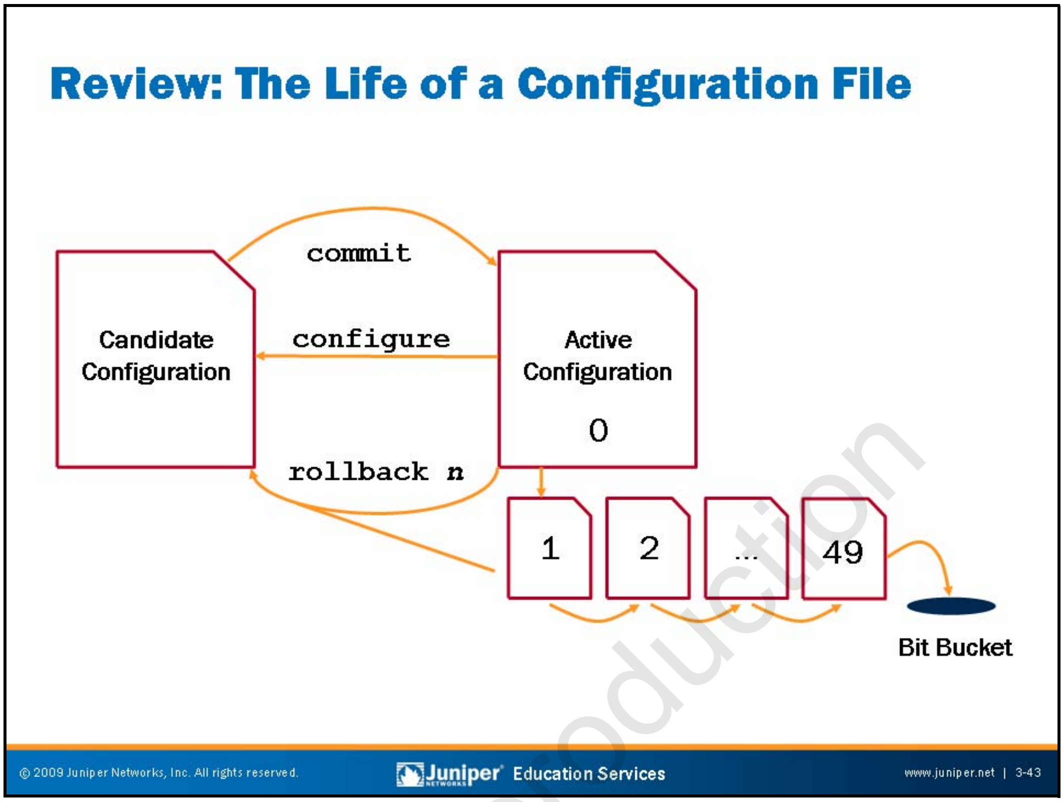
The ***`version`*** argument can be a number in the range 0 through 49. The most recently saved configuration is version 0, which is the active configuration. The oldest committed configuration the software automatically saves is version 49.

The factory-default configuration on some of the smaller JUNOS devices restricts the number of rollback files stored by the system. This default setting can be changed to increase the number of rollback files as shown in the following capture:

```
[edit system]
user@host# set max-configurations-on-flash ?
Possible completions:
  <max-configurations-on-flash>  Number of configuration files stored on flash
```

You Must Commit

The **`rollback`** command modifies only the candidate configuration. To activate the changes loaded through the rollback operation, issue the **`commit`** command.



Review: The Life of a Configuration File

Candidate Configuration

commit

configure

rollback *n*

Active Configuration

0

1

2

...

49

Bit Bucket

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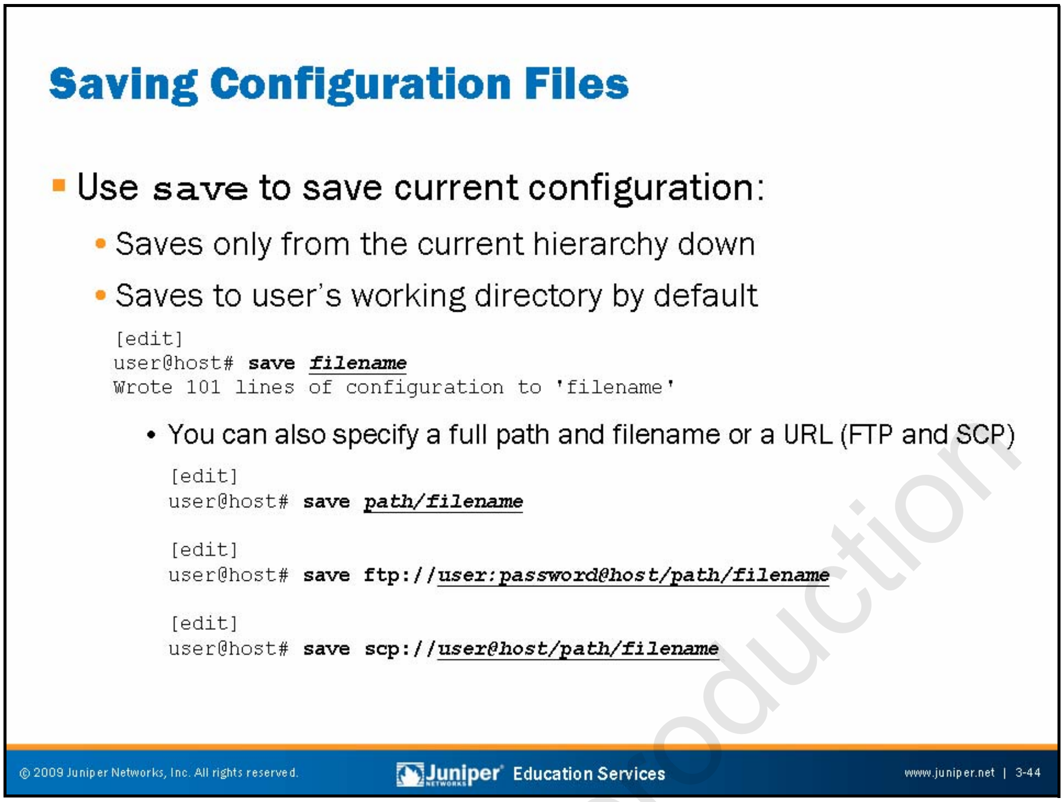
The Life of a Configuration File: A Review

As discussed on the previous slides, the **`configure`** command causes a candidate configuration to be created and populated with the contents of the active configuration. You can then modify the candidate configuration with your changes.

To have a candidate configuration take effect, you must commit the changes. At this time, JUNOS Software checks the candidate configuration for proper syntax and it installs it as the active configuration. If the syntax is not correct, an error message indicates the location of the error, and the software does not activate any part of the configuration. You must correct the errors before recommitting the configuration.

You can easily recover previous configurations with a **`rollback`** ***n*** command. JUNOS Software maintains a configuration history by storing previously active configurations. The software saves a maximum of 50 configurations. This number includes the current active configuration, which is also known as `rollback 0`, and up to 49 previously active configurations. If you perform a rollback operation, keep in mind that the related configuration does not become active until you issue a **`commit`** command. When you issue a **`commit`** command and there are 50 rollback configurations, the software purges the last rollback configuration—rollback 49.



Saving Configuration Files

- Use **save** to save current configuration:
  - Saves only from the current hierarchy down
  - Saves to user's working directory by default

```
[edit]
user@host# save filename
Wrote 101 lines of configuration to 'filename'
```

- You can also specify a full path and filename or a URL (FTP and SCP)

```
[edit]
user@host# save path/filename

[edit]
user@host# save ftp://user:password@host/path/filename

[edit]
user@host# save scp://user@host/path/filename
```

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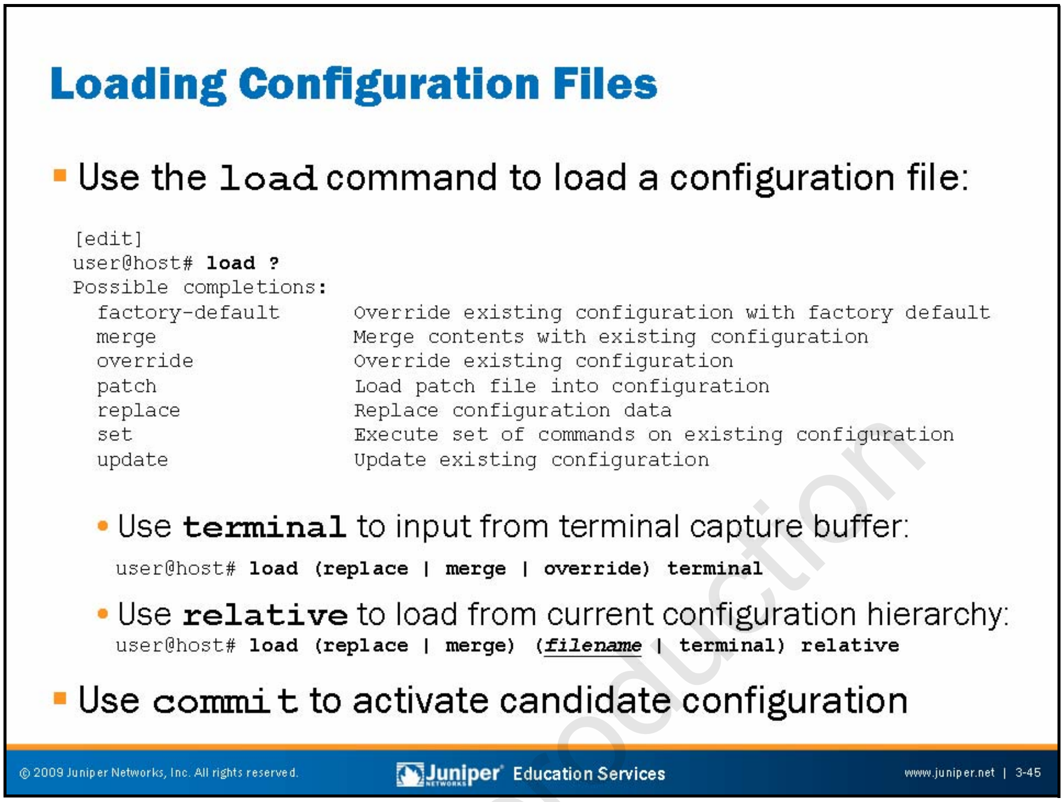
Saving Configuration Files

You can save the candidate configuration from your current configuration session to an ASCII file using the **save** command. Saving a candidate configuration saves the configuration in its current form, including any uncommitted changes.

Note that you are saving only the configuration statements at the current hierarchy level and below. To save the entire candidate configuration, you must be at the top level of the configuration hierarchy. If you do not specify a path, JUNOS Software saves the configuration to the user's working directory. As an example, if user nancy saved a configuration file without specifying a path name, the configuration file would be saved in the `/var/home/nancy` directory by default.

You can specify a filename in one of the following ways:

- *`filename`* or *`path/filename`*.
- `ftp://`*`user:password@host/path/filename`*: Puts the file in the location explicitly described by this URL using the FTP protocol. Substituting the word "prompt" for the password causes the FTP server to prompt you for the user's password.
- `scp://`*`user@host/path/filename`*: Puts the file on a remote system using the SSH protocol. The software prompts you for the user's password.



Loading Configuration Files

- Use the `load` command to load a configuration file:

```
[edit]
user@host# load ?
Possible completions:
  factory-default       Override existing configuration with factory default
  merge                 Merge contents with existing configuration
  override              Override existing configuration
  patch                 Load patch file into configuration
  replace               Replace configuration data
  set                   Execute set of commands on existing configuration
  update                Update existing configuration
```

  - Use **`terminal`** to input from terminal capture buffer:

```
user@host# load (replace | merge | override) terminal
```

  - Use **`relative`** to load from current configuration hierarchy:

```
user@host# load (replace | merge) (filename | terminal) relative
```

- Use `commit` to activate candidate configuration

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Loading Configuration Files

You can use the configuration mode **`load`** command to load a complete or partial configuration from a local file, from a file on a remote machine, or from a terminal emulation program’s capture buffer. The **`load`** command supports several arguments that determine the specifics of the operation.

The following list provides details for some of the arguments to the **`load`** command:

- **`factory-default`**: Replaces the full current configuration with the factory-default configuration.
- **`merge`**: Combines the current configuration with the configuration you load.
- **`override`**: Completely overwrites the current configuration with the configuration you load. You must perform override operations at the root of the configuration hierarchy.
- **`patch`**: Adds or deletes variables from the configuration based on the contents of a specified patch file. The patch file used in this operation uses the contextual diff format. The file generated from a **`show | compare | save`** operation creates such a file.
- **`replace`**: Looks for a replace tag in the configuration you load. The software replaces existing statements of the same name with those in the loaded configuration for stanzas marked with the `replace` tag.

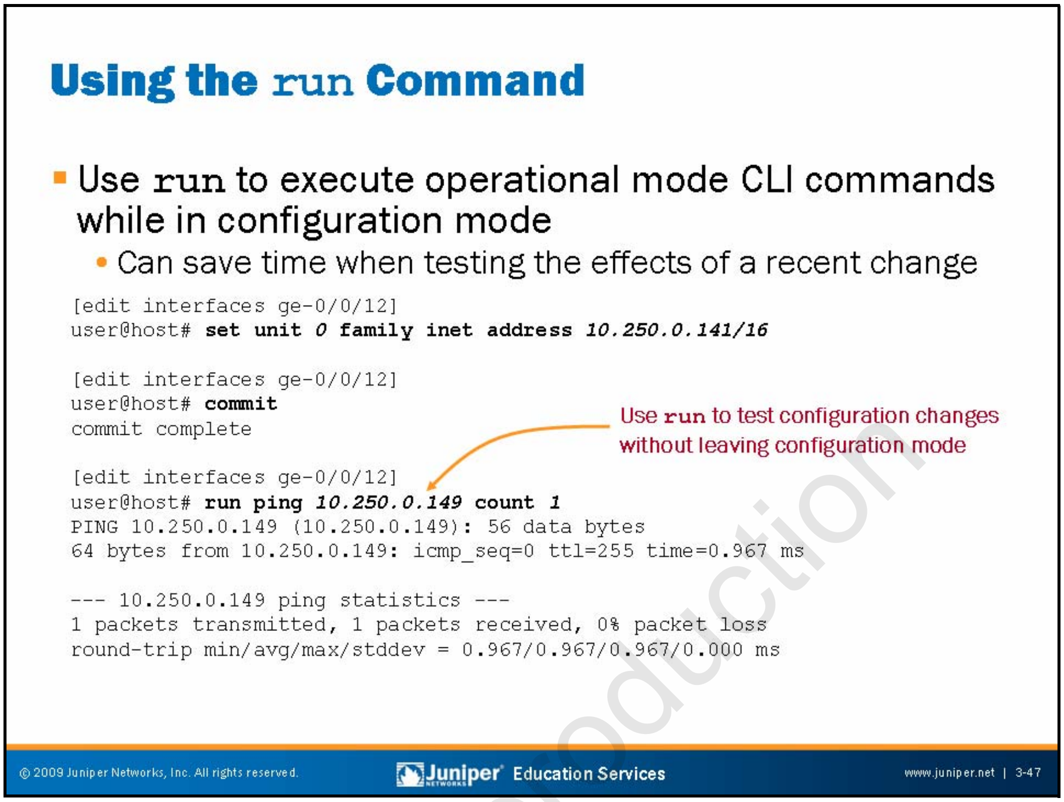
Continued on next page.

Loading Configuration Files (contd.)

- **`set`**: Allows users to load **`set`** commands from the terminal or from a saved file that consists of **`set`** configuration statements.
- **`update`**: Updates the existing configuration with the configuration you load. When the **`update`** option is used, the JUNOS Software attempts to notify only those processes affected by the configuration changes. When the **`override`** option is used, JUNOS Software makes no such attempt. You can use the **`update`** option from any hierarchy while you can use the **`override`** option only from the top level hierarchy.
- **`terminal`**: Uses the text you type at the terminal as input to the configuration. Type Ctrl+d to end terminal input. This option is usually used in conjunction with a terminal emulation program's copy and paste functionality to copy and paste configuration data from one system to another.
- **`relative`**: Normally, a **`load merge`** or **`load replace`** operation requires that the data you load contains a full path to the related configuration hierarchy. The **`relative`** option negates this need by telling the device to add the data you load *relative* to the current configuration hierarchy.

`commit` Activates Candidate Configuration

In all cases, after the **`load`** operation is complete, you must issue a **`commit`** to activate the changes made to the configuration.



Using the run Command

- Use run to execute operational mode CLI commands while in configuration mode
  - Can save time when testing the effects of a recent change

```
[edit interfaces ge-0/0/12]
user@host# set unit 0 family inet address 10.250.0.141/16

[edit interfaces ge-0/0/12]
user@host# commit
commit complete

[edit interfaces ge-0/0/12]
user@host# run ping 10.250.0.149 count 1
PING 10.250.0.149 (10.250.0.149): 56 data bytes
64 bytes from 10.250.0.149: icmp_seq=0 ttl=255 time=0.967 ms

--- 10.250.0.149 ping statistics ---
1 packets transmitted, 1 packets received, 0% packet loss
round-trip min/avg/max/stddev = 0.967/0.967/0.967/0.000 ms
```

Use run to test configuration changes without leaving configuration mode

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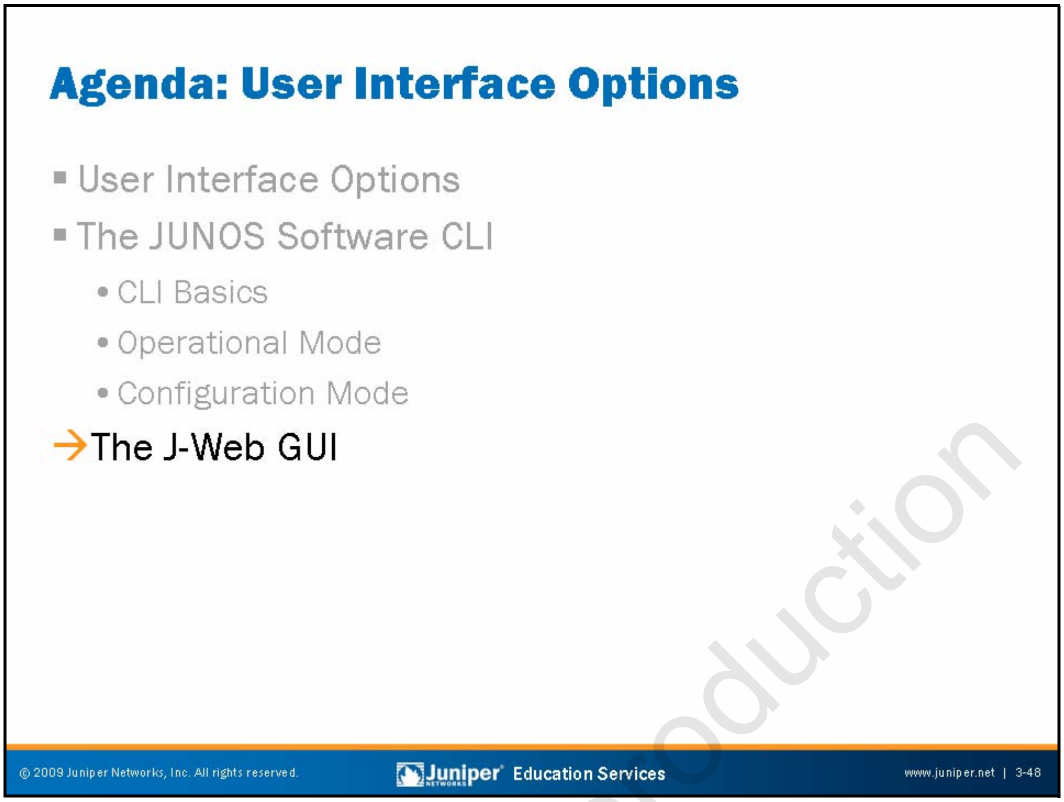
run Baby run

The **run** command allows you to execute operational mode commands while in configuration mode. It is similar to the **do** command on equipment from other vendors, but much more flexible. This extremely handy time-saver works for all operational mode commands and the software supports it at all configuration hierarchies. In the example on the slide, we are editing the configuration for the device's ge-0/0/12 interface. After assigning what we hope to be the correct IP address, we commit the change and invoke the **run** command to execute a quick ping test.



Agenda: User Interface Options

- User Interface Options
- The JUNOS Software CLI
  - CLI Basics
  - Operational Mode
  - Configuration Mode
- → The J-Web GUI

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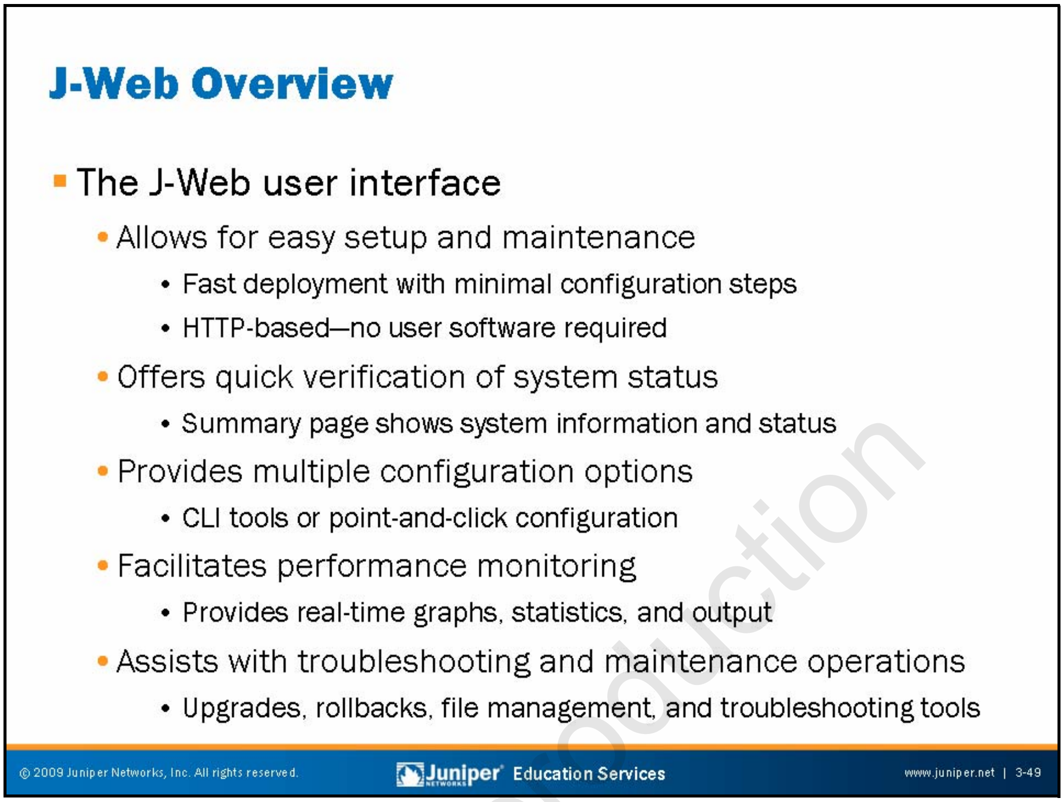
The J-Web GUI

The slide highlights the topic we discuss next.



J-Web Overview

- The J-Web user interface
  - Allows for easy setup and maintenance
    - Fast deployment with minimal configuration steps
    - HTTP-based—no user software required
  - Offers quick verification of system status
    - Summary page shows system information and status
  - Provides multiple configuration options
    - CLI tools or point-and-click configuration
  - Facilitates performance monitoring
    - Provides real-time graphs, statistics, and output
  - Assists with troubleshooting and maintenance operations
    - Upgrades, rollbacks, file management, and troubleshooting tools

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The J-Web User Interface

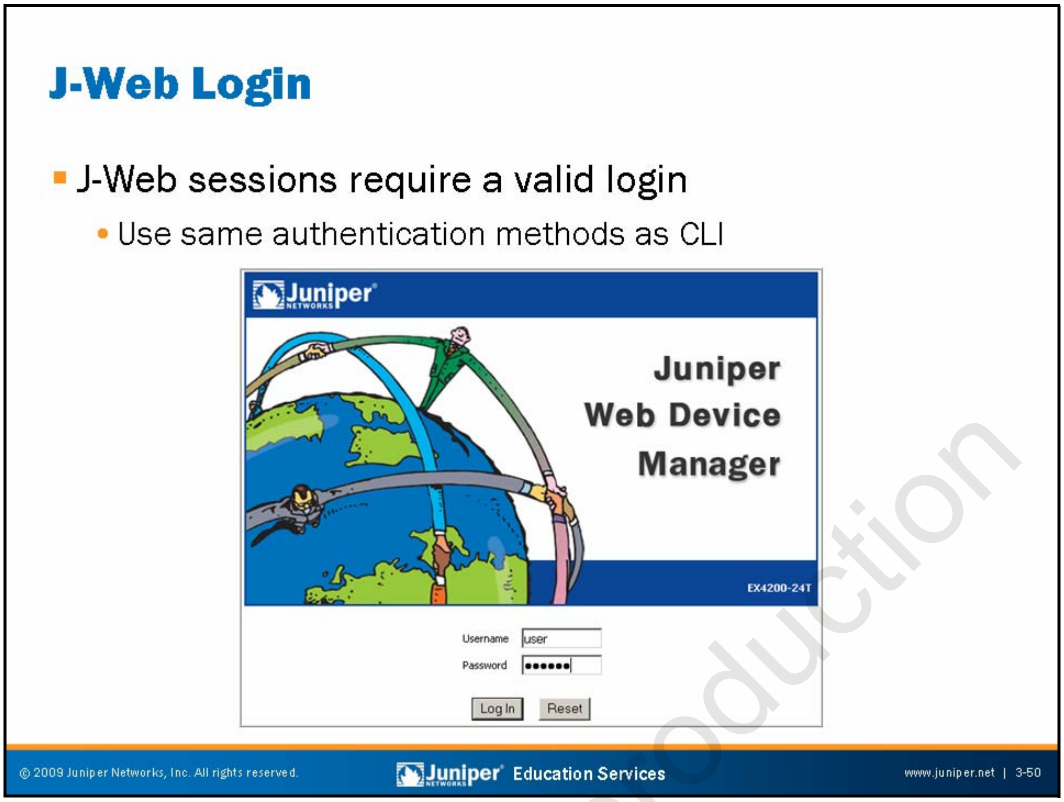
The J-Web makes initial deployment a snap. No client software is necessary other than a standard Web browser. After initial configuration, you can return to J-Web for system monitoring and maintenance.

When you log in to J-Web, you always start by viewing the J-Web `Dashboard`. The `Dashboard` provides a quick glance of system status, ports, alarms, and utilization information.

The `Configure` tab allows you to configure the system in a point-and-click fashion or by a direct edit of the configuration in text format. Help is available by clicking the question mark (?) next to the various configuration options.

You can also view the results of configuration changes, such as routing table entries. You can view most details related to the **show** commands of the CLI in J-Web using a point-and-click approach.

The `Troubleshoot` tab provides common network tools such as ping and traceroute to quickly assess network issues. You can use the `Maintain` tab to easily perform software upgrades and file system maintenance.



J-Web Login

- J-Web sessions require a valid login
  - Use same authentication methods as CLI

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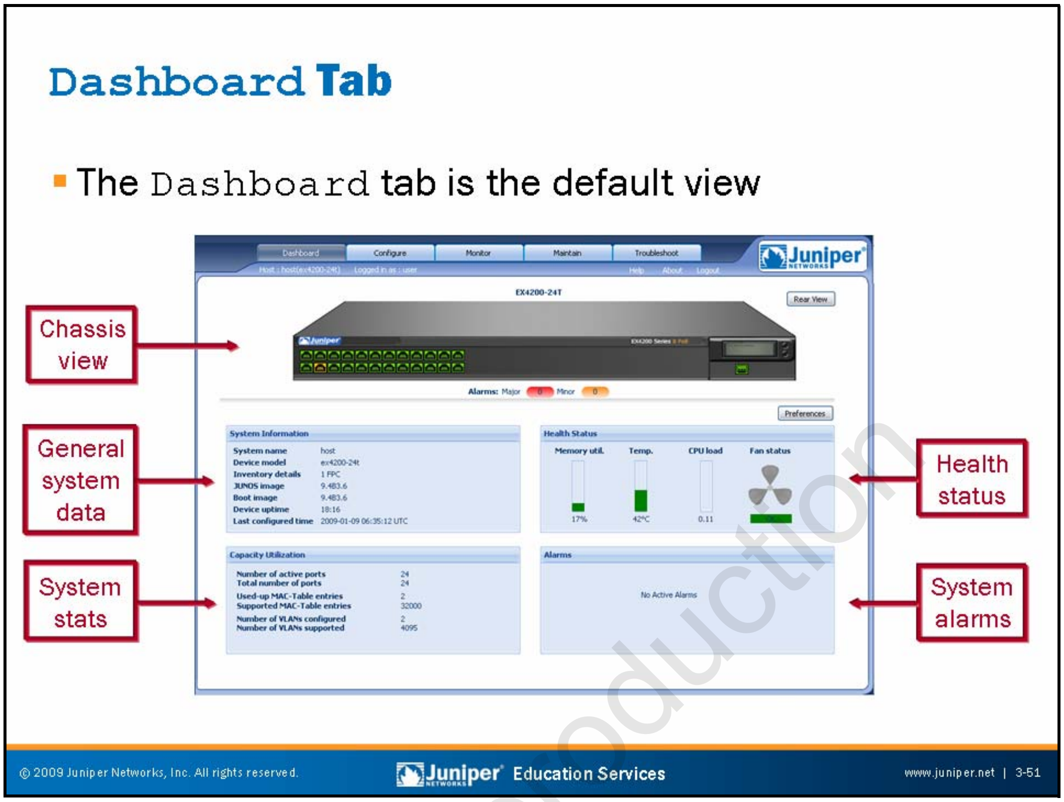
Logging In to J-Web

If you want remote access using J-Web, you must enable the HTTP or HTTPS service under the `[edit system services]` hierarchy level as shown:

```
[edit system]
user@host# show services
ssh;
telnet;
web-management {
    http;
}
```

If you configure HTTPS, you need to generate and install a local certificate for secure Web management.

Once you configure a device running JUNOS Software for access, you can log in using your Web browser. If you configured the system to use an external authentication mechanism such as a RADIUS server, J-Web will also use that mechanism for authentication. Otherwise, it uses the username and password configured on the local system.



Dashboard Tab

- The `Dashboard` tab is the default view

Chassis view

General system data

System stats

Health status

System alarms

System Information

System name	host
Device model	ex4200-24t
Inventory details	1 FPC
JUNOS image	9.4B3.6
Boot image	9.4B3.6
Device uptime	18:16
Last configured time	2009-01-09 06:35:12 UTC

Health Status

Memory util.	Temp.	CPU load	Fan status
17%	42°C	0.11	

Capacity Utilization

Number of active ports	24
Total number of ports	24
Used-up MAC-Table entries	2
Supported MAC-Table entries	32000
Number of VLANs configured	2
Number of VLANs supported	4095

Alarms

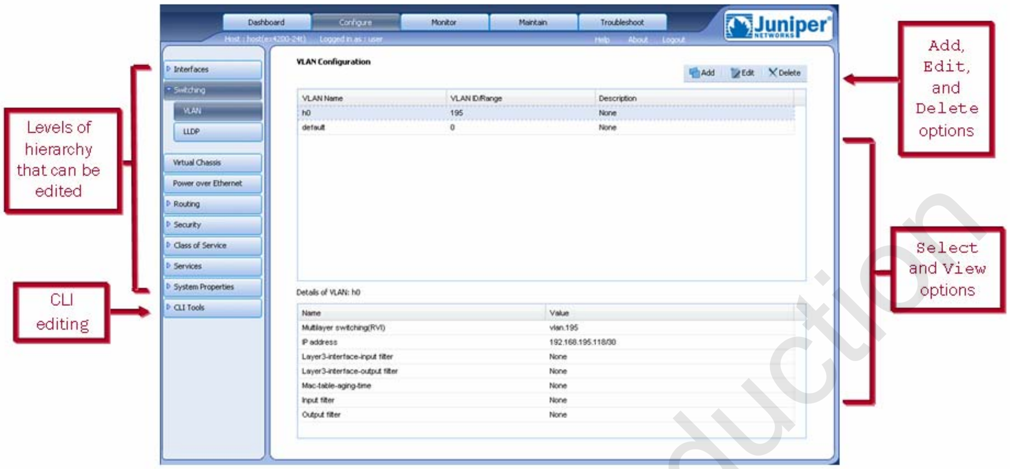
No Active Alarms

Quick Verification

J-Web's default tab is the `Dashboard` tab. The `Dashboard` provides a quick view of the system's current status along with other system-specific details.

Configure Tab

- Graphical configuration editing and viewing



VLAN Configuration

VLAN Name	VLAN ID/Range	Description
h0	195	None
default	0	None

Details of VLAN: h0

Name	Value
Multilayer switching(RVI)	vlan.195
IP address	192.168.195.118/30
Layer3-interface-input filter	None
Layer3-interface-output filter	None
Mac-table-aging-time	None
Input filter	None
Output filter	None

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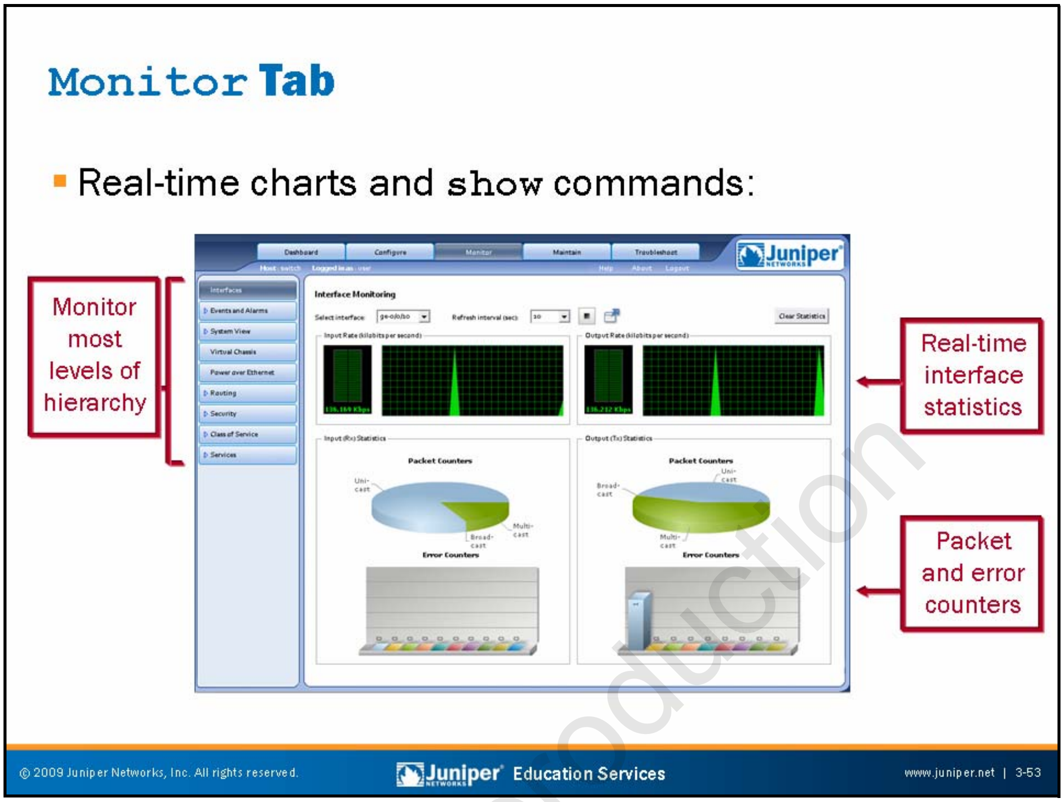
Performing Configuration Tasks with J-Web

J-Web offers an easy-to-use interface for configuring your device running JUNOS Software. Choose which configuration hierarchy you want to view or edit in the left navigation menu. Information about that hierarchy appears on the main portion of the screen. You can select various options for viewing or editing. You can add new configuration options with the Add button or edit existing configuration options with the Edit button. These buttons and a Delete button are located near the top right of the screen.

If you prefer to manipulate your configuration with a text-based approach, choose the CLI Tools option at the bottom of the navigation menu.



Monitor Tab

- Real-time charts and `show` commands:

Monitor most levels of hierarchy

Real-time interface statistics

Packet and error counters

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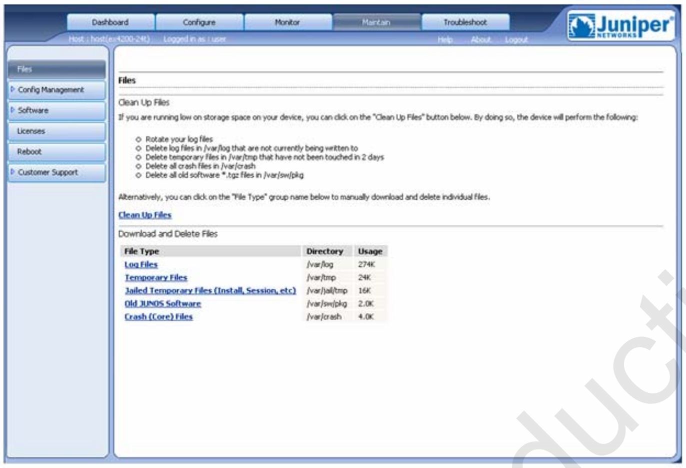
Performance Monitoring

On the `Monitor` tab, you can view detailed real-time statistics and the results of configuration-related activity. As seen on the slide, the `Interfaces` hierarchy provides statistics in a graphical fashion using colorful pie charts and graphs. Use the drop-down menus to customize your view. Hovering the mouse pointer over various parts of the screen presents you with more detailed information. Most of the hierarchies on the left side of the screen are carry-overs from the `Configure` tab. Selecting these options provides a point-and-click alternative over CLI **show** commands.

Maintain Tab

- Easy file and software management:



Files

Clean Up Files

If you are running low on storage space on your device, you can click on the "Clean Up Files" button below. By doing so, the device will perform the following:

- ○ Rotate your log files
- ○ Delete log files in /var/log that are not currently being written to
- ○ Delete temporary files in /var/tmp that have not been touched in 2 days
- ○ Delete all crash files in /var/crash
- ○ Delete all old software *.tgz files in /var/sw/pkg

Alternatively, you can click on the "File Type" group name below to manually download and delete individual files.

Clean Up Files

Download and Delete Files

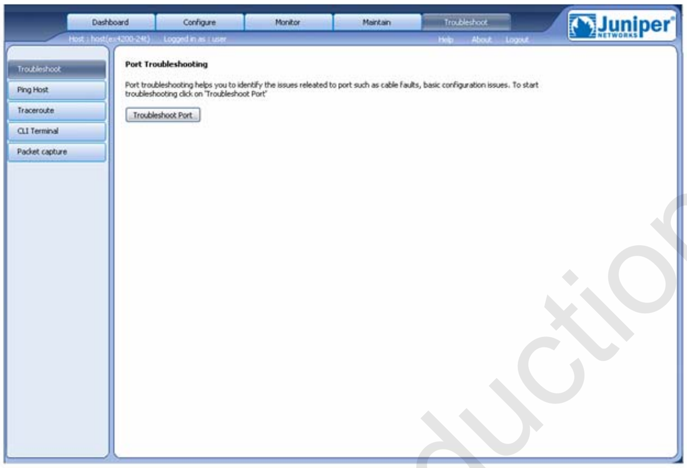
File Type	Directory	Usage
Log Files	/var/log	274K
Temporary Files	/var/tmp	24K
Jailed Temporary Files (Install, Session, etc)	/var/jail/tmp	16K
Old JUNOS Software	/var/sw/pkg	2.0K
Crash (Core) Files	/var/crash	4.0K

System Maintenance

The `Maintain` tab provides an interface to manage file systems, JUNOS Software, and configuration files. Under the `Files` section, you can download and delete log files, memory dump files, and other temporary files to keep your compact-flash device from becoming too full. `Config Management` allows you to retrieve historical configuration files and to compare differences between configurations. Choosing `Software` provides methods for upgrading and downgrading the JUNOS Software. You can automate the upgrade process by specifying a remote FTP server to retrieve the JUNOS Software. The system then upgrades with the retrieved software and issues a reboot of the system to complete the upgrade process. The `Licenses` section provides the details on installed licenses on the system, allowing you to add licenses. The `Reboot` section allows you to schedule reboots and provides other options for rebooting the system. `Customer Support` provides a quick method to register your device and retrieve support information required by Juniper Networks Technical Assistance Center (JTAC).

Troubleshoot Tab

- Port and network troubleshooting tools:



Port Troubleshooting

Port troubleshooting helps you to identify the issues releated to port such as cable faults, basic configuration issues. To start troubleshooting click on 'Troubleshoot Port'

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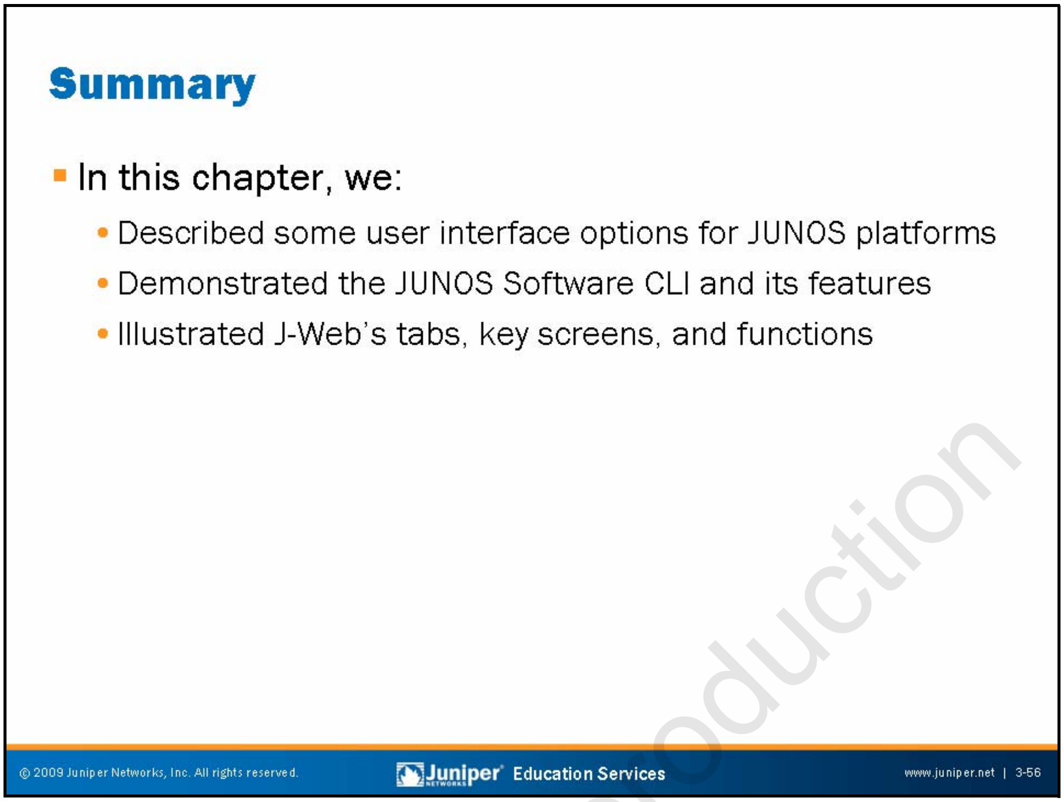
Troubleshooting Tools

The `Troubleshoot` tab offers several handy utilities that can ease your troubleshooting efforts. You can troubleshoot individual ports, ping a remote host, perform a traceroute, capture packet dumps, and even open an embedded Java-based terminal session to your system.



Summary

- In this chapter, we:
  - Described some user interface options for JUNOS platforms
  - Demonstrated the JUNOS Software CLI and its features
  - Illustrated J-Web's tabs, key screens, and functions

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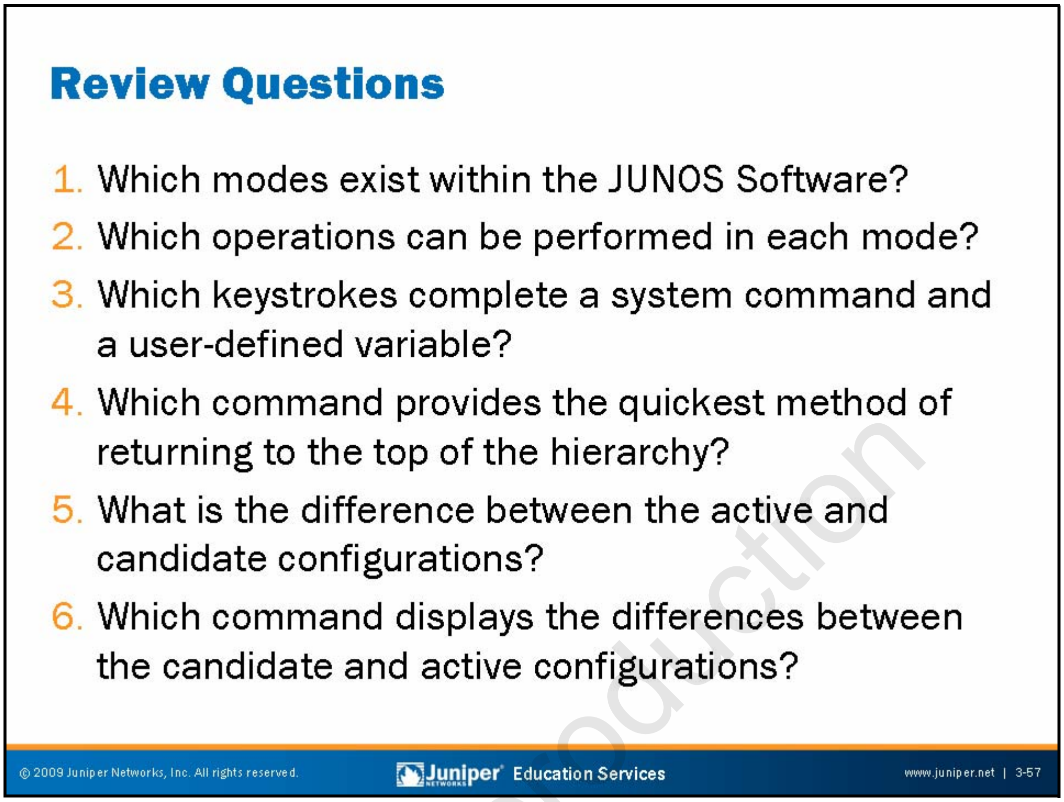
This Chapter Discussed:

- Common user interface options available for platforms running JUNOS Software;
- The JUNOS Software CLI and its related modes and features; and
- The J-Web GUI and its tabs, key screens, and functions.



Review Questions

1. Which modes exist within the JUNOS Software?
2. Which operations can be performed in each mode?
3. Which keystrokes complete a system command and a user-defined variable?
4. Which command provides the quickest method of returning to the top of the hierarchy?
5. What is the difference between the active and candidate configurations?
6. Which command displays the differences between the candidate and active configurations?

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Review Questions

1.

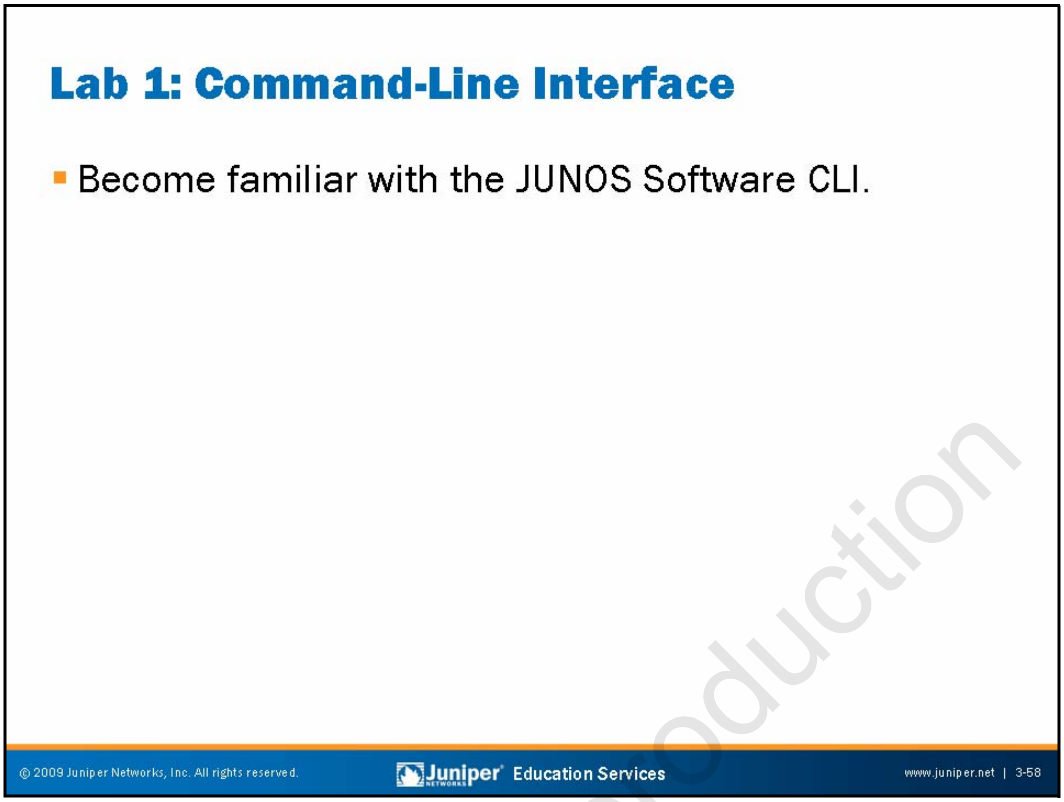
2.

3.

4.

5.

6.



Lab 1: Command-Line Interface

- Become familiar with the JUNOS Software CLI.

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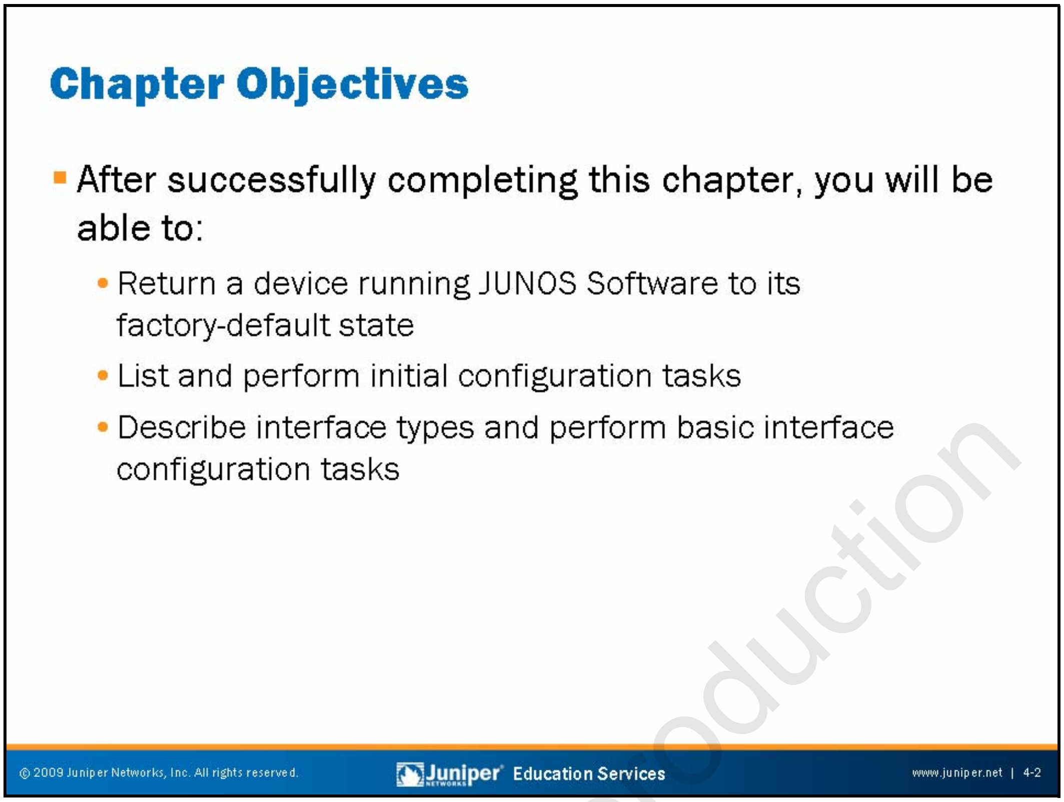
Lab 1: User Interface Options

The slide provides the objective for this lab.

Introduction to JUNOS Software

Chapter 4: Initial Configuration



Chapter Objectives

- After successfully completing this chapter, you will be able to:
  - Return a device running JUNOS Software to its factory-default state
  - List and perform initial configuration tasks
  - Describe interface types and perform basic interface configuration tasks

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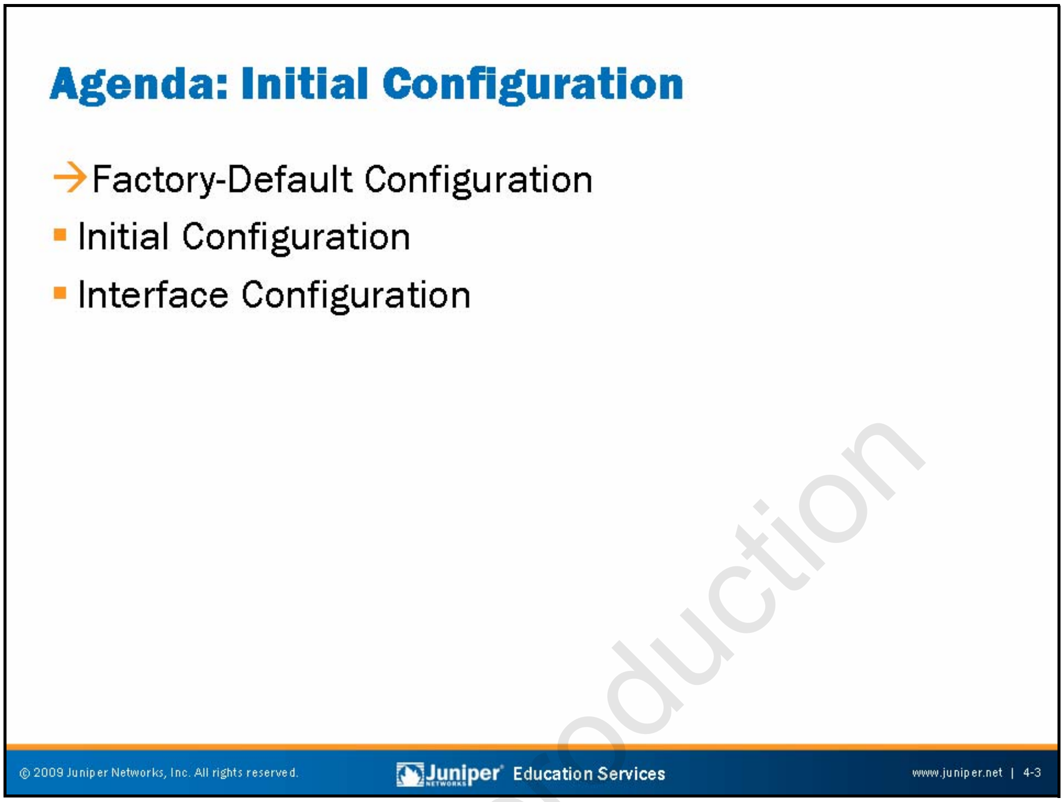
This Chapter Discusses:

- The factory-default configuration for platforms running JUNOS Software;
- Initial configuration tasks performed on devices running JUNOS Software; and
- Interface types and interface configuration basics.



Agenda: Initial Configuration

→Factory-Default Configuration
- Initial Configuration
- Interface Configuration

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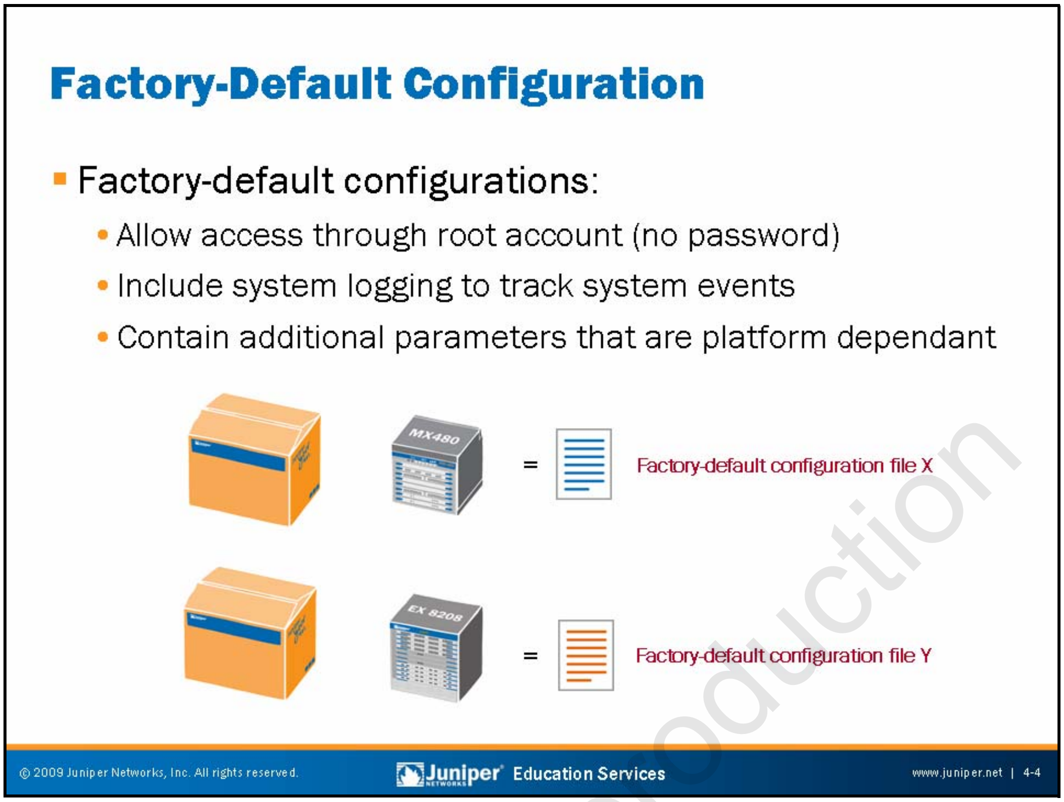
Factory-Default Configuration

The slide lists the topics we cover in this chapter. We discuss the highlighted topic first.



Factory-Default Configuration

- Factory-default configurations:
  - Allow access through root account (no password)
  - Include system logging to track system events
  - Contain additional parameters that are platform dependant

MX480
=
Factory-default configuration file X
EX 8208
=
Factory-default configuration file Y

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The Factory-Default Configuration

All platforms running JUNOS Software are shipped with a factory-default configuration. All factory-default configurations allow access using the root account. The root account does not include a password by default. Setting a root password is required before activating any changes to the configuration file.

All factory-default configurations also include system logging, which tracks system events and writes those events to pre-defined log files. The following is an example of a typical syslog configuration found within a factory-default configuration:

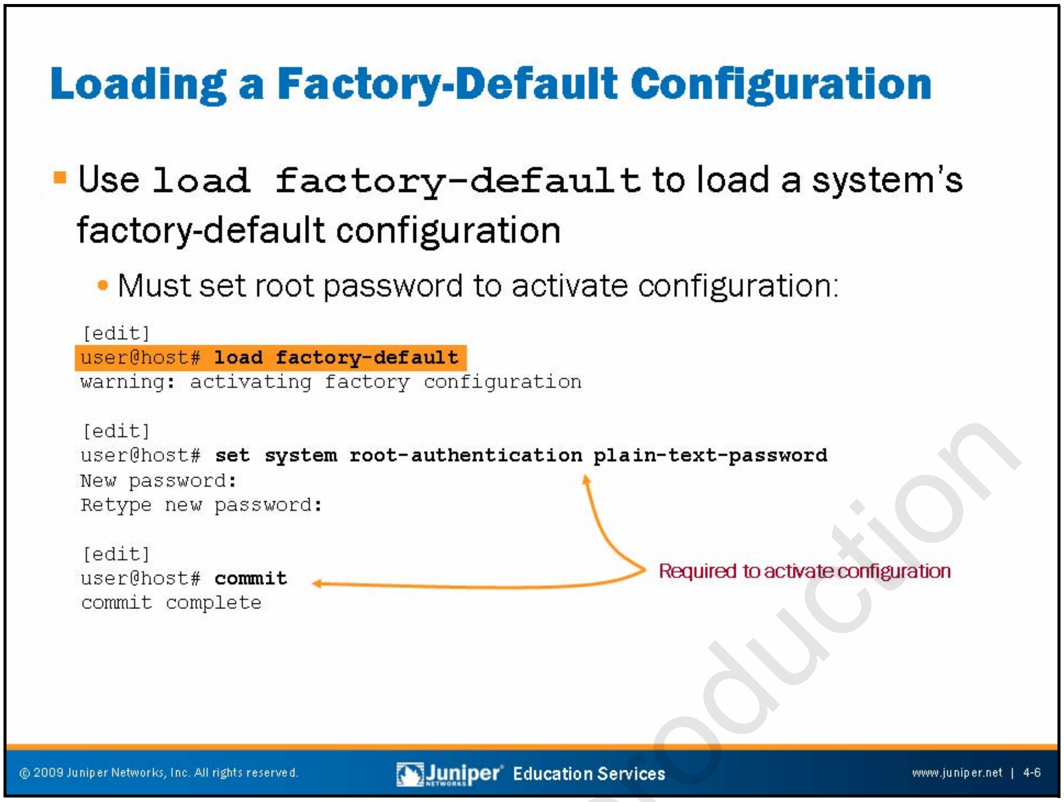
```
[edit]
user@host# show system syslog
user * {
    any emergency;
}
file messages {
    any any;
    authorization info;
}
file interactive-commands {
    interactive-commands any;
}
```

We discuss system logging in greater detail in the secondary system configuration chapter.

Continued on next page.

The Factory-Default Configuration (contd.)

Factory-default configurations can vary from one platform family to another or even between the different models within the same platform family. All platforms running JUNOS Software are designed for specific roles within a network environment and their factory-default configurations are created with those specific roles in mind. One example is the EX Series switches, which are designed to operate as Layer 2 switches right out of the box. To meet this default operational requirement the associated factory-default configurations have all interfaces configured for Layer 2 operation and also include protocol configuration commonly used on switches, such as Rapid Spanning Tree Protocol (RSTP) and Link Layer Discovery Protocol (LLDP). Other platforms do not have these same default operational requirements and thus do not include those configuration parameters in their factory-default configurations.



Loading a Factory-Default Configuration

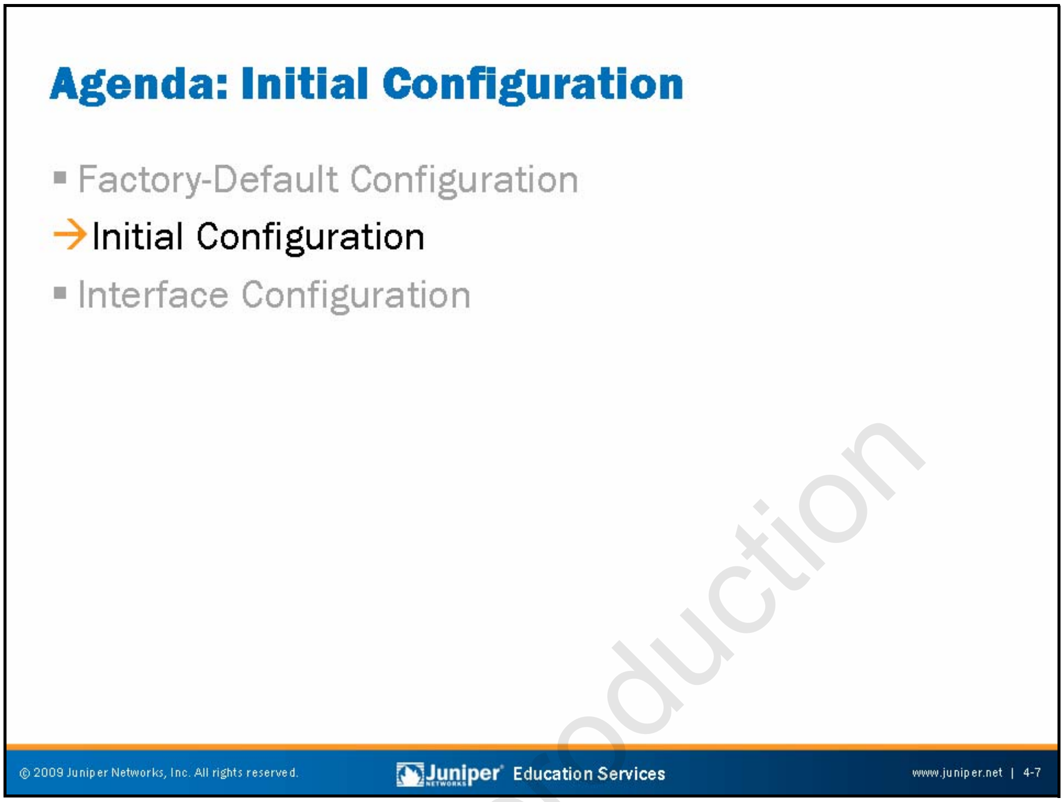
- Use `load factory-default` to load a system's factory-default configuration
  - Must set root password to activate configuration:

```
[edit]
user@host# load factory-default
warning: activating factory configuration

[edit]
user@host# set system root-authentication plain-text-password
New password:
Retype new password:

[edit]
user@host# commit
commit complete
```

Required to activate configuration

Loading a Factory-Default Configuration

Under certain conditions, you might want to return a device running JUNOS Software to its factory-default configuration. You can overwrite the candidate configuration while in configuration mode using the **`load factory-default`** command. The JUNOS Software does not allow you to save the configuration until you configure root authentication information. Do not forget to issue a **`commit`** to activate your changes.



Agenda: Initial Configuration

- Factory-Default Configuration
- →Initial Configuration
- Interface Configuration

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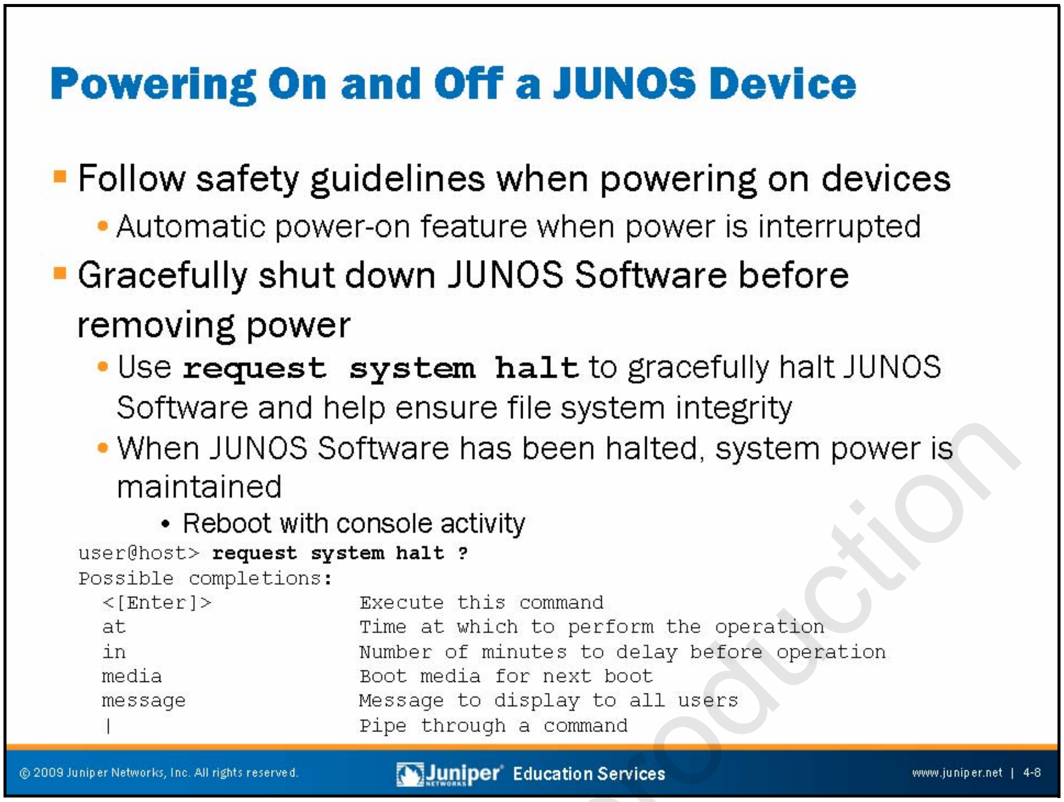
Initial Configuration

The slide highlights the topic we discuss next.



Powering On and Off a JUNOS Device

- Follow safety guidelines when powering on devices
  - Automatic power-on feature when power is interrupted
- Gracefully shut down JUNOS Software before removing power
  - Use **`request system halt`** to gracefully halt JUNOS Software and help ensure file system integrity
  - When JUNOS Software has been halted, system power is maintained
    - Reboot with console activity

```
user@host> request system halt ?
Possible completions:
  <[Enter]>           Execute this command
  at                  Time at which to perform the operation
  in                  Number of minutes to delay before operation
  media               Boot media for next boot
  message             Message to display to all users
  |                   Pipe through a command
```

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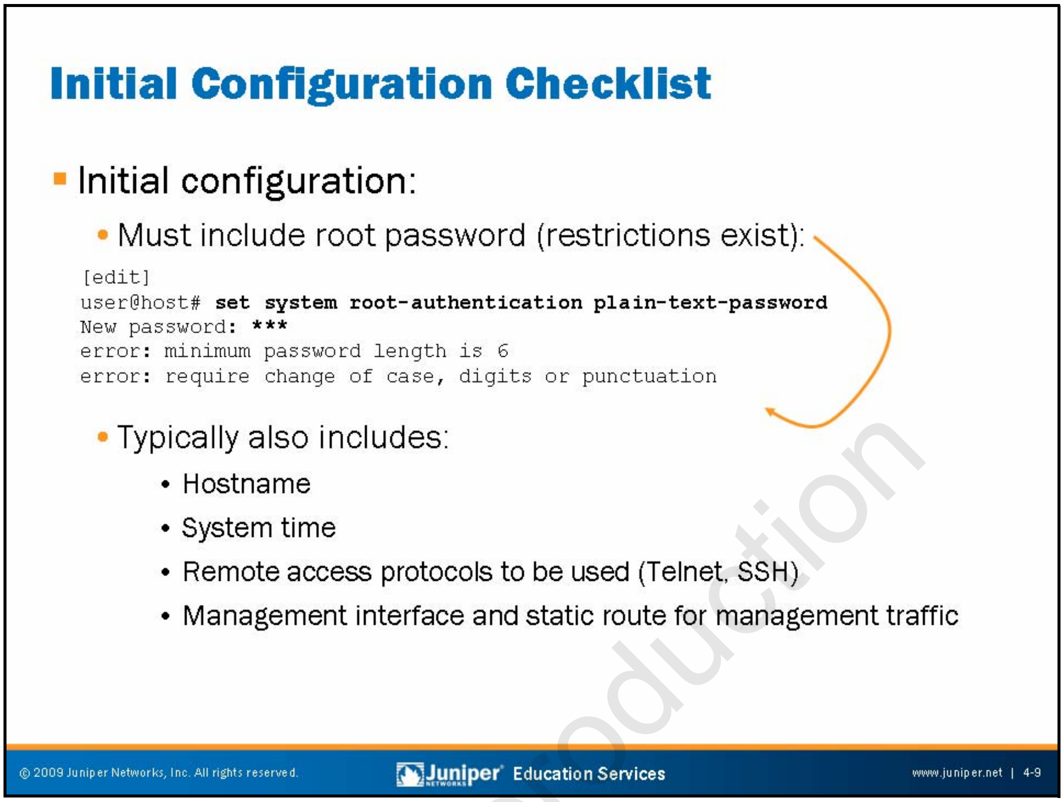
Powering On a Device Running JUNOS Software

Always refer to your platform-specific documentation and follow the safety guidelines when connecting power and powering on your device running JUNOS Software. Once a device running JUNOS Software is powered on and if power to that system is interrupted, the device automatically powers on when the power is restored. In other words, no manual intervention is required for the system to reboot in this situation.

Gracefully Shutting Down JUNOS Software

The JUNOS Software is a multitasking environment. To ensure file system integrity, you should always gracefully shut down platforms running JUNOS Software. Although unlikely, failure to gracefully shut down the system could possibly leave it unable to boot. As illustrated on the slide, you use the **`request system halt`** command to gracefully shut down JUNOS Software. This command provides options that allow you to schedule the shut down in a specified number of minutes or at an exact time, to specify the media from which the next boot up operation will use, and to log a message to the console and to the messages file.

For JUNOS platforms that offer redundant Routing Engines (REs), you can halt both REs simultaneously using the **`request system halt both-routing-engines`** command. For EX Series switches participating in a virtual chassis, where multiple switches function as a single virtual device, you can halt all participating members simultaneously with the **`request system halt all-members`** command.



Initial Configuration Checklist

- Initial configuration:
  - Must include root password (restrictions exist):

```
[edit]
user@host# set system root-authentication plain-text-password
New password: ***
error: minimum password length is 6
error: require change of case, digits or punctuation
```

  - Typically also includes:
    - Hostname
    - System time
    - Remote access protocols to be used (Telnet, SSH)
    - Management interface and static route for management traffic

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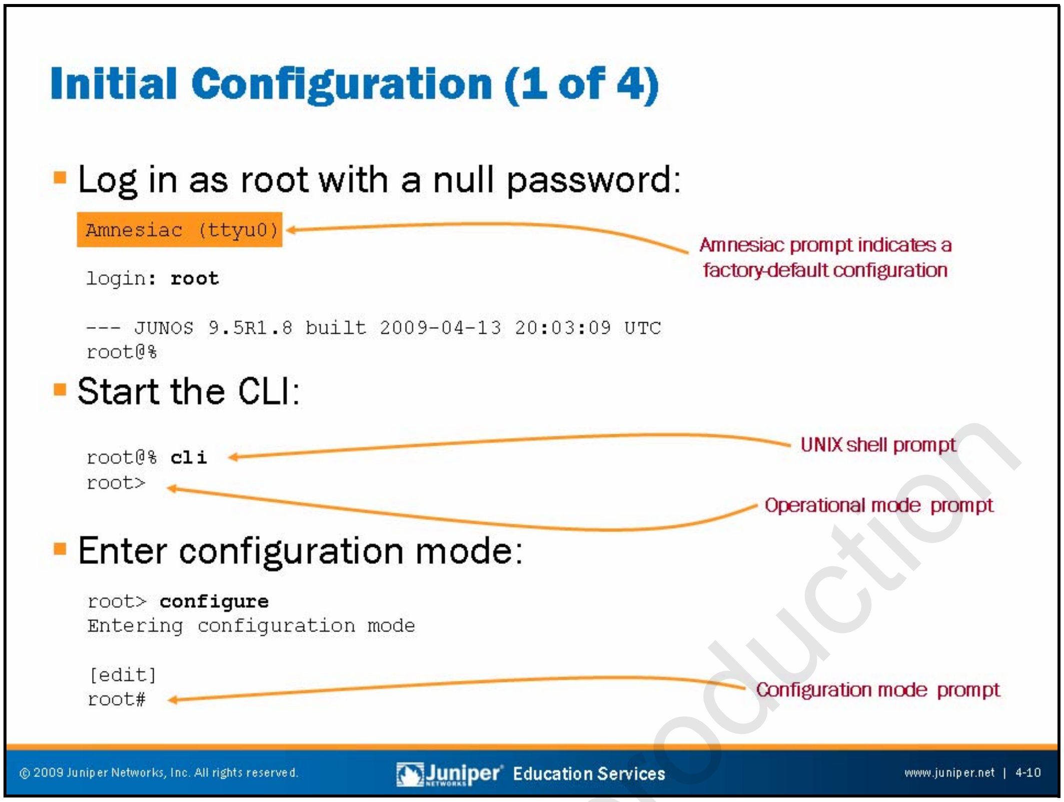
Initial Configuration Checklist

When you receive a device running JUNOS Software from the factory, the JUNOS Software is preinstalled. Once you power on the device, it is ready to be configured. When the initial configuration is performed, the root authentication must be included. In addition to root authentication, we also recommend that you configure the following items:

- Hostname;
- System time;
- System services for remote access (Telnet, SSH); and
- Management interface and static route for management traffic.

As displayed on the slide, JUNOS Software enforces password restrictions. All passwords are required to be no less than six characters and must include a change of case, digits, or punctuation.

The subsequent pages provide sample configuration syntax for the initial configuration tasks listed on the slide.



Initial Configuration (1 of 4)

- Log in as root with a null password:

```
Amnesiac (ttyu0)

login: root

--- JUNOS 9.5R1.8 built 2009-04-13 20:03:09 UTC
root@%
```

Amnesiac prompt indicates a factory-default configuration

- Start the CLI:

```
root@% cli
root>
```

UNIX shell prompt

Operational mode prompt

- Enter configuration mode:

```
root> configure
Entering configuration mode

[edit]
root#
```

Configuration mode prompt

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Logging In as Root

Remember when you receive a platform running JUNOS Software from the factory, the root password is not set. To log in to the CLI for the first time, you must log in through the console port using the root username with no password.

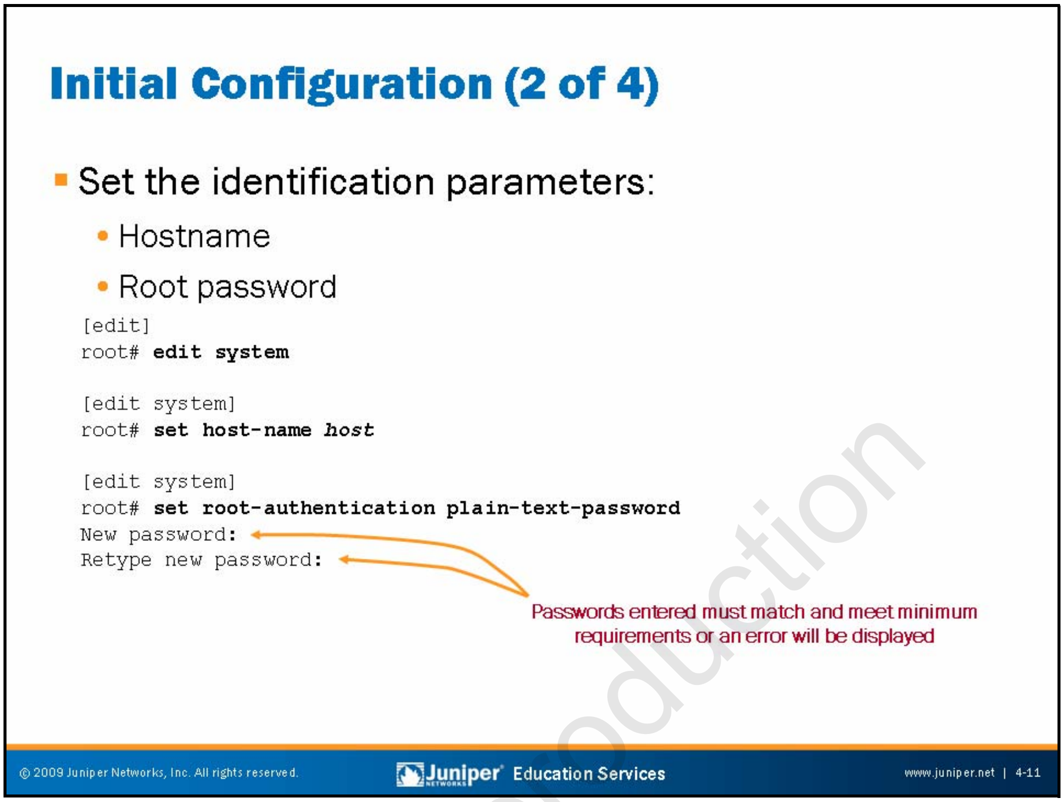
When configured, the console login displays the hostname of the device. When no hostname is configured, such as is the case with a factory-default configuration, `Amnesiac` is displayed in place of the hostname.

Starting the CLI

When you log in as the root user, you are placed at the UNIX shell. You must start the CLI by typing the **`cli`** command. When you exit the CLI, you return to the UNIX shell. For security reasons, make sure you also log out of the shell using the **`exit`** command.

Entering Configuration Mode

After starting the CLI, you enter operational mode. You can make changes to the configuration only in configuration mode. Enter configuration mode by entering **`configure`** at the operational mode prompt, as shown on the slide.



Initial Configuration (2 of 4)

- Set the identification parameters:
  - Hostname
  - Root password

```
[edit]
root# edit system

[edit system]
root# set host-name host

[edit system]
root# set root-authentication plain-text-password
New password:
Retype new password:
```

Passwords entered must match and meet minimum requirements or an error will be displayed

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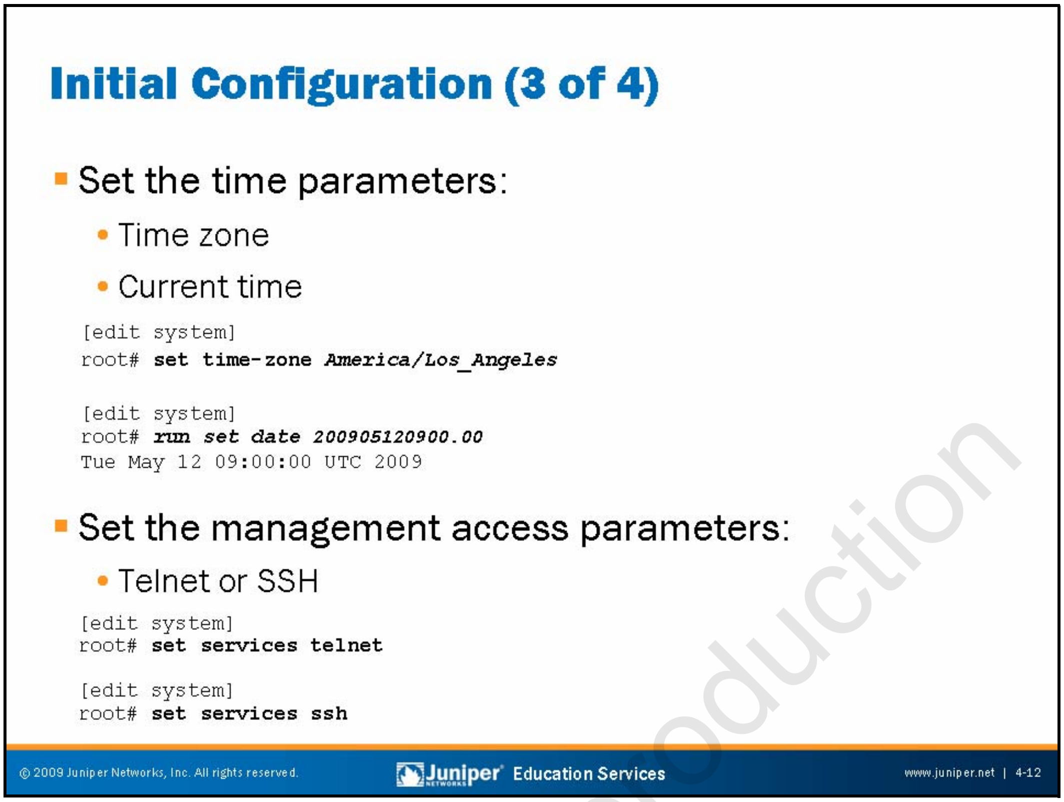
Identification Parameters

The slide shows how to use the CLI to configure the hostname and a root password. As displayed on the slide, a check is made when the root password is entered to ensure that it has been entered correctly. In the event that both entered passwords do not match, an error will be generated, the change is not made, and the password will need to be reentered.

The example on the slide uses the plain-text authentication option. Unlike the software from some vendors, JUNOS Software never actually displays the password in its plain-text format but rather encrypts the password for you. You can see the encrypted password by viewing the relevant configuration:

```
[edit system]
root# show root-authentication
encrypted-password "$1$ti58nUSg$8xnQtTJeA0dA/.eUjjZOq1"; ## SECRET-DATA
```

Because you cannot retrieve the passwords by looking at the configuration file, you should keep the configured passwords in a secure location. If you do forget the password and cannot login, you can always perform the password recovery process, which we cover in a subsequent chapter.



Initial Configuration (3 of 4)

- Set the time parameters:
  - Time zone
  - Current time

```
[edit system]
root# set time-zone America/Los_Angeles

[edit system]
root# run set date 200905120900.00
Tue May 12 09:00:00 UTC 2009
```

- Set the management access parameters:
  - Telnet or SSH

```
[edit system]
root# set services telnet

[edit system]
root# set services ssh
```

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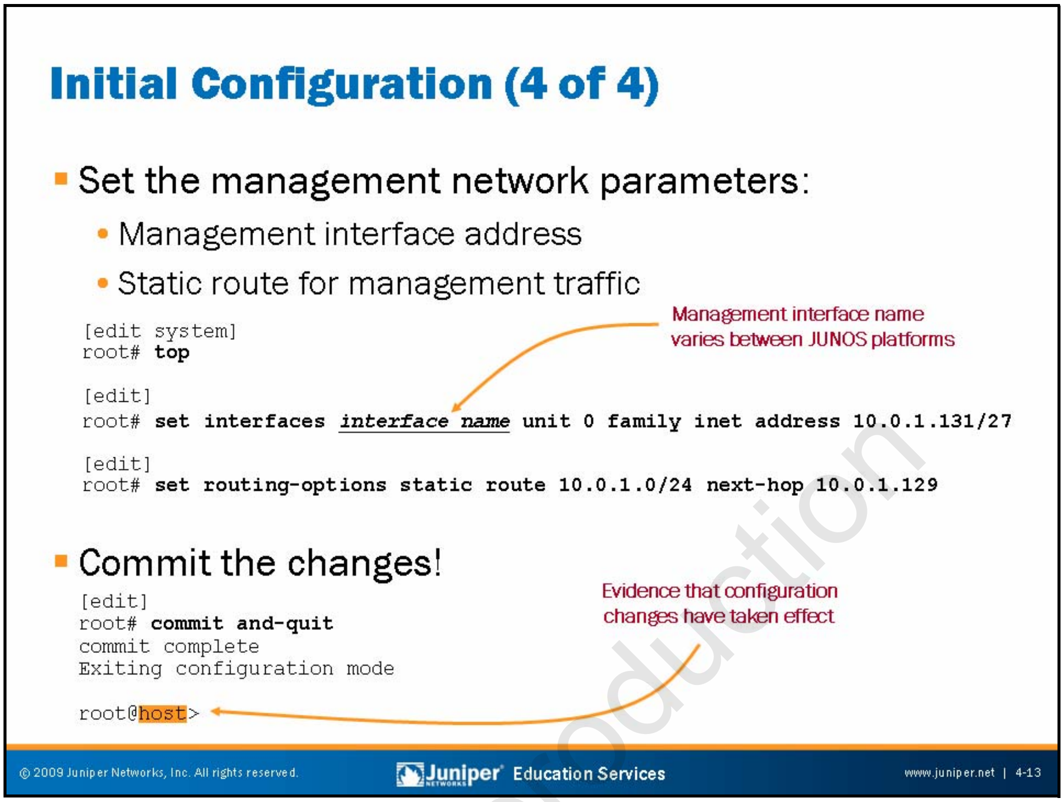
Time Parameters

The slide shows how to use the CLI to configure the time settings. You can configure the current date and time information along with the proper time zone for the device. The default time zone on JUNOS devices is UTC (Coordinated Universal Time, formerly known as Greenwich Mean Time, or GMT). When you define the local time on a JUNOS device, you must account for the time difference between the defined time zone and the default time zone. Once the time zone is changed and committed, the local time is adjusted accordingly to account for the difference. If you do not want to make the necessary adjustments, you can simply set the system's time after the defined time zone parameter has been committed.

Instead of setting the local time on each network device in your network, you might consider implementing the Network Time Protocol (NTP). We cover NTP in detail in the secondary system configuration chapter.

Management Access Parameters

The slide also shows how to use the CLI to enable SSH and Telnet access to a device running JUNOS Software. Although not shown on the slide, you could also enable the HTTP service, which allows the device to be accessed and managed through a Web browser. When connecting to a device running JUNOS Software using one of these access protocols, use the same user logins defined under the `[edit system login]` hierarchy.



Initial Configuration (4 of 4)

- Set the management network parameters:
  - Management interface address
  - Static route for management traffic

```
[edit system]
root# top

[edit]
root# set interfaces interface name unit 0 family inet address 10.0.1.131/27

[edit]
root# set routing-options static route 10.0.1.0/24 next-hop 10.0.1.129
```

Management interface name varies between JUNOS platforms

- Commit the changes!

```
[edit]
root# commit and-quit
commit complete
Exiting configuration mode

root@host>
```

Evidence that configuration changes have taken effect

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Management Network Parameters

The slide shows how to use the CLI to configure a management interface and a static route for management traffic. Note that we highly recommend against using a default static route for management traffic! You should be as specific as possible. You can also use the **no-readvertise** option for the static route used for management traffic. The **no-readvertise** option marks the route ineligible for readvertisement through routing policy.

Note that the static route defined for management traffic (or any other traffic) is only available when the system's routing protocol process (rpd) is running. When JUNOS devices boot, the routing protocol process is not running; therefore, the system has no static or default routes. To allow the device to boot and to ensure that it is reachable over the network if the routing protocol process fails to start properly, you configure a backup router, which is a router or gateway device that is directly connected to the local system (that is, on the same subnet). To configure a backup router running IPv4, include the backup-router statement at the [edit system] hierarchy level:

```
[edit system]
root# show backup-router
10.0.1.129 destination 10.0.1.0/24;
```

In the sample configuration shown above, hosts on the 10.0.1.0/24 subnet are reachable through the backup router. If the destination statement is omitted, then all hosts are reachable through the backup router.

Continued on next page.

Management Network Parameters (contd.)

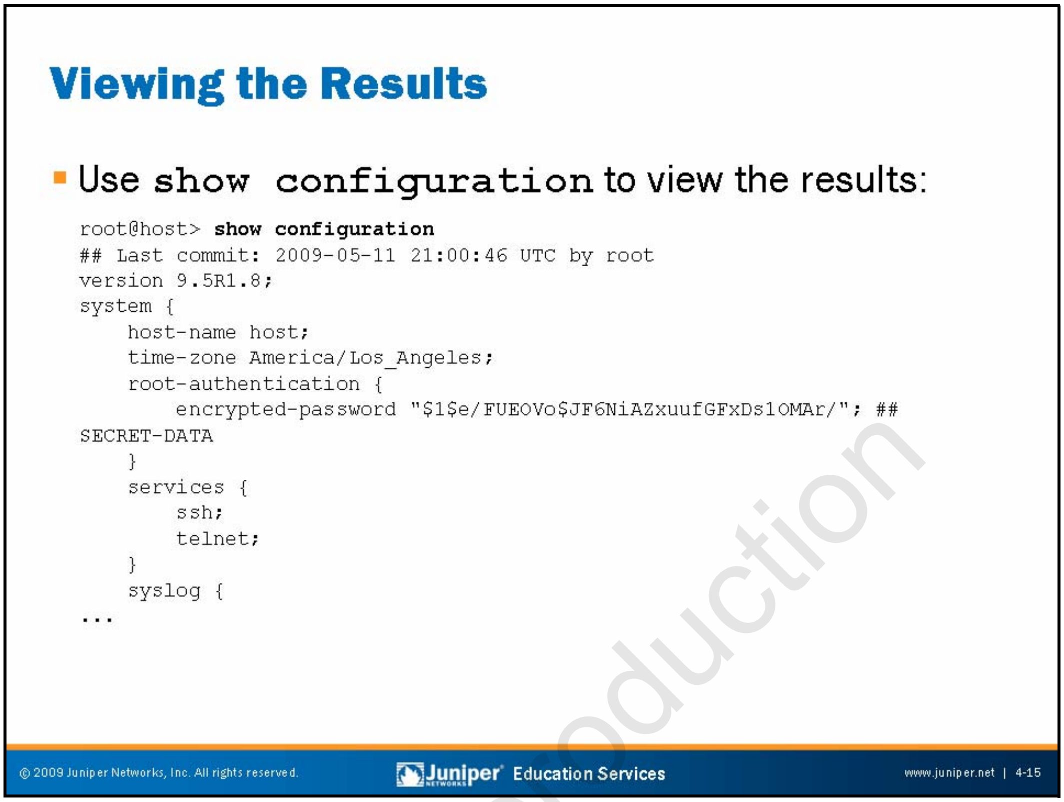
To eliminate the risk of installing a default route in the forwarding table, you should always include the destination option, specifying an address that is reachable through the backup router. Specify the address in the format network/mask-length, as shown in the previous example, so that the entire network is reachable through the backup router.

When the routing protocols start, the address of the backup router is removed from the local routing and forwarding tables. To have the address remain in these tables, configure a static route for the desired destination prefix with the backup router as the next hop and the retain option as shown in the following capture:

```
[edit routing-options]
root# show
static {
    route 10.0.1.0/24 {
        next-hop 10.0.1.129;
        retain;
        no-readvertise;
    }
}
```

Activating Your Configuration

Once you complete your initial configuration, use the **commit** command to apply your changes. You can include the **and-quit** option, as shown, to return to operational mode. In the example on the slide, we see that once the configuration changes are activated and the user returns to operational mode, the configured hostname is displayed. This displayed hostname is a sure sign that the active configuration has changed.



Viewing the Results

- Use `show configuration` to view the results:

```
root@host> show configuration
## Last commit: 2009-05-11 21:00:46 UTC by root
version 9.5R1.8;
system {
    host-name host;
    time-zone America/Los_Angeles;
    root-authentication {
        encrypted-password "$1$e/FUEOVo$JF6NiAZxuufGFxDs1OMAr/"; ##
SECRET-DATA
    }
    services {
        ssh;
        telnet;
    }
    syslog {
...
```

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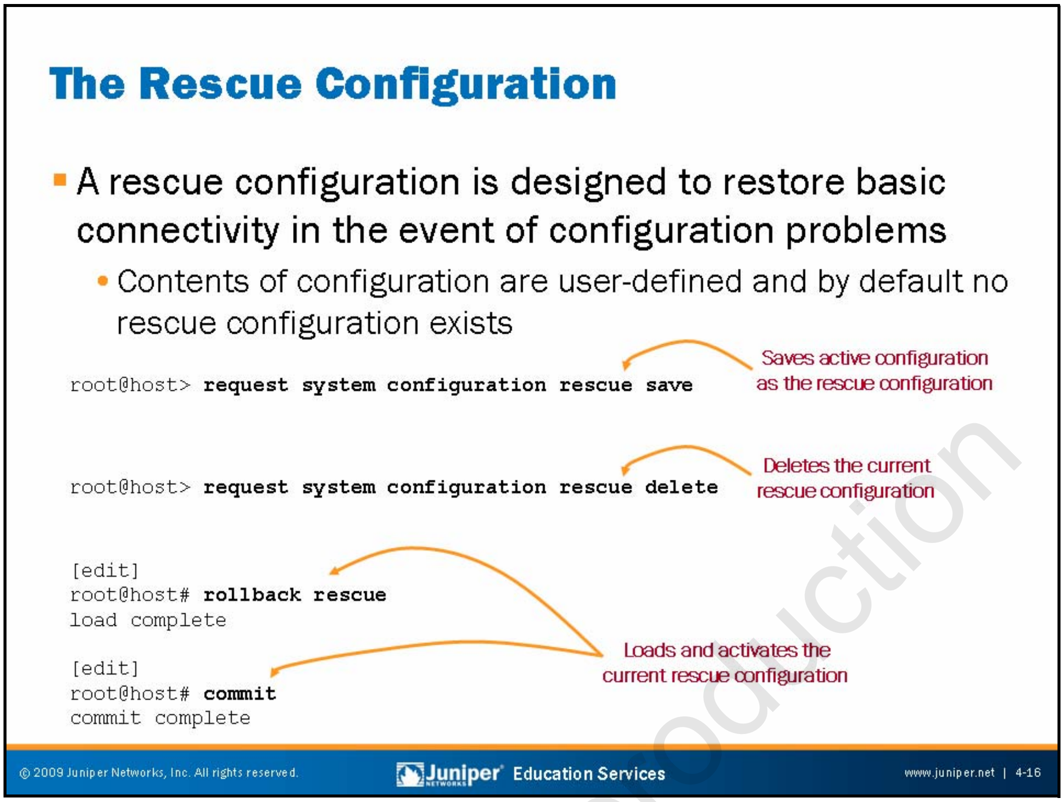
Viewing the Resulting Configuration

As the slide directs, use the operational-mode **`show configuration`** command to display the hierarchical configuration file as created by the initial configuration **`set`** statements. The complete configuration is not shown for the sake of brevity.



The Rescue Configuration

- A rescue configuration is designed to restore basic connectivity in the event of configuration problems
  - Contents of configuration are user-defined and by default no rescue configuration exists

```
root@host> request system configuration rescue save
```

Saves active configuration as the rescue configuration

```
root@host> request system configuration rescue delete
```

Deletes the current rescue configuration

```
[edit]
root@host# rollback rescue
load complete

[edit]
root@host# commit
commit complete
```

Loads and activates the current rescue configuration

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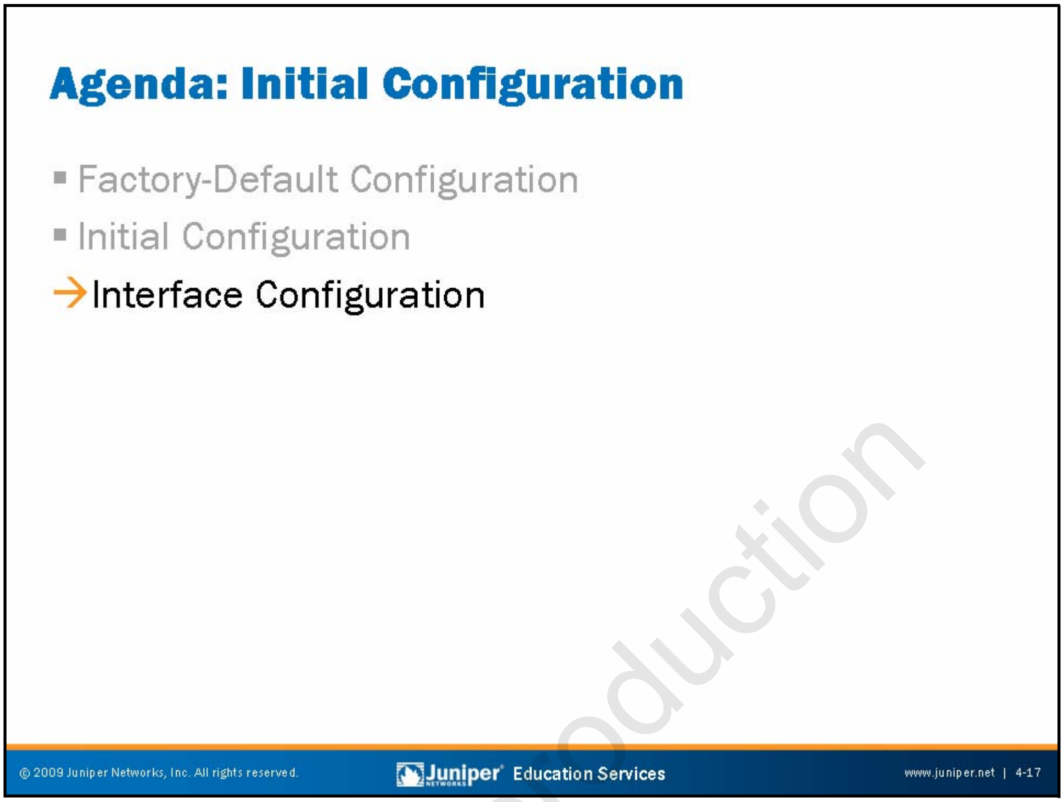
To the Rescue

A rescue configuration is a user-defined, known-good configuration that is designed to restore connectivity in the event of configuration problems. We recommend that the rescue configuration contain the minimum elements necessary to restore network connectivity. For added security, the rescue configuration must include a root password. By default, no rescue configuration is defined.

You can save the active configuration as the rescue configuration using the CLI's operational-mode **`request system configuration rescue save`** command. If a rescue configuration already exists, the **`request system configuration rescue save`** command replaces the rescue configuration file with the contents from the active configuration. To manually delete the current rescue configuration, issue the **`request system configuration rescue delete`** command.

Once saved, you can load the rescue configuration by entering the **`rollback rescue`** configuration mode command. Because the rollback operation only replaces the contents of the candidate configuration, you must issue **`commit`** to activate the configuration.



Agenda: Initial Configuration

- Factory-Default Configuration
- Initial Configuration

→Interface Configuration

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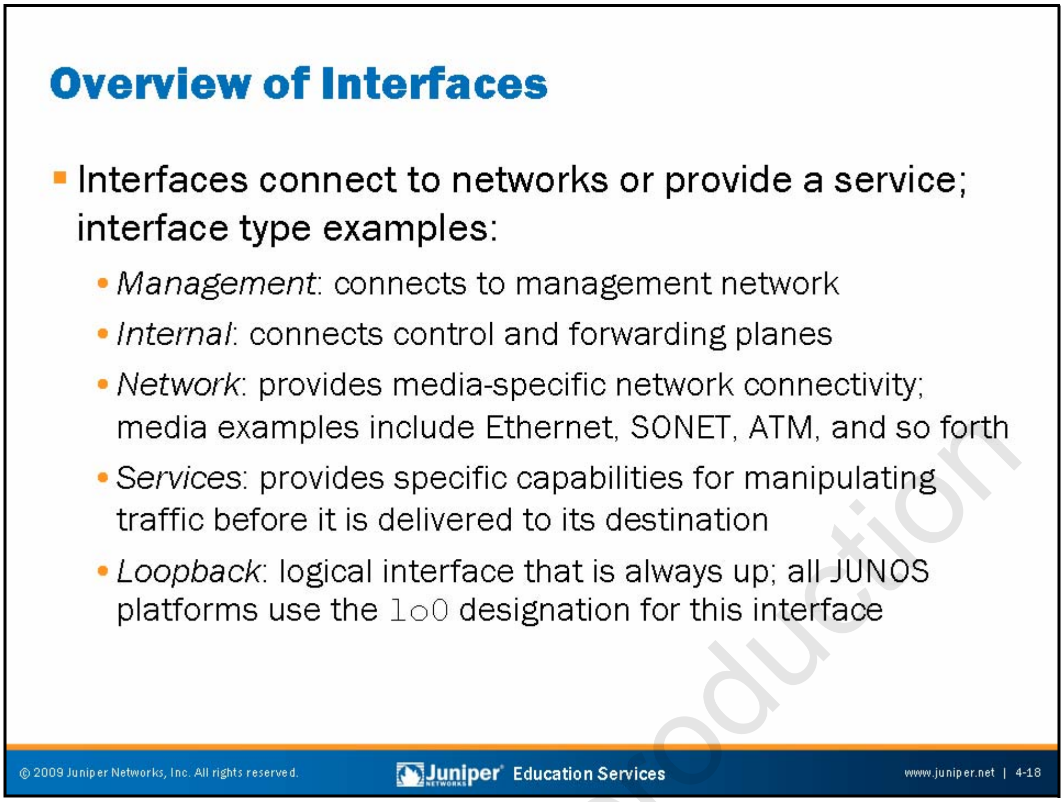
Interface Configuration

The slide highlights the topic we discuss next.



Overview of Interfaces

- Interfaces connect to networks or provide a service; interface type examples:
  - *Management*: connects to management network
  - *Internal*: connects control and forwarding planes
  - *Network*: provides media-specific network connectivity; media examples include Ethernet, SONET, ATM, and so forth
  - *Services*: provides specific capabilities for manipulating traffic before it is delivered to its destination
  - *Loopback*: logical interface that is always up; all JUNOS platforms use the `lo0` designation for this interface

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Interface Overview

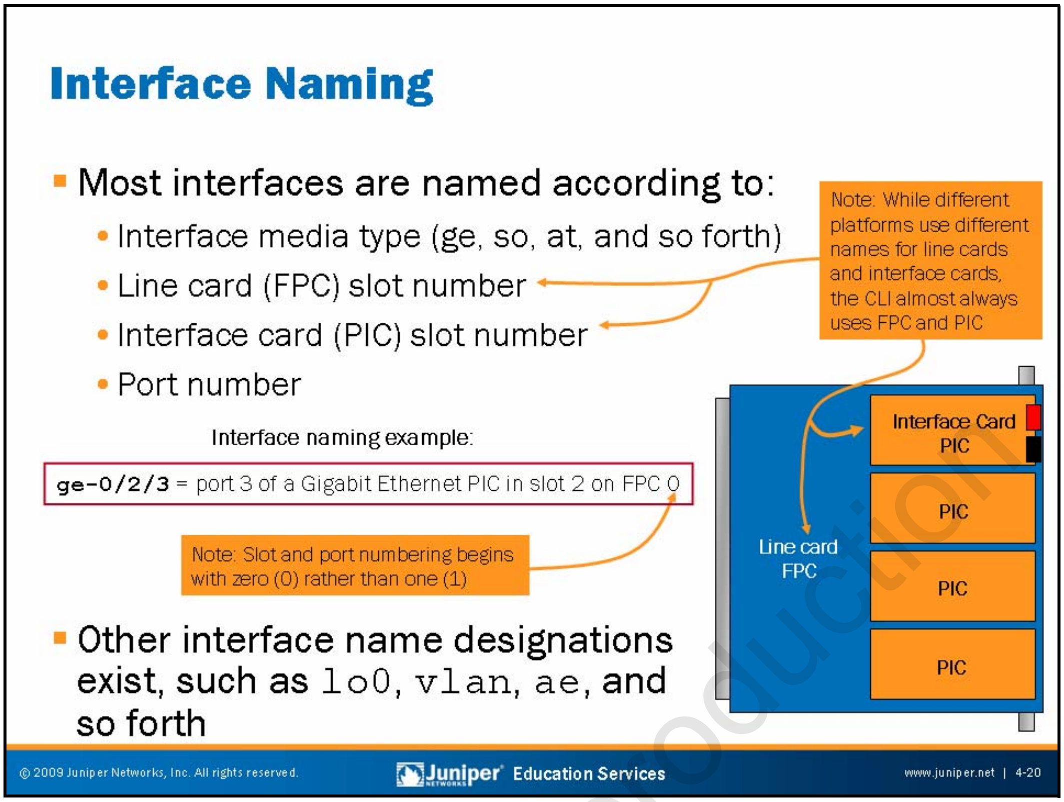
Interfaces are primarily used to connect a device to a network; however, some interfaces are used to provide a service or a specific function for the system on which it operates. On platforms running JUNOS Software, several types of interfaces exist, including:

- *Management interfaces*: Used to connect the device running JUNOS Software to a management network. The actual designation for this interface is platform-specific; examples include `fxp0` and `me0`.
- *Internal interfaces*: Used to connect the control and forwarding planes. The actual designation for this interface is platform-specific; examples include `fxp1` and `em0`.
- *Network interfaces*: Used to provide media-specific network connectivity. Some media examples include Ethernet, SONET, Asynchronous Transfer Mode (ATM), T1, and DS3. We cover examples of network interfaces on subsequent pages within this chapter.

Continued on next page.

Interface Overview (contd.)

- *Services interfaces*: Used to provide one or more user-configurable services such as encryption, tunneling, and link services. Services interfaces can be provided through a physical services interface card or through software. Services interfaces provided through a PIC do not have ports or media associated with them, but have two-letter interface type designations as shown in the list that follows. Actual coverage of the services provided by these interfaces is beyond the scope of this class.
  - `es`: Encryption interface;
  - `gr`: Generic route encapsulation tunnel interface;
  - `ip`: IP-over-IP encapsulation tunnel interface;
  - `ls`: Link services interface;
  - `ml`: Multilink interface;
  - `mo`: Passive monitoring interface;
  - `mt`: Multicast tunnel interface;
  - `sp`: Adaptive services interface; and
  - `vt`: Virtual loopback tunnel interface.
- *Loopback interfaces*: Used to provide a constant and dependable hardware-independent interface. The loopback interface uses the lo0 designation on all platforms running JUNOS Software. Use the lo0 interface in conjunction with routing protocols to facilitate routing in a redundant environment that is independent of the individual physical links within that environment. You can configure a single logical unit for the lo0 interface for each routing instance. Each logical unit associated with a given routing instance can, however, have multiple configured IP addresses.



Interface Naming

- Most interfaces are named according to:
  - Interface media type (ge, so, at, and so forth)
  - Line card (FPC) slot number
  - Interface card (PIC) slot number
  - Port number

Interface naming example:

`ge-0/2/3` = port 3 of a Gigabit Ethernet PIC in slot 2 on FPC 0

Note: Slot and port numbering begins with zero (0) rather than one (1)

- Other interface name designations exist, such as `lo0`, `vlan`, `ae`, and so forth

Note: While different platforms use different names for line cards and interface cards, the CLI almost always uses FPC and PIC

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Interface Naming

JUNOS Software uses a standard naming convention. Most interfaces have names based on the interface media type, the system slot number in which the line card is installed, the line card slot number in which the interface card is installed, and the port number for the interface card. As noted on the slide, the CLI almost always refers to line cards as Flexible PIC Concentrators (FPCs) and interface cards as PICs even though the actual names of these physical components might vary between JUNOS platforms. For platform-specific information, including details pertaining to the interface naming convention for your specific device, see http://www.juniper.net/techpubs/ for the technical publications.

In typical deployments, the slot and port numbering begins with zero (0) and increments based on the system hardware configuration. The slide shows a sample interface name that illustrates the interface naming format. The highlighted interface name is for the fourth physical port (number 3) on a Gigabit Ethernet interface card installed in the third slot (number 2) of a line card that resides on the first available line card slot (number 0) of a chassis.

Continued on next page.

Other Interface Name Designations

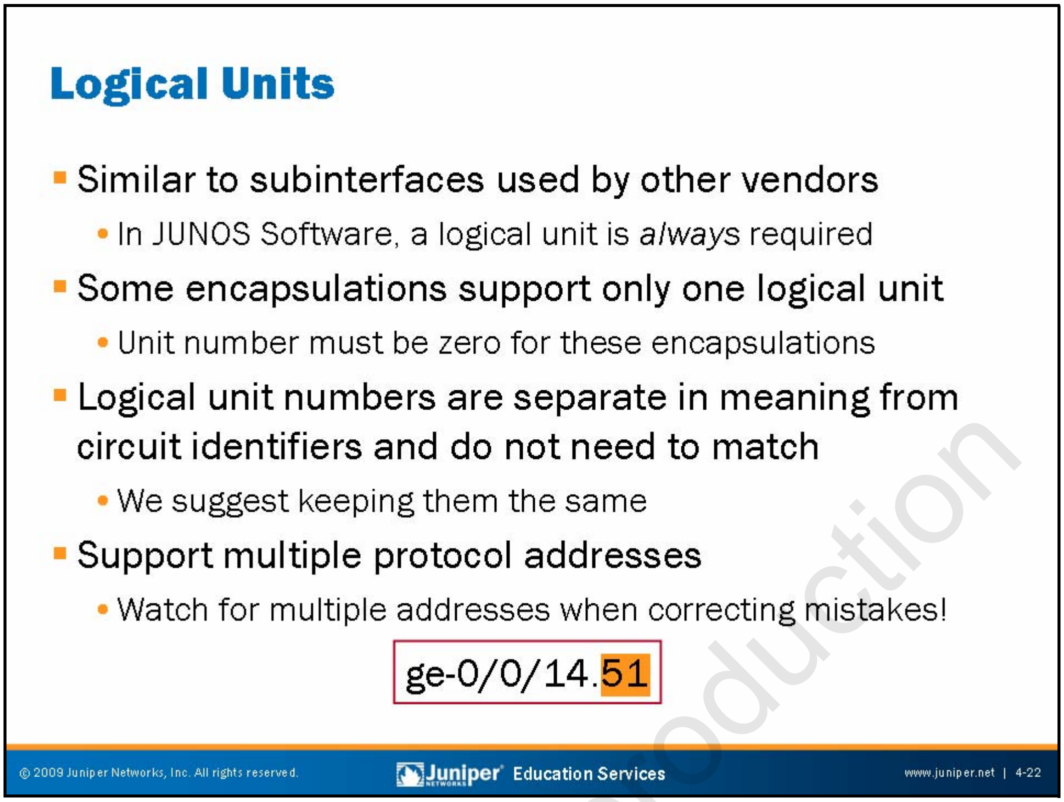
As mentioned on the slide, other interface name designations exist that do not adhere to the naming convention illustrated on the top of the slide. Interfaces with specific designations are created by the JUNOS Software and are not directly associated with or dependant on physical interfaces. The following are some examples:

- *lo0*: Loopback interface;
- *ae*: Aggregated Ethernet interface;
- *as*: Aggregated SONET interface; and
- *vlan*: VLAN interface.

The JUNOS Software also creates a number of internal interfaces. These internally generated interfaces are nonconfigurable. The following are some examples:

- *gre*;
- *mtun*;
- *ipip*; and
- *tap*.

Note that interface support varies between the different JUNOS platforms. For support information, always refer to the technical documentation for your specific product.



Logical Units

- Similar to subinterfaces used by other vendors
  - In JUNOS Software, a logical unit is *always* required
- Some encapsulations support only one logical unit
  - Unit number must be zero for these encapsulations
- Logical unit numbers are separate in meaning from circuit identifiers and do not need to match
  - We suggest keeping them the same
- Support multiple protocol addresses
  - Watch for multiple addresses when correcting mistakes!

ge-0/0/14.51

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Logical Interfaces

Each physical interface descriptor can contain one or more logical interface descriptors. These descriptors allow you to map one or more logical (sometimes called virtual) interfaces to a single physical device. Creating multiple logical interfaces is useful in environments where multiple virtual circuits or Data Link Layer connections are associated with a single physical interface, such as in ATM and Frame Relay networks.

Logical Units and Encapsulation

Some encapsulations, such as Point-to-Point Protocol (PPP) and Cisco High-Level Data Link Control (Cisco HDLC), support only a single logical interface, and its logical unit number must be zero. Other encapsulations, such as Frame Relay, ATM and tagged Ethernet, support multiple logical interfaces, so you can configure one or more logical unit numbers.

Continued on next page.

Circuit Identifier Versus Unit Number

The unit number and the circuit identifier are different in meaning. The circuit identifier identifies the logical tunnel or circuit, while the unit is used to identify a logical partition of the physical interface.

Although not required, it is generally considered best practice to keep the unit number and circuit identifier the same. This practice can greatly aid in troubleshooting when you have many logical circuits.

Multiple Addresses

JUNOS platforms can have more than one address on a single logical interface. Issuing a second **set** command does not overwrite the previous address but rather adds an additional address under the logical unit. Use of the CLI's **rename** command is an excellent way to correct addressing mistakes. The following is an example:

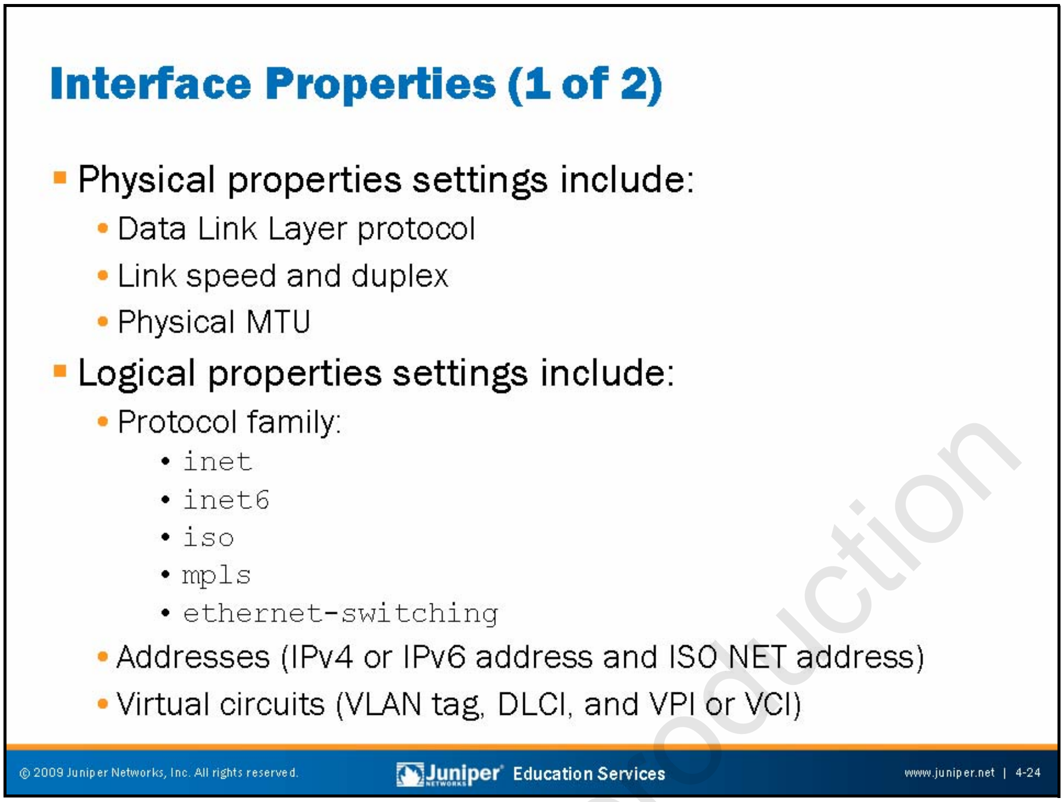
```
[edit interfaces ge-0/0/1 unit 0]
user@host# set family inet address 10.1.1.1

[edit interfaces ge-0/0/1 unit 0]
user@host# show
family inet {
    address 10.1.1.1/32;
}

[edit interfaces ge-0/0/1 unit 0]
user@host# rename family inet address 10.1.1.1/32 to address 10.1.1.1/24

[edit interfaces ge-0/0/1 unit 0]
user@host# show
family inet {
    address 10.1.1.1/24;
}
```

Also note that JUNOS Software forms interior gateway protocol (IGP) adjacencies over all subnets when the IGP is configured on a logical interface; this behavior is worth noting because some vendors form an adjacency over only the primary address of an interface.



Interface Properties (1 of 2)

- Physical properties settings include:
  - Data Link Layer protocol
  - Link speed and duplex
  - Physical MTU
- Logical properties settings include:
  - Protocol family:
    - `inet`
    - `inet6`
    - `iso`
    - `mpls`
    - `ethernet-switching`
  - Addresses (IPv4 or IPv6 address and ISO NET address)
  - Virtual circuits (VLAN tag, DLCI, and VPI or VCI)

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Physical Properties

The following list provides details for some physical interface properties:

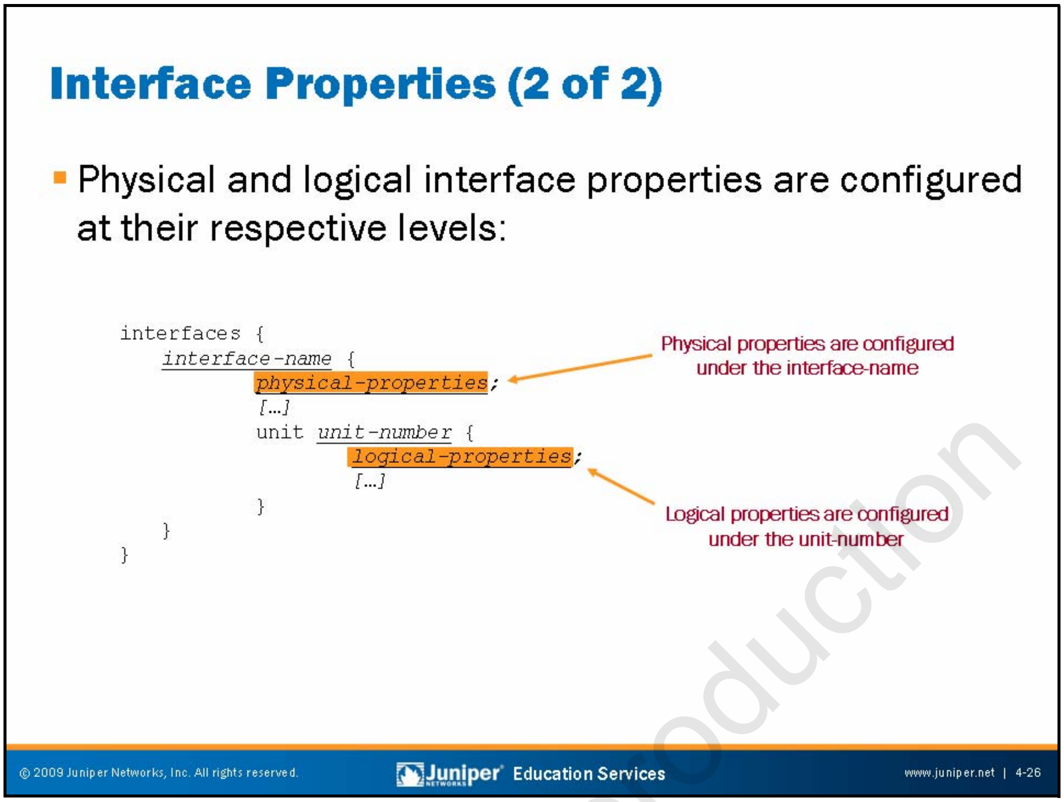
- *Data Link Layer protocol* and *keepalives*: You can change the Data Link Layer protocol for the particular media type (for example, PPP to Cisco HDLC), and you can turn keepalives on or off;
- *Link mode*: On Ethernet interfaces you can hardcode the duplex setting to either half-duplex or full-duplex;
- *Speed*: You can specify the link speed on certain interface types;
- *Maximum transmission unit (MTU)*: You can vary the size from 256 to 9192 bytes;
- *Clocking*: Refers to the interface clock source, either internal or external;
- *Scrambling*: Refers to payload scrambling, which can be on or off;
- *Frame check sequence (FCS)*: You can modify to 32-bit mode (the default is 16-bit mode); and
- *Diagnostic characteristics*: You can enable local or remote loopbacks or set up a BERT test.

Continued on next page.

Logical Properties

The following list provides details for some logical interface properties:

- *Protocol family*: Refers to the protocol family you want to use, such as family inet, inet6, iso, mpls, or ethernet-switching;
- *Addresses*: Refers to the address associated with the particular family (for example, IP address using family inet);
- *Virtual circuits*: Refers to the virtual circuit identifier, such as a data-link connection identifier (DLCI), virtual path identifier (VPI), virtual channel identifier (VCI), or virtual LAN (VLAN) tag; and
- *Other characteristics*: Some other configurable options include Inverse ARP, traps, and accounting profiles.



Interface Properties (2 of 2)

- Physical and logical interface properties are configured at their respective levels:

```
interfaces {
    interface-name {
            physical-properties;
            [...]
            unit unit-number {
                    logical-properties;
                    [...]
            }
    }
}
```

Physical properties are configured under the interface-name

Logical properties are configured under the unit-number

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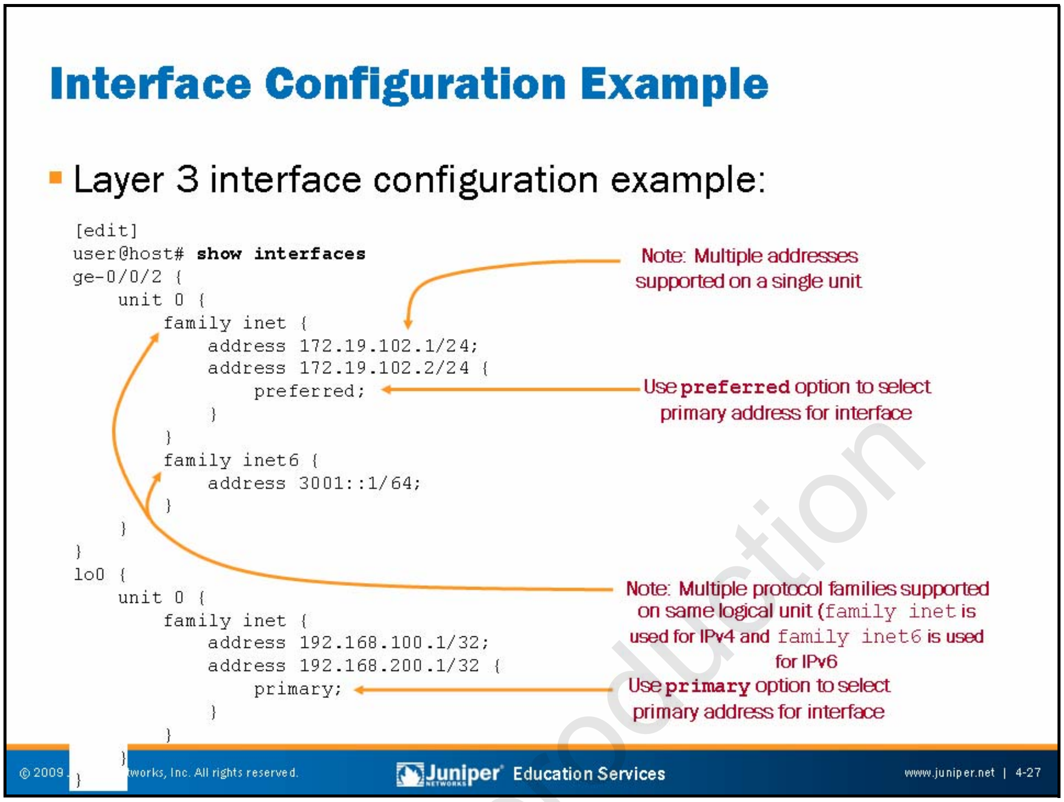
Configuration Hierarchy

All interfaces have the same configuration hierarchy organization. JUNOS Software considers all properties defined directly under the interface name to be the physical properties of that interface. The unit number represents a particular logical interface or subinterface. JUNOS Software considers all properties defined directly under the unit number to be the logical properties of each particular subinterface.



Interface Configuration Example

- Layer 3 interface configuration example:

```
[edit]
user@host# show interfaces
ge-0/0/2 {
    unit 0 {
        family inet {
            address 172.19.102.1/24;
            address 172.19.102.2/24 {
                preferred;
            }
        }
        family inet6 {
            address 3001::1/64;
        }
    }
}
lo0 {
    unit 0 {
        family inet {
            address 192.168.100.1/32;
            address 192.168.200.1/32 {
                primary;
            }
        }
    }
}
```

Note: Multiple addresses supported on a single unit

Use **preferred** option to select primary address for interface

Note: Multiple protocol families supported on same logical unit (family inet is used for IPv4 and family inet6 is used for IPv6

Use **primary** option to select primary address for interface

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Configuration Example

The slide provides a basic configuration example that includes multiple interfaces, multiple protocol families configured under a single logical unit, and multiple IP addresses configured for a single protocol family.

While a single logical unit does support multiple protocol families, such as `inet` and `inet6`, you cannot configure a second protocol family in conjunction with the `ethernet-switching` protocol family. The following example illustrates this point:

```
[edit]
user@host# commit
[edit interfaces ge-0/0/2 unit 0]
  'family'
    When ethernet-switching family is configured on an interface, no other
family type can be configured on the same interface.
error: configuration check-out failed
```

The example on the slide also highlights the use of the **`preferred`** and **`primary`** configuration options. The **`preferred`** option is used when you have multiple IP addresses belonging to the same subnet on the same interface. This option allows you to select which address will be used as the source address for packets sent by the local system to hosts on the directly connected subnet. By default, the numerically lowest local address is chosen. In the example on the slide, the default behavior has been overridden with the **`preferred`** option making 172.19.102.2/24 the preferred address.

Continued on next page.

Configuration Example (contd.)

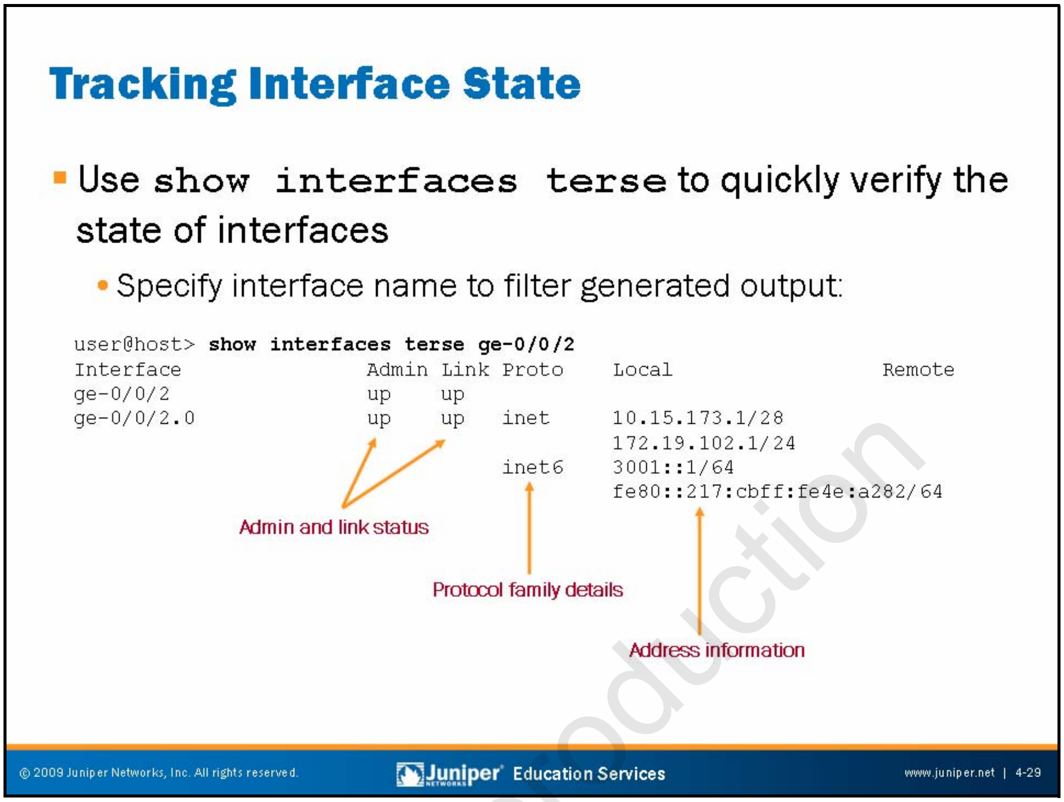
The primary address on an interface is the address that is used by default as the local address for broadcast and multicast packets sourced locally and sent out the interface. The primary address flag also can be useful for selecting the local address used for packets sent out unnumbered interfaces when multiple non-127 addresses are configured on the loopback interface, lo0. By default, the primary address on an interface is selected as the numerically lowest local address configured on the interface. In the example on the slide, 172.19.102.1/24 is the primary address for the ge-0/0/2.0 interface, because it is the numerically lowest address configured on that interface; 192.168.200.1/32 is the primary address for the lo0.0 interfaces, because it has the **`primary`** option. The following capture verifies the primary state:

```
user@host> show interfaces ge-0/0/2.0 | find addresses
      Addresses, Flags: Is-Primary
        Destination: 172.19.102/24, Local: 172.19.102.1,
        Broadcast: 172.19.102.255
      Addresses, Flags: Preferred Is-Preferred
        Destination: 172.19.102/24, Local: 172.19.102.2,
        Broadcast: 172.19.102.255
    Protocol inet6, MTU: 1500
      Flags: Is-Primary
      Addresses, Flags: Is-Default Is-Preferred Is-Primary
        Destination: 3001::/64, Local: 3001::1
      Addresses, Flags: Is-Preferred
        Destination: fe80::/64, Local: fe80::217:cbff:fe4e:ab02

user@host> show interfaces lo0.0 | find addresses
      Addresses
        Local: 192.168.100.1
      Addresses, Flags: Primary Is-Default Is-Primary
        Local: 192.168.200.1
```

Interface support varies between JUNOS platforms. Refer to the technical publications for detailed information for your specific product.

For additional interface configuration examples, refer to Appendix A.



Tracking Interface State

- Use `show interfaces terse` to quickly verify the state of interfaces
  - Specify interface name to filter generated output:

```
user@host> show interfaces terse ge-0/0/2
Interface               Admin Link Proto    Local                 Remote
ge-0/0/2                up    up
ge-0/0/2.0              up    up   inet     10.15.173.1/28
                                            172.19.102.1/24
                                   inet6    3001::1/64
                                            fe80::217:cbff:fe4e:a282/64
```

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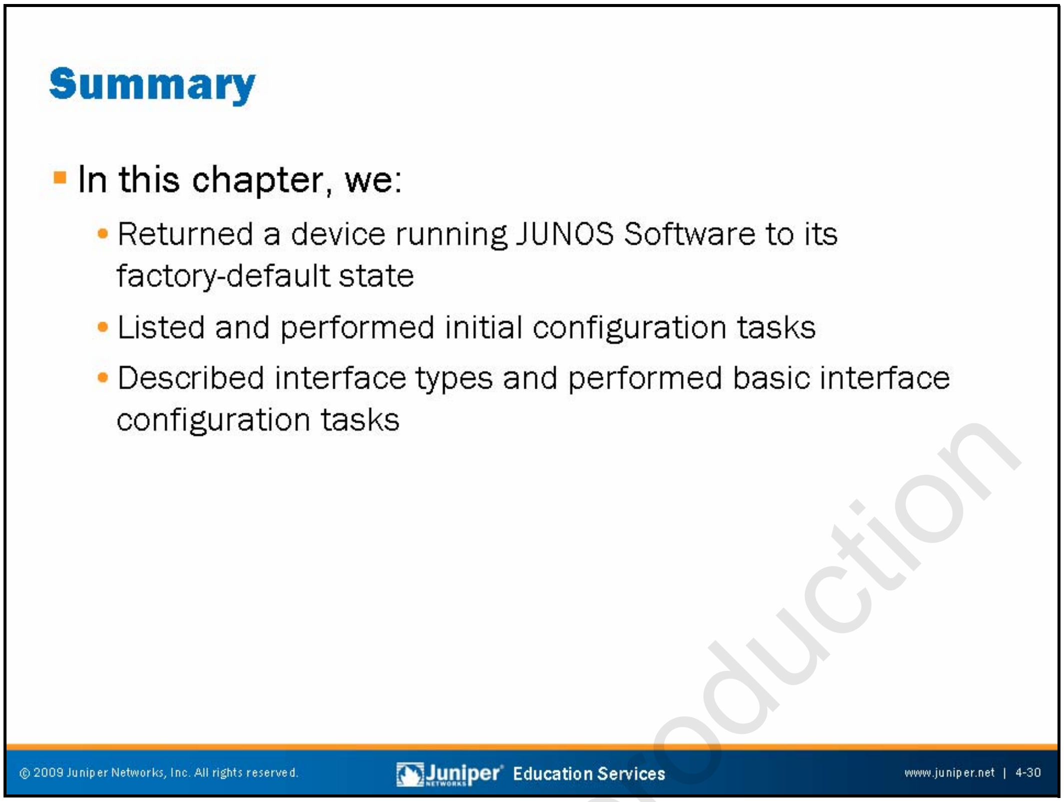
Tracking the State of an Interface

To quickly verify the state of an interface you can issue the **`show interfaces terse`** command. To filter the displayed output to an individual interface, add the name of the interface, as shown on the slide. In the sample output displayed on the slide, we see the admin and link status, the protocol family details, and the address information for the specified interface. We cover interface monitoring in greater detail in a subsequent chapter.



Summary

- In this chapter, we:
  - Returned a device running JUNOS Software to its factory-default state
  - Listed and performed initial configuration tasks
  - Described interface types and performed basic interface configuration tasks

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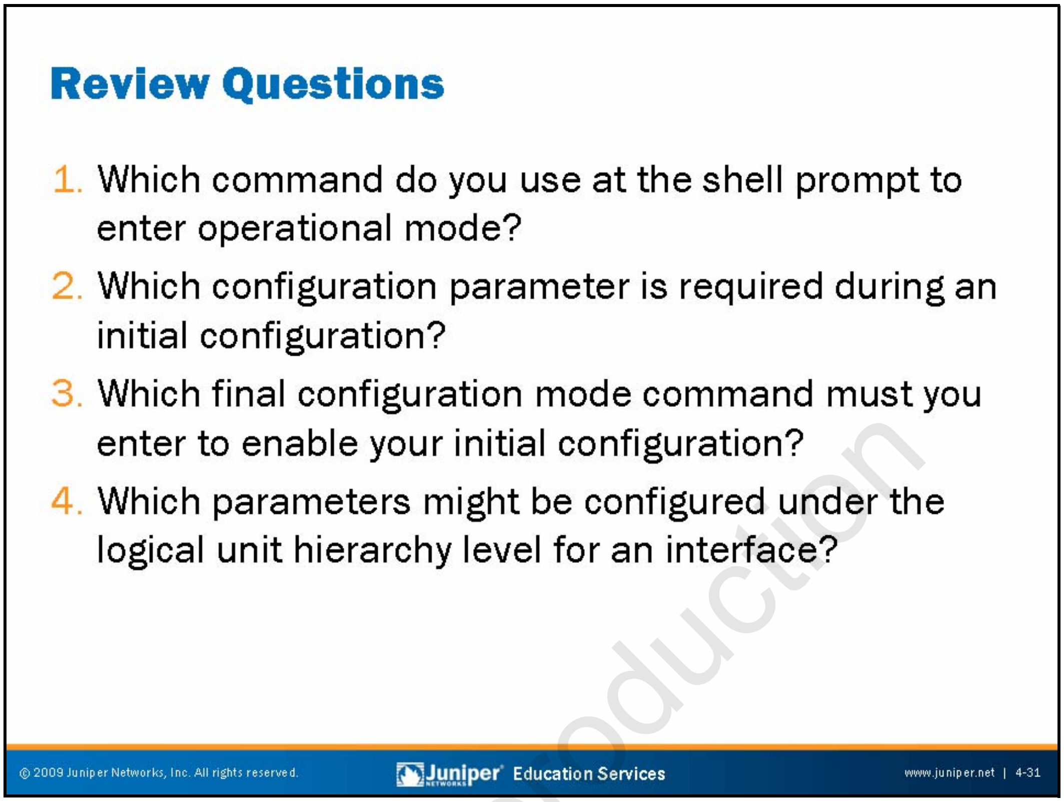
This Chapter Discussed:

- The factory-default configuration for platforms running JUNOS Software;
- Initial configuration tasks performed on devices running JUNOS Software; and
- Interface types and interface configuration basics.



Review Questions

1. Which command do you use at the shell prompt to enter operational mode?
2. Which configuration parameter is required during an initial configuration?
3. Which final configuration mode command must you enter to enable your initial configuration?
4. Which parameters might be configured under the logical unit hierarchy level for an interface?

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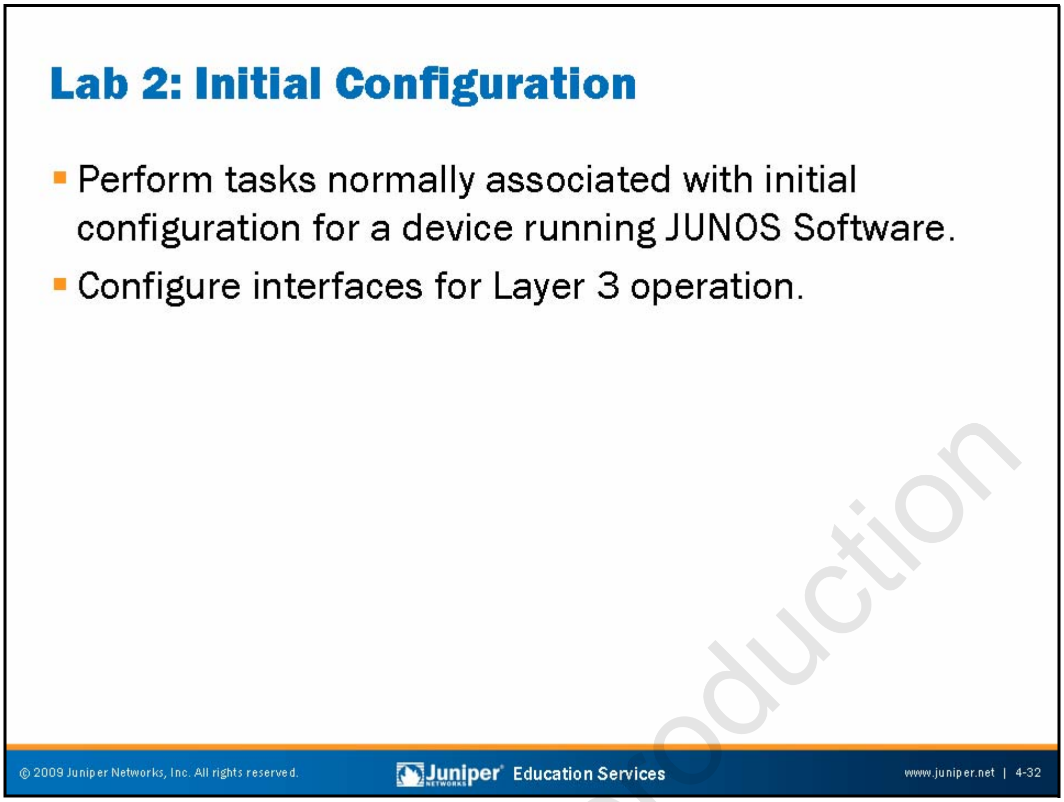
Review Questions

1.

2.

3.

4.



Lab 2: Initial Configuration

- Perform tasks normally associated with initial configuration for a device running JUNOS Software.
- Configure interfaces for Layer 3 operation.

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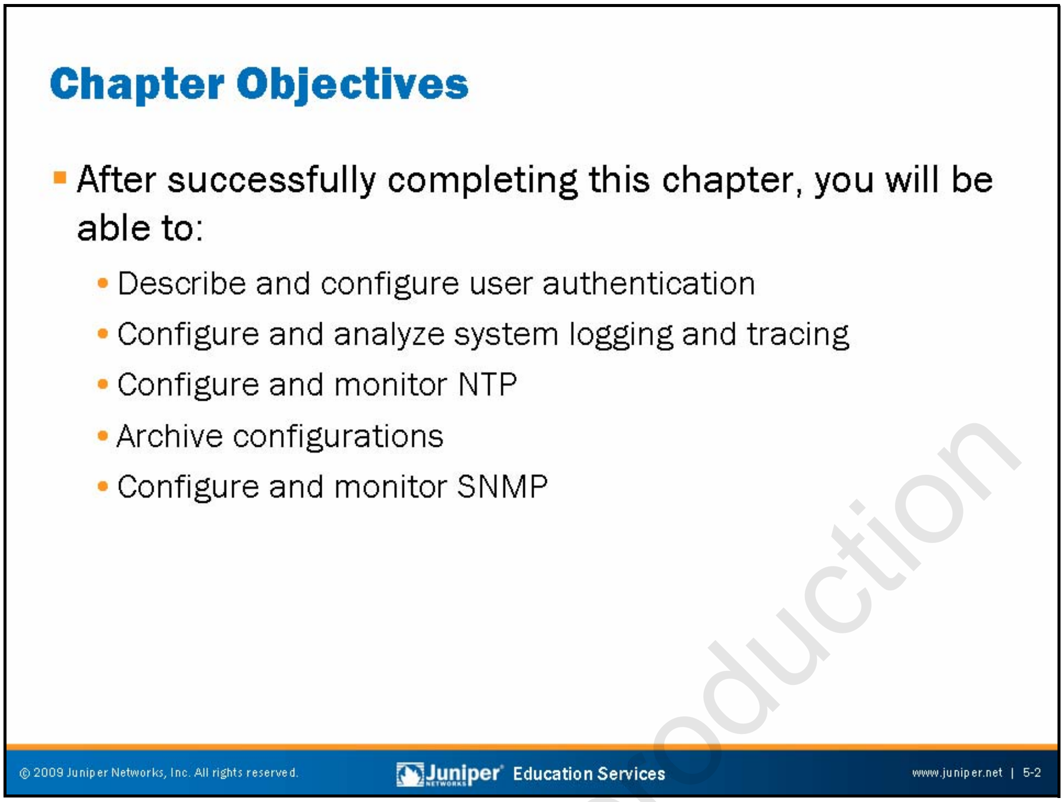
Lab 2: Initial Configuration

The slide provides the objectives for this lab.

Introduction to JUNOS Software

Chapter 5: Secondary System Configuration



Chapter Objectives

- After successfully completing this chapter, you will be able to:
  - Describe and configure user authentication
  - Configure and analyze system logging and tracing
  - Configure and monitor NTP
  - Archive configurations
  - Configure and monitor SNMP

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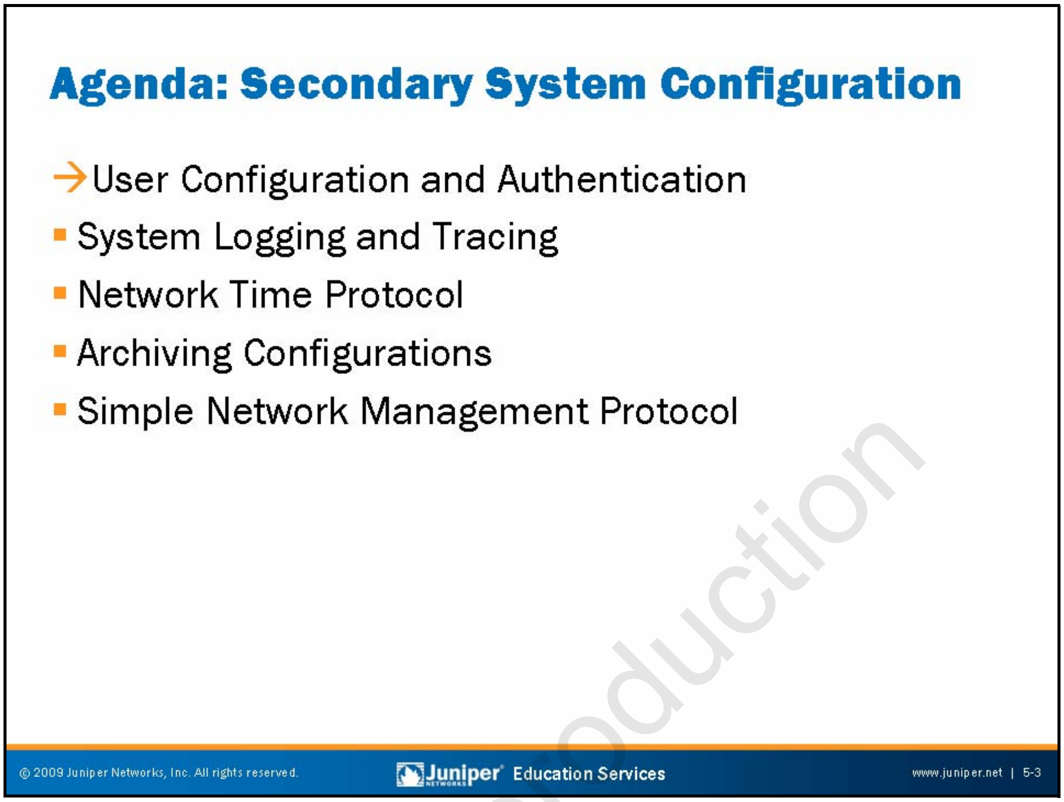
This Chapter Discusses:

- User authentication methods and configuration;
- Configuring and analyzing system logging and tracing;
- Network Time Protocol (NTP) configuration and operation;
- Archiving configurations on remote devices; and
- Configuring and monitoring SNMP.



Agenda: Secondary System Configuration

→User Configuration and Authentication

- System Logging and Tracing
- Network Time Protocol
- Archiving Configurations
- Simple Network Management Protocol

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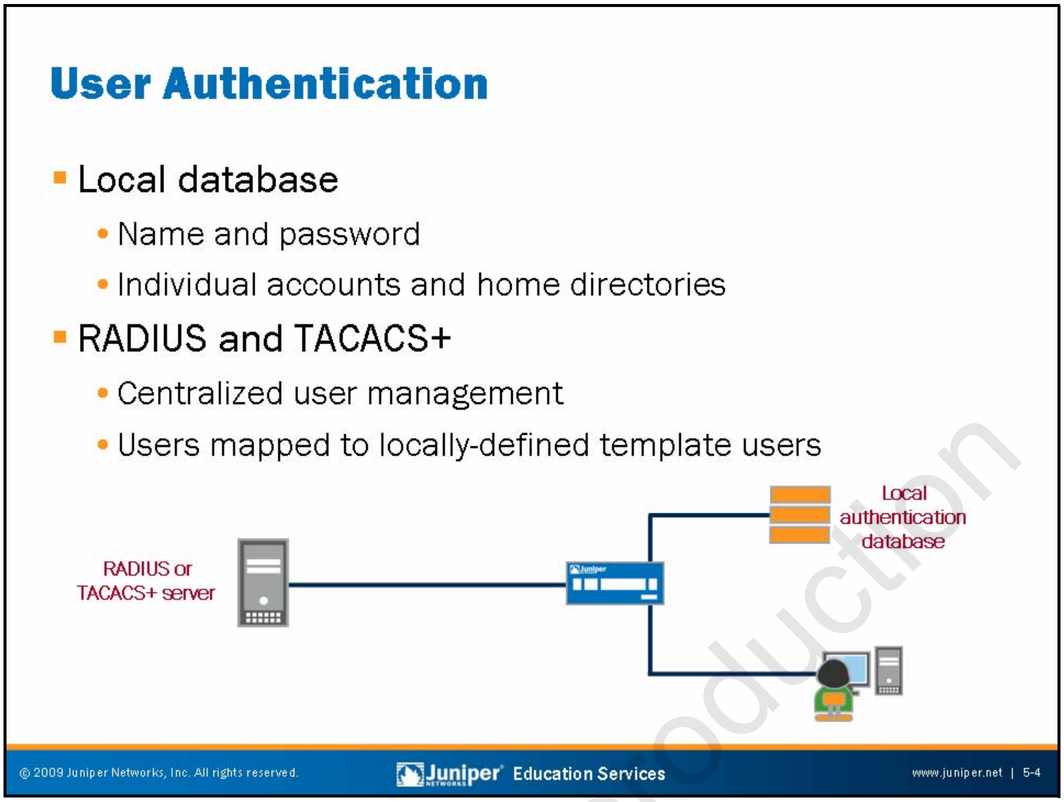
User Configuration and Authentication

The slide lists the topics we cover in this chapter. We discuss the highlighted topic first.



User Authentication

- Local database
  - Name and password
  - Individual accounts and home directories
- RADIUS and TACACS+
  - Centralized user management
  - Users mapped to locally-defined template users

Local Password Authentication

With local password authentication, you can configure usernames and passwords individually for each user to log in to a device running JUNOS Software. JUNOS Software enforces the following password restrictions:

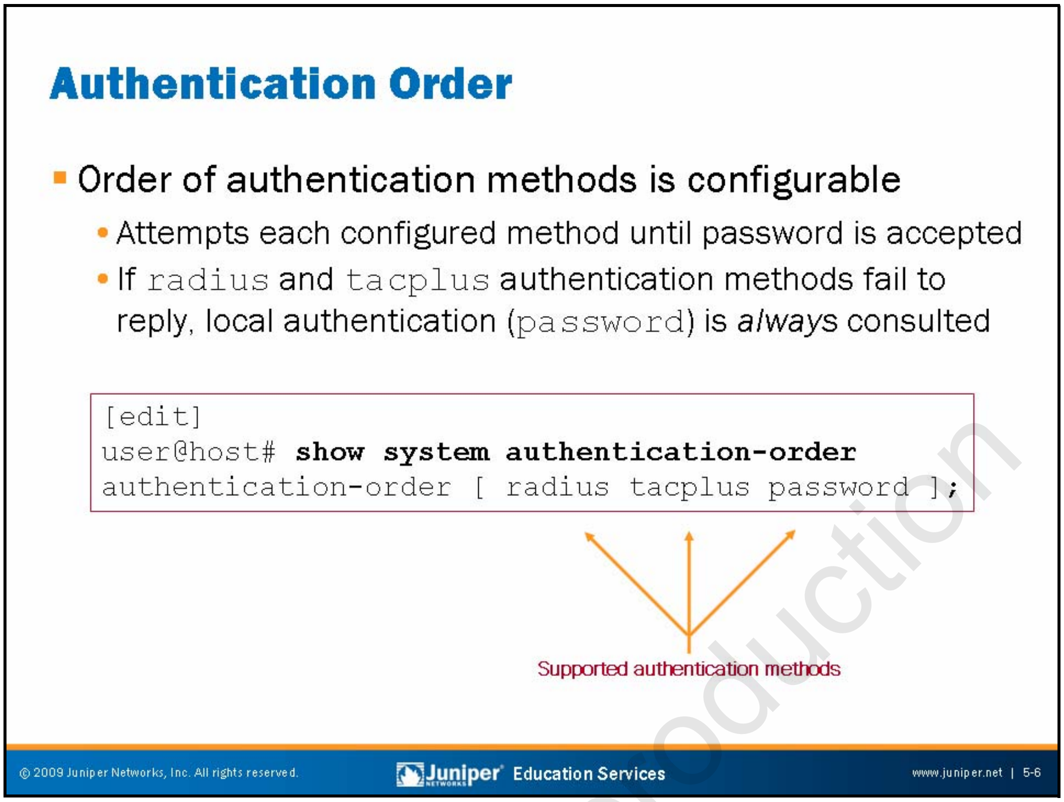
- The password must be at least 6 characters;
- You can include most character classes in a password (alphabetic, numeric, and special characters), except control characters; and
- Passwords must contain at least one change of case or character class.

When a user is configured on a device running JUNOS Software, the system automatically generates a home directory for that user. The home directory serves as the default working directory for each locally configured user. The user's working directory can be changed for individual sessions using the operational mode **`set cli directory`** ***directory*** command.

Continued on next page.

RADIUS and TACACS+

RADIUS and TACACS+ are distributed client and server systems used as authentication methods to validate users. The RADIUS and TACACS+ clients run on devices running JUNOS Software; the server runs on a host connected to a remote network. A locally defined user account determines authorization. Multiple RADIUS or TACACS+ authenticated users can be mapped to a locally defined template user account. Local template user accounts avoid the need for each RADIUS or TACACS+ user to also have a locally defined user account. With the appropriate Juniper Networks extensions loaded on the server, both RADIUS and TACACS+ can override these template user authorization parameters by passing extended regular expressions. Coverage of regular expressions is outside of the scope of this class.



Authentication Order

- Order of authentication methods is configurable
  - Attempts each configured method until password is accepted
  - If `radius` and `tacplus` authentication methods fail to reply, local authentication (`password`) is *always* consulted

```
[edit]
user@host# show system authentication-order
authentication-order [ radius tacplus password ];
```

Supported authentication methods

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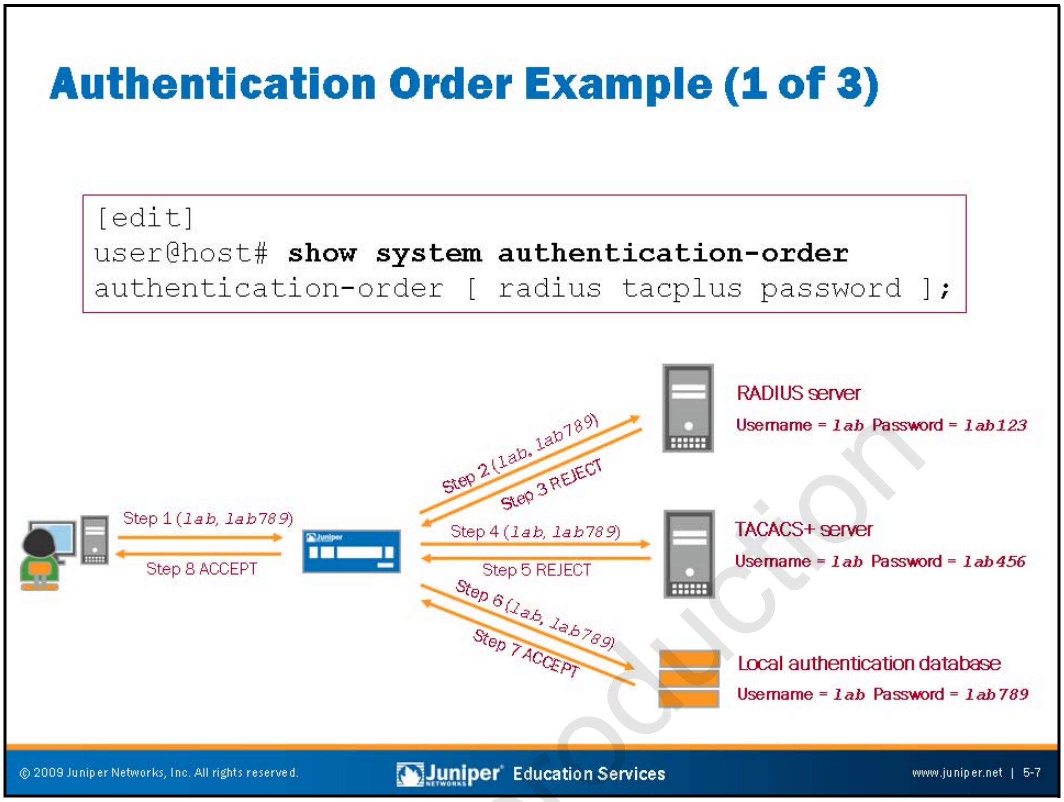
Authentication Order

You can configure devices running JUNOS Software to be both a RADIUS and TACACS+ client, and you can prioritize the order in which the software tries one or more of the three different authentication methods.

For each login attempt, JUNOS Software tries the authentication methods in order, until the password is accepted. The next method in the authentication order is consulted if the previous authentication method failed to reply or if the method rejected the login attempt. If no reply (accept or reject) is received from any of the listed authentication methods, JUNOS Software consults local authentication as a last resort.



Authentication Order Example (1 of 3)

```
[edit]
user@host# show system authentication-order
authentication-order [ radius tacplus password ];
```

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Example 1

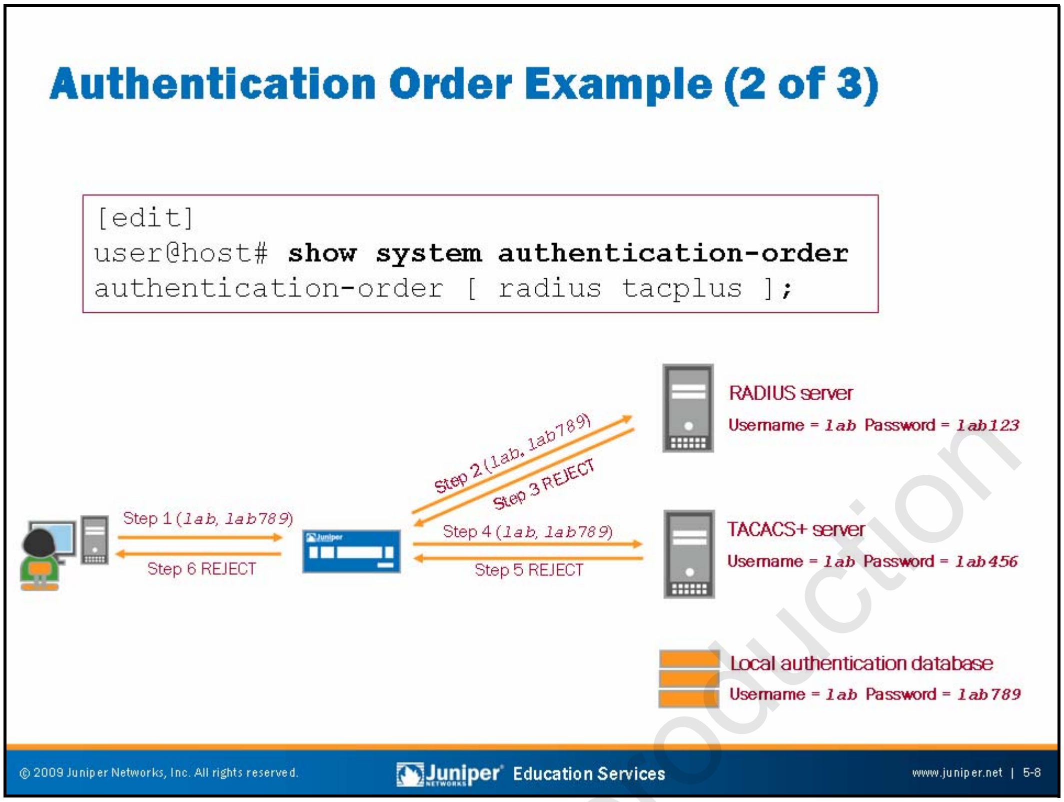
In the example shown on the slide, we configured `authentication-order [ radius tacplus password ]`. We entered a username of *lab* and a password of *lab789*. We successfully authenticated because each configured authentication method is attempted until the password is accepted by the local authentication database.

In addition to the authentication order shown on the slide, you would also need to configure the RADIUS and TACACS+ servers as well as the lab user. The following is a sample of these configuration parameters:

```
[edit system]
user@host# show radius-server
172.18.102.13 secret "$9$9ZKntpBvMX7Nb1RcleW-dbs2gaU"; ## SECRET-DATA

[edit system]
user@host# show tacplus-server
172.17.32.14 secret "$9$m5T31Icyrvn/A0ORlevWLXNb"; ## SECRET-DATA

[edit system]
user@host# show login user lab
class super-user;
authentication {
    encrypted-password "$1$dJ3NA9BW$nZGLZAp9kpiG52kru34IT."; ## SECRET-DATA
}
```



Authentication Order Example (2 of 3)

```
[edit]
user@host# show system authentication-order
authentication-order [ radius tacplus ];
```

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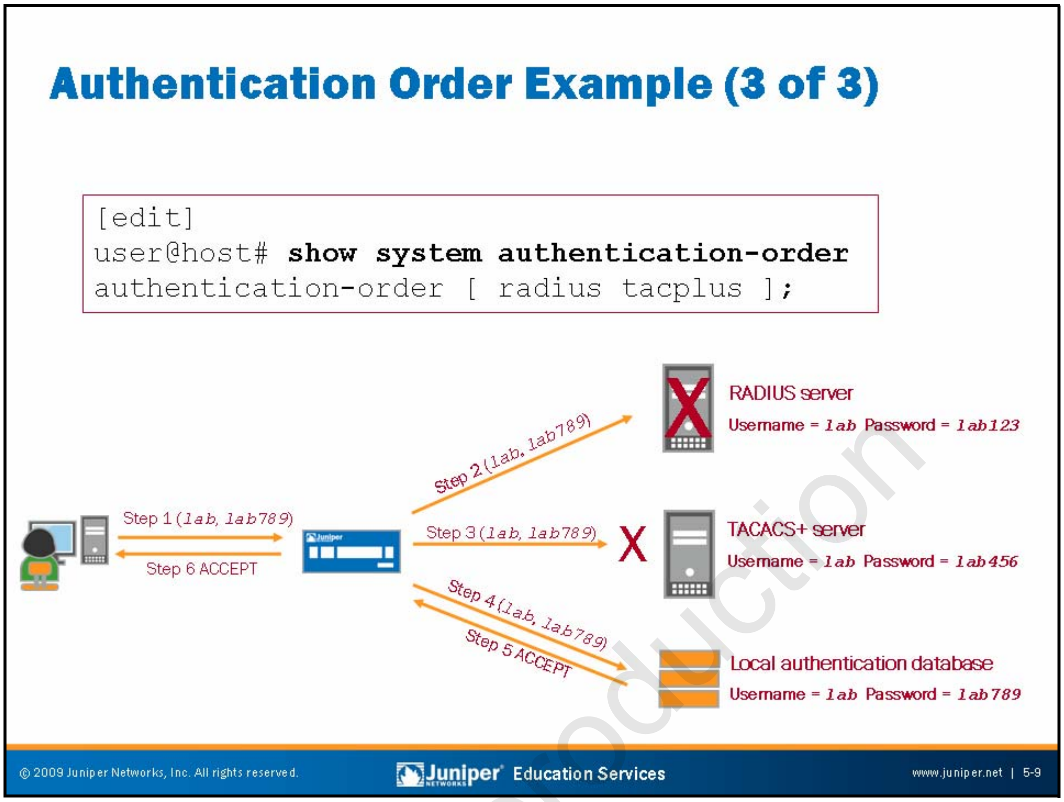
Example 2

In this example, we configured `authentication-order [ radius tacplus ]`. We entered a username of *lab* and a password of *lab789*. JUNOS Software attempted to authenticate the password against the RADIUS server, which rejected it. It then attempted to authenticate the password against the TACACS+ server, which also rejected it. JUNOS Software does not consult local authentication because it is not listed in the authentication order, and because at least one of the configured authentication methods did respond. The password was rejected.



Authentication Order Example (3 of 3)

```
[edit]
user@host# show system authentication-order
authentication-order [ radius tacplus ];
```

Step 1 (*lab, lab789*)

Step 6 ACCEPT

Step 2 (*lab, lab789*)

Step 3 (*lab, lab789*)

Step 4 (*lab, lab789*)

Step 5 ACCEPT

RADIUS server

Username = *lab* Password = *lab123*

TACACS+ server

Username = *lab* Password = *lab456*

Local authentication database

Username = *lab* Password = *lab789*

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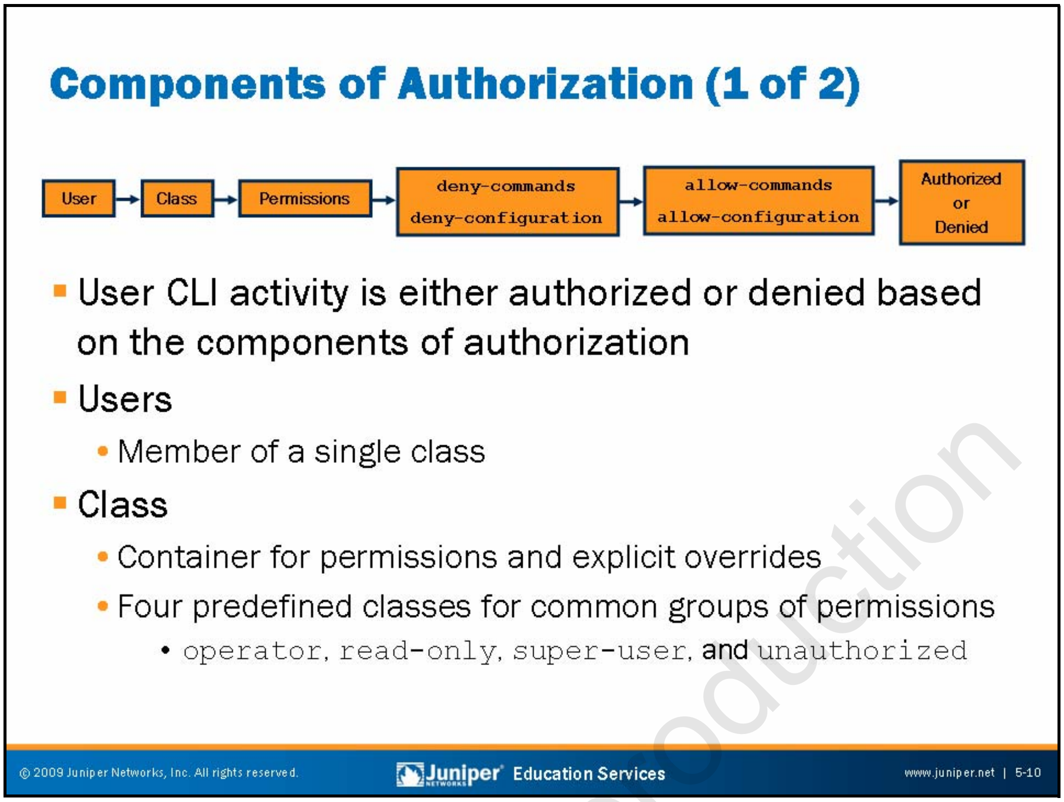
Example 3

In this example, `authentication-order [ radius tacplus ]` is still configured. We entered a username of *lab* and a password of *lab789*. JUNOS Software attempted to authenticate the password against the RADIUS server, which is down. The device running JUNOS Software received no response, and after a timeout period, tried the TACACS+ server. A temporary network problem caused the TACACS+ server to be unreachable. After a timeout period, local authentication was consulted and the password was accepted. JUNOS Software consulted local authentication because none of the configured authentication methods responded.



Components of Authorization (1 of 2)

User → Class → Permissions → deny-commands deny-configuration → allow-commands allow-configuration → Authorized or Denied

- User CLI activity is either authorized or denied based on the components of authorization
- Users
  - Member of a single class
- Class
  - Container for permissions and explicit overrides
  - Four predefined classes for common groups of permissions
    - `operator`, `read-only`, `super-user`, and `unauthorized`

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Authorization Overview

Each command or configuration statement is subject to authorization. JUNOS Software applies authorization to all nonroot users, and you cannot disable this feature. Authorization applies to both the J-Web interface and the command-line interface (CLI). A configured hierarchy of authorization components, as shown by the graphic on the slide, defines whether a command is authorized.

Users

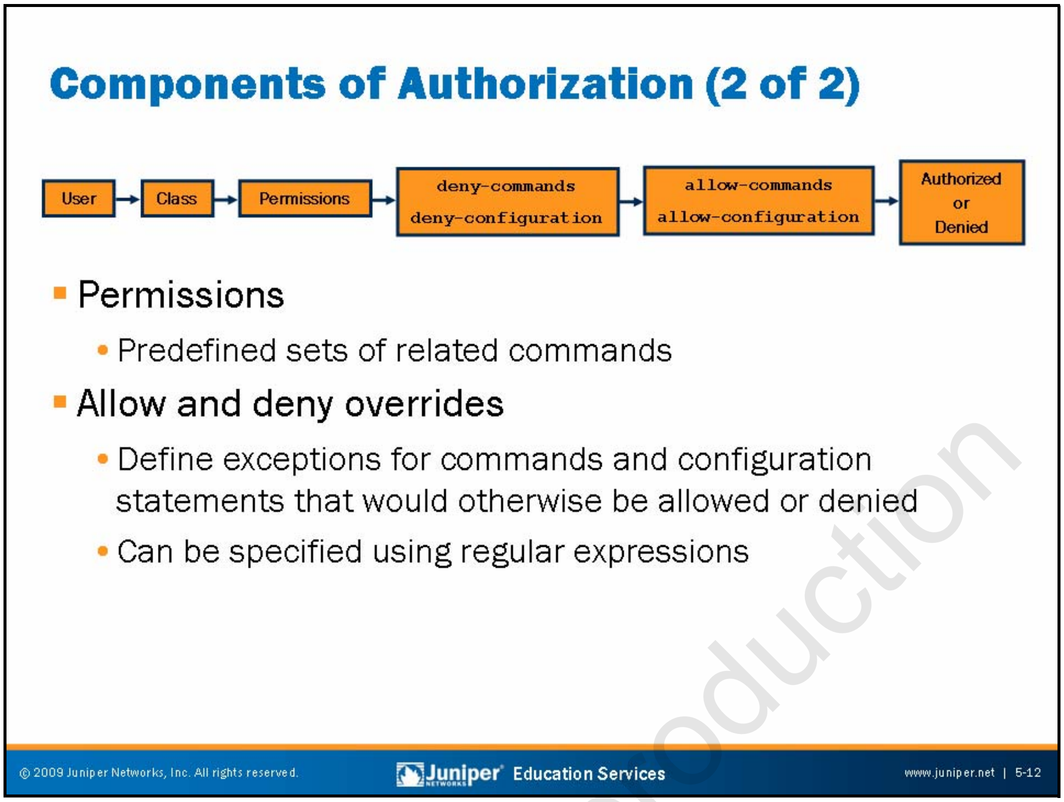
At the highest level, the configuration of user accounts define authorization parameters. As previously mentioned, multiple remotely authenticated users can be mapped to a locally defined template user. Users are members of a single login class.

Continued on next page.

Class

A login class is a named container that groups together a set of one or more permission flags. Login classes can also specify that the permission flags should be overridden for certain commands. You can configure custom login classes, but there are four predefined login classes that exist to handle most situations. These classes and associated permission flags are the following:

- `super-user`: All permissions;
- `operator`: Clear, network, reset, trace, and view permissions;
- `read-only`: View permissions; and
- `unauthorized`: No permissions.



Components of Authorization (2 of 2)

User → Class → Permissions → deny-commands deny-configuration → allow-commands allow-configuration → Authorized or Denied

- Permissions
  - Predefined sets of related commands
- Allow and deny overrides
  - Define exceptions for commands and configuration statements that would otherwise be allowed or denied
  - Can be specified using regular expressions

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Permissions

The following predefined permission flags group together the authorization of related commands:

- `access`: Allows the viewing of network access configuration;
- `access-control`: Allows the modifying of network access configuration;
- `admin`: Allows the viewing of user accounts;
- `admin-control`: Allows the modifying of user accounts;
- `all`: Enables all permission bits to be turned on;
- `clear`: Allows the clearing of learned network information;
- `configure`: Allows the entering of configuration mode;
- `control`: Allows the modifying of any configuration values (must be used in conjunction with the `configure` permission);
- `field`: Is reserved for field (debug) support;
- `firewall`: Allows the viewing of firewall configuration;
- `firewall-control`: Allows the modifying of firewall configuration;
- `floppy`: Allows the reading and writing of information to the floppy drive;

Continued on next page.

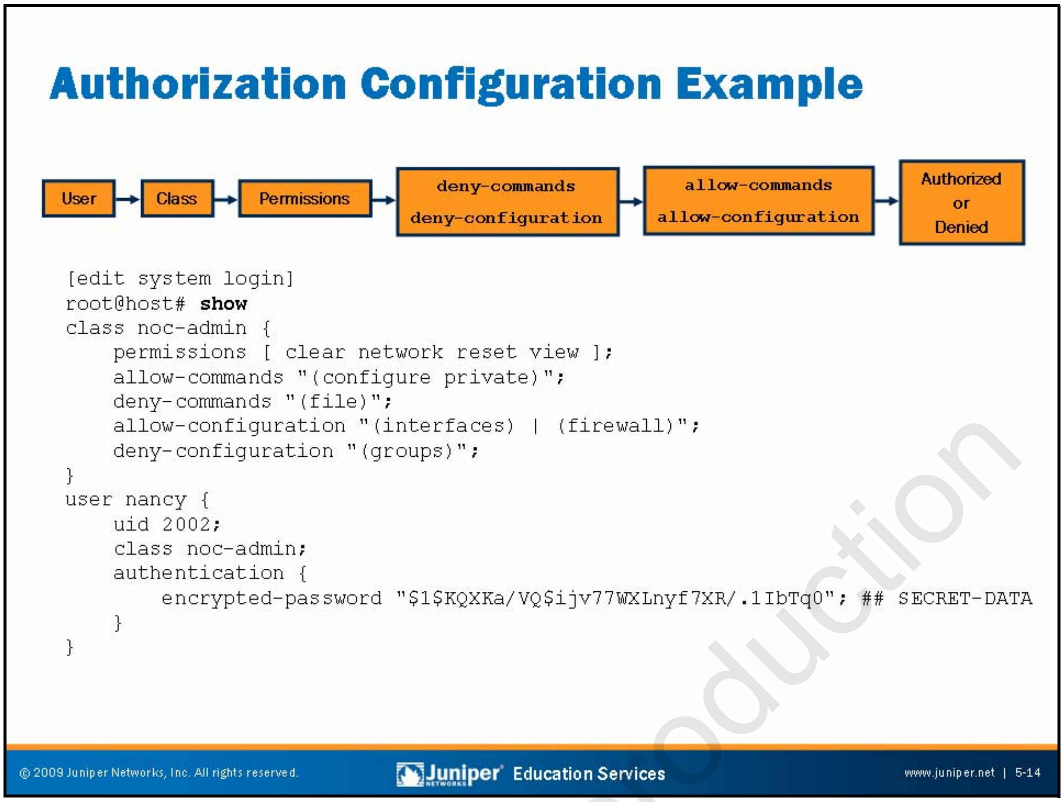
Permissions (contd.)

- `flow-tap`: Allows the viewing of flow-tap configuration;
- `flow-tap-control`: Allows the modifying of flow-tap configuration;
- `flow-tap-operation`: Enables the tapping of flows;
- `idp-profiler-operation`: Enables IDP profiler;
- `interface`: Allows the viewing of interface configuration;
- `interface-control`: Allows the modifying of interface configuration;
- `maintenance`: Allows system maintenance, including starting a local shell on the device and becoming the superuser in the shell, and can halt and reboot the system;
- `network`: Allows network access;
- `reset`: Allows the resetting and restarting of interfaces and processes;
- `rollback`: Allows the ability to roll back for depth greater than zero;
- `routing`: Allows the viewing of routing configuration;
- `routing-control`: Allows the modifying of routing configuration;
- `secret`: Allows the viewing of secret configuration;
- `secret-control`: Allows the modifying of secret configuration;
- `security`: Allows the viewing of security configuration;
- `security-control`: Allows the modifying of security configuration;
- `shell`: Allows the starting of a local shell;
- `snmp`: Allows the viewing of SNMP configuration;
- `snmp-control`: Allows the modifying of SNMP configuration;
- `system`: Allows the viewing of system configuration;
- `system-control`: Allows the modifying of system configuration;
- `trace`: Allows the viewing of trace file settings;
- `trace-control`: Allows the modifying of trace file settings;
- `view`: Allows the viewing of current values and statistics; and
- `view-configuration`: Allows the viewing of all configuration (not including secrets).

The configurable permissions might vary between JUNOS platforms and software versions. Refer to the technical publications for your specific device and version of JUNOS Software.

Allow and Deny Overrides

You can use the **`deny-commands`**, **`allow-commands`**, **`deny-configuration`**, and **`allow-configuration`** statements to define regular expressions that match operational commands or configuration statements. Matches are explicitly allowed or denied, regardless of whether you set the corresponding permission flags. The JUNOS Software applies the **`deny-`** statements before the corresponding **`allow-`** statements, resulting in the authorization of commands that match both.



Authorization Configuration Example

```
[edit system login]
root@host# show
class noc-admin {
    permissions [ clear network reset view ];
    allow-commands "(configure private)";
    deny-commands "(file)";
    allow-configuration "(interfaces) | (firewall)";
    deny-configuration "(groups)";
}
user nancy {
    uid 2002;
    class noc-admin;
    authentication {
        encrypted-password "$1$KQXKa/VQ$ijv77WXLnyf7XR/.1IbTq0"; ## SECRET-DATA
    }
}
```

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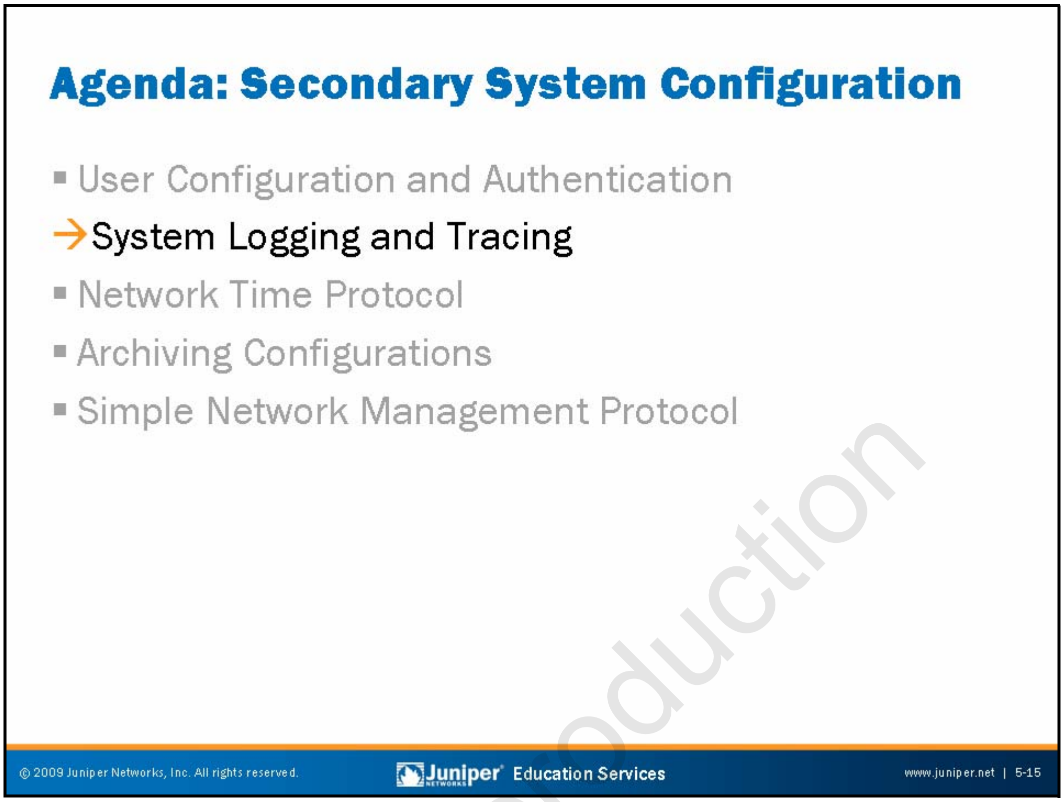
Authorization Example

The configuration example on the slide shows how the various authorization components are configured:

- User *nancy* is a member of the *noc-admin* class;
- The *noc-admin* class has the `clear`, `network`, `reset`, and `view` permissions;
- In addition, the *noc-admin* class can enter configuration mode using the **`configure private`** command and is allowed to alter configuration parameters at the `[edit interfaces]` and `[edit firewall]` hierarchy levels; and
- The *noc-admin* class is denied the ability to manipulate files using the operational mode's **`file`** command and is specifically excluded from navigating to or viewing configuration details at the `[edit groups]` hierarchy level.



Agenda: Secondary System Configuration

- User Configuration and Authentication
- → System Logging and Tracing
- Network Time Protocol
- Archiving Configurations
- Simple Network Management Protocol

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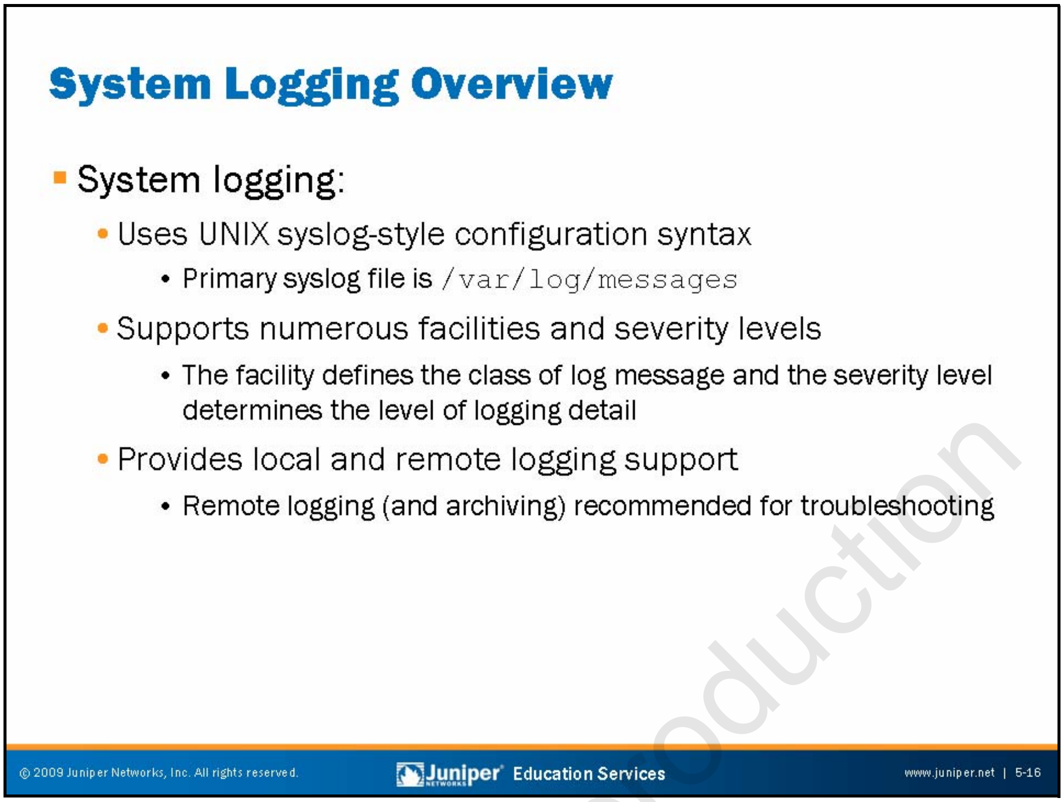
System Logging and Tracing

The slide highlights the topic we discuss next.



System Logging Overview

- System logging:
  - Uses UNIX syslog-style configuration syntax
    - Primary syslog file is `/var/log/messages`
  - Supports numerous facilities and severity levels
    - The facility defines the class of log message and the severity level determines the level of logging detail
  - Provides local and remote logging support
    - Remote logging (and archiving) recommended for troubleshooting

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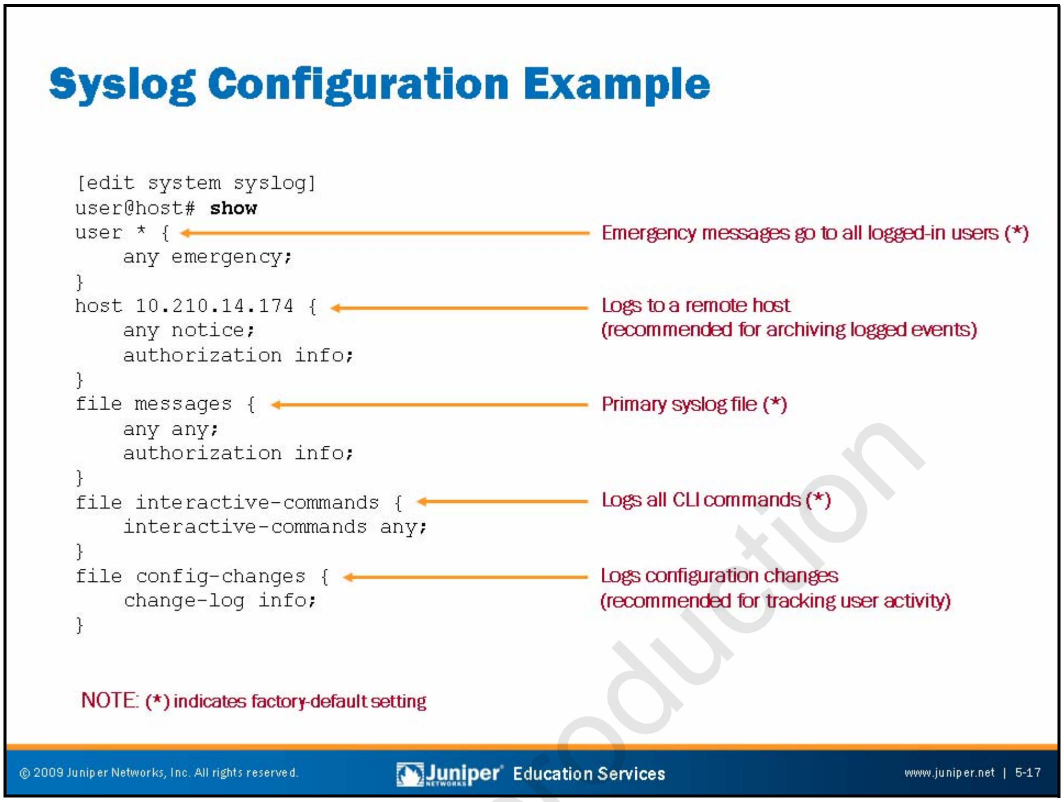
System Logging

System logging (syslog) operations use a UNIX syslog-style mechanism to record system-wide, high-level operations, such as interfaces going up or down or users logging in to or out of the device. JUNOS Software places the results of the logging operations in files that are stored in the `/var/log` directory. The primary syslog file, which is included in all factory-default configurations, is the `/var/log/messages` file.

JUNOS Software supports a number of facilities and severity levels. The facility is listed first and defines the class of log messages. The severity level is listed second and determines the level of detail to be logged.

Syslog information can be logged to individual files, such as the `/var/log/messages` file, or it can be sent to a remote server. Remote logging and log file archiving is recommended to aid in troubleshooting efforts.



Syslog Configuration Example

```
[edit system syslog]
user@host# show
user * {
    any emergency;
}
host 10.210.14.174 {
    any notice;
    authorization info;
}
file messages {
    any any;
    authorization info;
}
file interactive-commands {
    interactive-commands any;
}
file config-changes {
    change-log info;
}
```

Emergency messages go to all logged-in users (*)

Logs to a remote host
(recommended for archiving logged events)

Primary syslog file (*)

Logs all CLI commands (*)

Logs configuration changes
(recommended for tracking user activity)

NOTE: (*) indicates factory-default setting

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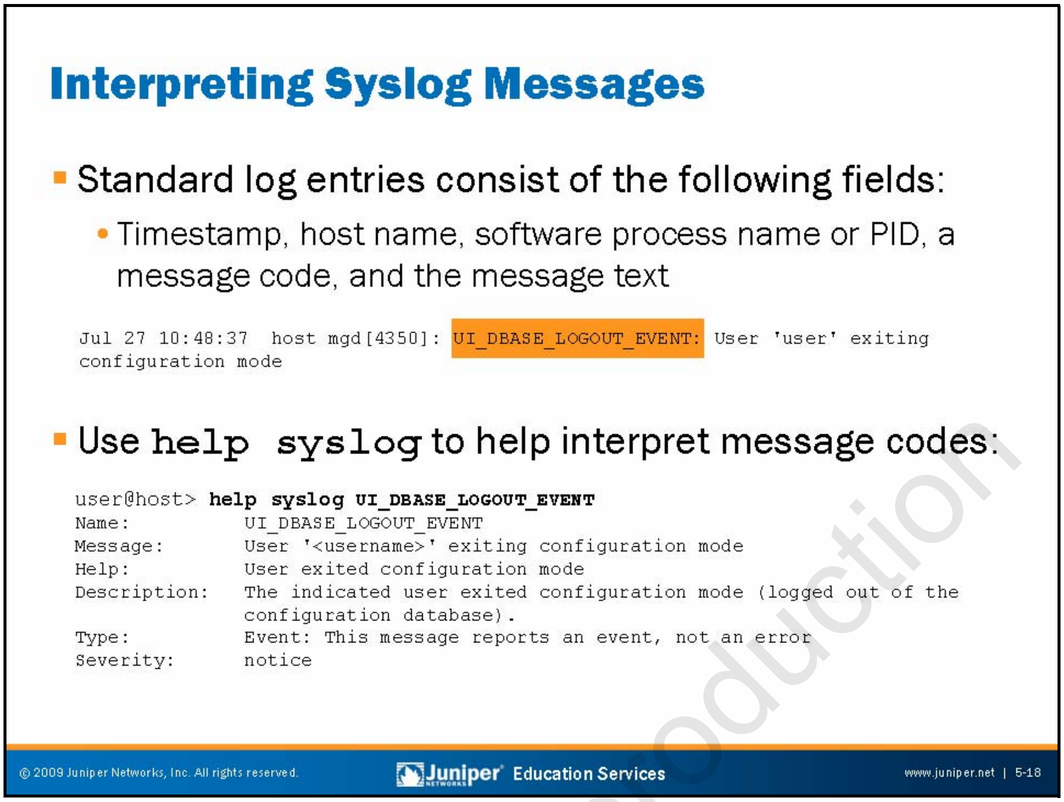
Syslog Configuration Example

The slide shows various syslog configuration examples including a number of the default settings. Syslog operations can be enabled or modified at the `[edit system syslog]` hierarchy level and the `[edit routing-options options syslog]` hierarchy level. General syslog configuration options include the following:

- **`host`** ***`name`*** or ***`IP address`***: Sends syslog messages to a remote host—typically a UNIX device configured to receive incoming syslog messages;
- **`archive`**: Configures how to archive system logging files (default is to keep 10 archive files with a maximum size of 128 K each);
- **`console`**: Configures the types of syslog messages to log to the system console;
- **`facility`**: Displays the class of log messages;
- **`severity`**: Displays the severity level of log messages;
- **`file`** ***`filename`***: Configures the name of the log file; and
- **`files`** ***`number`***: Displays the maximum number of system log files.



Interpreting Syslog Messages

- Standard log entries consist of the following fields:
  - Timestamp, host name, software process name or PID, a message code, and the message text

```
Jul 27 10:48:37  host mgd[4350]: UI_DBASE_LOGOUT_EVENT: User 'user' exiting
configuration mode
```

- Use **help syslog** to help interpret message codes:

```
user@host> help syslog UI_DBASE_LOGOUT_EVENT
Name:          UI_DBASE_LOGOUT_EVENT
Message:       User '<username>' exiting configuration mode
Help:          User exited configuration mode
Description:   The indicated user exited configuration mode (logged out of the
               configuration database).
Type:          Event: This message reports an event, not an error
Severity:      notice
```

Interpreting System Log Entries

When using the standard syslog format, each log entry written to the messages file consists of the following fields:

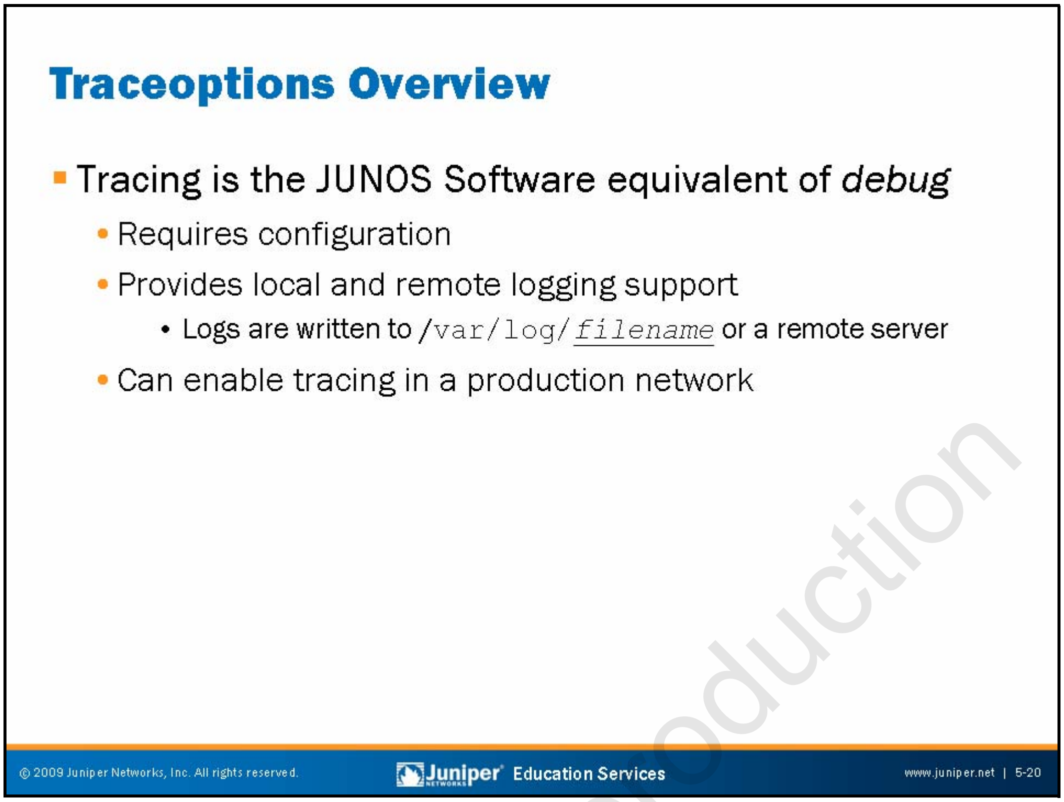
- `timestamp`: Indicates when the message was logged;
- `name`: Displays the configured system name;
- `Process name` or `PID`: Displays the name of the process (or the process ID when a name is not available) that generated the log entry;
- `message-code`: Provides a code that identifies the general nature and purpose of the message. In the example shown, the message code is `UI_DBASE_LOGOUT_EVENT`; and
- `message-text`: Provides additional information related to the message code.

When you add the **`explicit-priority`** statement, JUNOS Software alters the syslog message format to include a numeric priority value. In this situation, the value 0 indicates the most significant and urgent messages (emergency), and 7 indicates debug-level messages.

Continued on next page.

Interpreting Message Codes

Consult the *System Log Messages Reference* documentation for a full description of the various message codes and their meanings, or, better yet, use the CLI's **`help`** function to obtain this information. The example on the slide shows the operator obtaining help on the meaning of the `UI_DBASE_LOGOUT_EVENT` message code. Based on the output, you can clearly see that the message code shows a command that a user entered at the CLI prompt.



Traceoptions Overview

- Tracing is the JUNOS Software equivalent of *debug*
  - Requires configuration
  - Provides local and remote logging support
    - Logs are written to `/var/log/`*`filename`* or a remote server
  - Can enable tracing in a production network

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Hear Tracing, Think Debug

Tracing is the JUNOS Software term for what other vendors sometimes call *debug*. In most cases, when you enable tracing (through configuration), you create a trace file that is used to store decoded protocol information received or sent by the routing engine. JUNOS Software sends the tracing results to a specified file stored in the `/var/log` directory or to a remote syslog server. To enable remote logging, specify a syslog server at the `[edit system tracing]` hierarchy level as shown in the following screen capture:

```
[edit system tracing]
user@host# show
destination-override syslog host 1.1.1.1;
```

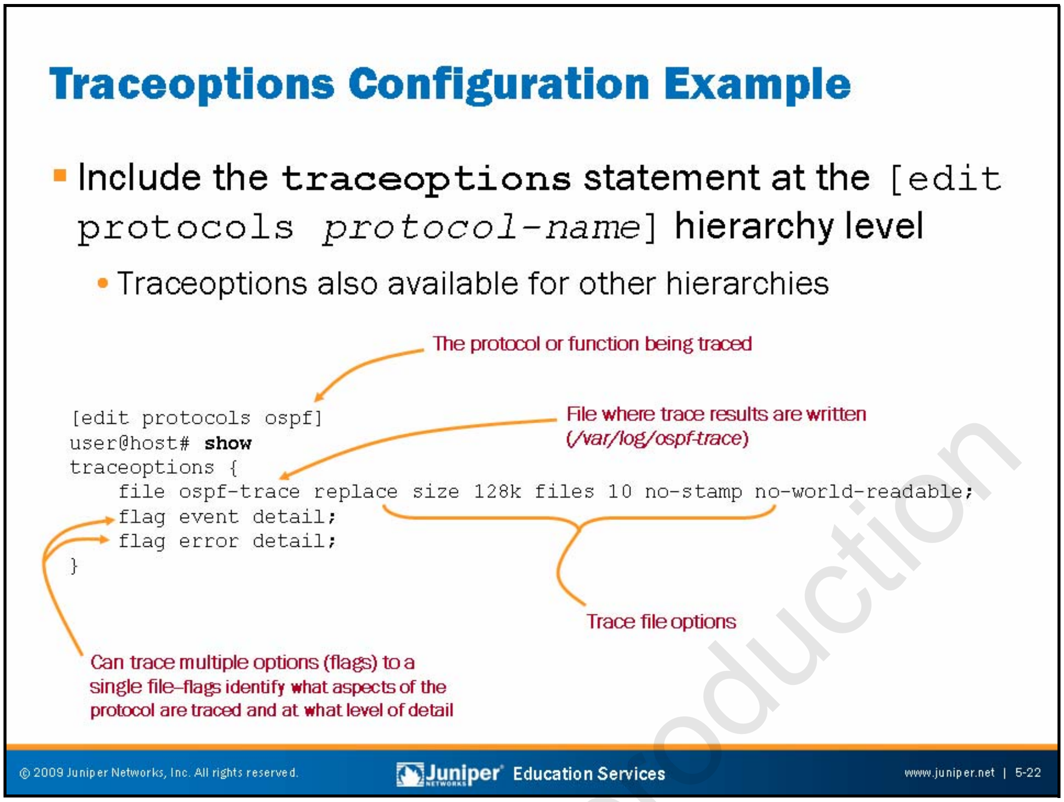
Continued on next page.

Hear Tracing, Think Debug (contd.)

You might see a warning when using the remote syslog server option. If the syslog server is configured properly and you have verified that the logs are being received on the server, you can safely ignore the warning. The following is a sample warning:

```
[edit]
user@host# commit
[edit protocols ospf]
  'traceoptions'
    warning: No file specified.
commit complete
```

Because of the design of JUNOS Software, you can enable detailed tracing in a production network without significantly impacting performance. Even so, you should always remember to turn off tracing once you have completed your testing to avoid unnecessary resource consumption.



Traceoptions Configuration Example

- Include the **traceoptions** statement at the `[edit protocols protocol-name]` hierarchy level
  - Traceoptions also available for other hierarchies

The protocol or function being traced

File where trace results are written (/var/log/ospf-trace)

```
[edit protocols ospf]
user@host# show
traceoptions {
    file ospf-trace replace size 128k files 10 no-stamp no-world-readable;
    flag event detail;
    flag error detail;
}
```

Trace file options

Can trace multiple options (flags) to a single file–flags identify what aspects of the protocol are traced and at what level of detail

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Traceoptions Configuration Example

Trace the operations of a specific protocol by including the **`traceoptions`** statement at the `[edit protocols` *`protocol-name`*`]` hierarchy. In most cases you will want to be selective in what you trace because selecting the **`all`** keyword will likely provide too much detail. The sample Open Shortest Path First (OSPF) Protocol stanza on the slide reflects a typical tracing configuration that provides details about OSPF events and errors. In many cases you will want to use the **`detail`** switch with a given protocol flag for the added information often needed in troubleshooting scenarios.

Continued on next page.

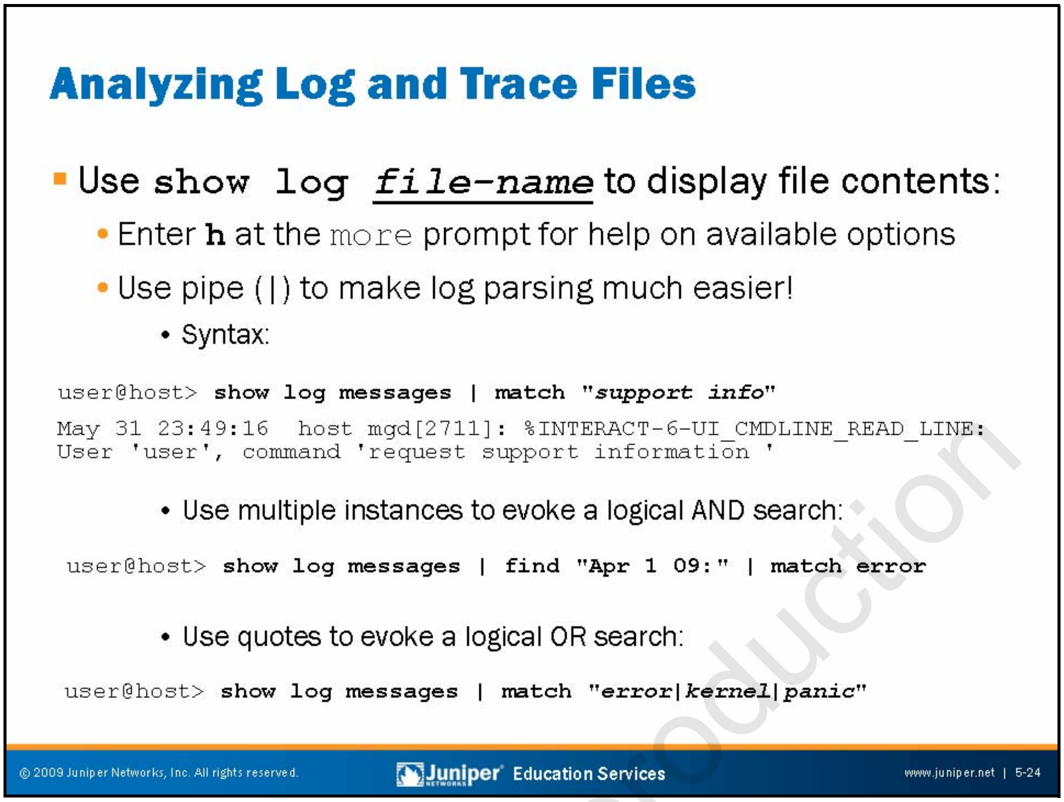
Traceoptions Configuration Example (contd.)

The following are configuration options for tracing files:

- **`file`** ***`filename`***: Specifies the name of the file in which to store information;
- **`size`** ***`size`***: Specifies the maximum size of each trace file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a trace file named *`trace-file`* reaches this size, it is renamed *`trace-file.0`*. When the trace file again reaches its maximum size, *`trace-file.0`* is renamed *`trace-file.1`*, and *`trace-file`* is renamed *`trace-file.0`*. This renaming scheme continues until the maximum number of trace files is reached. The software then overwrites the oldest trace file. If you specify a maximum file size, you also must specify a maximum number of trace files with the files option. The default size is 128 KB;
- **`files`** ***`number`***: Specifies the maximum number of trace files. When a trace file named *`trace-file`* reaches its maximum size, it is renamed *`trace-file.0`*, then *`trace-file.1`*, and so forth, until the maximum number of trace files is reached. The software then overwrites the oldest trace file. The default is ten files;
- **`no-stamp`**: Prevents timestamp information from being placed at the beginning of each line in the trace file. By default, if you omit this option, timestamp information is placed at the beginning of each line of the tracing output;
- **`replace`**: Replaces an existing trace file if one exists. By default, if you omit this option, tracing output is appended to an existing trace file;
- **`readable`**: Allows any user to view the file; and
- **`no-world-readable`**: Allows only the user who configured the file to view it. This is the default setting.

As mentioned on the slide, traceoptions are also available at other configuration hierarchies. Including the **`traceoptions`** statement at the `[edit interfaces` *`interface-name`*`]` hierarchy level allows you to trace the operations of individual interfaces. You can also trace the operations of the interface process, which is the device-control process (dcd).

When tracing a specific interface, the specification of a trace file is not supported. The JUNOS Software kernel does the logging in this case, so the tracing information is placed in the system's `messages` file. In contrast, global interface tracing supports an archive file; by default, `/var/log/dcd` is used for global interface tracing.



Analyzing Log and Trace Files

- Use `show log` *`file-name`* to display file contents:
  - Enter **h** at the `more` prompt for help on available options
  - Use pipe (|) to make log parsing much easier!
    - Syntax:

```
user@host> show log messages | match "support info"
May 31 23:49:16  host mgd[2711]: %INTERACT-6-UI_CMDLINE_READ_LINE:
User 'user', command 'request support information '
```

- Use multiple instances to evoke a logical AND search:

```
user@host> show log messages | find "Apr 1 09:" | match error
```

- Use quotes to evoke a logical OR search:

```
user@host> show log messages | match "error|kernel|panic"
```

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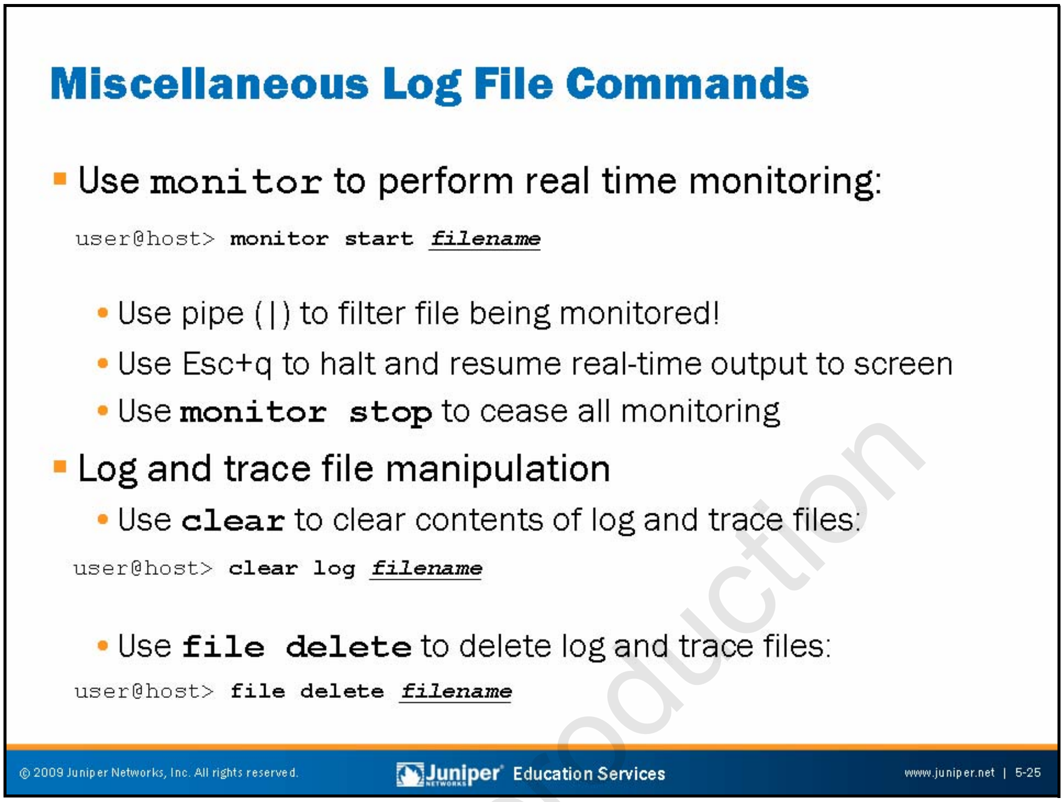
Viewing Log and Trace Files

By default, JUNOS Software stores log and trace files in `/var/log`. To view stored log files, use the **`show log`** command. Recall that the CLI automatically pauses when more than one screen of information exists, and that at this `more` prompt, you can enter a forward slash (/) character to conduct a forward search. As a hint, enter **h** at a `more` prompt to view the context help screen of available commands, shown in the following example:

```
---(Help for CLI automore)---
    Clear all match and except strings:                c or C
    Display all line matching a regexp:                m or M <string>
    Display all lines except those matching a regexp:  e or E <string>
    Display this help text:                            h
    Don't hold in automore at bottom of output:        N
    Hold in automore at bottom of output:              H
    Move down half display:                            TAB, d, or ^D
    Move down one line:           Enter, j, ^N, ^X, ^Z, or Down-Arrow
   . . .
```

The ability to cascade multiple instances of the CLI's pipe functionality is a real benefit when you must search a long file for specific information. The slide shows the required syntax to evoke logical AND and logical OR searches within extensive outputs and files.



Miscellaneous Log File Commands

- Use **monitor** to perform real time monitoring:

```
user@host> monitor start filename
```

  - Use pipe (|) to filter file being monitored!
  - Use Esc+q to halt and resume real-time output to screen
  - Use **monitor stop** to cease all monitoring
- Log and trace file manipulation
  - Use **clear** to clear contents of log and trace files:

```
user@host> clear log filename
```

  - Use **file delete** to delete log and trace files:

```
user@host> file delete filename
```

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Monitoring Log and Trace Files

Use the **monitor start** CLI command to view real-time log information. You can monitor several log files at one time. The messages from each log are identified by *filename*, where *filename* is the name of the file from which entries are being displayed. JUNOS Software displays this line initially and when the CLI switches between log files. To determine which log files are being monitored, you can issue the **monitor list** command.

In order for a user to monitor a log file using the **monitor start** command, the user must have the required access permissions to view the referenced log file. Also, since the **monitor start** command depends on the logged information being written to the log file first, the system must have the needed storage space for the log file and the log file must actually exist.

Note that you can use the CLI's **match** functionality to monitor a file in real time while displaying only entries that match your search criteria. To use this functionality, use a command in the following format:

```
user@host> monitor start messages | match fail
```

Use Esc+q to enable and disable syslog output to the screen; use the **monitor stop** command to cease all monitoring. If no output sends to the screen after issuing the **monitor start** command, you might want to issue the Esc+q key sequence to check if a previously initiated monitoring session was frozen rather than stopped.

Continued on next page.

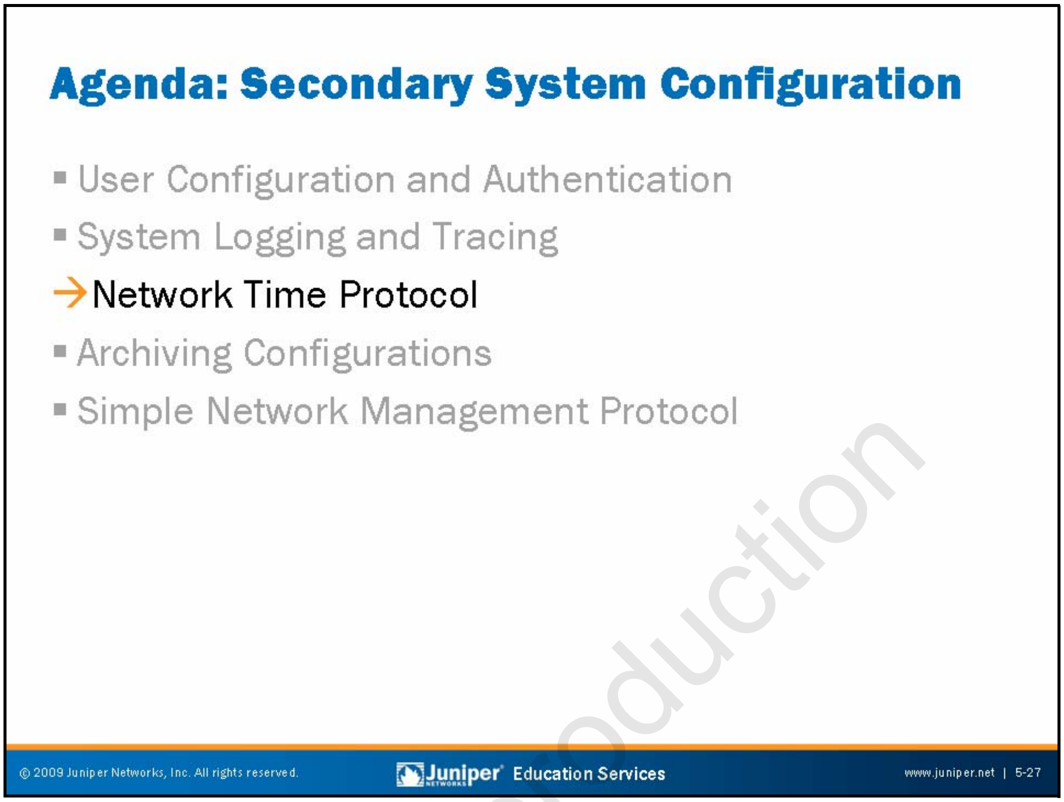
Monitoring Log and Trace Files (contd.)

If you do not delete or disable all trace flags, tracing continues in the background and the output continues to be written to the specified file. The file remains on the storage device of the system until you either manually deleted or overwrite it according to the `traceoptions` file parameters. To disable all tracing at a particular hierarchy, issue a **`delete traceoptions`** command at that hierarchy and commit the change.

Log and Trace File Manipulation

To truncate files used for logging, use the **`clear log`** ***`filename`*** command.

To delete a file, use the **`file delete`** command. If you want, you can also use wildcards with the file command's **`delete`**, **`compare`**, **`copy`**, **`list`**, and **`rename`** operations.



Agenda: Secondary System Configuration

- User Configuration and Authentication
- System Logging and Tracing
- → Network Time Protocol
- Archiving Configurations
- Simple Network Management Protocol

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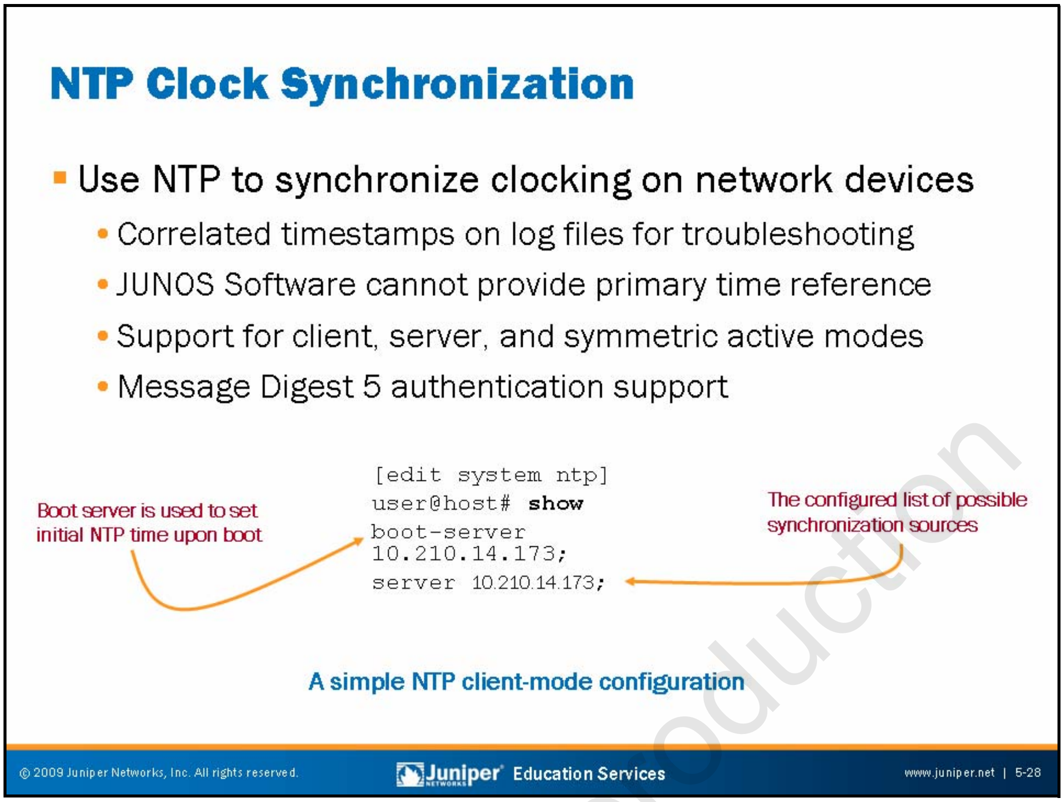
Network Time Protocol

The slide highlights the topic we discuss next.



NTP Clock Synchronization

- Use NTP to synchronize clocking on network devices
  - Correlated timestamps on log files for troubleshooting
  - JUNOS Software cannot provide primary time reference
  - Support for client, server, and symmetric active modes
  - Message Digest 5 authentication support

```
[edit system ntp]
user@host# show
boot-server
10.210.14.173;
server 10.210.14.173;
```

Boot server is used to set initial NTP time upon boot

The configured list of possible synchronization sources

A simple NTP client-mode configuration

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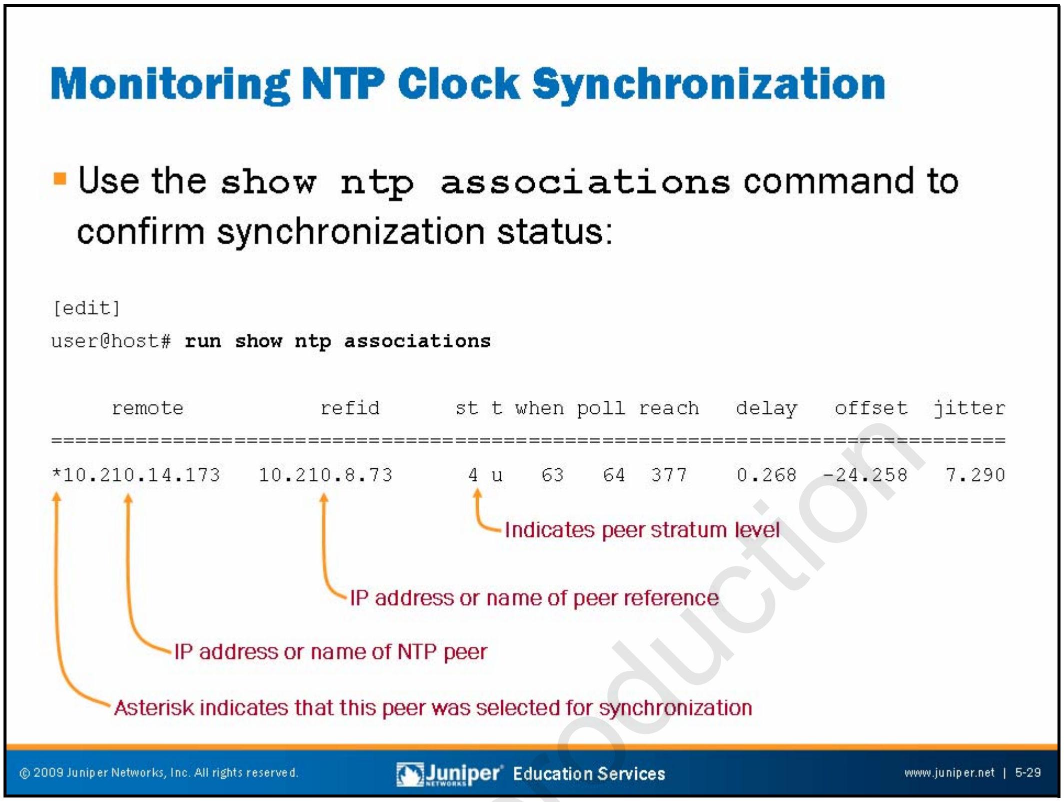
What Time Is It?

Use the Network Time Protocol (NTP) to synchronize network devices to a common, and preferably accurate, time source. By synchronizing all network devices, timestamps on log messages are both accurate and meaningful.

NTP is based on a series of timing hierarchies, with a Stratum 1 (atomic) timing source at the very top. While accuracy is desirable, there is no need to synchronize to a Stratum 1 reference to benefit from synchronizing to the time of day. JUNOS Software cannot provide its own timing source because the definition of a local, undisciplined clock source (for example, the local crystal oscillator) is not supported. If needed, obtain a commodity UNIX or Windows device configured to provide a timing reference based on its local clock. Any synchronization, even if based on an inaccurate local clock, is better than none.

JUNOS Software supports client, server, and symmetric modes of NTP operation, and can also support broadcast and authentication. We recommend that authentication be used to ensure that an attacker cannot compromise synchronization on a system.

The slide provides a typical NTP-related configuration stanza. Two machines can synchronize only when their current clocks are relatively close. By default, if the time difference between the local device's clock and the NTP server's clock is more than 128 milliseconds, the clocks are slowly stepped into synchronization. However, if the difference is more than 1000 seconds, the clocks are not synchronized. A boot server is used to set a system clock at boot time to ensure that it is close enough to later synchronize to the configured time server. Issue the operational mode **`set date ntp`** ***address*** command as a substitute for a boot server.



Monitoring NTP Clock Synchronization

- Use the `show ntp associations` command to confirm synchronization status:

```
[edit]
user@host# run show ntp associations

     remote           refid      st t when poll reach   delay   offset  jitter
==============================================================================
*10.210.14.173   10.210.8.73      4 u   63   64  377    0.268  -24.258   7.290
```

Indicates peer stratum level
IP address or name of peer reference
IP address or name of NTP peer
Asterisk indicates that this peer was selected for synchronization

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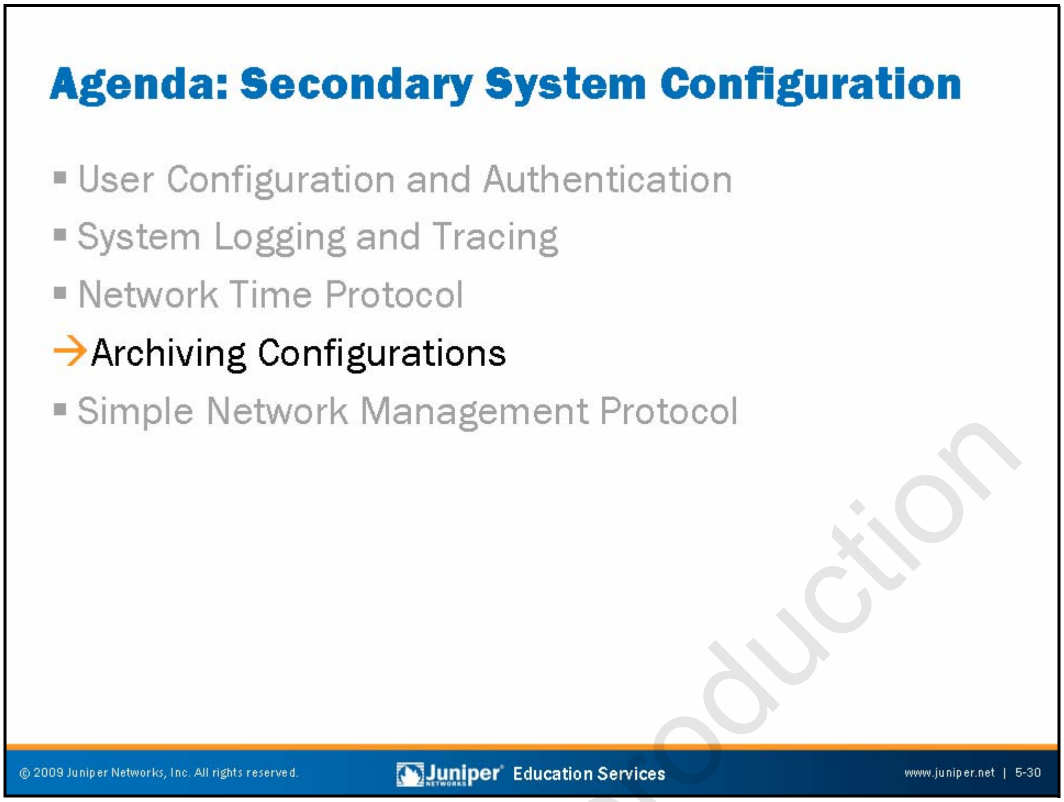
Monitoring NTP

Use the **`show ntp associations`** command to display synchronization status. The address column shows the hostname or IP address of remote NTP peers. The symbol next to the hostname or IP address gives the status of peers in the clock selection process. The following are possible symbols:

- Space: Discarded because of a high stratum value or failed sanity check;
- x: Designated *falseticker* by the intersection algorithm;
- . (period): Culled from the end of the candidate list;
- - (hyphen): Discarded by the clustering algorithm;
- + (plus): Included in the final selection set;
- # (pound): Selected for synchronization, but the distance exceeds the maximum;
- * (asterisk): Selected for synchronization; and
- o: Selected for synchronization, but the packets-per-second (pps) signal is in use.

You can view further synchronization details with the **`show ntp status`** command.



Agenda: Secondary System Configuration

- User Configuration and Authentication
- System Logging and Tracing
- Network Time Protocol
- → Archiving Configurations
- Simple Network Management Protocol

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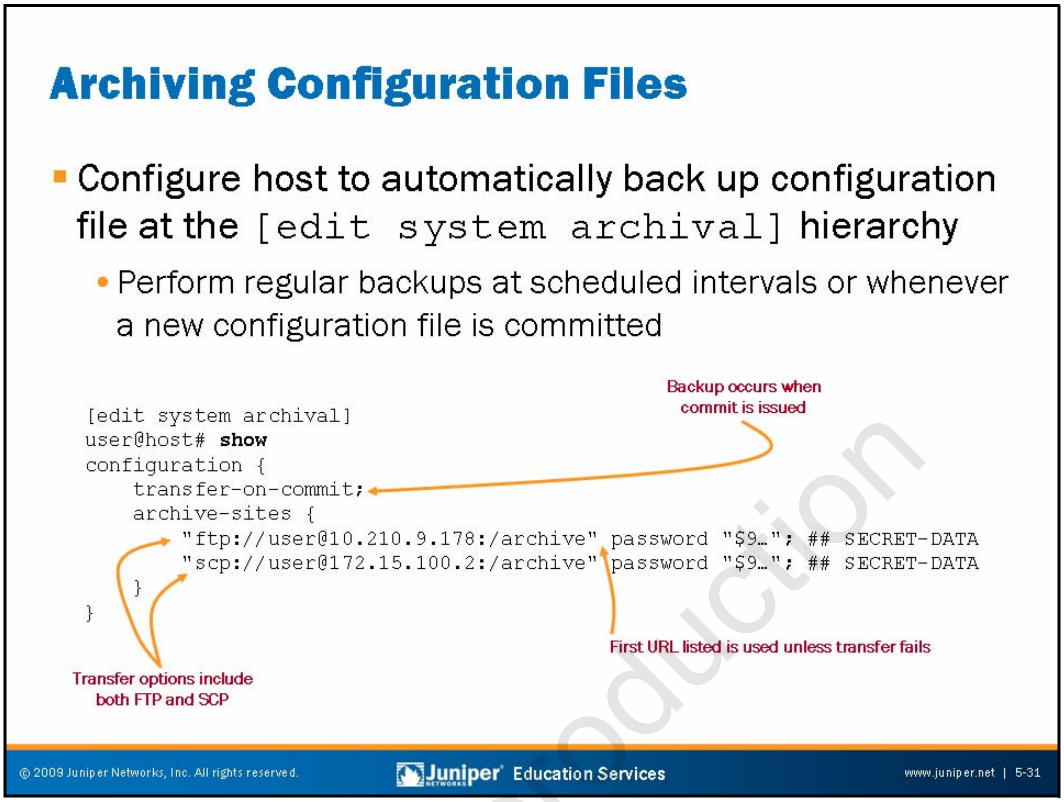
Archiving Configurations

The slide highlights the topic we discuss next.



Archiving Configuration Files

- Configure host to automatically back up configuration file at the `[edit system archival]` hierarchy
  - Perform regular backups at scheduled intervals or whenever a new configuration file is committed

```
[edit system archival]
user@host# show
configuration {
    transfer-on-commit;
    archive-sites {
        "ftp://user@10.210.9.178:/archive" password "$9…"; ## SECRET-DATA
        "scp://user@172.15.100.2:/archive" password "$9…"; ## SECRET-DATA
    }
}
```

Backup occurs when commit is issued

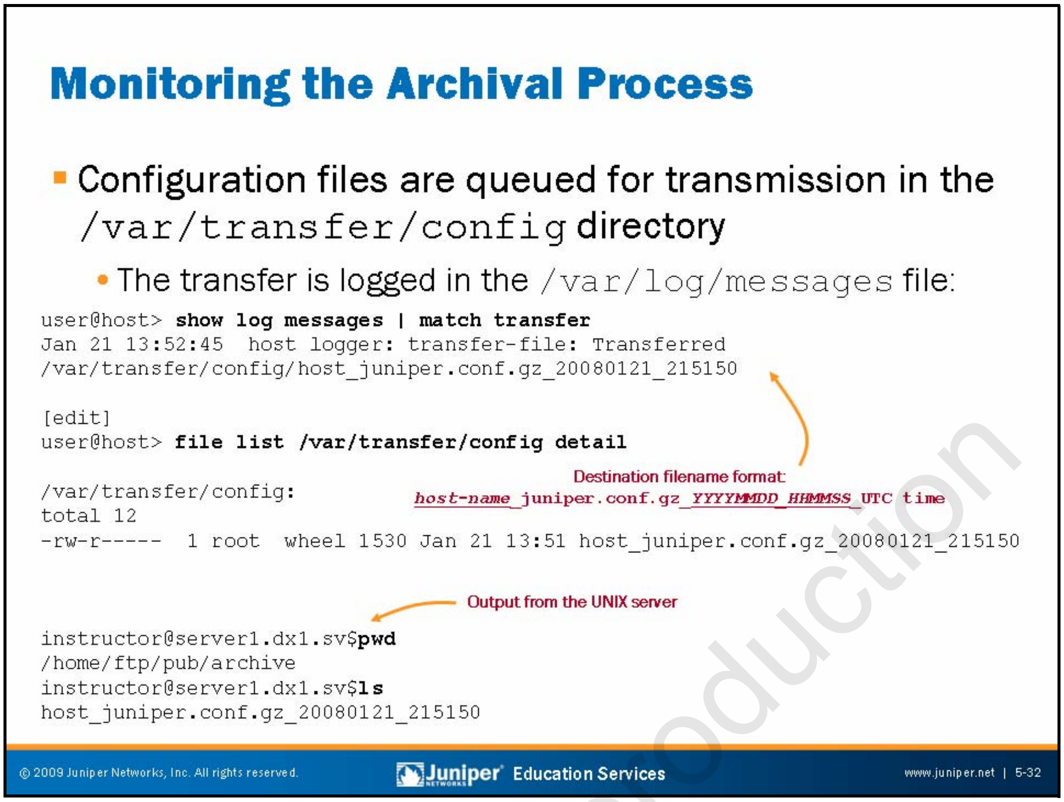
First URL listed is used unless transfer fails

Transfer options include both FTP and SCP

Automated Configuration Backup

Certain failures might render the storage device, which holds the configuration files, unusable. In the event of such a disaster, it might be helpful to have the most recent configuration file stored on a separate device, such as an FTP or SCP server. To automatically back up a system's configuration file to a remote device, configure the necessary configuration archival parameters at the `[edit system archival]` hierarchy level. When you configure the system to transfer its configuration files, you specify an archive site, in the form of a URL, to which the files are transferred. If you specify more than one archive site, the system attempts to transfer the configuration file to the first archive site in the list, moving to the next site only if the transfer fails.

Backups occur at regular intervals with the use of the **`transfer-interval`** statement. The frequency at which the file transfer occurs can be from 15 to 2880 minutes, and you can define this frequency. Alternatively, the configuration file can be transferred every time a new configuration becomes active with the use of the **`transfer-on-commit`** statement.



Monitoring the Archival Process

- Configuration files are queued for transmission in the `/var/transfer/config` directory
  - The transfer is logged in the `/var/log/messages` file:

```
user@host> show log messages | match transfer
Jan 21 13:52:45  host logger: transfer-file: Transferred
/var/transfer/config/host_juniper.conf.gz_20080121_215150

[edit]
user@host> file list /var/transfer/config detail

/var/transfer/config:
total 12
-rw-r-----  1 root  wheel 1530 Jan 21 13:51 host_juniper.conf.gz_20080121_215150
```

Destination filename format:
*host-name*_juniper.conf.gz_*YYYYMMDD_HHMMSS*_UTC time

Output from the UNIX server

```
instructor@server1.dx1.sv$pwd
/home/ftp/pub/archive
instructor@server1.dx1.sv$ls
host_juniper.conf.gz_20080121_215150
```

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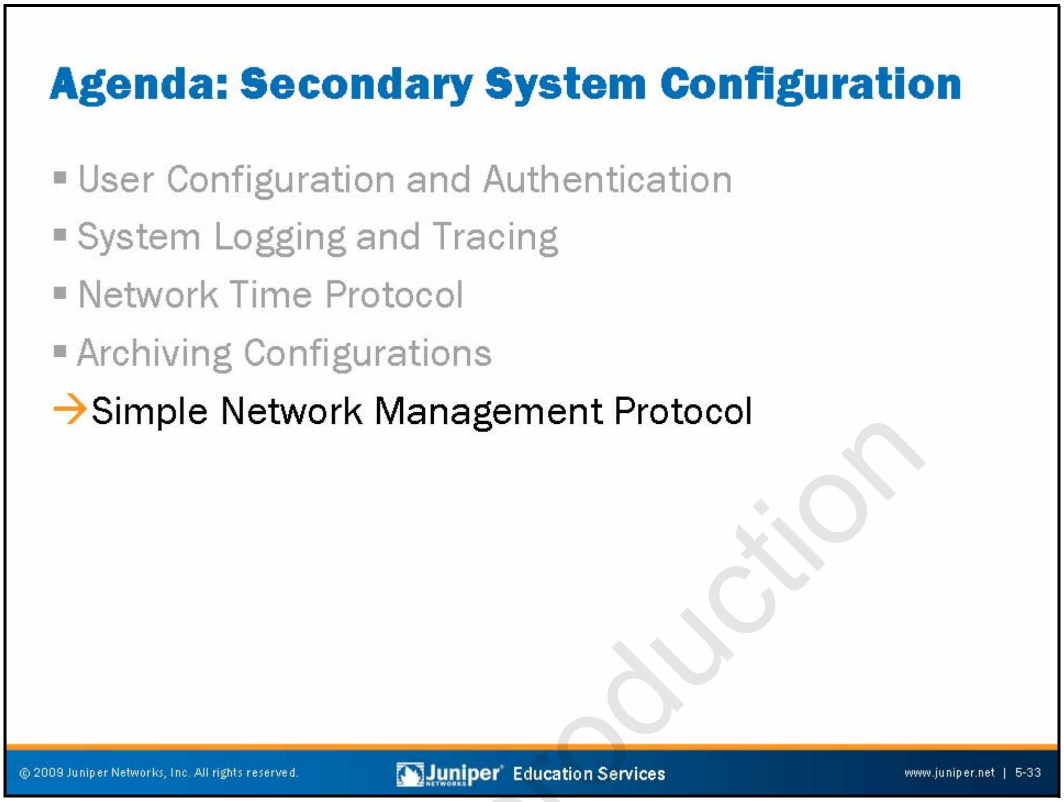
How It Works

Upon entering a **`commit`** command or reaching the specified time interval, the system copies the configuration file into the `/var/transfer/config` directory and an FTP or SCP session is opened with the remote storage device. Once the configuration file is transferred to the remote storage device, a system log message is generated, confirming success or failure of the transfer. The destination filename format, as shown on the slide, cannot be altered by configuration.



Agenda: Secondary System Configuration

- User Configuration and Authentication
- System Logging and Tracing
- Network Time Protocol
- Archiving Configurations

→Simple Network Management Protocol

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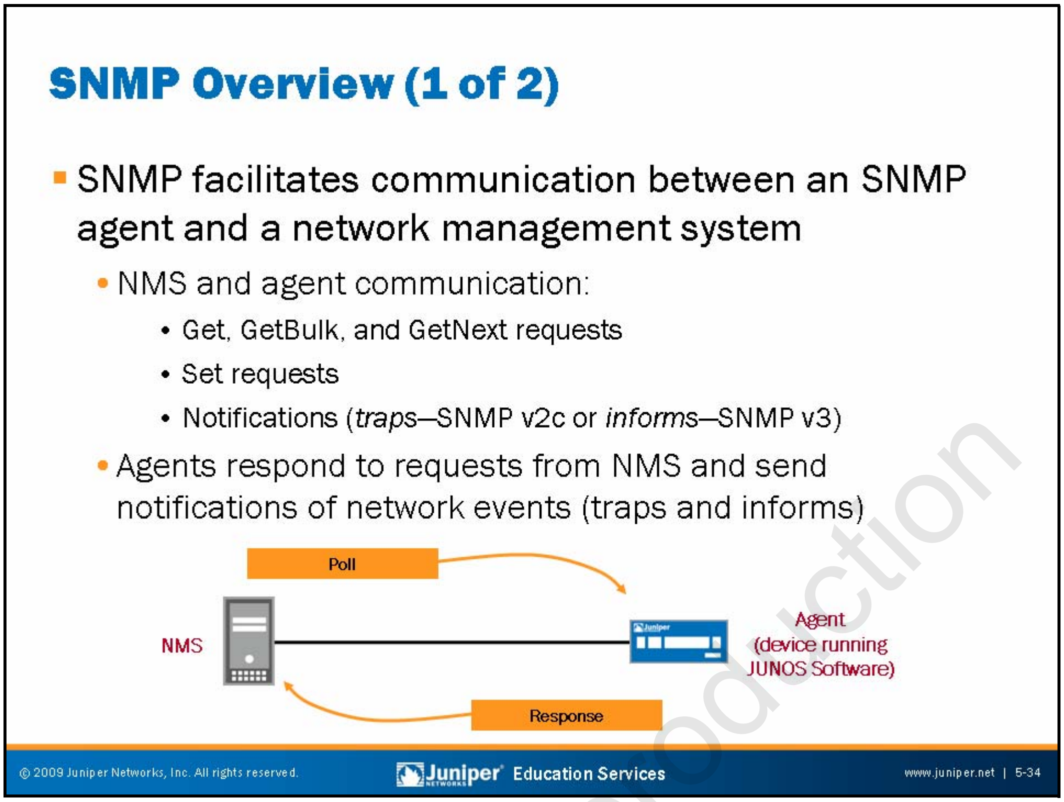
Simple Network Management Protocol

The slide highlights the topic we discuss next.



SNMP Overview (1 of 2)

- SNMP facilitates communication between an SNMP agent and a network management system
  - NMS and agent communication:
    - Get, GetBulk, and GetNext requests
    - Set requests
    - Notifications (*traps*—SNMP v2c or *informs*—SNMP v3)
  - Agents respond to requests from NMS and send notifications of network events (traps and informs)

Poll
NMS
Agent
(device running
JUNOS Software)
Response

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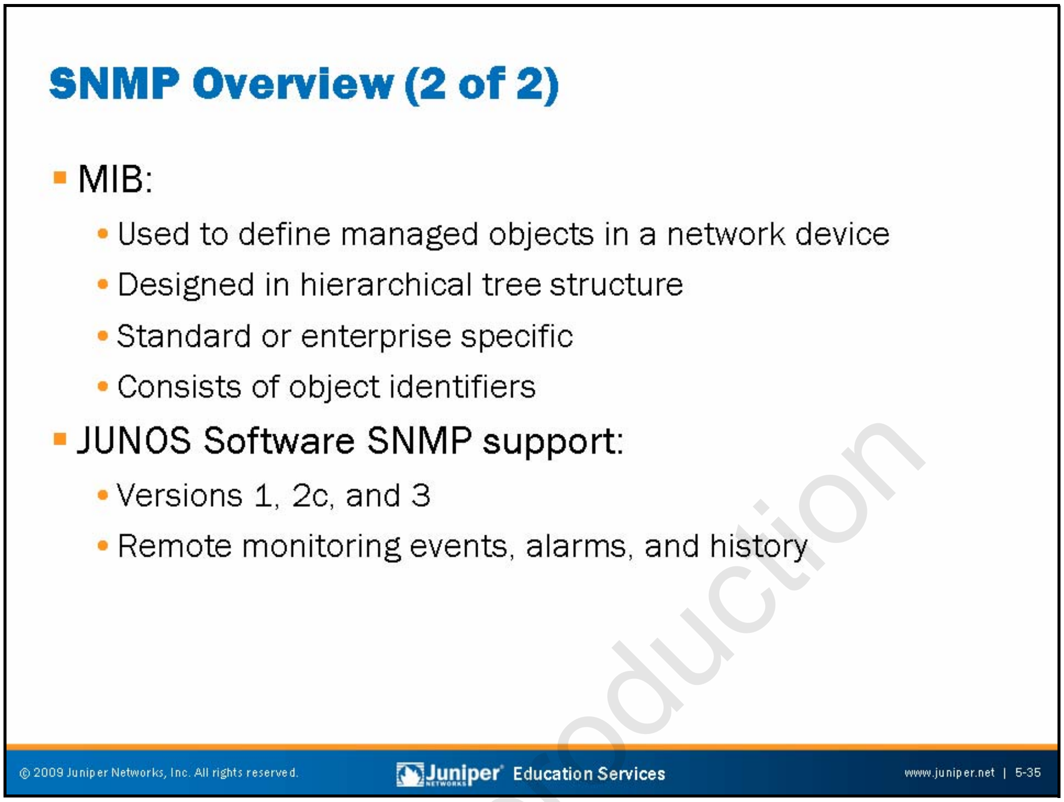
SNMP Operation

Devices running JUNOS Software act as SNMP agents. An SNMP agent exchanges network management information with SNMP manager software running on a network management system (NMS) or host. The agent responds to requests for information and actions from the manager. An agent communicates with the SNMP manager using the following message types:

- *Get, Getbulk, or Getnext requests*: The SNMP manager requests information from an SNMP agent. The agent responds with a Get response message;
- *Set requests*: The SNMP manager changes the value of a Management Information Base (MIB) object controlled by the agent. The agent returns the status in a Set response message; and
- *Notifications*: The SNMP agent sends traps to notify the manager of significant events regarding the network device. SNMP version 3 uses *informs* to notify the manager of significant events. Informs increase SNMP reliability by requiring the receiver to acknowledge the receipt of an inform notification.

By polling managed network devices, the NMS collects information about network resources. An SNMP agent can also notify the NMS of events and resource constraints through the use of SNMP traps.



SNMP Overview (2 of 2)

- MIB:
  - Used to define managed objects in a network device
  - Designed in hierarchical tree structure
  - Standard or enterprise specific
  - Consists of object identifiers
- JUNOS Software SNMP support:
  - Versions 1, 2c, and 3
  - Remote monitoring events, alarms, and history

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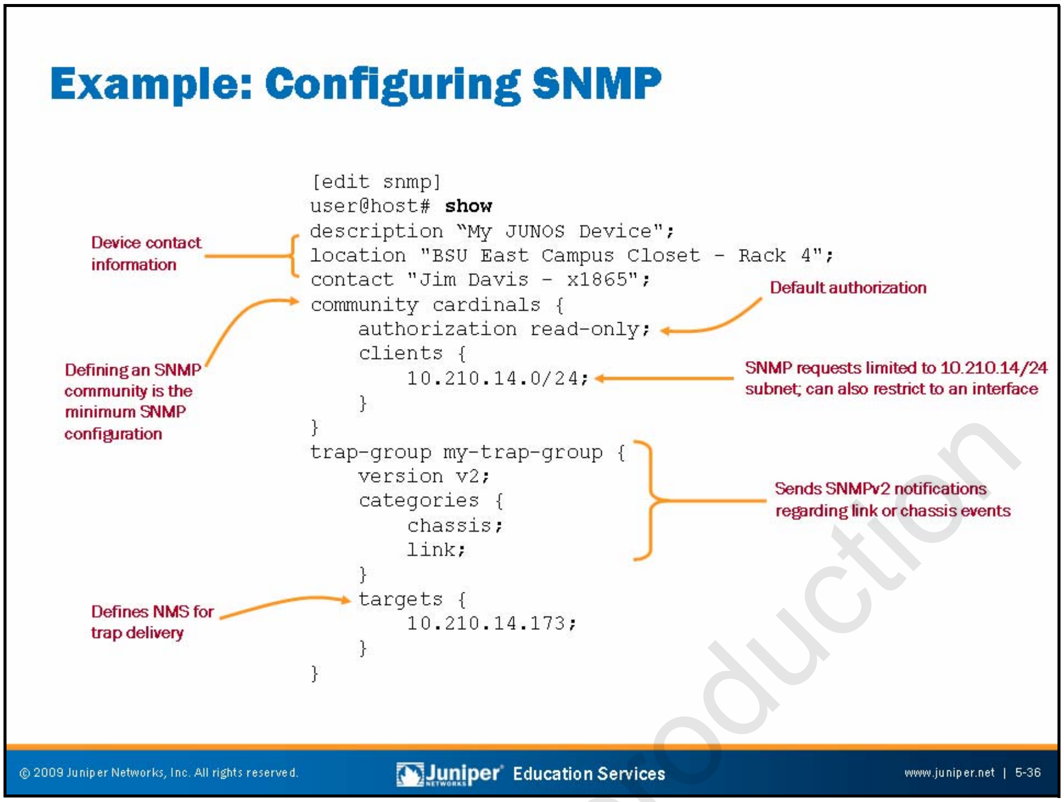
Management Information Bases

A MIB is a collection of objects maintained by the SNMP agent in a hierarchical fashion. The SNMP manager views or changes objects within the MIB structure. MIBs can be defined at the enterprise level to provide enterprise-specific information about the managed network device, or MIBs can be standardized to provide common information across multiple vendor network devices. NMS devices poll object identifiers (OIDs) to retrieve management information. An OID is considered a leaf in the tree-like hierarchy of a MIB. The Internet Engineering Task Force (IETF) provides standard MIBs you can download at http://www.ietf.org. You can download Juniper Networks enterprise MIBs at http://www.juniper.net/techpubs.

JUNOS Software SNMP Support

JUNOS Software provides support for SNMP versions 1, 2c, and 3. Version 1 is the initial implementation of SNMP that defines the architecture and framework for SNMP. Version 2 added support for community strings, which act as passwords determining access to SNMP agent MIBs. SNMPv3 is the most up-to-date version and provides enhanced security features including the definition of a user-based security model (USM) and a view-based access control model (VACM). SNMPv3 provides message integrity, authentication, and encryption, and is a superior security model over SNMPv2c, which uses plain text community strings. JUNOS Software also provides support for remote monitoring (RMON) events, alarms, and history.



Example: Configuring SNMP

```
[edit snmp]
user@host# show
description “My JUNOS Device";
location "BSU East Campus Closet - Rack 4";
contact "Jim Davis - x1865";
community cardinals {
    authorization read-only;
    clients {
        10.210.14.0/24;
    }
}
trap-group my-trap-group {
    version v2;
    categories {
        chassis;
        link;
    }
    targets {
        10.210.14.173;
    }
}
```

Device contact information

Defining an SNMP community is the minimum SNMP configuration

Default authorization

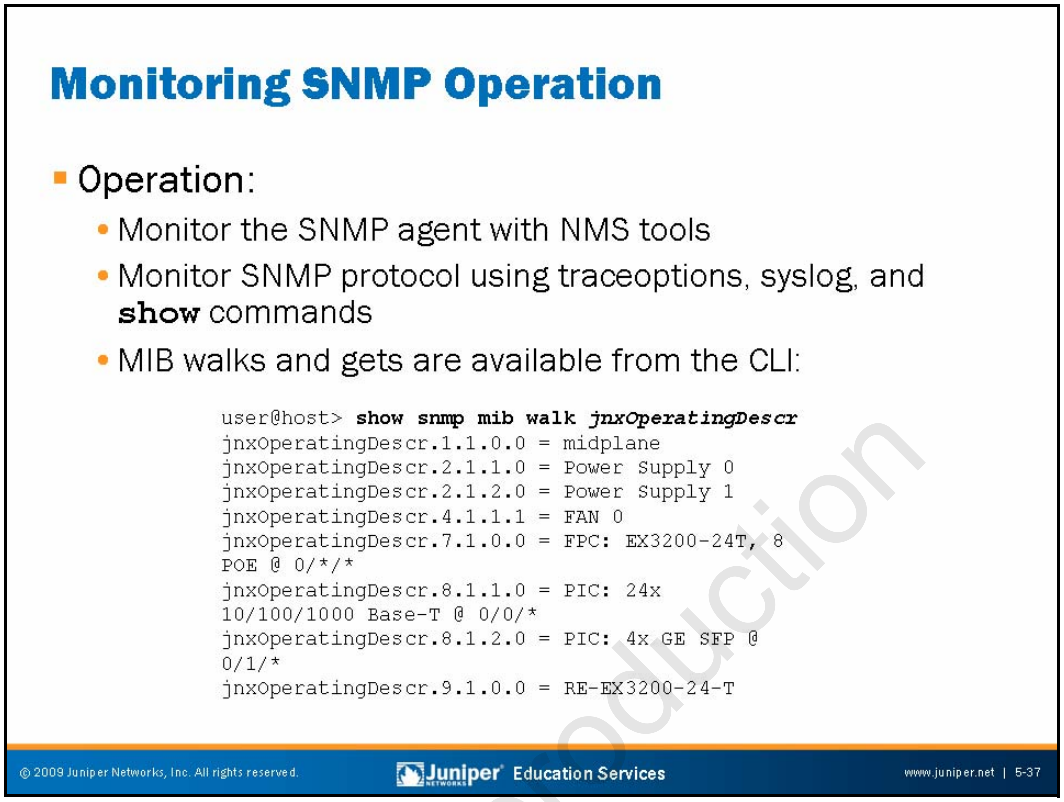
SNMP requests limited to 10.210.14/24 subnet; can also restrict to an interface

Sends SNMPv2 notifications regarding link or chassis events

Defines NMS for trap delivery

Sample SNMP Configuration

The slide shows a sample SNMP configuration using some common SNMP configuration options. When configuring contact information, you must be as specific as possible. This information is useful when trying to resolve issues with a network device. The example restricts SNMP access to the 10.210.14.0/24 network with read-only authorization. The example also shows the configuration of an SNMP trap group, necessary for the delivery of SNMP traps to an NMS.



Monitoring SNMP Operation

- Operation:
  - Monitor the SNMP agent with NMS tools
  - Monitor SNMP protocol using traceoptions, syslog, and **show** commands
  - MIB walks and gets are available from the CLI:

```
user@host> show snmp mib walk jnxOperatingDescr
jnxOperatingDescr.1.1.0.0 = midplane
jnxOperatingDescr.2.1.1.0 = Power Supply 0
jnxOperatingDescr.2.1.2.0 = Power Supply 1
jnxOperatingDescr.4.1.1.1 = FAN 0
jnxOperatingDescr.7.1.0.0 = FPC: EX3200-24T, 8
POE @ 0/*/*
jnxOperatingDescr.8.1.1.0 = PIC: 24x
10/100/1000 Base-T @ 0/0/*
jnxOperatingDescr.8.1.2.0 = PIC: 4x GE SFP @
0/1/*
jnxOperatingDescr.9.1.0.0 = RE-EX3200-24-T
```

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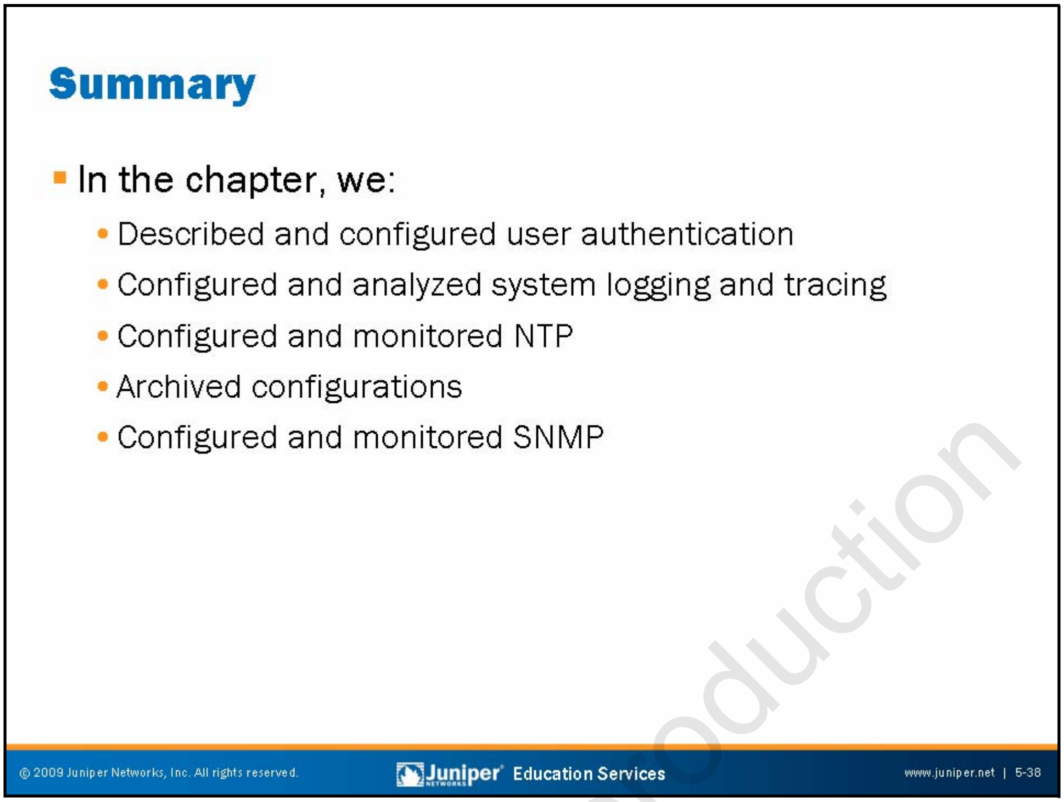
Monitoring SNMP Operation

An NMS or host provides the interface for most SNMP monitoring. To monitor SNMP operation directly from a device running JUNOS Software, you can use traceoptions, system logging, and various **show snmp** commands. When a trap condition occurs, some traps are logged if the system logging is configured with the appropriate facility and severity levels, regardless of whether a trap group is configured. The sample **show** command output on the slide illustrates that you can also issue standard SNMP manager commands to view agent OID values. You can specify the OIDs in ASCII text format or dotted-decimal notation.



Summary

- In the chapter, we:
  - Described and configured user authentication
  - Configured and analyzed system logging and tracing
  - Configured and monitored NTP
  - Archived configurations
  - Configured and monitored SNMP

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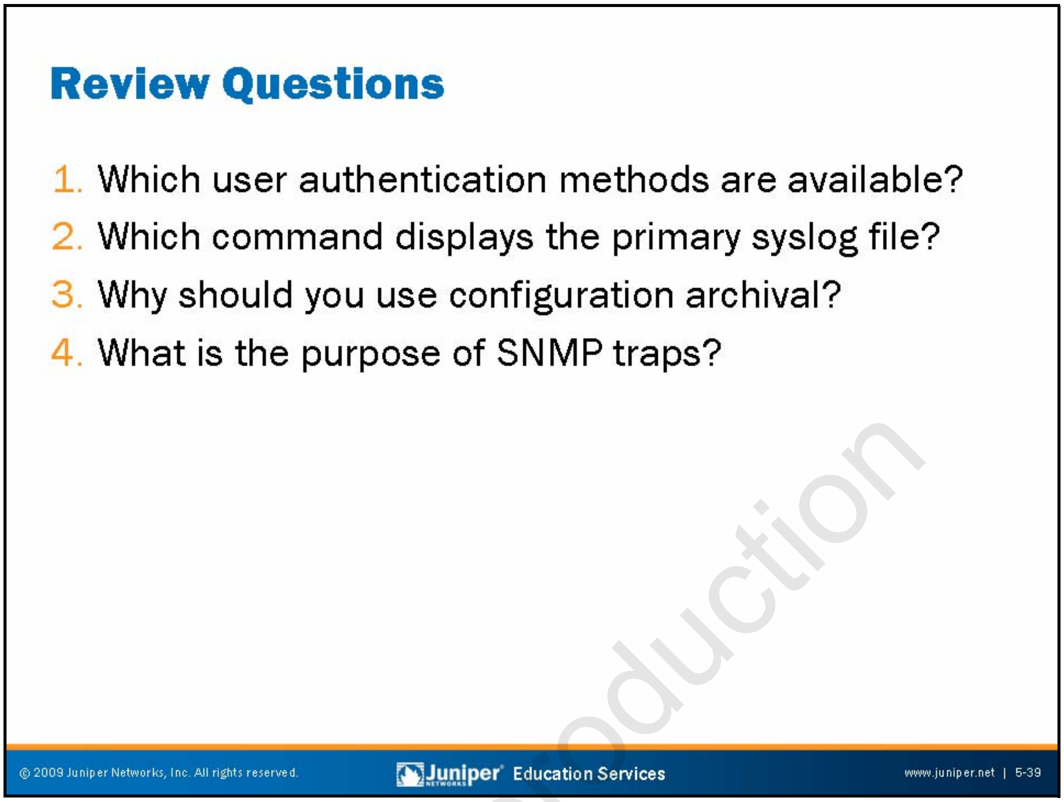
This Chapter Discussed:

- User authentication methods and configuration;
- Configuring and analyzing system logging and tracing;
- NTP configuration and operation;
- Archiving configurations on remote devices; and
- Configuring and monitoring SNMP.



Review Questions

1. Which user authentication methods are available?
2. Which command displays the primary syslog file?
3. Why should you use configuration archival?
4. What is the purpose of SNMP traps?

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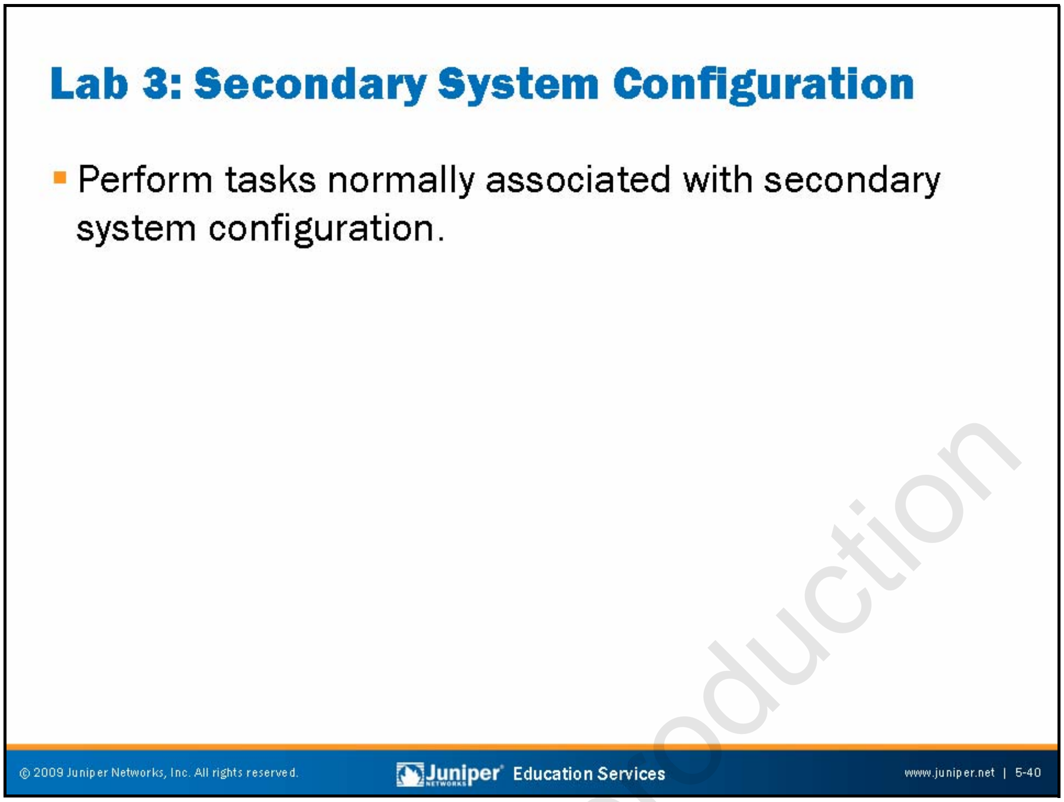
Review Questions

1.

2.

3.

4.



Lab 3: Secondary System Configuration

- Perform tasks normally associated with secondary system configuration.

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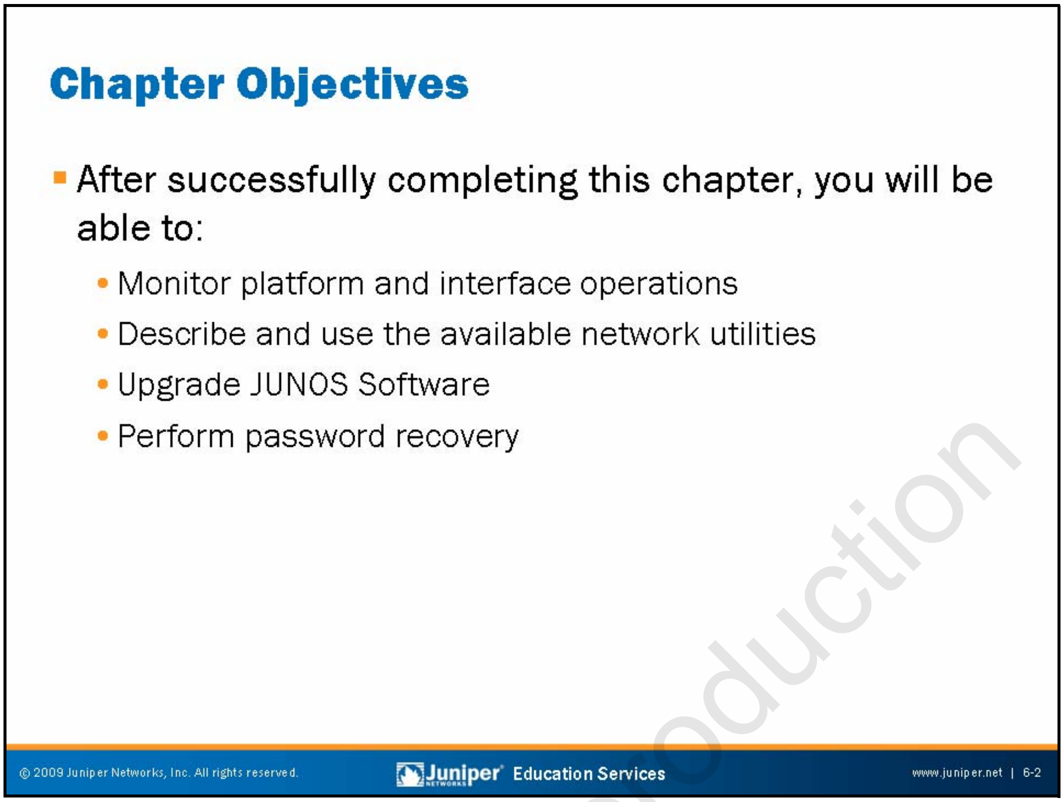
Lab 3: Secondary System Configuration

The slide provides the objective for this lab.

Introduction to JUNOS Software

Chapter 6: Operational Monitoring and Maintenance



Chapter Objectives

- After successfully completing this chapter, you will be able to:
  - Monitor platform and interface operations
  - Describe and use the available network utilities
  - Upgrade JUNOS Software
  - Perform password recovery

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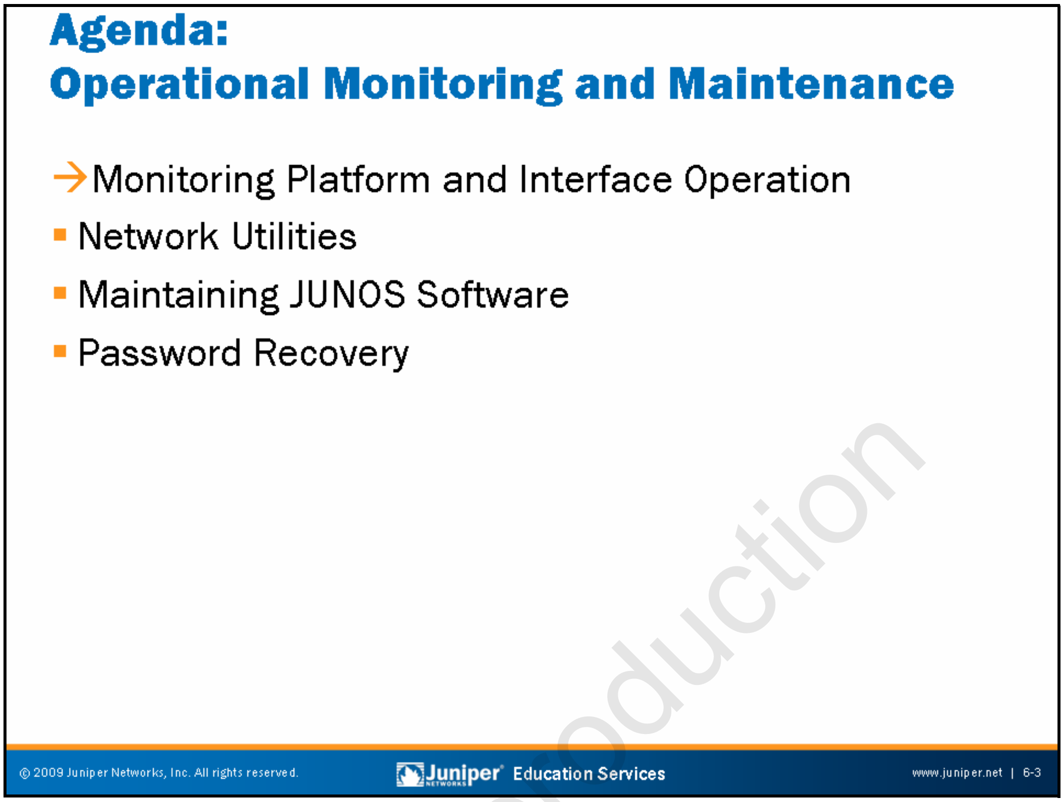
This Chapter Discusses:

- Monitoring platform and interface operations;
- Network utilities and usage guidelines;
- Maintaining JUNOS Software; and
- Performing password recovery.



Agenda: Operational Monitoring and Maintenance

→ Monitoring Platform and Interface Operation

- Network Utilities
- Maintaining JUNOS Software
- Password Recovery

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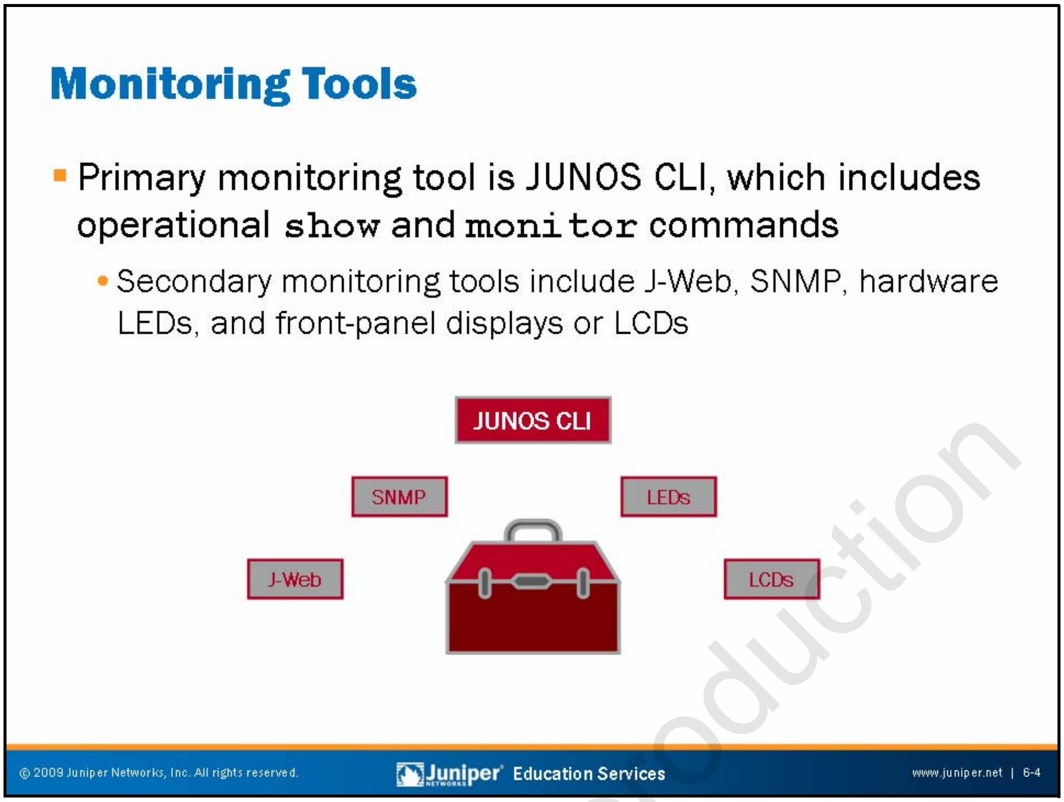
Monitoring Platform and Interface Operation

The slide lists the topics we cover in this chapter. We discuss the highlighted topic first.



Monitoring Tools

- Primary monitoring tool is JUNOS CLI, which includes operational `show` and `monitor` commands
  - Secondary monitoring tools include J-Web, SNMP, hardware LEDs, and front-panel displays or LCDs

JUNOS CLI
SNMP
LEDs
J-Web
LCDs

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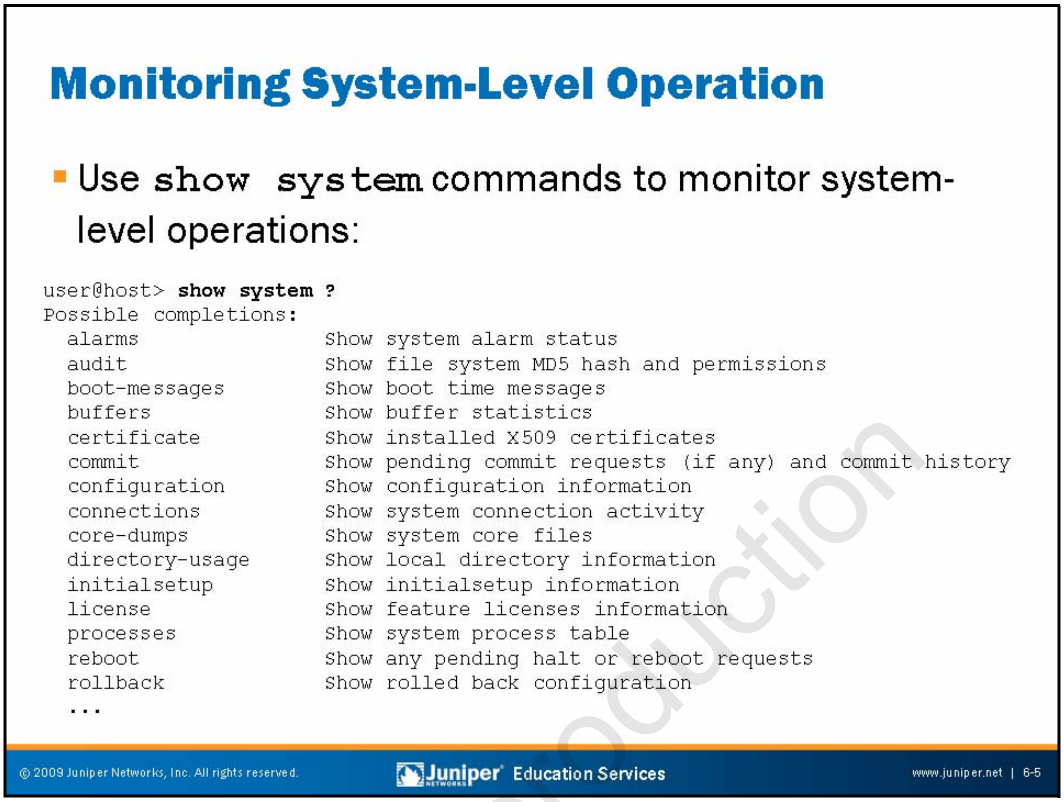
Monitoring Tools

The primary monitoring tool for avid JUNOS Software users is the JUNOS CLI. The JUNOS CLI includes several **`show`** and **`monitor`** commands that facilitate system monitoring. We highlight many of the monitoring capabilities available through the JUNOS CLI in this chapter.

In addition to the JUNOS CLI, a number of secondary monitoring tools exist such as the J-Web, SNMP, hardware LEDs, and front-panel displays or LCDs. Check the technical publications at http://www.juniper.net/techpubs/ for specific details on a particular platform.



Monitoring System-Level Operation

- Use **show system** commands to monitor system-level operations:

```
user@host> show system ?
Possible completions:
  alarms                    Show system alarm status
  audit                     Show file system MD5 hash and permissions
  boot-messages             Show boot time messages
  buffers                   Show buffer statistics
  certificate               Show installed X509 certificates
  commit                    Show pending commit requests (if any) and commit history
  configuration             Show configuration information
  connections               Show system connection activity
  core-dumps                Show system core files
  directory-usage           Show local directory information
  initialsetup              Show initialsetup information
  license                   Show feature licenses information
  processes                 Show system process table
  reboot                    Show any pending halt or reboot requests
  rollback                  Show rolled back configuration
  ...
```

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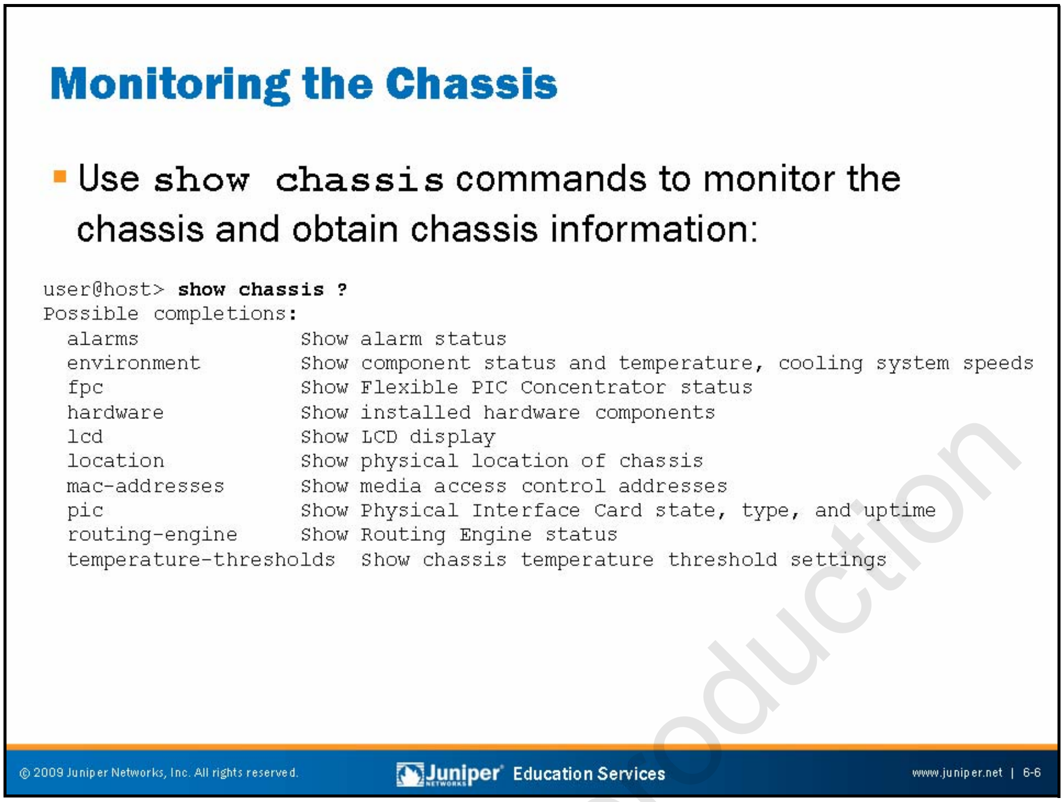
Monitoring System Operation

You can obtain most system information using **show system *argument*** commands. The following arguments are some of the most common:

- **alarms**: This argument displays current system alarms;
- **boot-messages**: This argument displays the messages seen during the last system boot;
- **connections**: This argument displays the status of local TCP and UDP connections;
- **statistics**: This argument provides options for viewing various protocol statistics; and
- **storage**: This argument displays the status of the file system storage space.



Monitoring the Chassis

- Use `show chassis` commands to monitor the chassis and obtain chassis information:

```
user@host> show chassis ?
Possible completions:
  alarms                Show alarm status
  environment           Show component status and temperature, cooling system speeds
  fpc                   Show Flexible PIC Concentrator status
  hardware              Show installed hardware components
  lcd                   Show LCD display
  location              Show physical location of chassis
  mac-addresses         Show media access control addresses
  pic                   Show Physical Interface Card state, type, and uptime
  routing-engine        Show Routing Engine status
  temperature-thresholds  Show chassis temperature threshold settings
```

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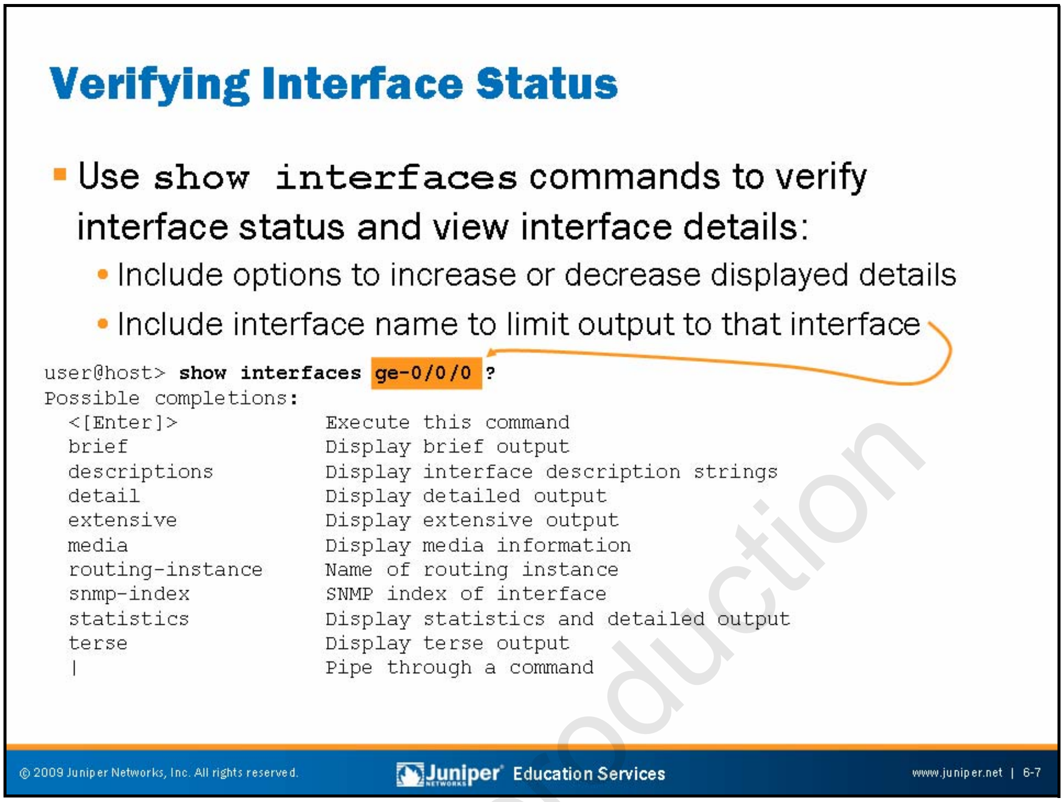
Monitoring the Chassis

You can monitor the chassis and obtain chassis information using **`show chassis`** ***`argument`*** commands. The following arguments are some of the most common:

- **`alarms`**: This argument displays current chassis alarms;
- **`environment`**: This argument displays component and environmental status as well as the operational speeds of the cooling system;
- **`hardware`**: This argument displays an inventory of the installed hardware components along with the serial number of each component; and
- **`routing-engine`**: This argument provides operational status and utilization details for the routing engine.



Verifying Interface Status

- Use `show interfaces` commands to verify interface status and view interface details:
  - Include options to increase or decrease displayed details
  - Include interface name to limit output to that interface

```
user@host> show interfaces ge-0/0/0 ?
Possible completions:
  <[Enter]>             Execute this command
  brief                 Display brief output
  descriptions          Display interface description strings
  detail                Display detailed output
  extensive             Display extensive output
  media                 Display media information
  routing-instance      Name of routing instance
  snmp-index            SNMP index of interface
  statistics            Display statistics and detailed output
  terse                 Display terse output
  |                     Pipe through a command
```

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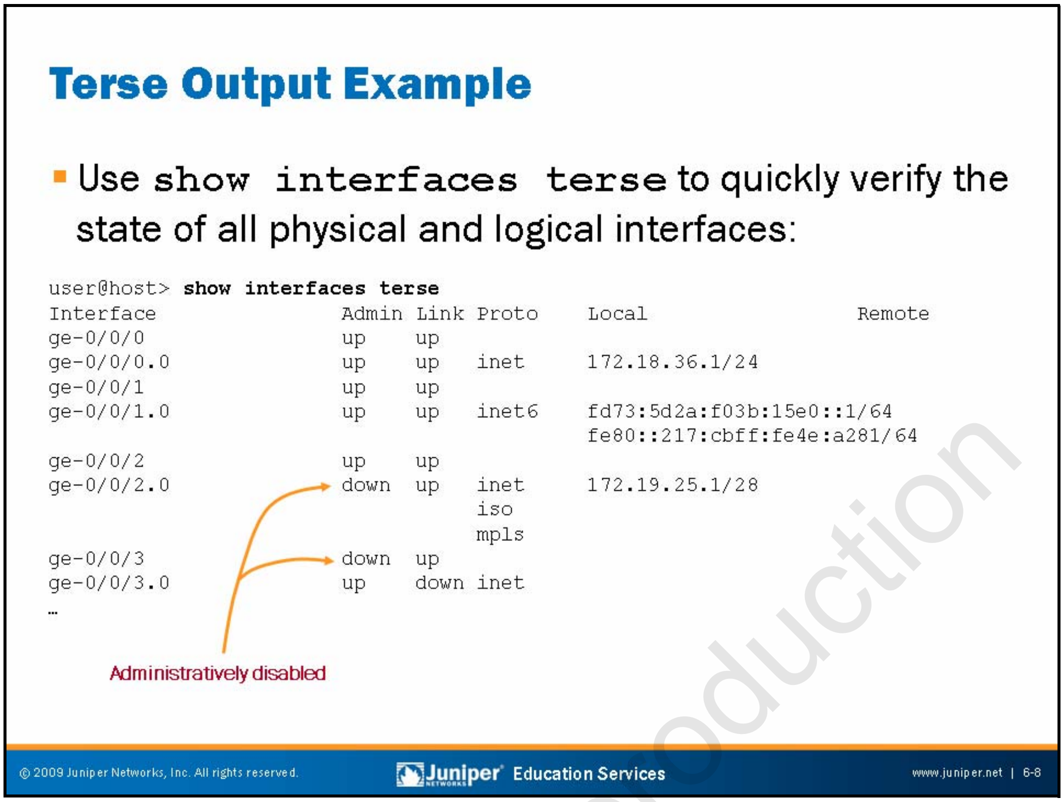
Interface Status Verification

You can use the **`show interfaces`** command to verify various details and status information for interfaces. A number of command options exist that determine the generated output for the **`show interfaces`** command. The example on the slide illustrates the use of the ***`interface-name`*** option, which filters the generated output and displays details only for the specified interface. If the ***`interface-name`*** option is excluded, the output provides interface details for all installed interfaces.



Terse Output Example

- Use `show interfaces terse` to quickly verify the state of all physical and logical interfaces:

```
user@host> show interfaces terse
Interface               Admin Link Proto    Local                 Remote
ge-0/0/0                up    up
ge-0/0/0.0              up    up   inet     172.18.36.1/24
ge-0/0/1                up    up
ge-0/0/1.0              up    up   inet6    fd73:5d2a:f03b:15e0::1/64
                                            fe80::217:cbff:fe4e:a281/64
ge-0/0/2                up    up
ge-0/0/2.0              down  up   inet     172.19.25.1/28
                                   iso
                                   mpls
ge-0/0/3                down  up
ge-0/0/3.0              up    down inet
…
```

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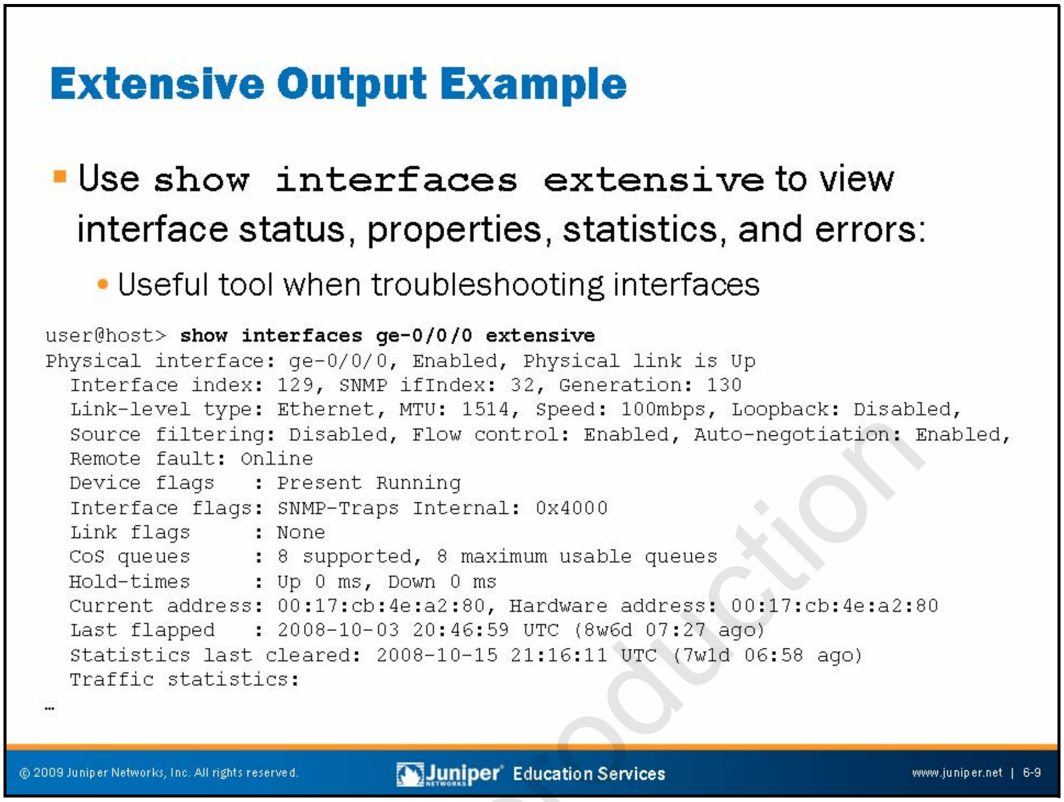
Terse Output Example

The example on the slide illustrates the **`show interfaces terse`** command. In this example the ***`interface-name`*** option is omitted, which causes all installed interfaces and their accompanying details to be displayed. This command is ideal when you simply need to verify state information for physical and logical interfaces. The output from this command displays all installed interfaces in the left column and provides state, protocol family, and addressing details to the right of each listed interface.



Extensive Output Example

- Use **show interfaces extensive** to view interface status, properties, statistics, and errors:
  - Useful tool when troubleshooting interfaces

```
user@host> show interfaces ge-0/0/0 extensive
Physical interface: ge-0/0/0, Enabled, Physical link is Up
  Interface index: 129, SNMP ifIndex: 32, Generation: 130
  Link-level type: Ethernet, MTU: 1514, Speed: 100mbps, Loopback: Disabled,
  Source filtering: Disabled, Flow control: Enabled, Auto-negotiation: Enabled,
  Remote fault: Online
  Device flags   : Present Running
  Interface flags: SNMP-Traps Internal: 0x4000
  Link flags     : None
  CoS queues     : 8 supported, 8 maximum usable queues
  Hold-times     : Up 0 ms, Down 0 ms
  Current address: 00:17:cb:4e:a2:80, Hardware address: 00:17:cb:4e:a2:80
  Last flapped   : 2008-10-03 20:46:59 UTC (8w6d 07:27 ago)
  Statistics last cleared: 2008-10-15 21:16:11 UTC (7w1d 06:58 ago)
  Traffic statistics:
…
```

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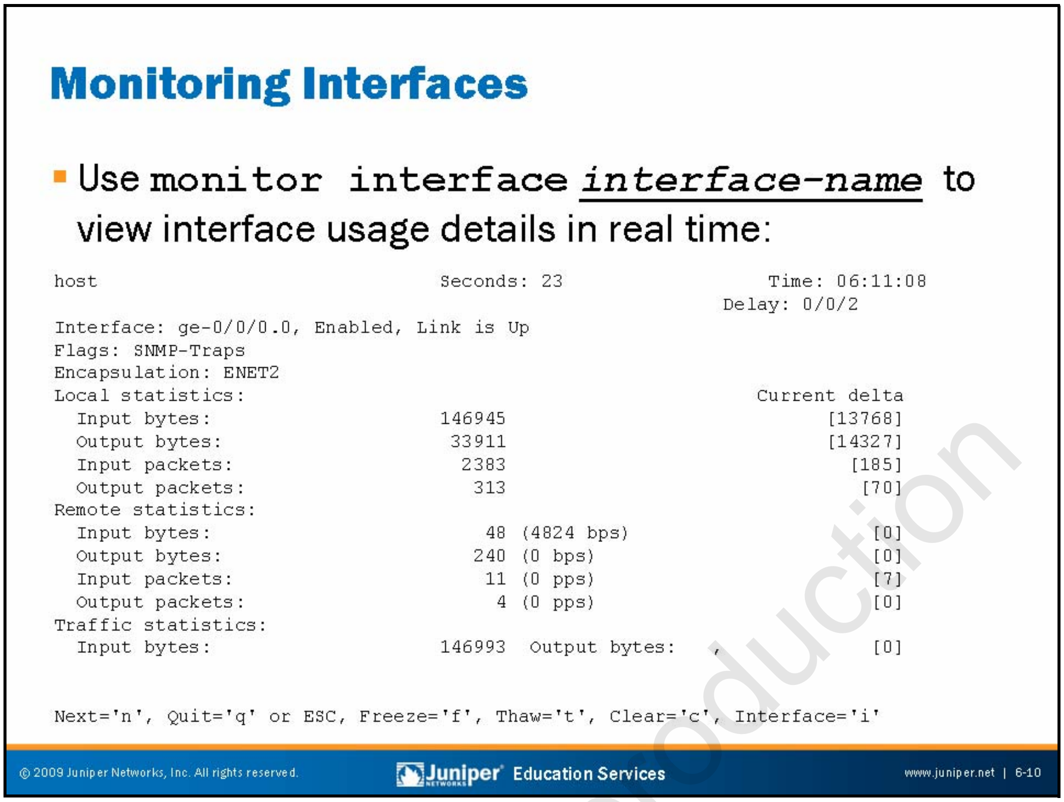
Gathering Extensive Interface Information

Use the **show interface extensive** command to view detailed information for a named interface (or all interfaces when a specific interface is not identified). The example on the slide shows a portion of the generated output when using the **extensive** option. This command is ideal when troubleshooting interfaces because it shows errors, statistics, and physical and logical interface properties. This command is also helpful when determining default settings for interfaces.



Monitoring Interfaces

- Use `monitor interface` *interface-name* to view interface usage details in real time:

```
host                              Seconds: 23                Time: 06:11:08
                                                         Delay: 0/0/2
Interface: ge-0/0/0.0, Enabled, Link is Up
Flags: SNMP-Traps
Encapsulation: ENET2
Local statistics:                                           Current delta
  Input bytes:                    146945                         [13768]
  Output bytes:                    33911                         [14327]
  Input packets:                    2383                           [185]
  Output packets:                    313                            [70]
Remote statistics:
  Input bytes:                        48 (4824 bps)                  [0]
  Output bytes:                      240 (0 bps)                     [0]
  Input packets:                      11 (0 pps)                     [7]
  Output packets:                      4 (0 pps)                     [0]
Traffic statistics:
  Input bytes:                    146993  Output bytes:    ,         [0]


Next='n', Quit='q' or ESC, Freeze='f', Thaw='t', Clear='c', Interface='i'
```

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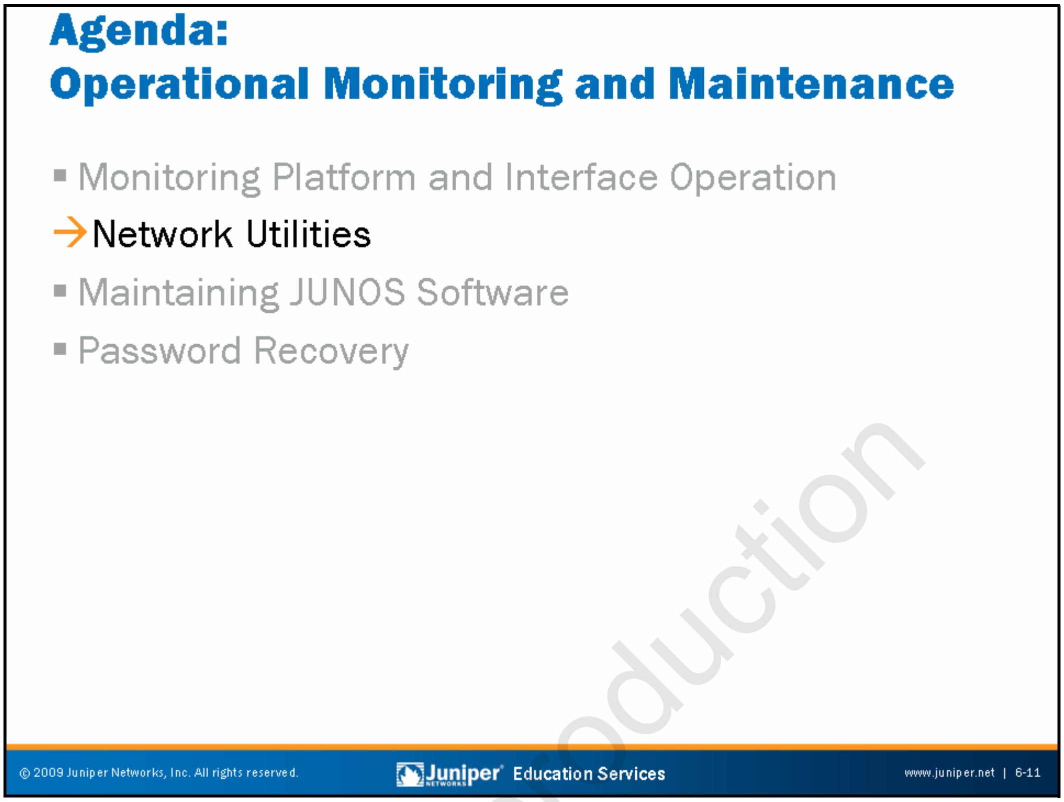
Monitoring an Interface

The slide depicts typical output from the **monitor interface** command. Your terminal session must support VT100 emulation for the screen to correctly display the output. This command provides real-time packet and byte counters as well as displaying error and alarm conditions. To view real-time usage statistics for all interfaces, use the **monitor interface traffic** command. The following is a sample of the output from this command:

```
user@host> monitor interface traffic
host                              Seconds: 27                    Time: 04:47:57

Interface    Link  Input packets        (pps)     Output packets        (pps)
 ge-0/0/0     Up           22763        (581)              21275        (581)
...

Bytes=b, Clear=c, Delta=d, Packets=p, Quit=q or ESC, Rate=r, Up=^U, Down=^D
```



Agenda: Operational Monitoring and Maintenance

- Monitoring Platform and Interface Operation
- → Network Utilities
- Maintaining JUNOS Software
- Password Recovery

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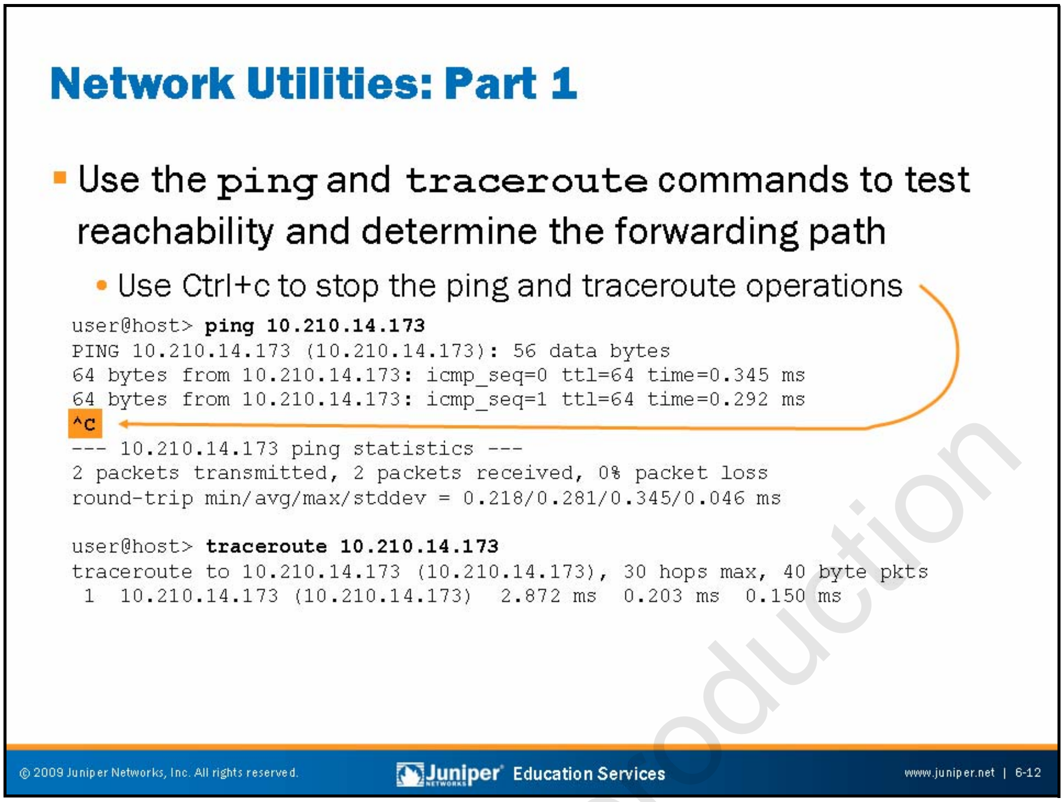
Network Utilities

The slide highlights the topic we discuss next.



Network Utilities: Part 1

- Use the `ping` and `traceroute` commands to test reachability and determine the forwarding path
  - Use Ctrl+c to stop the ping and traceroute operations

```
user@host> ping 10.210.14.173
PING 10.210.14.173 (10.210.14.173): 56 data bytes
64 bytes from 10.210.14.173: icmp_seq=0 ttl=64 time=0.345 ms
64 bytes from 10.210.14.173: icmp_seq=1 ttl=64 time=0.292 ms
^C
--- 10.210.14.173 ping statistics ---
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max/stddev = 0.218/0.281/0.345/0.046 ms

user@host> traceroute 10.210.14.173
traceroute to 10.210.14.173 (10.210.14.173), 30 hops max, 40 byte pkts
 1  10.210.14.173 (10.210.14.173)  2.872 ms  0.203 ms  0.150 ms
```

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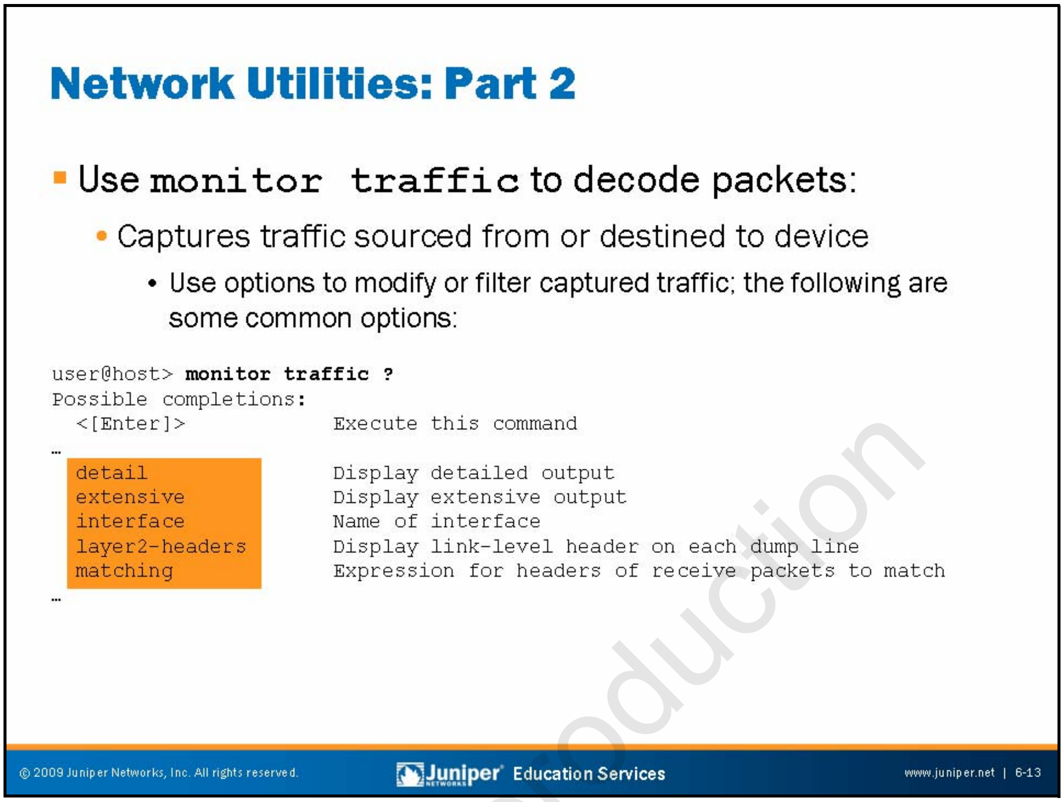
Ping and Traceroute Utilities

The JUNOS CLI provides ping and traceroute utilities. You can use these tools to determine general network reachability and the path that packets take to reach a destination. You can use various arguments with the **`ping`** and **`traceroute`** commands, such as source IP address and packet size, to further assist in problem isolation.

By default, the ping utility sends a continuous flow of ICMP echo requests to the referenced destination. To stop the ping operation, you press the Ctrl+c keys, as illustrated on the slide. Alternatively, you can include the **`count`** option with a specified number of ICMP echo requests to send out:

```
user@host> ping 10.210.11.177 count 5
PING 10.210.11.177 (10.210.11.177): 56 data bytes
64 bytes from 10.210.11.177: icmp_seq=0 ttl=64 time=0.071 ms
64 bytes from 10.210.11.177: icmp_seq=1 ttl=64 time=0.060 ms
64 bytes from 10.210.11.177: icmp_seq=2 ttl=64 time=0.125 ms
64 bytes from 10.210.11.177: icmp_seq=3 ttl=64 time=0.128 ms
64 bytes from 10.210.11.177: icmp_seq=4 ttl=64 time=0.080 ms

--- 10.210.11.177 ping statistics ---
5 packets transmitted, 5 packets received, 0% packet loss
round-trip min/avg/max/stddev = 0.060/0.093/0.128/0.028 ms
```



Network Utilities: Part 2

- Use `monitor traffic` to decode packets:
  - Captures traffic sourced from or destined to device
    - Use options to modify or filter captured traffic; the following are some common options:

```
user@host> monitor traffic ?
Possible completions:
  <[Enter]>            Execute this command
…
  detail               Display detailed output
  extensive            Display extensive output
  interface            Name of interface
  layer2-headers       Display link-level header on each dump line
  matching             Expression for headers of receive packets to match
…
```

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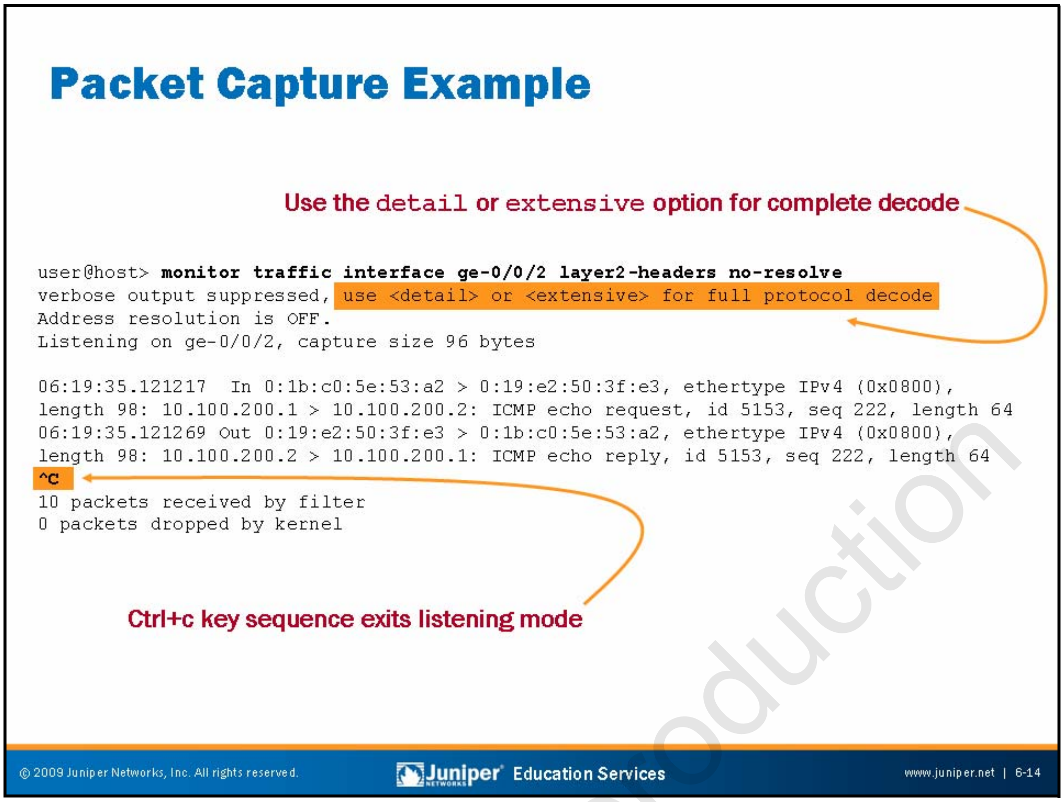
Monitoring Traffic

The CLI’s **`monitor traffic`** command provides access to the tcpdump utility. This tool monitors traffic that originates or terminates on the local Routing Engine (RE). If you do not specify an interface, the management interface will be monitored. This capability provides a way to monitor and diagnose problems at Layer 2 using the **`layer2-headers`** argument. You can match packet fields using the **`matching`** option and save packet captures for analysis from a third-party packet decoder such as Ethereal or Wireshark using the **`write-file`** option.

The **`write-file`** option is hidden and should be used with caution. If used improperly, this command option could fill the available storage space of the device.



Packet Capture Example

Use the detail or extensive option for complete decode

```
user@host> monitor traffic interface ge-0/0/2 layer2-headers no-resolve
verbose output suppressed, use <detail> or <extensive> for full protocol decode
Address resolution is OFF.
Listening on ge-0/0/2, capture size 96 bytes

06:19:35.121217  In 0:1b:c0:5e:53:a2 > 0:19:e2:50:3f:e3, ethertype IPv4 (0x0800),
length 98: 10.100.200.1 > 10.100.200.2: ICMP echo request, id 5153, seq 222, length 64
06:19:35.121269 Out 0:19:e2:50:3f:e3 > 0:1b:c0:5e:53:a2, ethertype IPv4 (0x0800),
length 98: 10.100.200.2 > 10.100.200.1: ICMP echo reply, id 5153, seq 222, length 64
^C
10 packets received by filter
0 packets dropped by kernel
```

Ctrl+c key sequence exits listening mode

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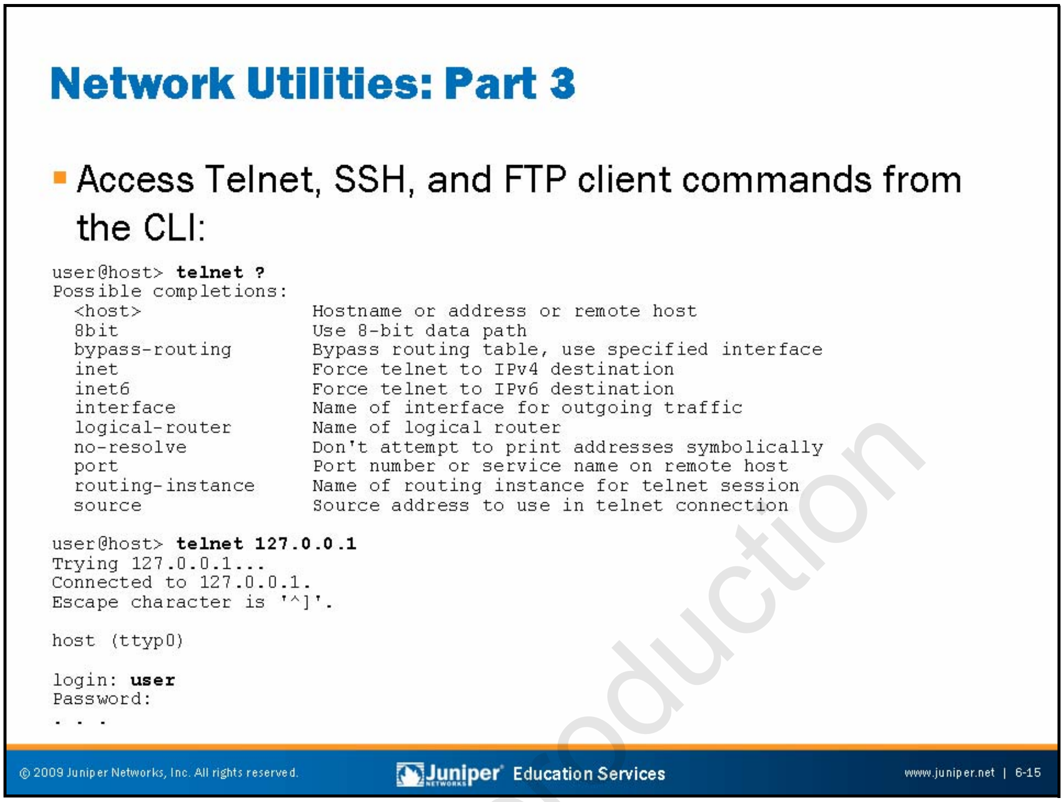
Packet Capture Example

The slide provides an example of the CLI **monitor traffic** command. Note that to stop a packet capture, you use the **Ctrl+C** keyboard sequence.



Network Utilities: Part 3

- Access Telnet, SSH, and FTP client commands from the CLI:

```
user@host> telnet ?
Possible completions:
  <host>                 Hostname or address or remote host
  8bit                   Use 8-bit data path
  bypass-routing         Bypass routing table, use specified interface
  inet                   Force telnet to IPv4 destination
  inet6                  Force telnet to IPv6 destination
  interface              Name of interface for outgoing traffic
  logical-router         Name of logical router
  no-resolve             Don't attempt to print addresses symbolically
  port                   Port number or service name on remote host
  routing-instance       Name of routing instance for telnet session
  source                 Source address to use in telnet connection

user@host> telnet 127.0.0.1
Trying 127.0.0.1...
Connected to 127.0.0.1.
Escape character is '^]'.

host (ttyp0)

login: user
Password:
. . .
```

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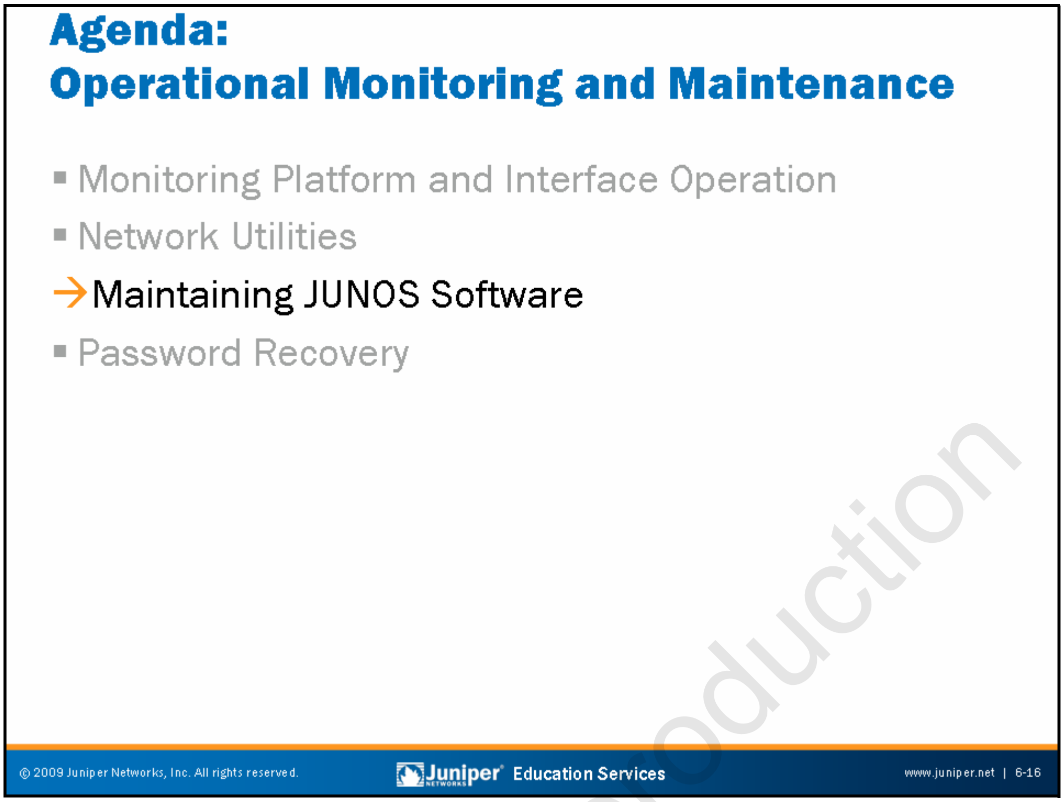
Network Utilities

The CLI supports powerful Telnet, SSH, and FTP clients. These clients support various arguments that tailor their specific operations.

You use the CLI's **file copy** command to transfer files to and from devices running JUNOS Software. The following example uses the **file copy** command in conjunction with the FTP client to transfer a file from a remote FTP server to the local device running JUNOS Software:

```
user@host> file copy ftp://ftp:ftp@10.210.11.189/junos-jseries-domestic.tgz /
var/tmp/junos-jseries-domestic.tgz
/var/tmp//...transferring.file.........Ri4PRe/100% of   41 MB 4071 kBps 00m00s
```



Agenda: Operational Monitoring and Maintenance

- Monitoring Platform and Interface Operation
- Network Utilities
- → Maintaining JUNOS Software
- Password Recovery

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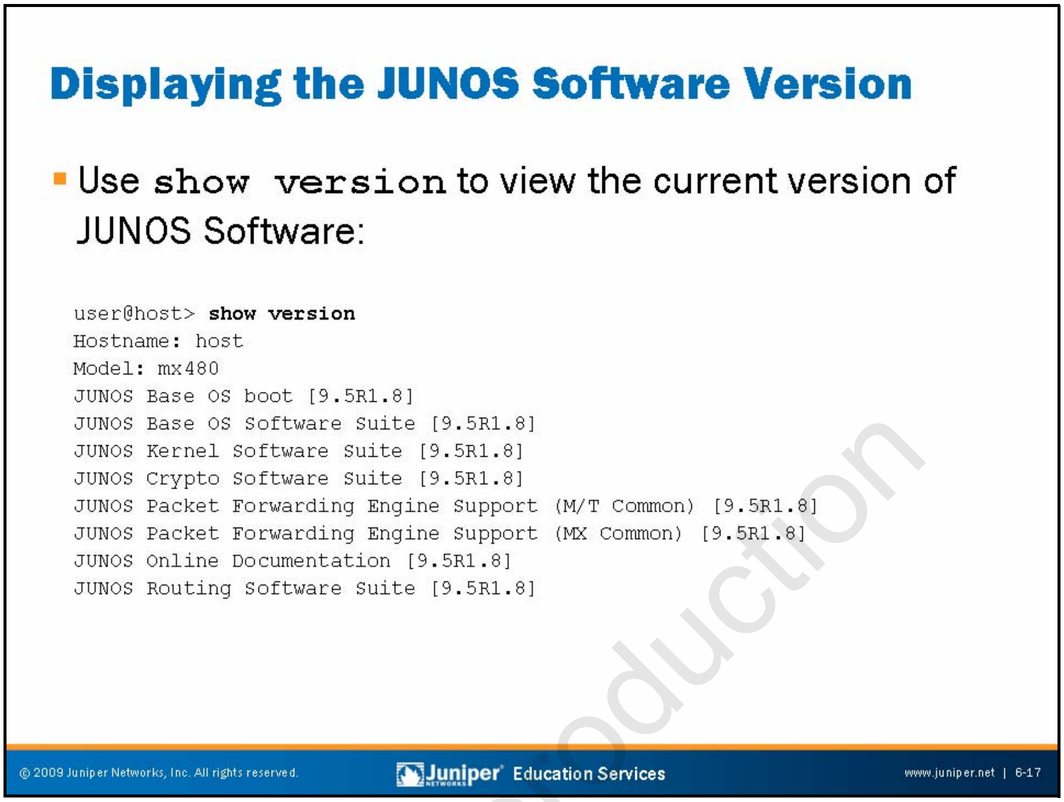
Maintaining JUNOS Software

The slide highlights the topic we discuss next.



Displaying the JUNOS Software Version

- Use `show version` to view the current version of JUNOS Software:

```
user@host> show version
Hostname: host
Model: mx480
JUNOS Base OS boot [9.5R1.8]
JUNOS Base OS Software Suite [9.5R1.8]
JUNOS Kernel Software Suite [9.5R1.8]
JUNOS Crypto Software Suite [9.5R1.8]
JUNOS Packet Forwarding Engine Support (M/T Common) [9.5R1.8]
JUNOS Packet Forwarding Engine Support (MX Common) [9.5R1.8]
JUNOS Online Documentation [9.5R1.8]
JUNOS Routing Software Suite [9.5R1.8]
```

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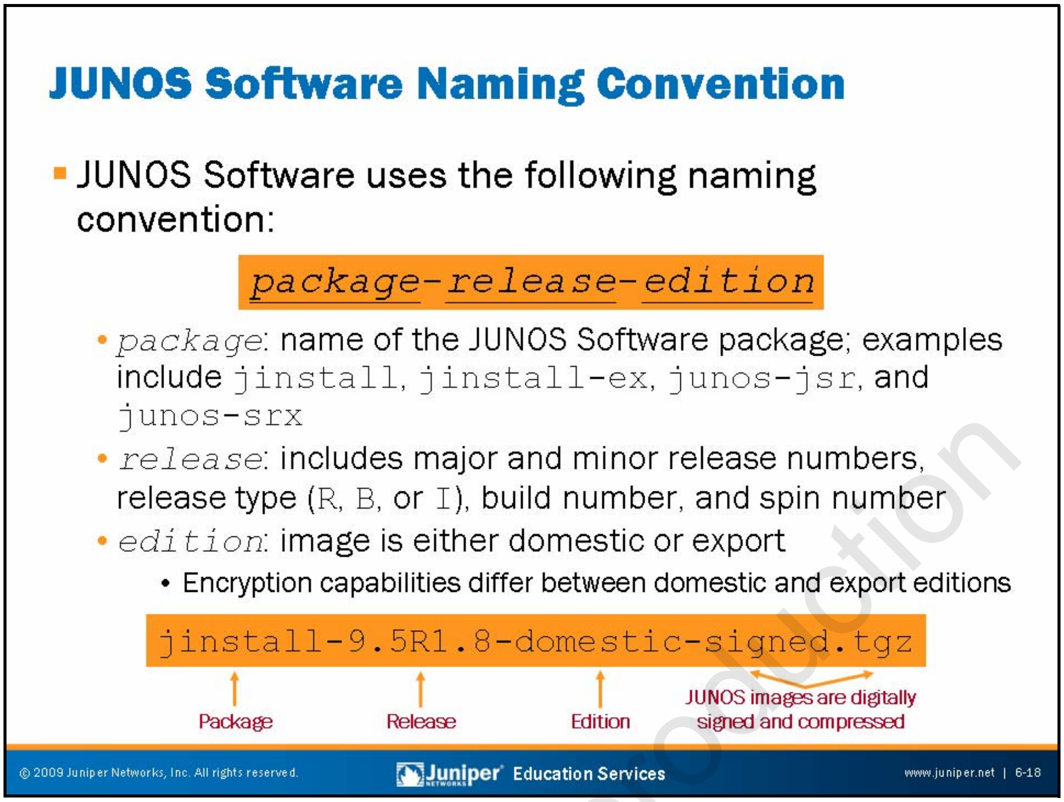
Determining the JUNOS Software Version

You use the **`show version`** CLI command to determine the current JUNOS Software version on a device running JUNOS Software. You can include the **`detail`** option to view additional details about the software packages and the processes included in the version. The following are some common JUNOS packages and a description of each:

- *jkernel*: The kernel and network tools package. This package contains the basic operating system files.
- *jroute*: The Routing Engine package. This package contains the Routing Engine software.
- *jpfe*: The Packet Forwarding Engine (PFE) package. This package contains the PFE software.
- *jdocs*: The documentation package. This package contains the documentation set for the software.
- *jcrypto*: The encryption package. This package contains the domestic version of the security software.



JUNOS Software Naming Convention

- JUNOS Software uses the following naming convention:

`package-release-edition`

- *package*: name of the JUNOS Software package; examples include `jinstall`, `jinstall-ex`, `junos-jsr`, and `junos-srx`
- *release*: includes major and minor release numbers, release type (R, B, or I), build number, and spin number
- *edition*: image is either domestic or export
  - Encryption capabilities differ between domestic and export editions

`jinstall-9.5R1.8-domestic-signed.tgz`

JUNOS Software Naming Convention

The JUNOS Software naming convention format is *package-release-edition*.

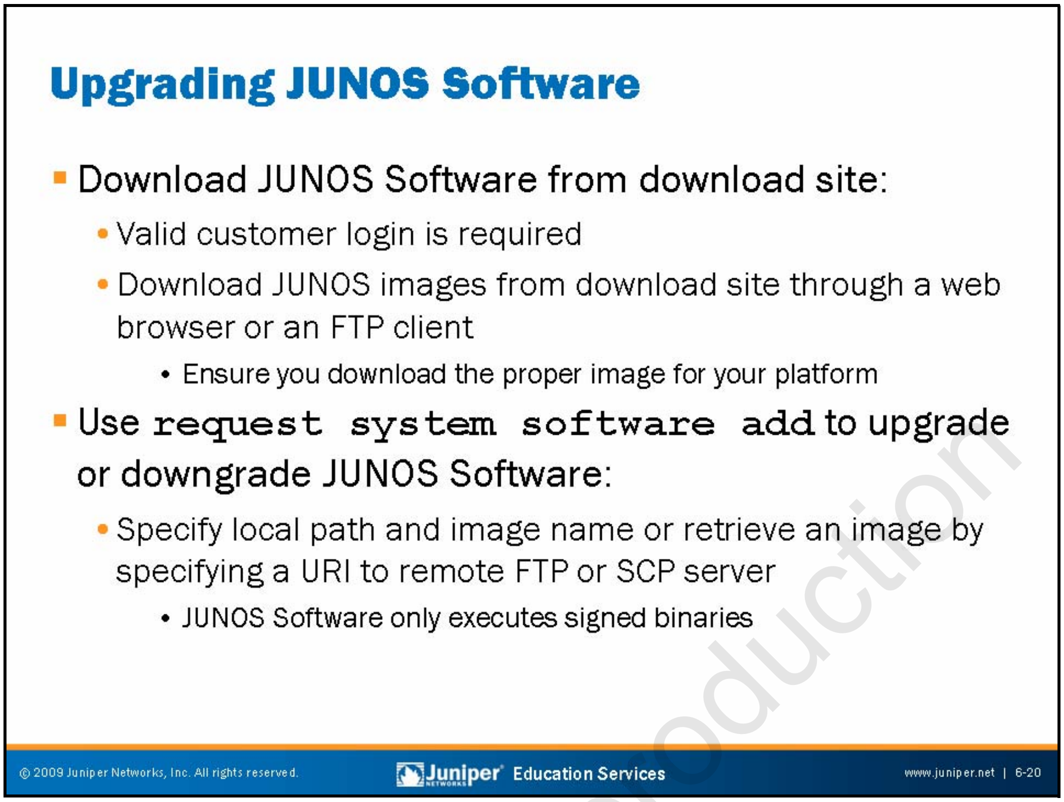
- *package* is a description of the software contents. Package descriptions include `jinstall`, which is used on M Series, T Series, and MX Series, `jinstall-ex`, which is used on EX Series, `junos-jsr`, which is used on J Series, and `junos-srx`, which is used on SRX Series. The actual package name might vary between platforms within a JUNOS product family. Always ensure that you download and install the proper image for your device.
- *release* describes the JUNOS Software version and includes several subcomponents. The release includes two integers that represent the major and minor release numbers as well as a capital letter that indicates the type of software release. The most commonly occurring letter is R, which stands for released software. If you are involved in testing prereleased software, this letter might be a B (for beta-level software) or I (for internal, test, or experimental versions of software). In some situations, you might see the letter S, which is reserved for service releases. The release also includes a build and spin number for the JUNOS Software version. For example, `jinstall-9.5R1.8-domestic.tgz` indicates a JUNOS Software image associated with version 9.5, build 1, spin 8.

Continued on next page.

JUNOS Software Naming Convention (contd.)

- *`edition`* will typically be either `domestic` or `export`. Domestic versions support strong encryption, whereas export versions do not. A third, less common, edition called FIPS exists that provides advanced network security for customers who must comply with and operate in a Federal Information Processing Standards (FIPS) 140-2 environment.

All JUNOS Software is delivered in signed packages that contain digital signatures, the Secure Hash Algorithm 1 (SHA-1), and Message Digest 5 (MD5) checksums. A package is installed only if the checksum within it matches the hash recorded in its corresponding file. The actual checksum used depends on the software version.



Upgrading JUNOS Software

- Download JUNOS Software from download site:
  - Valid customer login is required
  - Download JUNOS images from download site through a web browser or an FTP client
    - Ensure you download the proper image for your platform
- Use `request system software add` to upgrade or downgrade JUNOS Software:
  - Specify local path and image name or retrieve an image by specifying a URI to remote FTP or SCP server
    - JUNOS Software only executes signed binaries

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Downloading JUNOS Software

Before upgrading JUNOS Software, you must download the appropriate image for your device from the JUNOS Software download site. You can download JUNOS Software using a Web browser or through an FTP client (including the device running JUNOS Software itself). Regardless of the download method you choose, you must have a valid service contract and access account.

To download JUNOS Software through a Web browser, you point your browser to http://www.juniper.net/support/, login, select the desired image, and accept the request to begin the download process.

To access JUNOS Software through an FTP client, you open an FTP session from an FTP client to the FTP server using the ftp.juniper.net Uniform Reference Identifier (URI), login, navigate to the desired directory where the JUNOS image is stored, and download the desired image using the appropriate FTP commands.

Because individual JUNOS images are designed for specific platforms running JUNOS Software, you must ensure the correct image is downloaded!

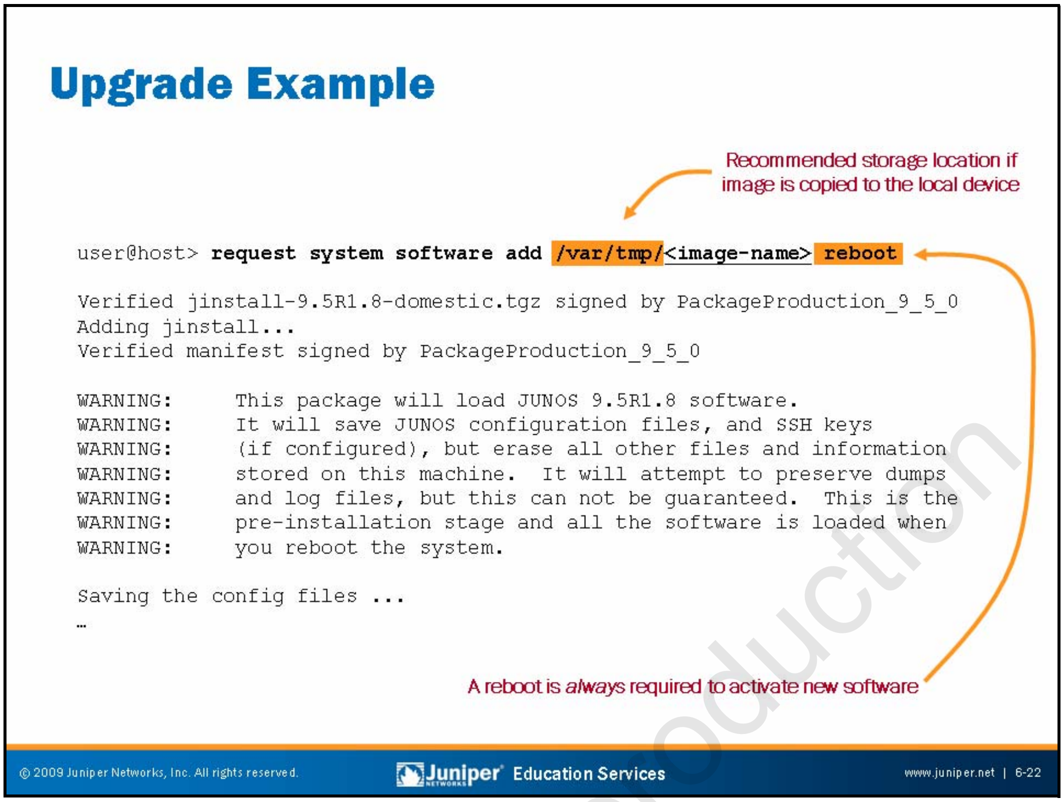
Continued on next page.

Upgrading JUNOS Software

Use the **`request system software add`** ***<u>`<path/image name>`</u>*** CLI command to upgrade JUNOS Software. You can specify a local path and file name or a remote FTP or SCP URI that contains the required JUNOS image to download and install. To activate the new software, you must reboot the system. The system reboot can be performed as a separate step or can be initiated by adding the **`reboot`** option at the end of the **`request system software add`** command.

Once the JUNOS Software is installed, you are notified that the system is rebooting to complete the installation. Use a console connection to view details of the upgrade process. Watch for any error messages indicating a problem with the upgrade.

Devices running JUNOS Software execute binaries supplied only by Juniper Networks. Each JUNOS Software image includes a digitally signed manifest of executables that are registered with the system only if the signature can be validated. JUNOS Software does not execute any binary without a registered fingerprint. This feature is designed to protect the system against unauthorized software and activity that might compromise the integrity of your device running JUNOS Software.



Upgrade Example

Recommended storage location if image is copied to the local device

```
user@host> request system software add /var/tmp/<image-name> reboot

Verified jinstall-9.5R1.8-domestic.tgz signed by PackageProduction_9_5_0
Adding jinstall...
Verified manifest signed by PackageProduction_9_5_0

WARNING:     This package will load JUNOS 9.5R1.8 software.
WARNING:     It will save JUNOS configuration files, and SSH keys
WARNING:     (if configured), but erase all other files and information
WARNING:     stored on this machine.  It will attempt to preserve dumps
WARNING:     and log files, but this can not be guaranteed.  This is the
WARNING:     pre-installation stage and all the software is loaded when
WARNING:     you reboot the system.

Saving the config files ...
…
```

A reboot is *always* required to activate new software

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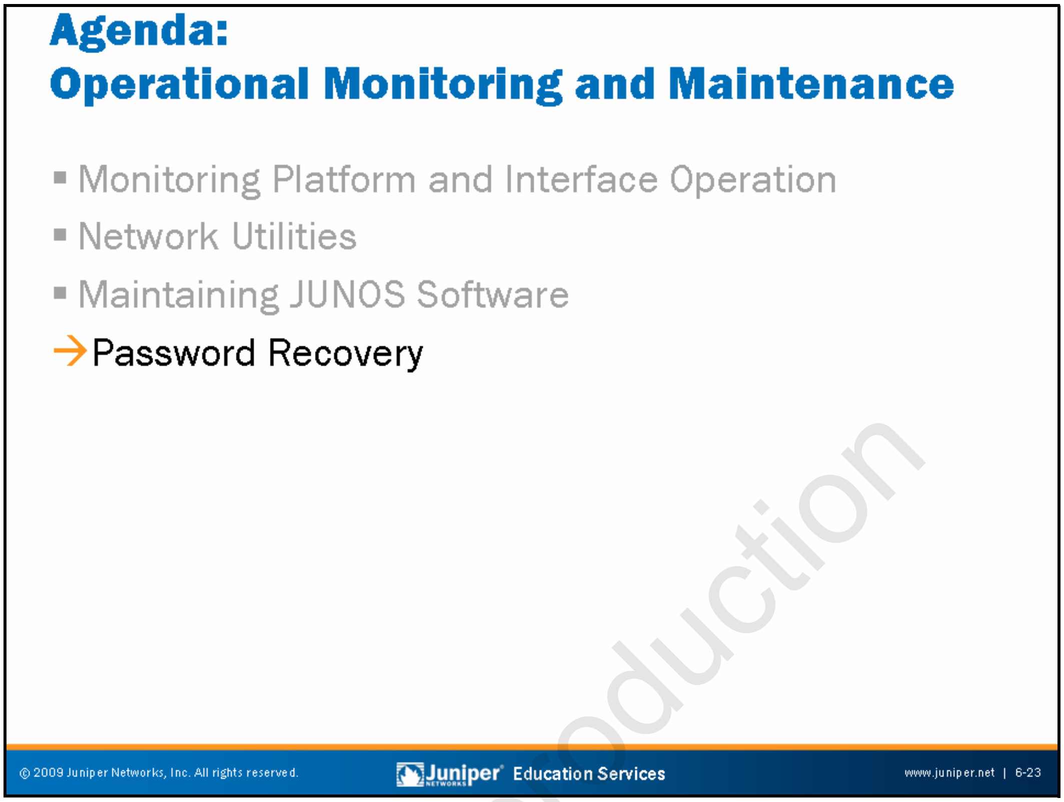
Upgrade Example

When upgrading JUNOS Software, you reference the image name and a local path or a remote server within a URI. JUNOS Software images copied to a device running JUNOS Software in preparation for an upgrade should be stored in the `/var/tmp` directory. JUNOS images stored in the `/var/tmp` directory can be deleted when the file system cleanup operation is performed using the **`request system storage cleanup`** CLI command. To determine which files are cleanup candidates, you can issue the **`request system storage cleanup dry-run`** command.

Although there is typically plenty of storage space, it is a good practice to check available storage capacity before downloading a new JUNOS Software image. You can view compact-flash device storage details with the CLI **`show system storage`** command.

As the slide indicates, when an upgrade is performed, the system must be rebooted in order for the new version to take affect. To save time and keystrokes, you can use the **`reboot`** option when performing the upgrade. Once the JUNOS Software is installed, you are notified that the system is rebooting to complete the installation. Use the console connection to view details of the upgrade process. Watch for any error messages indicating a problem with the upgrade. Once the system has rebooted, you can issue the **`show version`** command, illustrated earlier in this chapter, to verify the JUNOS Software version. You can also review the boot messages by issuing the **`show system boot-messages`** command.



Agenda: Operational Monitoring and Maintenance

- Monitoring Platform and Interface Operation
- Network Utilities
- Maintaining JUNOS Software
- → Password Recovery

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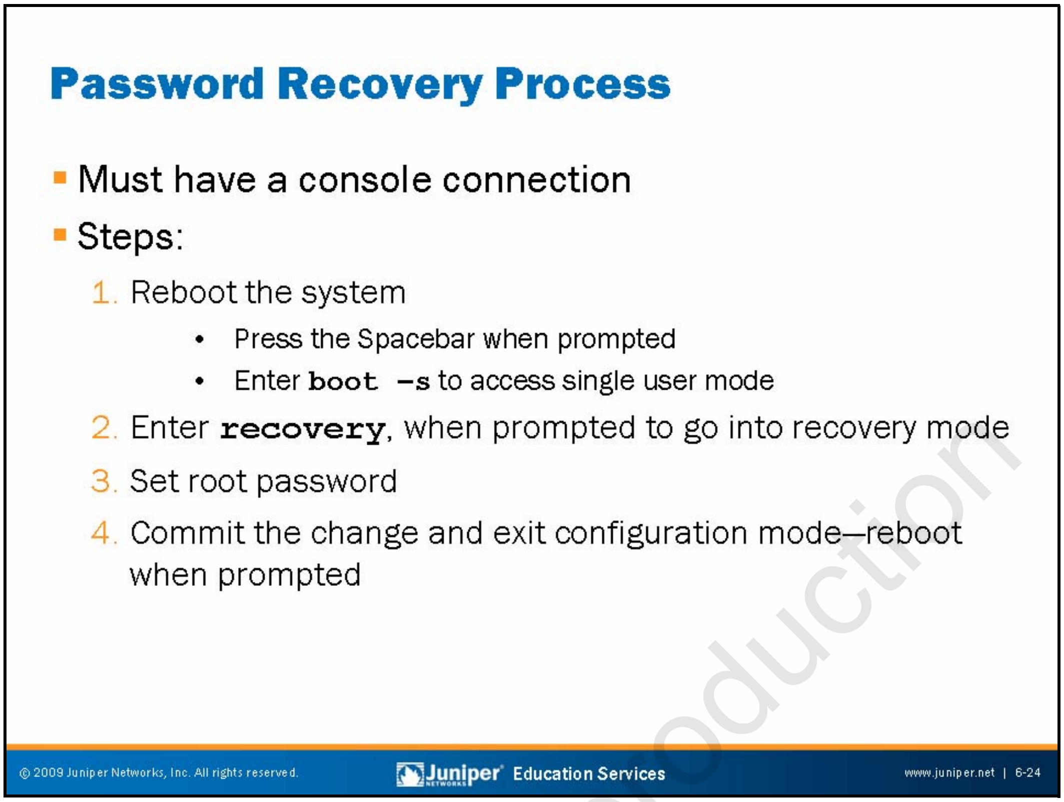
Password Recovery

The slide highlights the topic we discuss next.



Password Recovery Process

- Must have a console connection
- Steps:
  1. Reboot the system
     - Press the Spacebar when prompted
     - Enter **boot -s** to access single user mode
  2. Enter **recovery**, when prompted to go into recovery mode
  3. Set root password
  4. Commit the change and exit configuration mode—reboot when prompted

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Password Recovery Requires Console Connection

If you become locked out of a device running JUNOS Software, you can recover the root password. As a security precaution, the recovery can only be performed using the console connection. You can disable the password recovery option by setting the console port to the insecure mode as shown in the following screen capture:

```
[edit system ports]
user@host# show
console insecure;
```

Password Recovery Steps

The following steps list the process for recovering the root password.

1. Obtain console access and reboot the system. Watch as the system boots, and press the Spacebar when prompted during the boot loader process. When the system presents a `loader>` prompt or an OK prompt, enter **boot -s** to boot into single-user mode:

```
...TRIMMED...
Hit [Enter] to boot immediately, or space bar for command prompt.
<user presses Spacebar>
```

Continued on next page.

Password Recovery Steps (contd.)

```
Type '?' for a list of commands, 'help' for more detailed help.
loader> boot -s
```

2. The system performs a single-user boot-up process and prompts you to run the recovery script, enter a shell pathname, or press Enter for a default shell. Enter **`recovery`** at this point.

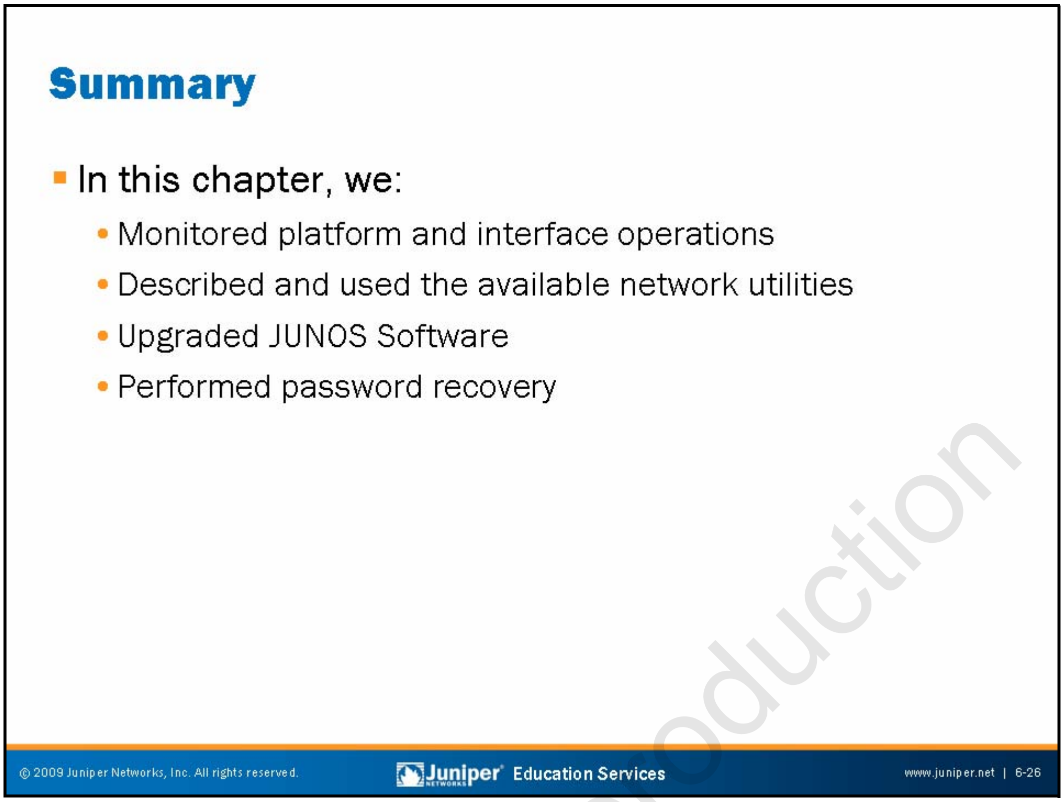
```
...TRIMMED...
Enter full pathname of shell or 'recovery' for root password recovery or RETURN
for /bin/sh: recovery
```

3. After a series of messages, the CLI starts and you are presented with an operational mode command prompt. At this point, you can enter configuration mode and reset the root password. Do not forget to commit your configuration.

```
...TRIMMED...
Starting CLI ...
root> configure
Entering configuration mode

[edit]
root# set system root-authentication plain-text-password
New password:
Retype new password:

[edit]
root# commit
commit complete
```

4. To complete the recovery, exit configuration mode. You are then prompted to reboot the system. Choose `y` (`yes`) to reboot the system. Once the reboot is complete, you can log in with the new root password.

```
[edit]
root# exit
Exiting configuration mode

root> exit

Reboot the system? [y/n] y
```



Summary

- In this chapter, we:
  - Monitored platform and interface operations
  - Described and used the available network utilities
  - Upgraded JUNOS Software
  - Performed password recovery

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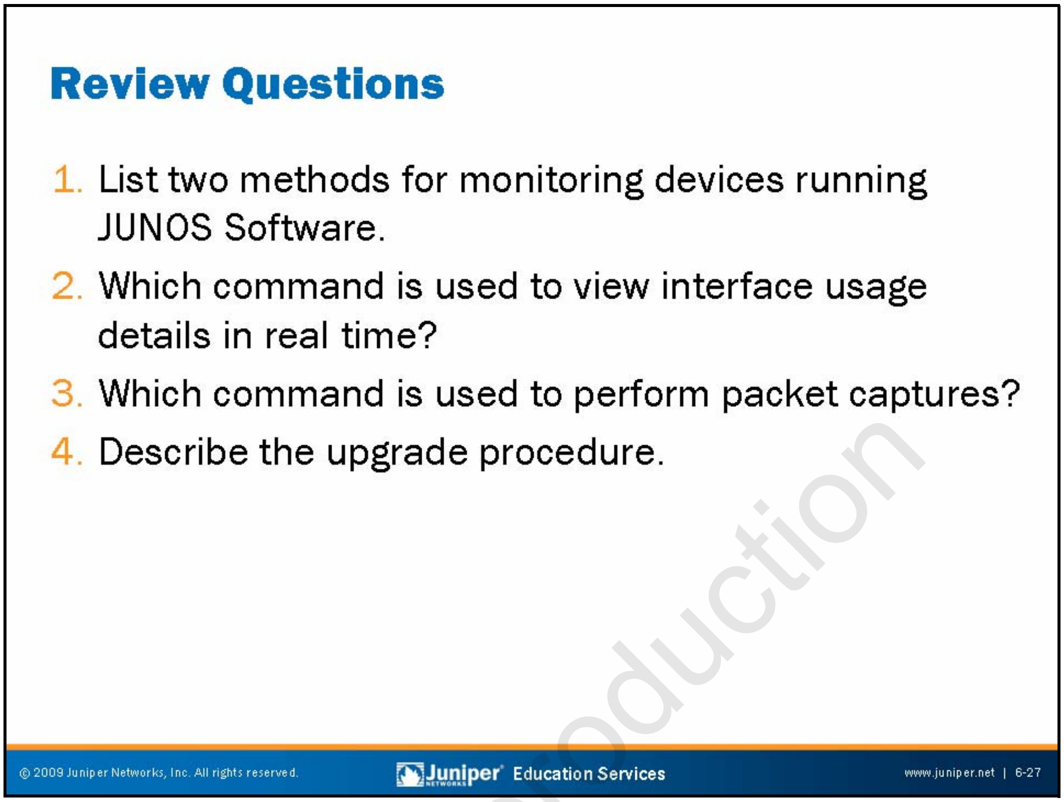
This Chapter Discussed:

- Monitoring platform and interface operations;
- Network utilities and usage guidelines;
- Maintaining JUNOS Software; and
- Performing password recovery.



Review Questions

1. List two methods for monitoring devices running JUNOS Software.
2. Which command is used to view interface usage details in real time?
3. Which command is used to perform packet captures?
4. Describe the upgrade procedure.

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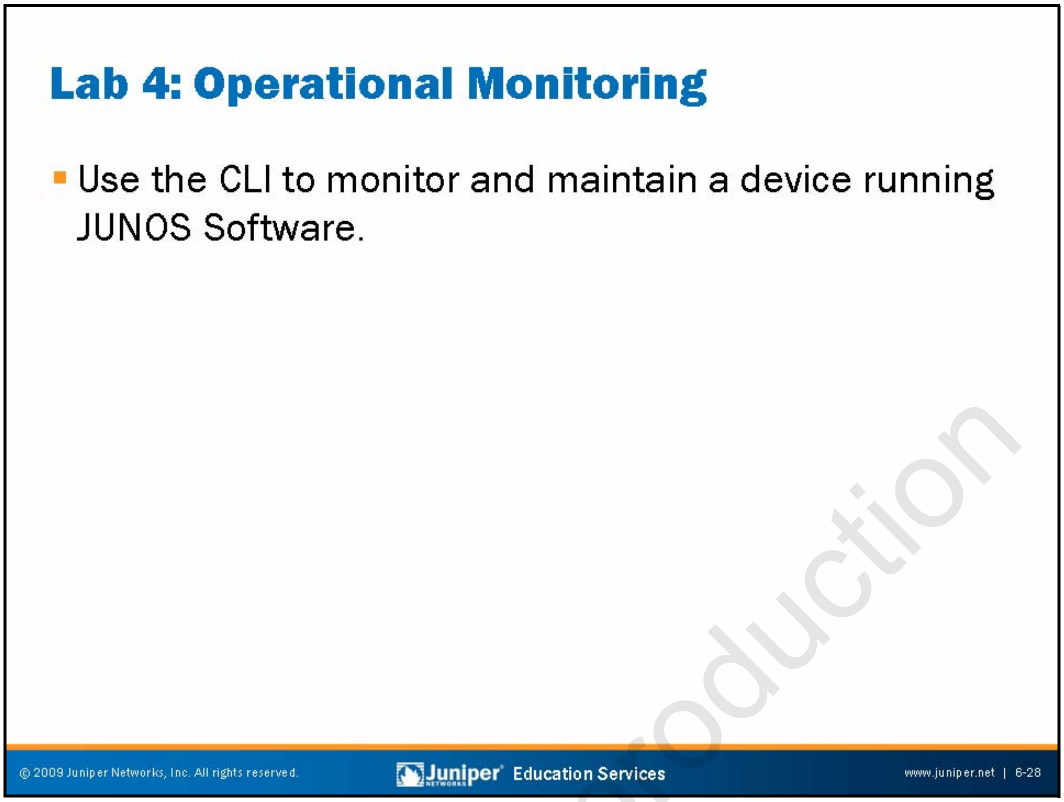
Review Questions

1.

2.

3.

4.



Lab 4: Operational Monitoring

- Use the CLI to monitor and maintain a device running JUNOS Software.

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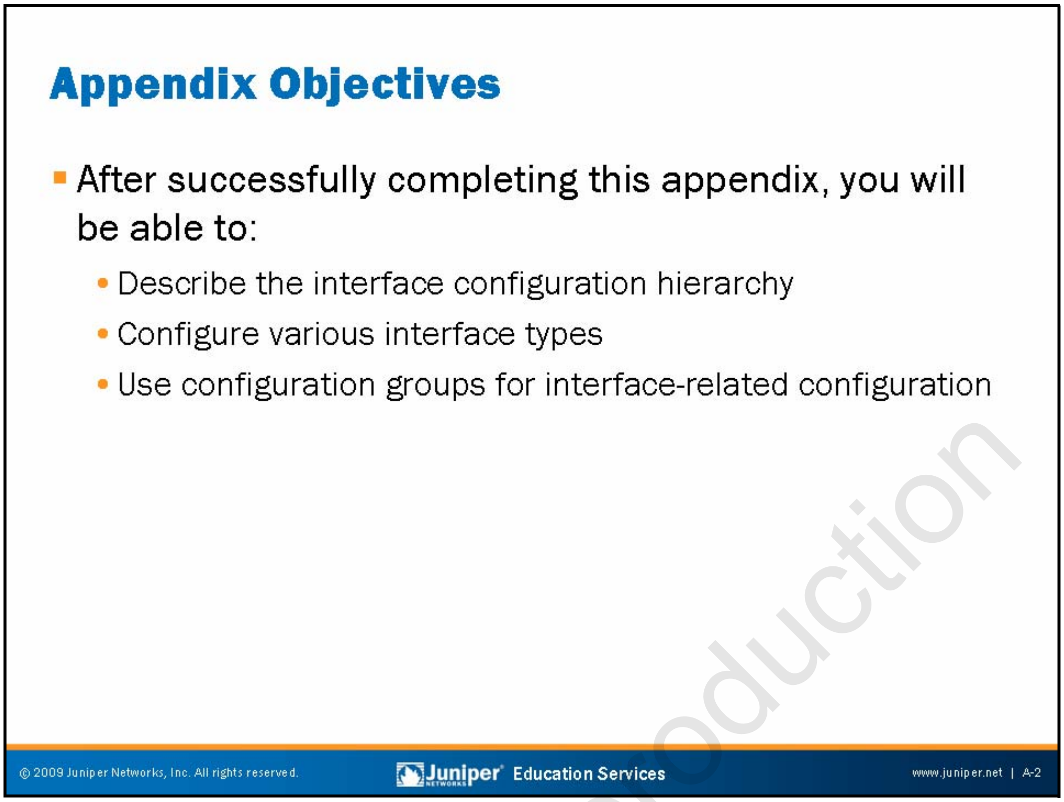
Lab 4: Operational Monitoring

The slide provides the objective for this lab.

Introduction to JUNOS Software

Appendix A: Interface Configuration Examples



Appendix Objectives

- After successfully completing this appendix, you will be able to:
  - Describe the interface configuration hierarchy
  - Configure various interface types
  - Use configuration groups for interface-related configuration

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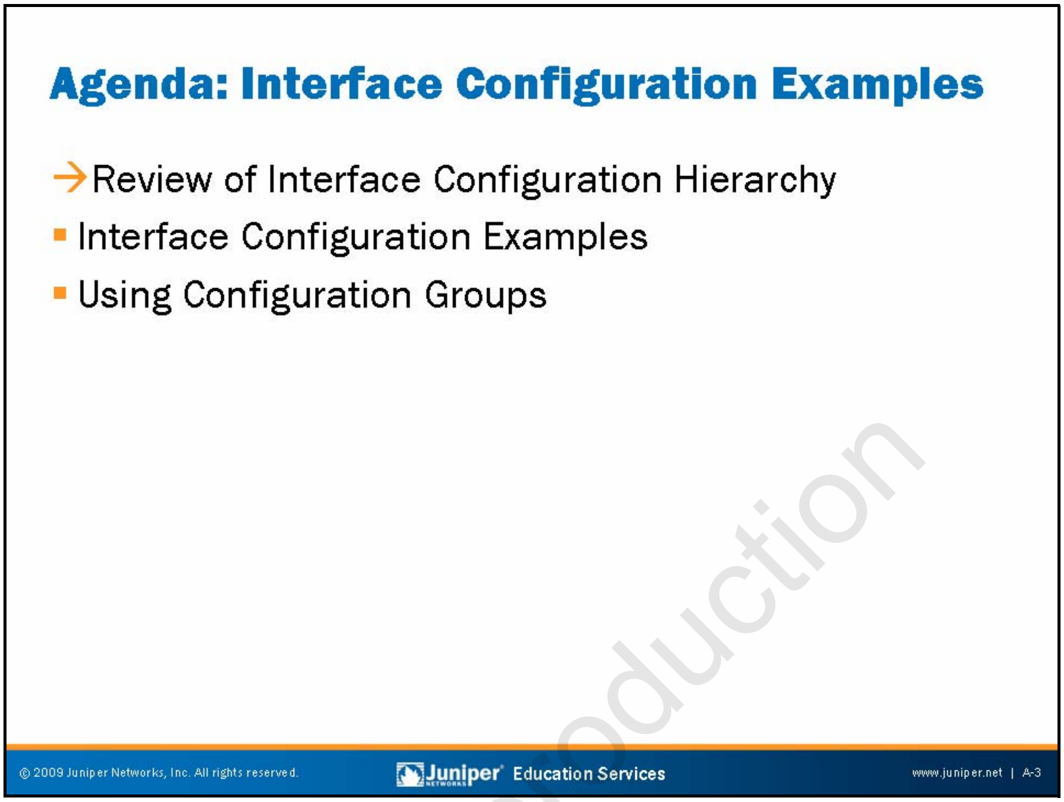
This Appendix Discusses:

- The interface configuration hierarchy;
- Configuration examples for various interface types; and
- Configuration groups.



Agenda: Interface Configuration Examples

→Review of Interface Configuration Hierarchy
- Interface Configuration Examples
- Using Configuration Groups

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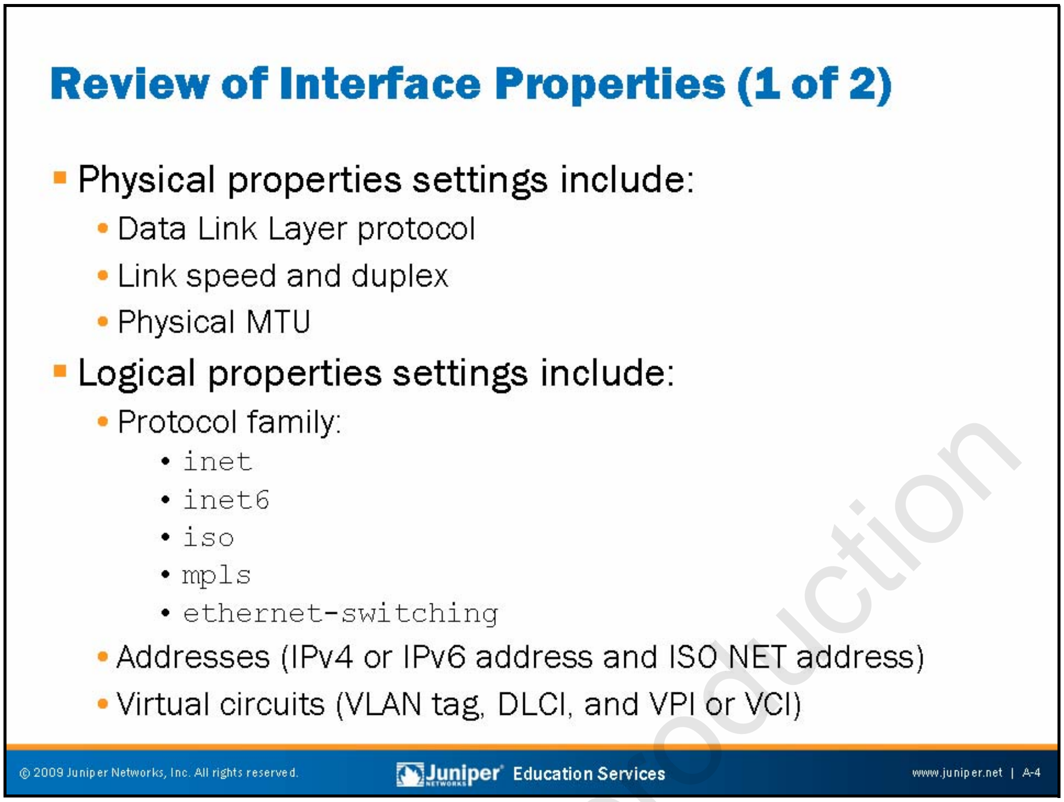
Review of Interface Configuration Hierarchy

The slide lists the topics we cover in this chapter. We discuss the highlighted topic first.



Review of Interface Properties (1 of 2)

- Physical properties settings include:
  - Data Link Layer protocol
  - Link speed and duplex
  - Physical MTU
- Logical properties settings include:
  - Protocol family:
    - `inet`
    - `inet6`
    - `iso`
    - `mpls`
    - `ethernet-switching`
  - Addresses (IPv4 or IPv6 address and ISO NET address)
  - Virtual circuits (VLAN tag, DLCI, and VPI or VCI)

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Physical Properties

The following list provides details for some physical interface properties:

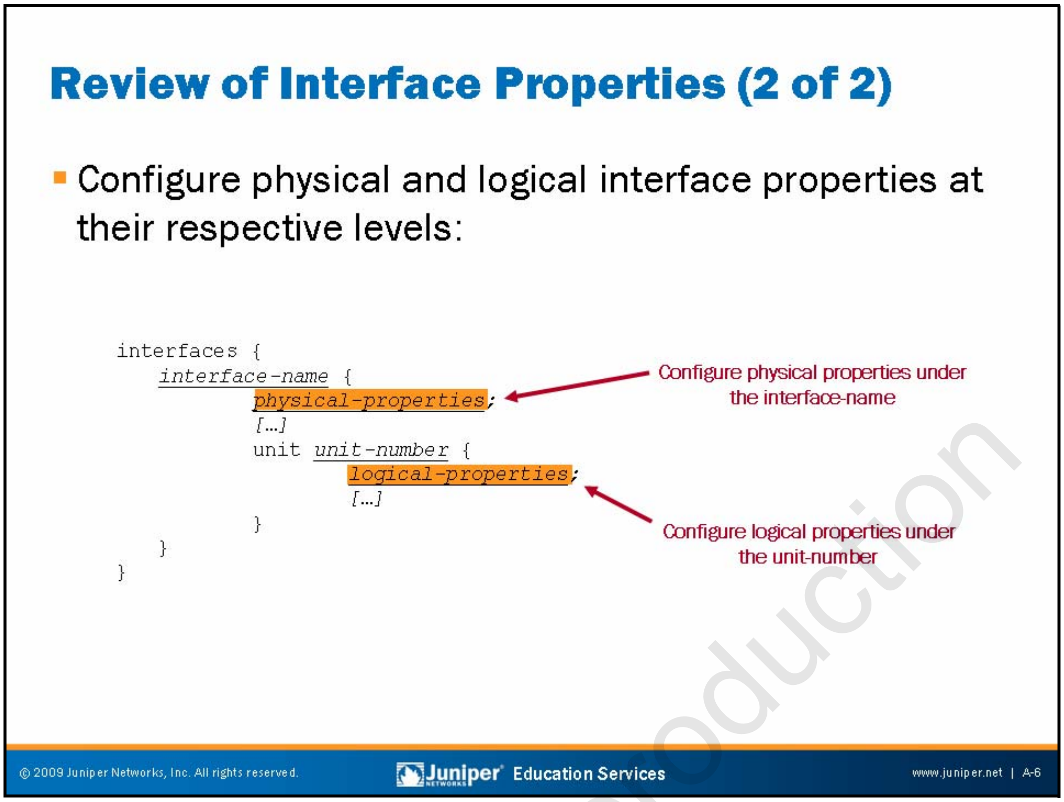
- *Data Link Layer protocol* and *keepalives*: You can change the Data Link Layer protocol for the particular media type (for example, PPP to Cisco HDLC), and you can turn keepalives on or off;
- *Link mode*: On Ethernet interfaces you can hardcode the duplex setting to either half-duplex or full-duplex;
- *Speed*: You can specify the link speed on certain interface types;
- *Maximum transmission unit (MTU)*: You can vary the size from 256 to 9192 bytes;
- *Clocking*: Refers to the interface clock source—either internal or external;
- *Scrambling*: Refers to payload scrambling, which can be on or off;
- *Frame check sequence (FCS)*: You can modify to 32-bit mode (the default is 16-bit mode); and
- *Diagnostic characteristics*: You can enable local or remote loopbacks or set up a BERT test.

Continued on next page.

Logical Properties

The following list provides details for some logical interface properties:

- *Protocol family*: Refers to the protocol family you want to use, such as family inet, inet6, iso, mpls, or ethernet-switching;
- *Addresses*: Refers to the address associated with the particular family (for example, IP address using family inet);
- *Virtual circuits*: Refers to the virtual circuit identifier, such as a data-link connection identifier (DLCI), virtual path identifier (VPI), virtual channel identifier (VCI), or virtual LAN (VLAN) tag; and
- *Other characteristics*: Some other configurable options include Inverse ARP, traps, and accounting profiles.



Review of Interface Properties (2 of 2)

- Configure physical and logical interface properties at their respective levels:

```
interfaces {
    interface-name {
          physical-properties;
          [...]
          unit unit-number {
                logical-properties;
                [...]
          }
    }
}
```

Configure physical properties under the interface-name

Configure logical properties under the unit-number

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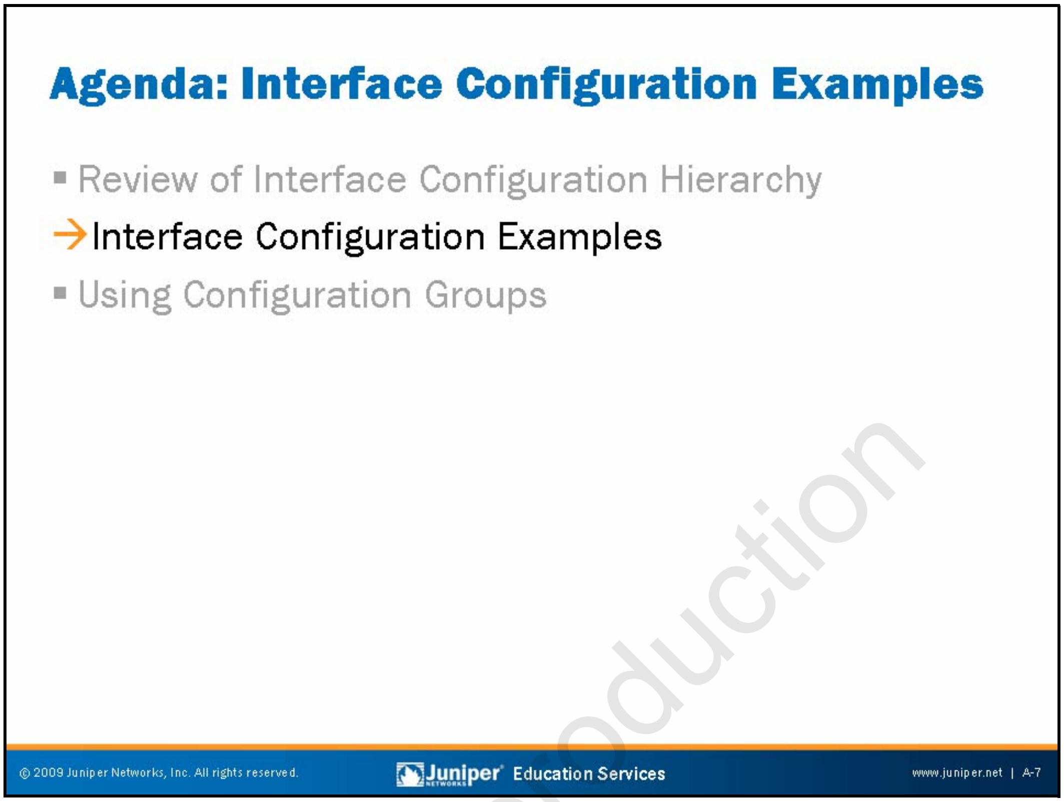
Configuration Hierarchy

All interfaces have the same configuration hierarchy organization. JUNOS Software considers all properties defined directly under the interface name to be the physical properties of that interface. The unit number represents a particular logical interface or subinterface. JUNOS Software considers all properties defined directly under the unit number to be the logical properties of each particular subinterface.



Agenda: Interface Configuration Examples

- Review of Interface Configuration Hierarchy
- →Interface Configuration Examples
- Using Configuration Groups

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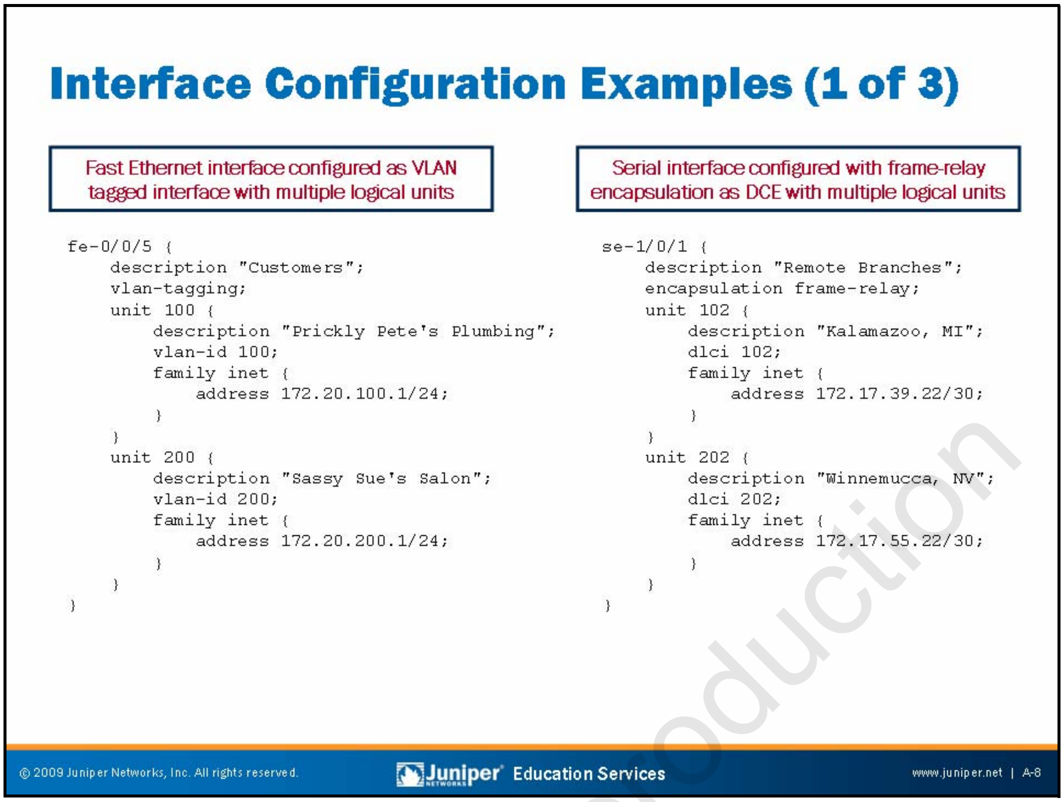
Interface Configuration Examples

The slide highlights the topic we discuss next.



Interface Configuration Examples (1 of 3)

Fast Ethernet interface configured as VLAN tagged interface with multiple logical units

```
fe-0/0/5 {
    description "Customers";
    vlan-tagging;
    unit 100 {
        description "Prickly Pete's Plumbing";
        vlan-id 100;
        family inet {
            address 172.20.100.1/24;
        }
    }
    unit 200 {
        description "Sassy Sue's Salon";
        vlan-id 200;
        family inet {
            address 172.20.200.1/24;
        }
    }
}
```

Serial interface configured with frame-relay encapsulation as DCE with multiple logical units

```
se-1/0/1 {
    description "Remote Branches";
    encapsulation frame-relay;
    unit 102 {
        description "Kalamazoo, MI";
        dlci 102;
        family inet {
            address 172.17.39.22/30;
        }
    }
    unit 202 {
        description "Winnemucca, NV";
        dlci 202;
        family inet {
            address 172.17.55.22/30;
        }
    }
}
```

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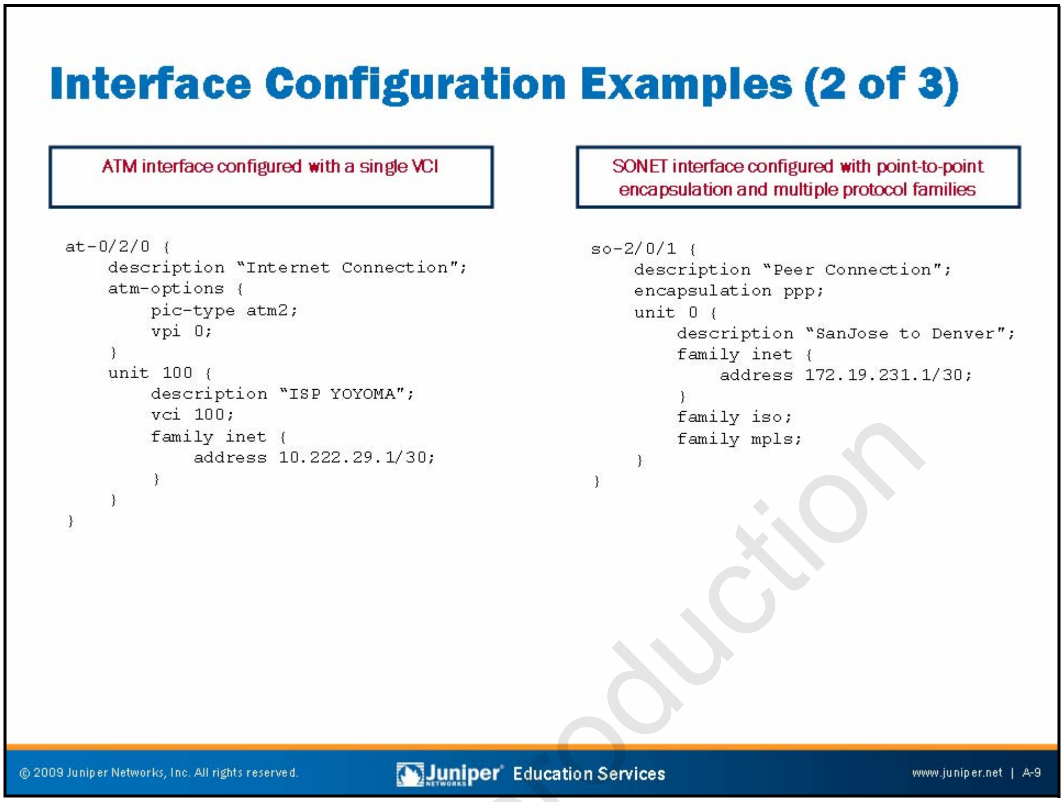
Configuration Examples: Part 1

The slide shows two configuration examples. The first configuration example displays a tagged Ethernet interface with multiple logical interfaces; each logical unit is assigned its respective VLAN ID. The second configuration example shows a serial interface configured with the frame-relay encapsulation. Each logical interface assigned to the serial interface has a corresponding data-link connection identifier (DLCI). Both configuration examples are configured for IPv4 routing, which uses the `inet` protocol family.



Interface Configuration Examples (2 of 3)

ATM interface configured with a single VCI

```
at-0/2/0 {
    description "Internet Connection";
    atm-options {
        pic-type atm2;
        vpi 0;
    }
    unit 100 {
        description "ISP YOYOMA";
        vci 100;
        family inet {
            address 10.222.29.1/30;
        }
    }
}
```

SONET interface configured with point-to-point encapsulation and multiple protocol families

```
so-2/0/1 {
    description "Peer Connection";
    encapsulation ppp;
    unit 0 {
        description "SanJose to Denver";
        family inet {
            address 172.19.231.1/30;
        }
        family iso;
        family mpls;
    }
}
```

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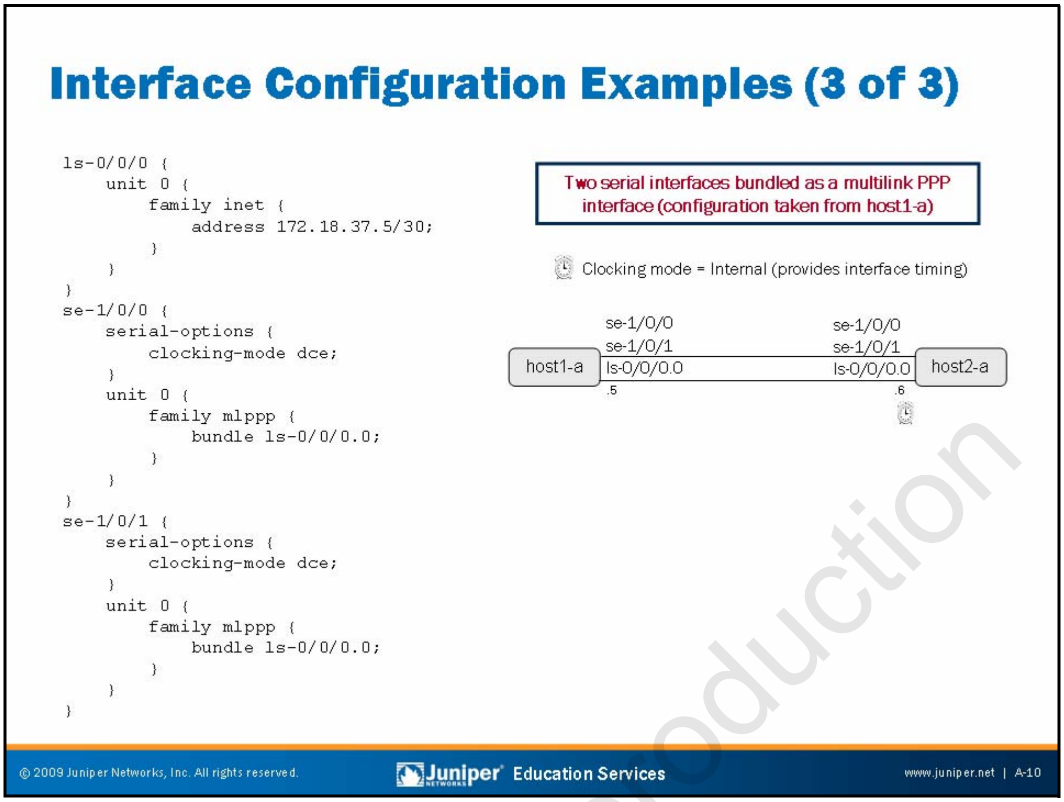
Configuration Examples: Part 2

The slide shows two configuration examples. The first configuration example displays an Asynchronous Transfer Mode (ATM) interface with a single logical unit and corresponding VCI. Note that this ATM interface configuration example is based on the ATM2 IQ interface. A second ATM interface configuration example is shared in the Using Configuration Groups section, which is based on the ATM1 interface.

The second configuration example above shows a SONET interface configured with Point-to-Point Protocol (PPP) encapsulation and multiple protocol families. We used the `iso` protocol family for the IS-IS routing protocol, and we used the `mpls` protocol family for traffic engineering. Both configuration examples are for IPv4 routing, which uses the `inet` protocol family.



Interface Configuration Examples (3 of 3)

```
ls-0/0/0 {
    unit 0 {
        family inet {
            address 172.18.37.5/30;
        }
    }
}
se-1/0/0 {
    serial-options {
        clocking-mode dce;
    }
    unit 0 {
        family mlppp {
            bundle ls-0/0/0.0;
        }
    }
}
se-1/0/1 {
    serial-options {
        clocking-mode dce;
    }
    unit 0 {
        family mlppp {
            bundle ls-0/0/0.0;
        }
    }
}
```

Two serial interfaces bundled as a multilink PPP interface (configuration taken from host1-a)

Clocking mode = Internal (provides interface timing)

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Configuration Examples: Part 3

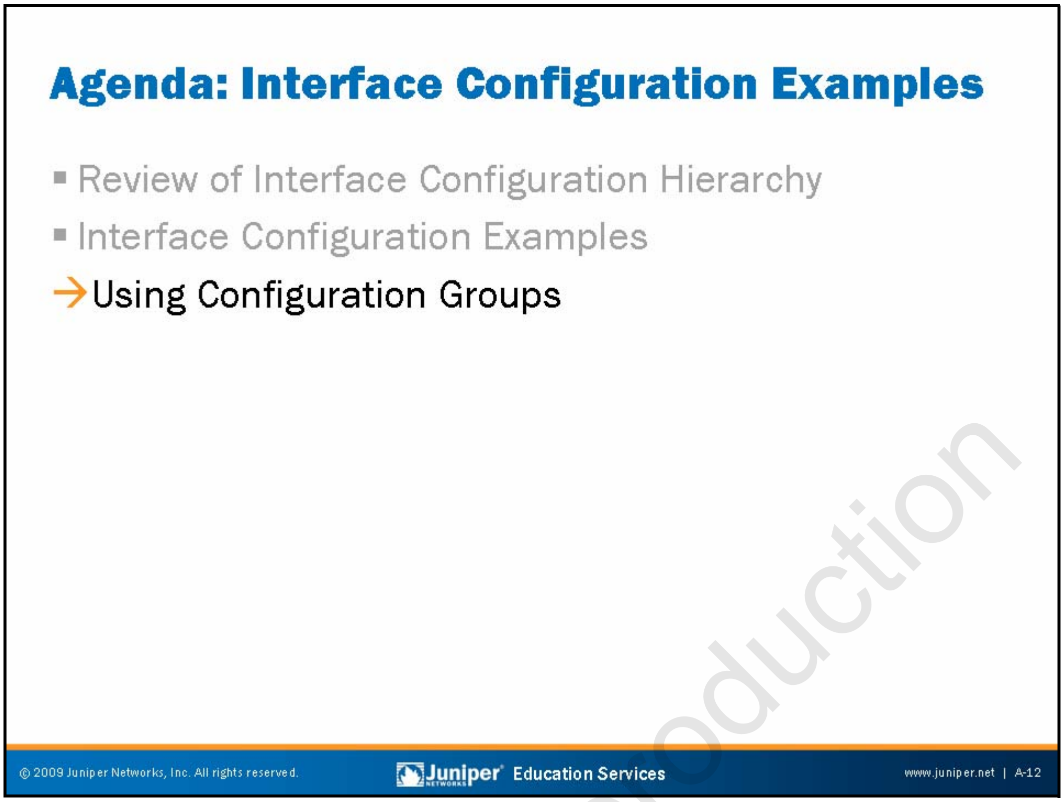
The slide highlights a basic Multilink Point-to-Point Protocol (MLPPP) configuration. In this example, two serial interfaces function as member links for the configured bundle. The sample configuration is from the `host1-a` device.

Continued on next page.

Configuration Examples: Part 3 (contd.)

The following is the configuration for the *host2-a* device:

```
interfaces {
    ls-0/0/0 {
        unit 0 {
            family inet {
                address 172.18.37.6/30;
            }
        }
    }
    se-1/0/0 {
        serial-options {
            clocking-mode internal;
        }
        unit 0 {
            family mlppp {
                bundle ls-0/0/0.0;
            }
        }
    }
    se-1/0/1 {
        serial-options {
            clocking-mode internal;
        }
        unit 0 {
            family mlppp {
                bundle ls-0/0/0.0;
            }
        }
    }
}
```



Agenda: Interface Configuration Examples

- Review of Interface Configuration Hierarchy
- Interface Configuration Examples

→Using Configuration Groups

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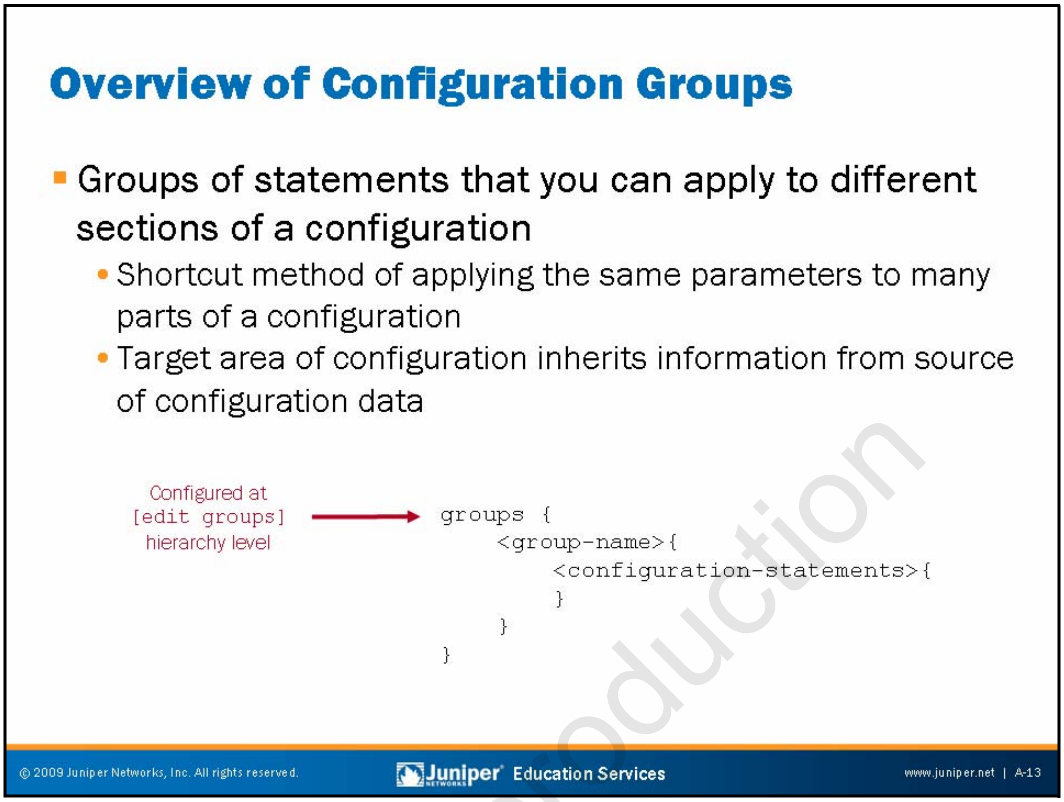
Using Configuration Groups

The slide highlights the topic we discuss next.



Overview of Configuration Groups

- Groups of statements that you can apply to different sections of a configuration
  - Shortcut method of applying the same parameters to many parts of a configuration
  - Target area of configuration inherits information from source of configuration data

Configured at [edit groups] hierarchy level →

```
groups {
    <group-name>{
        <configuration-statements>{
        }
    }
}
```

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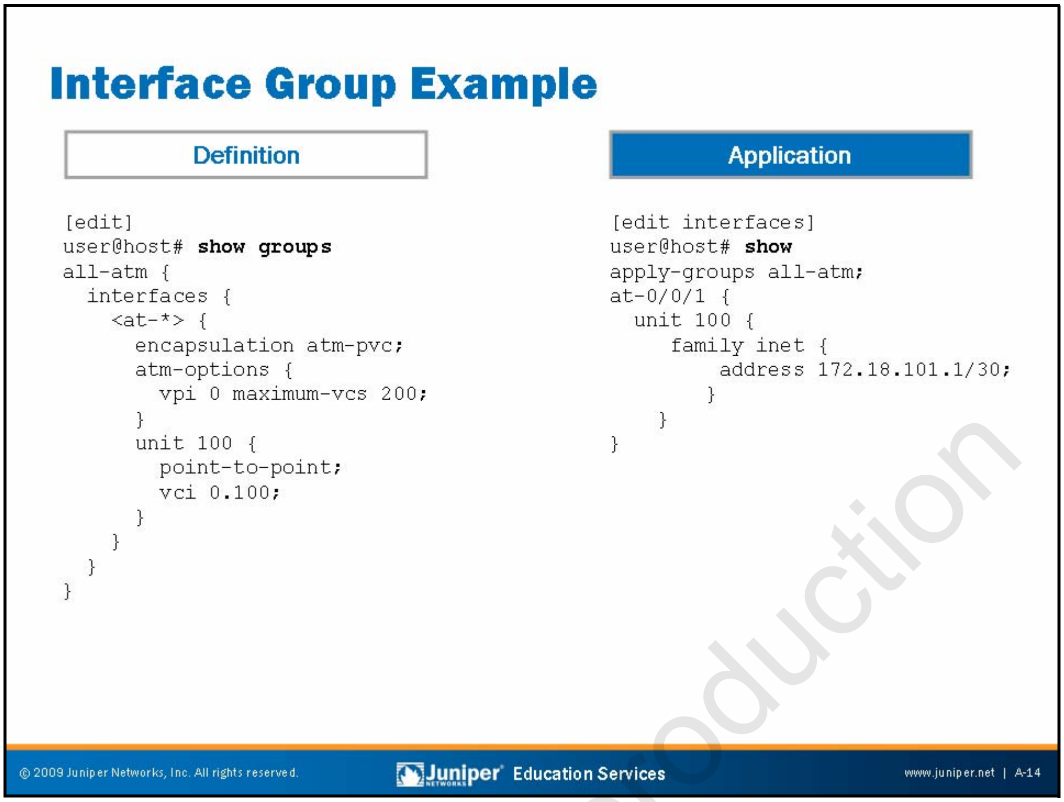
Configuration Groups

Configuration groups allow you to create a group containing configuration statements and to direct the inheritance of that group's statements in the rest of the configuration. You can apply the same group to different sections of the configuration, and different sections of one group's configuration statements can be inherited in different places in the configuration.

Configuration groups allow you to create smaller, more logically constructed configuration files, making it easier to configure and maintain the JUNOS Software. For example, you can group statements that repeat in many places in the configuration, such as when configuring interfaces, and thereby limit updates to just the group.

You can also use wildcards in a configuration group to allow configuration data to be inherited by any object that matches a wildcard expression.

The configuration group mechanism is separate from the grouping mechanisms used elsewhere in the configuration, such as BGP groups. Configuration groups provide a generic mechanism that you can use throughout the configuration but that only the JUNOS Software command-line interface (CLI) recognizes. The individual software processes that perform the actions directed by the configuration receive the expanded form of the configuration; they have no knowledge of configuration groups.



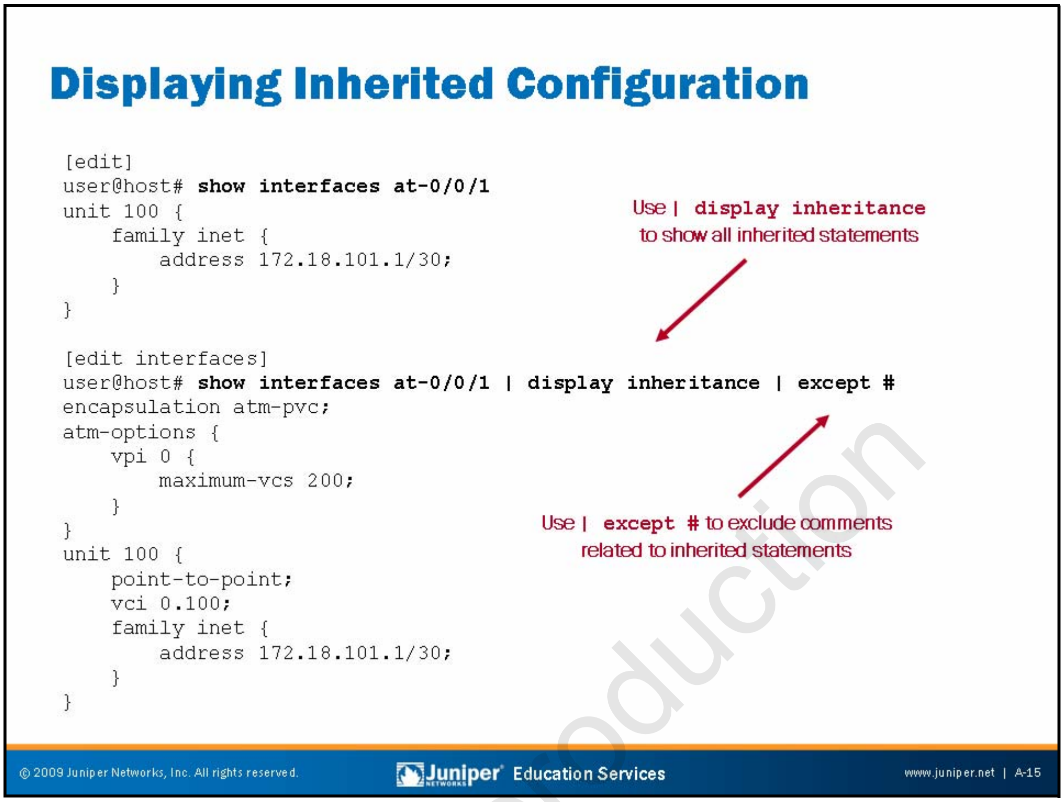
Interface Group Example

```
[edit]
user@host# show groups
all-atm {
  interfaces {
    <at-*> {
      encapsulation atm-pvc;
      atm-options {
        vpi 0 maximum-vcs 200;
      }
      unit 100 {
        point-to-point;
        vci 0.100;
      }
    }
  }
}
```

```
[edit interfaces]
user@host# show
apply-groups all-atm;
at-0/0/1 {
  unit 100 {
     family inet {
         address 172.18.101.1/30;
        }
    }
}
```

Interface Group Example

You can use configuration groups to separate the common interface media parameters from the interface-specific addressing information. The example on the slide places configuration data for ATM interfaces into a group called *`all-atm`*, which is applied at the `[edit interfaces]` hierarchy. In this example, all configuration parameters defined within the *`all-atm`* configuration group apply to the at-0/0/1 interface. If competing statements existed, the software would use the statements configured directly under the ATM interface.



Displaying Inherited Configuration

```
[edit]
user@host# show interfaces at-0/0/1
unit 100 {
    family inet {
        address 172.18.101.1/30;
    }
}

[edit interfaces]
user@host# show interfaces at-0/0/1 | display inheritance | except #
encapsulation atm-pvc;
atm-options {
    vpi 0 {
        maximum-vcs 200;
    }
}
unit 100 {
    point-to-point;
    vci 0.100;
    family inet {
        address 172.18.101.1/30;
    }
}
```

Use | **display inheritance** to show all inherited statements

Use | **except #** to exclude comments related to inherited statements

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Displaying Inherited Configuration

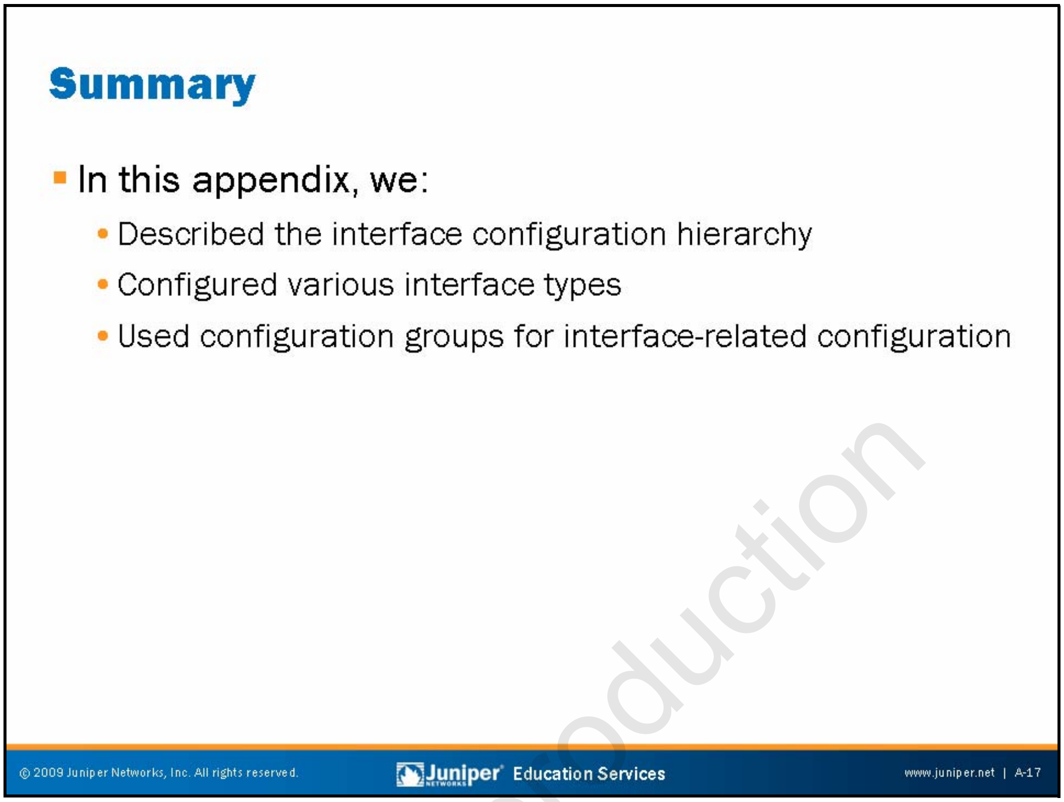
Configuration groups can make determining the actual values used by a device running JUNOS Software difficult, because configuration data can be inherited from configuration groups. To view the actual values used by a device running JUNOS Software, use the **| display inheritance** option after the show command. This command displays the inherited statements at the level at which they are inherited and the group from which they have been inherited. As mentioned on the slide, you can also add the **| except #** option to exclude the inheritance notes.

Continued on next page.

Displaying Inherited Configuration (contd.)

The following is the command illustrated on the slide without the **| except #** command:

```
[edit]
user@host# show interfaces at-0/0/1 | display inheritance
##
## 'atm-pvc' was inherited from group 'all-atm'
##
encapsulation atm-pvc;
##
## 'atm-options' was inherited from group 'all-atm'
##
atm-options {
    ##
    ## '0' was inherited from group 'all-atm'
    ##
    vpi 0 {
        ##
        ## '200' was inherited from group 'all-atm'
        ##
        maximum-vcs 200;
    }
}
unit 100 {
    ##
    ## 'point-to-point' was inherited from group 'all-atm'
    ##
    point-to-point;
    ##
    ## '0.100' was inherited from group 'all-atm'
    ##
    vci 0.100;
    family inet {
        address 172.18.101.1/30;
    }
}
```



Summary

- In this appendix, we:
  - Described the interface configuration hierarchy
  - Configured various interface types
  - Used configuration groups for interface-related configuration

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This Appendix Discussed:

- The interface configuration hierarchy;
- Configuration examples for various interface types; and
- Configuration groups.

Appendix B: Acronym List

ASIC	application-specific integrated circuit
ATM	Asynchronous Transfer Mode
Cisco HDLC	Cisco High-Level Data Link Control
CLI	command-line interface
CoS	class of service
dcd	device control process
DLCI	data-link connection identifier
DNS	Domain Name System
DoS	denial of service
FCS	frame check sequence
FIPS	Federal Information Processing Standards
FPC	Flexible PIC Concentrator
FT1	fractional T1
GB	gigabyte
GRES	graceful Routing Engine switchover
GUI	graphical user interface
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol over Secure Sockets Layer
ICMP	Internet Control Message Protocol
IETF	Internet Engineering Task Force
IGP	interior gateway protocol
ISSU	in-service software upgrade
JNTCP	Juniper Networks Technical Certification Program
JTAC	Juniper Networks Technical Assistance Center
KB	kilobytes
LLDP	Link Layer Discovery Protocol
MB	megabytes
MD5	Message Digest 5
MIB	Management Information Base
MLPPP	Multilink Point-to-Point Protocol
MTU	maximum transmission unit
NMS	network management system
NSR	nonstop active routing
NTP	Network Time Protocol
OID	object identifier
OoB	out-of-band
OSPF	Open Shortest Path First
PFE	Packet Forwarding Engine
POP	point of presence
PPP	Point-to-Point Protocol
pps	packets per second
RE	Routing Engine
RMON	Remote Monitoring
RSTP	Rapid Spanning Tree Protocol
SHA-1	Secure Hash Algorithm 1
TTL	time-to-live
URI	uniform resource identifier
USM	user-based security model
VACM	view-based access control model

VCI	virtual channel identifier
VLAN	virtual LAN
VPI	virtual path identifier

Appendix C: Answer Key

Chapter 1: Course Introduction

This chapter does not contain any review questions.

Chapter 2: JUNOS Software Fundamentals

1.

JUNOS Software is compartmentalized into multiple software processes. Each process runs in its own protected memory space, ensuring that one process cannot directly interfere with another. This modularity also ensures that new features can be added with less likelihood of breaking current functionality.

2.

The primary functions of the control plane are to maintain routing intelligence, control and monitor the chassis, and manage the packet forwarding engine. The primary functions of the forwarding plane are to forward packets and to implement advanced services.

3.

Transit traffic is forwarded through the PFE on platforms running JUNOS Software, based on the forwarding table installed on the PFE. Exception traffic is processed locally by the platform running JUNOS Software by either the PFE or the RE depending on the type of traffic. Host-bound packets, such as protocol and management traffic, are passed directly to the RE for processing, while traffic requiring ICMP error message responses is typically handled by the PFE.

4.

Platform families that run JUNOS Software include M Series, T Series, J Series, MX Series, EX Series, and SRX Series.

Chapter 3: User Interface Options

1.

Two primary modes exist within the JUNOS Software, the operational mode and the configuration mode. A third mode also exists in the form of the FreeBSD shell.

2.

You use the operational mode to monitor and troubleshoot the software, network connectivity, and hardware. You use the configuration mode to configure a device running JUNOS Software, including interfaces, protocols, user access, and system hardware.

3.

You use the Spacebar to complete a command and the Tab key to complete a variable.

4.

The **top** command is the quickest method of returning to the top of the hierarchy.

Chapter 3: User Interface Options (contd.)

5.

The active configuration has been committed and is in use, whereas the candidate configuration is not active until you perform a **`commit`** operation.

6.

The **`show | compare`** command displays the differences between the current active and candidate configurations.

Chapter 4: Initial Configuration

1.

Use the **`cli`** command at the shell prompt to enter operational mode.

2.

The root authentication is the only required parameter during the initial configuration.

3.

As always, you must issue a **`commit`** for any configuration changes to take effect.

4.

Some examples of logical interface properties you might configure include the protocol family (such as `inet`, `inet6`, `iso`, `mpls`, or `ethernet-switching`), addresses, and virtual circuit identifiers (such as VPI, VCI, DLCI, and VLAN tag).

Chapter 5: Secondary System Configuration

1.

Users can be authenticated using the local password database, RADIUS authentication, and TACACS+ authentication.

2.

The `messages` log is the primary syslog file, and is stored in `/var/log` directory. Use the **`show log messages`** command to view the `messages` log.

3.

Configuration archival allows for disaster recovery in situations where a system storage device becomes unusable. Archiving configurations can also be a useful part of a company's configuration management policy.

4.

An SNMP trap is an agent-initiated notification of network events relative to the sending agent.

Chapter 6: Operational Monitoring and Maintenance

1.

The primary method for monitoring devices running JUNOS Software is the JUNOS CLI, which includes operational `show` and `monitor` commands. Some secondary methods include J-Web, SNMP, hardware LEDs, and front-panel displays or LCDs.

Chapter 6: Operational Monitoring and Maintenance (contd.)

2.

Use the CLI **`monitor interface`** or **`monitor interface traffic`** commands to view interface usage in real time.

3.

Use the CLI **`monitor traffic interface`** command to perform a packet capture.

4.

You must first download the JUNOS Software image for your respective platform from the Juniper Networks download site. The install package can be copied to the device running JUNOS Software directly (recommended directory is /var/tmp) or you can copy the image to a server that is reachable through FTP or SCP from the device being upgraded. You then perform the upgrade using the CLI **`request system software add`** command. You can monitor the upgrade process through a console connection and verify the JUNOS Software version using the CLI **`show version`** command.