Chapter 11: It's a Network

Introduction to Networking

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Chapter 11

Chapter 11: Objectives

Upon completion of this chapter, you will be able to:

- Identify the devices and protocols used in a small network.
- Explain how a small network serves as the basis of larger networks.
- Describe the need for basic security measures on network devices.
- Identify security vulnerabilities and general mitigation techniques.
- Configure network devices with device hardening features to mitigate security threats.
- Use the output of **`ping`** and **`tracert`** commands to establish relative network performance.
- Use basic **`show`** commands to verify the configuration and status of a device interface.

Chapter 11: Objectives (Cont.)

- Use the basic host and IOS commands to acquire information about the devices in a network.
- Explain the file systems on Routers and Switches.
- Apply the commands to back up and restore an IOS configuration file.

11.1 Create and Grow

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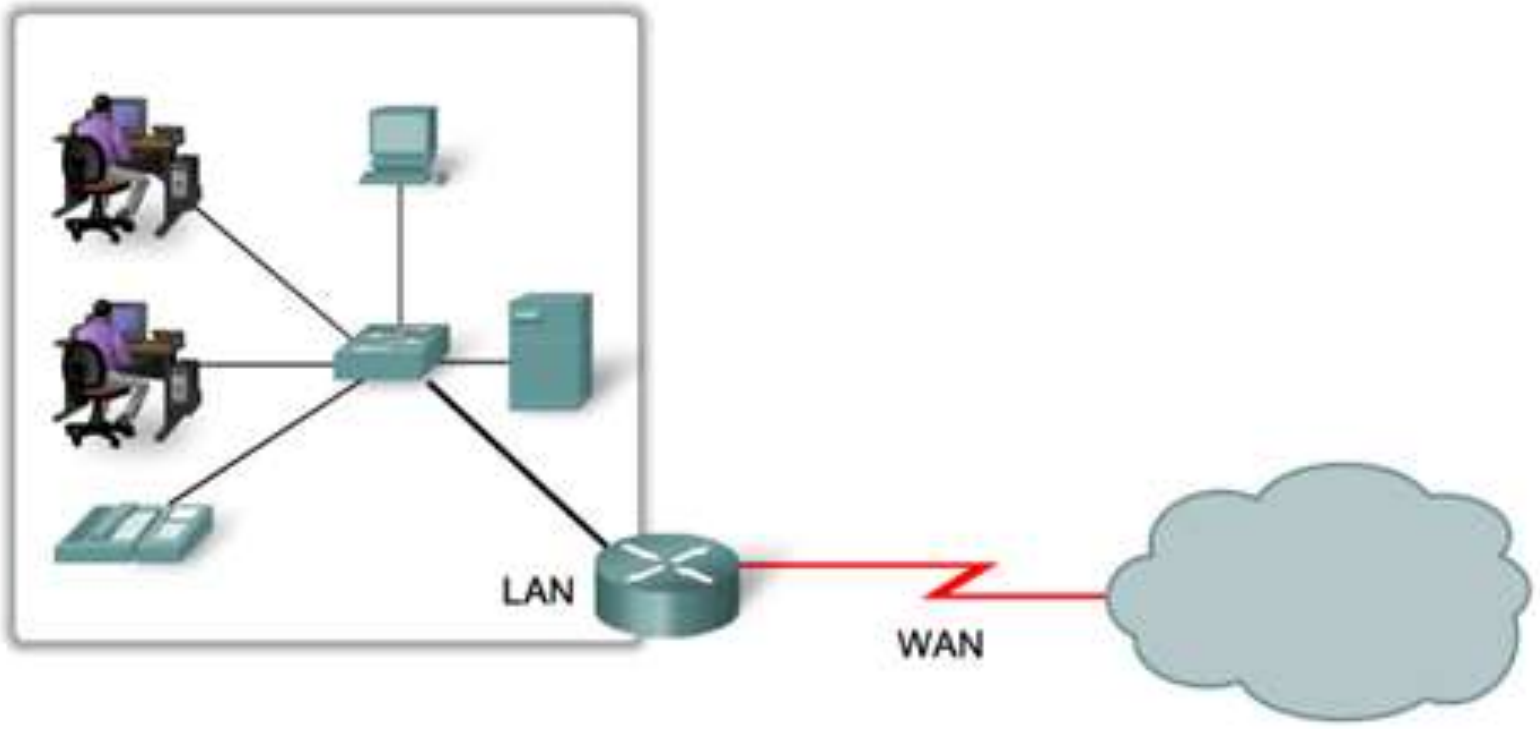
Small Network Topologies

Typical Small Network Topology



Device Selection for a Small Network

Factors to be considered when selecting intermediate devices.

COST

PORTS

SPEED

EXPANDABLE/ MODULAR

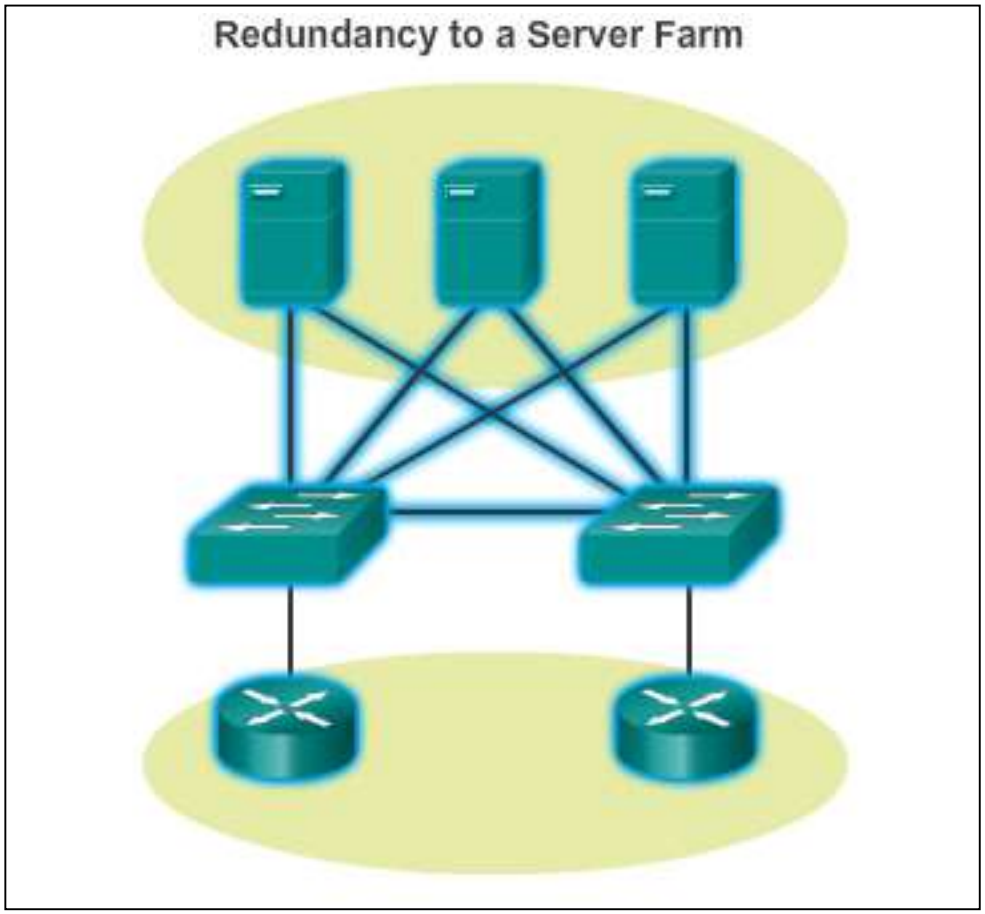
MANAGEABLE

IP Addressing for a Small Network

- IP addressing scheme should be planned, documented and maintained based on the type of devices receiving the address.
- Examples of devices that will be part of the IP design:
  - End devices for users
  - Servers and peripherals
  - Hosts that are accessible from the Internet
  - Intermediary devices
- Planned IP schemes help the administrator:
  - Track devices and troubleshoot
  - Control access to resources

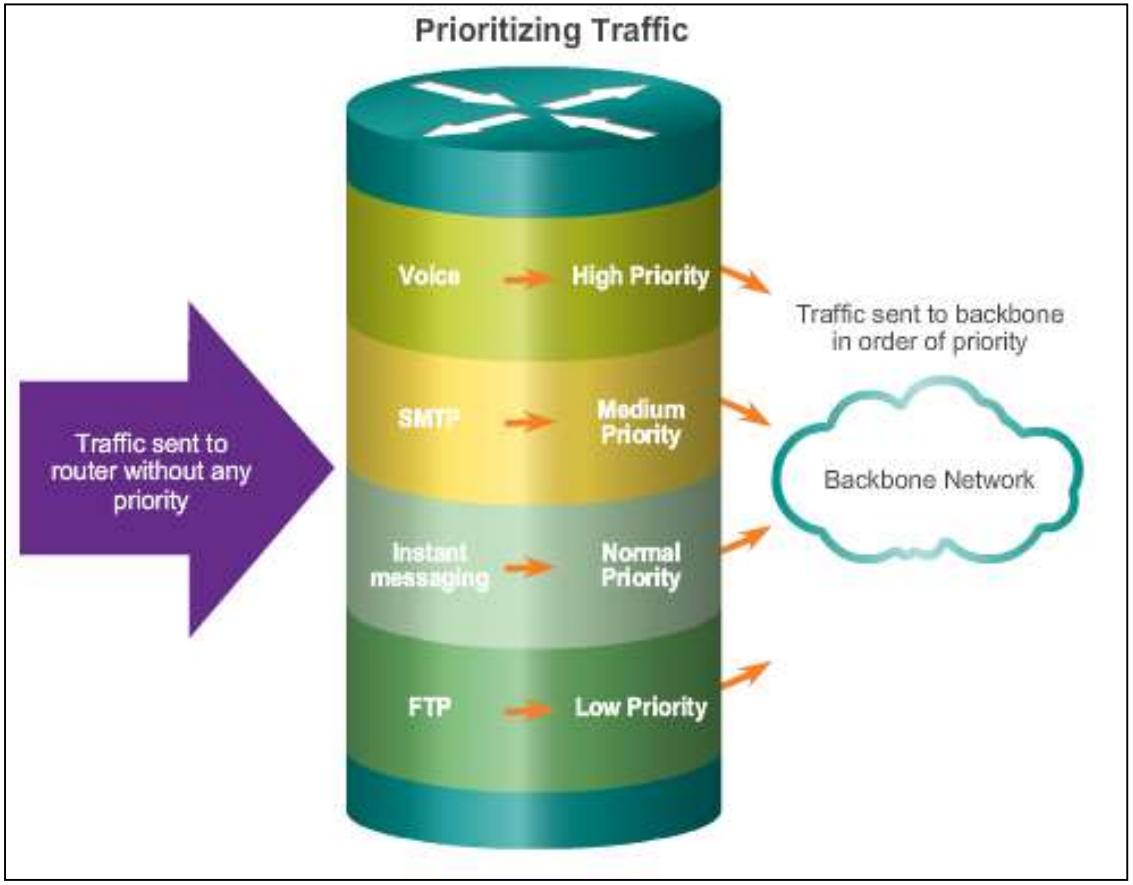
Redundancy in a Small Network

- Redundancy helps to eliminate single points of failure.
- Improves the reliability of the network.



Design Considerations for a Small Network

- The following should be included in the network design:
  - Secure file and mail servers in a centralized location.
  - Protect the location by physical and logical security measures.
  - Create redundancy in the server farm.
  - Configure redundant paths to the servers.



Common Applications in a Small Network

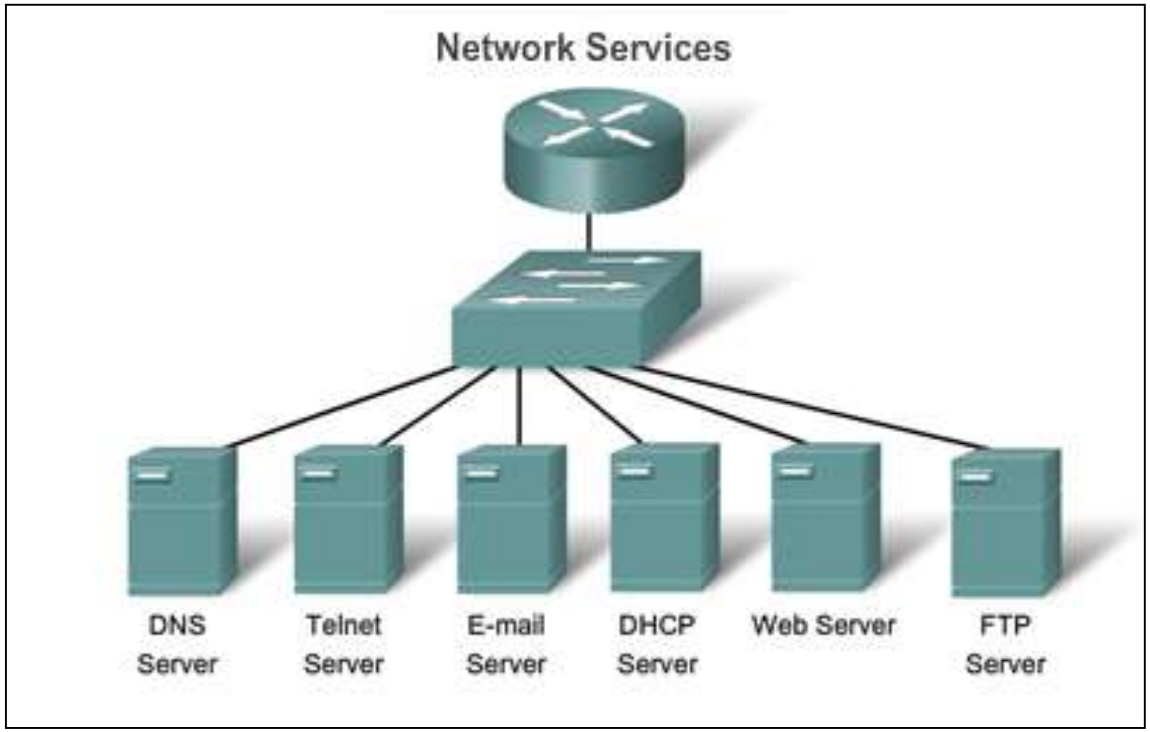
Network-Aware Applications – Software programs that are used to communicate over the network.

Application Layer Services – Programs that interface with the network and prepare the data for transfer.

Common Protocols in a Small Network

Network Protocols Define:

- Processes on either end of a communication session.
- Types of messages.
- Syntax of the messages.
- Meaning of informational fields.
- How messages are sent and the expected response.
- Interaction with the next lower layer.



Real-Time Applications for a Small Network

Real-time applications require planning and dedicated services to ensure priority delivery of voice and video traffic.

- **Infrastructure** – Needs to be evaluated to ensure it will support proposed real time applications.
- **VoIP** – Is implemented in organizations that still use traditional telephones.
- **IP telephony** – The IP phone itself performs voice-to-IP conversion**.**
- **Real-time Video Protocols** – Use Time Transport Protocol (RTP) and Real-Time Transport Control Protocol (RTCP).

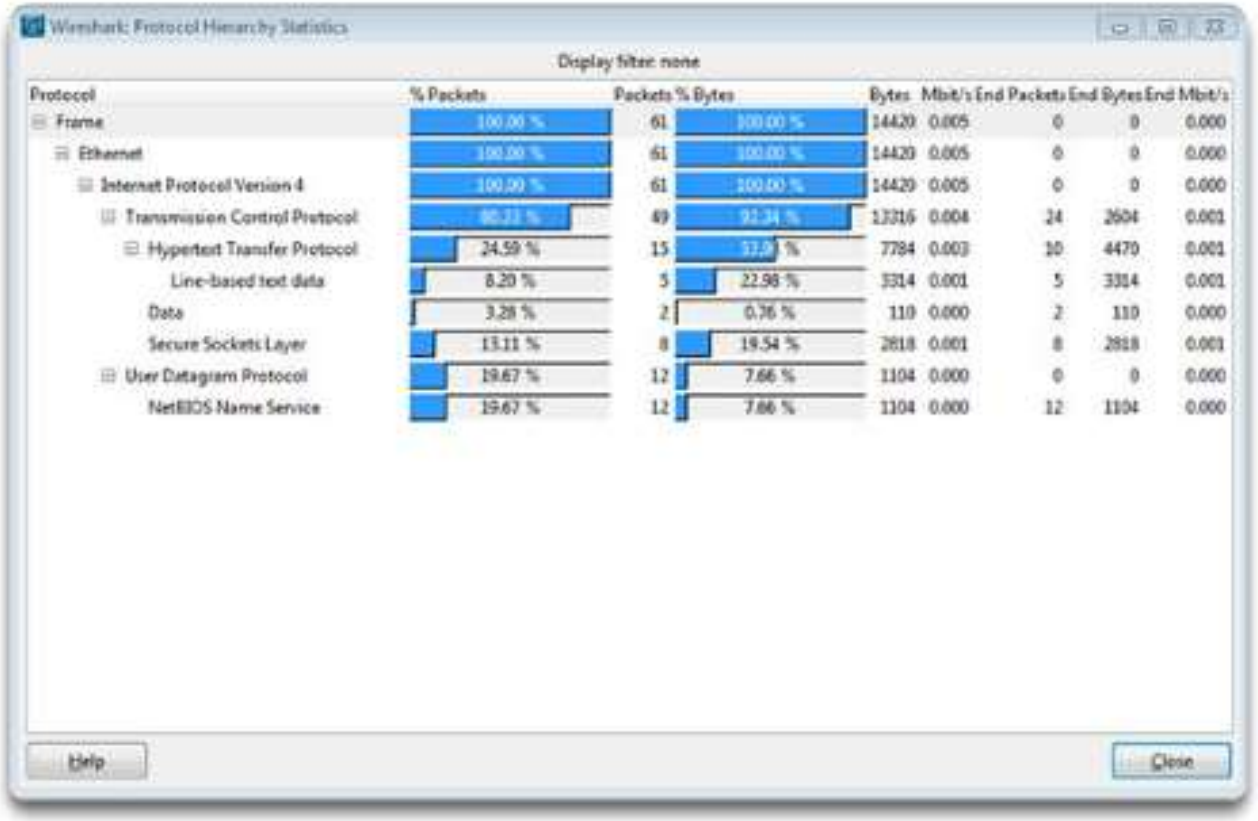
Scaling a Small Network

Important considerations when growing to a larger network:

- **Documentation** –Physical and logical topology.
- **Device inventory** – List of devices that use or comprise the network.
- **Budget** – Itemized IT expense items, including the amount of money allocated to equipment purchase for that fiscal year.
- **Traffic Analysis** – Protocols, applications, and services and their respective traffic requirements should be documented.

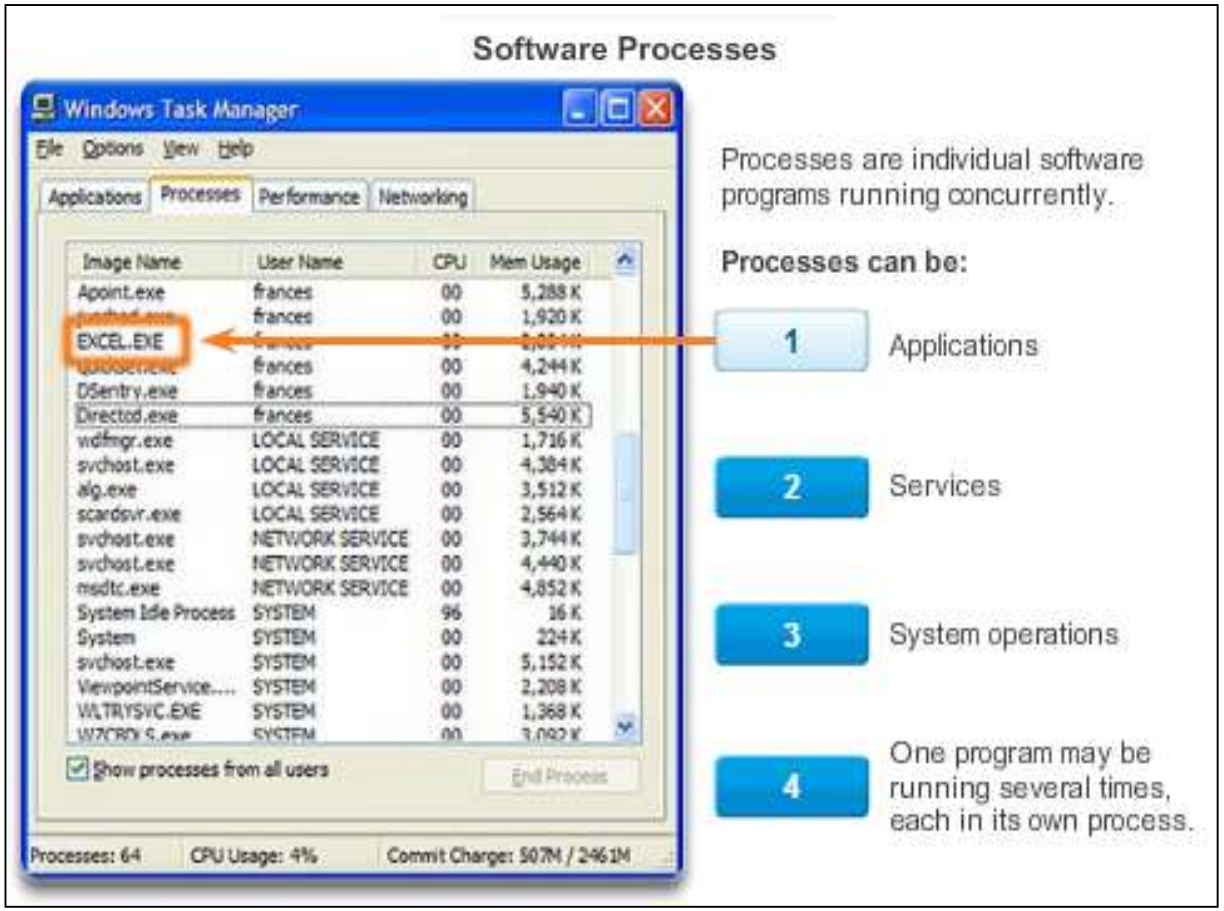
Protocol Analysis of a Small Network

Information gathered by protocol analysis can be used to make decisions on how to manage traffic more efficiently.



Evolving Protocol Requirements

- Network administrator can obtain IT “snapshots” of employee application utilization.
- Snapshots track network utilization and traffic flow requirements.
- Snapshots help inform network modifications needed.



11.2 Keeping the Network Safe

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Threats to Network Security

Categories of Threats to Network Security

Physical Security

Four classes of physical threats are:

- **Hardware threats** – Physical damage to servers, routers, switches, cabling plant, and workstations
- **Environmental threats** – Temperature extremes (too hot or too cold) or humidity extremes (too wet or too dry)
- **Electrical threats** – Voltage spikes, insufficient supply voltage (brownouts), unconditioned power (noise), and total power loss
- **Maintenance threats** – Poor handling of key electrical components (electrostatic discharge), lack of critical spare parts, poor cabling, and poor labeling

Types of Security Vulnerabilities

Types of Security Weaknesses:

- Technological
- Configuration
- Security policy

Vulnerabilities - Technology

Network security weaknesses:

TCP/IP protocol weakness
- Hypertext Transfer Protocol (HTTP), File Transfer Protocol (FTP) and Internet Control Message Protocol (ICMP) are inherently insecure.
- Simple Network Management Protocol (SNMP) and Simple Mail Transfer Protocol (SMTP) are related to the inherently insecure structure upon which TCP was designed.

Operating system weakness
- Each operating system has security problems that must be addressed.
- UNIX, Linux, Mac OS, Mac OS X, Windows Server 2012, Windows 7, Windows 8
- They are documented in the Computer Emergency Response Team (CERT) archives at http://www.cert.org.

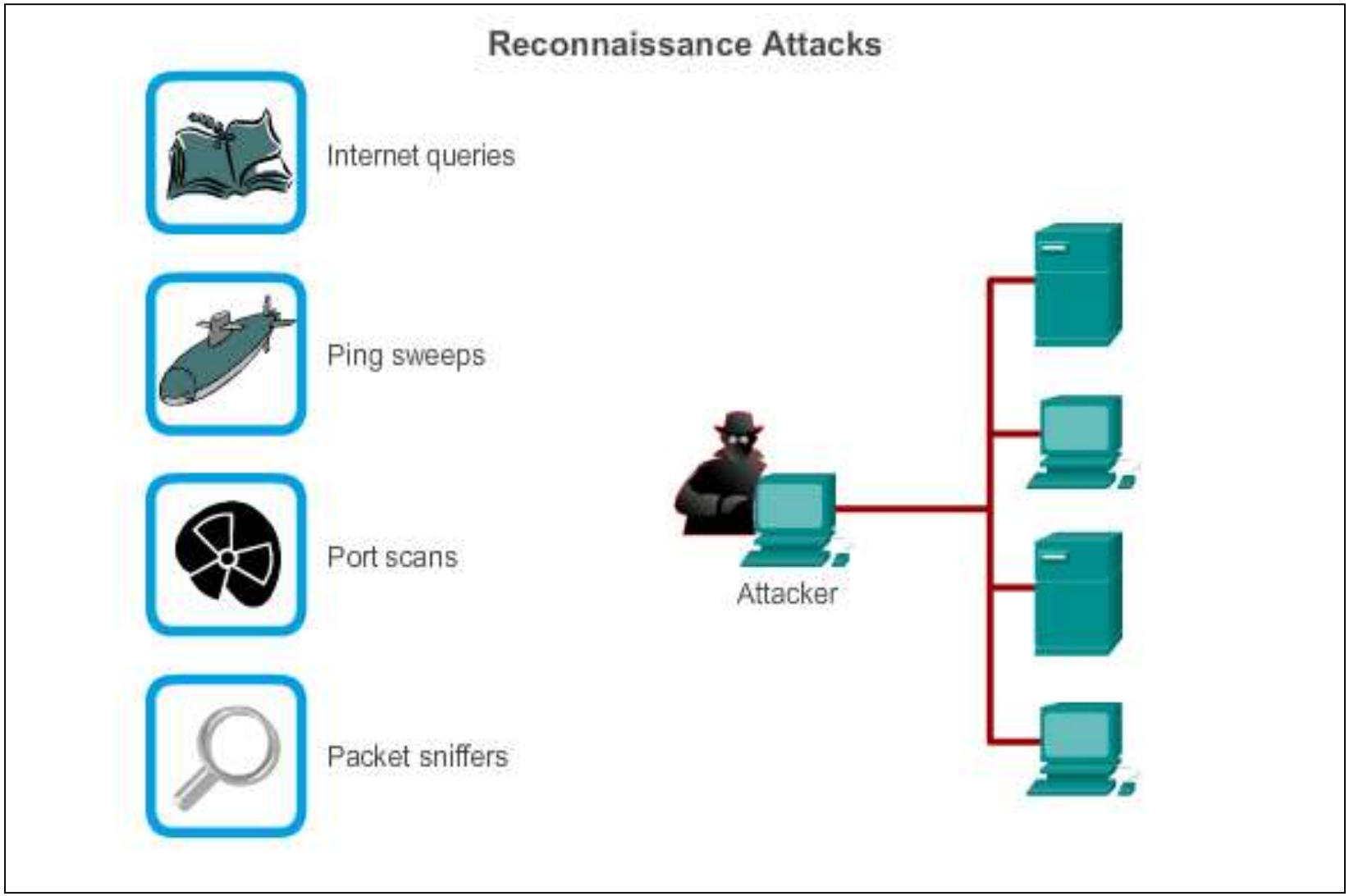
Network equipment weakness

Various types of network equipment, such as routers, firewalls, and switches have security weaknesses that must be recognized and protected against. Their weaknesses include password protection, lack of authentication, routing protocols, and firewall holes.

Viruses, Worms and Trojan Horses

- **Virus** – Malicious software that is attached to another program to execute a particular unwanted function on a workstation.
- **Trojan horse** – An entire application written to look like something else, when in fact it is an attack tool.
- **Worms** – Worms are self-contained programs that attack a system and try to exploit a specific vulnerability in the target. The worm copies its program from the attacking host to the newly exploited system to begin the cycle again.

Reconnaissance Attacks

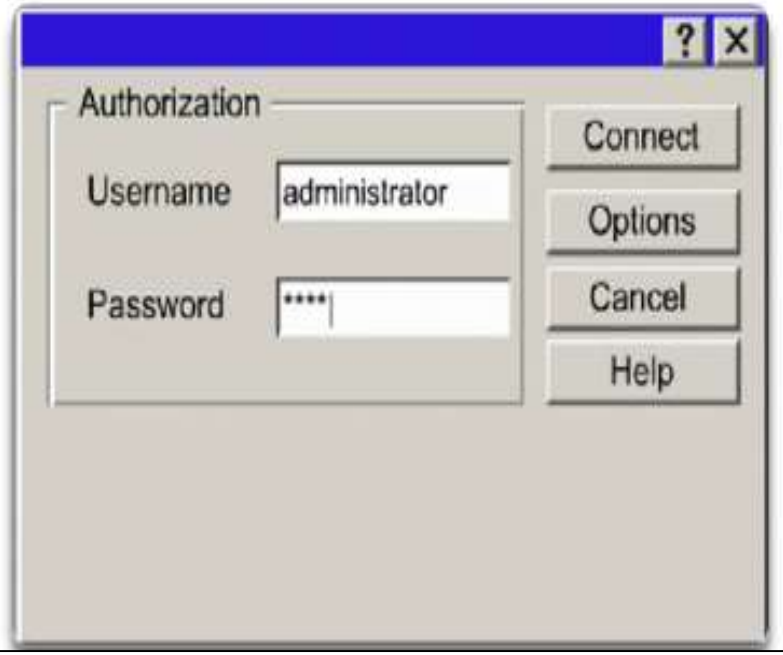


Access Attacks

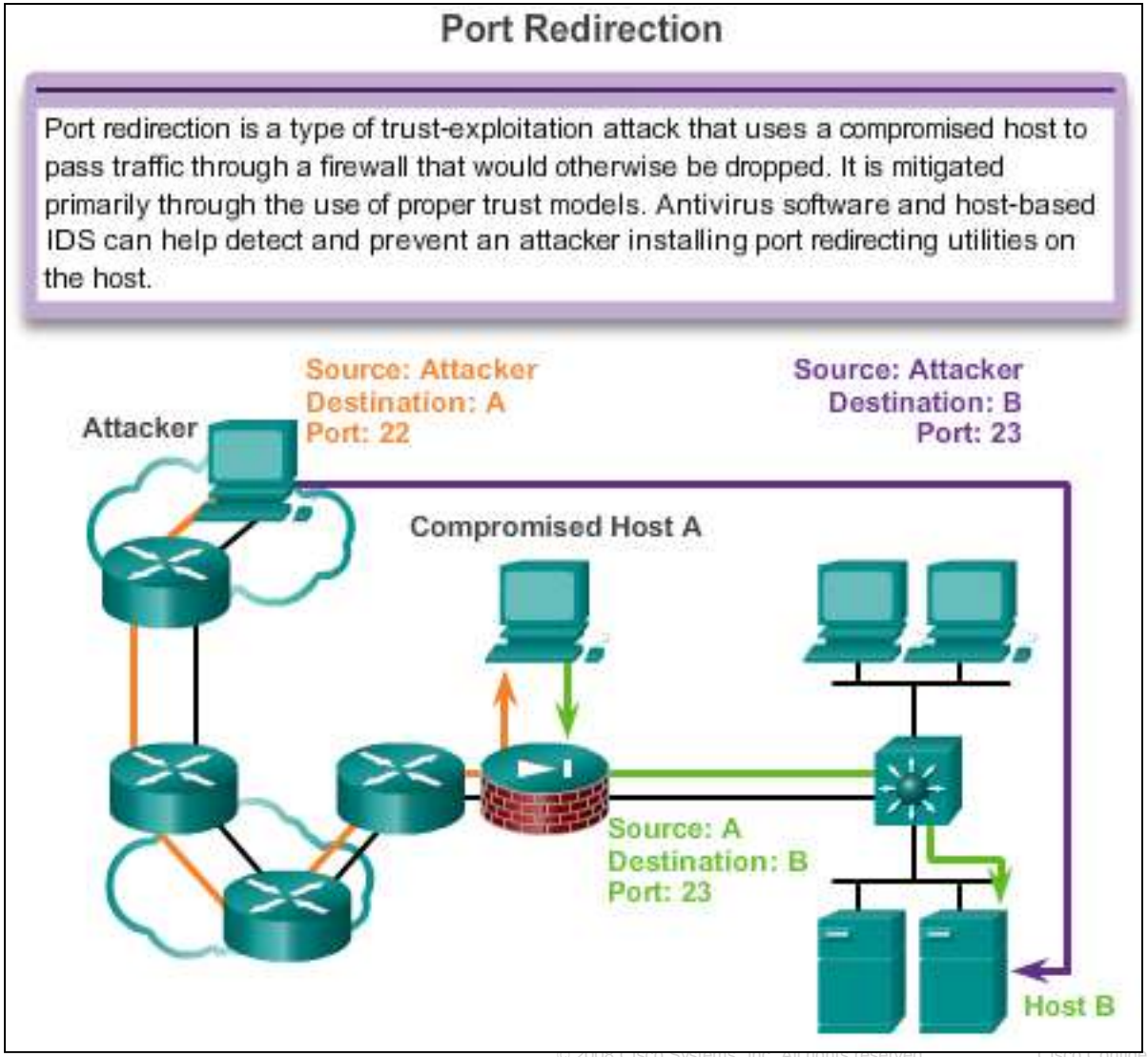
Password Attack

Attackers can implement password attacks using several different methods:

- Brute-force attacks
- Trojan horse programs
- Packet sniffers



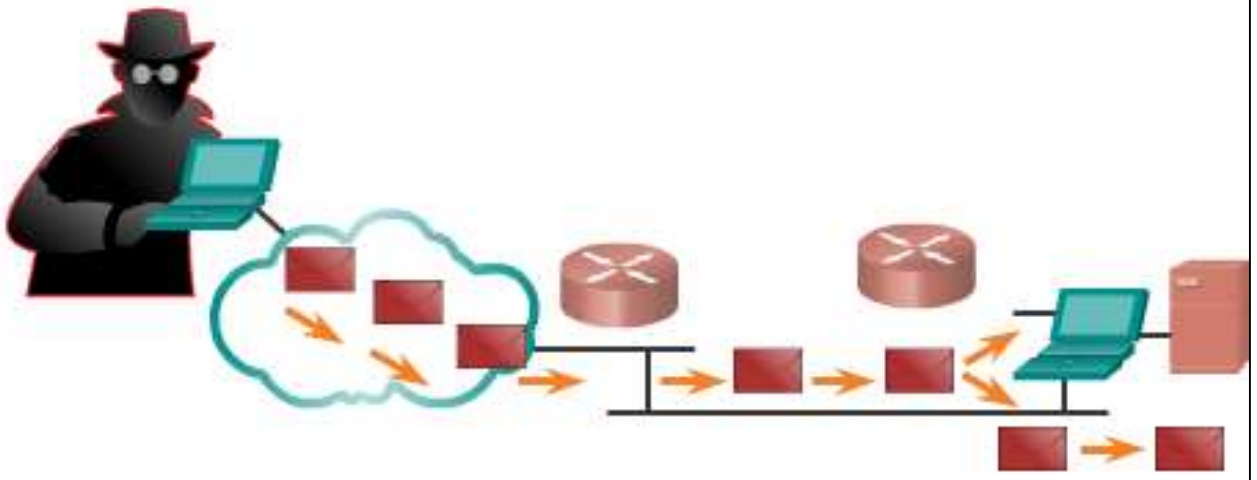
Access Attacks (Cont.)



Denial of Service Attacks (DoS)

DoS Attack

Resource overloads	Malformed data
Disk space, bandwidth, buffers	Oversized packets such as ping of death
Ping floods such as smurf	Overlapping packet such as winuke
Packet storms such as UDP bombs and fraggle	Unhandled data such as teardrop



DoS attacks prevent authorized people from using a service by using up system resources.

Backup, Upgrade, Update, and Patch

Antivirus software can detect most viruses and many Trojan horse applications and prevent them from spreading in the network.

- Keep current with the latest versions of antivirus software.
- Install updated security patches.

Authentication, Authorization, and Accounting

Authentication, Authorization, and Accounting (AAA, or "triple A")

- **Authentication** – Users and administrators must prove their identity. Authentication can be established using username and password combinations, challenge and response questions, token cards, and other methods.
- **Authorization** – Determines which resources the user can access and the operations that the user is allowed to perform.
- **Accounting** – Records what the user accessed, the amount of time the resource is accessed, and any changes made.

Firewalls

A Firewall resides between two or more networks. It controls traffic and helps prevent unauthorized access.

Methods used are:

- Packet Filtering
- Application Filtering
- URL Filtering
- Stateful Packet Inspection (SPI) – Incoming packets must be legitimate responses to requests from internal hosts.

Firewalls

Endpoint Security

- Common endpoints are laptops, desktops, servers, smart phones, and tablets.
- Employees must follow the companies documented security policies to secure their devices.
- Policies often include the use of anti-virus software and host intrusion prevention.

Common Endpoint Devices

Introduction to Securing Devices

- Part of network security is securing devices, including end devices and intermediate devices.
- Default usernames and passwords should be changed immediately.
- Access to system resources should be restricted to only the individuals that are authorized to use those resources.
- Any unnecessary services and applications should be turned off and uninstalled, when possible.
- Update with security patches as they become available.

Passwords

Weak and Strong Passwords

Weak Password	Why it is weak
secret	Simple dictionary password
smith	Mother's maiden name
toyota	Make of car
bob1967	Name and birthday of user
Blueleaf23	Simple words and numbers

Strong Password	Why it is strong
b67n42d39c	Combines alphanumeric characters
12^h u4@1p7	Combines alphanumeric characters, symbols and also includes a space

Basic Security Practices

- Encrypt passwords.
- Require minimum length passwords.
- Block brute force attacks.
- Use Banner Message.
- Set EXEC timeout.

Securing Devices

```
Router(config)#service password-encryption
Router(config)#security password min-length 8
Router(config)#login block-for 120 attempts 3 within 60
Router(config)#line vty 0 4
Router(config-vty)#exec-timeout 10
Router(config-vty)#end
Router#show running-config
-more-
!
line vty 0 4
 password 7 03095A0F034F38435B49150A1819
 exec-timeout 10
 login
```

Securing Devices

Enable SSH


```
R1# conf t
R1(config)# ip domain-name span.com
R1(config)# crypto key generate rsa general-keys modulus 1024
The name for the keys will be: R1.span.com
% The key modulus size is 1024 bits
% Generating 1024 bit RSA keys, keys will be non-exportable...[OK]
R1(config)#
*Dec 13 16:19:12.079: %SSH-5-ENABLED: SSH 1.99 has been enabled
R1(config)# username Bob secret cisco
R1(config)# line vty 0 4
R1(config-line)# login local
R1(config-line)# transport input ssh
R1(config-line)# exit
```

Step 1: Configure the IP domain name.
Step 2: Generate one-way secret keys.
Step 3: Verify or create a local database entry.
Step 4: Enable VTY inbound SSH sessions.

11.3 Basic Network Performance

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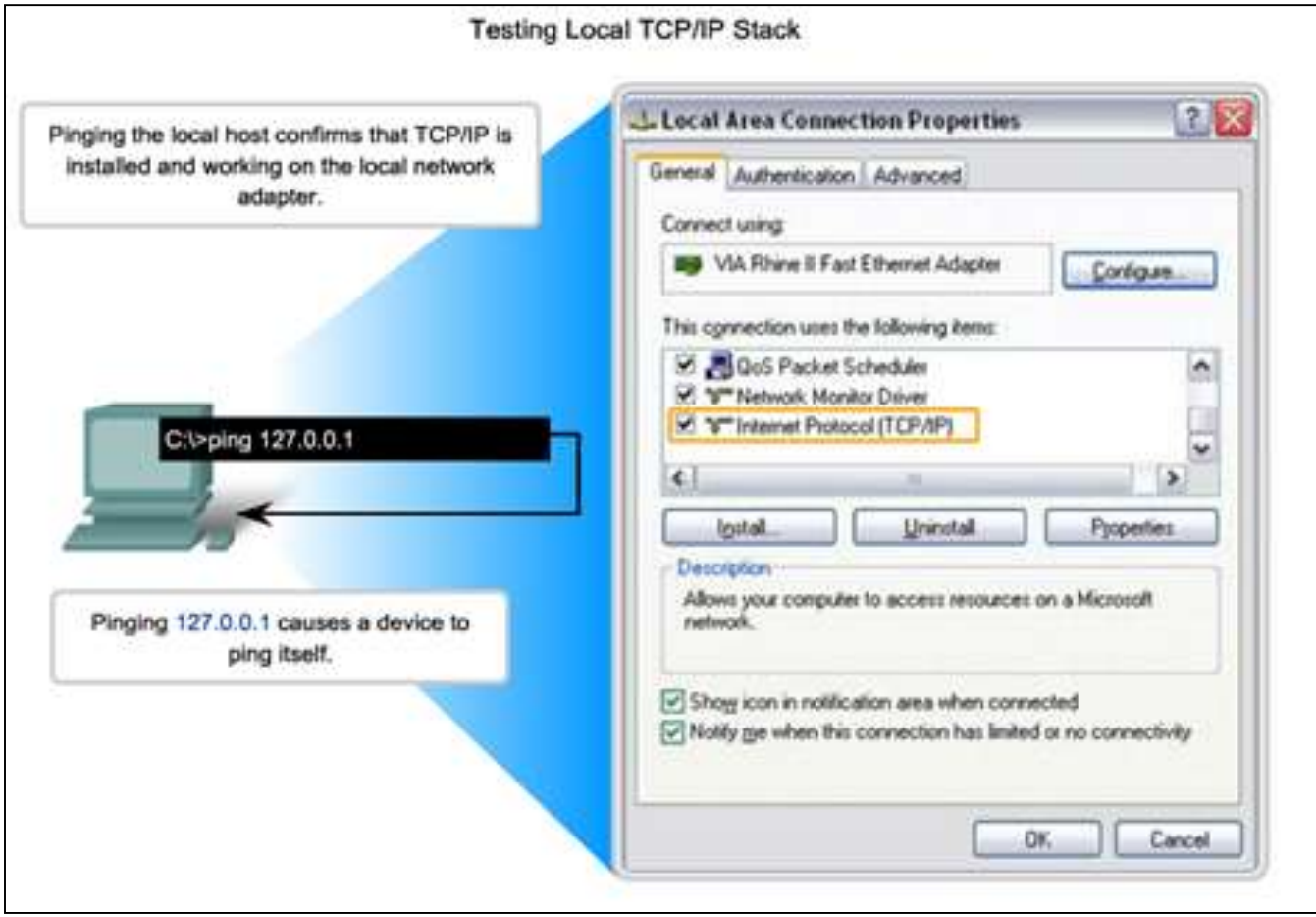
Interpreting ICMP Messages

- **!** – indicates receipt of an ICMP echo reply message
- **.** – indicates a time expired while waiting for an ICMP echo reply message
- **U** – an ICMP unreachable message was received



Leveraging Extended Ping

The Cisco IOS offers an "extended" mode of the **`ping`** command:

- R2# **`ping`**
- Protocol [ip]:
- Target IP address: **192.168.10.1**
- Repeat count [5]:
- Datagram size [100]:
- Timeout in seconds [2]:
- Extended commands [n]: **`y`**
- Source address or interface: **10.1.1.1**
- Type of service [0]:

Ping

Network Baseline

Baseline with `ping`

```
C:\>ping 10.66.254.159

Pinging 10.66.254.159 with 32 bytes of data:

Reply from 10.66.234.159: bytes=32 time<1ms TTL=128
Reply from 10.66.234.159: bytes=32 time<1ms TTL=128
Reply from 10.66.234.159: bytes=32 time<1ms TTL=128
Reply from 10.66.234.159: bytes=32 time<1ms TTL=128

Ping statistics for 10.66.254.159:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

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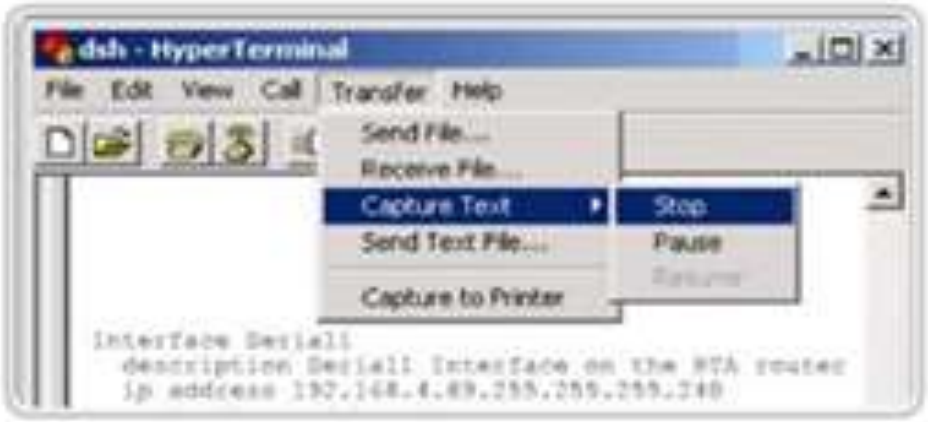
```
C:\>ping 10.66.254.159

Pinging 10.66.254.159 with 32 bytes of data:

Reply from 10.66.234.159: bytes=32 time<6ms TTL=128
Reply from 10.66.234.159: bytes=32 time<6ms TTL=128
Reply from 10.66.234.159: bytes=32 time<6ms TTL=128
Reply from 10.66.234.159: bytes=32 time<6ms TTL=128

Ping statistics for 10.66.254.159:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 6ms, Maximum = 6ms, Average = 6ms
```

Network Baseline (Cont.)

Router Ping Capture - Saving to a text file

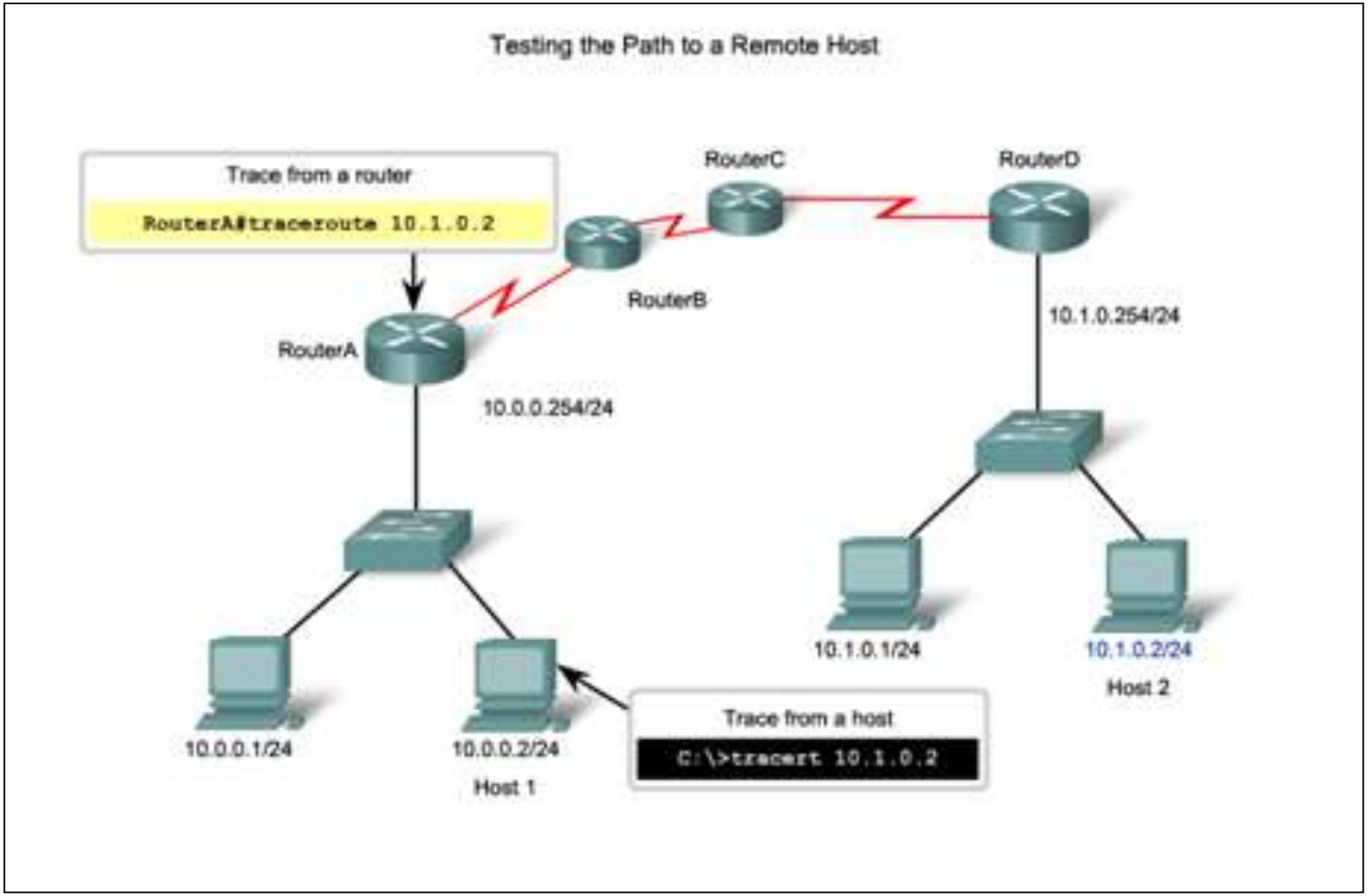


In the terminal session:

1. Start the text capture process.
2. Issue a `ping <ip address>` command.
3. Stop the capture process.
4. Save the text file.

Tracert

Interpreting Tracert Messages



Common Show Commands Revisited

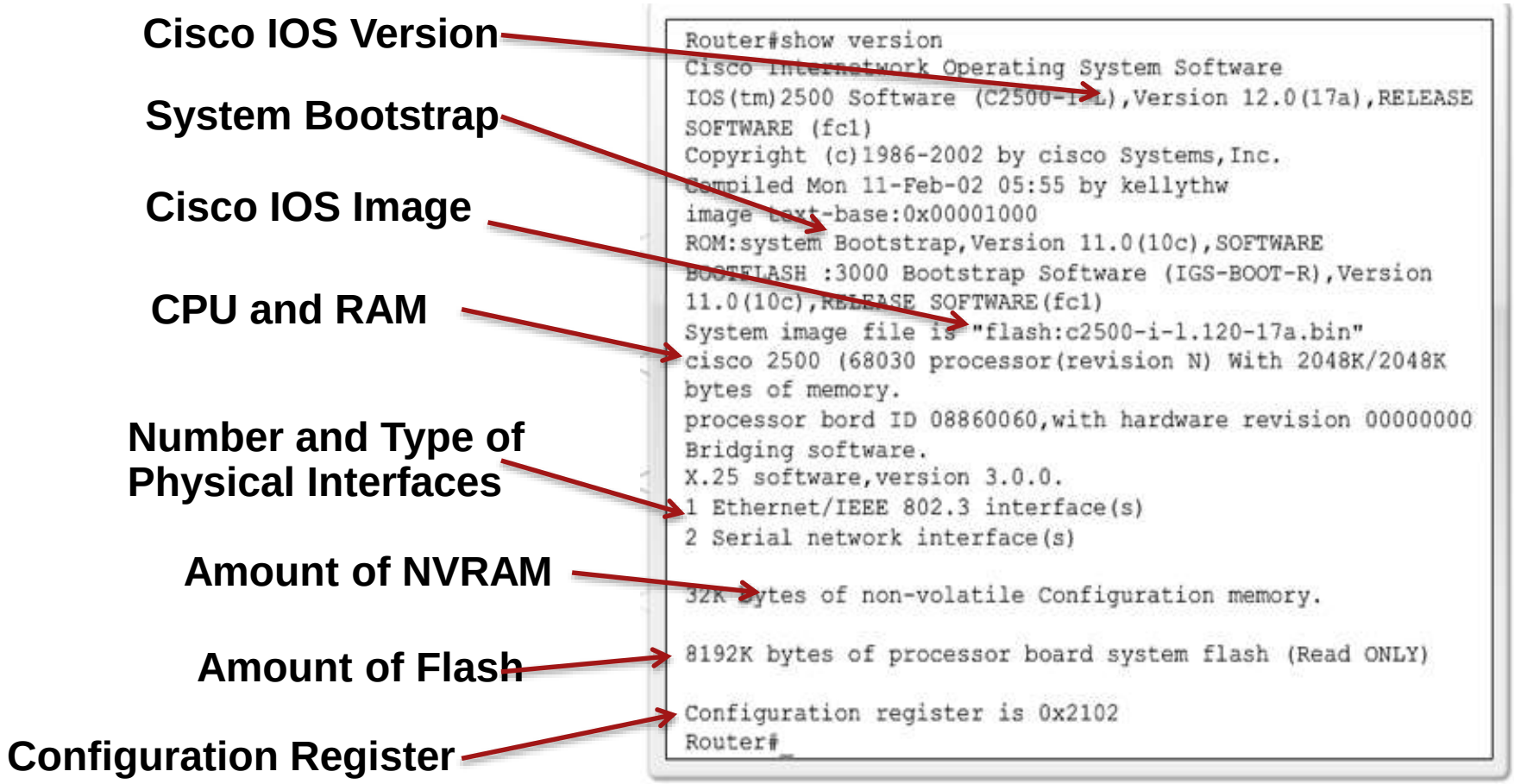
The status of nearly every process or function of the router can be displayed using a **show** command.

Frequently used show commands:

- **show running-config**
- **show interfaces**
- **show arp**
- **show ip route**
- **show protocols**
- **show version**

Show Commands

Viewing Router Settings With Show Version



Show Commands

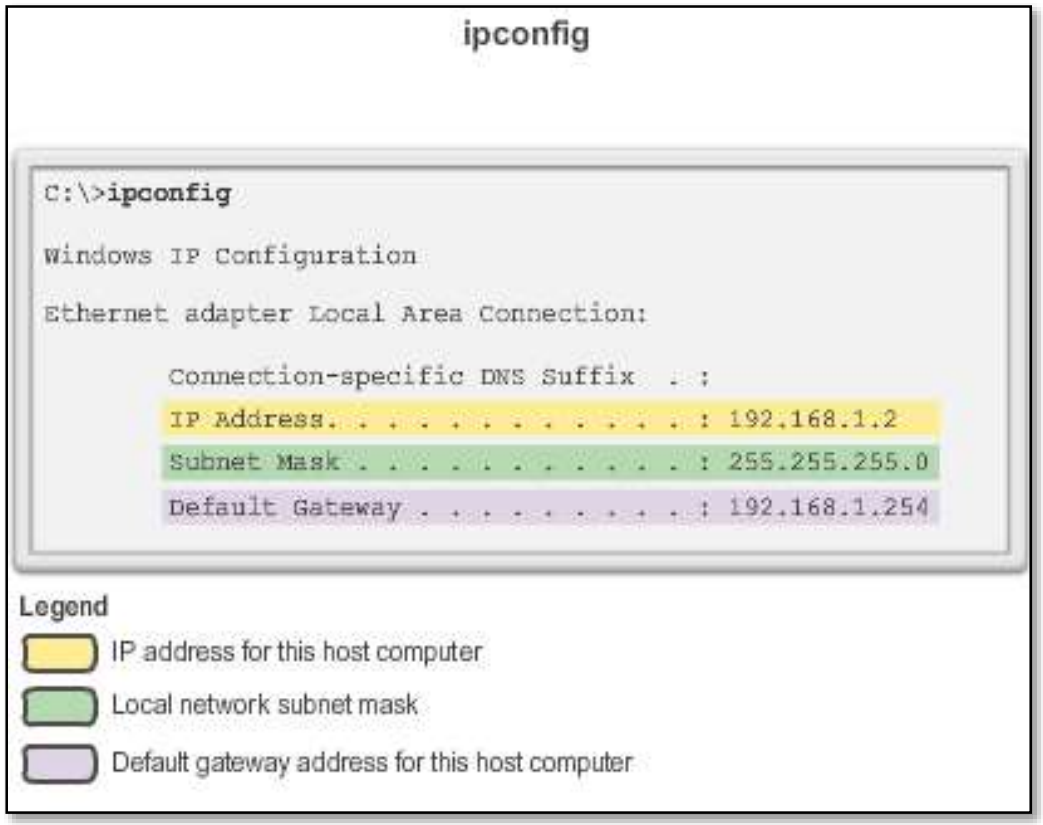
Viewing Switch Settings With Show Version

show version Command

```
Switch#show version
Cisco IOS Software, C2960 Software (C2960-LANBASE-M), Version 12.2(25)SEE2,
RELEASE SOFTWARE (fc1)
Copyright (c) 1986-2006 by Cisco Systems, Inc.
Compiled Fri 28-Jul-06 04:33 by yenanh
Image text-base: 0x00003000, data-base: 0x00AA2F34

ROM: Bootstrap program is C2960 boot loader
BOOTLDR: C2960 Boot Loader (C2960-HBOOT-M) Version 12.2(25r)SEE1, RELEASE
SOFTWARE (fc1)

Switch uptime is 2 minutes
System returned to ROM by power-on
System image file is "flash:c2960-lanbase-mz.122-25.SEE2/c2960-lanbase-
mz.122-25.SEE2.bin"

cisco WS-C2960-24TT-L (PowerPC405) processor (revision B0) with 61440K/4088K
bytes of memory.
Processor board ID FOC1107Z9ZN
Last reset from power-on
1 Virtual Ethernet interface
```

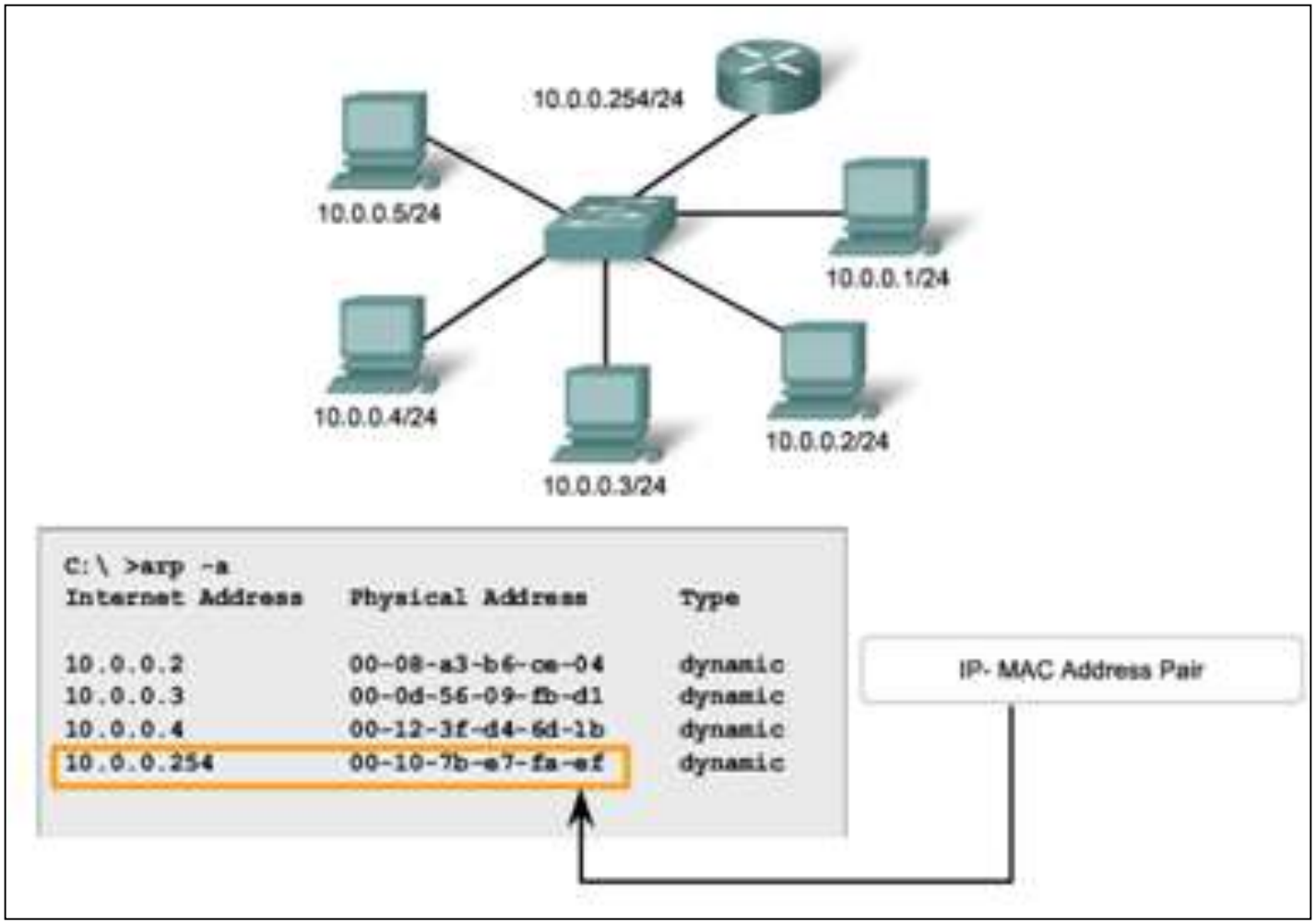
ipconfig Command Options

- **ipconfig** – Displays ip address, subnet mask, default gateway.
- **ipconfig /all** – Also displays MAC address.
- **ipconfig /displaydns** – Displays all cached dns entries in a Windows system.



arp Command Options

arp Command Options



show cdp neighbors Command Options

show cdp neighbors command provides information about each directly connected CDP neighbor device.

```
R3#show cdp neighbors
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater, P - Phone

Device ID        Local Intrfce     Holdtme    Capability  Platform  Port ID
S3               Fas 0/0            151         S I       WS-C2950  Fas 0/6
R2               Ser 0/0/1          125          R        1841      Ser 0/0/1

R3#show cdp neighbors detail

Device ID: R2
Entry address(es):
  IP address : 192.168.1.2
Platform: Cisco 1841,  Capabilities: Router Switch IGMP
Interface: Serial0/0/1,  Port ID (outgoing port): Serial0/0/1
Holdtime : 161 sec

Version :
```

Host and IOS Commands

Using `show ip interface brief` Command

`show ip interface brief` command–used to verify the status of all network interfaces on a router or a switch.

```
Router1#show ip interface brief
Interface              IP-Address        OK?  Method  Status                  Protocol
FastEthernet0/0        192.168.254.254   YES  NVRAM   up                      up
FastEthernet0/1/0      unassigned        YES  unset   down                    down
Serial0/0/0            172.16.0.254      YES  NVRAM   up                      up
Serial0/0/1            unassigned        YES  unset   administratively down   down
```

```
Router1#ping 192.168.254.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.254.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
```

```
Router1#traceroute 192.168.0.1
Type escape sequence to abort.
Tracing the route to 192.168.0.1
  1 172.16.0.253 8 msec 4 msec 8 msec
  2 10.0.0.254 16 msec 16 msec 8 msec
  3 192.168.0.1 16 msec * 20 msec
```

11.4 Managing IOS Configuration Files

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Router File Systems

show file systems command – Lists all of the available file systems on a Cisco 1941 route.

The asterisk (*) indicates this is the current default file system.

```
Router# show file systems
File Systems:

        Size(b)       Free(b)      Type  Flags  Prefixes
              -             -    opaque     rw   archive:
              -             -    opaque     rw   system:
              -             -    opaque     rw   tmpsys:
              -             -    opaque     rw   null:
              -             -   network     rw   tftp:
*     256487424     183234560      disk     rw   flash0:  flash:#
              -             -      disk     rw   flash1:
         262136        254779     nvram     rw   nvram:
              -             -    opaque     wo   syslog:
              -             -    opaque     rw   xmodem:
              -             -    opaque     rw   ymodem:
              -             -   network     rw   rcp:
              -             -   network     rw   http:
              -             -   network     rw   ftp:
              -             -   network     rw   scp:
              -             -    opaque     ro   tar:
              -             -   network     rw   https:
              -             -    opaque     ro   cns:
```

Switch File Systems

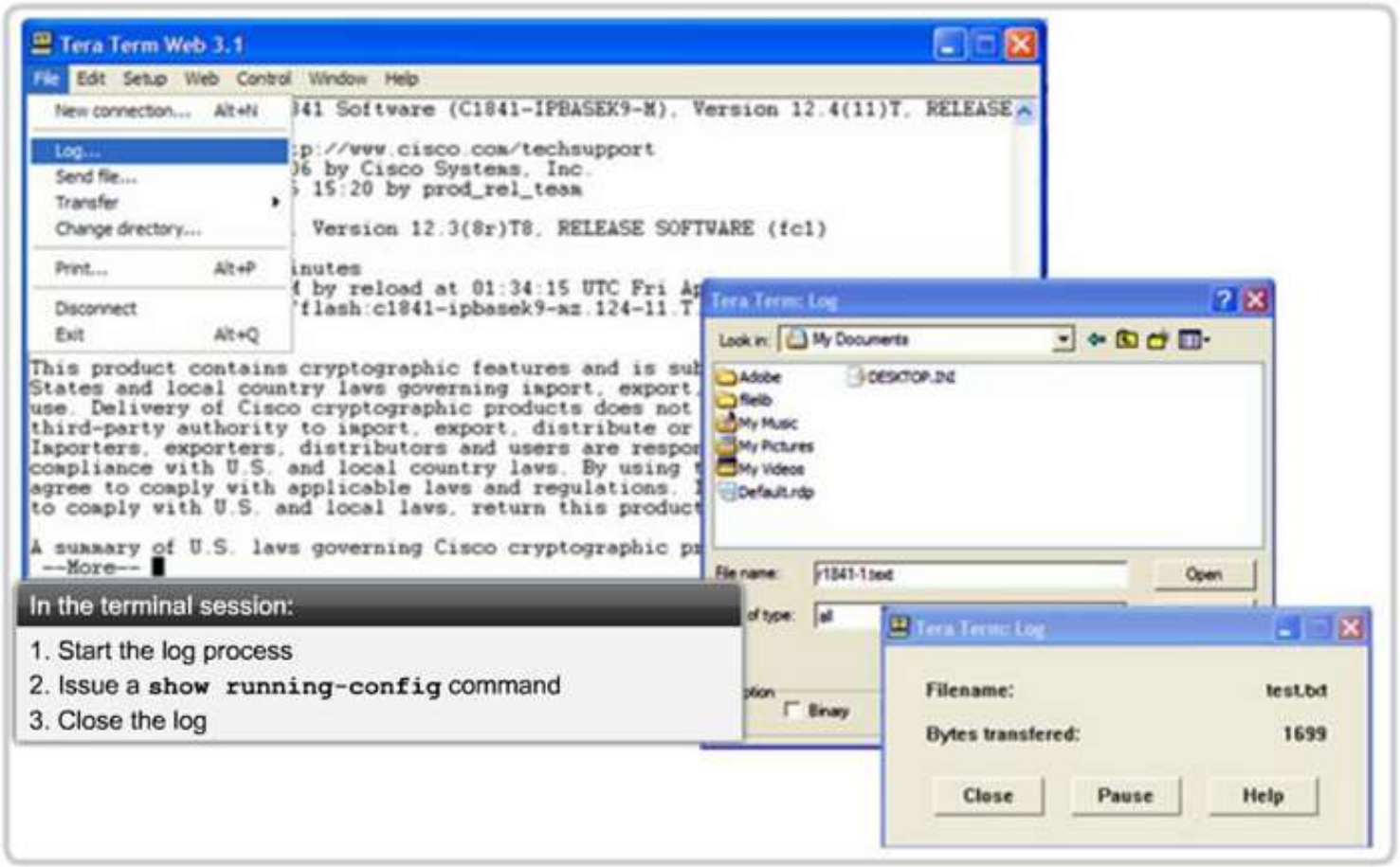
`show file systems` command – Lists all of the available file systems on a Catalyst 2960 switch.

```
Switch#show file systems
File Systems:

       Size(b)     Free(b)      Type  Flags  Prefixes
*    32514048    20887552     flash     rw   flash:
           -           -    opaque     rw      vb:
           -           -    opaque     ro      bs:
           -           -    opaque     rw  system:
           -           -    opaque     rw  tmpsys:
       65536       48897     nvram     rw   nvram:
           -           -    opaque     ro  xmodem:
           -           -    opaque     ro  ymodem:
           -           -    opaque     rw    null:
           -           -    opaque     ro     tar:
           -           -   network     rw    tftp:
           -           -   network     rw     rcp:
           -           -   network     rw    http:
           -           -   network     rw     ftp:
           -           -   network     rw     scp:
           -           -   network     rw   https:
           -           -    opaque     ro     cns:
```

Backup and Restore Using Text Files

Saving to a Text File in Tera Term



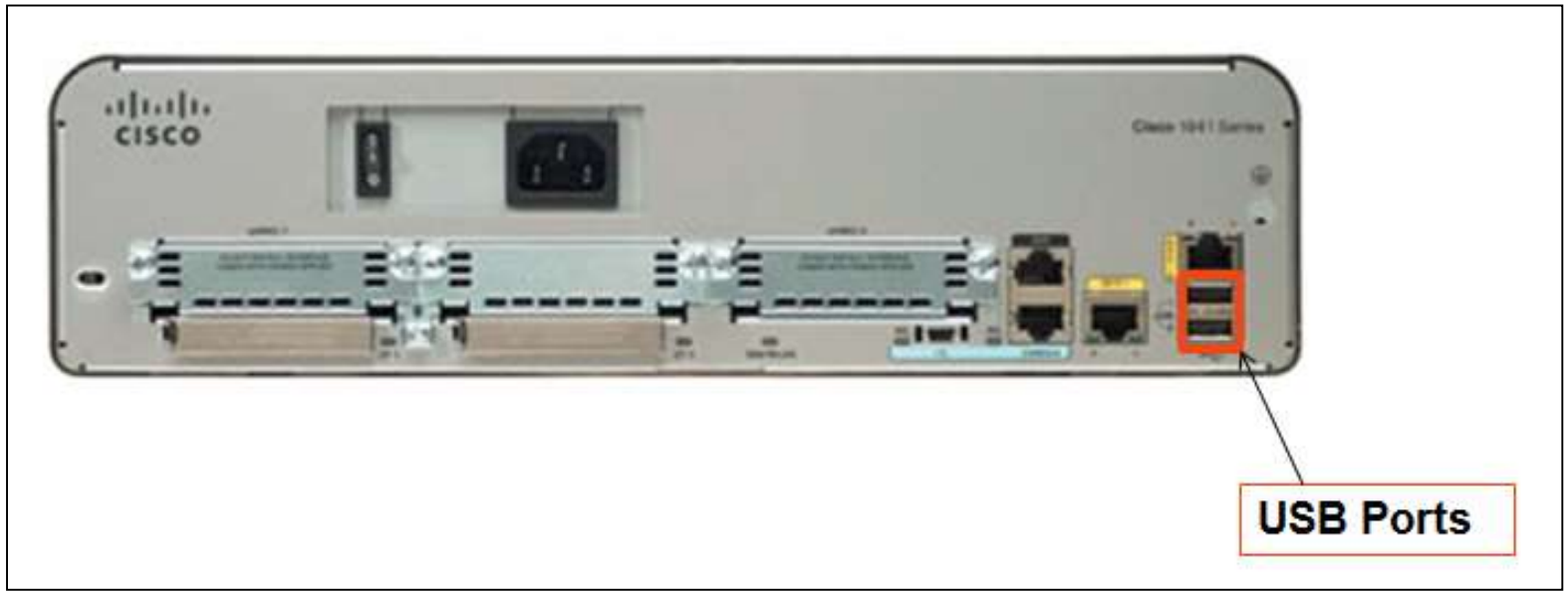
Backup and Restore Using TFTP

- Configuration files can be stored on a Trivial File Transfer Protocol (TFTP) server.
- copy running-config tftp – Save running configuration to a tftp server.
- **copy startup-config tftp** – Save startup configuration to a tftp server.

```
Router#copy running-config tftp
Remote host []? 131.108.2.155
Name of configuration file to write[tokyo-config]?tokyo.2
Write file tokyo.2 to 131.108.2.155? [confirm]
Writing tokyo.2 !!!!!! [OK]
```

Using USB Interfaces on a Cisco Router

- USB flash drive must be formatted in a FAT16 format.
- Can hold multiple copies of the Cisco IOS and multiple router configurations.
- Allows administrator to easily move configurations from router to router.



Backup and Restore Using USB

Backup to USB Drive

```
R1#copy running-config usbflash0:/   ()
Destination filename [running-config]? R1-Config
5024 bytes copied in 0.736 secs (6826 bytes/sec)
```

Copying to USB flash drive, and no file pre-exists

```
R1#copy running-config usbflash0:/
Destination filename [running-config]? R1-Config
%Warning:There is a file already existing with this name
Do you want to over write? [confirm]
5024 bytes copied in 1.796 secs (2797 bytes/sec)
```

Copying to USB flash drive, and the same configuration file already exists on the drive.

11.5 Integrated Routing Services

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Multi-function Device

Multi-function Device

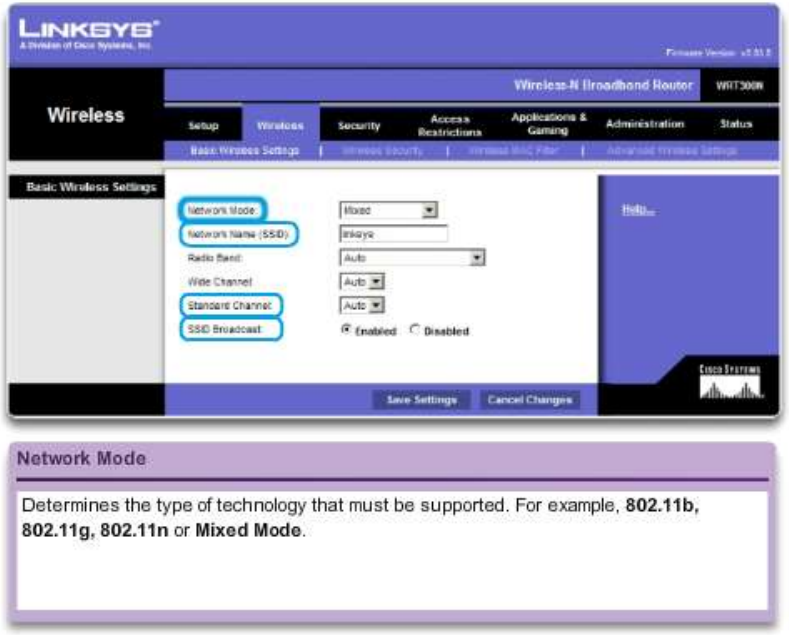
- Incorporates a switch, router, and wireless access point.
- Provides routing, switching and wireless connectivity.
- Linksys wireless routers, are simple in design and used in home networks

Cisco Integrated Services Router (ISR) product family offers a wide range of products, designed for small office to larger networks.

Wireless Capability

- **Wireless Mode –** Most integrated wireless routers support 802.11b, 802.11g and 802.11n.
- **Service Set Identifier (SSID) –** Case-sensitive, alpha-numeric name for your home wireless network.
- **Wireless Channel –** RF spectrum can be divided up into channels.

Linksys Wireless Settings



Basic Security of Wireless

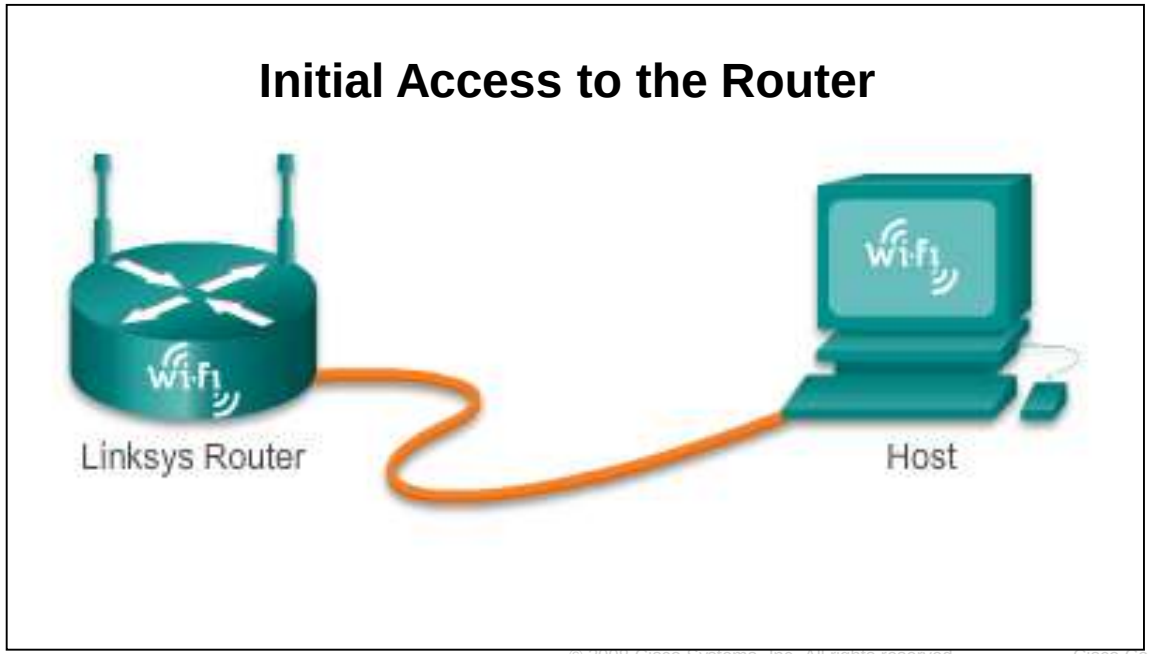
- Change default values
- Disable SSID broadcasting
- Configure Encryption using WEP or WPA
- **Wired Equivalency Protocol (WEP)** - Uses pre-configured keys to encrypt and decrypt data. Every wireless device allowed to access the network must have the same WEP key entered.
- **Wi-Fi Protected Access (WPA) –** Also uses encryption keys from 64 bits up to 256 bits. New keys are generated each time a connection is established with the AP; therefore, more secure.

Configuring the Integrated Router

Step 1 - Access the router by cabling a computer to one of the router's LAN Ethernet ports.

Step 2 - The connecting device will automatically obtain IP addressing information from Integrated Router.

Step 3 - Change default username and password and the default Linksys IP address for security purposes.



Integrated Router

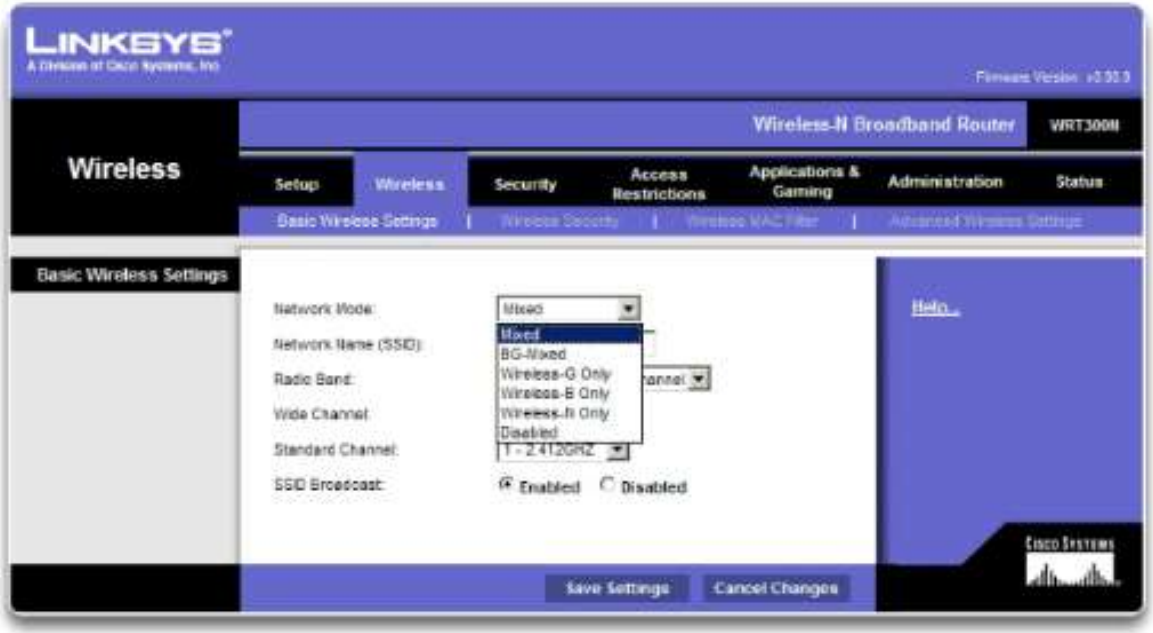
Enabling Wireless

Step 1 - Configure the wireless mode

Step 2 - Configure the SSID

Step 3 - Configure RF channel

Step 4 - Configure any desired security encryption



Configure a Wireless Client

- The wireless client configuration settings must match that of the wireless router.
  - SSID
  - Security Settings
  - Channel
- Wireless client software can be integrated into the device operating system or stand alone, downloadable, wireless utility software.

11.6 Summary

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Chapter 11: Summary

In this chapter, you learned:

- Good network design incorporates reliability, scalability, and availability.
- Networks must be secured from viruses, Trojan horses, worms and network attacks.
- The importance of documenting Basic Network Performance.
- How to test network connectivity using **`ping`** and **`traceroute`**.
- How to use IOS commands to monitor and view information about the network and network devices.
- How to backup configuration files using TFTP or USB.
- Home networks and small business often use integrated routers, which provide the functions of a switch, router and wireless access point.