



CCNA Exploration 4.0

Network Fundamentals

Student Lab Manual

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Activity 1.1.1: Using Google Earth™ to View the World

Learning Objectives

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

- Explain the purpose of Google Earth.
- Explain the different versions of Google Earth.
- Explain the hardware and software requirements needed to use Google Earth (free edition).
- Experiment with Google Earth features such as Help | Tutorial.
- Experiment with Google Earth to explore continents, countries, and places of interest.

Background

Google Earth is a popular application that executes on the desktop of most operating systems. It requires a broadband connection to the Internet and displays Earth as a manipulated 2D, or 3D image. The popular world news channel, CNN, regularly uses Google Earth to emphasize where a news story has occurred.

At the time of writing this activity, there are three versions of Google Earth. The version that fits most needs is Google's free version, Google Earth. A Google Earth Plus version includes GPS support, a spreadsheet importer, and other support features. The Google Earth Pro version is for professional and commercial use. The URL http://earth.google.com/product_comparison.html contains a description of the versions. Use this link to answer the following questions:

Which versions support Tilt and 3D rotation? _____

Which Google Earth version supports the highest resolution? _____

To use Google Earth, version 4, minimum computer hardware requirements must be met:

Operating System	Microsoft Windows 2000 or Windows XP
CPU	Pentium 3 with 500 MHz
System Memory (RAM)	128 MB
Hard Disk	400 MB of free space
Network Speed	128 kbps
Graphics Card	3D-capable with 16 MB of VRAM
Screen	1024x768 pixels, 16-bit High Color screen

Scenario

This activity is to be performed on a computer that has Internet access and on which you can install software.

Estimated completion time, depending on network speed, is 30 minutes.

Task 1: Install Google Earth.

If Google Earth is not installed on the computer, the free application can be downloaded directly from <http://earth.google.com/download-earth.html>. Follow the installation instructions, and the Google Earth download should start automatically. Remember, you may have to disable any popup blockers on your browser.

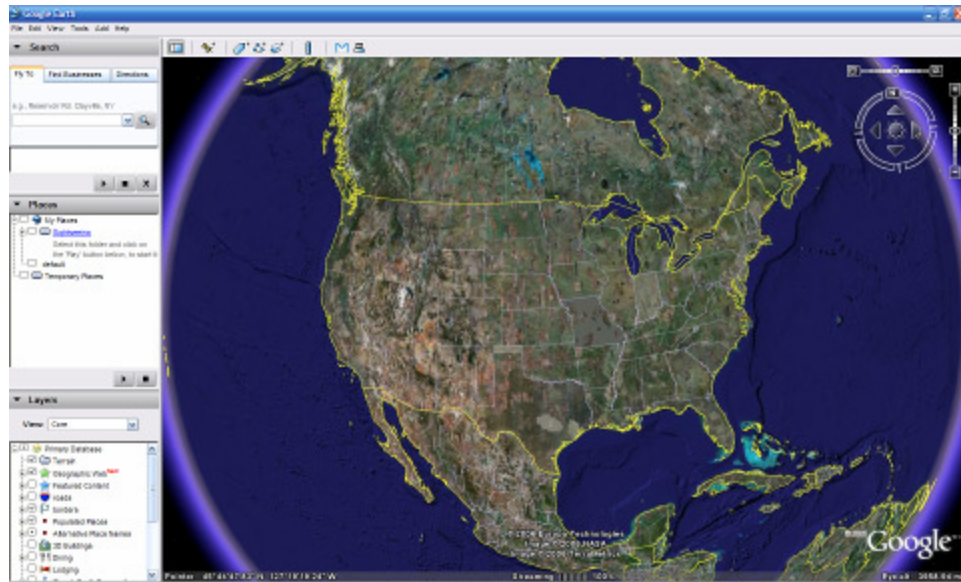


Figure 1. Google Earth Opening Screen

Task 2: Run Google Earth.

Step 1: Refer to Figure 1, the opening screen. The Menu bar is located in the upper left corner of the screen. On the **Help** menu, choose **User Guide** to launch a default web browser and bring up the Google Earth User's Guide. <http://earth.google.com/userguide/v4/>. Take a few minutes to browse the User's Guide. Before leaving the User's Guide web site, answer the following questions:

List the three ways to move the image.

Which mouse control will zoom in or zoom out?

What is the purpose of the left mouse button?

Task 3: Navigatie the Google Earth Interface.

Step 1: Use the Overview Map feature.

On the **View** menu, choose **Overview Map**. This handy feature provides a relative global position of the magnified image.

Step 2: Review the navigation controls.

Navigation controls are located in the upper right quadrant and control the image magnification and position. The mouse pointer must be moved close to the controls, otherwise only a compass is displayed. Refer to Figure 2 for a description of the navigation controls.

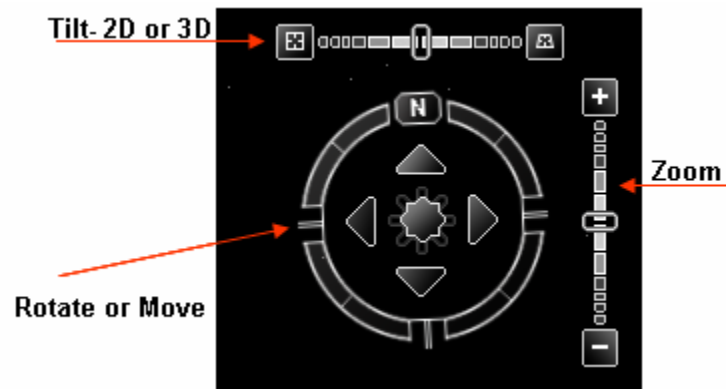


Figure 2. Google Earth Screen Navigation Tools

Step 3: Use the Sightseeing feature.

On the left navigation bar, experiment with the **Places > Sightseeing** folder. Expand Sightseeing, choose a location that you would like to see, and double-click that location. The image will take you to that site. When the location has been reached, an image streaming indicator reports when the image resolution is complete.

Step 4: Experiment with the Search > Fly To folder.

Enter 95134, a U.S. Zip Code.

What U.S. State and City are displayed? _____

What if you would like to "Fly To" London, UK? What data would you need to enter?

Step 5: Use the Fly To feature.

Some locations have better resolution than others, and some location images are older than others. For example, one user commented that he found his home, but the new home next door had not yet been built. Try to find your home using the **Search > Fly To** folder.

Is the resolution for your home the same quality as the Sightseeing location in Step 3? _____

If the resolution for your neighborhood is sufficient, browse the surrounding area to see if you can determine approximately how old the image is.



Figure 3. World Map with Latitude and Longitude Lines

Step 6: View geographic coordinates.

Geographic coordinates are displayed in the lower left quadrant of the image. The first number is called the latitude, and is the angle between a point and the equator. For example, the equator is an imaginary line dividing the globe into the Northern or Southern Hemisphere. The equator has a 0° latitude. The second number is called the longitude, and is the angle east or west of an arbitrary earth point. The Royal Observatory, United Kingdom, is the international zero-longitude point. The combined longitude and latitude is called the common graticule. The coordinate measurements are in degrees°, minutes', seconds, and tenths". For latitude, the reference is North (N) or South (S) of the equator. For longitude, the reference is East (E) or West (W) of the Royal Observatory. Refer to Figure 3. For a layman's definition of geographic coordinates, go to URL

http://en.wikipedia.org/wiki/Geographic_coordinate_system. On the **View** menu, choose **Grid** to display Google Earth Gridlines.

Using the pointer and coordinates shown in the lower left quadrant of the image, what are the coordinates of your home? _____

Task 4: Reflection

Google Earth can bring the world into the home or office. While enjoying the images, consider what digital communication resources were used. For example, satellite communication with an earth station transmitted the image of your home to a ground location. Some type of database was used to store the image. A Local Area Network (LAN) sent your image request across the Internet, probably through several Wide Area Networks (WANs) and then to another LAN with a computer that returned the image to you. The delay in retrieving the image may have been short or long, depending on the slowest speed of all network connections in the path between the database repository and your computer.

Could the image be displayed faster if data compression techniques were used?

Consider network security. Could someone eavesdrop on your network connection?

Task 5: Challenge

Google Earth displays image coordinates in the lower left quadrant of the image. Use the following URL to learn about different coordinate systems:

<http://www.colorado.edu/geography/gcraft/notes/coordsys/coordsys.html>. Wikipedia contains a useful definition of common geographical terms.

Use the geographic coordinate system to describe your home with as much accuracy and detail as possible.

Task 6: Clean Up

You may be required to remove Google Earth from the computer. If so, perform these steps:

1. Click **Start** > **Settings** > **Control Panel**.
2. Double-click **Add or Remove Programs**.
3. Locate and click **Google Earth**.
4. Click **Remove** and follow the prompts.

Additional removal information is available from URL

http://earth.google.com/support/bin/answer.py?answer=20738&ctx=sibling_

Unless instructed otherwise, turn off the computer.

Activity 1.4.5: Identifying Top Security Vulnerabilities

Learning Objectives

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

- Use the SANS site to quickly identify Internet security threats.
- Explain how threats are organized.
- List several recent security vulnerabilities.
- Use the SANS links to access other security-related information.

Background

One of the most popular and trusted sites related to defending against computer and network security threats is SANS. SANS stands for SysAdmin, Audit, Network, Security. SANS contains several components, each a major contributor to information security. For additional information about the SANS site, go to <http://www.sans.org/>, and select items from the Resources menu.

How can a corporate security administrator quickly identify security threats? SANS and the FBI have compiled their list of the top 20 Internet Security Attack Targets at <http://www.sans.org/top20/>. The list is regularly updated with information formatted by:

- Operating Systems—Windows, Unix/Linux, MAC
- Applications—Cross-platform, including web, database, Peer-to-Peer, instant messaging, media players, DNS servers, backup software, and management servers
- Network Devices—Network infrastructure devices (routers, switches, etc.), VoIP devices
- Human Elements—Security policies, human behavior, personnel issues
- Special Section—Security issues not related to any of the above categories

Scenario

This lab will introduce students to computer security issues vulnerabilities. The SANS web site will be used as a tool for threat vulnerability identification, understanding, and defense.

This lab must be completed outside of the Cisco lab from a computer with Internet access.

Estimated completion time is one hour.

Task 1: Locate the SANS Resources.

Step 1: Open the SANS Top 20 List.

Using a web browser, go to URL <http://www.sans.org>. On the **resources** menu, choose **top 20 list**, shown in Figure 1.

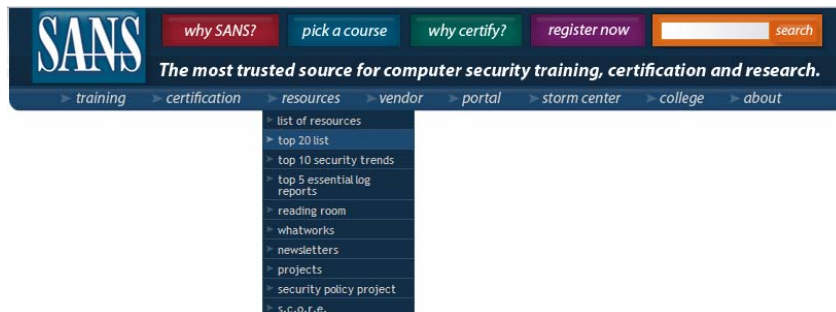


Figure 1. SANS Menu

The SANS Top-20 Internet Security Attack Targets list is organized by category. An identifying letter indicates the category type, and numbers separate category topics. These topics change annually due in part to rapid changes in technology. For the purpose of this activity, navigate to <http://www.sans.org/top20/2006/?portal=8cd2978e94c0c1ae18da87e90a085409>.

Router and switch topics fall under the Network Devices category, **N**. There are two major hyperlink topics:

N1. VoIP Servers and Phones

N2. Network and Other Devices Common Configuration Weaknesses

Step 2: Click hyperlink N2. Network and Other Devices Common Configuration Weaknesses to jump to this topic.

Task 2: Review the SANS Resources.

Step 1: Review the contents of N2.2 Common Default Configuration Issues.

For example, N.2.2.2 (in January 2007) contains information about threats associated with default accounts and values. A Google search on “wireless router passwords” returns links to multiple sites that publish a list of wireless router default administrator account names and passwords. Failure to change the default password on these devices can lead to compromise and vulnerability by attackers.

Step 2: Note the CVE references.

The last line under several topics references Common Vulnerability Exposure (CVE). The CVE name is linked to the National Institute of Standards and Technology (NIST) National Vulnerability Database (NVD), sponsored by the Department of Homeland Security (DHS) National Cyber Security Division and US-CERT, which contains information about the vulnerability.

Task 3: Collect Data.

The remainder of this lab walks you through a vulnerability investigation and solution.

Step 1: Choose a topic to investigate, and click on an example CVE hyperlink.

Note: Because the CVE list changes, the current list may not contain the same vulnerabilities as those in January 2007.

The link should open a new web browser connected to <http://nvd.nist.gov/> and the vulnerability summary page for the CVE.

Step 2: Fill in information about the vulnerability:

Original release date: _____

Last revised: _____

Source: _____

Overview:

Under Impact, there are several values. The Common Vulnerability Scoring System (CVSS) severity is displayed and contains a value between 1 and 10.

Step 3: Fill in information about the vulnerability impact:

CVSS Severity: _____

Range: _____

Authentication: _____

Impact Type: _____

The next heading contains links with information about the vulnerability and possible solutions.

Step 4: Using the hyperlinks, write a brief description of the solution as found on those pages.

Task 4: Reflection

The number of vulnerabilities to computers, networks, and data continues to increase. The governments have dedicated significant resources to coordinating and disseminating information about the vulnerability and possible solutions. It remains the responsibility of the end user to implement the solution. Think of ways that users can help strengthen security. Think about user habits that create security risks.

Task 5: Challenge

Try to identify an organization that will meet with us to explain how vulnerabilities are tracked and solutions applied. Finding an organization willing to do this may be difficult, for security reasons, but will benefit students, who will learn how vulnerability mitigation is accomplished in the world. It will also give representatives of the organization an opportunity to meet the class and conduct informal intern interviews.

Lab 1.6.1: Using Collaboration Tools— IRC and IM

Topology Diagram



Learning Objectives

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

- Define Internet Relay Chat (IRC) and Instant Messaging (IM).
- List several collaborative uses of IM.
- List several misuses and data security issues involving IM.
- Use IRC to demonstrate collaboration.

Background

E-mail permits multiple users to collaborate, share ideas, and transfer files. However, unless the user constantly monitors the e-mail account, unread e-mail may go unnoticed for a long period of time. When people have wanted immediate contact, the telephone has been the technology of choice. Unfortunately, the telephone cannot be used to transfer files. What collaborators need for communication in the human network is a tool that has the flexibility of e-mail with the responsiveness of the telephone. Internet Relay Chat (IRC) and Instant Messaging (IM) fit nicely into these requirements. Using the Internet or a private corporate network, users can easily exchange ideas and files. IMing and Chatting are both methods of real-time communication; however, they are implemented differently.

Instant Messaging provides one-on-one communication with "accepted" individuals. To initiate an Instant Message, one person needs to "invite" another. The recipient of the invitation needs to know—and accept—the IM session based on the other user's screen name. IM clients allow you to have an approved list of users, often called a Buddy List. If you want to communicate with more than one person at a time, you can open additional IM windows. Each of these windows represents a two-person communication.

Internet Relay Chat, on the other hand, allows multiple people to interact. Chat also provides a degree of anonymity. To start chatting, you establish a connection to a chat server and join a discussion on a particular topic. When you join, you are said to "join a room." In the chat room, you typically create your own identity and can give as little information about yourself as you choose.

While the following discussion focuses primarily on IM, a brief hands-on lab with our "model Internet cloud" will demonstrate the ease of IRC.

IM requires a device providing services that allows users to communicate. This device is referred to as the *Instant Messenger Server*. The users on the end devices, such as a computer, use a piece of software called the *Instant Messenger Client*. This arrangement is called a client/server relationship. IM

clients connect to an IM server, and the server joins clients. This relationship is called an IM network. There are many different IM networks available, each with a dedicated following of users. Popular IM networks include America On Line (AOL) Instant Messenger (AIM), Windows Live Messenger (MSN), Yahoo! Messenger, and ICQ (I Seek You). Figure 1 shows the AIM client application connected to the AIM network.

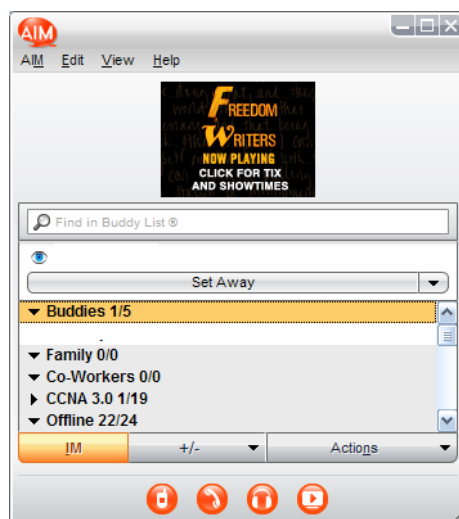


Figure 1. AIM Client

Features

IM services have several common features:

- When an IM client connects to the IM network, any existing connections can be alerted through a contact list, a list of other people that you communicate with through the IM Client.
- File sharing between IM clients enables work collaboration.
- Text messaging between clients is possible, and can be logged.
- Some IM networks offer audio services.
- Newer services that some IM networks are beginning to provide include video conferencing, Voice over IP (VoIP), web conferencing, desktop sharing, and even IP radio and IPTV.

Protocols

Each IM network uses an agreed-upon method of communication, called a protocol. Many of the IM networks use proprietary protocols. AIM and ICQ (purchased by AOL) use the proprietary Open System for Communication in Realtime (OSCAR) protocol. Both Microsoft and Yahoo! have proprietary protocols but have partnered services for joint connectivity.

Throughout this course we will learn about many different protocols. The Internet Engineering Task Force (IETF) has attempted to standardize IM protocols, notably with the Session Initialization Protocol (SIP). SIPv2 was originally defined in RFC 2543, and made obsolete by RFC 3261. As with proprietary IM protocols, there are numerous open source protocols.

Some IM client applications, such as Gaim and Trillian, can differentiate between the various IM network protocols; IM servers can also incorporate this support. The IETF formalized an open standard, Jabber, based on the Extensible Messaging and Presence Protocol (EMPP). Applicable IETF references are RFC 3290 and RFC 3291. Encrypted communication is supported.

Social misuse of IM has been a concern for parents, and many IM networks encourage parental control. Child restrictions include limiting IM contacts and providing supervision while online. AIM and Yahoo! Messenger provide free supervision software tools. Some parental supervision tools include background logging, online time limits, chat room blocking, blocking specific users, and disabling certain functions of the client.

Security

Multiple security issues have been identified with IM. As a result, many organizations either limit or completely block IM from entering the corporate network. Computer worms, viruses, and Trojan horses, categorized as malware, have been transferred to IM client computers. Without strong security methods, information exchanged between users can be captured and disclosed. IM clients and IM servers have experienced application vulnerabilities, which have resulted in vulnerable computers. Even legitimate users can congest network throughput by transferring large files.

How does a system administrator protect his or her network from IM vulnerabilities and misuse? The SysAdmin, Audit, Network, Security (SANS) Institute recommends several countermeasures. The following list is from the SANS web site, <http://www.sans.org/top20/#c4>:

C4.4 How to Protect against IM Vulnerabilities and Unauthorized IM Usage

- Establish policies for acceptable use of IM. Ensure that all users are aware of those policies and clearly understand the potential risks.
- Standard users should not be permitted to install software. Restrict Administrative and Power User level privileges to support personnel acting in their support capacity. If a user must have Administrative or Power User privileges, create a separate account to be used for his or her daily office functions, Internet surfing, and online communication.
- Ensure that vendor patches are promptly applied to IM software, interrelated applications, and the underlying operating system.
- Employ antivirus and antispyware products.
- Do not rely on external IM servers for internal use of IM; provide a commercial grade IM proxy or internal IM server.
- Create secure communication paths when using IM with trusted business partners.
- Appropriately configure intrusion detection and prevention systems. Understand that many IM applications are capable of enabling associated communications to masquerade as otherwise legitimate traffic (for example, http).
- Consider deploying products specifically designed for IM security.
- Filter all http traffic through an authenticating proxy server to provide additional capabilities of filtering and monitoring IM traffic.
- Block access to known public IM servers that have not been explicitly authorized. (Note: This offers only partial protection due to the number of potential external servers.)
- Block popular IM ports. (Note: This offers only partial protection, due to the number of potential protocols and associated ports, and the ability of applications to bypass port restrictions.)
- Monitor using an Intrusion Detection/Prevention system for users creating tunnels for IM or bypassing proxies.

The Future of IM

The future of IM is promising, enabling users to adapt new technologies for collaboration. For example, mobile IM supports mobile users, providing IM services to hand-held cellular phones. Most popular cellular phone manufacturers have their own form of mobile IM. Another popular hand-held appliance is the Blackberry. The Blackberry supports common IM tools, such as text messaging, as well as push e-mail, telephony, and web browsing.

Scenario

The topology diagram shows two computers connected to a “cloud.” In networking, a cloud is often used to symbolize a more complex network, such as the Internet, which is not the current focus of this discussion. In this lab, you will use two computers that must first obtain communication software from the network cloud. After installing the software, the cloud will still be necessary to provide communication services. In subsequent chapters you will study in great detail the devices and protocols that are inside the cloud. Inside the cloud is a server called *eagle-server* as well as other networking devices. This lab uses eagle-server as the IRC server, and Gaim as the IRC client. Gaim is used for this lab, but any IRC client may be used if available. An IRC client is available for download from eagle-server, URL <http://eagle-server.example.com/pub>.

Estimated completion time is 45 minutes.

Task 1: Configuring the Chat Client

The IRC protocol is an open standard, originally described in RFC 1459, communicating across plain text links.

Step 1: Verify that there is an IRC client on the lab computer.

If not, download and install gaim-1.5.0.exe (windows executable) from URL ftp://eagle-server.example.com/pub/eagle_labs/eagle1/chapter1. Accept the default settings during the installation. After verifying that the Gaim chat client is installed, use the following steps to configure Gaim:

Step 2: Open Accounts window.

1. Open Gaim and select the Login window, icon **Accounts**. The Accounts window is shown in Figure 2.

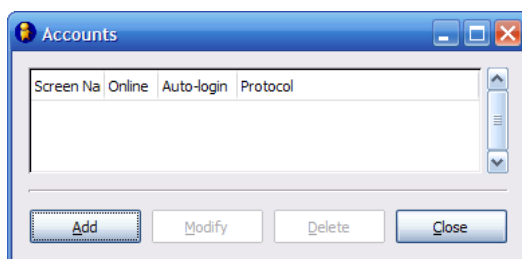


Figure 2. Gaim Accounts Window

2. On the Accounts window, click **Add**.

Step 2: Add a new account.

1. See Figure 3. On the Add Account window, expand the “Show more options” option. Fill in required information:

Protocol: IRC
Screen Name: (how others will know you)
Server: eagle-server.example.com
Proxy Type: No Proxy

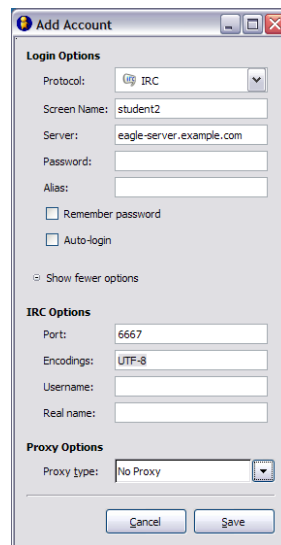


Figure 3. Gaim Add Account Window

2. When finished, click **Save**.
3. Close the Accounts window.

Task 2: Connection to Chat Server

Step 1: Sign On.

Return to the Login window, where the new account to eagle-server should be visible. Click **Sign-on**. Two windows should open. Figure 4 shows the IRC connect status window. Figure 5 shows the main Gaim IM client window, used for chatting or IM.

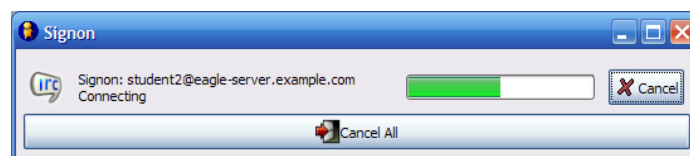


Figure 4. IRC Connect Status Window

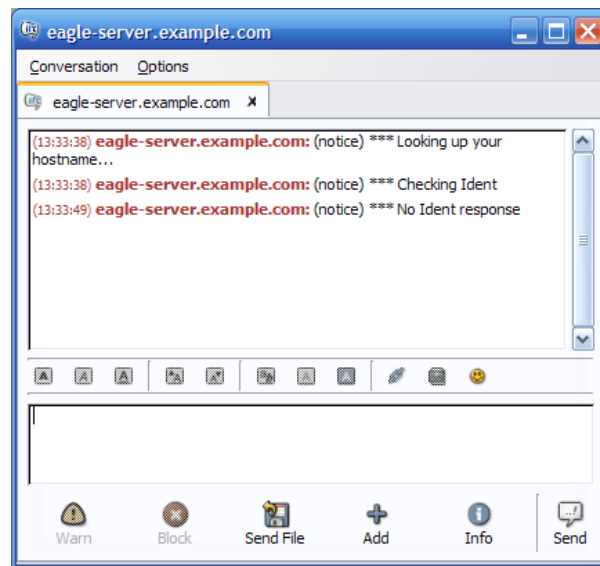


Figure 5. Gaim IRC Client Window

Step 2: Join the Chat.

When the IRC client connects to the IRC server, the status window closes and a Buddy List window displays. Click **Chat**, as shown in Figure 6.

Note: To join a chat channel, the Channel name *must* start with #. If the Channel name is incorrect, you will be in a chat room alone (unless other students made a similar error).

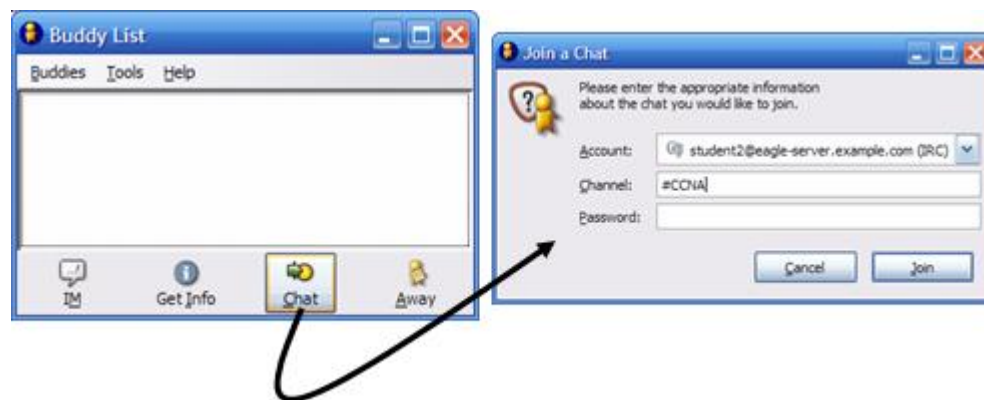


Figure 6. Joining a Chat

Task 3: The Chat Session

Figure 7 shows a brief chat between users *Root* and *student2*. Multiple students can join and interact with each other.

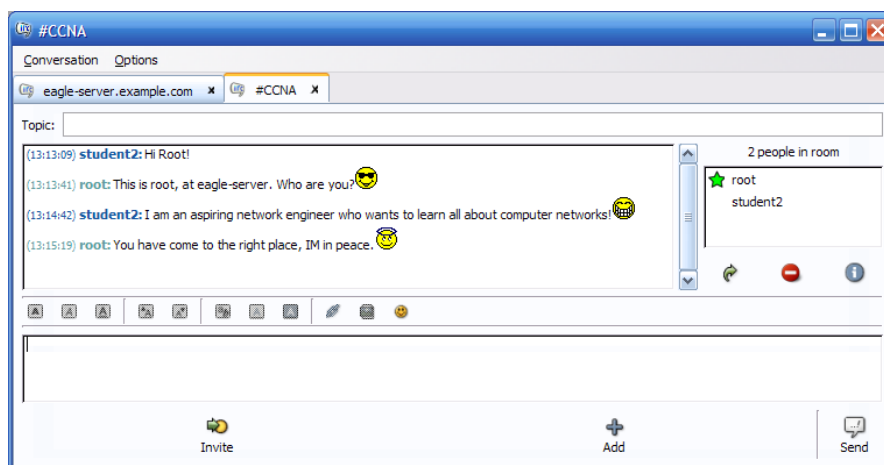


Figure 7. Participating in Chat

During the chat, consider how you—as a parent or network administrator—would manage this type of connection.

Task 4: Reflection

On a network with an Internet connection, the Gaim IM client can be used to connect to several different IM providers. Most teenagers and young adults today are familiar with IMing between friends and sharing files, but the communication between the client and server may not be understood. As a future network engineer, you should understand the social and security issues with IM and IRC.

Task 5: Challenge

While you are connected in chat, transfer files between partners. Use a continuous ping from the host to the eagle server to monitor network throughput. Observe the response time before and during the file transfer. Write a brief description of the network response time—during file transfers and without file transfers.

Task 6: Clean Up

Check with your instructor before removing Gaim and shutting down the computer.

Lab 1.6.2: Using Collaboration Tools—Wikis and Web Logs

Topology Diagram



Learning Objectives

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

- Define the terms *wiki* and *blog*.
- Explore wiki features.

Background

The lab topology should be configured and ready for use. If there are connectivity issues with the lab computer connecting to Eagle Server, ask the instructor for assistance.

The topology diagram shows two computers connected to a “cloud.” In networking, a cloud is often used to symbolize a more complex network that is not the current focus of discussion. In this lab, you will use a host computer that connects across the cloud to access a Twiki. In subsequent chapters you will study in great detail the devices and protocols that are inside the cloud.

Scenario

In this lab, you will have the opportunity to learn about the different parts of a wiki. If you ever used *Wikipedia*, you are probably already familiar with the look and feel of a wiki. After using *Wikipedia*, with its rich content and flexible links, moving back to flat files may feel constricting and unsatisfying.

To gain experience with a wiki, the TWiki wiki server installed on Eagle Server will be explored.

Task 1: Define the Terms Wiki and Blog.

Wikis

“Wiki” is a Hawaiian-language word that means *fast*. In networking terms, a wiki is a web-based collaboration tool that permits almost anyone to immediately post information, files, or graphics to a common site for other users to read and modify. A wiki enables a person to access a home page (first page) that provides a search tool to assist you in locating the articles that interest you. A wiki can be installed for the internet community or behind a corporate firewall for employee use. The user not only reads wiki contents but also participates by creating content within a web browser.

Although many different wiki servers are available, the following common features that have been formalized into every wiki:

- Any web browser can be used to edit pages or create new content.
- Edit and auto links are available to edit a page and automatically link pages. Text formatting is similar to creating an e-mail.
- A search engine is used for quick content location.
- Access control can be set by the topic creator, defining who is permitted to edit content.
- A wiki web is a grouping of pages with different collaboration groups.

For more information on Wiki, visit the following URLs outside of class:

<http://www.wiki.org/wiki.cgi?WhatsWiki>
<http://www.wikispaces.com/>

Blogs

A web log, called a blog, is similar to a wiki in that users create and post content for others to read. Blogs are normally the creation of a single person and the blog owner controls blog content. Some blogs permit users to leave comments and provide feedback to the author while others are more restrictive. Free internet blog hosting is available, similar to a free web site or e-mail account, such as www.blogger.com.

Task 2: Explore Wiki Features with Twiki Tutorial.

The Twiki tutorial consists of exploring some of the more common features of a wiki. Listed below are the major topics covered in the tutorial:

20-Minute TWiki Tutorial

1. Get set...
2. Take a quick tour...
3. Open a private account...
4. Check out TWiki users, groups.
5. Test the page controls...
6. Change a page, and create a new one...
7. Use your browser to upload files as page attachments...
8. Get e-mail alerts whenever pages are changed...

As each topic in the tutorial is investigated, complete the questions in this task. The exception is “3. Open a private account...”. Twiki requires email verification for new accounts, and email has not been configured on the lab host computers. Instead, users have already been created for steps that require login privileges.

The power of a wiki is in the rich hyperlink content. Following hyperlinks can present continuity problems. It is recommended to open two browsers. Point one browser at the Twiki URL, and use the other browser for ‘working’ pages. Adjust the browser window sizes so that instructions can be viewed in one browser while actions can be performed in the other. Any external links that are selected will result in an error.

Step 1: Establish a web client connection to Eagle Server wiki.

Open a web browser and connect to the TWiki Sandbox, URL <http://eagle-server.example.com/twiki/bin/view/Sandbox/WebHome>. The URL name is case sensitive, and must be typed exactly as shown. The Sandbox is a web topic designed to test wiki features. Refer to Figure 1.

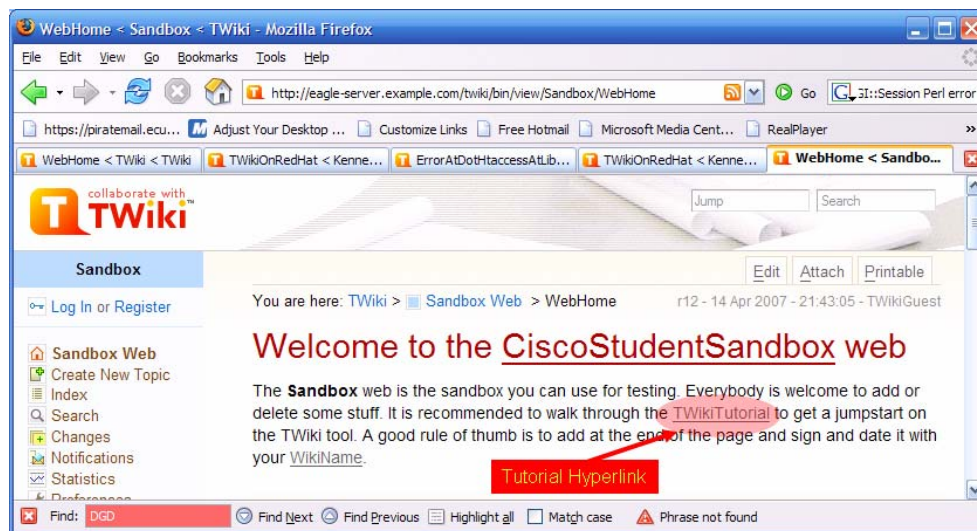


Figure 1. TWiki Sandbox Web.

Step 2: Open the TWiki Tutorial.

Click the TWiki Tutorial link, highlighted in the red oval in Figure 1, to open the wiki tutorial page.

Step 3: Complete the TWiki tutorial.

Refer to the tutorial, step 1, “Get set . . .”, and step 2, “Take a quick tour...”. After completing the first two tutorial sections, answer the following questions:

What is a WikiWord?

How many results are returned from a search of WebSearch? _____

Refer to the tutorial, step 3, “Open a private account...”. Email is not possible at this time, therefore you will not be able to register. Instead, userids have been created for you to use later in this lab.

The key point to understand about this step is that registration is a two-part process. First, users fill in registration information and submit the form to TWiki.

List the mandatory information required for registration:

TWiki responds to a registration request by sending an email to the user that contains a unique activation code.

The second part of the registration process is when the user (1) enters the code in the activation window, or (2) responds with email by clicking on the TWiki response link. At this time, the user account is added to the TWiki database.

Refer to the tutorial, step 4, "Check out TWiki users, groups.". A list of TWiki users and groups is displayed. After completing this tutorial section, answer the following questions related to user and group issues:

How is a user's password reset?

How can inappropriate changes be fixed in a wiki topic?

Tutorial step 5, "Test the page controls...", will familiarize you with page editing commands. After completing this tutorial section, answer the following questions:

What is the latest revision number?

Place the correct action link next to the description for page controls:

Attach **Backlinks** **Edit** **History** **More** **Printable**
r3 > r2 > r1 **Raw View**

Description	Action Link
add to or edit the topic	
show the source text without editing the topic	
attach files to a topic	
find out what other topics link to this topic (reverse link)	
additional controls, such as rename / move, version control and setting the topic's parent.	
topics are under revision control- shows the complete change history of the topic. For example, who changed what and when.	
view a previous version of the topic or the difference between two versions	
goes to a stripped down version of the page, good for printing	

:

Tutorial step 6, "Change a page, and create a new one...", is an opportunity for you to add content to the wiki. Complete this tutorial, using the table below to login to the wiki server.

On Eagle Server a group with private accounts has been created to allow participation in a private TWiki topic. These accounts are **StudentCcna1** through **StudentCcna22**. All accounts have the same password, **cisco**. You should use the account that reflects your pod and host computer number. Refer to the following table:

Lab pod#host#	Account Login ID (case sensitive)
Pod1host1	StudentCcna1
Pod1host2	StudentCcna2
Pod2host1	StudentCcna3
Pod2host2	StudentCcna4
Pod3host1	StudentCcna5
Pod3host2	StudentCcna6
Pod4host1	StudentCcna7
Pod4host2	StudentCcna8
Pod5host1	StudentCcna9
Pod5host2	StudentCcna10
Pod6host1	StudentCcna11
Pod6host2	StudentCcna12
Pod7host1	StudentCcna13
Pod7host2	StudentCcna14
Pod8host1	StudentCcna15
Pod8host2	StudentCcna16
Pod9host1	StudentCcna17
Pod9host2	StudentCcna18
Pod10host1	StudentCcna19
Pod10host2	StudentCcna20
Pod11host1	StudentCcna21
Pod11host2	StudentCcna22

From the lab Wiki Welcome Screen, click the **Log In** link located in the upper left corner of the page. See Figure 2.



Figure 2. Log In Link.

A login box similar to that shown in Figure 3 should appear. Enter the applicable Twiki username, and password **cisco**. Both the username and password are case sensitive.

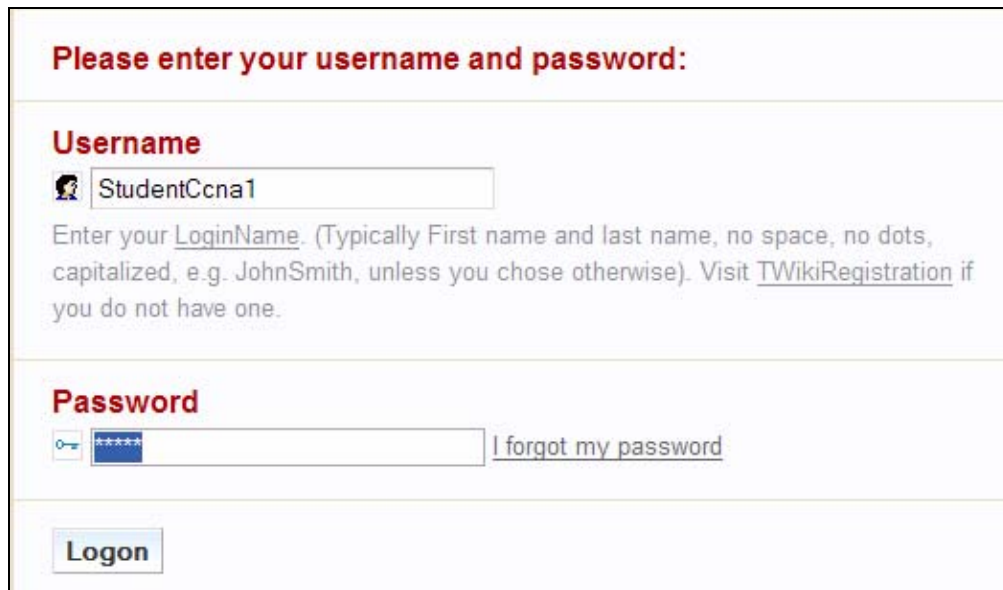


Figure 3. Login Box.

This should bring you to your wiki topic page, similar to the one shown in Figure 4.

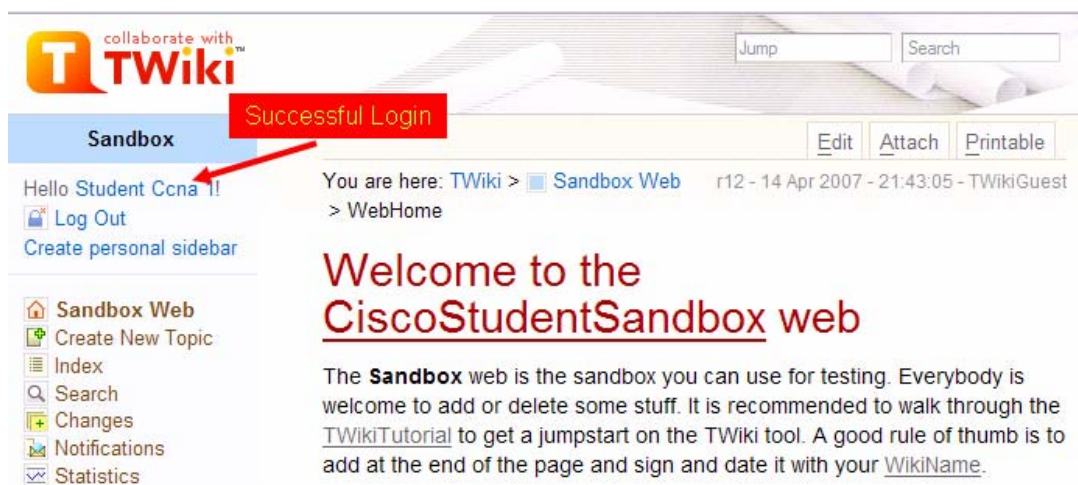


Figure 4. wiki Topic Page.

Tutorial step 7, “Use your browser to upload files as page attachments...”, describes the process for uploading files into the wiki. To complete this tutorial, create a document using notepad and upload it to the wiki server.

What is the default maximum file size that can be transferred?

Tutorial step 8, “Get e-mail alerts whenever pages are changed...”, details how to receive email alerts whenever a particular page has been updated. Sometimes it is not convenient to return regularly to a wiki simply to check for updates to postings. Because Email is not configured on the host computer, alerts will not be sent.

Describe how you could receive e-mail notifications whenever a topic changes?

Task 3: Reflection

This lab presented the mechanics of a wiki. Usefulness and collaboration will not be realized until you actually join a wiki. Wikis of possible interest include:

- CCNA—http://en.wikibooks.org/wiki/CCNA_Certification
- Cisco systems history—http://en.wikipedia.org/wiki/Cisco_Systems
- Wiki web about Cisco equipment and technology—<http://www.nyetwork.org/wiki/Cisco>
- Network+ —http://en.wikibooks.org/wiki/Network_Plus_Certification/Study_Guide
- Network Dictionary—http://wiki.networkdictionary.com/index.php/Main_Page
- Wireshark network protocol analyzer—<http://wiki.wireshark.org/>

Task 4: Challenge

Depending on the type of Eagle Server installation, the class may be able use the TWiki wiki server to post interesting topics related to computer network theory and class progress.

Create a personal blog of your network education experience. Internet access will be required.

Task 5: Clean Up

Close all web browsers and shut down the computer unless instructed otherwise.

Activity 2.2.5: Using NeoTrace™ to View Internetworks

Learning Objectives

- Explain the use of route tracing programs, such as tracert and NeoTrace.
- Use tracert and NeoTrace to trace a route from its PC to a distant server.
- Describe the interconnected and global nature of the Internet with respect to data flow.

Background

Route tracing computer software is a utility that lists the networks data has to traverse from the user's originating end device to a distant destination network.

This network tool is typically executed at the command line as:

```
tracert <destination network name or end device address>
```

(Unix and similar systems)

or

```
tracert <destination network name or end device address>
```

(MS Windows systems)

and determines the route taken by packets across an IP network.

The **tracert** (or **tracert**) tool is often used for network troubleshooting. By showing a list of routers traversed, it allows the user to identify the path taken to reach a particular destination on the network or across internetworks. Each router represents a point where one network connects to another network and the packet was forwarded through. The number of routers is known as the number of "hops" the data traveled from source to destination.

The displayed list can help identify data flow problems when trying to access a service such as a website. It can also be useful when performing tasks such as downloading data. If there are multiple websites (mirrors) available for the same file of data, one can trace each mirror to get a good idea of which mirror would be the fastest to use.

However, it should be noted that because of the "meshed" nature of the interconnected networks that make up the Internet and the Internet Protocol's ability to select different pathways over which to send packets, two trace routes between the same source and destination conducted some time apart may produce different results.

Tools such as these are usually embedded with the operating system of the end device.

Others such as NeoTrace™ are proprietary programs that provide extra information. NeoTrace uses available online information to display graphically the route traced on a global map, for example.

Scenario

Using an Internet connection, you will use two routing tracing programs to examine the Internet pathway to destination networks.

This activity should be preformed on a computer that has Internet access and access to a command line. First, you will use the Windows embedded **tracert** utility and then the more enhanced NeoTrace program. This lab assumes the installation of NeoTrace. If the computer you are using does not have NeoTrace installed, you can download the program using the following link:

<http://www.softpedia.com/get/Network-Tools/Traceroute-Whois-Tools/McAfee-NeoTrace-Professional.shtml>

If you have any trouble downloading or installing NeoTrace, ask your instructor for assistance.

Task 1: Trace Route to Remote Server.

Step 1: Trace the route to a distant network.

To trace the route to a distant network, the PC being used must have a working connection to the class/lab network.

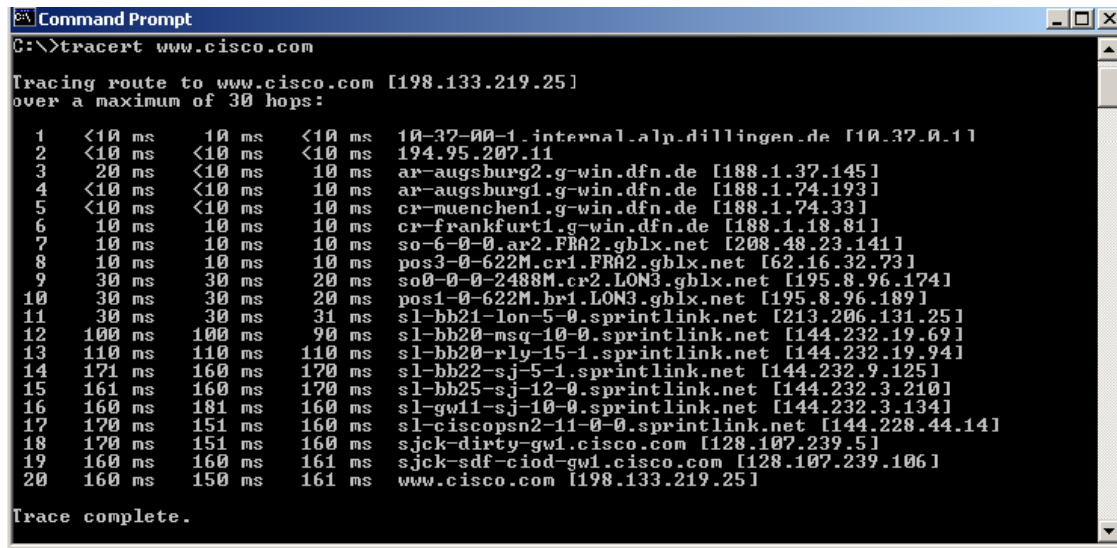
1. At the command line prompt, type: `tracert www.cisco.com`

The first output line should show the Fully Qualified Domain Name (FQDN) followed by the IP address. The Lab Domain Name Service (DNS) server was able to resolve the name to an IP address. Without this name resolution, the `tracert` would have failed, because this tool operates at the TCP/IP layers that only understand valid IP addresses.

If DNS is not available, the IP address of the destination device has to be entered after the `tracert` command instead of the server name.

2. Examine the output displayed.

How many hops between the source and destination? _____



```
Command Prompt
C:\>tracert www.cisco.com

Tracing route to www.cisco.com [198.133.219.25]
over a maximum of 30 hops:
  0  <10 ms    <10 ms    <10 ms    10-37-00-1.internal.alp.dillingen.de [10.37.0.1]
  1  <10 ms    <10 ms    <10 ms    194.95.207.11
  2  <10 ms    <10 ms    <10 ms    ar-augsburg2.g-win.dfn.de [188.1.37.145]
  3  <10 ms    <10 ms    <10 ms    ar-augsburg1.g-win.dfn.de [188.1.74.193]
  4  <10 ms    <10 ms    <10 ms    cr-muenchen1.g-win.dfn.de [188.1.74.33]
  5  <10 ms    <10 ms    <10 ms    cr-frankfurt1.g-win.dfn.de [188.1.18.81]
  6  <10 ms    <10 ms    <10 ms    so-6-0-0.ar2.FRA2.gblx.net [208.48.23.141]
  7  <10 ms    <10 ms    <10 ms    pos3-0-622M.cr1.FRA2.gblx.net [62.16.32.73]
  8  <10 ms    <10 ms    <10 ms    so0-0-0-2488M.cr2.LON3.gblx.net [195.8.96.174]
  9  <10 ms    <10 ms    <10 ms    pos1-0-622M.br1.LON3.gblx.net [195.8.96.189]
 10  <10 ms    <10 ms    <10 ms    sl-bb21-lon-5-0.sprintlink.net [213.206.131.25]
 11  <10 ms    <10 ms    <10 ms    sl-bb20-msq-10-0.sprintlink.net [144.232.19.69]
 12  <10 ms    <10 ms    <10 ms    sl-bb20-rly-15-1.sprintlink.net [144.232.19.94]
 13  <10 ms    <10 ms    <10 ms    sl-bb22-sj-5-1.sprintlink.net [144.232.9.125]
 14  <10 ms    <10 ms    <10 ms    sl-bb25-sj-12-0.sprintlink.net [144.232.3.210]
 15  <10 ms    <10 ms    <10 ms    sl-gw11-sj-10-0.sprintlink.net [144.232.3.134]
 16  <10 ms    <10 ms    <10 ms    sl-ciscopsn2-11-0-0.sprintlink.net [144.228.44.14]
 17  <10 ms    <10 ms    <10 ms    sjck-dirty-gw1.cisco.com [128.107.239.5]
 18  <10 ms    <10 ms    <10 ms    sjck-sdf-ciod-gw1.cisco.com [128.107.239.106]
 19  <10 ms    <10 ms    <10 ms    www.cisco.com [198.133.219.25]
 20  <10 ms    <10 ms    <10 ms    www.cisco.com [198.133.219.25]

Trace complete.
```

Figure 1. tracert Command

Figure 1 shows the successful result when running:

`tracert www.cisco.com`

from a location in Bavaria, Germany.

The first output line shows the FQDN, followed by the IP address. Therefore, a DNS server was able to resolve the name to an IP address. Then there are listings of all routers through which the `tracert` requests had to pass to get to the destination.

3. Try the same trace route on a PC connected to the Internet, and examine your output.

Number of hops to www.cisco.com: _____

Step 2: Try another trace route on the same PC, and examine your output.

Destination URL: _____

Destination IP Address: _____

Task 2: Trace Route using NeoTrace.

1. Launch the NeoTrace program.
2. On the **View** menu, choose **Options**. Click the **Map** tab and in the **Home Location** section click the **Set Home Location** button.
3. Follow the instructions to select your country and location in your country.
Alternatively, you can click the **Advanced** button, which enables you to enter the precise latitude and longitude of your location. See the Challenge section of Activity 1.2.5(1).
4. Enter "www.cisco.com" in the **Target** field and click **Go**.
5. From the **View** menu, **List View** displays the list of routers similar to `tracert`.
Node View from the **View** menu displays the connections graphically with symbols.
Map View on the **View** menu displays the links and routers in their geographic location on a global map.
6. Select each view in turn and note the differences and similarities.
7. Try a number of different URLs and view the routes to those destinations.

Task 3: Reflection

Review the purpose and usefulness of trace route programs.

Relate the displays of the output of NeoTrace to the concept of interconnected networks and the global nature of the Internet.

Task 4: Challenge

Consider and discuss possible network security issues that could arise from the use of programs like traceroute and NeoTrace. Consider what technical details are revealed and how perhaps this information could be misused.

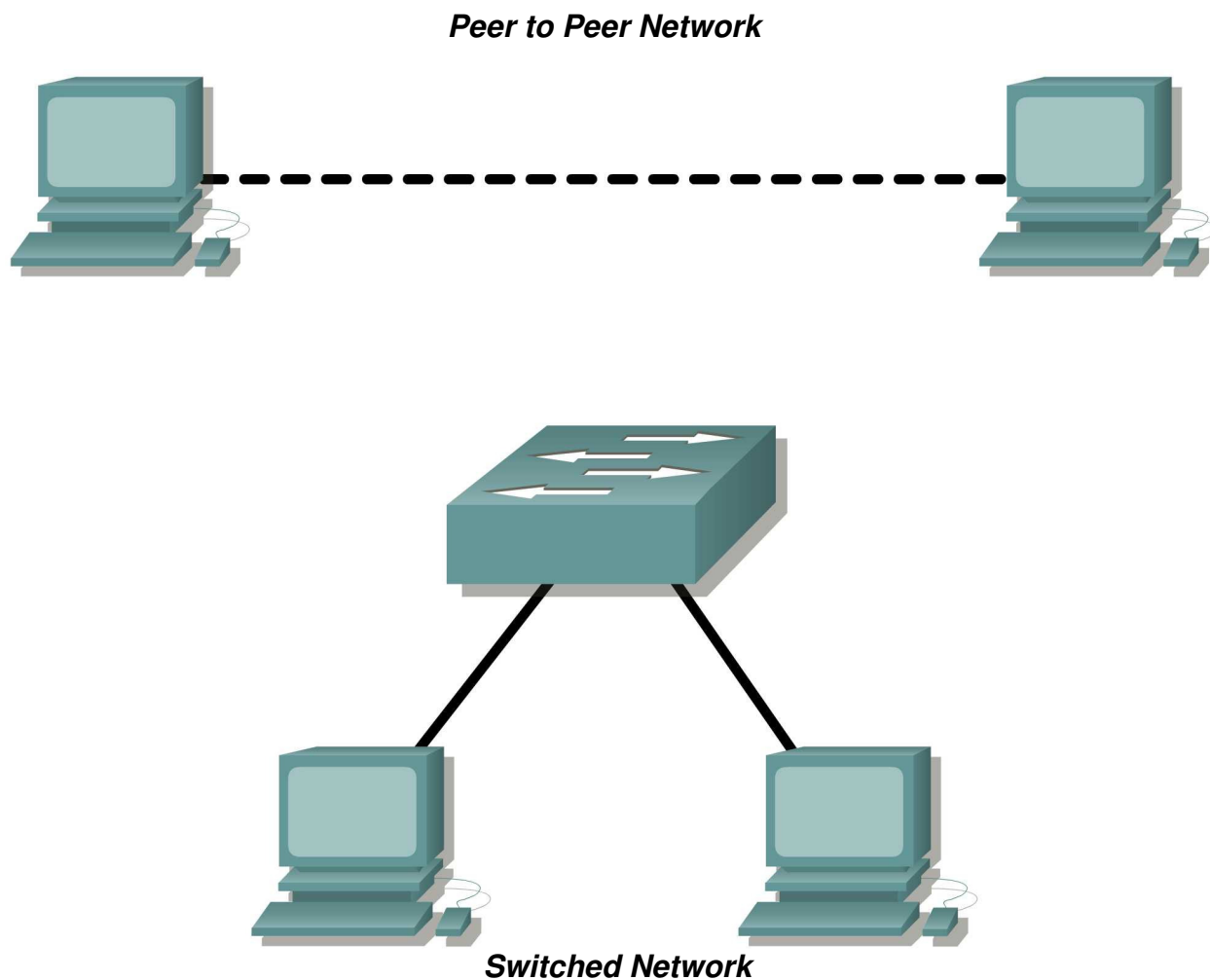
Task 5: Clean Up

Exit the NeoTrace program.

Unless instructed otherwise by your instructor, properly shut down the computer.

Lab 2.6.1: Topology Orientation and Building a Small Network

Topology Diagram



Learning Objectives

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

- Correctly identify cables for use in the network.
- Physically cable a peer-to-peer and switched network.
- Verify basic connectivity on each network.

Background

Many network problems can be fixed at the Physical layer of a network. For this reason, it is important to have a clear understanding of which cables to use for your network connections.

At the Physical layer (Layer 1) of the OSI model, end devices must be connected by media (cables). The type of media required depends on the type of device being connected. In the basic portion of this lab, straight-through or patch—cables will be used to connect workstations and switches.

In addition, two or more devices communicate through an address. The Network layer (Layer 3) requires a unique address (also known as a logical address or IP Addresses), which allows the data to reach the appropriate destination device.

Addressing for this lab will be applied to the workstations and will be used to enable communication between the devices.

Scenario

This lab starts with the simplest form of networking (peer-to-peer) and ends with the lab connecting through a switch.

Task 1: Create a Peer-to-Peer Network.

Step 1: Select a lab partner.

Step 2: Obtain equipment and resources for the lab.

Equipment needed:

- 2 workstations
- 2 straight through (patch) cables
- 1 crossover cable
- 1 switch (or hub)

Task 2: Identify the Cables used in a Network.

Before the devices can be cabled, you will need to identify the types of media you will be using. The cables used in this lab are crossover and straight-through.

Use a **crossover cable** to connect two workstations to each other through their NIC's Ethernet port. This is an Ethernet cable. When you look at the plug you will notice that the orange and green wires are in opposite positions on each end of the cable.

Use a **straight-through cable** to connect the router's Ethernet port to a switch port or a workstation to a switch port. This is also an Ethernet cable. When you look at the plug you will notice that both ends of the cable are exactly the same in each pin position.

Task 3: Cable the Peer-to-peer Network.



Step 1: Connect two workstations.

Using the correct Ethernet cable, connect two workstations together. Connect one end of the cable to the NIC port on PC1 and the other end of the cable to PC2.

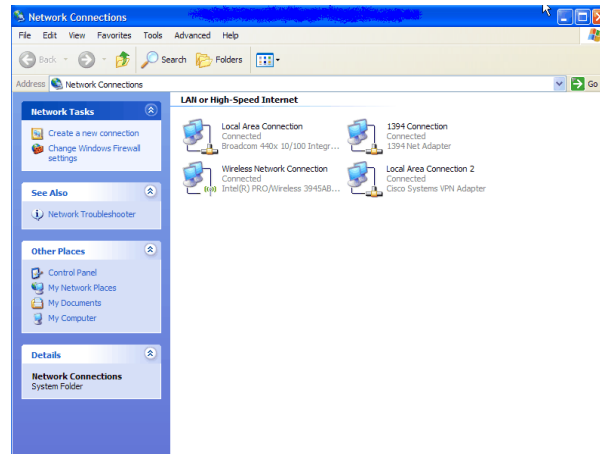
Which cable did you use? _____

Step 2: Apply a Layer 3 address to the workstations.

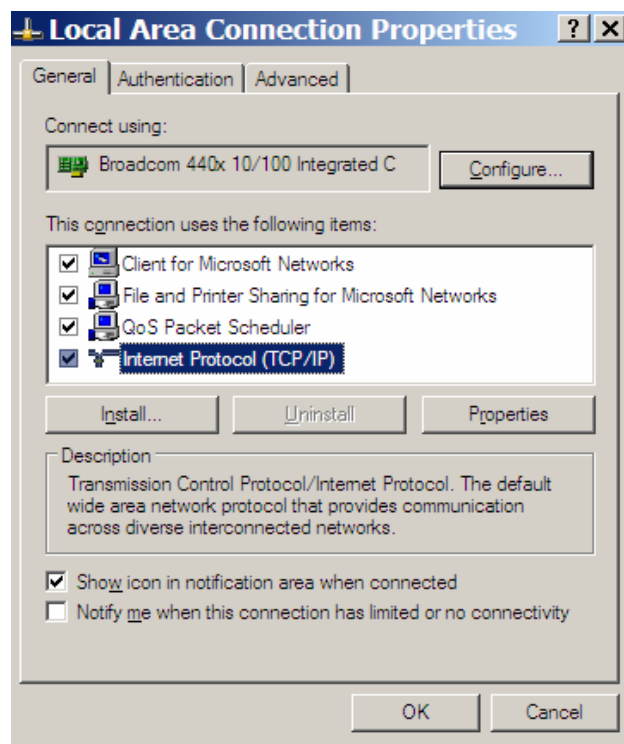
To complete this task, you will need to follow the step-by-step instructions below.

Note: These steps must be completed on *each* workstation. The instructions are for Windows XP—steps may differ slightly if you are using a different operating system.

1. On your computer, click **Start**, right-click **My Network Places**, and then click **Properties**. The Network Connections window should appear, with icons showing the different network connections.

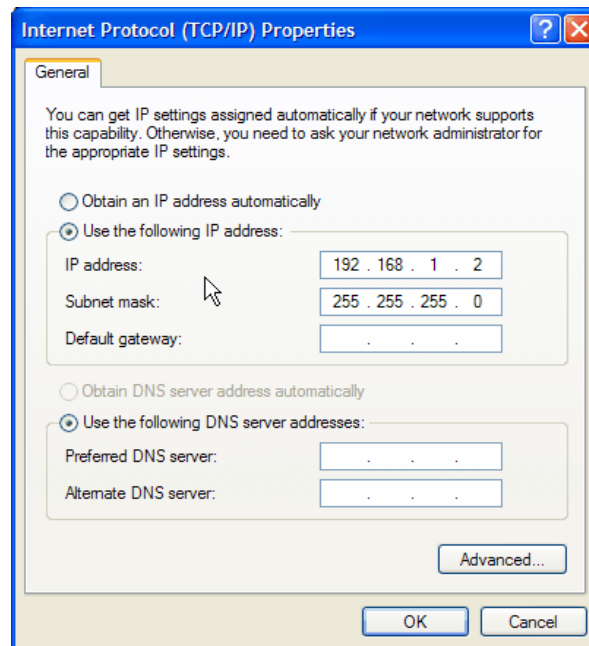


2. Right-click the **Local Area Connection** and click **Properties**.
3. Select the **Internet Protocol (TCP/IP)** item and then click the **Properties** button.



4. On the General tab of the Internet Protocol (TCP/IP) Properties window, select the **Use the following IP address** option.

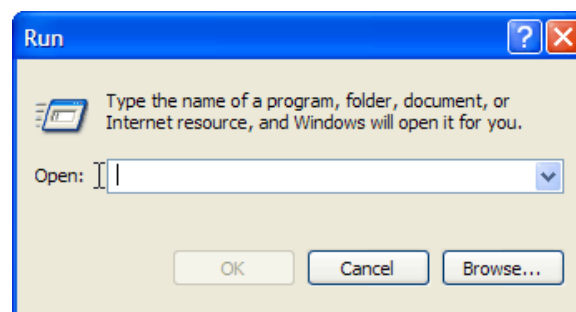
5. In the **IP address** box, enter the IP address 192.168.1.2 for PC1. (Enter the IP address 192.168.1.3 for PC2.)
6. Press the tab key and the Subnet mask is automatically entered. The subnet address should be 255.255.255.0. If this address is not automatically entered, enter this address manually.
7. Click **OK**.



8. Close the Local Area Connection Properties window.

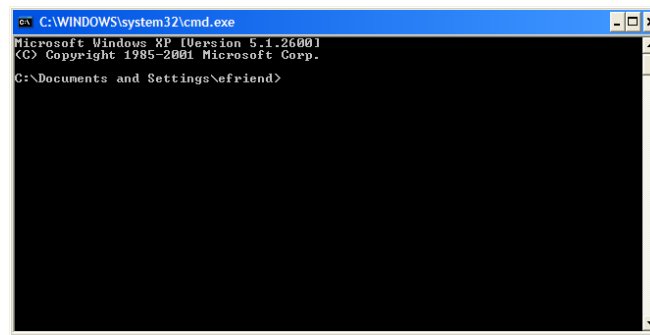
Step 3: Verify connectivity.

1. On your computer, click **Start**, and then click **Run**.



2. Type **cmd** in the Open box and then click **OK**.

The DOS command (cmd.exe) window will appear. You can enter DOS commands using this window. For the purposes of this lab, basic network commands will be entered to allow you to test you computer connections.



The **ping** command is a computer network tool used to test whether a host (workstation, router, server, etc.) is reachable across an IP network.

3. Use the **ping** command to verify that PC1 can reach PC2 and PC2 can reach PC1. From the PC1 DOS command prompt, type **ping 192.168.1.3**. From the PC2 DOS command prompt, type **ping 192.168.1.2**.

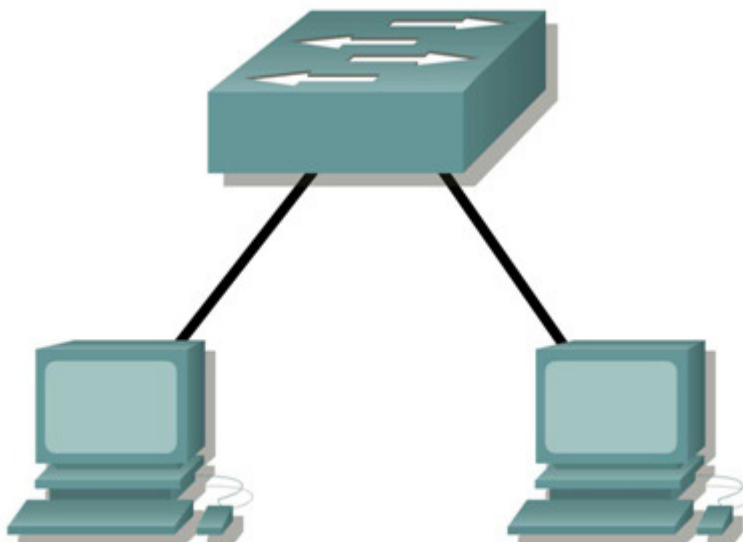
What is the output of the **ping** command?

If the **ping** command displays an error message or doesn't receive a reply from the other workstation, troubleshoot as necessary. Possible areas to troubleshoot include:

- Verifying the correct IP addresses on both workstations
- Ensuring that the correct type of cable is used between the workstations

What is the output of the **ping** command if you unplug the network cable and ping the other workstation?

Task 4: Connect Your Workstations to the Classroom Lab Switch.



Step 1: Connect workstation to switch.

Using the correct cable, connect one end of the cable to the NIC port on the workstation and the other end to a port on the switch.

Step 2: Repeat this process for each workstation on your network.

Which cable did you use? _____

Step 3: Verify connectivity.

Verify network connectivity by using the **ping** command to reach the other workstations attached to the switch.

What is the output of the **ping** command?

What is the output of the **ping** command if you ping an address that is not connected to this network?

Step 4: Share a document between PCs.

1. On your desktop, create a new folder and name it **test**.
2. Right-click the folder and click File sharing. **Note:** A hand will be placed under the icon.

3. Place a file in the folder.
4. On the desktop, double-click **My Network Places** and then **Computers Near Me**.
5. Double-click the workstation icon. The **test** folder should appear. You will be able to access this folder across the network. Once you are able to see it and work with the file, you have access through all 7 layers of the OSI model.

Task 5: Reflection

What could prevent a ping from being sent between the workstations when they are directly connected?

What could prevent the ping from being sent to the workstations when they are connected through the switch?

Lab 2.6.2: Using Wireshark™ to View Protocol Data Units

Learning Objectives

- Be able to explain the purpose of a protocol analyzer (Wireshark).
- Be able to perform basic PDU capture using Wireshark.
- Be able to perform basic PDU analysis on straightforward network data traffic.
- Experiment with Wireshark features and options such as PDU capture and display filtering.

Background

Wireshark is a software protocol analyzer, or "packet sniffer" application, used for network troubleshooting, analysis, software and protocol development, and education. Before June 2006, Wireshark was known as Ethereal.

A packet sniffer (also known as a network analyzer or protocol analyzer) is computer software that can intercept and log data traffic passing over a data network. As data streams travel back and forth over the network, the sniffer "captures" each protocol data unit (PDU) and can decode and analyze its content according to the appropriate RFC or other specifications.

Wireshark is programmed to recognize the structure of different network protocols. This enables it to display the encapsulation and individual fields of a PDU and interpret their meaning.

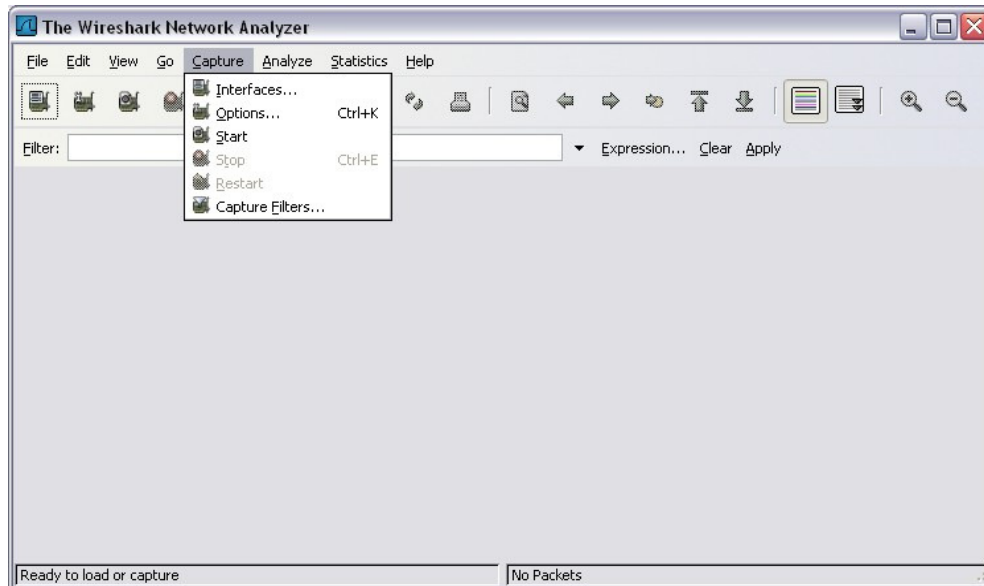
It is a useful tool for anyone working with networks and can be used with most labs in the CCNA courses for data analysis and troubleshooting.

For information and to download the program go to - <http://www.Wireshark.org>

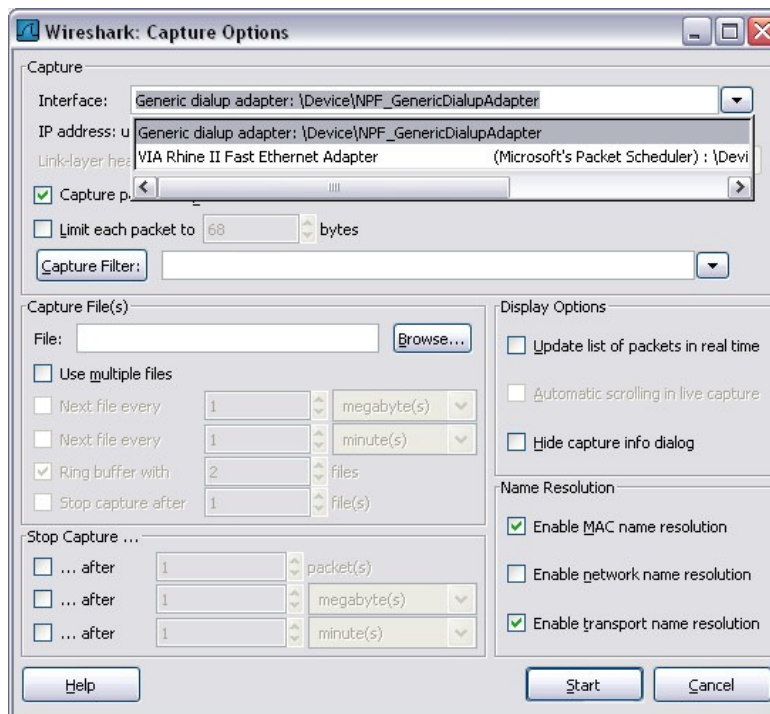
Scenario

To capture PDUs the computer on which Wireshark is installed must have a working connection to the network and Wireshark must be running before any data can be captured.

When Wireshark is launched, the screen below is displayed.

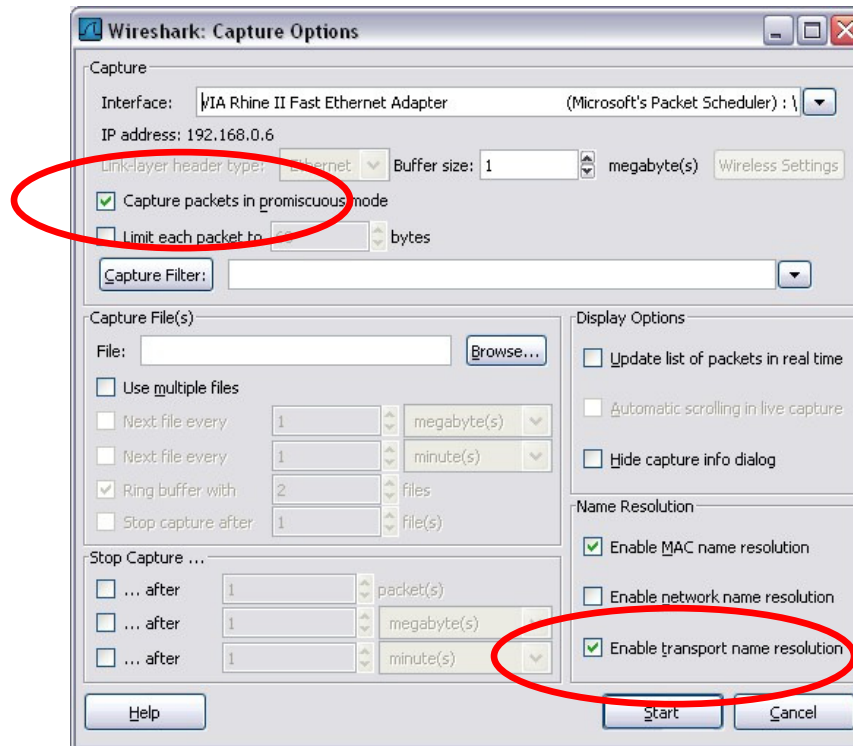


To start data capture it is first necessary to go to the **Capture** menu and select the **Options** choice. The **Options** dialog provides a range of settings and filters which determines which and how much data traffic is captured.



First, it is necessary to ensure that Wireshark is set to monitor the correct interface. From the **Interface** drop down list, select the network adapter in use. Typically, for a computer this will be the connected Ethernet Adapter.

Then other Options can be set. Among those available in **Capture Options**, the two highlighted below are worth examination.



Setting Wireshark to capture packets in promiscuous mode

If this feature is NOT checked, only PDUs destined for this computer will be captured.

If this feature is checked, all PDUs destined for this computer AND all those detected by the computer NIC on the same network segment (i.e., those that "pass by" the NIC but are not destined for the computer) are captured.

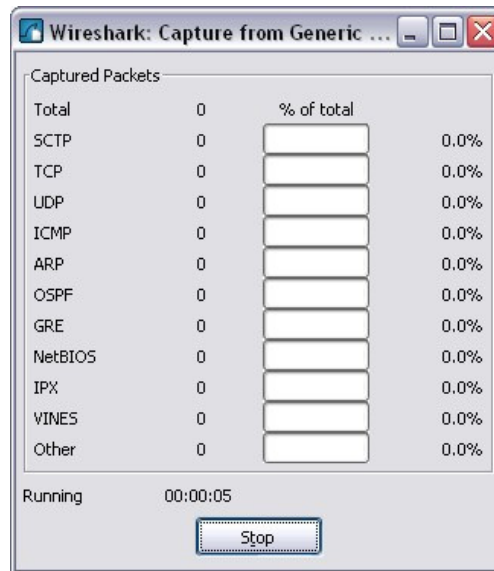
Note: The capturing of these other PDUs depends on the intermediary device connecting the end device computers on this network. As you use different intermediary devices (hubs, switches, routers) throughout these courses, you will experience the different Wireshark results.

Setting Wireshark for network name resolution

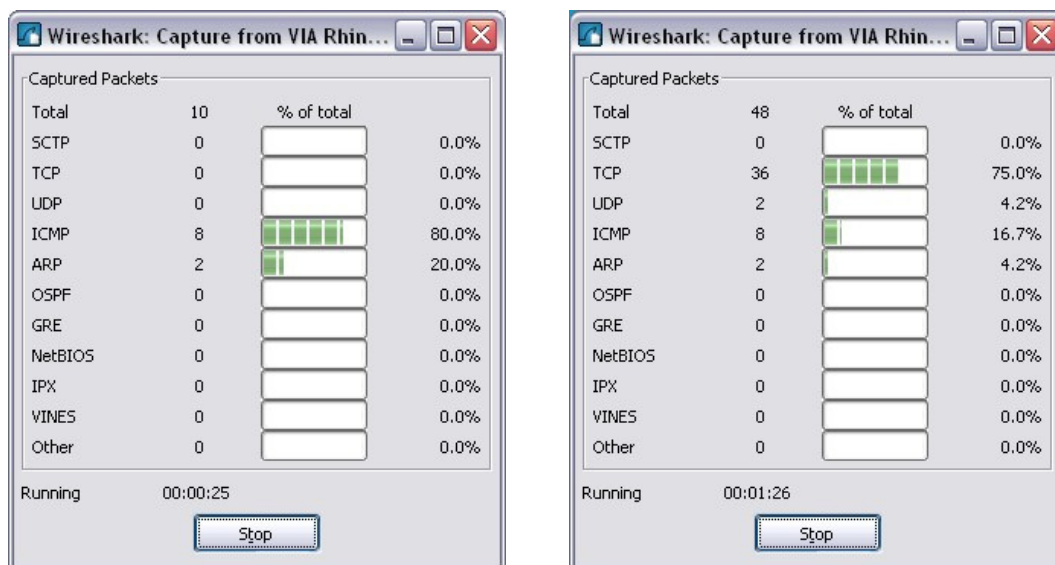
This option allows you to control whether or not Wireshark translates network addresses found in PDUs into names. Although this is a useful feature, the name resolution process may add extra PDUs to your captured data perhaps distorting the analysis.

There are also a number of other capture filtering and process settings available.

Clicking on the **Start** button starts the data capture process and a message box displays the progress of this process.



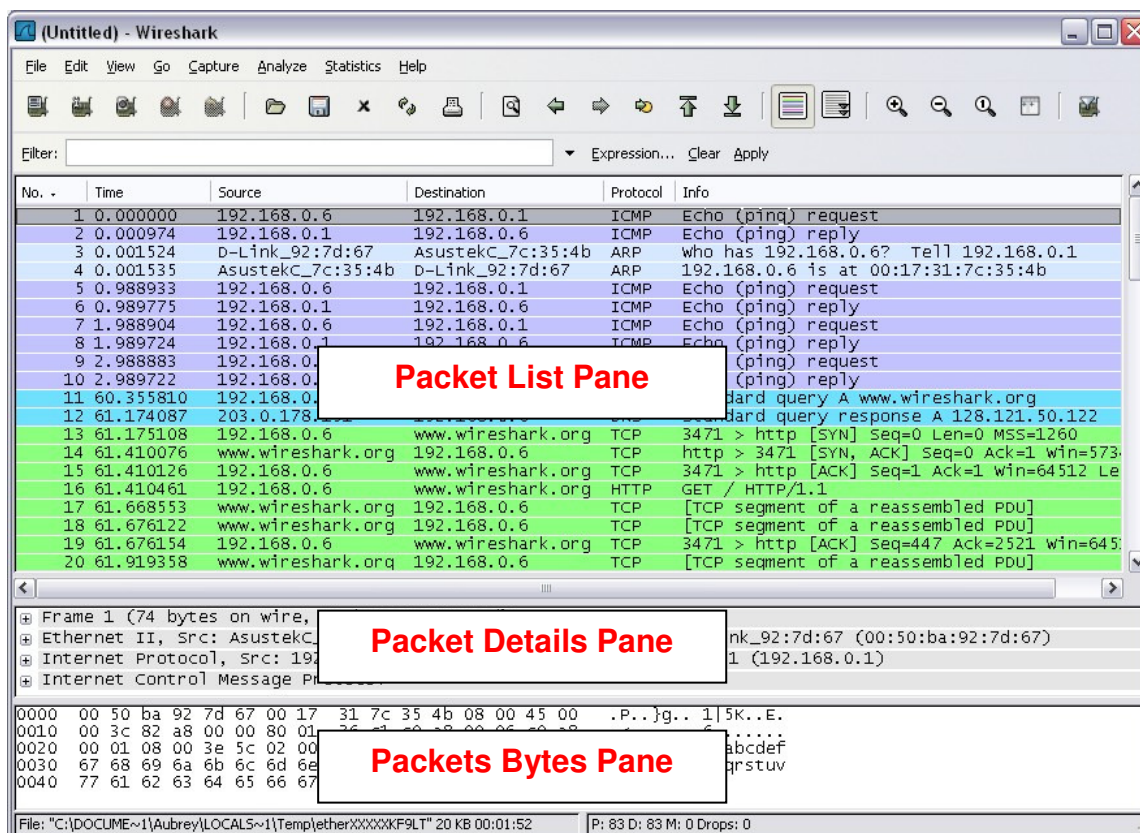
As data PDUs are captured, the types and number are indicated in the message box



The examples above show the capture of a ping process and then accessing a web page.

When the **Stop** button is clicked, the capture process is terminated and the main screen is displayed.

This main display window of Wireshark has three panes.



The PDU (or Packet) List Pane at the top of the diagram displays a summary of each packet captured. By clicking on packets in this pane, you control what is displayed in the other two panes.

The PDU (or Packet) Details Pane in the middle of the diagram displays the packet selected in the Packet List Pane in more detail.

The PDU (or Packet) Bytes Pane at the bottom of the diagram displays the actual data (in hexadecimal form representing the actual binary) from the packet selected in the Packet List Pane, and highlights the field selected in the Packet Details Pane.

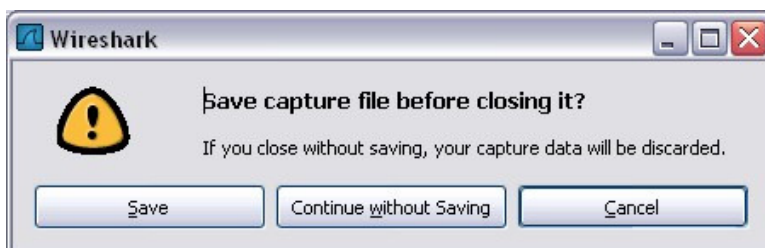
Each line in the Packet List corresponds to one PDU or packet of the captured data. If you select a line in this pane, more details will be displayed in the "Packet Details" and "Packet Bytes" panes. The example above shows the PDUs captured when the ping utility was used and <http://www.Wireshark.org> was accessed. Packet number 1 is selected in this pane.

The Packet Details pane shows the current packet (selected in the "Packet List" pane) in a more detailed form. This pane shows the protocols and protocol fields of the selected packet. The protocols and fields of the packet are displayed using a tree, which can be expanded and collapsed.

The Packet Bytes pane shows the data of the current packet (selected in the "Packet List" pane) in what is known as "hexdump" style. In this lab, this pane will not be examined in detail. However, when a more in-depth analysis is required this displayed information is useful for examining the binary values and content of PDUs.

The information captured for the data PDUs can be saved in a file. This file can then be opened in Wireshark for analysis some time in the future without the need to re-capture the same data traffic again. The information displayed when a capture file is opened is the same as the original capture.

When closing a data capture screen or exiting Wireshark you are prompted to save the captured PDUs.



Clicking on **Continue without Saving** closes the file or exits Wireshark without saving the displayed captured data.

Task 1: Ping PDU Capture

Step 1: After ensuring that the standard lab topology and configuration is correct, launch Wireshark on a computer in a lab pod.

Set the Capture Options as described above in the overview and start the capture process.

From the command line of the computer, ping the IP address of another network connected and powered on end device on in the lab topology. In this case, ping the Eagle Server at using the command ping **192.168.254.254**.

After receiving the successful replies to the ping in the command line window, stop the packet capture.

Step 2: Examine the Packet List pane.

The Packet List pane on Wireshark should now look something like this:

A screenshot of the Wireshark Packet List pane. It displays a table of captured packets with columns for No., Time, Source, Destination, Protocol, and Info. The packets are numbered 1 through 18. Packets 6, 7, 8, 9, 11, 12, 14, and 15 are highlighted in blue. The 'Info' column shows details for each packet, such as 'Spanning-tree-(for STP)', 'Broadcast', 'ARP', 'ICMP Echo (ping) request/reply', and 'CDP/VTP/DTP/PagP/U DTP'.

No.	Time	Source	Destination	Protocol	Info
1	0.000000	Cisco_9f:6c:c9	Spanning-tree-(for STP)	STP	Conf. Root = 32769/00:0f:f7:9f:6c:c0 Cost =
2	2.000032	Cisco_9f:6c:c9	Spanning-tree-(for STP)	STP	Conf. Root = 32769/00:0f:f7:9f:6c:c0 Cost =
3	4.000059	Cisco_9f:6c:c9	Spanning-tree-(for STP)	STP	Conf. Root = 32769/00:0f:f7:9f:6c:c0 Cost =
4	4.072858	QuantaCo_bd:0c:7c	Broadcast	ARP	who has 10.1.1.254? Tell 10.1.1.1
5	4.073609	Cisco_cf:66:40	QuantaCo_bd:0c:7c	ARP	10.1.1.254 is at 00:0c:85:cf:66:40
6	4.073626	10.1.1.1	192.168.254.254	ICMP	Echo (ping) request
7	4.074122	192.168.254.254	10.1.1.1	ICMP	Echo (ping) reply
8	5.067535	10.1.1.1	192.168.254.254	ICMP	Echo (ping) request
9	5.068007	192.168.254.254	10.1.1.1	ICMP	Echo (ping) reply
10	6.000113	Cisco_9f:6c:c9	Spanning-tree-(for STP)	STP	Conf. Root = 32769/00:0f:f7:9f:6c:c0 Cost =
11	6.067548	10.1.1.1	192.168.254.254	ICMP	Echo (ping) request
12	6.068019	192.168.254.254	10.1.1.1	ICMP	Echo (ping) reply
13	6.084103	Cisco_9f:6c:c9	Cisco_9f:6c:c9	LOOP	Reply
14	7.067603	10.1.1.1	192.168.254.254	ICMP	Echo (ping) request
15	7.068131	192.168.254.254	10.1.1.1	ICMP	Echo (ping) reply
16	8.000126	Cisco_9f:6c:c9	Spanning-tree-(for STP)	STP	Conf. Root = 32769/00:0f:f7:9f:6c:c0 Cost =
17	9.975700	Cisco_9f:6c:c9	CDP/VTP/DTP/PagP/U DTP	DTP	dynamic Trunking Protocol
18	10.000134	Cisco_9f:6c:c9	Spanning-tree-(for STP)	STP	Conf. Root = 32769/00:0f:f7:9f:6c:c0 Cost =

Look at the packets listed above; we are interested in packet numbers 6, 7, 8, 9, 11, 12, 14 and 15.

Locate the equivalent packets on the packet list on your computer.

If you performed Step 1A above match the messages displayed in the command line window when the ping was issued with the six packets captured by Wireshark.

From the Wireshark Packet List answer the following:

What protocol is used by ping? _____

What is the full protocol name? _____

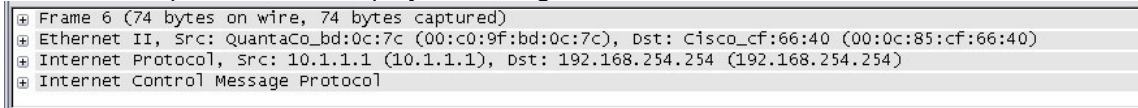
What are the names of the two ping messages? _____

Are the listed source and destination IP addresses what you expected? Yes / No

Why? _____

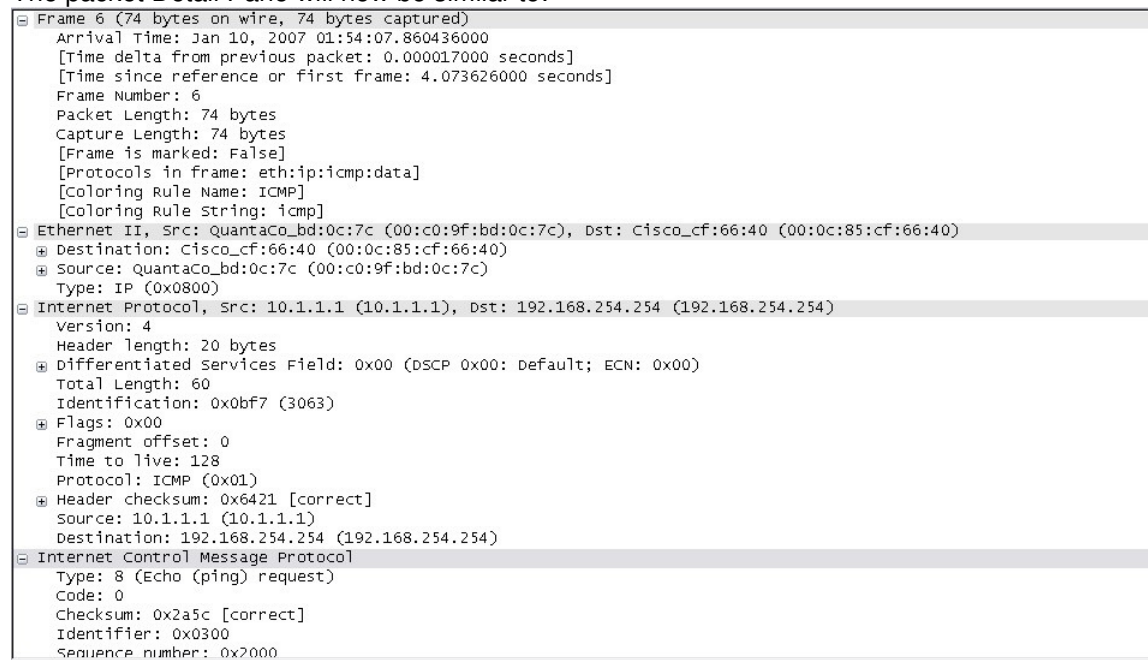
Step 3: Select (highlight) the first echo request packet on the list with the mouse.

The Packet Detail pane will now display something similar to:



Click on each of the four "+" to expand the information.

The packet Detail Pane will now be similar to:



As you can see, the details for each section and protocol can be expanded further. Spend some time scrolling through this information. At this stage of the course, you may not fully understand the information displayed but make a note of the information you do recognize.

Locate the two different types of "Source" and "Destination". Why are there two types?

What protocols are in the Ethernet frame?

As you select a line in the Packets Detail pane all or part of the information in the Packet Bytes pane also becomes highlighted.

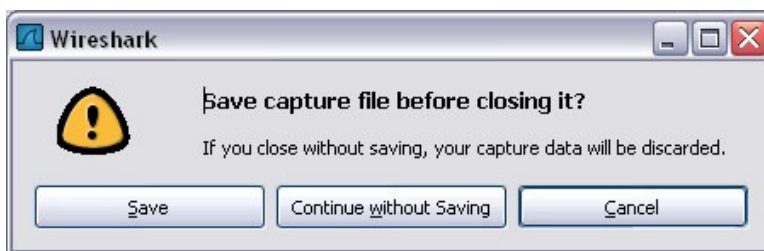
For example, if the second line (+ Ethernet II) is highlighted in the Details pane the Bytes pane now highlights the corresponding values.



This shows the particular binary values that represent that information in the PDU. At this stage of the course, it is not necessary to understand this information in detail.

Step 4: Go to the File menu and select Close.

Click on **Continue without Saving** when this message box appears.



Task 2: FTP PDU Capture

Step 1: Start packet capture.

Assuming Wireshark is still running from the previous steps, start packet capture by clicking on the **Start** option on the **Capture** menu of Wireshark.

At the command line on your computer running Wireshark, enter [ftp 192.168.254.254](ftp://192.168.254.254)

When the connection is established, enter **anonymous** as the user without a password.

Username: **anonymous**

Password: <ENTER>

You may alternatively use login with userid **cisco** and with password **cisco**.

When successfully logged in enter **get /pub/eagle_labs/eagle1/chapter1/gaim-1.5.0.exe** and press the enter key <ENTER>. This will start downloading the file from the ftp server. The output will look similar to:

```
C:\Documents and Settings\ccna1>ftp eagle-server.example.com
Connected to eagle-server.example.com.
220 Welcome to the eagle-server FTP service.
User (eagle-server.example.com:(none)): anonymous
331 Please specify the password.
Password:<ENTER>
230 Login successful.
ftp> get /pub/eagle_labs/eagle1/chapter1/gaim-1.5.0.exe
200 PORT command successful. Consider using PASV.
150 Opening BINARY mode data connection for
pub/eagle_labs/eagle1/chapter1/gaim-1.5.0.exe (6967072 bytes).
226 File send OK.
ftp: 6967072 bytes received in 0.59Seconds 11729.08Kbytes/sec.
```

When the file download is complete enter **quit**

```
ftp> quit
221 Goodbye.
C:\Documents and Settings\ccna1>
```

When the file has successfully downloaded, stop the PDU capture in Wireshark.

Step 2: Increase the size of the Wireshark Packet List pane and scroll through the PDUs listed.

Locate and note those PDUs associated with the file download.
These will be the PDUs from the Layer 4 protocol TCP and the Layer 7 protocol FTP.

Identify the three groups of PDUs associated with the file transfer.

| If you performed the step above, match the packets with the messages and prompts in the FTP command line window.

The first group is associated with the "connection" phase and logging into the server.
List examples of messages exchanged in this phase.

Locate and list examples of messages exchanged in the second phase that is the actual download request and the data transfer.

The third group of PDUs relate to logging out and "breaking the connection".
List examples of messages exchanged during this process.

Locate recurring TCP exchanges throughout the FTP process. What feature of TCP does this indicate?

Step 3: Examine Packet Details.

Select (highlight) a packet on the list associated with the first phase of the FTP process.
View the packet details in the Details pane.

What are the protocols encapsulated in the frame?

Highlight the packets containing the user name and password.
Examine the highlighted portion in the Packet Bytes pane.

What does this say about the security of this FTP login process?

Highlight a packet associated with the second phase.
From any pane, locate the packet containing the file name.

The filename is: _____

Highlight a packet containing the actual file content - note the plain text visible in the Bytes pane.

Highlight and examine, in the Details and Bytes panes, some packets exchanged in the third phase of the file download.

What features distinguish the content of these packets?

When finished, close the Wireshark file and continue without saving

Task 3: HTTP PDU Capture

Step 1: Start packet capture.

Assuming Wireshark is still running from the previous steps, start packet capture by clicking on the **Start** option on the **Capture** menu of Wireshark.

Note: Capture Options do not have to be set if continuing from previous steps of this lab.

Launch a web browser on the computer that is running Wireshark.
Enter the URL of the Eagle Server of **example.com** or enter the IP address-192.168.254.254. When the webpage has fully downloaded, stop the Wireshark packet capture.

Step 2: Increase the size of the Wireshark Packet List pane and scroll through the PDUs listed.

Locate and identify the TCP and HTTP packets associated with the webpage download.

Note the similarity between this message exchange and the FTP exchange.

Step 3: In the Packet List pane, highlight an HTTP packet that has the notation "(text/html)" in the Info column.

In the Packet Detail pane click on the "+" next to "**Line-based text data: html**"
When this information expands what is displayed?

Examine the highlighted portion of the Byte Panel.
This shows the HTML data carried by the packet.

When finished close the Wireshark file and continue without saving

Task 4: Reflection

Consider the encapsulation information pertaining to captured network data Wireshark can provide. Relate this to the OSI and TCP/IP layer models. It is important that you can recognize and link both the protocols represented and the protocol layer and encapsulation types of the models with the information provided by Wireshark.

Task 5: Challenge

Discuss how you could use a protocol analyzer such as Wireshark to:

- (1) Troubleshoot the failure of a webpage to download successfully to a browser on a computer.
and
- (2) Identify data traffic on a network that is requested by users.

Task 6: Cleanup

Unless instructed otherwise by your instructor, exit Wireshark and properly shutdown the computer.

Activity 3.4.1: Data Stream Capture

Learning Objectives

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

- Capture or download an audio stream
- Record the characteristics of the file
- Examine data transfer rates associated with the file

Background

When an application creates a file, the data that comprises that file must be stored somewhere. The data can be stored on the end device where it was created, or it can be transferred for storage on another device.

In this activity, you will use a microphone and Microsoft Sound Recorder to capture an audio stream. Microsoft Sound Recorder is a Windows accessory that can be found in Windows XP at **Start > Programs > Accessories > Entertainment > Sound Recorder**. If a microphone and Microsoft Sound Recorder are not available, you can download an audio file to use in this activity from http://newsroom.cisco.com/dlls/podcasts/audio_feeds.html.

Scenario

This activity is to be performed on a computer that has a microphone and Microsoft Sound Recorder or Internet access so that an audio file can be downloaded.

Estimated completion time, depending on network speed, is 30 minutes.

Task 1: Create a Sound File

Step 1: Open the Windows Sound Recorder application.

The application can be found in Windows XP at **Start > Programs > Accessories > Entertainment > Sound Recorder**. The Sound Recorder interface is shown in Figure 1.

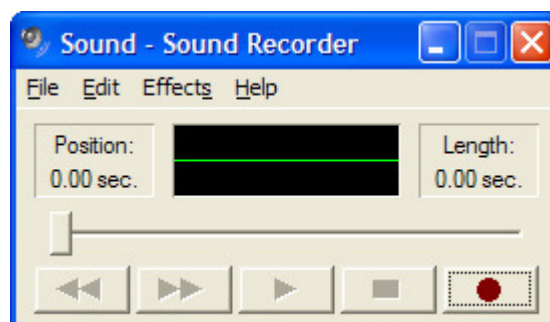


Figure 1. The Sound Recorder Interface

Step 2: Record an audio file.

1. To begin recording, click the Record button on the Sound Recorder interface.
2. Speak into the microphone, or create sounds that can be picked up by the microphone. As the audio is recorded, the waveform of the sound should appear on the Sound Recorder interface, as shown in Figure 2.



Figure 2. Recording in Progress

3. Click the Stop button when you are finished.

Step 3: Check the audio file that was recorded.

1. Press the Play button to listen to the recording. The recording that you have made should be played back, as shown in Figure 3.



Figure 3. Playback

If you are unable to hear the recording, check the configuration of the microphone, speakers, and volume settings, and attempt to create the recording again.

If you are unable to create a recording, download an audio file from News@Cisco at the following URL: http://newsroom.cisco.com/dlls/podcasts/audio_feeds.html

2. Save the audio file to the desktop and proceed to Task 2.

Step 4: Save the audio file.

1. Save the audio file that you have created to the desktop. Name the file **myaudio.wav**.
2. After the file is saved, close the Sound Recorder application.

Task 2: Observe the Properties of the Audio File

Step 1: View audio file properties.

Right-click the audio file that you saved to the desktop and click **Properties** from the popup menu.

What is the file size in kilobytes? _____

What is the file size in bytes? _____

What is the file size in bits? _____

Step 2: Open the audio file in Windows Media Player.

1. Right-click the audio file and select **Open With > Windows Media Player**.
2. When the file is open, right-click at the top of the Media Player interface and select **File > Properties** from the popup menu.

What is the length of the audio file in seconds? _____

Calculate the amount of data per second in the audio file and record the result. _____

Task 3: Reflection

Data files do not have to remain on the end devices where they are created. For example, you may want to copy the audio file that you created to another computer or a portable audio device.

If the audio file that you saved to the desktop were to be transferred at a rate of 100 megabits per second (Mbps), how long would it take for the file transfer to be completed?

Even with an Ethernet connection operating at 100 Mbps, the data that makes up a file is not transferred at this speed. All Ethernet frames contain other information, such as source and destination addresses, that is necessary for the delivery of the frame.

If 5% of the available 100 Mbps bandwidth is used up by the Ethernet overhead, and 95% of the bandwidth is left for the data payload, how long would it take for the file transfer to be completed?

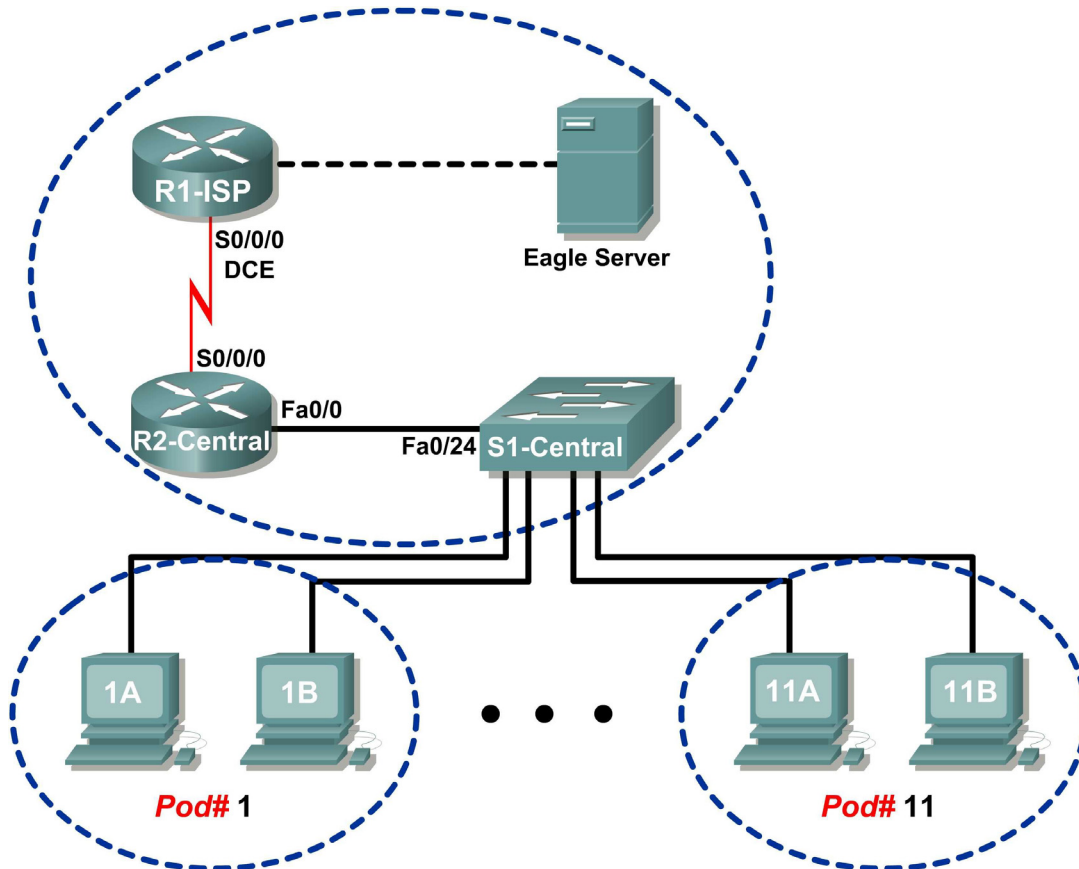
Task 4: Clean Up

You may be required to remove the audio file that you have saved from the computer. If so, delete the file from the desktop.

Unless instructed otherwise, turn off the computer.

Lab 3.4.2: Managing a Web Server

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16. Pod#. 1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16. Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Download, install, and verify a web server application
- Verify the default web server configuration file
- Capture and analyze HTTP traffic with Wireshark

Background

Web servers are an important part of the business plan for any organization with a presence on the Internet. Web browsers are used by consumers to access business web sites. However, web browsers are only half of the communication channel. The other half of the communication channel is web server support. Web server support is a valuable skill for network administrators. Based on a survey by Netcraft in January, 2007, the following table shows the top three web server applications by percent of use:

Web Server	Percent of use
Apache	60 %
Microsoft	31 %
Sun	1.6 %

Scenario

In this lab you will download, install, and configure the popular Apache web server. A web browser will be used to connect to the server, and Wireshark will be used to capture the communication. Analysis of the capture will help you understand how the HTTP protocol operates.

Task 1: Download, Install, and Verify the Apache Web Server.

The lab should be configured as shown in the Topology Diagram and logical address table. If it is not, ask the instructor for assistance before proceeding.

Step 1: Download the software from Eagle Server.

The Apache web server application is available for download from Eagle Server.

1. Use a web browser and URL ftp://eagle-server.example.com/pub/eagle_labs/eagle1/chapter3 to access and download the software. See Figure 1.



Figure 1. FTP Download Screen for the Apache Web Server

2. Right-click the file and save the software on the pod host computer.

Step 2: Install the Apache web server on the pod host computer.

1. Open the folder where the software was saved, and double-click the Apache file to begin installation. Choose default values and consent to the licensing agreement. The next installation step requires customized configuration of the web server, shown in Figure 2.

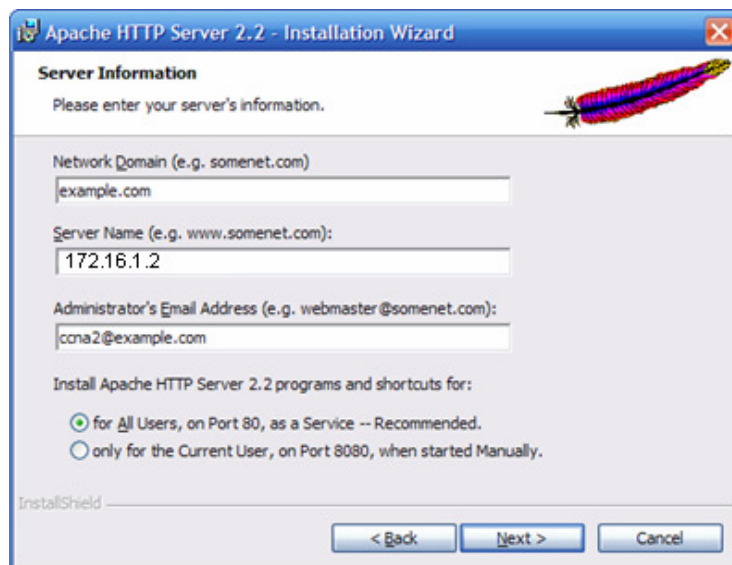


Figure 2. Customized Configuration Screen

Use the following values:

Information	Value
Network Domain	example.com
Server Name	IP address of computer
Administrator's E-mail Address	ccna*@example.com

* For example, for users 1 through 22, if the computer is on Pod 5, Host B, the administrator's e-mail number is ccna10@example.com

2. Accept the recommended port and service status. Click **Next**.
3. Accept the default typical installation, and click **Next**.

What is the default installation folder?

4. Accept the default installation folder, click **Next**, and then **Install**. When the installation has finished, close the screen.

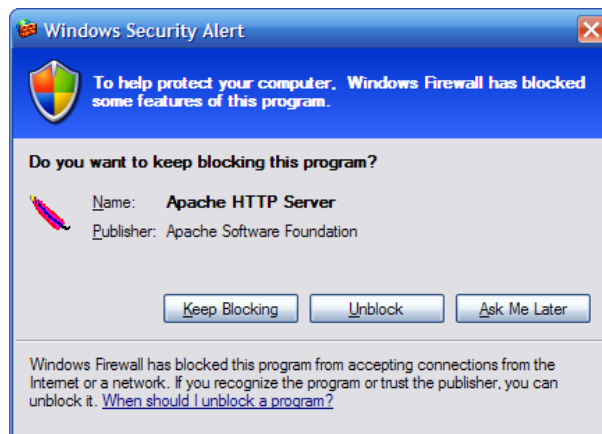


Figure 3. Windows Security Alert

Note: If a Windows Security Alert is displayed, select unblock. See Figure 3. This will permit connections to the web server.

Step 3: Verify the web server.

The **netstat** command will display protocol statistics and connection information for this lab computer.


1. Choose **Start > Run** and open a command line window. Type **cmd**, and then click **OK**. Use the **netstat -a** command to discover open and connected ports on your computer:

```
C:\>netstat -a
Active Connections
```

Proto	Local Address	Foreign Address	State
TCP	GW-desktop-hom:http	GW-desktop-hom:0	LISTENING
TCP	GW-desktop-hom:epmap	GW-desktop-hom:0	LISTENING
TCP	GW-desktop-hom:microsoft-ds	GW-desktop-hom:0	LISTENING
TCP	GW-desktop-hom:3389	GW-desktop-hom:0	LISTENING

<output omitted>
C:\>

2. Using the command **netstat -a**, verify that the web server is operating properly on the pod host computer.

The Apache web server monitor icon  should be visible on the lower right side of the screen, close to the time.

3. Open a web browser, and connect to the URL of your computer. A web page similar to Figure 4 will be displayed if the web server is working properly.

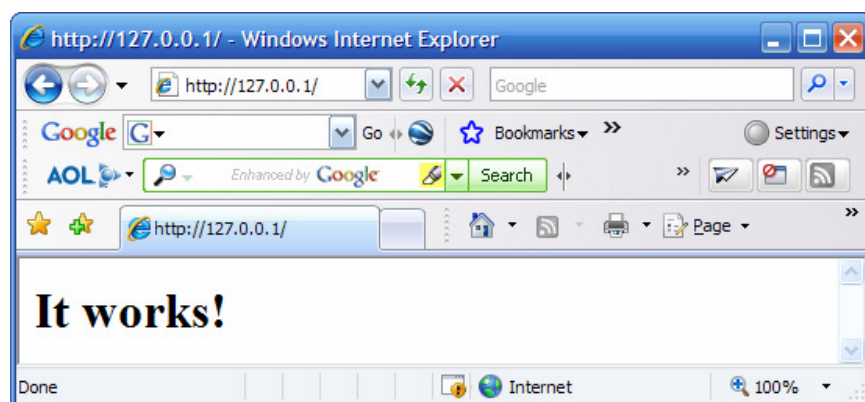


Figure 4. Web Server Default Page

The 127.0.0.0 / 8 network address is reserved and is used for local IP addresses. The same page should be displayed if the URL is changed to the IP address on the Ethernet interface or to any host IP address in the 127.0.0.0 / 8 network range.

4. Test the web server on several different IP addresses from the 127.0.0.0 / 8 network range. Fill in the following table with the results:

IP Address	Status	Explanation
127.0.0.1		
127.255.255.254		
127.255.255.255		
127.0.0.0		

Task 2: Verify the Default Web Server Configuration File.

Step 1: Access the `httpd.conf` file.

A system administrator may find the need to verify or modify the default configuration file.

Open the Apache web server configuration file, `C:\Program Files\Apache Software Foundation\Apache2.2\conf\httpd.conf`. See Figure 5.

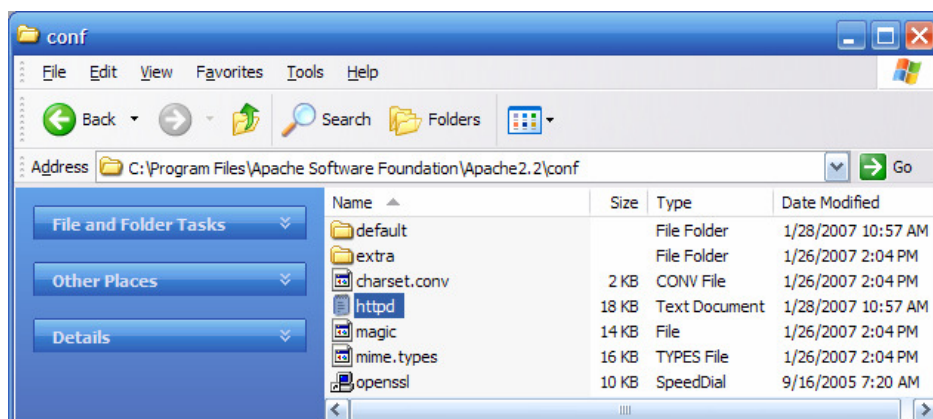


Figure 5. Apache Web Server Configuration File

Step 2: Review the `httpd.conf` file.

Numerous configuration parameters allow the Apache web server to be fully customizable. The “#” character indicates a comment for system administrators, exempt from access by the web server. Scroll down the configuration file, and verify the following settings:

Value	Meaning
<code>#Listen 12.34.56.78:80</code> <code>Listen 80</code>	Listen on TCP port 80 for all incoming connections. To accept connections from only this host, change the line to <code>Listen 127.0.0.1 80</code> .
<code>ServerAdmin ccna2@example.com</code>	If there are problems, e-mail the web server at this e-mail address.
<code>ServerName 172.16.1.2:80</code>	For servers without DNS names, use the IP address:port number.
<code>DocumentRoot "C:/Program Files/Apache Software Foundation/Apache2.2/htdocs"</code>	This is the root directory for the web server.
<code><IfModule dir_module></code> <code> DirectoryIndex index.html</code> <code></IfModule></code>	<code>DirectoryIndex</code> sets the file that Apache will serve if a directory is requested. If no page is requested from that directory, display <code>index.html</code> if it is present.

Step 3: Modify the web server default page.

Figure 4 shows the default web page from file `index.html`. Although this page is sufficient for testing, something more personal should be displayed.

1. Open folder `C:\Program Files\Apache Software Foundation\Apache2.2\htdocs`. The file `index.html` should be present. Right-click the file, and choose **Open With**. From the pull-down list, choose **notepad**. Change the file content to something similar to the following example:

```
<html><body><h1>Welcome to the Pod1HostB Web Server!!!</h1>
<center><b>
Operated by me!
</center></b>
Contact web administrator: ccna2@example.com
</body></html>
```

2. Save the file, and refresh the web browser. Or, open URL <http://127.0.0.1>. The new default page should be displayed. As changes to `index.html` are made and saved, simply refresh the web browser to view the new content.

Task 3: Capture and Analyze HTTP Traffic with Wireshark.

Wireshark will not capture packets sent from or to the 127.0.0.0 network on a Windows computer. The interface will not display. To complete this task, connect to either a student's computer or Eagle Server and analyze the data exchange.

Step 1: Analyze HTTP traffic.

1. Start Wireshark, and set the capture interface to the interface bound to the 172.16 network. Open a web browser, and connect to another computer with an active web server.

Why does `index.html` *not* have to be entered in the URL for the file contents to be displayed?

2. Deliberately enter a web page that is not on the web server, as shown in Figure 6. Note that an error message is displayed in the web browser.



Figure 6. 404 Not Found Error

Figure 7 contains a captured HTTP session. File index.htm was requested from the web server, but the server did not have the file. Instead, the server sent a **404** error. The web browser simply displayed the server response “The page cannot be found”.

No. -	Time	Source	Destination	Protocol	Info
20	14.384747	172.16.1.2	172.16.1.1	TCP	1149 > http [SYN] Seq=0 Len=0 MSS=1460
21	14.384993	172.16.1.1	172.16.1.2	TCP	http > 1149 [SYN, ACK] Seq=0 Ack=1 win=65535 Len=0 MSS=1460
22	14.385030	172.16.1.2	172.16.1.1	TCP	1149 > http [ACK] Seq=1 Ack=1 win=64240 Len=0
23	14.388292	172.16.1.2	172.16.1.1	HTTP	GET /index.htm HTTP/1.1
24	14.389299	172.16.1.1	172.16.1.2	HTTP	HTTP/1.1 404 Not Found (text/html)
25	14.541723	172.16.1.2	172.16.1.1	TCP	1149 > http [ACK] Seq=256 Ack=423 win=63818 Len=0

Figure 7. Wireshark Capture of HTTP Traffic

3. Highlight the capture line with the 404 error, and move into the second (middle) Wireshark window. Expand the line-based text-data record.

What are the contents?

Task 4: Challenge

Modify the default web server configuration file `httpd.conf` and change the `Listen 80` line to `Listen 8080`. Open a web browser and access URL <http://127.0.0.1:8080>. Verify with the `netstat` command that the new web server TCP port is 8080.

Task 5: Reflection

Web servers are an important component of e-commerce. Depending on the organization, the network or web administrator has the responsibility of maintaining the corporate web server. This lab demonstrated how to install and configure the Apache web server, test for proper operation, and identify several key configuration parameters.

The student modified the default web page `index.html` and observed the effect on the web browser output.

Finally, Wireshark was used to capture an HTTP session of a file not found. The web server responded with an HTTP 1.1 error 404 and returned a file not found message to the web browser.

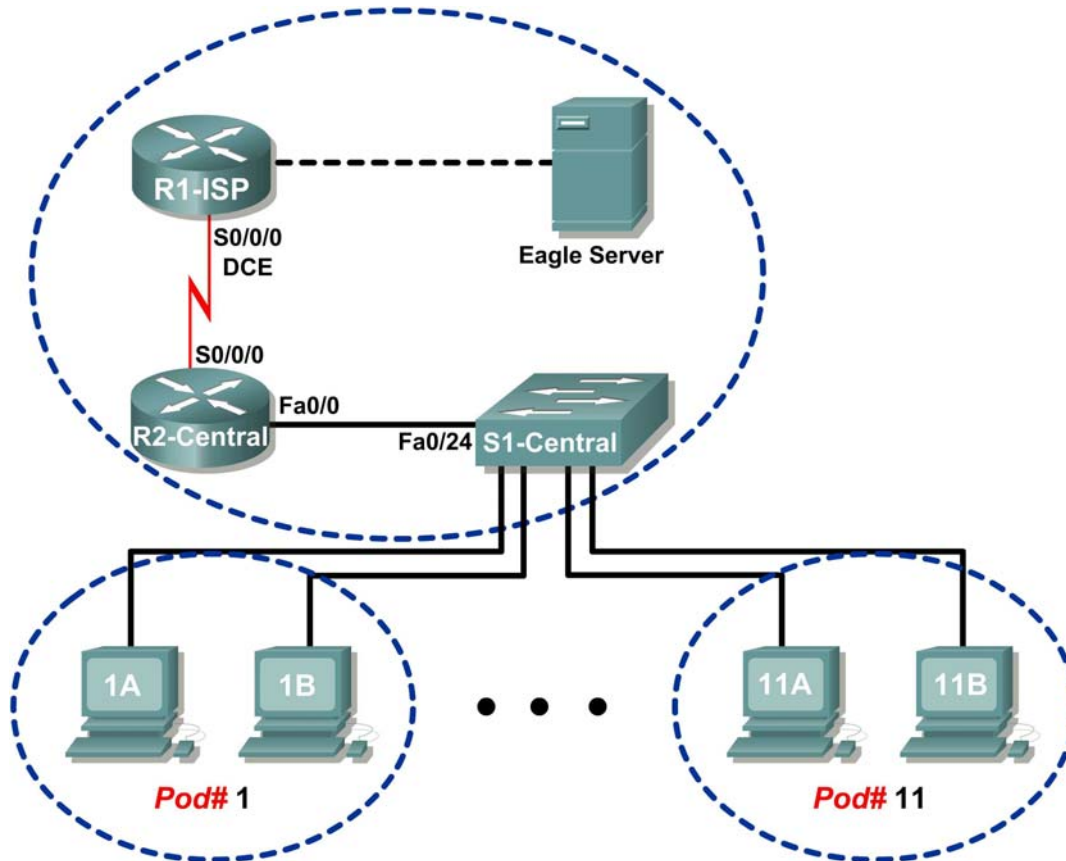
Task 6: Clean Up

During this lab the Apache web server was installed on the pod host computer. It should be uninstalled. To uninstall the web server, click **Start > Control Panel > Add or Remove Programs**. Click **Apache Web Server**, and then click **Remove**.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 3.4.3: E-mail Services and Protocols

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	10.10.10.6
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16. Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16. Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Configure the pod host computer for e-mail service
- Capture and analyze e-mail communication between the pod host computer and a mail server

Background

E-mail is one of the most popular network services that uses a client/server model. The e-mail client is configured on a user's computer, and configured to connect to an e-mail server. Most Internet service providers (ISPs) provide step-by-step instructions for using e-mail services; consequently, the typical user may be unaware of the complexities of e-mail or the protocols used.

In network environments where the MUA client must connect to an e-mail server on another network to send and receive e-mail, the following two protocols are used:

- Simple Mail Transfer Protocol (SMTP) was originally defined in RFC 821, August, 1982, and has undergone many modifications and enhancements. RFC 2821, April, 2001, consolidates and updates previous e-mail -related RFCs. The SMTP server listens on well-known TCP port 25. SMTP is used to send e-mail messages from the external e-mail client to the e-mail server, deliver e-mail to local accounts, and relay e-mail between SMTP servers.
- Post Office Protocol version 3 (POPv3) — is used when an external e-mail client wishes to receive e-mail messages from the e-mail server. POPv3 servers listen on well-known TCP port 110.
- **Internet Message Access Protocol (IMAP)**—An Internet protocol that allows a central server to provide remote access to e-mail messages. IMAP servers listen on well-known TCP port 143.

In this lab, you will use IMAP instead of POP for e-mail delivery to the client.

Earlier versions of both protocols should not be used. Also, there are secure versions of both protocols that employ secure socket layers/Transport layer security (SSL/TSL) for communication.

E-mail is subject to multiple computer security vulnerabilities. Spam attacks flood networks with useless, unsolicited e-mail, consuming bandwidth and network resources. E-mail servers have had numerous vulnerabilities, which left the computer open to compromise.

Scenario

In this lab, you will configure and use an e-mail client application to connect to eagle-server network services. You will monitor the communication with Wireshark and analyze the captured packets.

An e-mail client such as Outlook Express or Mozilla Thunderbird will be used to connect to the eagle-server network service. Eagle-server has SMTP mail services preconfigured, with user accounts capable of sending and receiving external e-mail messages.

Task 1: Configure the Pod Host Computer for E-mail Service.

The lab should be configured as shown in the Topology Diagram and logical address table. If it is not, ask the instructor for assistance before proceeding.

Step 1: Download and install Mozilla Thunderbird.

If Thunderbird is not installed on the pod host computer, it can be downloaded from eagle-server.example.com. See Figure 1. The download URL is ftp://eagle-server.example.com/pub/eagle_labs/eagle1/chapter3/.

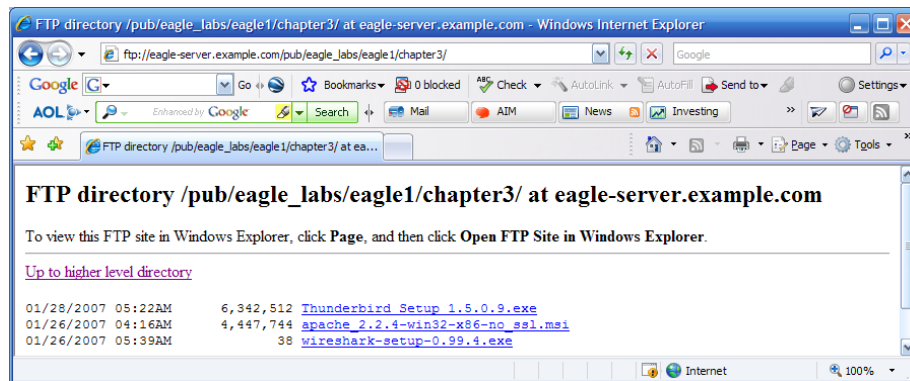


Figure 1. FTP Download for Wireshark

1. Double click the Thunderbird filename, and then select Save to save the file to the host pod computer.

Note: Depending on the connection speed of the link between the two routers and the number of students downloading the file, this download may be slow.

2. When the file has downloaded, double-click the filename, accept the software license, and install Thunderbird with the default settings.
3. When installation is complete, start Thunderbird.

Step 2: Configure Thunderbird to receive and send e-mail messages.

1. If prompted for Import Options, select “Don’t import anything” and select Next
2. When Thunderbird starts, e-mail account settings must be configured. In the New Account Setup, select “**Email account**” and select **Next**.
3. As prompted, fill in the Account information as follows:

Field	Value
Account Name	The account name is based on the pod and host computer. There are a total of 22 accounts configured on Eagle Server, labeled ccna[1..22]. If this pod host is on Pod1, Host A, then the account name is ccna1. If the pod host is on Pod 3, Host B, then the account name is ccna6. And so on.
Your Name	Use the same name as above.
E-mail address	Your_name@example.com
Type of incoming server you are using	IMAP
Incoming Server (IMAP)	Eagle-server.example.com
Outgoing Server (SMTP)	Eagle-server.example.com
Incoming User Name	Use the same name as above.
Account Name	Your_name@eagle-server.example.com

4. When Thunderbird starts, you may be prompted for a password for your email account. At this screen select **"Cancel"**

The Thunderbird client needs to have SMTP server login disabled. To do this, select **Tools > Account Settings>Outgoing Server (SMTP)**. Then from the Outgoing server screen, select **Edit**. See figure 2.

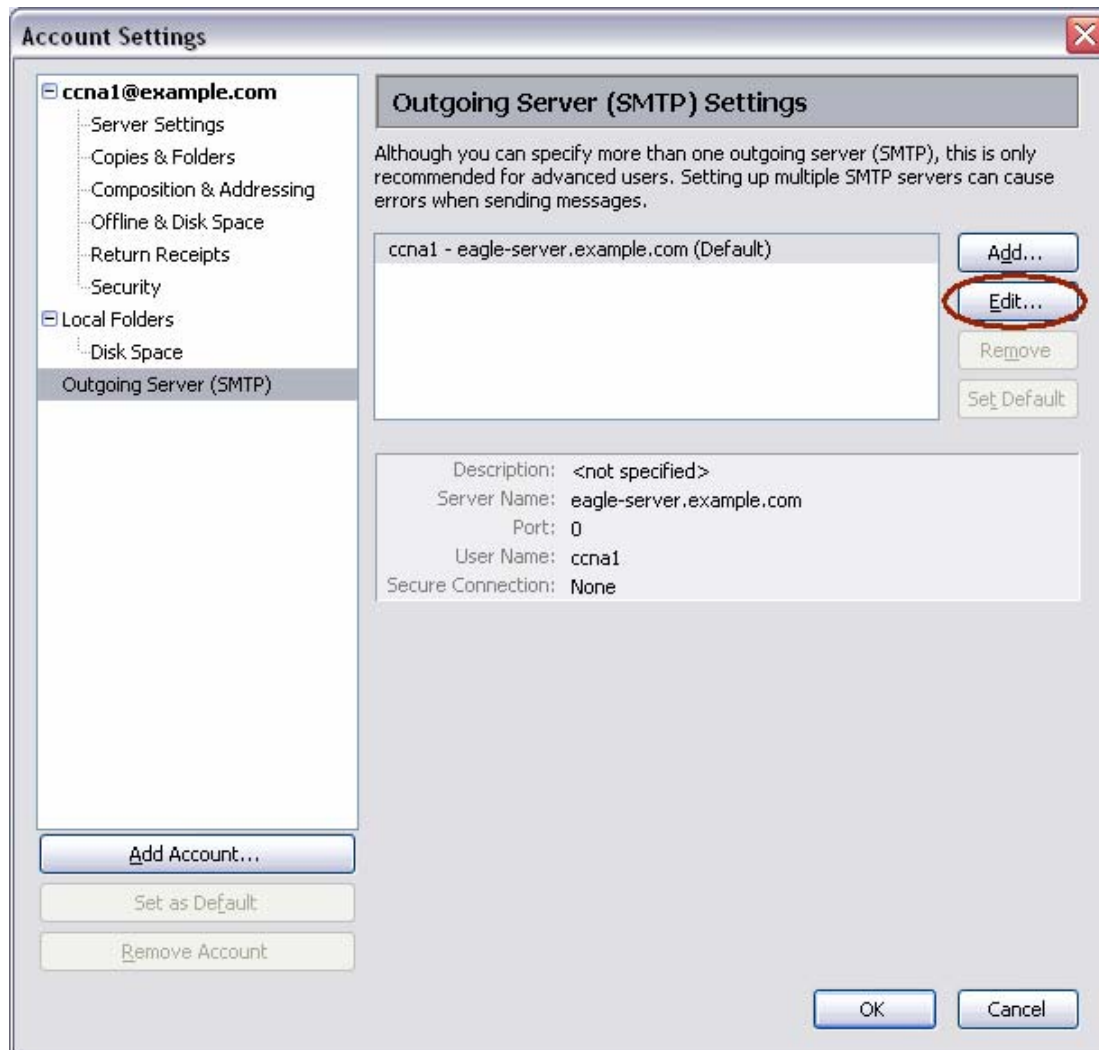


Figure 2. Thunderbird SMTP server settings

At the SMTP Server screen, uncheck the **"Use name and password"** box and select **OK** at the two screens. See Figure 3.

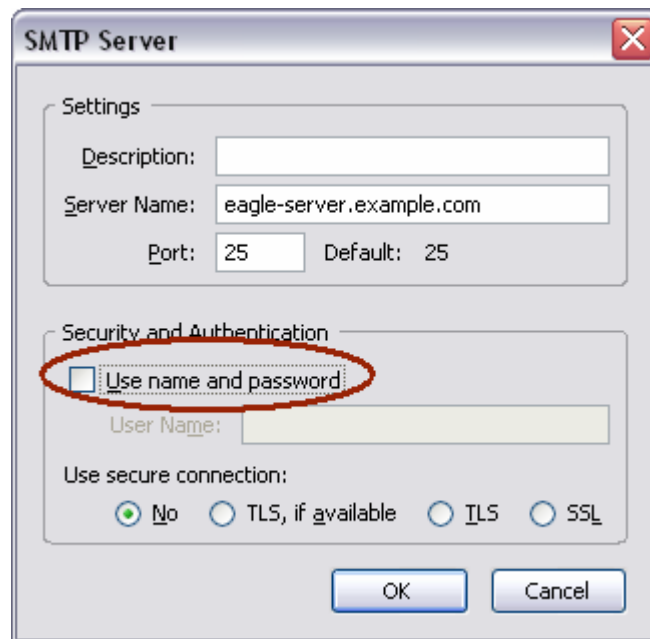


Figure 3. SMTP server edit

5. You may also want to verify account settings from **Tools > Account Settings**. See Figure 4.

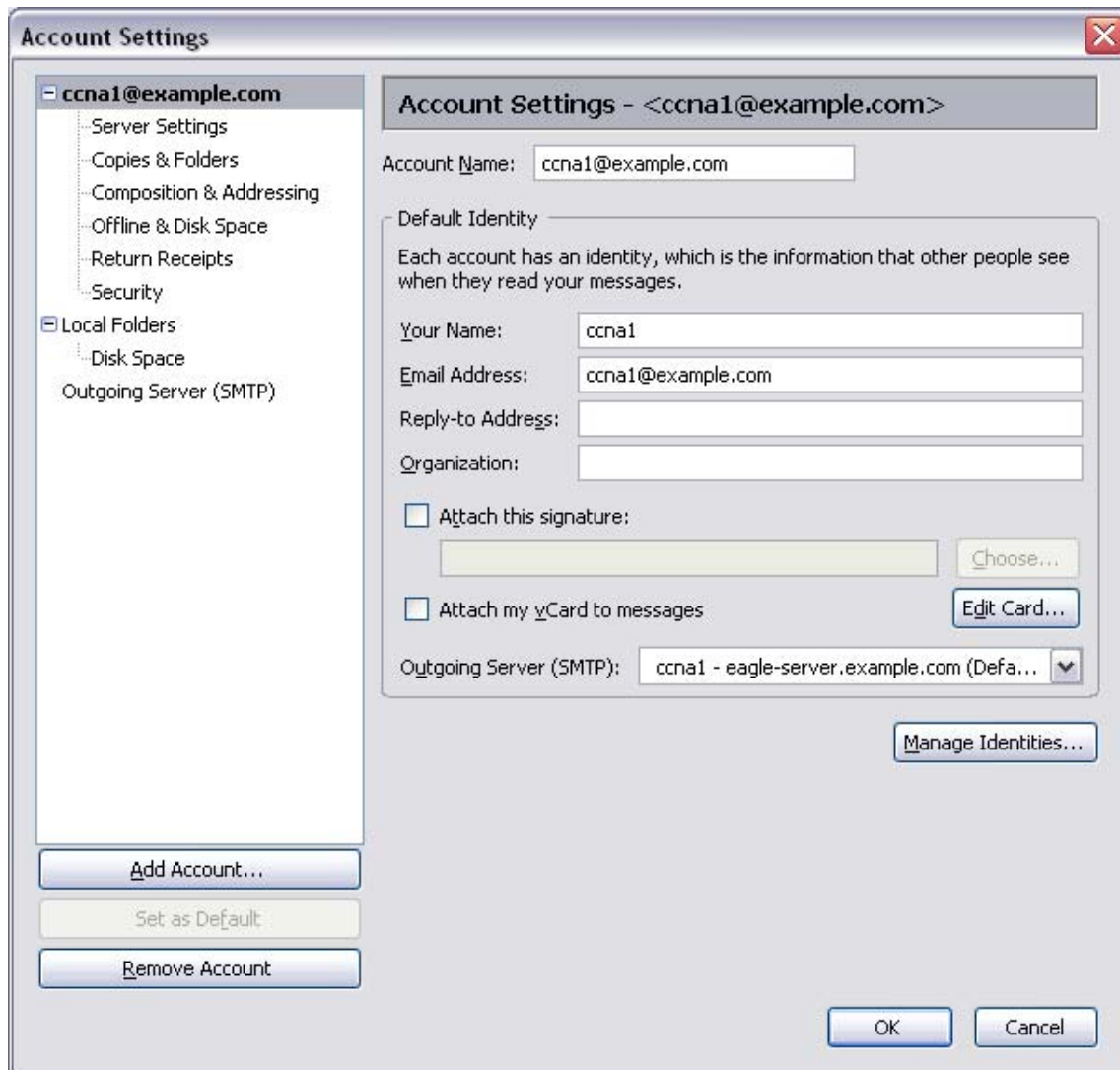


Figure 4. Thunderbird Account Settings

6. In the left pane of the Account Settings screen, click **Server Settings**. A screen similar to the one shown in Figure 5 will be displayed.

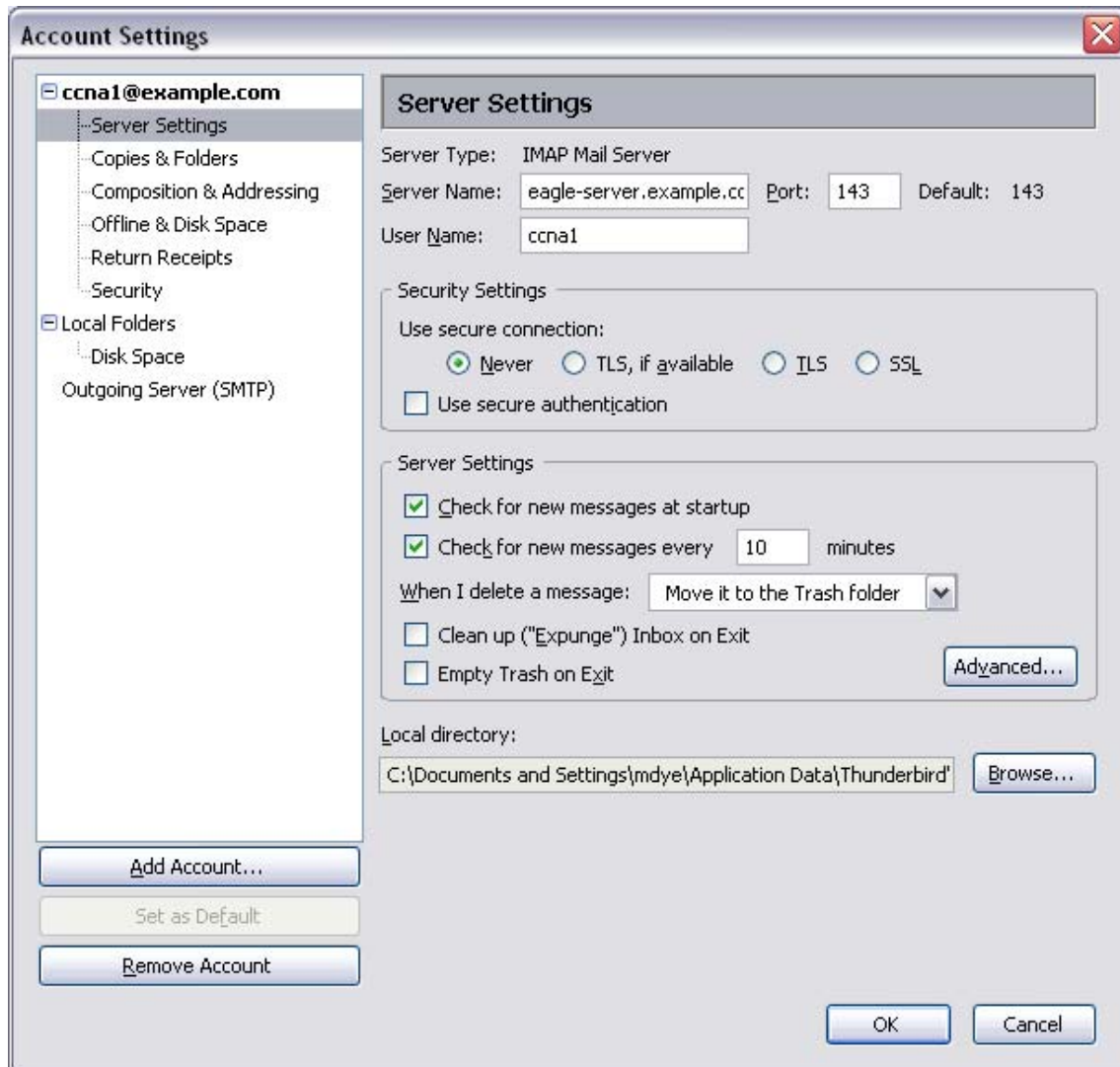


Figure 5. Thunderbird Server Settings Screen

What is the purpose of the SMTP protocol, and what is the well-known TCP port number?

Task 2: Capture and Analyze E-mail Communication between the Pod Host Computer and an E-mail Server.

Step 1: Send an e-mail.

1. Ask another student in the class for his or her e-mail name.
2. To create and send an email, select the "Write" icon. Using this name, each of you should compose and send an e-mail message to each other.
3. When the emails have been sent, check your email. In order to check your email, you must be logged in. If you have not previously logged in, enter **cisco** as the password. Please note that this is the default password which is embedded within the Eagle server.

Step 2: Start Wireshark captures.

When you are certain that the e-mail operation is working properly for both sending and receiving, start a Wireshark capture. Wireshark will display captures based on packet type.

Step 3: Analyze a Wireshark capture session of SMTP.

1. Using the e-mail client, again send and receive e-mail to a classmate. This time, however, the e-mail transactions will be captured.
2. After sending and receiving one e-mail message, stop the Wireshark capture. A partial Wireshark capture of an outgoing e-mail message using SMTP is shown in Figure 6.

No. -	Time	Source	Destination	Protocol	Info
1	0.000000	172.16.1.1	172.16.255.255	NBNS	Name query NB WORKGROUP<1b>
2	0.741371	172.16.1.1	172.16.255.255	NBNS	Name query NB WORKGROUP<1b>
3	1.492443	172.16.1.1	172.16.255.255	NBNS	Name query NB WORKGROUP<1b>
4	3.306445	172.16.1.1	192.168.254.254	TCP	1250 > smtp [SYN] Seq=0 Len=0 MSS=1460
5	3.306968	192.168.254.254	172.16.1.1	TCP	smtp > 1250 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460
6	3.307012	172.16.1.1	192.168.254.254	TCP	1250 > smtp [ACK] Seq=1 Ack=1 Win=64240 Len=0
7	3.313519	192.168.254.254	172.16.1.1	SMTP	Response: 220 localhost.localdomain ESMTP Sendmail 8.13.1/8.13
8	3.353004	172.16.1.1	192.168.254.254	SMTP	Command: EHLO [172.16.1.1]
9	3.353436	192.168.254.254	172.16.1.1	TCP	smtp > 1250 [ACK] Seq=90 Ack=20 Win=5840 Len=0
10	3.353657	192.168.254.254	172.16.1.1	SMTP	Response: 250-localhost.localdomain Hello host-1.example.com [172.16.1.1]
11	3.356823	172.16.1.1	192.168.254.254	SMTP	Command: MAIL FROM:<ccna1@example.com> SIZE=398
12	3.359743	192.168.254.254	172.16.1.1	SMTP	Response: 250 2.1.0 <ccna1@example.com>... Sender ok
13	3.363127	172.16.1.1	192.168.254.254	SMTP	Command: RCPT TO:<ccna2@example.com>
14	3.365007	192.168.254.254	172.16.1.1	SMTP	Response: 250 2.1.5 <ccna2@example.com>... Recipient ok
15	3.367680	172.16.1.1	192.168.254.254	SMTP	Command: DATA
16	3.368230	192.168.254.254	172.16.1.1	SMTP	Response: 354 Enter mail, end with "." on a line by itself
17	3.376881	172.16.1.1	192.168.254.254	SMTP	Message Body
18	3.387830	192.168.254.254	172.16.1.1	SMTP	Response: 250 2.0.0 1088dIOY005299 Message accepted for delivery
19	3.395347	172.16.1.1	192.168.254.254	SMTP	Message Body
20	3.395855	192.168.254.254	172.16.1.1	SMTP	Response: 221 2.0.0 localhost.localdomain closing connection
21	3.395897	192.168.254.254	172.16.1.1	TCP	smtp > 1250 [FIN, ACK] Seq=564 Ack=502 Win=6432 Len=0
22	3.395929	172.16.1.1	192.168.254.254	TCP	1250 > smtp [ACK] Seq=502 Ack=565 Win=63677 Len=0
23	3.405772	172.16.1.1	192.168.254.254	TCP	1250 > smtp [FIN, ACK] Seq=502 Ack=565 Win=63677 Len=0
24	3.406204	192.168.254.254	172.16.1.1	TCP	smtp > 1250 [ACK] Seq=565 Ack=503 Win=6432 Len=0

Figure 6. SMTP Capture

3. Highlight the first SMTP capture in the top Wireshark window. In Figure 6, this is line number 7.
4. In the second Wireshark window, expand the Simple Mail Transfer Protocol record.

There are many different types of SMTP servers. Malicious attackers can gain valuable knowledge simply by learning the SMTP server type and version.

What is the SMTP server name and version?

E-mail client applications send commands to e-mail servers, and e-mail servers send responses. In every first SMTP exchange, the e-mail client sends the command **EHLO**. The syntax may vary between clients, however, and the command may also be **HELO** or **HELLO**. The e-mail server must respond to the command.

What is the SMTP server response to the EHLO command?

The next exchanges between the e-mail client and server contain e-mail information. Using your Wireshark capture, fill in the e-mail server responses to the e-mail client commands:

E-mail Client	E-mail Server
MAIL FROM: ,ccna1@example.com>	
RCPT TO: <ccna2@example.com>	
DATA	
(message body is sent)	

What are the contents of the last message body from the e-mail client?

How does the e-mail server respond?

Task 3: Challenge

Access a computer that has Internet access. Look up the SMTP server name and version for known weaknesses or compromises. Are there any newer versions available?

Task 4: Reflection

E-mail is probably the most common network service used. Understanding the flow of traffic with the SMTP protocol will help you understand how the protocol manages the client/server data connection. E-mail can also experience configuration issues. Is the problem with the e-mail client or e-mail server? One simple way to test SMTP server operation is to use the Windows command line Telnet utility to telnet into the SMTP server.

1. To test SMTP operation, open the Windows command line window and begin a Telnet session with the SMTP server.

```
C:\>telnet eagle-server.example.com 25
220 localhost.localdomain ESMTP Sendmail 8.13.1/8.13.1; Sun, 28 Jan
2007 20:41:0
3 +1000
HELO eagle-server.example.com
250 localhost.localdomain Hello [172.16.1.2], pleased to meet you
MAIL From: ccna2@example.com
250 2.1.0 ccna2@example.com... Sender ok
RCPT To: instructor@example.com
250 2.1.5 instructor@example.com... Recipient ok
DATA
354 Please start mail input.
e-mail SMTP server test...
.
250 Mail queued for delivery.
QUIT
221 Closing connection. Good bye.
Connection to host lost.
C:\ >
```

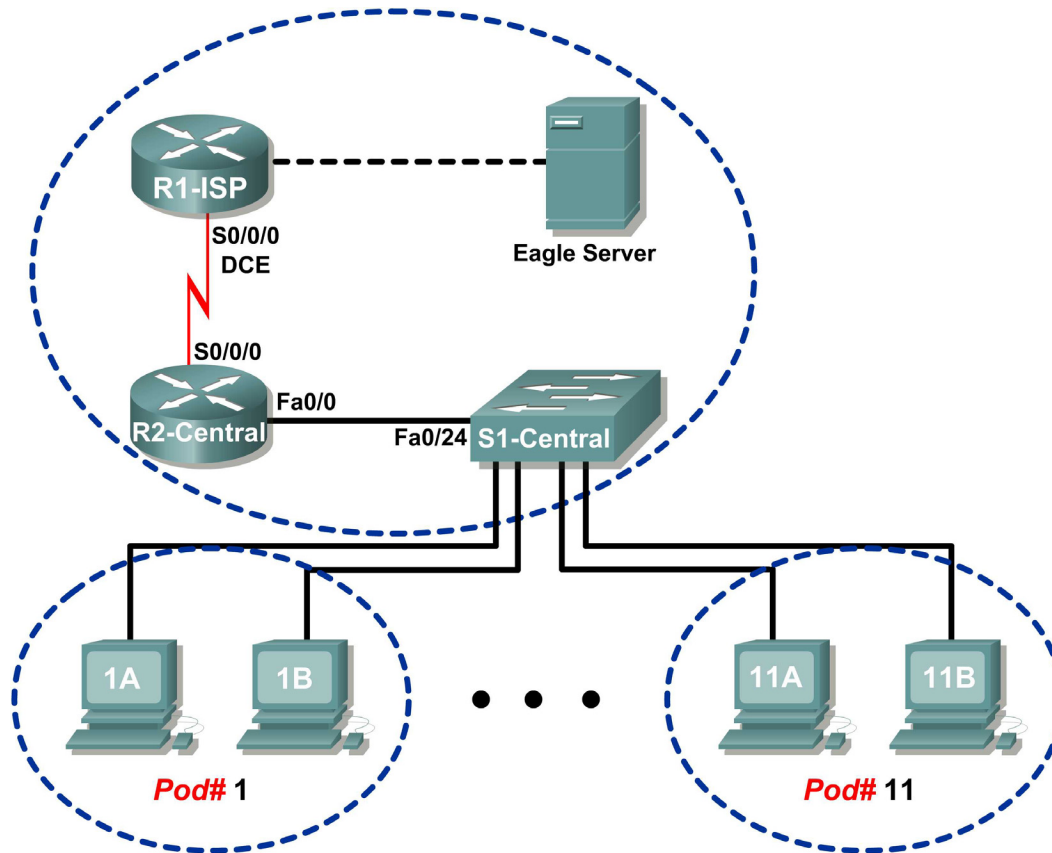
Task 5: Clean Up

If Thunderbird was installed on the pod host computer for this lab, the instructor may want the application removed. To remove Thunderbird, click **Start > Control Panel > Add or Remove Programs**. Scroll to and click **Thunderbird**, and then click **Remove**.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 4.5.1: Observing TCP and UDP using Netstat

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16.Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16.Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

- Explain common **netstat** command parameters and outputs.
- Use **netstat** to examine protocol information on a pod host computer.

Background

netstat is an abbreviation for the network statistics utility, available on both Windows and Unix / Linux computers. Passing optional parameters with the command will change output information. **netstat** displays incoming and outgoing network connections (TCP and UDP), host computer routing table information, and interface statistics.

Scenario

In this lab the student will examine the **netstat** command on a pod host computer, and adjust **netstat** output options to analyze and understand TCP/IP Transport Layer protocol status.

Task 1: Explain common **netstat** command parameters and outputs.

Open a terminal window by clicking on Start | Run. Type **cmd**, and press **OK**.

To display help information about the **netstat** command, use the **/?** options, as shown:

```
C:\> netstat /? <ENTER>
```

Use the output of the **netstat /?** command as reference to fill in the appropriate option that best matches the description:

Option	Description
	Display all connections and listening ports.
	Display addresses and port numbers in numerical form.
	Redisplay statistics every five seconds. Press CTRL+C to stop redisplaying statistics.
	Shows connections for the protocol specified by proto; proto may be any of: TCP, UDP, TCPv6, or UDPv6. If used with the -s option to display per-protocol statistics, proto may be any of: IP, IPv6, ICMP, ICMPv6, TCP, TCPv6, UDP, or UDPv6.
	Redisplay all connections and listening ports every 30 seconds.
	Display only open connections. This is a tricky problem.

When **netstat** statistics are displayed for TCP connections, the TCP state is displayed. During the life of a TCP connection, the connection passes through a series of states. The following table is a summary of TCP states, compiled from RFC 793, Transmission Control Protocol, September, 1981, as reported by **netstat**:

State	Connection Description
LISTEN	The local connection is waiting for a connection request from any remote device.
ESTABLISHED	The connection is open, and data may be exchanged through the connection. This is the normal state for the data transfer phase of the connection.
TIME-WAIT	The local connection is waiting a default period of time after sending a connection termination request before closing the connection. This is a normal condition, and will normally last between 30 - 120 seconds.
CLOSE-WAIT	The connection is closed, but is waiting for a termination request from the local user.
SYN-SENT	The local connection is waiting for a response after sending a connection request. The connection should transition quickly through this state.
SYN_RECEIVED	The local connection is waiting for a confirming connection request acknowledgment. The connection should transition quickly through this state. Multiple connections in SYN_RECEIVED state may indicate a TCP SYN attack.

IP addresses displayed by **netstat** fall into several categories:

IP Address	Description
127.0.0.1	This address refers to the local host, or this computer.
0.0.0.0	A global address, meaning "ANY".
Remote Address	The address of the remote device that has a connection with this computer.

Task 2: Use **netstat** to Examine Protocol Information on a Pod Host Computer.

Step 1: Use **netstat** to view existing connections.

From the terminal window in Task 1, above, issue the command **netstat -a**:

```
C:\> netstat -a <ENTER>
```

A table will be displayed that lists protocol (TCP and UDP), Local address, Foreign address, and State information. Addresses and protocols that can be translated into names are displayed.

The **-n** option forces **netstat** to display output in raw format. From the terminal window, issue the command **netstat -an**:

```
C:\> netstat -an <ENTER>
```

Use the window vertical scroll bar to go back and forth between the outputs of the two commands. Compare outputs, noting how well-known port numbers are changed to names.

Write down three TCP and three UDP connections from the **netstat -a** output, and the corresponding translated port numbers from the **netstat -an** output. If there are fewer than three connections that translate, note that in your table.

Connection	Proto	Local Address	Foreign Address	State

Refer to the following **netstat** output. A new network engineer suspects that his host computer has been compromised by an outside attack against ports 1070 and 1071. How would you respond?

```
C:\> netstat -n
Active Connections
Proto Local Address          Foreign Address         State
TCP    127.0.0.1:1070          127.0.0.1:1071         ESTABLISHED
TCP    127.0.0.1:1071          127.0.0.1:1070         ESTABLISHED
C:\>
```

Step 2: Establish multiple concurrent TCP connections and record netstat output.

In this task, several simultaneous connections will be made with Eagle Server. The venerable **telnet** command will be used to access Eagle Server network services, thus providing several protocols to examine with **netstat**.

Open an additional four terminal windows. Arrange the windows so that all are visible. The four terminal windows that will be used for telnet connections to Eagle Server can be relatively small, approximately $\frac{1}{2}$ screen width by $\frac{1}{4}$ screen height. The terminal windows that will be used to collect connection information should be $\frac{1}{2}$ screen width by full screen height.

Several network services on Eagle Server will respond to a telnet connection. We will use:

- DNS- domain name server, port 53
- FTP- FTP server, port 21
- SMTP- SMTP mail server, port 25
- TELNET- Telnet server, port 23

Why should telnet to UDP ports fail?

To close a telnet connection, press the <CTRL>] keys together. That will bring up the telnet prompt, Microsoft Telnet>. Type **quit** <ENTER> to close the session.

In the first telnet terminal window, telnet to Eagle Server on port 53. In the second terminal window, telnet on port 21. In the third terminal window, telnet on port 25. In the fourth terminal window, telnet on port 23. The command for a telnet connection on port 21 is shown below:

```
C:\> telnet eagle-server.example.com 53
```

In the large terminal window, record established connections with Eagle Server. Output should look similar to the following. If typing is slow, a connection may close before all connections have been made. Eventually, connections should terminate from inactivity.

Proto	Local Address	Foreign Address	State
TCP	192.168.254.1:1688	192.168.254.254:21	ESTABLISHED
TCP	192.168.254.1:1691	192.168.254.254:25	ESTABLISHED
TCP	192.168.254.1:1693	192.168.254.254:53	ESTABLISHED
TCP	192.168.254.1:1694	192.168.254.254:23	ESTABLISHED

Task 3: Reflection.

The **netstat** utility displays incoming and outgoing network connections (TCP and UDP), host computer routing table information, and interface statistics.

Task 4: Challenge.

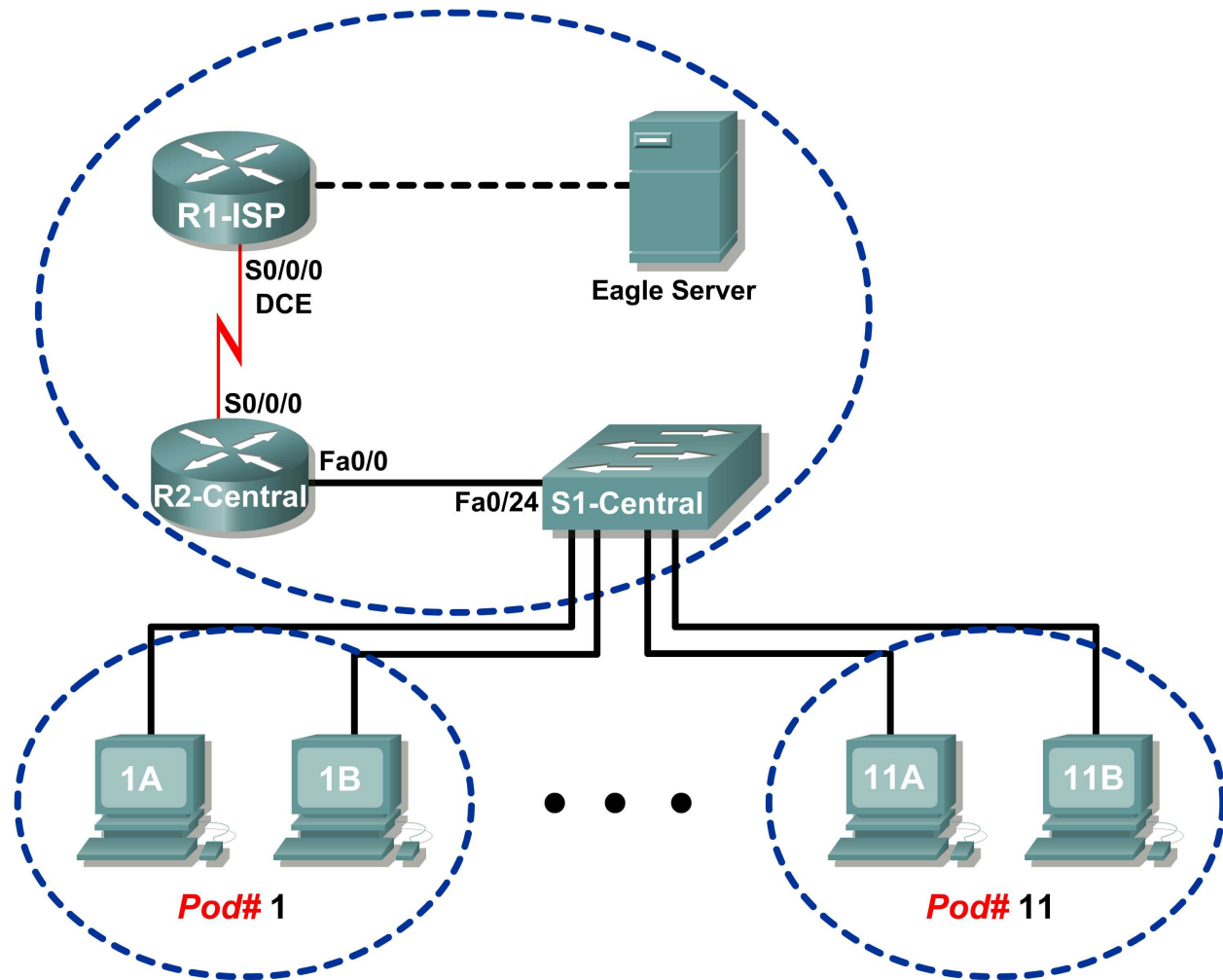
Close Established sessions abruptly (close the terminal window), and issue the **netstat -an** command. Try to view connections in stages different from ESTABLISHED.

Task 5: Cleanup.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 4.5.2: TCP/IP Transport Layer Protocols, TCP and UDP

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16.Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16.Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

- Identify TCP header fields and operation using a Wireshark FTP session capture.
- Identify UDP header fields and operation using a Wireshark TFTP session capture.

Background

The two protocols in the TCP/IP Transport Layer are the transmission control protocol (TCP), defined in RFC 761, January, 1980, and user datagram protocol (UDP), defined in RFC 768, August, 1980. Both protocols support upper-layer protocol communication. For example, TCP is used to provide Transport Layer support for the HTTP and FTP protocols, among others. UDP provides Transport Layer support for domain name services (DNS) and trivial file transfer protocol (TFTP), among others.

The ability to understand the parts of the TCP and UDP headers and operation are a critical skill for network engineers.

Scenario

Using Wireshark capture, analyze TCP and UDP protocol header fields for file transfers between the host computer and Eagle Server. If Wireshark has not been loaded on the host pod computer, it may be downloaded from URL ftp://eagle-server.example.com/pub/eagle_labs/eagle1/chapter4/, file `wireshark-setup-0.99.4.exe`.

Windows command line utilities `ftp` and `tftp` will be used to connect to Eagle Server and download files.

Task 1: Identify TCP Header Fields and Operation using a Wireshark FTP Session Capture.

Step 1: Capture a FTP session.

TCP sessions are well controlled and managed by information exchanged in the TCP header fields. In this task, a FTP session will be made to Eagle Server. When finished, the session capture will be analyzed. Windows computers use the FTP client, **ftp**, to connect to the FTP server. A command line window will start the FTP session, and the text configuration file for S1-central from Eagle Server will be downloaded, `/pub/eagle_labs/eagle1/chapter4/s1-central`, to the host computer.

Open a command line window by clicking on Start | Run, type `cmd`, then press OK.

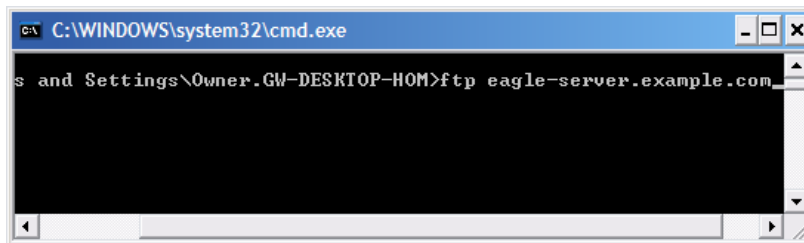


Figure 1. Command line window.

A window similar to Figure 1 should open.

Start a Wireshark capture on the interface that has IP address `172.16.Pod#. [1-2]`.

Start an FTP connection to Eagle Server. Type the command:

```
> ftp eagle-server.example.com
```

When prompted for a user id, type **anonymous**. When prompted for a password, press **<ENTER>**.

Change the FTP directory to `/pub/eagle_labs/eagle1/chapter4/`:

```
ftp> cd /pub/eagle_labs/eagle1/chapter4/
```

Download the file `s1-central`:

```
ftp> get s1-central
```

When finished, terminate the FTP sessions in each command line window with the FTP **quit** command:

```
ftp> quit
```

Close the command line window with the command **exit**:

```
> exit
```

Stop the Wireshark capture.

Step 2: Analyze the TCP fields.

No.	Time	Source	Destination	Protocol	Info
1	0.000000	172.16.1.1	192.168.254.254	TCP	1052 > ftp [SYN] Seq=0 Len=0 MSS=1460
2	0.000568	192.168.254.254	172.16.1.1	TCP	ftp > 1052 [SYN, ACK] Seq=0 Ack=1 win=5840 Len=0 MSS=1460
3	0.000610	172.16.1.1	192.168.254.254	TCP	1052 > ftp [ACK] Seq=1 Ack=1 win=64240 Len=0
4	0.004818	192.168.254.254	172.16.1.1	FTP	Response: 220 Welcome to the eagle-server FTP service.
5	0.115430	172.16.1.1	192.168.254.254	TCP	1052 > ftp [ACK] Seq=1 Ack=47 win=64194 Len=0
6	8.223541	172.16.1.1	192.168.254.254	FTP	Request: USER anonymous
7	8.224089	192.168.254.254	172.16.1.1	TCP	ftp > 1052 [ACK] Seq=47 Ack=17 win=5840 Len=0
8	8.224126	192.168.254.254	172.16.1.1	FTP	Response: 331 Please specify the password.
9	8.327214	172.16.1.1	192.168.254.254	TCP	1052 > ftp [ACK] Seq=17 Ack=81 win=64160 Len=0
10	9.517629	172.16.1.1	192.168.254.254	FTP	Request: PASS
11	9.519135	192.168.254.254	172.16.1.1	FTP	Response: 230 Login successful.
12	9.629097	172.16.1.1	192.168.254.254	TCP	1052 > ftp [ACK] Seq=24 Ack=104 win=64137 Len=0
13	32.365752	172.16.1.1	192.168.254.254	FTP	Request: CWD /pub/eagle_labs/eagle1/chapter4
14	32.366375	192.168.254.254	172.16.1.1	FTP	Response: 250 Directory successfully changed.
15	32.376653	172.16.1.1	192.168.254.254	FTP	Request: PORT 172,16,1,1,4,33
16	32.377165	192.168.254.254	172.16.1.1	FTP	Response: 200 PORT command successful. Consider using PASV.
17	32.381726	172.16.1.1	192.168.254.254	FTP	Request: RETR sl-central
18	32.382337	192.168.254.254	172.16.1.1	TCP	ftp-data > 1057 [SYN] Seq=0 Len=0 MSS=1460 TSV=4755496 TSER=0 WS=2
19	32.382398	172.16.1.1	192.168.254.254	TCP	1057 > ftp-data [SYN, ACK] Seq=0 Ack=1 win=64240 Len=0 MSS=1460 WS=0 TSV=0 TSER=0
20	32.382777	192.168.254.254	172.16.1.1	TCP	ftp-data > 1057 [ACK] Seq=1 Ack=1 win=5840 Len=0 TSV=4755496 TSER=0
21	32.382891	192.168.254.254	172.16.1.1	FTP	Response: 350 Opening BINARY mode data connection for sl-central (3100 bytes).
22	32.383528	192.168.254.254	172.16.1.1	FTP-DATA	FTP data: 1448 bytes
23	32.383589	192.168.254.254	172.16.1.1	FTP-DATA	FTP data: 1448 bytes
24	32.383631	172.16.1.1	192.168.254.254	TCP	1057 > ftp-data [ACK] Seq=1 Ack=2897 win=64240 Len=0 TSV=36854 TSER=4755496
25	32.383736	192.168.254.254	172.16.1.1	FTP-DATA	FTP data: 204 bytes
26	32.383753	192.168.254.254	172.16.1.1	FTP	Response: 226 File send OK.
27	32.383773	172.16.1.1	192.168.254.254	TCP	1052 > ftp [ACK] Seq=100 Ack=281 win=63960 Len=0
28	32.383778	192.168.254.254	172.16.1.1	TCP	ftp-data > 1057 [FIN, ACK] Seq=3101 Ack=1 win=5840 Len=0 TSV=4755496 TSER=0
29	32.383805	172.16.1.1	192.168.254.254	TCP	1057 > ftp-data [ACK] Seq=1 Ack=3102 win=64036 Len=0 TSV=36854 TSER=4755496
30	32.389457	172.16.1.1	192.168.254.254	TCP	1057 > ftp-data [FIN, ACK] Seq=1 Ack=3102 win=64036 Len=0 TSV=36854 TSER=4755496
31	32.389845	192.168.254.254	172.16.1.1	TCP	ftp-data > 1057 [ACK] Seq=3102 Ack=2 win=5840 Len=0 TSV=4755503 TSER=36854
32	34.438952	172.16.1.1	192.168.254.254	FTP	Request: QUIT
33	34.439532	192.168.254.254	172.16.1.1	FTP	Response: 221 Goodbye.
34	34.439893	192.168.254.254	172.16.1.1	TCP	ftp > 1052 [FIN, ACK] Seq=295 Ack=106 win=5840 Len=0
35	34.439934	172.16.1.1	192.168.254.254	TCP	1052 > ftp [ACK] Seq=106 Ack=296 win=63946 Len=0
36	34.442705	172.16.1.1	192.168.254.254	TCP	1052 > ftp [FIN, ACK] Seq=106 Ack=296 win=63946 Len=0
37	34.443144	192.168.254.254	172.16.1.1	TCP	ftp > 1052 [ACK] Seq=296 Ack=107 win=5840 Len=0

Figure 2. FTP capture.

Switch to the Wireshark capture windows. The top window contains summary information for each captured record. Student capture should be similar to the capture shown in Figure 2. Before delving into TCP packet details, an explanation of the summary information is needed. When the FTP client is connected to the FTP server, the Transport Layer protocol TCP created a reliable session. TCP is routinely used during a session to control datagram delivery, verify datagram arrival, and manage window size. For each exchange of data between the FTP client and FTP server, a new TCP session is started. At the conclusion of the data transfer, the TCP session is closed. Finally, when the FTP session is finished TCP performs an orderly shutdown and termination.

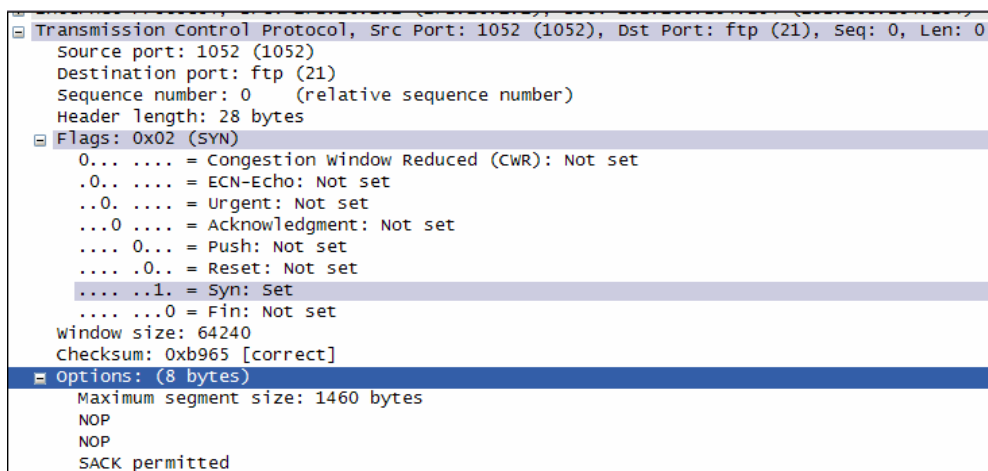


Figure 3. Wireshark capture of a TCP datagram.

In Wireshark, detailed TCP information is available in the middle window. Highlight the first TCP datagram from the host computer, and move the mouse pointer to the middle window. It may be necessary to adjust the middle window and expand the TCP record by clicking on the protocol expand box. The expanded TCP datagram should look similar to Figure 3.

How is the first datagram in a TCP session identified?

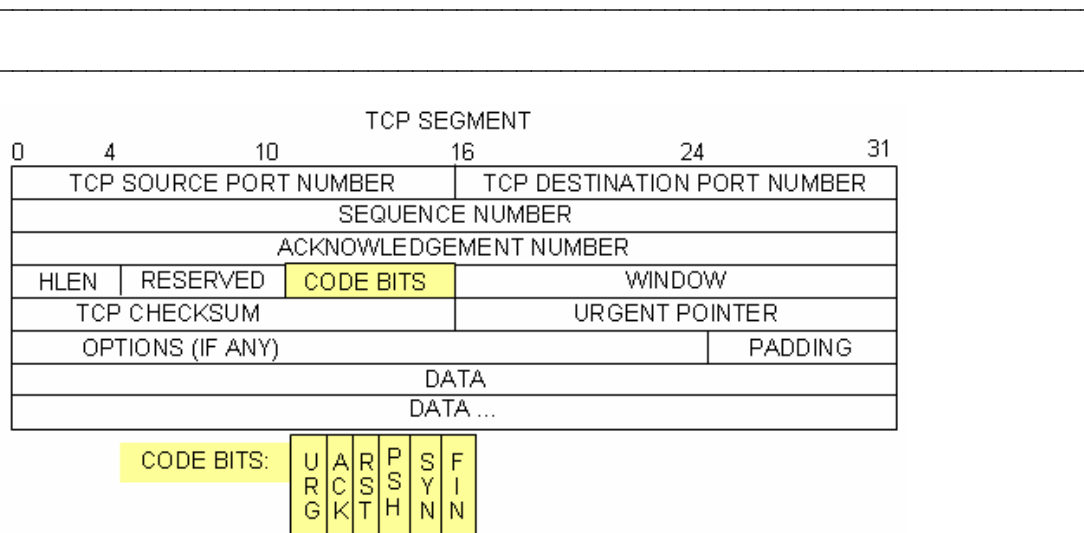


Figure 4. TCP packet fields.

Refer to Figure 4, a TCP datagram diagram. An explanation of each field is provided to refresh the student's memory:

- **TCP Source port number** belongs to the TCP session host that opened a connection. The value is normally a random value above 1023.
- **Destination port number** is used to identify the upper layer protocol or application on the remote site. The values in the range 0–1023 represent the so called "well known ports" and are associated with popular services and applications (as described in RFC 1700, such as telnet, File Transfer Protocol (FTP), HyperText Transfer Protocol (HTTP), etc). The quadruple field combination (Source IP Address, Source Port, Destination IP Address, Destination Port) uniquely identifies the session to both sender and receiver.
- **Sequence number** specifies the number of the last octet in a segment.
- **Acknowledgment number** specifies the next octet expected by the receiver.
- **Code Bits** have a special meaning in session management and in the treatment of segments. Among interesting values are:
 - ACK (Acknowledgement of a segment receipt),
 - SYN (Synchronize, only set when a new TCP session is negotiated during the TCP three-way handshake).
 - FIN (Finish, request to close the TCP session).
- **Window size** is the value of the sliding window - how many octets can be sent before waiting for an acknowledgement.
- **Urgent pointer** is only used with an URG (Urgent) flag - when the sender needs to send urgent data to the receiver.
- **Options**: The only option currently defined is the maximum TCP segment size (optional value).

Using the Wireshark capture of the first TCP session start-up (SYN bit set to 1), fill in information about the TCP header:

From pod host computer to Eagle Server (only the SYN bit is set to 1):

Source IP Address: 172.16. .	
Destination IP Address: .	
Source port number: .	
Destination port number: .	
Sequence number: .	
Acknowledgement number: .	
Header length: .	
Window size: .	

From Eagle Server to pod host computer (only SYN and ACK bits are set to 1):

Source IP Address: .	
Destination IP Address: 172.16. .	
Source port number: .	
Destination port number: .	
Sequence number: .	
Acknowledgement number: .	
Header length: .	
Window size: .	

From pod host computer to Eagle Server (only ACK bit is set to 1):

Source IP Address: 172.16. .	
Destination IP Address: .	
Source port number: .	
Destination port number: .	
Sequence number: .	
Acknowledgement number: .	
Header length: .	
Window size: .	

Ignoring the TCP session started when a data transfer occurred, how many other TCP datagrams contained a SYN bit?

Attackers take advantage of the three-way handshake by initiating a “half-open” connection. In this sequence, the opening TCP session sends a TCP datagram with the SYN bit set and the receiver sends a related TCP datagram with the SYN ACK bits set. A final ACK bit is never sent to finish the TCP handshake. Instead, a new TCP connection is started in half-open fashion. With sufficient TCP sessions in the half-open state, the receiving computer may exhaust resources and crash. A crash could involve a loss of networking services, or corrupt the operating system. In either case the attacker has won, networking service has been stopped on the receiver. This is one example of a denial-of-service (DoS) attack.

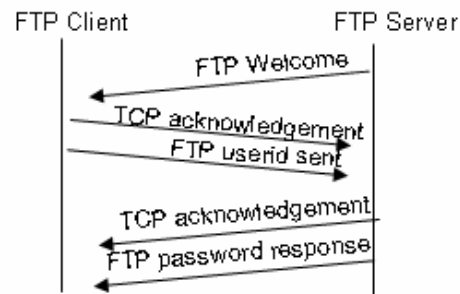


Figure 5. TCP session management.

The FTP client and server communicate between each other, unaware and uncaring that TCP has control and management over the session. When the FTP server sends a Response: 220 to the FTP client, the TCP session on the FTP client sends an acknowledgment to the TCP session on Eagle Server. This sequence is shown in Figure 5, and is visible in the Wireshark capture.

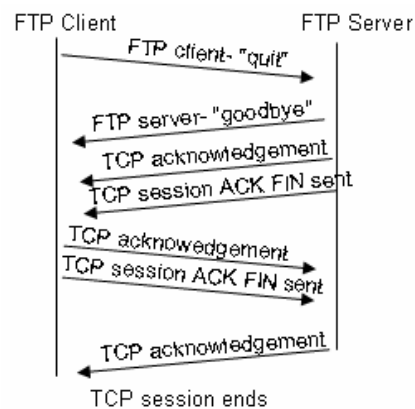


Figure 6. Orderly TCP session termination.

When the FTP session has finished, the FTP client sends a command to "quit". The FTP server acknowledges the FTP termination with a Response :221 Goodbye. At this time the FTP server TCP session sends a TCP datagram to the FTP client, announcing the termination of the TCP session. The FTP client TCP session acknowledges receipt of the termination datagram, then sends its own TCP session termination. When the originator of the TCP termination, FTP server, receives a duplicate termination, an ACK datagram is sent to acknowledge the termination and the TCP session is closed. This sequence is shown in Figure 6, and visible in the Wireshark capture.

Without an orderly termination, such as when the connection is broken, the TCP sessions will wait a certain period of time until closing. The default timeout value varies, but is normally 5 minutes.

Task 2: Identify UDP header fields and operation using a Wireshark TFTP session capture.

Step 1: Capture a TFTP session.

Following the procedure in Task 1 above, open a command line window. The TFTP command has a different syntax than FTP. For example, there is no authentication. Also, there are only two commands, **get**, to retrieve a file, and **put**, to send a file.

```
>tftp -help
```

Transfers files to and from a remote computer running the TFTP service.

TFTP [-i] host [GET | PUT] source [destination]

-i	Specifies binary image transfer mode (also called octet). In binary image mode the file is moved literally, byte by byte. Use this mode when transferring binary files.
host	Specifies the local or remote host.
GET	Transfers the file destination on the remote host to the file source on the local host.
PUT	Transfers the file source on the local host to the file destination on the remote host.
source	Specifies the file to transfer.
destination	Specifies where to transfer the file.

Table 1. TFTP syntax for a Windows TFTP client.

Table 1 contains Windows TFTP client syntax. The TFTP server has its own directory on Eagle Server, /tftpboot, which is different from the directory structure supported by the FTP server. No authentication is supported.

Start a Wireshark capture, then download the s1-central configuration file from Eagle Server with the Windows TFTP client. The command and syntax to perform this is shown below:

```
>tftp eagle-server.example.com get s1-central
```

Step 2: Analyze the UDP fields.

No. -	Time	Source	Destination	Protocol	Info
1	0.000000	172.16.1.1	192.168.254.254	TFTP	Read Request, File: s1-central, Transfer type: netascii
2	0.003171	192.168.254.254	172.16.1.1	TFTP	Data Packet, Block: 1
3	0.003314	172.16.1.1	192.168.254.254	TFTP	Acknowledgement, Block: 1
4	0.003962	192.168.254.254	172.16.1.1	TFTP	Data Packet, Block: 2
5	0.004021	172.16.1.1	192.168.254.254	TFTP	Acknowledgement, Block: 2
6	0.004615	192.168.254.254	172.16.1.1	TFTP	Data Packet, Block: 3
7	0.004673	172.16.1.1	192.168.254.254	TFTP	Acknowledgement, Block: 3
8	0.005274	192.168.254.254	172.16.1.1	TFTP	Data Packet, Block: 4
9	0.005332	172.16.1.1	192.168.254.254	TFTP	Acknowledgement, Block: 4
10	0.005930	192.168.254.254	172.16.1.1	TFTP	Data Packet, Block: 5
11	0.005989	172.16.1.1	192.168.254.254	TFTP	Acknowledgement, Block: 5
12	0.006588	192.168.254.254	172.16.1.1	TFTP	Data Packet, Block: 6
13	0.006644	172.16.1.1	192.168.254.254	TFTP	Acknowledgement, Block: 6
14	0.007078	192.168.254.254	172.16.1.1	TFTP	Data Packet, Block: 7 (last)
15	0.007131	172.16.1.1	192.168.254.254	TFTP	Acknowledgement, Block: 7

Figure 7. Summary capture of a UDP session.

Switch to the Wireshark capture windows. Student capture should be similar to the capture shown in Figure 7. A TFTP transfer will be used to analyze Transport Layer UDP operation.

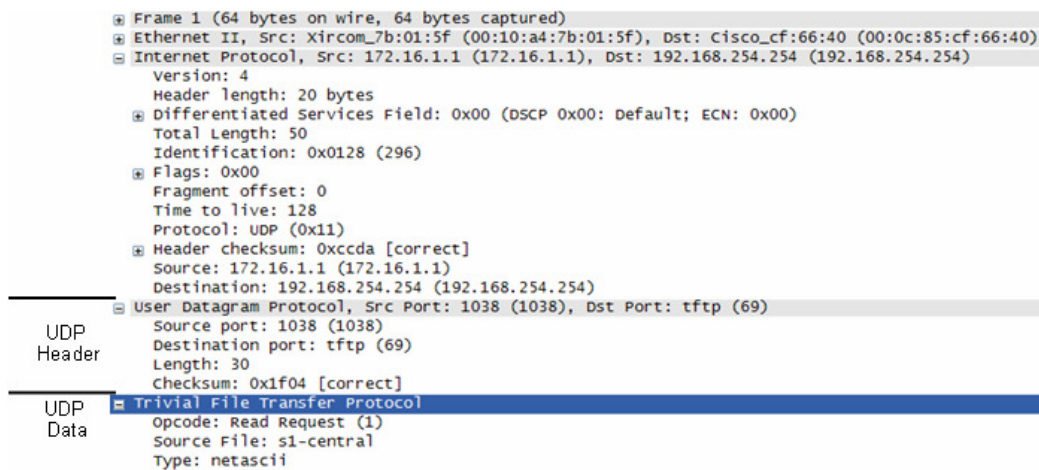


Figure 8. Wireshark capture of a UDP datagram.

In Wireshark, detailed UDP information is available in the middle window. Highlight the first UDP datagram from the host computer, and move the mouse pointer to the middle window. It may be necessary to adjust the middle window and expand the UDP record by clicking on the protocol expand box. The expanded UDP datagram should look similar to Figure 8.

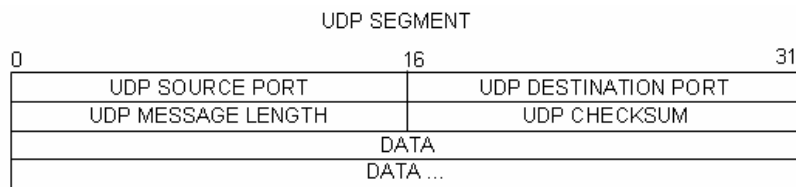


Figure 9. UDP format.

Refer to Figure 9, a UDP datagram diagram. Header information is sparse, compared to the TCP datagram. There are similarities, however. Each UDP datagram is identified by the UDP source port and UDP destination port.

Using the Wireshark capture of the first UDP datagram, fill in information about the UDP header. The checksum value is a hexadecimal (base 16) value, denoted by the preceding 0x code:

Source IP Address: 172.16.____.____	
Destination IP Address: _____	
Source port number: _____	
Destination port number: _____	
UDP message length: _____	
UDP checksum: _____	

How does UDP verify datagram integrity?

Examine the first packet returned from Eagle Server. Fill in information about the UDP header:

Source IP Address:	
Destination IP Address: 172.16. .	
Source port number:	
Destination port number:	
UDP message length:	
UDP checksum: 0x	

Notice that the return UDP datagram has a different UDP source port, but this source port is used for the remainder of the TFTP transfer. Since there is no reliable connection, only the original source port used to begin the TFTP session is used to maintain the TFTP transfer.

Task 5: Reflection.

This lab provided students with the opportunity to analyze TCP and UDP protocol operations from captured FTP and TFTP sessions. TCP manages communication much differently from UDP, but reliability and guaranteed delivery requires additional control over the communication channel. UDP has less overhead and control, and the upper-layer protocol must provide some type of acknowledgement control. Both protocols, however, transport data between clients and servers using Application Layer protocols and are appropriate for the upper-layer protocol each supports.

Task 6: Challenge.

Since neither FTP nor TFTP are secure protocols, all data transferred is sent in clear text. This includes any user ids, passwords, or clear text file contents. Analyzing the upper-layer FTP session will quickly identify the user id, password, and configuration file passwords. Upper-layer TFTP data examination is a bit more complicated, but the data field can be examined and configuration user id and password information extracted.

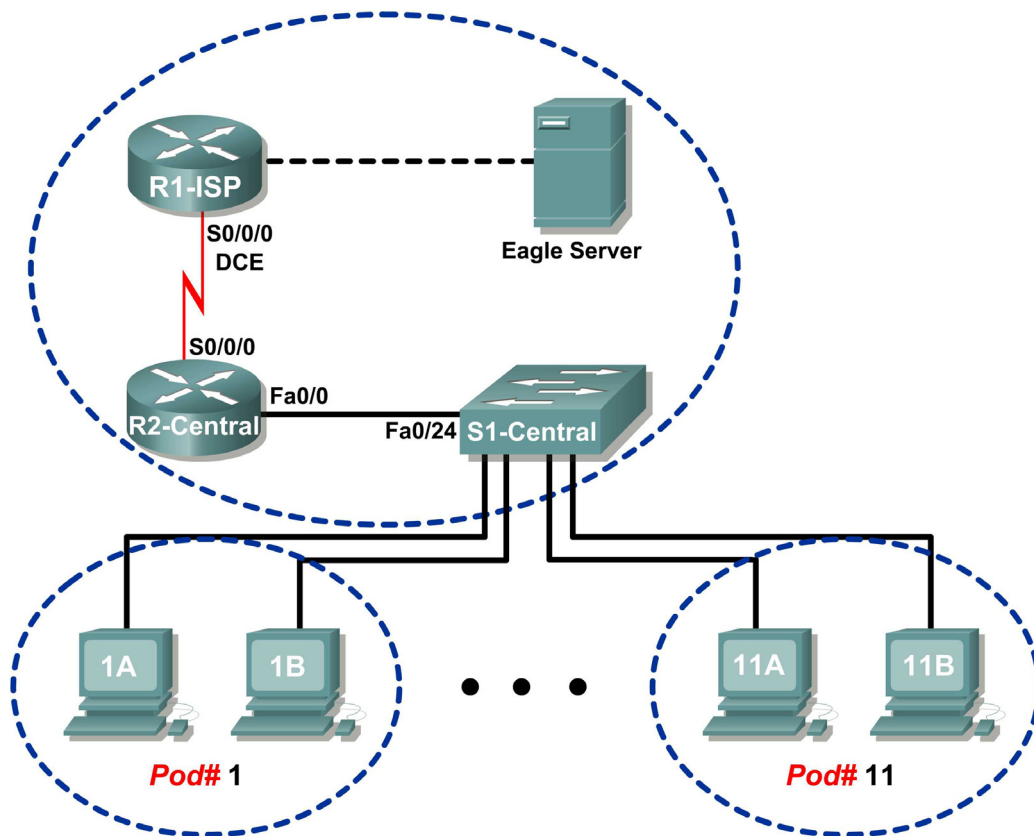
Task 7: Cleanup

During this lab several files were transferred to the host computer, and should be removed.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 4.5.3: Application and Transport Layer Protocols Examination

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16.Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16.Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Configure the host computer to capture Application layer protocols.
- Capture and analyze HTTP communication between the pod host computer and a web server.
- Capture and analyze FTP communication between the pod host computer and an FTP server.
- Observe TCP establish and manage communication channels with HTTP and FTP connections

Background

The primary function of the Transport Layer is to keep track of multiple application conversations on the same host. However, different applications have different requirements for their data, and therefore different Transport protocols have been developed to meet these requirements.

Application layer protocols define the communication between network services, such as a web server and client, and an FTP server and client. Clients initiate communication to the appropriate server, and the server responds to the client. For each network service there is a different server listening on a different port for client connections. There may be several servers on the same end device. A user may open several client applications to the same server, yet each client communicates exclusively with a session established between the client and server.

Application layer protocols rely on lower level TCP/IP protocols, such as TCP or UDP. This lab will examine two popular Application Layer protocols, HTTP and FTP, and how Transport Layer protocols TCP and UDP manage the communication channel. Also examined are popular client requests and corresponding server responses.

Scenario

In this lab, you will use client applications to connect to eagle-server network services. You will monitor the communication with Wireshark and analyze the captured packets.

A web browser such as Internet Explorer or Firefox will be used to connect to the eagle-server network service. Eagle-server has several network services preconfigured, such as HTTP, waiting to respond to client requests.

The web browser will also be used to examine the FTP protocol, as well as the FTP command line client. This exercise will demonstrate that although clients may differ the underlying communication to the server remains the same.

Task 1: Configure the Pod Host Computer to Capture Application Layer Protocols.

The lab should be configured as shown in the Topology Diagram and logical address table. If it is not, ask the instructor for assistance before proceeding.

Step 1: Download and install wireshark.



Figure 1. FTP Download for Wireshark

If Wireshark is not installed on the pod host computer, it can be downloaded from eagle-server.example.com. See Figure 1. The download URL is ftp://eagle-server.example.com/pub/eagle_labs/eagle1/chapter3/.

1. Right-click the wireshark filename, then save the file to the host pod computer.
2. When the file has downloaded, double-click the filename and install Wireshark with the default settings.

Step 2: Start Wireshark and configure the Capture Interface.

1. Start Wireshark from **Start > All Programs > Wireshark > Wireshark**.
2. When the opening screen appears, set the correct Capture Interface. The interface with the IP address of the pod host computer is the correct interface. See Figure 2.

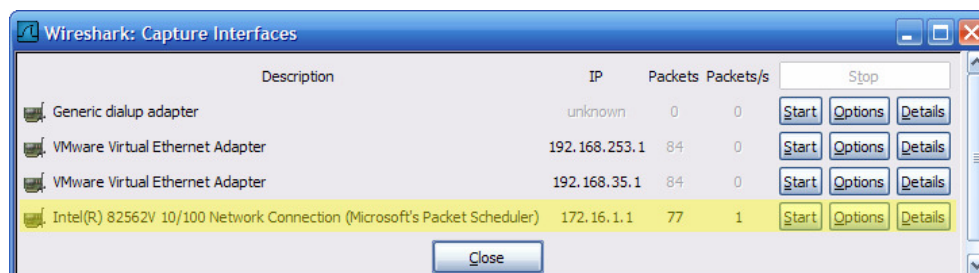


Figure 2. Wireshark Interface Capture Screen

Wireshark can be started by clicking the interface **Start** button. Thereafter, the interface is used as the default and does not need to be changed.

Wireshark should begin to log data.

3. Stop Wireshark for the moment. Wireshark will be used in upcoming tasks.

Task 2: Capture and Analyze HTTP Communication Between the Pod Host Computer and a Web Server.

HTTP is an Application layer protocol, relying on lower level protocols such as TCP to establish and manage the communication channel. HTTP version 1.1 is defined in RFC 2616, dated 1999. This part of the lab will demonstrate how sessions between multiple web clients and the web server are kept separate.

Step 1: Start Wireshark captures.

Start a Wireshark capture. Wireshark will display captures based on packet type.

Step 2: Start the pod host web browser.

1. Using a web browser such as Internet Explorer or Firefox, connect to URL <http://eagle-server.example.com>. A web page similar to Figure 3 will be displayed. Do not close this web browser until instructed to do so.

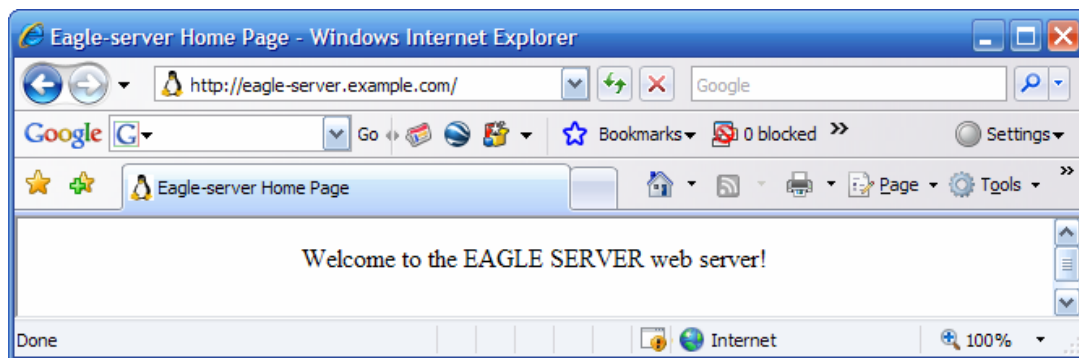


Figure 3. Web Browser Connected to Web Server

2. Click the web browser **Refresh** button. There should be no change to the display in the web client.
3. Open a second web browser, and connect to URL <http://eagle-server.example.com/page2.html>. This will display a different web page.

Do not close either browser until Wireshark capture is stopped.

Step 3: Stop Wireshark captures and analyze the captured data.

1. Stop Wireshark captures.
2. Close the web browsers.

The resulting Wireshark data will be displayed. There were actually at least three HTTP sessions created in Step 2. The first HTTP session started with a connection to <http://eagle-server.example.com>. The second session occurred with a refresh action. The third session occurred when the second web browser accessed <http://eagle-server.example.com/page2.html>.

No. -	Time	Source	Destination	Protocol	Info
10	10.168217	172.16.1.2	192.168.254.254	TCP	1056 > http [SYN] Seq=0 Len=0 MSS=1460
11	10.170734	192.168.254.254	172.16.1.2	TCP	http > 1056 [SYN, ACK] Seq=0 Ack=1 win=5840 Len=0 MSS=1460
12	10.170767	172.16.1.2	192.168.254.254	TCP	1056 > http [ACK] Seq=1 Ack=1 win=64240 Len=0
13	10.171086	172.16.1.2	192.168.254.254	HTTP	GET / HTTP/1.1
14	10.171625	192.168.254.254	172.16.1.2	TCP	http > 1056 [ACK] Seq=1 Ack=208 win=6432 Len=0
15	10.172518	192.168.254.254	172.16.1.2	HTTP	HTTP/1.1 200 OK (text/html)
16	10.172540	192.168.254.254	172.16.1.2	TCP	http > 1056 [FIN, ACK] Seq=448 Ack=208 win=6432 Len=0
17	10.172567	172.16.1.2	192.168.254.254	TCP	1056 > http [ACK] Seq=208 Ack=449 win=63793 Len=0
18	10.174196	172.16.1.2	192.168.254.254	TCP	1056 > http [FIN, ACK] Seq=208 Ack=449 win=63793 Len=0
19	10.174661	192.168.254.254	172.16.1.2	TCP	http > 1056 [ACK] Seq=449 Ack=209 win=6432 Len=0

Figure 4. Captured HTTP Session

A sample captured HTTP session is shown in Figure 4. Before HTTP can begin, the TCP session must be created. This is seen in the first three session lines, numbers 10, 11, and 12. Use your capture or similar Wireshark output to answer the following questions:

3. Fill in the following table from the information presented in the HTTP session:

Web browser IP address	
Web server IP address	
Transport layer protocol (UDP/TCP)	
Web browser port number	
Web server port number	

4. Which computer initiated the HTTP session, and how?

5. Which computer initially signaled an end to the HTTP session, and how?

6. Highlight the first line of the HTTP protocol, a **GET** request from the web browser. In Figure 4 above, the **GET** request is on line 13. Move into the second (middle) Wireshark window to examine the layered protocols. If necessary, expand the fields.

7. Which protocol is carried (encapsulated) inside the TCP segment?

8. Expand the last protocol record, and any subfields. This is the actual information sent to the web server. Complete the following table using information from the protocol.

Protocol Version	
Request Method	
* Request URI	
Language	

- * Request URI is the path to the requested document. In the first browser, the path is the root directory of the web server. Although no page was requested, some web servers are configured to display a default file if one is available.

The web server responds with the next HTTP packet. In Figure 4, this is on line 15. A response to the web browser is possible because the web server (1) understands the type of request and (2) has a file to return. Crackers sometimes send unknown or garbled requests to web servers in an attempt to stop the server or gain access to the server command line. Also, a request for an unknown web page will result in an error message.

9. Highlight the web server response, and then move into the second (middle) window. Open all collapsed sub-fields of HTTP. Notice the information returned from the server. In this reply, there are only a few lines of text (web server responses can contain thousands or millions of bytes). The web browser understands and correctly formats the data in the browser window. .
10. What is the web server response to the web client **GET** request?

11. What does this response mean?

12. Scroll down the top window of Wireshark until the second HTTP session, refresh, is visible. A sample capture is shown in Figure 5.

21	12.487941	172.16.1.2	192.168.254.254	TCP	1057 > http [SYN] Seq=0 Len=0 MSS=1460
22	12.488485	192.168.254.254	172.16.1.2	TCP	http > 1057 [SYN, ACK] Seq=0 Ack=1 win=5840 Len=0 MSS=1460
23	12.488526	172.16.1.2	192.168.254.254	TCP	1057 > http [ACK] Seq=1 Ack=1 win=64240 Len=0
24	12.488864	172.16.1.2	192.168.254.254	HTTP	GET / HTTP/1.1
25	12.489370	192.168.254.254	172.16.1.2	TCP	http > 1057 [ACK] Seq=1 Ack=294 win=6432 Len=0
26	12.489927	192.168.254.254	172.16.1.2	HTTP	HTTP/1.1 304 Not Modified
27	12.489953	192.168.254.254	172.16.1.2	TCP	http > 1057 [FIN, ACK] Seq=145 Ack=294 win=6432 Len=0
28	12.489989	172.16.1.2	192.168.254.254	TCP	1057 > http [ACK] Seq=294 Ack=146 win=64096 Len=0
29	12.490345	172.16.1.2	192.168.254.254	TCP	1057 > http [FIN, ACK] Seq=294 Ack=146 win=64096 Len=0
30	12.490705	192.168.254.254	172.16.1.2	TCP	http > 1057 [ACK] Seq=146 Ack=295 win=6432 Len=0

Figure 5. Captured HTTP Session for Refresh

The significance of the refresh action is in the server response, 304 Not Modified. With a single packet returned for both the initial **GET** request and refresh, the bandwidth used is minimal. However, for an initial response that contains millions of bytes, a single reply packet can save significant bandwidth.

Because this web page was saved in the web client's cache, the **GET** request contained the following additional instructions to the web server:

```
If-modified-since: Fri, 26 Jan 2007 06:19:33 GMT\r\n
If-None-Match: "98072-b8-82da8740"\r\n <- page tag number (ETAG)
```

13. What is the ETAG response from the web server?

Task 3: Capture and Analyze FTP Communication Between the Pod Host Computer and a Web Server.

The Application layer protocol FTP has undergone significant revision since it first appeared in RFC 114, in 1971. FTP version 5.1 is defined in RFC 959, dated October, 1985.

The familiar web browser can be used to communicate with more than just the HTTP server. In this task, the web browser and a command line FTP utility will be used to download data from an FTP server.

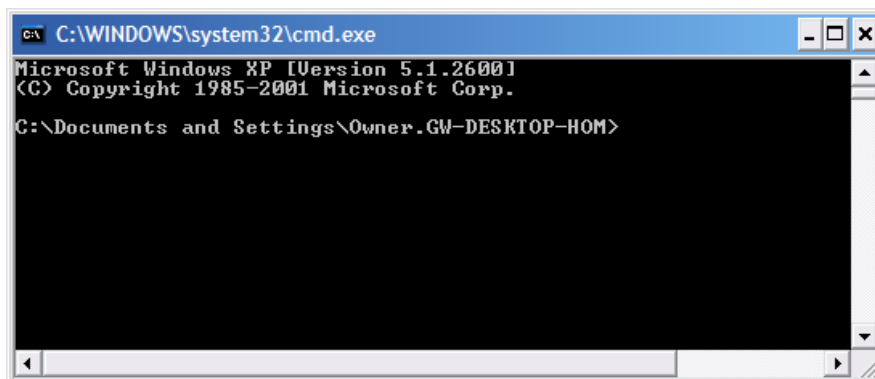


Figure 6. Windows Command Line Screen

In preparation for this task, open a command line on the host pod computer. This can be accomplished by clicking **Start > Run**, then typing **CMD** and clicking **OK**. A screen similar to Figure 6 will be displayed.

Step 1: Start Wireshark captures.

If necessary, refer to Task 1, Step 2, to open Wireshark.

Step 2: Start the pod host command line FTP client.

1. Start a pod host computer FTP session with the FTP server, using the Windows FTP client utility. To authenticate, use userid **anonymous**. In response to the password prompt, press **<ENTER>**.

```
>ftp eagle-server.example.com
Connected to eagle-server.example.com.
220 Welcome to the eagle-server FTP service.
User (eagle-server.example.com:(none)): anonymous
331 Please specify the password.
Password: <ENTER>
230 Login successful.
```

2. The FTP client prompt is **ftp>**. This means that the FTP client is waiting for a command to send to the FTP server. To view a list of FTP client commands, type **help <ENTER>**:

```
ftp> help
Commands may be abbreviated.  Commands are:

!           delete      literal    prompt    send
?           debug       ls         put        status
append     dir               mdelete   pwd        trace
ascii      disconnect  mdir      quit       type
bell       get         mget      quote      user
binary     glob        mkdir     recv       verbose
bye        hash        mls       remotehelp
cd         help       mput      rename
close     lcd        open      rmdir
```

Unfortunately, the large number of FTP client commands makes using the command line utility difficult for a novice. We will only use a few commands for Wireshark evaluation.

3. Type the command **dir** to display the current directory contents:

```
ftp> dir
200 PORT command successful. Consider using PASV.
150 Here comes the directory listing.
drwxr-xr-x    3 0          0          4096 Jan 12 04:32 pub
```

The FTP client is at the root directory of the FTP server. This is not the real root directory of the server—only the highest point that user **anonymous** can access. User **anonymous** has been placed into a root jail, prohibiting access outside of the current directory.

4. Subdirectories can be traversed, however, and files transferred to the pod host computer. Move into directory `pub/eagle_labs/eagle1/chapter2`, download a file, and exit.

```
ftp> cd pub/eagle_labs/eagle1/chapter2
250 Directory successfully changed.
ftp> dir
200 PORT command successful. Consider using PASV.
150 Here comes the directory listing.
-rw-r--r--    1 0 100      5853 Jan 12 04:26 ftptoeagle-server.pcap
-rw-r--r--    1 0 100      4493 Jan 12 04:27 http to eagle-server.pcap
-rw-r--r--    1 0 100      1486 Jan 12 04:27 ping to 192.168.254.254.pcap
-rw-r--r--    1 0 100 15163750 Jan 12 04:30 wireshark-setup-0.99.4.exe
226 Directory send OK.
ftp: 333 bytes received in 0.04Seconds 8.12Kbytes/sec.
ftp> get "ftptoeagle-server.pcap"
200 PORT command successful. Consider using PASV.
150 Opening BINARY mode data connection for ftptoeagle-server.pcap (5853 bytes).
226 File send OK.
ftp: 5853 bytes received in 0.34Seconds 17.21Kbytes/sec.
ftp> quit
221 Goodbye.
```

5. Close the command line window with the exit command.
6. Stop Wireshark captures, and save the captures as `FTP_Command_Line_Client`.

Step 3: Start the pod host web browser.

1. Start Wireshark captures again.

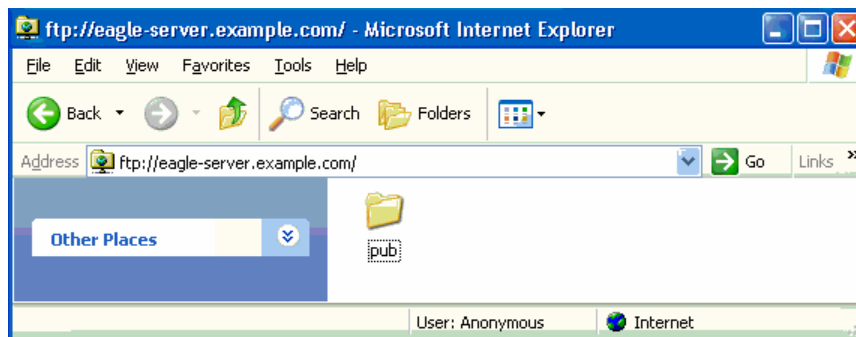


Figure 7. Web Browser Used as an FTP Client

2. Open a web browser as shown in Figure 7, and type in URL <ftp://eagle-server.example.com>. A browser window opens with the pub directory displayed. Also, the web browser logged into the FTP server as user Anonymous as shown on the bottom of the screen capture.
3. Using the browser, go down the directories until the URL path is `pub/eagle-labs/eagle1/chapter2`. Double-click the file `ftptoeagle-server.pcap` and save the file.
4. When finished, close the web browser.
5. Stop Wireshark captures, and save the captures as `FTP_Web_Browser_Client`.

Step 4: Stop Wireshark captures and analyze the captured data.

1. If not already opened, open the Wireshark capture `FTP_Web_Browser_Client`.
2. On the top Wireshark window, select the FTP capture that is the first FTP protocol transmission, Response: 220. In Figure 8, this is line 23.

No.	Time	Source	Destination	Protocol	Info
12	16.276555	172.16.1.2	192.168.254.254	DNS	Standard query A eagle-server.example.com
13	16.277284	192.168.254.254	172.16.1.2	DNS	Standard query response A 192.168.254.254
14	16.278059	172.16.1.2	192.168.254.254	TCP	1073 > ftp [SYN] Seq=0 Len=0 MSS=1460
15	16.278540	192.168.254.254	172.16.1.2	TCP	ftp > 1073 [SYN, ACK] Seq=0 Ack=1 win=5840 Len=0 MSS=1460
16	16.278575	172.16.1.2	192.168.254.254	TCP	1073 > ftp [ACK] Seq=1 Ack=1 win=64240 Len=0
23	26.281472	192.168.254.254	172.16.1.2	FTP	Response: 220 welcome to the eagle-server FTP service.
24	26.281672	172.16.1.2	192.168.254.254	FTP	Request: USER anonymous
25	26.282120	192.168.254.254	172.16.1.2	TCP	ftp > 1073 [ACK] Seq=47 Ack=17 win=5840 Len=0
26	26.282137	192.168.254.254	172.16.1.2	FTP	Response: 331 Please specify the password.
27	26.282201	172.16.1.2	192.168.254.254	FTP	Request: PASS iUser@
28	26.283451	192.168.254.254	172.16.1.2	FTP	Response: 230 Login successful.
29	26.313423	172.16.1.2	192.168.254.254	FTP	Request: opts utf8 on
30	26.313959	192.168.254.254	172.16.1.2	FTP	Response: 501 option not understood.
31	26.314042	172.16.1.2	192.168.254.254	FTP	Request: syst
32	26.314493	192.168.254.254	172.16.1.2	FTP	Response: 215 UNIX Type: L8
33	26.314595	172.16.1.2	192.168.254.254	FTP	Request: site help
34	26.315028	192.168.254.254	172.16.1.2	FTP	Response: 550 Permission denied.
35	26.315113	172.16.1.2	192.168.254.254	FTP	Request: PWD
36	26.315566	192.168.254.254	172.16.1.2	FTP	Response: 257 "/"
37	26.352350	172.16.1.2	192.168.254.254	FTP	Request: noop
38	26.352821	192.168.254.254	172.16.1.2	FTP	Response: 200 NOOP ok.
39	26.482680	172.16.1.2	192.168.254.254	FTP	Request: CWD /
40	26.483243	192.168.254.254	172.16.1.2	FTP	Response: 250 Directory successfully changed.
41	26.484334	172.16.1.2	192.168.254.254	FTP	Request: TYPE A
42	26.484824	192.168.254.254	172.16.1.2	FTP	Response: 200 Switching to ASCII mode.
43	26.485292	172.16.1.2	192.168.254.254	FTP	Request: PORT 172,16,1,2,4,50
44	26.485800	192.168.254.254	172.16.1.2	FTP	Response: 200 PORT command successful. Consider using PASV.
45	26.485892	172.16.1.2	192.168.254.254	FTP	Request: LIST
46	26.486503	192.168.254.254	172.16.1.2	TCP	ftp-data > 1074 [SYN] Seq=0 Len=0 MSS=1460 TSV=12998374 TSER=0 WS=2
47	26.486558	172.16.1.2	192.168.254.254	TCP	1074 > ftp-data [SYN, ACK] Seq=0 Ack=1 win=64240 Len=0 MSS=1460 WS=0 TSV=0 TSER=
48	26.486948	192.168.254.254	172.16.1.2	TCP	ftp-data > 1074 [ACK] Seq=1 Ack=1 win=5840 Len=0 TSV=12998375 TSER=0
49	26.487052	192.168.254.254	172.16.1.2	FTP	Response: 150 Here comes the directory listing.
50	26.487252	192.168.254.254	172.16.1.2	FTP-DA	FTP Data: 61 bytes
51	26.487267	192.168.254.254	172.16.1.2	FTP	Response: 226 Directory send OK.

Figure 8. Wireshark Capture of an FTP Session with a Web Browser

3. Move into the middle Wireshark window and expand the FTP protocol. FTP communicates using codes, similar to HTTP.

What is the FTP server response 220?

When the FTP server issued a Response: 331 Please specify the password, what was the web browser reply?

Which port number does the FTP client use to connect to the FTP server port 21?

When data is transferred or with simple directory listings, a new port is opened. This is called the transfer mode. The transfer mode can be either active or passive. In active mode, the server opens a TCP session to the FTP client and transfers data across that port. The FTP server source port number is 20, and the FTP client port number is some number above 1023. In passive mode, however, the client opens a new port to the server for data transfer. Both port numbers are above 1023.

What is the FTP-DATA port number used by the FTP server?

4. Open the Wireshark capture FTP_Web_Browser_Client, and observe the FTP communication. Although the clients are different, the commands are similar.

Step 5: FTP active and passive transfer modes

The implications between the two modes are very important from an information security perspective. The transfer mode sets how the data port is configured.

In active transfer mode, a client initiates an FTP session with the server on well-known TCP port 21. For data transfer, the server initiates a connection from well-known TCP port 20 to a client's high port, a port number above 1023. See Figure 9.

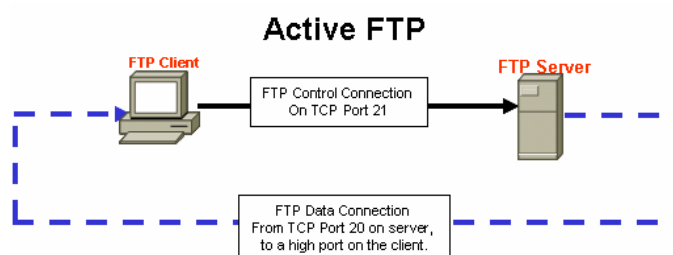


Figure 9.

Unless the FTP client firewall is configured to permit connections from the outside, data transfer may fail. To establish connectivity for data transfer, the FTP client must permit either FTP-related connections (implying stateful packet filtering), or disable blocking.

In passive transfer mode, a client initiates an FTP session with the server on well-known TCP port 21, the same connection used in the active transfer mode. For data transfer, however, there are two significant changes. First, the client initiates the data connection to the server. Second, high ports are used on both ends of the connection. See Figure 10.

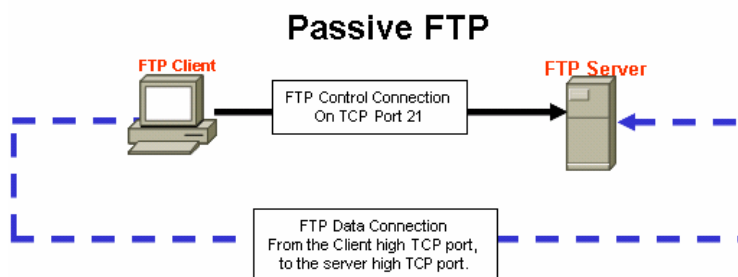


Figure 10.

Unless the FTP server is configured to permit a connection to a random high port, data transfer will fail. Not all FTP client applications support changes to the transfer mode.

Task 4: Reflection

Both HTTP and FTP protocols rely on TCP to communicate. TCP manages the connection between client and server to ensure datagram delivery.

A client application may be either a web browser or command line utility, but each must send and receive messages that can be correctly interpreted. The communication protocol is normally defined in an RFC.

The FTP client must authenticate to the FTP server, even if the authentication is open to the world. User Anonymous normally has restricted access to the FTP server and cannot upload files.

An HTTP session begins when a request is made to the HTTP server and ends when the response has been acknowledged by the HTTP client. An FTP session, however, lasts until the client signals that it is leaving with the **quit** command.

HTTP uses a single protocol to communicate with the HTTP server. The server listens on port 80 for client connections. FTP, however, uses two protocols. The FTP server listens on TCP port 21, as the command line. Depending on the transfer mode, the server or client may initiate the data connection.

Multiple Application layer protocols can be accessed through a simple web browser. While only HTTP and FTP were examined, Telnet and Gopher may also be supported on the browser. The browser acts as a client to the server, sending requests and processing replies.

Task 5: Challenge

Enabling Wireshark capture, use a web browser or command line Telnet client to connect to a Cisco device such as S1-Central or R2-Central. Observe the Telnet protocol behavior. Issue a **GET** request and observe the results.

How is the Application layer protocol Telnet similar to HTTP and FTP? How is TELNET different?

Task 6: Clean Up

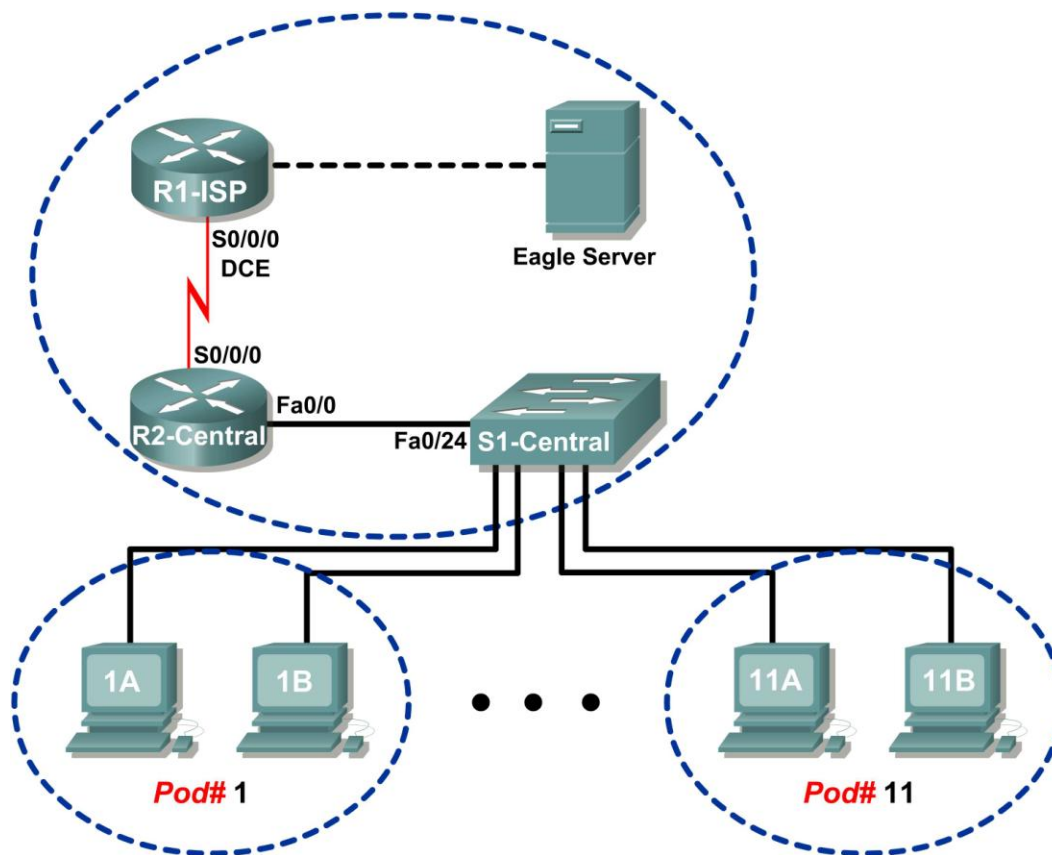
If Wireshark was installed on the pod host computer for this lab, the instructor may want the application removed. To remove Wireshark, click **Start > Control Panel > Add or Remove Programs**. Scroll to the bottom of the list, right-click on **Wireshark**, and click **Remove**.

If downloaded files need to be removed from the host pod computer, delete all files retrieved from the FTP server.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 5.5.1: Examining a Device's Gateway

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16.Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16.Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Understand and explain the purpose of a gateway address.
- Understand how network information is configured on a Windows computer.
- Troubleshoot a hidden gateway address problem.

Background

An IP address is composed of a network portion and a host portion. A computer that communicates with another device must first know how to reach the device. For devices on the same local area network (LAN), the host portion of the IP address is used as the identifier. The network portion of the destination device is the same as the network portion of the host device.

However, devices on different networks have different source and destination network numbers. The network portion of the IP address is used to identify when a packet must be sent to a gateway address, which is assigned to a network device that forwards packets between distant networks.

A router is assigned the gateway address for all the devices on the LAN. One purpose of a router is to serve as an entry point for packets coming into the network and exit point for packets leaving the network.

Gateway addresses are very important to users. Cisco estimates that 80 percent of network traffic will be destined to devices on other networks, and only 20 percent of network traffic will go to local devices. This is called the 80/20 rule. Therefore, if a gateway cannot be reached by the LAN devices, users will not be able to perform their job.

Scenario

Pod host computers must communicate with Eagle Server, but Eagle Server is located on a different network. If the pod host computer gateway address is not configured properly, connectivity with Eagle Server will fail.

Using several common utilities, network configuration on a pod host computer will be verified.

Task 1: Understand and Explain the Purpose of a Gateway Address.

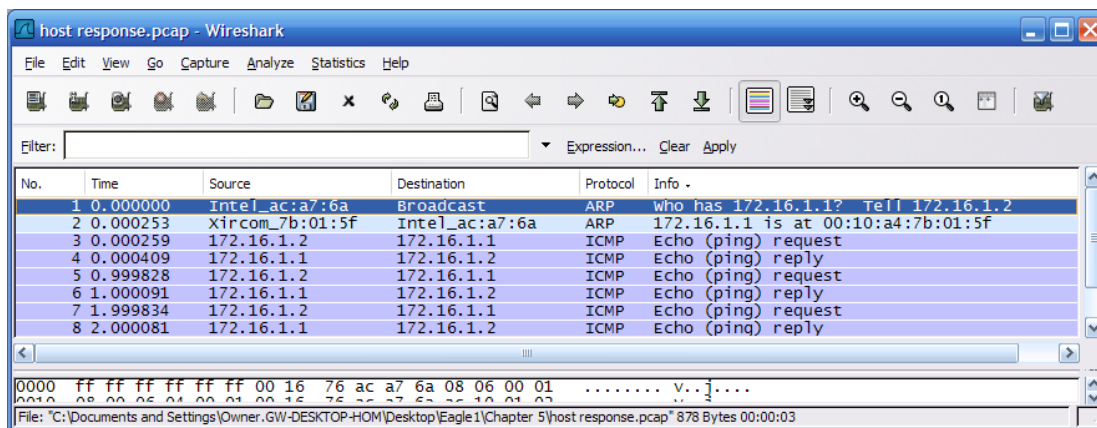


Figure 1. Communication Between LAN Devices

For local area network (LAN) traffic, the gateway address is the address of the Ethernet interface connected to the LAN. Figure 1 shows two devices on the same network communicating with the ping

command. Any device that has the same network address—in this example, 172.16.0.0—is on the same LAN.

Referring to Figure 1, what is the MAC address of the network device on IP address 172.16.1.1?

There are several Windows commands that will display a network gateway address. One popular command is `netstat -r`. In the following transcript, the `netstat -r` command is used to view the gateway addresses for this computer. The top highlight shows what gateway address is used to forward all network packets destined outside of the LAN. The "quad-zero" Network Destination and Netmask values, 0.0.0.0 and 0.0.0.0, refer to *any* network not specifically known. For any non-local network, this computer will use 172.16.255.254 as the default gateway. The second yellow highlight displays the information in human-readable form. More specific networks are reached through other gateway addresses. A local interface, called the loopback interface, is automatically assigned to the 127.0.0.0 network. This interface is used to identify the local host to local network services. Refer to the gray highlighted entry. Finally, any device on network 172.16.0.0 is accessed through gateway 172.16.1.2, the IP address for this Ethernet interface. This entry is highlighted in green.

```
C:\>netstat -r

Route Table
=====
Interface List
0x1 ..... MS TCP Loopback interface
0x20005 ...00 16 76 ac a7 6a Intel(R) 82562V 10/100 Network Connection
=====

Active Routes:
Network Destination    Netmask          Gateway          Interface        Metric
0.0.0.0                0.0.0.0          172.16.255.254   172.16.1.2        1
127.0.0.0              255.0.0.0        127.0.0.1        127.0.0.1        1
172.16.0.0             255.255.0.0      172.16.1.2       172.16.1.2       20
172.16.1.2            255.255.255.255   127.0.0.1        127.0.0.1       20
172.16.255.255        255.255.255.255   172.16.1.2       172.16.1.2       20
255.255.255.255        255.255.255.255   172.16.1.2       172.16.1.2        1
Default Gateway:      172.16.255.254
=====

Persistent Routes:
None
C:\>
```

Step 1: Open a terminal window on a pod host computer.

What is the default gateway address?

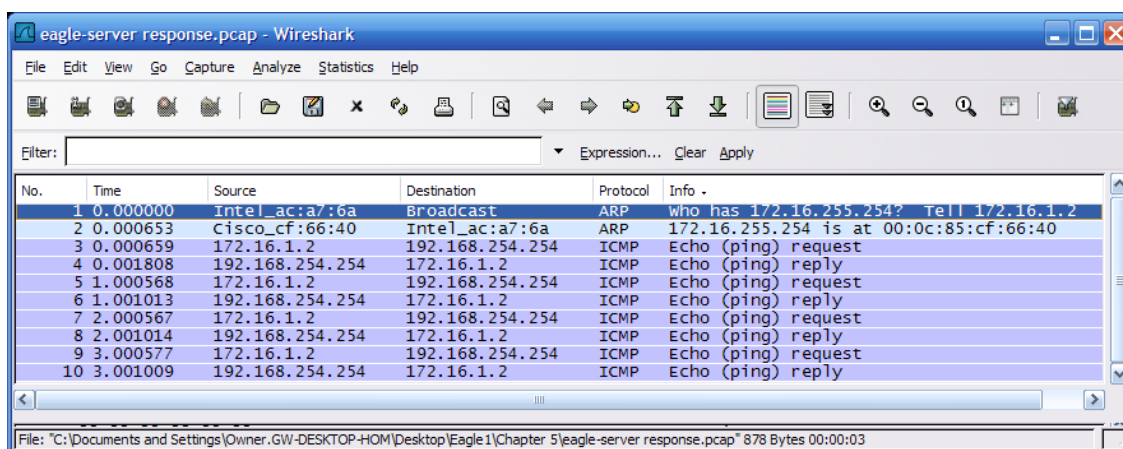
Step 2: Use the `ping` command to verify connectivity with IP address 127.0.0.1.

Was the ping successful? _____

Step 3: Use the ping command to ping different IP addresses on the 127.0.0.0 network, 127.10.1.1, and 127.255.255.255.

Were responses successful? If not, why?

A default gateway address permits a network device to communicate with other devices on different networks. In essence, it is the door to other networks. All traffic destined to different networks must go through the network device that has the default gateway address.



The image shows a Wireshark packet capture window titled 'eagle-server response.pcap - Wireshark'. The packet list table contains the following data:

No.	Time	Source	Destination	Protocol	Info
1	0.000000	Intel_ac:a7:6a	Broadcast	ARP	who has 172.16.255.254? Tell 172.16.1.2
2	0.000653	Cisco_cf:66:40	Intel_ac:a7:6a	ARP	172.16.255.254 is at 00:0c:85:cf:66:40
3	0.000659	172.16.1.2	192.168.254.254	ICMP	Echo (ping) request
4	0.001808	192.168.254.254	172.16.1.2	ICMP	Echo (ping) reply
5	1.000568	172.16.1.2	192.168.254.254	ICMP	Echo (ping) request
6	1.001013	192.168.254.254	172.16.1.2	ICMP	Echo (ping) reply
7	2.000567	172.16.1.2	192.168.254.254	ICMP	Echo (ping) request
8	2.001014	192.168.254.254	172.16.1.2	ICMP	Echo (ping) reply
9	3.000577	172.16.1.2	192.168.254.254	ICMP	Echo (ping) request
10	3.001009	192.168.254.254	172.16.1.2	ICMP	Echo (ping) reply

Figure 2. Communication Between Devices on Different Networks

As shown in Figure 2, communication between devices on different networks is different than on a LAN. Pod host computer #2, IP address 172.16.1.2, initiates a ping to IP address 192.168.254.254. Because network 172.16.0.0 is different from 192.168.254.0, the pod host computer requests the MAC address of the default gateway device. This gateway device, a router, responds with its MAC address. The computer composes the Layer 2 header with the destination MAC address of the router and places frames on the wire to the gateway device.

Referring to Figure 2, what is the MAC address of the gateway device?

Referring to Figure 2, what is the MAC address of the network device with IP address 192.168.254.254?

Task 2: Understand how Network Information is Configured on a Windows Computer.

Many times connectivity issues are attributed to wrong network settings. In troubleshooting connectivity issues, several tools are available to quickly determine the network configuration for any Windows computer.

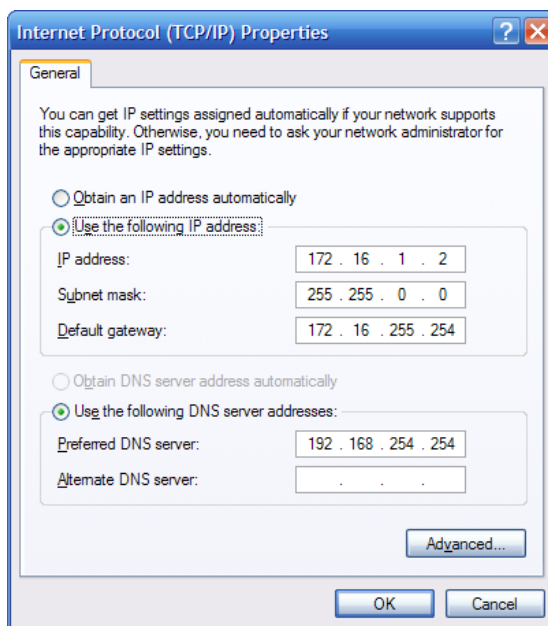


Figure 3. Network Interface with Static IP Address

Step 1: Examine network properties settings.

One method that may be useful in determining the network interface IP properties is to examine the pod host computer's Network Properties settings. To access this window:

1. Click **Start > Control Panel > Network Connections**.
2. Right-click **Local Area Connection**, and choose **Properties**.
3. On the **General** tab, scroll down the list of items in the pane, select **Internet Protocol (TCP/IP)**, and click the **Properties** button. A window similar to the one in Figure 3 will be displayed.

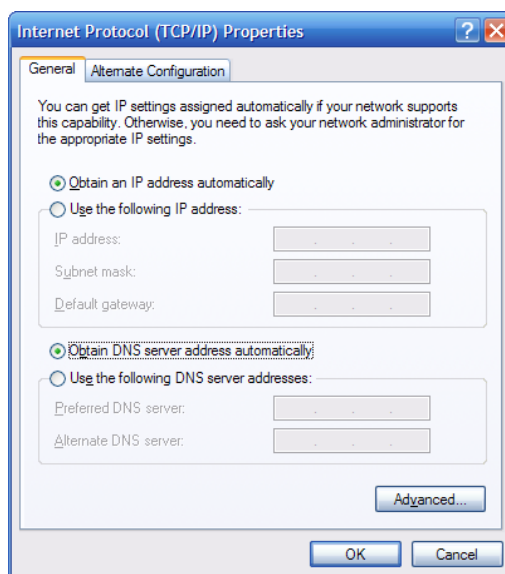


Figure 4. Network Interface with Dynamic IP Address

However, a dynamic IP address may be configured, as shown in Figure 4. In this case, the Network Properties settings window is not very useful for determining IP address information.

A more consistently reliable method for determining network settings on a Windows computer is to use the `ipconfig` command:

```
C:\>ipconfig
Windows IP Configuration
Ethernet adapter Local Area Connection:

    Connection-specific DNS Suffix . : 
    ① IP Address. . . . . : 172.16.1.2
    ② Subnet Mask . . . . . : 255.255.0.0
    ③ Default Gateway . . . . . : 172.16.255.254
```

- ① IP address for this pod host computer
- ② Subnet mask
- ③ Default gateway address

There are several options available with the `ipconfig` command, accessible with the command `ipconfig /?`. To show the most information about the network connections, use the command `ipconfig /all`.

```
C:\>ipconfig /all
Windows IP Configuration
    Host Name . . . . . : GW-desktop-hom
    Primary Dns Suffix . . . . . : 
    Node Type . . . . . : Unknown
    IP Routing Enabled. . . . . : No
    WINS Proxy Enabled. . . . . : No
Ethernet adapter Local Area Connection:
    Connection-specific DNS Suffix . : 
    Description . . . . . : Intel(R) 82562V 10/100
Network Connection
    Physical Address. . . . . : 00-16-76-AC-A7-6A
    Dhcp Enabled. . . . . : No
    IP Address. . . . . : 172.16.1.2
    Subnet Mask . . . . . : 255.255.0.0
    Default Gateway . . . . . : 172.16.255.254
    ① DNS Servers . . . . . : 192.168.254.254
C:\>
```

- ① Domain name server IP address

Step 2: Using the command `ipconfig /all`, fill in the following table with information from your pod host computer:

Description	Address
IP Address	
Subnet Mask	
Default Gateway	
DNS Server	

Task 3: Troubleshoot a Hidden Gateway Address Problem.

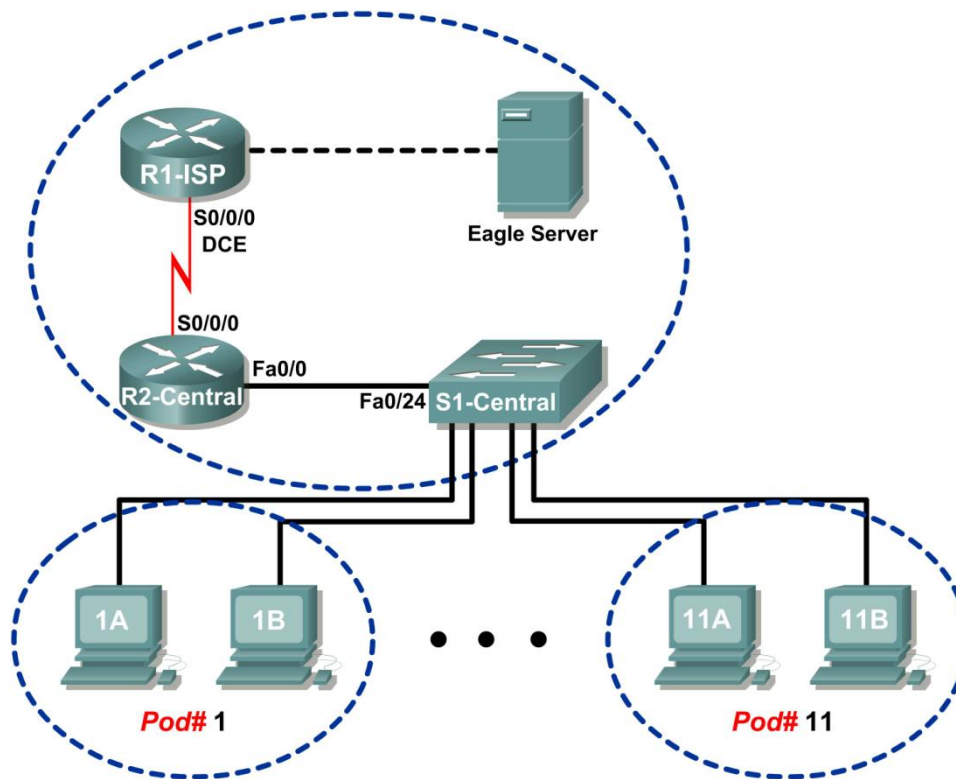


Figure 5. Topology Diagram

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16.Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16.Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Table 1. Logical Address Assignments

When troubleshooting network issues, a thorough understanding of the network can often assist in identifying the real problem. Refer to the network topology in Figure 5 and the logical IP address assignments in Table 1.

As the 3rd shift help desk Cisco engineer, you are asked for assistance from the help desk technician. The technician received a trouble ticket from a user on computer host-1A, complaining that computer host-11B, `host-11B.example.com`, does not respond to pings. The technician verified the cables and network settings on both computers, but nothing unusual was found. You check with the corporate network engineer, who reports that R2-Central has been temporarily brought down for a hardware upgrade.

Nodding your head in understanding, you ask the technician to ping the IP address for host-11B, `172.16.11.2` from host-1A. The pings are successful. Then, you ask the technician to ping the gateway IP address, `172.16.255.254`, and the pings fail.

What is wrong?

You instruct the help desk technician to tell the user to use the IP address for host-11B temporarily, and the user is able to establish connectivity with the computer. Within the hour the gateway router is back on line, and normal network operation resumes.

Task 4: Reflection

A gateway address is critical to network connectivity, and in some instances LAN devices require a default gateway to communicate with other devices on the LAN.

Using Windows command line utilities such as `netstat -r` and `ipconfig /all` will report gateway settings on host computers.

Task 5: Challenge

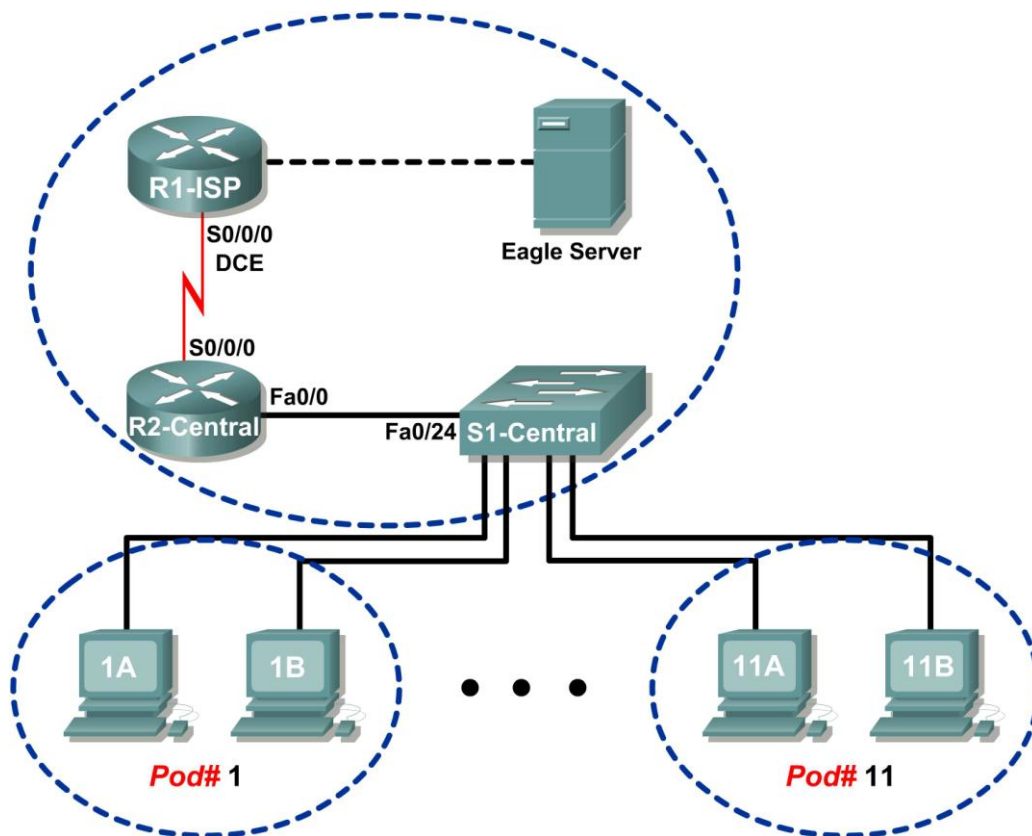
Use Wireshark to capture a ping between two pod host computers. It may be necessary to restart the host computer to flush the DNS cache. First, use the hostname of the destination pod computer for DNS to reply with the destination IP address. Observe the communication sequence between network devices, especially the gateway. Next, capture a ping between network devices using only IP addresses. The gateway address should not be needed.

Task 6: Clean Up.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 5.5.2: Examining a Route

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16.Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16.Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Use the `route` command to modify a Windows computer routing table.
- Use a Windows Telnet client command `telnet` to connect to a Cisco router.
- Examine router routes using basic Cisco IOS commands.

Background

For packets to travel across a network, a device must know the route to the destination network. This lab will compare how routes are used in Windows computers and the Cisco router.

Some routes are added to routing tables automatically, based upon configuration information on the network interface. The device considers a network directly connected when it has an IP address and network mask configured, and the network route is automatically entered into the routing table. For networks that are not directly connected, a default gateway IP address is configured that will send traffic to a device that should know about the network.

Scenario

Using a pod host computer, examine the routing table with the `route` command and identify the different routes and gateway IP address for the route. Delete the default gateway route, test the connection, and then add the default gateway route back to the host table.

Use a pod host computer to telnet into R2-Central, and examine the routing table.

Task 1: Use the `route` Command to Modify a Windows Computer Routing Table.

```
C:\>netstat -r

Route Table
=====
Interface List
0x1 ..... MS TCP Loopback interface
0x20005 ....00 16 76 ac a7 6a Intel(R) 82562V 10/100 Network Connection
=====

Active Routes:
Network Destination        Netmask          Gateway          Interface        Metric
0.0.0.0                    0.0.0.0          172.16.255.254   172.16.1.2        1
127.0.0.0                  255.0.0.0         127.0.0.1        127.0.0.1         1
172.16.0.0                 255.255.0.0       172.16.1.2       172.16.1.2        20
172.16.1.2                 255.255.255.255   127.0.0.1        127.0.0.1        20
172.16.255.255            255.255.255.255   172.16.1.2       172.16.1.2        20
255.255.255.255           255.255.255.255   172.16.1.2       172.16.1.2         1
Default Gateway:          172.16.255.254
=====

Persistent Routes:
None
C:\>
```

Figure 1. Output of the `netstat` Command

Shown in Figure 1, output from the `netstat -r` command is useful to determine route and gateway information.

Step 1: Examine the active routes on a Windows computer.

A useful command to modify the routing table is the **route** command. Unlike the **netstat -r** command, the **route** command can be used to view, add, delete, or change routing table entries. To view detailed information about the **route** command, use the option **route /?**.

An abbreviated option list for the **route** command is shown below:

route PRINT	Prints active routes
route ADD	Adds a route: <i>route ADD network MASK mask gateway</i>
route DELETE	Deletes a route: <i>route DELETE network</i>
route CHANGE	Modifies an existing route

To view active routes, issue the command **route PRINT**:

```
C:\>route PRINT
=====
Interface List
0x1 ..... MS TCP Loopback interface
0x70003 ...00 16 76 ac a7 6a .Intel(R) 82562V 10/100 Network Connection
=====
Active Routes:
Network Destination    Netmask          Gateway          Interface        Metric
0.0.0.0                0.0.0.0         172.16.255.254   172.16.1.2        1
127.0.0.0              255.0.0.0        127.0.0.1        127.0.0.1         1
172.16.0.0             255.255.0.0      172.16.1.2       172.16.1.2        20
172.16.1.2             255.255.255.255  127.0.0.1        127.0.0.1         20
172.16.255.255         255.255.255.255  172.16.1.2       172.16.1.2        20
255.255.255.255        255.255.255.255  172.16.1.2       172.16.1.2         1
Default Gateway:       172.16.255.254
=====
Persistent Routes:
None
C:\>
```

Verify network connectivity to Eagle Server:

```
C:\> ping eagle-server.example.com
Pinging eagle-server.example.com [192.168.254.254] with 32 bytes
of data:

Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63

Ping statistics for 192.168.254.254:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\>
```

What is the gateway address to eagle-server.example.com?

Step 2: Delete a route from the Windows computer routing table.

How important is the default gateway route? Delete the gateway route, and try to ping Eagle Server. The syntax to remove the default gateway route is:

```
route DELETE network  
  
C: /> route DELETE 0.0.0.0
```

Examine the active routing table and verify that the default gateway route has been removed:

What is the default gateway IP address?

Try to ping Eagle Server. What are the results?

If the default gateway IP address is removed, how can the DNS server be reached to resolve `eagle-server.example.com`?

Can other LAN devices be reached, such as `172.16.255.254`?

Step 3: Insert a route into the Windows computer routing table.

In the following configuration, use the IP address assigned to your host pod interface. The syntax to add a route to the Windows computer routing table is:

```
route ADD network MASK mask gateway-IP address  
  
C: /> route ADD 0.0.0.0 MASK 0.0.0.0 172.16.255.254
```

Examine the active routing table, and verify that the default gateway route has been restored:

Has the default gateway route been restored? _____:

Try to ping Eagle Server. What are the results?

Task 2: Use a Windows Telnet Client Command `telnet` to Connect to a Cisco Router.

In this task, you will telnet into the R2-Central router and use common IOS commands to examine the router routing table. Cisco devices have a Telnet server and, if properly configured, will permit remote logins. Access to the router is restricted, however, and requires a username and password. The password for all usernames is `cisco`. The username depends on the pod. Username `ccna1` is for users on pod 1 computer, `ccna2` is for students on pod 2 computers, and so on.

Step 1: Using the Windows Telnet client, log in to a Cisco router.

Open a terminal window by clicking **Start > Run**. Type `cmd`, and click **OK**. A terminal window and prompt should be available. The Telnet utility has several options and can be viewed with the `telnet /?` command. A username and password will be required to log in to the router. For all usernames, the corresponding password is `cisco`.

Pod Number	Username
1	ccna1
2	ccna2
3	ccna3
4	ccna4
5	ccna5
6	ccna6
7	ccna7
8	ccna8
9	Ccna9
10	ccna10
11	ccna11

To start a Telnet session with router R2-central, type the command:

```
C:/> telnet 172.16.255.254 <ENTER>
```

A login window will prompt for a username, as shown below. Enter the applicable username, and press <ENTER>. Enter the password, `cisco`, and press <ENTER>. The router prompt should be visible after a successful login.

```
*****
                This is Eagle 1 lab router R2-Central.
                Authorized access only.
*****

User Access Verification

Username: ccna1
Password: cisco (hidden)
R2-Central#
```

At the prompt, `R2-Central#`, a successful Telnet login has been created. Only limited permissions for `ccnax` usernames are available; therefore, it is not possible to modify router settings or view the configuration. The purpose of this task was to establish a Telnet session, which has been accomplished. In the next task, the router routing table will be examined.

Task 3: Examine Router Routes using Basic Cisco IOS Commands.

As with any network device, gateway addresses instruct the device about how to reach other networks when no other information is available. Similar to the host computer default gateway IP address, a router may also employ a default gateway. Also similar to a host computer, a router is knowledgeable about directly connected networks.

This task will not examine Cisco IOS commands in detail but will use a common IOS command to view the routing table. The syntax to view the routing table is:

```
show ip route <ENTER>
```

Step 1: Enter the command to display the router routing table.

The route information displayed is much more detailed than the route information on a host computer. This is to be expected, because the job of a router is to route traffic between networks. The information required of this task, however, is not difficult to glean. Figure 2 shows the routing table for R2-Central.

```
R2-Central#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default, U - per-user static route
        o - ODR, P - periodic downloaded static route

Gateway of last resort is 10.10.10.6 to network 0.0.0.0

C    172.16.0.0/16 is directly connected, FastEthernet0/0
    10.0.0.0/30 is subnetted, 1 subnets
C      10.10.10.4 is directly connected, Serial0/2/0
S*   0.0.0.0/0 [1/0] via 10.10.10.6
R2-Central#
```

Figure 2. Output of the Cisco IOS show ip route Command

The Codes section shown in Figure 3 provides an explanation for the symbols to the left of each route entry.

```
R2-Central#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default, U - per-user static route
        o - ODR, P - periodic downloaded static route

4 Gateway of last resort is 10.10.10.6 to network 0.0.0.0

1 C    172.16.0.0/16 is directly connected, FastEthernet0/0
    10.0.0.0/30 is subnetted, 1 subnets
1 C      10.10.10.4 is directly connected, Serial0/2/0
2 3 S*   0.0.0.0/0 [1/0] via 10.10.10.6
R2-Central#
```

Figure 3. Explanation of Codes

- ① C denotes directly connected networks and the interface that supports the connection.
- ② S denotes a static route, which is manually entered by the Cisco network engineer.
- ③ Because the route is "quad-zero," it is a candidate default route.
- ④ If there is no other route in the routing table, use this gateway of last resort IP address to forward packets.

How is IP mask information displayed in a router routing table?

What would the router do with packets destined to 192.168.254.254?

When finished examining the routing table, exit the router with the command **exit** <ENTER>. The telnet client will also close the connection with the telnet escape sequence <CTRL>] and **quit**. Close the terminal window.

Task 4: Reflection

Two new Windows commands were used in this lab. The **route** command was used to view, delete, and add route information on the pod host computer.

The Windows Telnet client, **telnet**, was used to connect to a lab router, R2-Central. This technique will be used in other labs to connect to Cisco network devices.

The router routing table was examined with the Cisco IOS command **show ip route**. Routes for directly connected networks, statically assigned routes, and gateway of last resort information are displayed.

Task 5: Challenge

Other Cisco IOS commands can be used to view IP address information on a router. Similar to the Windows **ipconfig** command, the Cisco IOS command **show ip interface brief** will display IP address assignments.

```
R2-Central#show ip interface brief
Interface      IP-Address      OK? Method Status      Protocol
FastEthernet0/0 172.16.255.254 YES manual up          up
FastEthernet0/1 unassigned      YES unset  administratively down down
Serial0/2/0     10.10.10.5     YES manual up          up
Serial0/2/1     unassigned      YES unset  administratively down down
R2-Central#
```

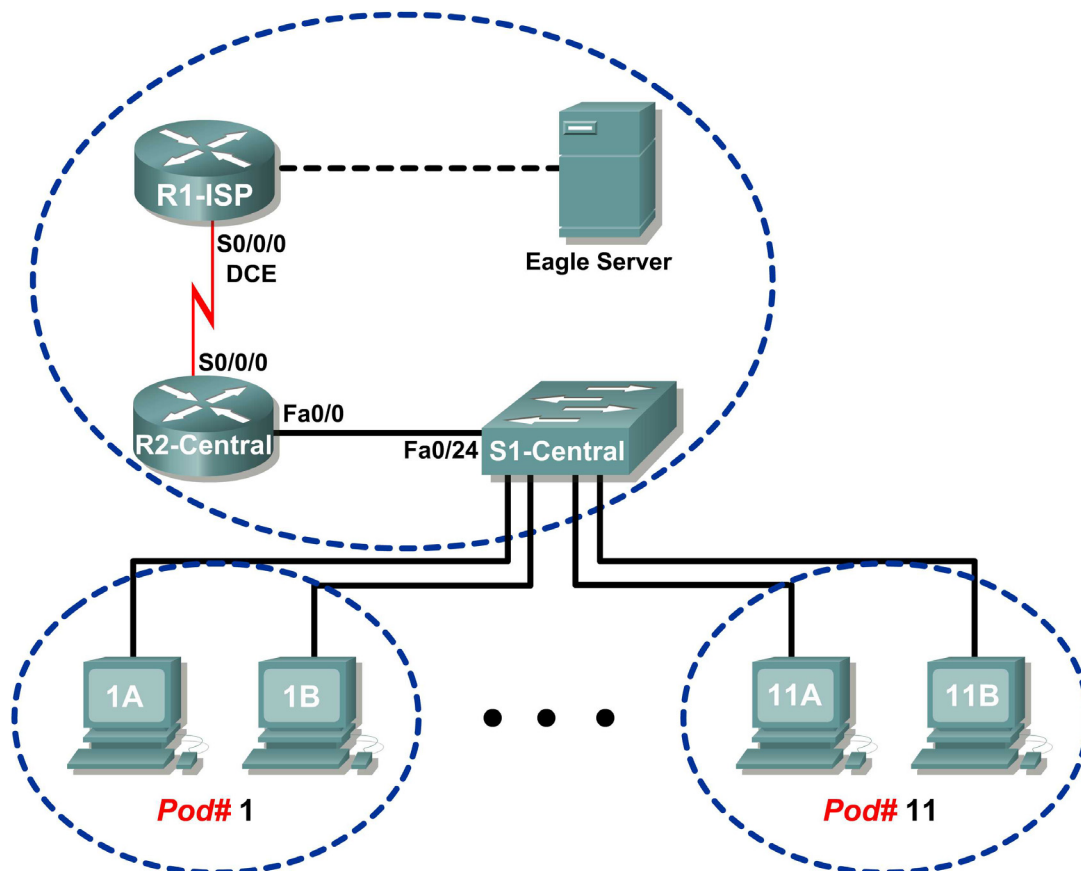
Using Windows commands and the Cisco IOS commands in this lab, compare network information output. What was missing? What critical network information was similar?

Task 6: Clean Up.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 6.7.1: Ping and Traceroute

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16.Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16.Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Use the **ping** command to verify simple TCP/IP network connectivity.
- Use the **tracert/traceroute** command to verify TCP/IP connectivity.

Background

Two tools that are indispensable when testing TCP/IP network connectivity are **ping** and **tracert**. The **ping** utility is available on Windows, Linux, and Cisco IOS, and tests network connectivity. The **tracert** utility is available on Windows, and a similar utility, **traceroute**, is available on Linux and Cisco IOS. In addition to testing for connectivity, **tracert** can be used to check for network latency.

For example, when a web browser fails to connect to a web server, the problem can be anywhere between client and the server. A network engineer may use the **ping** command to test for local network connectivity or connections where there are few devices. In a complex network, the **tracert** command would be used. Where to begin connectivity tests has been the subject of much debate; it usually depends on the experience of the network engineer and familiarity with the network.

The Internet Control Message Protocol (ICMP) is used by both **ping** and **tracert** to send messages between devices. ICMP is a TCP/IP Network layer protocol, first defined in RFC 792, September, 1981. ICMP message types were later expanded in RFC 1700.

Scenario

In this lab, the **ping** and **tracert** commands will be examined, and command options will be used to modify the command behavior. To familiarize the students with the use of the commands, devices in the Cisco lab will be tested.

Measured delay time will probably be less than those on a production network. This is because there is little network traffic in the Eagle 1 lab.

Task 1: Use the **ping** Command to Verify Simple TCP/IP Network Connectivity.

The **ping** command is used to verify TCP/IP Network layer connectivity on the local host computer or another device in the network. The command can be used with a destination IP address or qualified name, such as eagle-server.example.com, to test domain name services (DNS) functionality. For this lab, only IP addresses will be used.

The **ping** operation is straightforward. The source computer sends an ICMP echo request to the destination. The destination responds with an echo reply. If there is a break between the source and destination, a router may respond with an ICMP message that the host is unknown or the destination network is unknown.

Step 1: Verify TCP/IP Network layer connectivity on the local host computer.

```
C:\> ipconfig
Windows IP Configuration
Ethernet adapter Local Area Connection:
    Connection-specific DNS Suffix  . : 
    IP Address. . . . . : 172.16.1.2
    Subnet Mask . . . . . : 255.255.0.0
    Default Gateway . . . . . : 172.16.255.254
C:\>
```

Figure 1. Local TCP/IP Network Information

1. Open a Windows terminal and determine IP address of the pod host computer with the **ipconfig** command, as shown in Figure 1.

The output should look the same except for the IP address. Each pod host computer should have the same network mask and default gateway address; only the IP address may differ. If the information is missing or if the subnet mask and default gateway are different, reconfigure the TCP/IP settings to match the settings for this pod host computer.

2. Record information about local TCP/IP network information:

TCP/IP Information	Value
IP Address	
Subnet Mask	
Default Gateway	

```

C:\> ping 172.16.1.2
Pinging 172.16.1.2 with 32 bytes of data:
Reply from 172.16.1.2: bytes=32 time<1ms TTL=128
Reply from 172.16.1.2: bytes=32 time<1ms TTL=128
Reply from 172.16.1.2: bytes=32 time<1ms TTL=128
Reply from 172.16.1.2: bytes=32 time<1ms TTL=128

Ping statistics for 172.16.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\>

```

Figure 2. Output of the ping Command on the Local TCP/IP Stack

3. Use the **ping** command to verify TCP/IP Network layer connectivity on the local host computer.

By default, four ping requests are sent to the destination and reply information is received. Output should look similar to that shown in Figure 2.

- ① Destination address, set to the IP address for the local computer.

- ② Reply information:

bytes—size of the ICMP packet.

time—elapsed time between transmission and reply.

TTL—default TTL value of the DESTINATION device, minus the number of routers in the path. The maximum TTL value is 255, and for newer Windows machines the default value is 128.

- ③ Summary information about the replies:

- ④ Packets Sent—number of packets transmitted. By default, four packets are sent.

- ⑤ Packets Received—number of packets received.

- ⑥ Packets Lost —difference between number of packets sent and received.

- ⑦ Information about the delay in replies, measured in milliseconds. Lower round trip times indicate faster links. A computer timer is set to 10 milliseconds. Values faster than 10 milliseconds will display 0.

4. Fill in the results of the **ping** command on your computer:

Field	Value
Size of packet	
Number of packets sent	
Number of replies	
Number of lost packets	
Minimum delay	
Maximum delay	
Average delay	

Step 2: Verify TCP/IP Network layer connectivity on the LAN.

```
C:\> ping 172.16.255.254
Pinging 172.16.255.254 with 32 bytes of data:
Reply from 172.16.255.254: bytes=32 time=1ms TTL=255
Reply from 172.16.255.254: bytes=32 time<1ms TTL=255
Reply from 172.16.255.254: bytes=32 time<1ms TTL=255
Reply from 172.16.255.254: bytes=32 time<1ms TTL=255
Ping statistics for 172.16.255.254:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms
C:\>
```

Figure 3. Output of the ping Command to the Default Gateway

1. Use the **ping** command to verify TCP/IP Network layer connectivity to the default gateway. Results should be similar to those shown in Figure 3.

Cisco IOS default TTL value is set to 255. Because the datagrams did not travel through a router, the TTL value returned is 255.

2. Fill in the results of the **ping** command to the default Gateway:

Field	Value
Size of packet	
Number of packets sent	
Number of replies	
Number of lost packets	
Minimum delay	
Maximum delay	
Average delay	

What would be the result of a loss of connectivity to the default gateway?

Step 3: Verify TCP/IP Network layer connectivity to a remote network.

```
C:\> ping 192.168.254.254
Pinging 192.168.254.254 with 32 bytes of data:
Reply from 192.168.254.254: bytes=32 time<1ms TTL=62
Reply from 192.168.254.254: bytes=32 time<1ms TTL=62
Reply from 192.168.254.254: bytes=32 time<1ms TTL=62
Reply from 192.168.254.254: bytes=32 time<1ms TTL=62
Ping statistics for 192.168.254.254:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\>
```

Figure 4. Output of the ping Command to Eagle Server

1. Use the **ping** command to verify TCP/IP Network layer connectivity to a device on a remote network. In this case, Eagle Server will be used. Results should be similar to those shown in Figure 4.

Linux default TTL value is set to 64. Since the datagrams traveled through two routers to reach Eagle Server, the returned TTL value is 62.

2. Fill in the results of the **ping** command on your computer:

Field	Value
Size of packet	
Number of packets sent	
Number of replies	
Number of lost packets	
Minimum delay	
Maximum delay	
Average delay	

```
C:\> ping 192.168.254.254
Pinging 192.168.254.254 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Ping statistics for 192.168.254.254:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
C:\>
```

Figure 5. Output of a ping Command with Lost Packets

The **ping** command is extremely useful when troubleshooting network connectivity. However, there are limitations. In Figure 5, the output shows that a user cannot reach Eagle Server. Is the problem with Eagle Server or a device in the path? The **tracert** command, examined next, can display network latency and path information.

Task 2: Use the `tracert` Command to Verify TCP/IP Connectivity.

The `tracert` command is useful for learning about network latency and path information. Instead of using the `ping` command to test connectivity of each device to the destination, one by one, the `tracert` command can be used.

On Linux and Cisco IOS devices, the equivalent command is `traceroute`.

Step 1: Verify TCP/IP Network layer connectivity with the `tracert` command.

1. Open a Windows terminal and issue the following command:

```
C:\> tracert 192.168.254.254
```

```
C:\> tracert 192.168.254.254
Tracing route to 192.168.254.254 over a maximum of 30 hops
  1    <1 ms    <1 ms    <1 ms    172.16.255.254
  2    <1 ms    <1 ms    <1 ms    10.10.10.6
  3    <1 ms    <1 ms    <1 ms    192.168.254.254
Trace complete.
C:\>
```

Figure 6. Output of the `tracert` command to Eagle Server.

Output from the `tracert` command should be similar to that shown in Figure 6.

2. Record your result in the following table:

Field	Value
Maximum number of hops	
First router IP address	
Second router IP address	
Destination reached?	

Step 2: Observe `tracert` output to a host that lost network connectivity.

If there is a loss of connectivity to an end device such as Eagle Server, the `tracert` command can give valuable clues as to the source of the problem. The `ping` command would show the failure but not any other kind of information about the devices in the path. Referring to the Eagle 1 lab Topology Diagram, both R2-Central and R1-ISP are used for connectivity between the pod host computers and Eagle Server.

```
C:\> tracert -w 5 -h 4 192.168.254.254
Tracing route to 192.168.254.254 over a maximum of 4 hops
  1    <1 ms    <1 ms    <1 ms    172.16.255.254
  2    <1 ms    <1 ms    <1 ms    10.10.10.6
  3    *        *        *        Request timed out.
  4    *        *        *        Request timed out.

Trace complete.
C:\>
```

Figure 7. Output of the `tracert` Command

Refer to Figure 7. Options are used with the `tracert` command to reduce wait time (in milliseconds), `-w 5`, and maximum hop count, `-h 4`. If Eagle Server was disconnected from the network, the default gateway would respond correctly, as well as R1-ISP. The problem must be on the 192.168.254.0/24 network. In this example, Eagle Server has been turned off.

What would the **tracert** output be if R1-ISP failed?

What would the **tracert** output be if R2-Central failed?

Task 3: Challenge

The default values for the **ping** command normally work for most troubleshooting scenarios. There are times, however, when fine tuning **ping** options may be useful. Issuing the **ping** command without any destination address will display the options shown in Figure 8:

```
C:\> ping

Usage: ping [-t] [-a] [-n count] [-l size] [-f] [-i TTL] [-v TOS]
           [-r count] [-s count] [[-j host-list] | [-k host-list]]
           [-w timeout] target_name

Options:
    -t                Ping the specified host until stopped.
                     To see statistics and continue - type Control-
Break;
                     To stop - type Control-C.
    -a                Resolve addresses to hostnames.
    -n count          Number of echo requests to send.
    -l size            Send buffer size.
    -f                Set Don't Fragment flag in packet.
    -i TTL            Time To Live.
    -v TOS            Type Of Service.
    -r count          Record route for count hops.
    -s count          Timestamp for count hops.
    -j host-list      Loose source route along host-list.
    -k host-list      Strict source route along host-list.
    -w timeout        Timeout in milliseconds to wait for each reply.

C:\>
```

Figure 8. Output of a ping Command with no Destination Address

The most useful options are highlighted in yellow. Some options do not work together, such as the **-t** and **-n** options. Other options can be used together. Experiment with the following options:

To **ping** the destination address until stopped, use the **-t** option. To stop, press <CTRL> C:

```
C:\> ping -t 192.168.254.254
Pinging 192.168.254.254 with 32 bytes of data:
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Ping statistics for 192.168.254.254:
    Packets: Sent = 6, Received = 6, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
Control-C
^C
C:\>
```

Figure 9. Output of a ping Command using the -t Option

To **ping** the destination once, and record router hops, use the **-n** and **-r** options, as shown in Figure 10.
Note: Not all devices will honor the **-r** option.

```
C:\> ping -n 1 -r 9 192.168.254.254
Pinging 192.168.254.254 with 32 bytes of data:
Reply from 192.168.254.254: bytes=32 time=1ms TTL=63
    Route:          10.10.10.5 ->
                192.168.254.253 ->
                192.168.254.254 ->
                10.10.10.6 ->
                172.16.255.254
Ping statistics for 192.168.254.254:
    Packets: Sent = 1, Received = 1, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 1ms, Average = 1ms
C:\>
```

Figure 10. Output of a ping Command using the -n and -r Options

Task 4: Reflection

Both **ping** and **tracert** are used by network engineers to test network connectivity. For basic network connectivity, the **ping** command works best. To test latency and the network path, the **tracert** command is preferred.

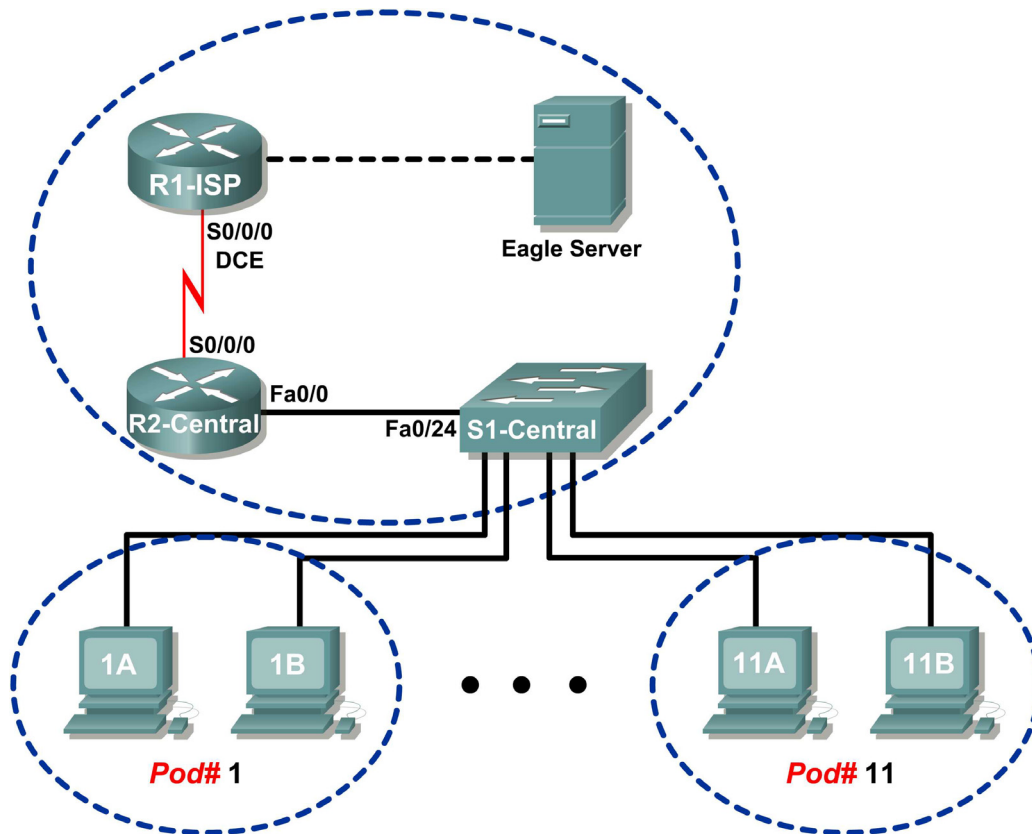
The ability to accurately and quickly diagnose network connectivity issues is a skill expected from a network engineer. Knowledge about the TCP/IP protocols and practice with troubleshooting commands will build that skill.

Task 5: Clean Up.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 6.7.2: Examining ICMP Packets

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16.Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16.Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Understand the format of ICMP packets.
- Use Wireshark to capture and examine ICMP messages.

Background

The Internet Control Message Protocol (ICMP) was first defined in RFC 792, September, 1981. ICMP message types were later expanded in RFC 1700. ICMP operates at the TCP/IP Network layer and is used to exchange information between devices.

ICMP packets serve many uses in today's computer network. When a router cannot deliver a packet to a destination network or host, an informational message is returned to the source. Also, the **ping** and **tracert** commands send ICMP messages to destinations, and destinations respond with ICMP messages.

Scenario

Using the Eagle 1 Lab, Wireshark captures will be made of ICMP packets between network devices.

Task 1: Understand the Format of ICMP Packets.

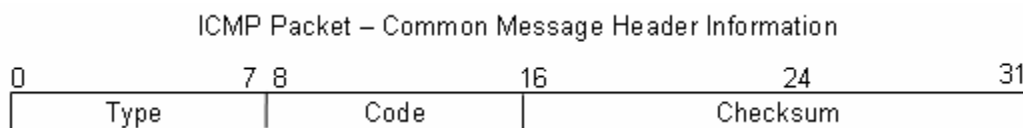


Figure 1. ICMP Message Header

Refer to Figure 1, the ICMP header fields common to all ICMP message types. Each ICMP message starts with an 8-bit Type field, an 8-bit Code field, and a computed 16-bit Checksum. The ICMP message type describes the remaining ICMP fields. The table in Figure 2 shows ICMP message types from RFC 792:

Value	Meaning
0	Echo Reply
3	Destination Unreachable
4	Source Quench
5	Redirect
8	Echo
11	Time Exceeded
12	Parameter Problem
13	Timestamp
14	Timestamp Reply
15	Information Request
16	Information Reply

Figure 2. ICMP Message Types

Codes provide additional information to the Type field. For example, if the Type field is 3, destination unreachable, additional information about the problem is returned in the Code field. The table in Figure 3 shows message codes for an ICMP Type 3 message, destination unreachable, from RFC 1700:

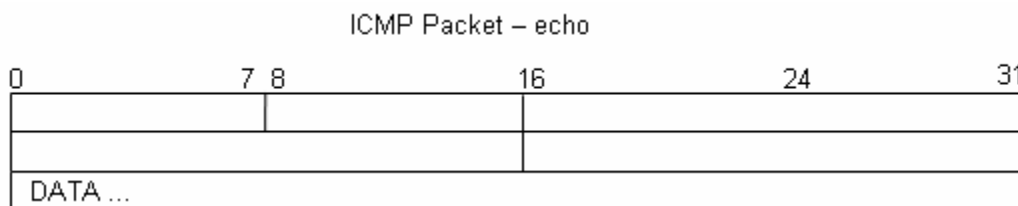
Code Value	Meaning
0	Net Unreachable
1	Host Unreachable
2	Protocol Unreachable
3	Port Unreachable
4	Fragmentation Needed and Don't Fragment was Set
5	Source Route Failed
6	Destination Network Unknown
7	Destination Host Unknown
8	Source Host Isolated
9	Communication with Destination Network is Administratively Prohibited
10	Communication with Destination Host is Administratively Prohibited
11	Destination Network Unreachable for Type of Service
12	Destination Host Unreachable for Type of Service

Figure 3. ICMP Type 3 Message Codes

Using ICMP message capture shown in Figure 4, fill in the fields for the ICMP packet echo request. Values beginning with 0x are hexadecimal numbers:

```
Internet Control Message Protocol
Type: 8 (Echo (ping) request)
Code: 0
Checksum: 0x365c [correct]
Identifier: 0x0200
Sequence number: 0x1500
Data (32 bytes)
```

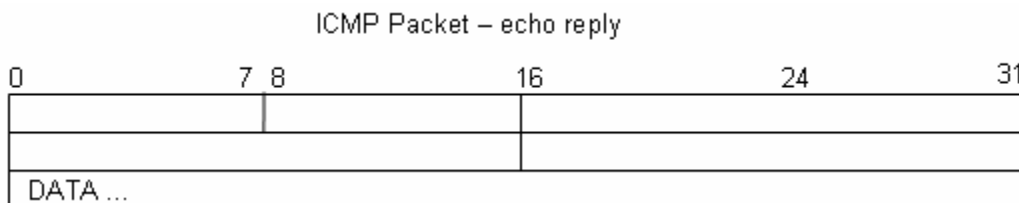
Figure 4. ICMP Packet Echo Request



Using the ICMP message capture shown in Figure 5, fill in the fields for the ICMP packet echo reply:

```
Internet Control Message Protocol
Type: 0 (Echo (ping) reply)
Code: 0
Checksum: 0x3e5c [correct]
Identifier: 0x0200
Sequence number: 0x1500
Data (32 bytes)
```

Figure 5. ICMP Packet Echo Reply



At the TCP/IP Network layer, communication between devices is not guaranteed. However, ICMP does provide minimal checks for a reply to match the request. From the information provided in the ICMP messages above, how does the sender know that the reply is to a specific echo?

Task 2: Use Wireshark to Capture and Examine ICMP Messages.



Figure 6. Wireshark Download Site

If Wireshark has not been loaded on the pod host computer, it can be downloaded from Eagle Server.

1. Open a web browser, URL [FTP://eagle-server.example.com/pub/eagle_labs/eagle1/chapter6](ftp://eagle-server.example.com/pub/eagle_labs/eagle1/chapter6), as shown in Figure 6.
2. Right-click the Wireshark filename, click **Save Link As**, and save the file to the pod host computer.
3. When the file has been downloaded, open and install Wireshark.

Step 1: Capture and evaluate ICMP echo messages to Eagle Server.

In this step, Wireshark will be used to examine ICMP echo messages.

1. Open a Windows terminal on the pod host computer.
2. When ready, start Wireshark capture.

```
C:\> ping eagle-server.example.com
Pinging eagle-server.example.com [192.168.254.254] with 32 bytes of
data:
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Reply from 192.168.254.254: bytes=32 time<1ms TTL=63
Ping statistics for 192.168.254.254:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\>
```

Figure 7. Successful ping Replies from Eagle Server

- From the Windows terminal, **ping** Eagle Server. Four successful replies should be received from Eagle Server, as shown in Figure 7.
- Stop Wireshark capture. There should be a total of four ICMP echo requests and matching echo replies, similar to those shown in Figure 8.

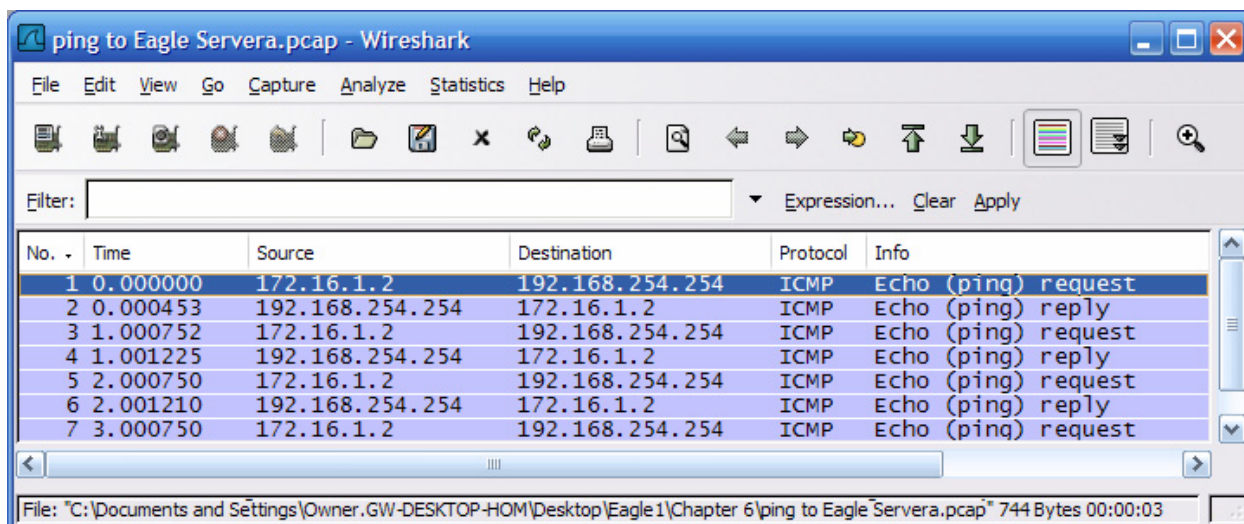


Figure 8. Wireshark Capture of ping Requests and Replies

Which network device responds to the ICMP echo request? _____

- Expand the middle window in Wireshark, and expand the Internet Control Message Protocol record until all fields are visible. The bottom window will also be needed to examine the Data field.
- Record information from the *first* echo request packet to Eagle Server:

Field	Value
Type	
Code	
Checksum	
Identifier	
Sequence number	
Data	

Are there 32 bytes of data? _____

7. Record information from the *first* echo reply packet from Eagle Server:

Field	Value
Type	
Code	
Checksum	
Identifier	
Sequence number	
Data	

Which fields, if any, changed from the echo request?

8. Continue to evaluate the remaining echo requests and replies. Fill in the following information from each new ping:

Packet	Checksum	Identifier	Sequence number
Request # 2			
Reply # 2			
Request # 3			
Reply # 3			
Request # 4			
Reply # 4			

Why did the Checksum values change with each new request?

Step 2: Capture and evaluate ICMP echo messages to 192.168.253.1.

In this step, pings will be sent to a fictitious network and host. The results from the Wireshark capture will be evaluated—and may be surprising.

Try to ping IP address 192.168.253.1.

```
C:\> ping 192.168.253.1
```

```
C:\> ping 192.168.253.1
Pinging 192.168.253.1 with 32 bytes of data:
Reply from 172.16.255.254: Destination host unreachable.
Reply from 172.16.255.254: Destination host unreachable.
Reply from 172.16.255.254: Destination host unreachable.
Reply from 172.16.255.254: Destination host unreachable.
Ping statistics for 192.168.253.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\>
```

Figure 9. Ping Results from a Fictitious Destination

See Figure 9. Instead of a request timeout, there is an echo response.

What network device responds to pings to a fictitious destination?

No. -	Time	Source	Destination	Protocol	Info
1	0.000000	172.16.1.2	192.168.253.1	ICMP	Echo (ping) request
2	0.000816	172.16.255.254	172.16.1.2	ICMP	Destination unreachable (Host unreachable)
3	1.000854	172.16.1.2	192.168.253.1	ICMP	Echo (ping) request
4	1.001686	172.16.255.254	172.16.1.2	ICMP	Destination unreachable (Host unreachable)
5	2.001815	172.16.1.2	192.168.253.1	ICMP	Echo (ping) request
6	2.002547	172.16.255.254	172.16.1.2	ICMP	Destination unreachable (Host unreachable)
7	3.002815	172.16.1.2	192.168.253.1	ICMP	Echo (ping) request
8	3.003588	172.16.255.254	172.16.1.2	ICMP	Destination unreachable (Host unreachable)

Figure 10. Wireshark Capture from a Fictitious Destination

Wireshark captures to a fictitious destination are shown in Figure 10. Expand the middle Wireshark window and the Internet Control Message Protocol record.

Which ICMP message type is used to return information to the sender?

What is the code associated with the message type?

Step 3: Capture and evaluate ICMP echo messages that exceed the TTL value.

In this step, pings will be sent with a low TTL value, simulating a destination that is unreachable. Ping Eagle Server, and set the TTL value to 1:

```
C:\> ping -i 1 192.168.254.254
```

```
C:\> ping -i 1 192.168.254.254
Pinging 192.168.254.254 with 32 bytes of data:
Reply from 172.16.255.254: TTL expired in transit.
Reply from 172.16.255.254: TTL expired in transit.
Reply from 172.16.255.254: TTL expired in transit.
Reply from 172.16.255.254: TTL expired in transit.
Ping statistics for 192.168.254.254:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\>
```

Figure 11. Ping Results for an Exceeded TTL

See Figure 11, which shows ping replies when the TTL value has been exceeded.

What network device responds to pings that exceed the TTL value?

No. -	Time	Source	Destination	Protocol	Info
1	0.000000	172.16.1.2	192.168.254.254	ICMP	Echo (ping) request
2	0.000701	172.16.255.254	172.16.1.2	ICMP	Time-to-live exceeded (Time to live exceeded in transit)
3	1.000003	172.16.1.2	192.168.254.254	ICMP	Echo (ping) request
4	1.000687	172.16.255.254	172.16.1.2	ICMP	Time-to-live exceeded (Time to live exceeded in transit)
5	1.999996	172.16.1.2	192.168.254.254	ICMP	Echo (ping) request
6	2.000761	172.16.255.254	172.16.1.2	ICMP	Time-to-live exceeded (Time to live exceeded in transit)
7	3.000970	172.16.1.2	192.168.254.254	ICMP	Echo (ping) request
8	3.001723	172.16.255.254	172.16.1.2	ICMP	Time-to-live exceeded (Time to live exceeded in transit)

Figure 12. Wireshark Capture of TTL Value Exceeded

Wireshark captures to a fictitious destination are shown in Figure 12. Expand the middle Wireshark window and the Internet Control Message Protocol record.

Which ICMP message type is used to return information to the sender?

What is the code associated with the message type?

Which network device is responsible for decrementing the TTL value?

Task 3: Challenge

Use Wireshark to capture a `tracert` session to Eagle Server and then to 192.168.254.251. Examine the ICMP TTL exceeded message. This will demonstrate how the `tracert` command traces the network path to the destination.

Task 4: Reflection

The ICMP protocol is very useful when troubleshooting network connectivity issues. Without ICMP messages, a sender has no way to tell why a destination connection failed. Using the `ping` command, different ICMP message type values were captured and evaluated.

Task 5: Clean Up

Wireshark may have been loaded on the pod host computer. If the program must be removed, click **Start > Control Panel > Add or Remove Programs**, and scroll down to Wireshark. Click the filename, click **Remove**, and follow uninstall instructions.

Remove any Wireshark pcap files that were created on the pod host computer.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Activity 6.7.3: IPv4 Address Subnetting Part 1

Learning Objectives

Upon completion of this activity, you will be able to determine network information for a given IP address and network mask.

Background

This activity is designed to teach how to compute network IP address information from a given IP address.

Scenario

When given an IP address and network mask, you will be able to determine other information about the IP address such as:

- Network address
- Network broadcast address
- Total number of host bits
- Number of hosts

Task 1: For a given IP address, Determine Network Information.

Given:

Host IP Address	172.25.114.250
Network Mask	255.255.0.0 (/16)

Find:

Network Address	
Network Broadcast Address	
Total Number of Host Bits	
Number of Hosts	

Step 1: Translate Host IP address and network mask into binary notation.

Convert the host IP address and network mask to binary:

	172	25	114	250
IP Address	10101100	11001000	01110010	11111010
Network Mask	11111111	11111111	00000000	00000000
	255	255	0	0

Step 2: Determine the network address.

1. Draw a line under the mask.
2. Perform a bit-wise AND operation on the IP address and the subnet mask.

Note: 1 AND 1 results in a 1; 0 AND anything results in a 0.

3. Express the result in dotted decimal notation.
4. The result is the network address for this host IP address, which is **172.25.0.0**.

	172	25	114	250
IP Address	10101100	11001000	01110010	11111010
Subnet Mask	11111111	11111111	00000000	00000000
Network Address	10101100	11001000	00000000	00000000
	172	25	0	0

Step 3: Determine the broadcast address for the network address

The network mask separates the network portion of the address from the host portion. The network address has all 0s in the host portion of the address and the broadcast address has all 1s in the host portion of the address.

	172	25	0	0
Network Add.	10101100	11001000	00000000	00000000
Mask	11111111	11111111	00000000	00000000
Broadcast.	10101100	11001000	11111111	11111111
	172	25	255	255

By counting the number of host bits, we can determine the total number of usable hosts for this network.

Host bits: 16

Total number of hosts:

$$2^{16} = 65,536$$

65,536 – 2 = 65,534 (addresses that cannot use the *all 0s* address, network address, or the *all 1s* address, broadcast address.)

Add this information to the table:

Host IP Address	172.25.114.250
Network Mask	255.255.0.0 (/16)
Network Address	
Network Broadcast Address	
Total Number of Host Bits Number of Hosts	

Task 2: Challenge

For all problems:

Create a Subnetting Worksheet to show and record all work for each problem.

Problem 1

Host IP Address	172.30.1.33
Network Mask	255.255.0.0
Network Address	
Network Broadcast Address	
Total Number of Host Bits	
Number of Hosts	

Problem 2

Host IP Address	172.30.1.33
Network Mask	255.255.255.0
Network Address	
Network Broadcast Address	
Total Number of Host Bits	
Number of Hosts	

Problem 3

Host IP Address	192.168.10.234
Network Mask	255.255.255.0
Network Address	
Network Broadcast Address	
Total Number of Host Bits	
Number of Hosts	

Problem 4

Host IP Address	172.17.99.71
Network Mask	255.255.0.0
Network Address	
Network Broadcast Address	
Total Number of Host Bits	
Number of Hosts	

Problem 5

Host IP Address	192.168.3.219
Network Mask	255.255.0.0
Network Address	
Network Broadcast Address	
Total Number of Host Bits	
Number of Hosts	

Problem 6

Host IP Address	192.168.3.219
Network Mask	255.255.255.224
Network Address	
Network Broadcast Address	
Total Number of Host Bits	
Number of Hosts	

Task 3: Clean Up

Remove anything that was brought into the lab, and leave the room ready for the next class.

Activity 6.7.4: IPv4 Address Subnetting Part 2

Learning Objectives

Upon completion of this activity, you will be able to determine subnet information for a given IP address and subnetwork mask.

Background

Borrowing Bits

How many bits must be borrowed to create a certain number of subnets or a certain number of hosts per subnet?

Using this chart, it is easy to determine the number of bits that must be borrowed.

Things to remember:

- Subtract 2 for the usable number of hosts per subnet, one for the subnet address and one for the broadcast address of the subnet.

2 ¹⁰	2 ⁹	2 ⁸	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰
1,024	512	256	128	64	32	16	8	4	2	1
Number of bits borrowed:										
10	9	8	7	6	5	4	3	2	1	1
1,024	512	256	128	64	32	16	8	4	2	1
Hosts or Subnets										

Possible Subnet Mask Values

Because subnet masks must be contiguous 1's followed by contiguous 0's, the converted dotted decimal notation can contain one of a certain number of values:

Dec.	Binary
255	11111111
254	11111110
252	11111100
248	11111000
240	11110000
224	11100000
192	11000000
128	10000000
0	00000000

Scenario

When given an IP address, network mask, and subnetwork mask, you will be able to determine other information about the IP address such as:

- The subnet address of this subnet
- The broadcast address of this subnet
- The range of host addresses for this subnet
- The maximum number of subnets for this subnet mask
- The number of hosts for each subnet
- The number of subnet bits
- The number of this subnet

Task 1: For a Given IP Address and Subnet Mask, Determine Subnet Information.

Given:

Host IP Address	172.25.114.250
Network Mask	255.255.0.0 (/16)
Subnet Mask	255.255.255.192 (/26)

Find:

Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Step 1: Translate host IP address and subnet mask into binary notation.

	172	25	114	250
IP Address	10101100	11001000	01110010	11111010
	11111111	11111111	11111111	11000000
Subnet Mask	255	255	255	192

Step 2: Determine the network (or subnet) where this host address belongs.

1. Draw a line under the mask.
2. Perform a bit-wise AND operation on the IP Address and the Subnet Mask.

Note: 1 AND 1 results in a 1' 0 AND anything results in a 0.

3. Express the result in dotted decimal notation.

4. The result is the Subnet Address of this Subnet, which is **172.25.114.192**

	172	25	114	250
IP Address	10101100	11001000	01110010	11111010
Subnet Mask	11111111	11111111	11111111	11000000
Subnet Address	10101100	11001000	01110010	11000000
	172	25	114	192

Add this information to the table:

Subnet Address for this IP Address	172.25.114.192
---	-----------------------

Step 3: Determine which bits in the address contain network information and which contain host information.

1. Draw the *Major Divide* (M.D.) as a wavy line where the 1s in the major network mask end (also the mask if there was no subnetting). In our example, the major network mask is 255.255.0.0, or the first 16 left-most bits.
2. Draw the *Subnet Divide* (S.D.) as a straight line where the 1s in the given subnet mask end. The network information ends where the 1s in the mask end.

		M.D.	S.D.	
IP Address	10101110	11001000	01110010	11111010
Subnet Mask	11111111	11111111	11111111	11000000
Subnet Add.	10001010	11001000	01110010	11000000
← 10 bits →				

3. The result is the Number of Subnet Bits, which can be determined by simply counting the number of bits between the M.D. and S.D., which in this case is 10 bits.

Step 4: Determine the bit ranges for subnets and hosts.

1. Label the *subnet counting range* between the M.D. and the S.D. This range contains the bits that are being incremented to create the subnet numbers or addresses.
2. Label the *host counting range* between the S.D. and the last bits at the end on the right. This range contains the bits that are being incremented to create the host numbers or addresses.

		M.D.	S.D.	
IP Address	10101110	11001000	01110010	11111010
Subnet Mask	11111111	11111111	11111111	11000000
Subnet Add.	10001010	11001000	01110010	11000000
← subnet counting range → ← host counting range →				

Step 5: Determine the range of host addresses available on this subnet and the broadcast address on this subnet.

1. Copy down all of the network/subnet bits of the network address (that is, all bits before the S.D.).
2. In the host portion (to the right of the S.D.), make the host bits all 0s except for the right-most bit (or least significant bit), which you make a 1. This gives us the *first* host IP address on this subnet, which is the *first part* of the result for *Range of Host Addresses for This Subnet*, which in the example is **172.25.114.193**.
3. Next, in the host portion (to the right of the S.D.), make the host bits all 1s except for the right-most bit (or least significant bit), which you make a 0. This gives us the *last* host IP address on this subnet, which is the last part of the result for *Range of Host Addresses for This Subnet*, which in the example is **172.25.114.254**.
4. In the host portion (to the right of the S.D.), make the host bits all 1s. This gives us the broadcast IP address on this subnet. This is the result for *Broadcast Address of This Subnet*, which in the example is **172.25.114.255**.

	M.D.		S.D.		
IP Address	10101100	11001000	01110010	11	111010
Subnet Mask	11111111	11111111	11111111	11	000000
Subnet Add.	10101100	11001000	01110010	11	000000
			~ subnet ~ counting range		~ host ~ counting range
First Host	10101100	11001000	01110010	11	000001
	172	25	114		193
Last Host	10101100	11001000	01110010	11	111110
	172	25	114		254
Broadcast	10101100	11001000	01110010	11	111111
	172	25	114		255

Let's add some of this information to our table:

Host IP Address	172.25.114.250
Major Network Mask	255.255.0.0 (/16)
Major (Base) Network Address	172.25.0.0
Major Network Broadcast Address	172.25.255.255
Total Number of Host Bits Number of Hosts	16 bits or 2^{16} or 65,536 total hosts 65,536 – 2 = 65,534 usable hosts
Subnet Mask	255.255.255.192 (/26)
Number of Subnet Bits Number of Subnets	
Number of Host Bits per Subnet Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Step 6: Determine the number of subnets.

The number of subnets is determined by how many bits are in the *subnet counting range* (in this example, 10 bits).

Use the formula 2^n , where n is the number of bits in the *subnet counting range*.

$$1. \quad 2^{10} = 1024$$

Number of Subnet Bits Number of Subnets (all 0s used, all 1s not used)	10 bits $2^{10} = 1024$ subnets
--	------------------------------------

Step 7: Determine the number usable hosts per subnet.

The number of hosts per subnet is determined by the number of host bits (in this example, 6 bits) minus 2 (1 for the subnet address and 1 for the broadcast address of the subnet).

$$2^6 - 2 = 64 - 2 = 62 \text{ hosts per subnet}$$

Number of Host Bits per Subnet Number of Usable Hosts per Subnet	6 bits $2^6 - 2 = 64 - 2 = 62$ hosts per subnet
---	--

Step 8: Final Answers

Host IP Address	172.25.114.250
Subnet Mask	255.255.255.192 (/26)
Number of Subnet Bits Number of Subnets	26 bits $2^{10} = 1024$ subnets
Number of Host Bits per Subnet Number of Usable Hosts per Subnet	6 bits $2^6 - 2 = 64 - 2 = 62$ hosts per subnet
Subnet Address for this IP Address	172.25.114.192
IP Address of First Host on this Subnet	172.25.114.193
IP Address of Last Host on this Subnet	172.25.114.254
Broadcast Address for this Subnet	172.25.114.255

Task 2: Challenge.

For all problems:

Create a Subnetting Worksheet to show and record all work for each problem.

Problem 1

Host IP Address	172.30.1.33
Subnet Mask	255.255.255.0
Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Problem 2

Host IP Address	172.30.1.33
Subnet Mask	255.255.255.252
Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Problem 3

Host IP Address	192.192.10.234
Subnet Mask	255.255.255.0
Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Problem 4

Host IP Address	172.17.99.71
Subnet Mask	255.255.0.0
Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Problem 5

Host IP Address	192.168.3.219
Subnet Mask	255.255.255.0
Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Problem 6

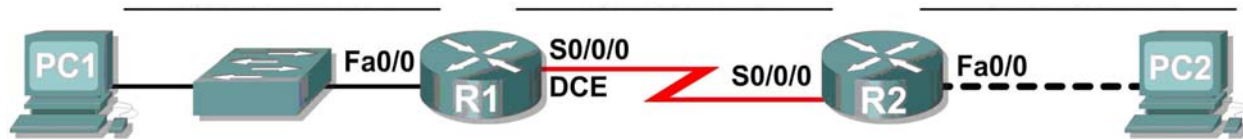
Host IP Address	192.168.3.219
Subnet Mask	255.255.255.252
Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Task 3: Clean Up

Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 6.7.5: Subnet and Router Configuration

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0			N/A
	S0/0/0			N/A
R2	Fa0/0			N/A
	S0/0/0			N/A
PC1	NIC			
PC2	NIC			

Learning Objectives

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

- Subnet an address space per given requirements.
- Assign appropriate addresses to interfaces and document.
- Configure and activate Serial and FastEthernet interfaces.
- Test and verify configurations.
- Reflect upon and document the network implementation.

Scenario

In this lab activity, you will design and apply an IP addressing scheme for the topology shown in the Topology Diagram. You will be given one address block that you must subnet to provide a logical addressing scheme for the network. The routers will then be ready for interface address configuration according to your IP addressing scheme. When the configuration is complete, verify that the network is working properly.

Task 1: Subnet the Address Space.

Step 1: Examine the network requirements.

You have been given the 192.168.1.0/24 address space to use in your network design. The network consists of the following segments:

- The LAN connected to router R1 will require enough IP addresses to support 15 hosts.
- The LAN connected to router R2 will require enough IP addresses to support 30 hosts.
- The link between router R1 and router R2 will require IP addresses at each end of the link.

The plan should have equal size subnets and use the smallest subnet sizes that will accommodate the appropriate number of hosts.

Step 2: Consider the following questions when creating your network design.

How many subnets are needed for this network? _____

What is the subnet mask for this network in dotted decimal format? _____

What is the subnet mask for the network in slash format? _____

How many usable hosts are there per subnet? _____

Step 3: Assign subnetwork addresses to the Topology Diagram.

1. Assign second subnet to the network attached to R1.
2. Assign third subnet to the link between R1 and R2.
3. Assign fourth subnet to the network attached to R2.

Task 2: Determine Interface Addresses.

Step 1: Assign appropriate addresses to the device interfaces.

1. Assign the first valid host address in second subnet to the LAN interface on R1.
2. Assign the last valid host address in second subnet to PC1.
3. Assign the first valid host address in third subnet to the WAN interface on R1.
4. Assign the last valid host address in third subnet to the WAN interface on R2.
5. Assign the first valid host address in fourth subnet to the LAN interface of R2.
6. Assign the last valid host address in fourth subnet to PC2.

Step 2: Document the addresses to be used in the table provided under the Topology Diagram.

Task 3: Configure the Serial and FastEthernet Addresses.

Step 1: Configure the router interfaces.

Configure the interfaces on the R1 and R2 routers with the IP addresses from your network design. Please note, to complete the activity in Packet Tracer you will be using the Config Tab. When you have finished, be sure to save the running configuration to the NVRAM of the router.

Step 2: Configure the PC interfaces.

Configure the Ethernet interfaces of PC1 and PC2 with the IP addresses and default gateways from your network design.

Task 4: Verify the Configurations.

Answer the following questions to verify that the network is operating as expected.

From the host attached to R1, is it possible to ping the default gateway? _____

From the host attached to R2, is it possible to ping the default gateway? _____

From the router R1, is it possible to ping the Serial 0/0/0 interface of R2? _____

From the router R2, is it possible to ping the Serial 0/0/0 interface of R1? _____

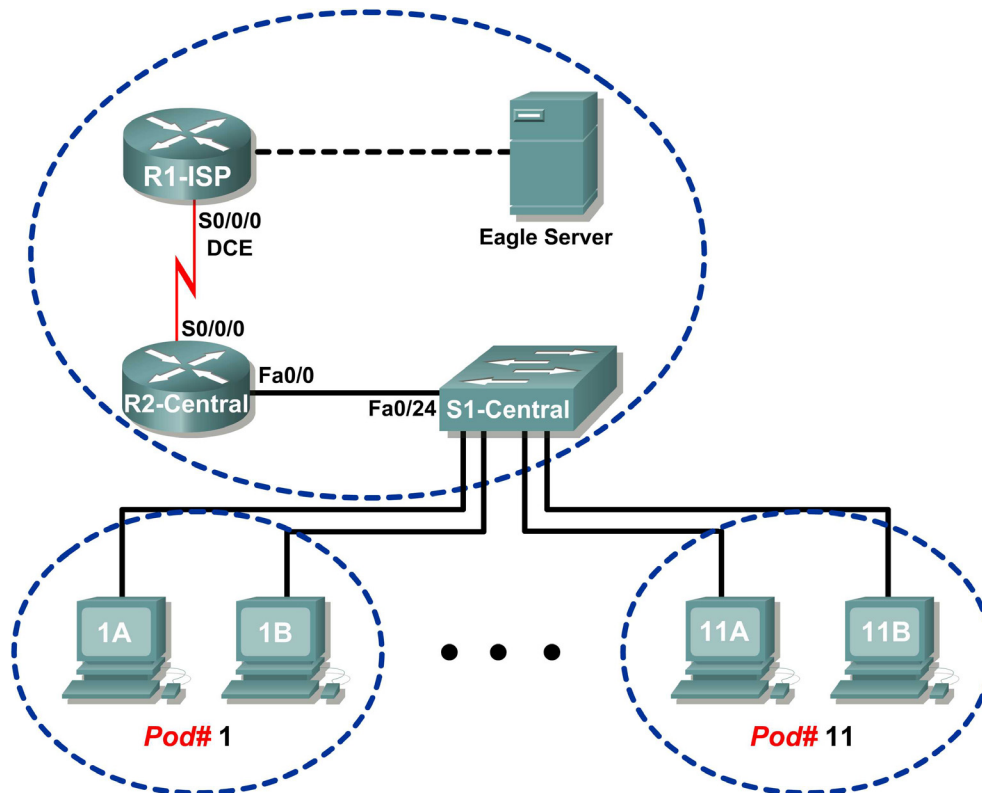
Task 5: Reflection

Are there any devices on the network that cannot ping each other?

What is missing from the network that is preventing communication between these devices?

Lab 7.5.2: Frame Examination

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16.Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16.Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Explain the header fields in an Ethernet II frame.
- Use Wireshark to capture and analyze Ethernet II frames.

Background

When upper layer protocols communicate with each other, data flows down the OSI layers and is encapsulated into a Layer 2 frame. The frame composition is dependent on the media access type. For example, if the upper layer protocol is TCP/IP and the media access is Ethernet, then the Layer 2 frame encapsulation will be Ethernet II.

When learning about Layer 2 concepts, it is helpful to analyze frame header information. The Ethernet II frame header will be examined in this lab. Ethernet II frames can support various upper layer protocols, such as TCP/IP.

Scenario

Wireshark will be used to capture and analyze Ethernet II frame header fields. If Wireshark has not been loaded on the host pod computer, it can be downloaded from URL ftp://eagle-server.example.com/pub/eagle_labs/eagle1/chapter7/, file `wireshark-setup-0.99.4.exe`.

The Windows `ping` command will be used to generate network traffic for Wireshark to capture.

Task 1: Explain the Header Fields in an Ethernet II Frame.

The format for an Ethernet II frame is shown in Figure 1.

Ethernet II Frame Format					
Preamble	Destination Address	Source Address	Frame Type	Data	FCS
8 Octets	6 Octets	6 Octets	2 Octets	46- 1500 Octets	4 Octets

Figure 1. Ethernet II Frame Format

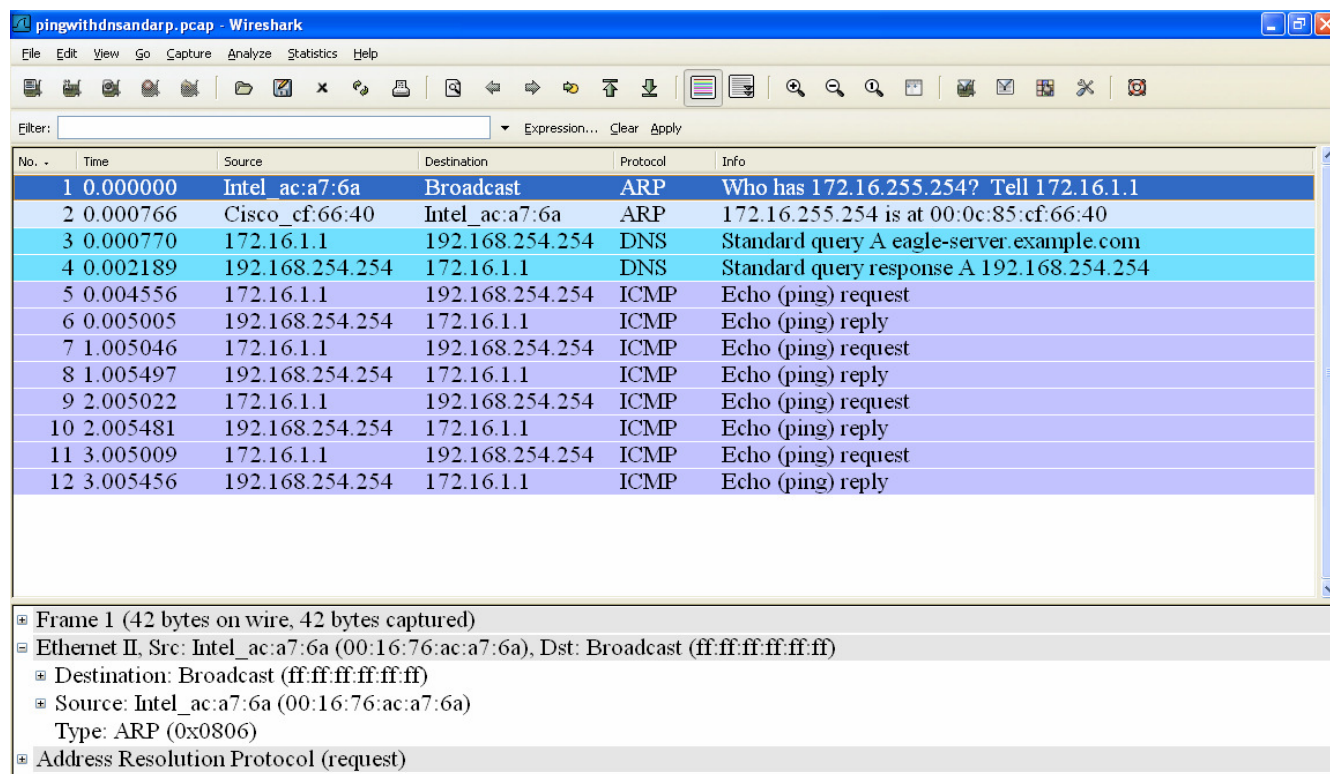


Figure 2. Wireshark Capture of the ping Command

In Figure 2, the Panel List window shows a Wireshark capture of the **ping** command between a pod host computer and Eagle Server. The session begins with the ARP protocol querying for the MAC address of the Gateway router, followed by a DNS query. Finally, the **ping** command issues echo requests.

In Figure 2, the Packet Details window shows Frame 1 detail information. Using this window, the following Ethernet II frame information can be obtained:

Field	Value	Description
Preamble	Not shown in capture.	This field contains synchronizing bits, processed by the NIC hardware.
Destination Address	ff:ff:ff:ff:ff:ff	Layer 2 addresses for the frame. Each address is 48 bits long, or 6 bytes, expressed as 12 hexadecimal digits, 0–9, A–F. A common format is 12:34:56:78:9A:BC. The first six hex numbers indicate the manufacturer of the network interface card (NIC). Refer to http://www.neotechcc.org/forum/macid.htm for a list of vendor codes. The last six hex digits, ac:a7:6a, are the serial number of the NIC. The destination address may be a broadcast which contains all 1s or unicast. The source address is always unicast.
Source Address	00:16:76:ac:a7:6a	
Frame Type	0x0806	For Ethernet II frames, this field contains a hexadecimal value that is used to indicate the type of upper layer protocol in the data field. There are numerous upper layer protocols supported by Ethernet II. Two common frame

Field	Value	Description
		types are: <div> <div>Value</div> <div>Description</div> <div>0x0800</div> <div>IPv4 Protocol</div> <div>0x0806</div> <div>Address resolution protocol (ARP)</div> </div>
Data	ARP	Contains the encapsulated upper level protocol. The data field is between 46 – 1500 bytes.
FCS	Not shown in capture.	Frame Check Sequence, used by the NIC to identify errors during transmission. The value is computed by the sending machine, encompassing frame addresses, type, and data field. It is verified by the receiver.

What is the significance of all **1s** in the destination address field?

From the information contained in the Packet List window for the **first** frame, answer the following questions about the destination and source MAC address:

Destination Address:

MAC address: _____
NIC manufacturer: _____
NIC serial number: _____

Source Address:

MAC address: _____
NIC manufacturer: _____
NIC serial number: _____

From the information contained in the Packet List window for the **second** frame, answer the following questions about the destination and source MAC address:

Destination Address:

MAC address: _____
NIC manufacturer: _____
NIC serial number: _____

Source Address:

MAC address: _____
NIC manufacturer: _____
NIC serial number: _____

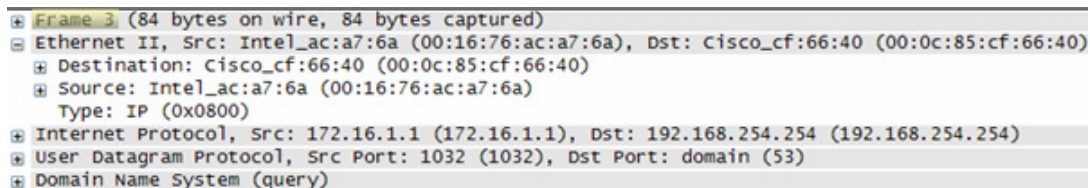


Figure 3. Frame 3 Fields

Figure 3 contains an exploded view of the Frame 3 Wireshark capture. Use the information to complete the following table:

Field	Value
Preamble	
Destination Address	
Source Address	
Frame Type	
Data	
FCS	

In the following task, Wireshark will be used to capture and analyze packets captured on the pod host computer.

Task 2: Use Wireshark to Capture and Analyze Ethernet II Frames.

Step 1: Configure Wireshark for packet captures.

Prepare Wireshark for captures. Click **Capture > Interfaces**, and then click the start button that corresponds to the 172.16.x.y interface IP address. This will begin the packet capture.

Step 2: Start a ping to Eagle Server and capture the session.

Open a Windows terminal window. Click **Start > Run**, type `cmd`, and click **OK**.

```

Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\> ping eagle-server.example.com

Pinging eagle-server.example.com [192.168.254.254] with 32 bytes of
data:

Reply from 192.168.254.254: bytes=32 time<1ms TTL=62
Reply from 192.168.254.254: bytes=32 time<1ms TTL=62
Reply from 192.168.254.254: bytes=32 time<1ms TTL=62
Reply from 192.168.254.254: bytes=32 time<1ms TTL=62

Ping statistics for 192.168.254.254:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
  
```

Figure 4. Ping to eagle-server.example.com

Ping eagle-server.example.com, as shown in Figure 4. When the command has finished execution, stop Wireshark captures.

Step 3: Analyze the Wireshark capture.

The Wireshark Packet List window should start with an ARP request and reply for the MAC address of the Gateway. Next, a DNS request is made for the IP address of eagle-server.example.com. Finally, the **ping** command is executed. Your capture should look similar to the one shown in Figure 2.

Use your Wireshark capture of the **ping** command to answer the following questions:

Pod computer MAC address information:

MAC address: _____
NIC manufacturer: _____
NIC serial number: _____

R2-Central MAC address information:

MAC address: _____
NIC manufacturer: _____
NIC serial number: _____

A student from another school would like to know the MAC address for Eagle Server. What would you tell the student?

What is the Ethernet II frame type value for an ARP Request? _____

What is the Ethernet II frame type value for an ARP Reply? _____

What is the Ethernet II frame type value for a DNS query? _____

What is the Ethernet II frame type value for a DNS query response? _____

What is the Ethernet II frame type value for an ICMP echo? _____

What is the Ethernet II frame type value for an ICMP echo reply? _____

Task 3: Challenge

Use Wireshark to capture sessions from other TCP/IP protocols, such as FTP and HTTP. Analyze the captured packets, and verify that the Ethernet II frame type remains 0x0800.

Task 4: Reflection

In this lab, Ethernet II frame header information was examined. A preamble field contains seven bytes of alternating 0101 sequences, and one byte that signals the beginning of the frame, 01010110. Destination and source MAC addresses each contain 12 hex digits. The first six hex digits contain the manufacturer of the NIC, and the last six hex digits contain the NIC serial number. If the frame is a broadcast, the destination MAC address contains all 1s. A 4-byte frame type field contains a value that indicates the protocol in the data field. For IPv4, the value is 0x0800. The data field is variable and contains the encapsulated upper layer protocol. At the end of a frame, a 4-byte FCS value is used to verify that there were no errors during transmission.

Task 5: Clean Up

Wireshark was installed on the pod host computer. If Wireshark needs to be uninstalled, click **Start > Control Panel**. Open **Add or Remove Programs**. Highlight Wireshark, and click **Remove**.

Remove any files created on the pod host computer during the lab.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 8.4.1: Media Connectors Lab Activity



Fluke 620 LAN CableMeter

Learning Objectives

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

- Test cables using a Fluke620 LAN CableMeter and a Fluke LinkRunner
- Become familiar with the most common functions of a cable tester.
- Test different cables for type and wiring problems.

Background

Category (CAT 5) unshielded twisted-pair (UTP) cables are wired according to function. End devices, such as routers and host computers, connect to switches with CAT 5 straight-through cables. When connected together, however, a CAT 5 crossover cable must be used. This is also true of switches. When connecting one switch to another, a CAT 5 crossover cable is used again.

Problems related to cables are one of the most common causes of network failure. Basic cable tests can be very helpful in troubleshooting cabling problems with UTP. The quality of cabling components used, the routing and installation of the cable, and quality of the connector terminations will be the main factors in determining how trouble-free the cabling will be.

The following resources are required:

- Good CAT 5 straight-through and crossover wired cables of different colors.
- Category 5 straight-through and crossover wired cables with open wire connections in the middle or one or more conductors shorted at one end that are different colors and different lengths.
- Fluke 620 LAN CableMeter or equivalent.
- Fluke LinkRunner

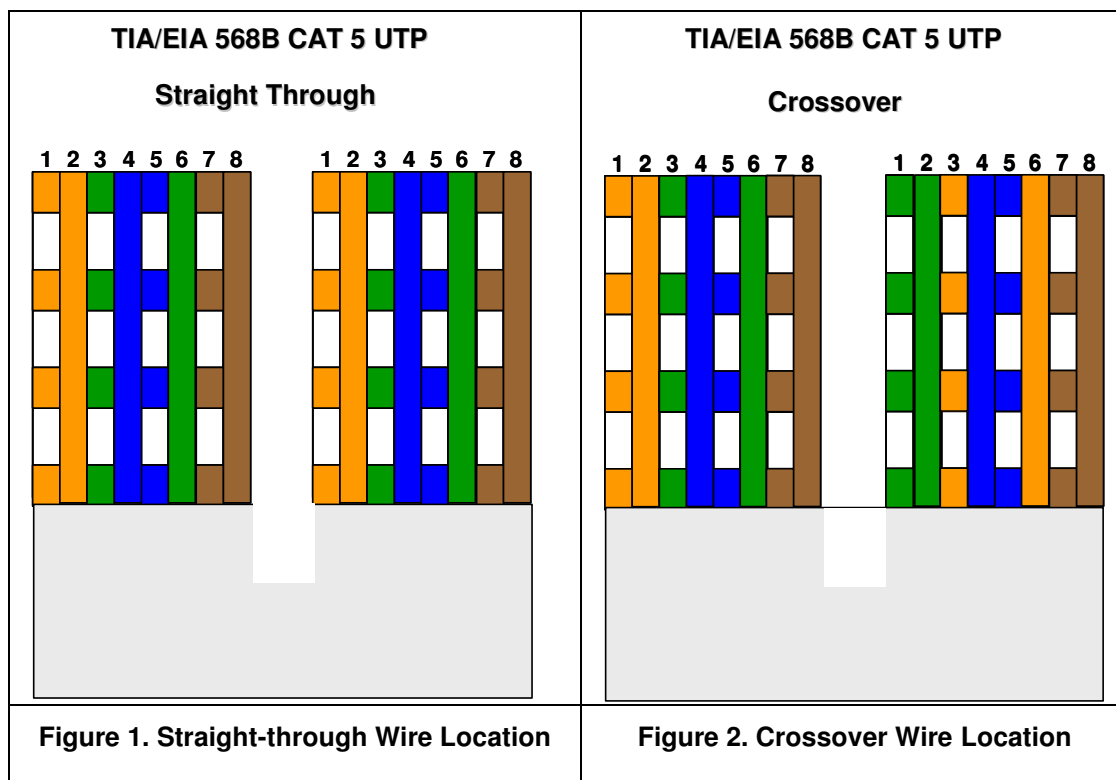
TIA/EIA 568B is different from TIA/EIA 568A wiring. TIA/EIA 568A straight-through cables can be identified by the color coding. Similar to Figure 2, below, the right wiring diagram, starting with the green-white cable, will be identical on both ends.

Scenario

First, you will visually determine whether the CAT 5 cable type is crossover or straight-through. Next, you will use the cable tester to verify the cable type, as well as common features available with the tester.

Finally, you will use the cable tester to test for bad cables that cannot be determined with a visual inspection.

Task 1: Become Familiar with the Most Common Functions of a Cable Tester.



Figures 1 and 2 show the TIA/EIA 568B CAT 5 UTP wire positioning for a straight-through and crossover cable, respectively. When CAT 5 connectors are held together, wire color is a quick way to determine the cable type.

Step 1: Visually determine cable types.

There should be two numbered cables available. Perform a visual inspection of the cables and then fill out the chart below with the cable color, cable type, and use:

Cable No.	Cable Color	Cable Type (straight-through or crossover)	Cable Use (Circle correct device)
1			Switch to: host / switch
2			Switch to: host / switch

It is now time to verify the cable type and learn about the common features of the cable tester.

Step 2: Perform initial configuration of the Fluke 620 LAN CableMeter.

Turn the rotary switch selector on the tester to the WIRE MAP position. The wire map function displays which pins on one end of the cable are connected to which pins on the other end.

Press the **SETUP** button to enter the setup mode, and observe the LCD screen on the tester. The first option should be CABLE. Press the **UP** or **DOWN** arrow buttons until the desired cable type of UTP is selected. Press **ENTER** to accept that setting and go to the next one. Continue pressing the **UP/DOWN** arrows and pressing **ENTER** until the tester is set to the following cabling settings:

Tester Option	Desired Setting – UTP
CABLE:	UTP
WIRING:	10BASE-T or EIA/TIA 4PR
CATEGORY:	CATEGORY 5
WIRE SIZE	AWG 24
CAL to CABLE?	NO
BEEPING:	ON or OFF
LCD CONTRAST	From 1 through 10 (brightest)

When satisfied with the correct settings, press the **SETUP** button to exit setup mode.

Step 3: Verify cable wire map.



Figure 3. Cable Coupler and Cable Identifier

Use the following procedure to test each cable with the LAN cable coupler and cable identifier, shown in Figure 3. The coupler and the cable identifier are accessories that come with the Fluke 620 LAN CableMeter.

Place the near end of the cable into the RJ-45 jack labeled UTP/FTP on the tester. Place the RJ-45-RJ-45 female coupler on the far end of the cable, and then insert the cable identifier into the other side of the coupler.

The wiring of both the near and far end of the cable will be displayed. The top set of numbers displayed on the LCD screen refers to the near end, and the bottom set of numbers refers to the far end.

Perform a Wire Map test on each of the cables provided, and fill in the following table based on the results. For each cable, write down the number and color, and whether the cable is straight-through or crossover.

Cable No.	Cable Color	Cable Type (straight-through or crossover)
1		
2		

Note any problems encountered during this test:

Step 4: Verify cable length.

Move the rotary switch selector on the tester to the LENGTH position. If power was cycled, repeat the setup steps described in Step 2. The tester LENGTH function displays the length of the cable.

Perform a basic cable test on each of the cables, and complete the following table based on the results. For each cable, write down the number and color, the cable length, the tester screen test results, and what the problem is, if there is a problem.

Cable No.	Cable Color	Cable Length
1		
2		

Note any problems encountered during this test:

Repeat these steps until you are comfortable with the use of the cable tester. In the next task, unknown cables will be tested.

Task 2: Test Different Cables for Type and Wiring Problems.

Obtain at least 5 different cables from your instructor. Move the rotary switch selector on the tester to the WIRE MAP position. If power was cycled, repeat the setup steps described in Task 1, Step 2.

Using the cable tester WIRE MAP function, perform a Wire Map test on each of the cables provided. Then fill in the following table based on the result for each Category 5 cable tested. For each cable, write down the number and color, whether the cable is straight-through or crossover, the tester screen test results, and any problem.

Cable No.	Cable Type (Visual inspection)	Cable Color	Cable type (straight-through or crossover)	* Test Results	Problem Description
1					
2					
3					
4					
5					

* Refer to the Fluke manual for detailed description of test results for wire map.

Task 3: Perform initial configuration of the Fluke LinkRunner



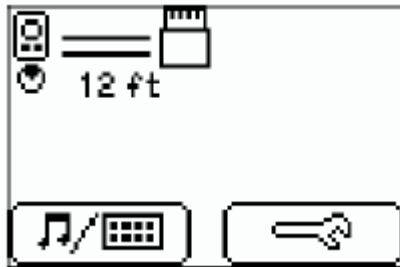
Fluke LinkRunner

Step 1: Turn the Fluke LinkRunner on by pressing the green button on the lower right along with the blue button on the right.

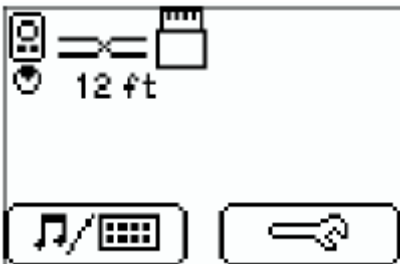
Step 2: Press the green button on the lower right to turn it back off.


Step 3: Place both ends of the cable into the LAN and MAP ports located on top of the LinkRunner and press the green button on the lower right along with the blue button to the left.

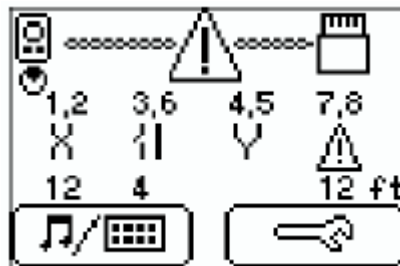
If it is a correct straight-through cable then two parallel lines (as shown below) will appear on the upper left corner on the screen.



If it is a correct crossover cable then two intersecting lines (as shown below) will appear on the upper left corner on the screen.



If it is a bad cable,  will appear and details will be displayed below.



 Open
 Short
 Split
 Reversal
 Unknown

Task 4: Verify Cable Length

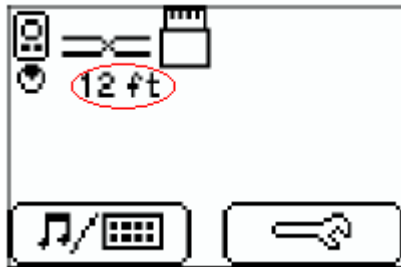
Note: The instructions to test a cable are the same as determining cable length.

Step 1: Turn the Fluke LinkRunner on by pressing the green button on the lower right along with the blue button on the right.

Step 2: Press the green button on the lower right to turn it back off.

Step 3: Place both ends of the cable into the LAN and MAP ports located on top of the LinkRunner and press the green button on the lower right along with the blue button to the left.

Step 4: Locate the length of the cable below the icon indicating the type of cable (as shown below).



Task 5: Reflection

Problems related to cables are one of the most common causes of network failure. Network technicians should be able to determine when to use CAT 5 UTP straight-through and crossover cables.

A cable tester is used to determine cable type, length, and wire map. In a lab environment, cables are constantly moved and reconnected. A properly functioning cable today may be broken tomorrow. This isn't unusual, and is part of the learning process.

Task 6: Challenge

Look for opportunities to test other cables with the Fluke 620 LAN CableMeter. Skills learned in this lab will enable you to quickly troubleshoot wrong cable types and broken cables.

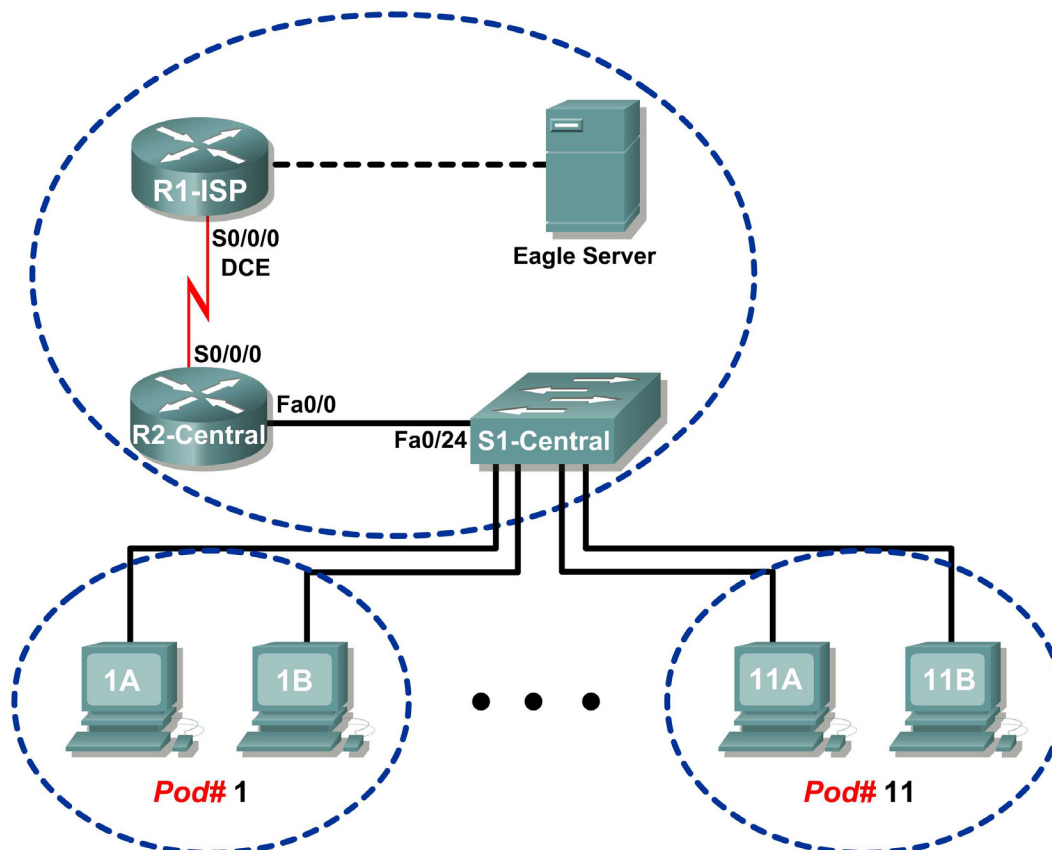
Task 7: Clean Up

The cable tester is very expensive and should never be left unattended. Return the cable tester to the instructor when finished.

Ask the instructor where to return used cables. Store the cables neatly for the next class.

Lab 9.8.1: Address Resolution Protocol (ARP)

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16.Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16.Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Use Windows **arp** command.
- Use Wireshark to examine ARP exchanges.

Background

Address Resolution Protocol (ARP) is used by TCP/IP to map a Layer 3 IP address to a Layer 2 MAC address. When a frame is placed on the network, it must have a destination MAC address. To dynamically discover the MAC address to the destination device, an ARP request is broadcast on the LAN. The device that contains the destination IP address responds, and the MAC address is recorded in ARP cache. Every device on the LAN keeps its own ARP cache, or small area in RAM that holds ARP results. An ARP cache timer removes ARP entries that have not been used for a certain period of time. Depending on the device, times differ. For example, some Windows operating systems store ARP cache entries for 2 minutes. If the entry is used again during that time, the ARP timer for that entry is extended to 10 minutes.

ARP is an excellent example in performance tradeoff. With no cache, ARP must continually request address translations each time a frame is placed on the network. This adds latency to the communication and could congest the LAN. Conversely, unlimited hold times could cause errors with devices that leave the network or change the Layer 3 address.

A network engineer needs to be aware of ARP but may not interact with the protocol on a regular basis. ARP is a protocol that enables network devices to communicate with the TCP/IP protocol. Without ARP, there is no efficient method to build the datagram Layer 2 destination address. Also, ARP is a potential security risk. ARP spoofing, or ARP poisoning, is a technique used by an attacker to inject the wrong MAC address association in a network. An attacker forges the MAC address of a device, and frames are sent to the wrong destination. Manually configuring static ARP associations is one way to prevent ARP spoofing. Finally, an authorized MAC address list may be configured Cisco devices to restrict network access to only approved devices.

Scenario

With a pod host computer, use the Windows **arp** utility command to examine and change ARP cache entries.

In Task 2, Wireshark will be used to capture and analyze ARP exchanges between network devices. If Wireshark has not been loaded on the host pod computer, it can be downloaded from URL ftp://eagle-server.example.com/pub/eagle_labs/eagle1/chapter9/, file `wireshark-setup-0.99.4.exe`.

Task 1: Use the Windows `arp` Command.

Step 1: Access the Windows terminal.

```
C:\> arp
Displays and modifies the IP-to-Physical address translation tables
used by address resolution protocol (ARP).
ARP -s inet_addr eth_addr [if_addr]
ARP -d inet_addr [if_addr]
ARP -a [inet_addr] [-N if_addr]
-a          Displays current ARP entries by interrogating the current
            protocol data. If inet_addr is specified, the IP and
            Physical addresses for only the specified computer are
            displayed. If more than one network interface uses ARP,
            entries for each ARP table are displayed.
-g          Same as -a.
inet_addr   Specifies an internet address.
-N if_addr  Displays the ARP entries for the network interface
            specified by if_addr.
-d          Deletes the host specified by inet_addr. inet_addr may be
            wildcarded with * to delete all hosts.
-s          Adds the host and associates the Internet address inet_addr
            with the Physical address eth_addr. The Physical address
            is given as 6 hexadecimal bytes separated by hyphens. The
            entry is permanent.
eth_addr    Specifies a physical address.
if_addr     If present, this specifies the Internet address of the
            interface whose address translation table should be
            modified. If not present, the first applicable interface
            will be used.

Example:
> arp -s 157.55.85.212 00-aa-00-62-c6-09 .... Adds a static entry.
> arp -a                                     .... Displays the arp table.
C:\>
```

Figure 1. `arp` Command Syntax

1. Open a Windows terminal by clicking **Start > Run**. Type `cmd`, and click **OK**.
With no options, the `arp` command will display useful help information. See Figure 1.
2. Issue the `arp` command on the pod host computer, and examine the output.
3. Answer the following questions about the `arp` command:

What command would be used to display all entries in ARP cache?

What command would be used to delete all ARP cache entries (flush ARP cache)?

What command would be used to delete the ARP cache entry for 172.16.255.254?

Step 2: Use the `arp` command to examine local ARP cache.

```
C:\> arp -a
No ARP Entries Found
C:\>
```

Figure 2. Empty ARP Cache

Without any network communication, the ARP cache should be empty. This is shown in Figure 2.

Issue the command that displays ARP entries. What are the results?

Step 3: Use the `ping` command to dynamically add entries in the ARP cache.

The `ping` command can be used to test network connectivity. By accessing other devices, ARP associations are dynamically added to ARP cache.

```
C:\> ping 172.16.1.2
Pinging 172.16.1.2 with 32 bytes of data:
Reply from 172.16.1.2: bytes=32 time<1ms TTL=128
Reply from 172.16.1.2: bytes=32 time<1ms TTL=128
Reply from 172.16.1.2: bytes=32 time<1ms TTL=128
Reply from 172.16.1.2: bytes=32 time<1ms TTL=128
Ping statistics for 172.16.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\>
```

Figure 3. `ping` Command to a Pod Host Computer

1. Use the command `ipconfig /all` to verify the pod host computer's Layer 2 and Layer 3 information.
2. Issue the `ping` command to another pod host computer, shown in Figure 3. Figure 4 shows the new ARP cache entry.

```
C:\> arp -a
Interface: 172.16.1.1 --- 0x60004
    Internet Address      Physical Address      Type
    172.16.1.2            00-10-a4-7b-01-5f    dynamic
C:\>
```

Figure 4. Display of ARP Cache

How was the ARP entry added to the ARP cache? Hint: review the Type column.

What is the physical address of the destination pod host computer?

What is the physical address of the destination pod host computer?

IP Address	Physical Address	How Discovered?

- Do not send any traffic to the computer accessed previously. Wait between 2 and 3 minutes, and check ARP cache again. Was the ARP cache entry cleared? _____
- Issue the **ping** command to the Gateway, R2-Central. Examine ARP cache entry. What is the physical address of the Gateway? _____

IP Address	Physical Address	How Discovered?

- Issue the **ping** command to Eagle Server, eagle-server.example.com. Examine ARP cache entry. What is the physical address of Eagle Server? _____

Step 4: Manually adjust entries in the ARP cache.

To delete entries in ARP cache, issue the command **arp -d {inet-addr | *}**. Addresses can be deleted individually by specifying the IP address, or all entries can be deleted with the wildcard *****.

Verify that the ARP cache contains two entries: one for the Gateway and one to the destination pod host computer. It may be easier to ping both devices more than once, which will retain the cache entry for approximately 10 minutes.

```
C:\> arp -a
Interface: 172.16.1.1 --- 0x60004
    Internet Address      Physical Address      Type
    172.16.1.2            00-10-a4-7b-01-5f    dynamic
    172.16.255.254        00-0c-85-cf-66-40    dynamic
C:\>
C:\>arp -d 172.16.255.254
C:\> arp -a
Interface: 172.16.1.1 --- 0x60004
    Internet Address      Physical Address      Type
    172.16.1.2            00-10-a4-7b-01-5f    dynamic
C:\>
```

Figure 5. Manually Removing an ARP Cache Entry

See Figure 5, which shows how to manually delete an ARP cache entry.

- On your computer, first verify that the two entries are present. If not, ping the missing entry.
- Next, delete the entry for the pod host computer.
- Finally, verify your change.
- Record the two ARP cache entries:

Device	IP Address	Physical Address	How Discovered?

- Write the command that will delete the entry for the pod host computer:

6. Issue the command on your pod host computer. Record the remaining ARP cache entry:

Device	IP Address	Physical Address	How Discovered?

7. Simulate removing all entries. Write the command that will delete all entries in ARP cache:

8. Issue the command on your pod host computer, and examine the ARP cache with the command **arp -a**. All entries should be removed. _____

9. Consider a secure environment where the Gateway controls access to a web server that contains Top Secret information. What is one layer of security that can be applied to ARP cache entries that could aid in countering ARP spoofing? _____

10. Write the command that will add a static ARP entry for the Gateway to ARP cache:

11. Examine the ARP cache again, and fill in the following table:

IP Address	Physical Address	Type
------------	------------------	------

For the next task, Wireshark will be used to capture and examine an ARP exchange. Do not close the Windows terminal—it will be used to view the ARP cache.

Task 2: Use Wireshark to Examine ARP Exchanges .

Step 1: Configure Wireshark for packet captures.

Prepare Wireshark for captures.

1. Click **Capture > Options**.
2. Select the Interface that corresponds to the LAN.
3. Check the box to Update list of packets in real time.
4. Click **Start**.

This will begin the packet capture.

Step 2: Prepare the pod host computer for ARP captures.

1. If not already completed, open a Windows terminal window by clicking **Start > Run**. Type **cmd**, and click **OK**.
2. Flush the ARP cache, which will require ARP to rediscover address maps. Write the command that you used: _____

Step 3: Capture and evaluate ARP communication.

In this step, one ping request will be sent to the Gateway, and one ping request will be sent to Eagle Server. Afterward, Wireshark capture will be stopped and the ARP communication evaluated.

1. Send one ping request to the Gateway, using the command **ping -n 1 172.16.255.254**.
2. Send one ping request to Eagle Server, using the command **ping -n 1 192.168.254.254**.

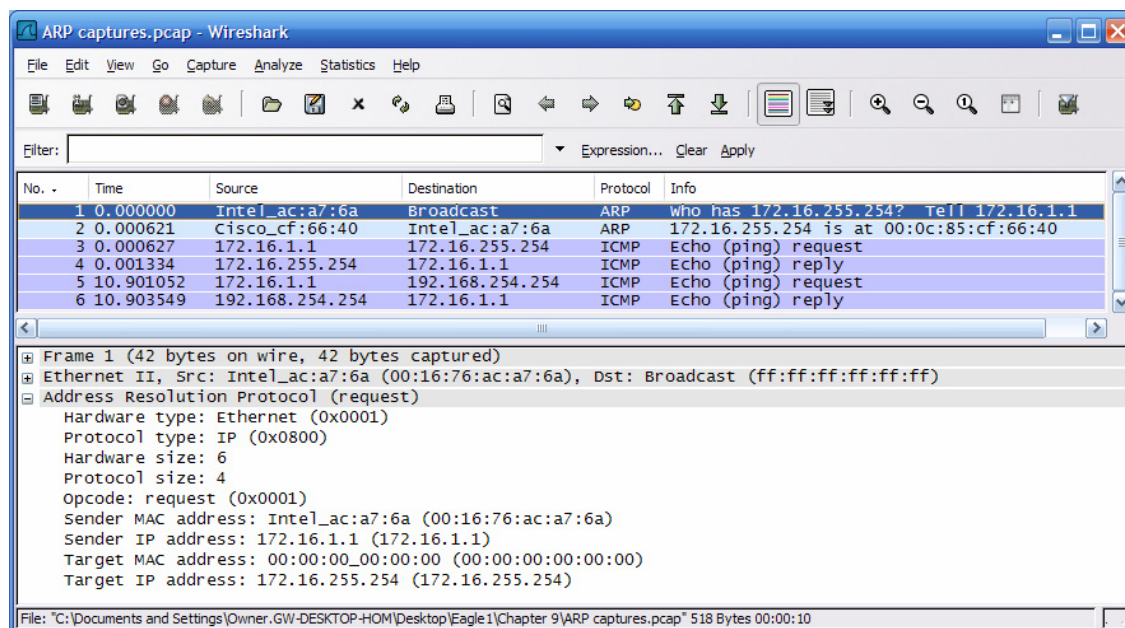


Figure 6. Wireshark Capture of ARP Communication

- Stop Wireshark and evaluate the communication. You should see a Wireshark screen similar to the screen shown in Figure 6. The Wireshark Packet list window displays the number of packets captured. The Packet Details Window shows ARP protocol contents.
- Using your Wireshark capture, answer the following questions:

What was the first ARP packet? _____

What was the second ARP packet? _____

Fill in the following table with information about the first ARP packet:

Field	Value
Sender MAC address	
Sender IP address	
Target MAC address	
Target IP address	

Fill in the following table with information about the second ARP packet:

Field	Value
Sender MAC address	
Sender IP address	
Target MAC address	
Target IP address	

If the Ethernet II frame for an ARP request is a broadcast, why does the Target MAC address contain all 0s? _____

Why was there no ARP request for the ping to Eagle Server? _____

How long should the Gateway mapping be stored in ARP cache on the pod host computer? Why?

Task 3: Reflection

The ARP protocol maps Layer 3 IP addresses to Layer 2 MAC addresses. If a packet must move across networks, the Layer 2 MAC address changes with each hop across a router, but the Layer 3 address never changes.

ARP cache stores ARP address mappings. If the entry was learned dynamically, it will eventually be deleted from cache. If the entry was manually inserted in ARP cache, it is a static entry and will remain until the computer is turned off or the ARP cache is manually flushed.

Task 4: Challenge

Using outside resources, perform a search on ARP spoofing. Discuss several techniques used to counter this type of attack.

Most wireless routers support wireless network access. Using this technique, MAC addresses that are permitted access to the wireless network are manually added to the wireless router. Using outside resources, discuss the advantages of configuring wireless network access. Discuss ways that attackers can circumvent this security.

Task 5: Clean Up

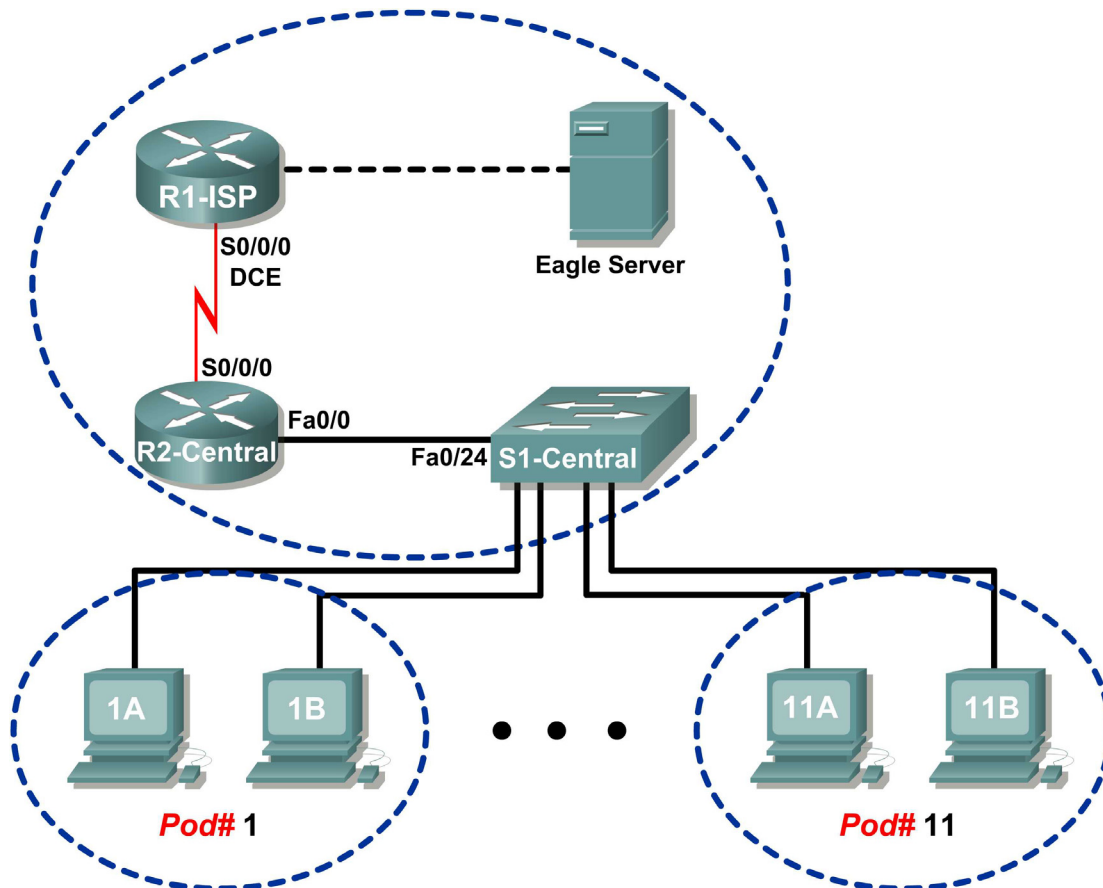
Wireshark was installed on the pod host computer. If Wireshark needs to be uninstalled, click **Start > Control Panel**. Open **Add or Remove Programs**. Highlight Wireshark, and click **Remove**.

Remove any files created on the pod host computer during the lab.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 9.8.2: Cisco Switch MAC Table Examination

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16.Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16.Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Use the Telnet protocol to log into a Cisco Switch.
- Use the Cisco IOS **show mac-address-table** command to examine MAC address and port associations.

Background

Switches maintain a table of MAC addresses and associated switch port. When a switch receives a frame, the destination MAC address is checked against the table, and the corresponding port is used to route the frame out of the switch. If a switch does not know which port to route the frame, or the frame is a broadcast, then the frame is routed out all ports except the port where it originated.

Access to Cisco devices can be accomplished through several means. A console port can be used if the Cisco router or switch is within the same physical proximity of a computer. Using Windows hyperterm utility, a serial connection can be established. For devices physically distant from the network engineer, network connectivity can be established through two means. If the network is not secure, a modem configured on the AUX port enables telephone access. For secure networks, the Cisco device can be configured for a Telnet session. In this lab, the student will connect to the switch via a Telnet session.

Lab

- Telnet to S1-Central.
- Log in with student account.
- Use **show mac-address-table** command to examine the mac addresses and association to ports.

Scenario

Use the Cisco IOS **show mac-address-table** command to examine the switch MAC address table and other address-related information.

Telnet is a network service that uses a client-server model. Cisco IOS devices provide a default Telnet server, and operating systems such as Windows have built-in Telnet clients. Using Telnet, network engineers can log into network devices from anywhere across a secure network. The Cisco device must be configured for Telnet access, otherwise it is denied. In Eagle 1, limited privileges have been configured for student use.

Task 1: Use the Telnet Protocol to Log in to a Cisco Switch.

Step 1: Access the Windows terminal.

Open a Windows terminal by clicking **Start > Run**. Type **cmd**, and click **OK**.

Step 2: Use the Windows Telnet client to access S1-Central.

S1-Central has been configured with 11 student accounts, **ccna1** through **ccna11**. To provide access to each student, use the userid corresponding to your pod. For example, for host computers on pod 1, use userid **ccna1**. Unless directed otherwise by your instructor, the password is **cisco**.

1. From the Windows terminal, issue the Telnet command, **telnet destination-ip-address:**

```
C:/> telnet 172.16.254.1
```

An access prompt will be displayed, similar to the one shown in Figure 1.

```
*****
                        This is Lab switch S1-Central.
                        Authorized access only.
*****
User Access Verification
Username: ccna1
Password: cisco  (*hidden*)
S1-Central#
```

Figure 1. Telnet Client

2. Enter the applicable user name. When the password prompt appears, type `cisco` <ENTER>.

The `S1-Central#` prompt should appear.

Task 2: Use the Cisco IOS `show mac-address-table` Command to Examine MAC Addresses and Port Associations.

Step 1: Examine the switch MAC address table.

1. Issue the command `show mac-address-table ?` <ENTER>. This will output all options for the command.
2. Use the following table to fill in the command options:

Option	Description

Step 2: Examine dynamic MAC address table entries.

1. Issue the command `show mac-address-table`.
This command will display static (CPU) and dynamic, or learned, entries.

- List the MAC addresses and corresponding switch ports:

MAC Address	Switch Port

Suppose there was a hub with five active hosts connected to switch port `gi0/0`. How many MAC addresses would be listed for switch port `gi0/0`? _____

Step 3: Examine MAC address table aging time.

- Issue the command `show mac-address-table aging-time`.
This command will display the default time, in seconds, that MAC address entries are stored.
- What is the default aging time for VLAN 1? _____

Task 3: Challenge

What would be the result if the MAC address table was flushed of dynamic entries?

Task 4: Reflection

Using the Telnet protocol, network engineers can access Cisco devices remotely across secure LANs. This has the benefit of permitting access to remote devices for troubleshooting and monitoring purposes.

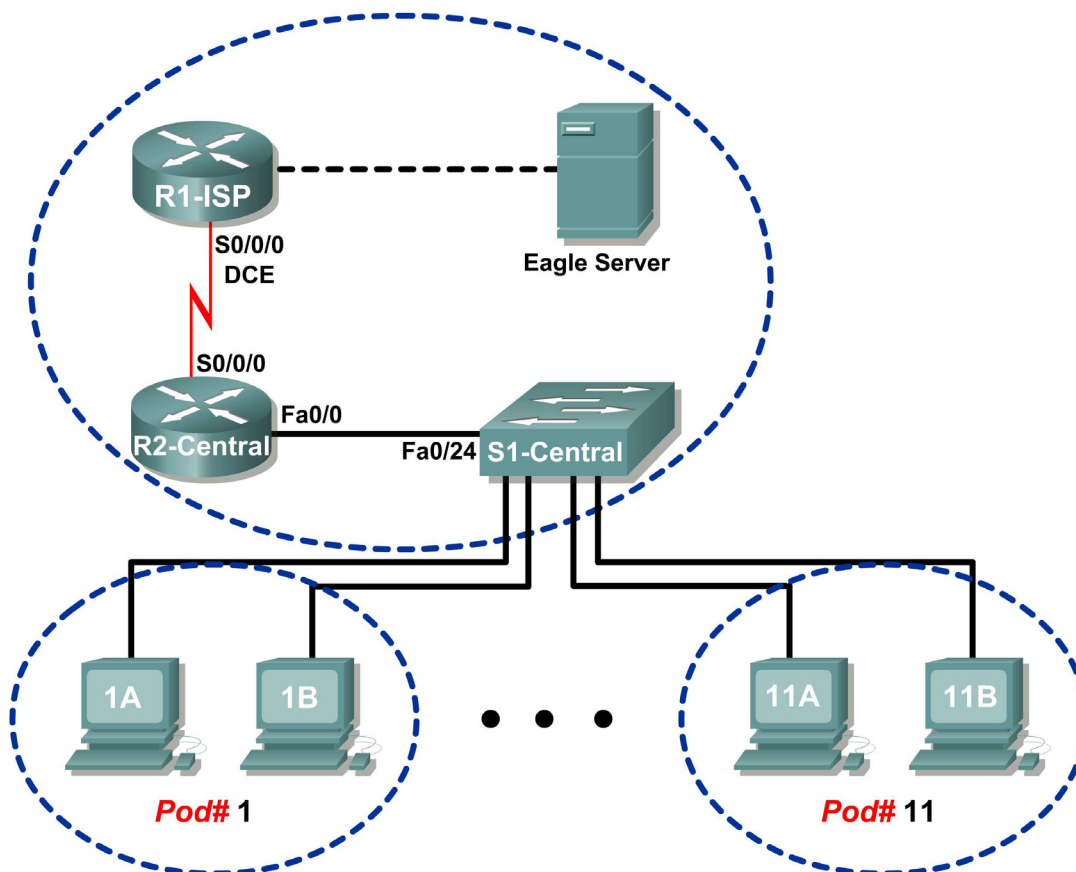
A switch contains a MAC address table that lists the MAC address connected to each switch port. When a frame enters the switch, the switch performs a lookup of the frame destination MAC address. If there is a match in the MAC address table, the frame is routed out the corresponding port. Without a MAC address table, the switch would have to flood the frame out each port.

Task 5: Clean Up

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 9.8.3: Intermediary Device as an End Device

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1-ISP	S0/0/0	10.10.10.6	255.255.255.252	N/A
	Fa0/0	192.168.254.253	255.255.255.0	N/A
R2-Central	S0/0/0	10.10.10.5	255.255.255.252	N/A
	Fa0/0	172.16.255.254	255.255.0.0	N/A
Eagle Server	N/A	192.168.254.254	255.255.255.0	192.168.254.253
	N/A	172.31.24.254	255.255.255.0	N/A
hostPod#A	N/A	172.16.Pod#.1	255.255.0.0	172.16.255.254
hostPod#B	N/A	172.16.Pod#.2	255.255.0.0	172.16.255.254
S1-Central	N/A	172.16.254.1	255.255.0.0	172.16.255.254

Learning Objectives

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

- Use Wireshark to capture and analyze frames originating from network nodes.
- Examine the origination of frames in a small network.

Background

A switch is used to route frames between network devices. A switch does not normally originate the frame to node devices. Rather, a switch efficiently passes the frame from one device to another in the LAN.

Scenario

Wireshark will be used to capture and analyze Ethernet frames. If Wireshark has not been loaded on the host pod computer, it can be downloaded from URL ftp://eagle-server.example.com/pub/eagle_labs/eagle1/chapter9/, file `wireshark-setup-0.99.4.exe`.

In this lab you will ping a neighbor's pod host computer.

Write down the IP address and port connection on S1-Central for the neighbor's pod host computer:

IP Address: _____ S1-Central port number: _____

Task 1: Use Wireshark to Capture and Analyze Frames Originating From Network Nodes.

Step 1: Configure Wireshark for packet captures.

Prepare Wireshark for captures.

1. Click **Capture > Options**.
2. Select the Interface that corresponds to the LAN.
3. Check the box to Update list of packets in real time.
4. Click **Start**.

This will begin the packet capture. During this capture there will probably be more than 200 captures, making analysis a bit tedious. The critical Telnet conversation between the pod host computer and S1-Central will be easy to filter.

Step 2: Use the Windows Telnet client to access S1-Central.

S1-Central has been configured with 11 student accounts, `ccna1` through `ccna11`. To provide access to each student, use the userid corresponding to your pod. For example, for host computers on pod 1, use userid `ccna1`. Unless directed otherwise by your instructor, the password is `cisco`.

1. From the Windows terminal, issue the Telnet command, `telnet destination-ip-address:`

```
C:/> telnet 172.16.254.1
```
2. Enter the appropriate user name and password, `cisco`.
The S1-Central prompt should be returned, `S1-Central#`.

Step 3: Clear the MAC address table.

1. Examine the switch MAC address table with the command **show mac-address-table**. In addition to several static CPU entries, there should be numerous dynamic address table entries.
2. To clear dynamic MAC address table entries, use the **clear mac-address-table dynamic** command.
3. List the dynamic MAC address entries:

MAC Address	Switch Port

4. Open a second terminal window. Ping your neighbor's IP address, which was recorded earlier:

```
C:>\ ping -n 1 ip-address
```
5. The MAC address for this computer should be dynamically added in the S1-Central MAC address table.
6. Again list the dynamic MAC address entries:

MAC Address	Switch Port

What conclusion can be made about how a switch learns MAC addresses connected to switch interfaces?

7. Close Wireshark capture.
The capture will be analyzed in the next task.

Task 2: Examine the Origination of Frames in a Small Network.

Step 1: Examine a Telnet session to S1-Central.

1. Highlight one of the Telnet session packets. On Wireshark menu, click **Analyze | Follow TCP Stream**. A stream content window will open, default display ASCII. If the username and passwords are not visible, switch to HEX Dump.
2. Verify the username and password that you entered:
Username: _____ Password: _____
3. Close the stream content window.

Step 2: Examine output of the show mac-address-table command.

1. Open Notepad. Captured data will be transferred to Notepad for analysis. There may be numerous packets that were captured.
2. In the top Wireshark Packet List pane, scroll down to the captured ICMP request. If the bottom Wireshark Packet Byte window is not visible, click **View > Packet bytes**.

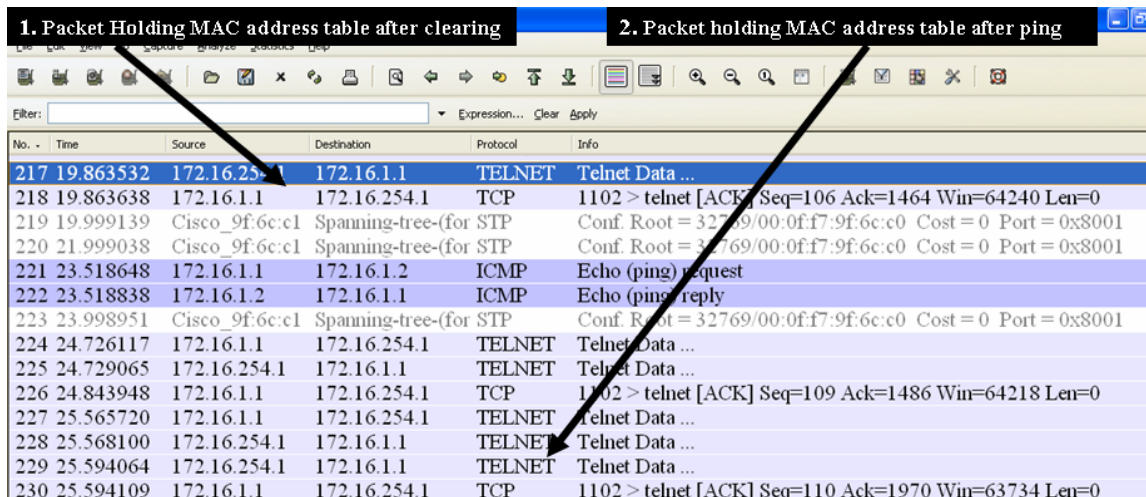


Figure 1. Wireshark Capture of Telnet

See Figure 1, a partial output of the Wireshark capture:

- 1 Select the last Telnet data packet from S1-Central before the **ping** command. Next, select the corresponding Packet byte. Right-click the Packet byte and click **Copy > Text only**. In Notepad, click **Edit > Paste**. Dynamic mappings should be similar to the following output:

```
{_lEMaNL;RPC          Mac Address Table
-----
Vlan    Mac Address          Type      Ports
----
All     000f.f79f.6cc0       STATIC    CPU
All     0100.0ccc.cccc       STATIC    CPU
All     0100.0ccc.cccd       STATIC    CPU
All     0100.0cdd.dddd       STATIC    CPU
1       0010.a47b.015f       DYNAMIC   Fa0/1
Total Mac Addresses for this criterion: 5
S1-Central#
```

3. Write down the MAC address and Port number displayed in the output. Does the switch port correspond to your pod host computer? _____

MAC Address	Type	Port

Why is your pod host computer mapping still in the MAC address table, despite having been cleared? _____

- 2 Select the last Telnet data packet immediately after the ping reply. Next, select the corresponding Packet byte. Right-click the Packet byte and click **Copy > Text only**. In Notepad, click **Edit > Paste**. Text should be similar to the following Paste action:

```
{_lEPaNM;VP          Mac Address Table
-----
Vlan    Mac Address      Type      Ports
----
All     000f.f79f.6cc0    STATIC    CPU
All     0100.0ccc.cccc    STATIC    CPU
All     0100.0ccc.cccd    STATIC    CPU
All     0100.0cdd.dddd    STATIC    CPU
1       0010.a47b.015f    DYNAMIC   Fa0/1
1       0016.76ac.a76a    DYNAMIC   Fa0/2
Total Mac Addresses for this criterion: 6
S1-Central#
```

4. Write down the MAC address and Port number for the second dynamic displayed in the output. Does the switch port correspond to your neighbor's pod host computer? _____

MAC Address	Type	Port

Task 3: Reflection

The Wireshark capture of a Telnet session between a pod host computer and S1-Central was analyzed to show how a switch dynamically learns about nodes directly connected to it.

Task 4: Challenge

Use Wireshark to capture and analyze a Telnet session between the pod host computer and the Cisco switch. Use the Wireshark menu option **Analyze > Follow TCP Stream** to view the login user ID and password. How secure is the Telnet protocol? What can be done to make communication with Cisco devices more secure?

Task 5: Clean Up

Wireshark was installed on the pod host computer. If Wireshark needs to be uninstalled, click **Start > Control Panel**. Open **Add or Remove Programs**. Select Wireshark, and click **Remove**.

Remove any files created on the pod host computer during the lab.

Unless directed otherwise by the instructor, turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 10.3.2: How Many Networks?

Learning Objectives

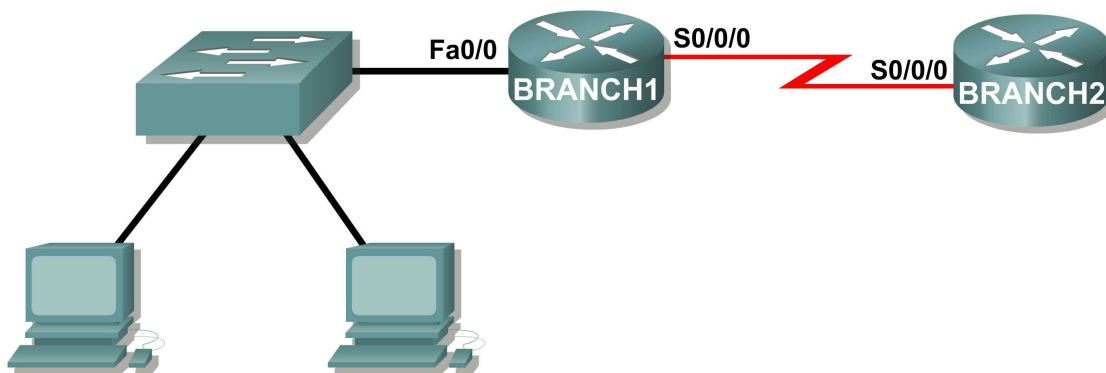
Upon completion of this lab, you will be able to:

- Determine the number of subnets.
- Design an appropriate addressing scheme.
- Assign addresses and subnet mask pairs to device interfaces.
- Examine the use of the available network address space.

Scenario

In this lab, you have been given the network address 192.168.26.0/24 to subnet and provide the IP addressing for the networks shown in the Topology Diagrams. You must determine the number of networks needed then design an appropriate addressing scheme. Place the correct address and mask in the Addressing Table. In this example, the number of hosts is not important. You are only required to determine the number of subnets per topology example.

Topology Diagram A



Task 1: Determine the Number of Subnets in the Topology Diagram.

Step 1: How many networks are there? ____

Step 2: How many bits should you borrow to create the required number of subnets? ____

Step 3: How many usable host addresses and usable subnets did this give you? ____

Step 4: What is the new subnet mask in decimal form? ____

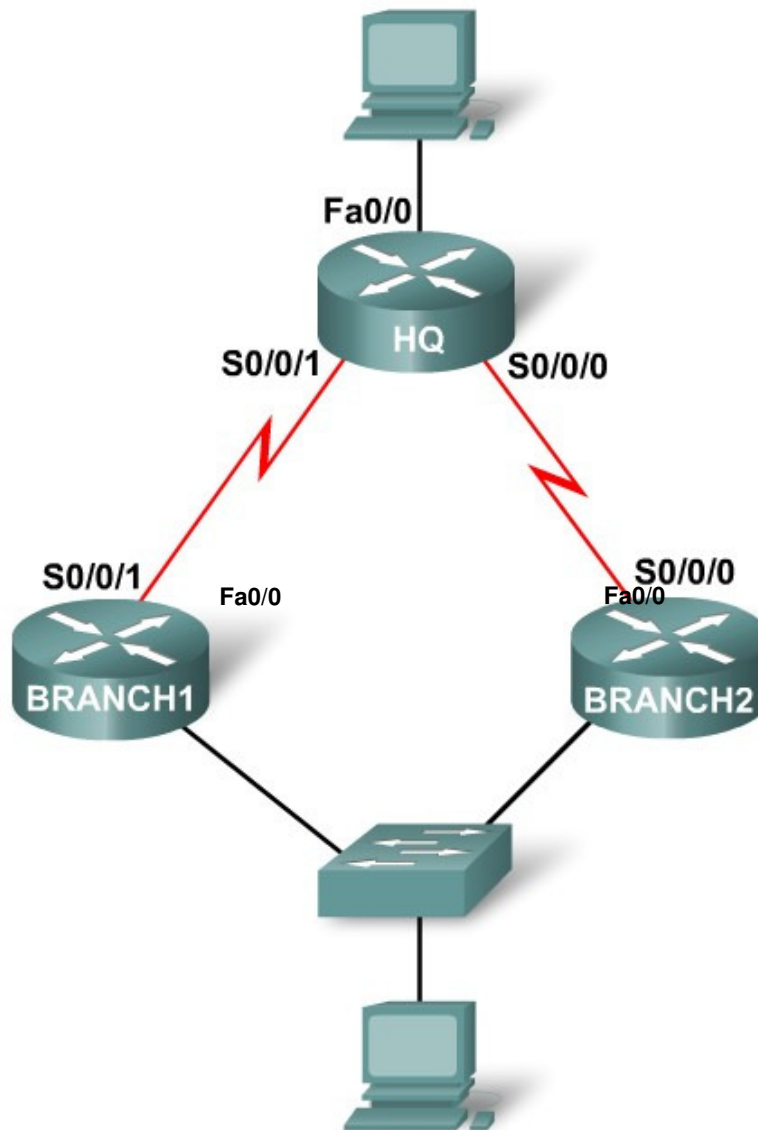
Step 5: How many subnets are available for future use? ____

Task 2: Record Subnet Information.

Step 1: Fill in the following chart with the subnet information.

Subnet Number	Subnet Address	First Usable Host Address	Last Usable Host Address	Broadcast Address
0				
1				
2				
3				
4				
5				
6				
7				

Topology Diagram B



Task 1: Determine the Number of Subnets in the Topology Diagram.

Step 1: How many networks are there? ____

Step 2: How many bits should you borrow to create the required number of subnets? ____

Step 3: How many usable host addresses and usable subnets did this give you? ____

Step 4: What is the new subnet mask in decimal form? ____

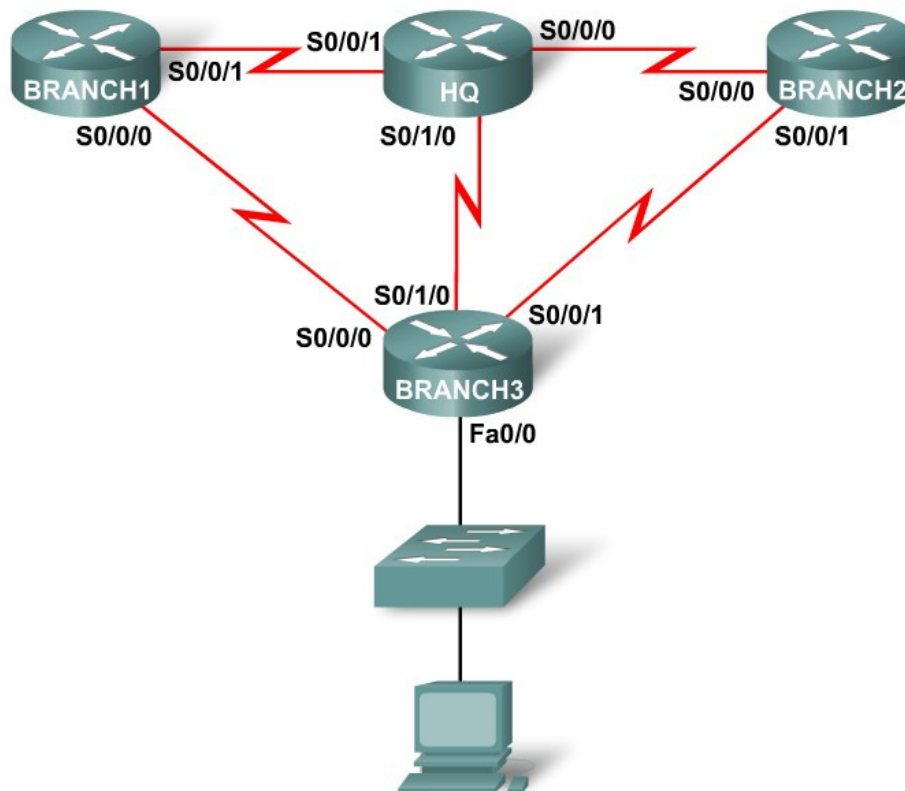
Step 5: How many subnets are available for future use? ____

Task 2: Record Subnet Information.

Step 1: Fill in the following chart with the subnet information.

Subnet Number	Subnet Address	First Usable Host Address	Last Usable Host Address	Broadcast Address
0				
1				
2				
3				
4				
5				
6				
7				

Topology Diagram C



Task 1: Determine the Number of Subnets in the Topology Diagram.

Step 1: How many networks are there? _____

Step 2: How many bits should you borrow to create the required number of subnets? _____

Step 3: How many usable host addresses and usable subnets did this give you? _____

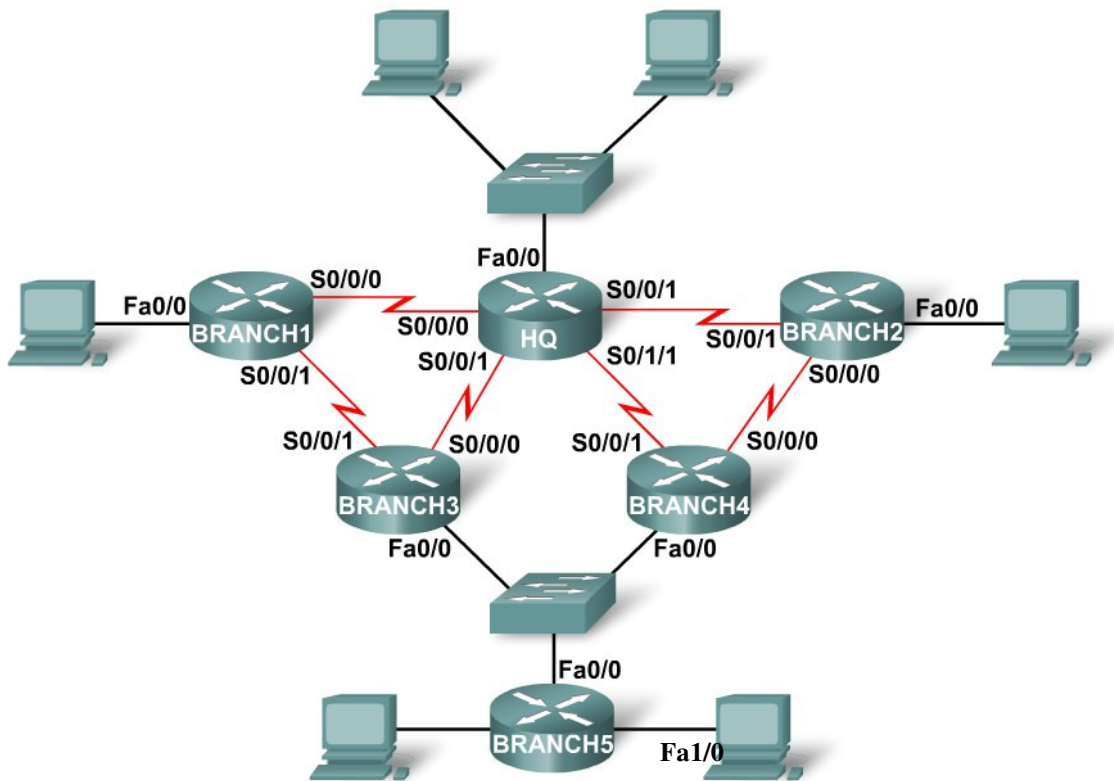
Step 4: What is the new subnet mask in decimal form? _____

Step 5: How many subnets are available for future use? _____

Task 2: Record Subnet Information.

Step 1: Fill in the following chart with the subnet information.

Subnet Number	Subnet Address	First Usable Host Address	Last Usable Host Address	Broadcast Address
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				



Task 2: Record Subnet Information.

Step 1: Fill in the following chart with the subnet information.

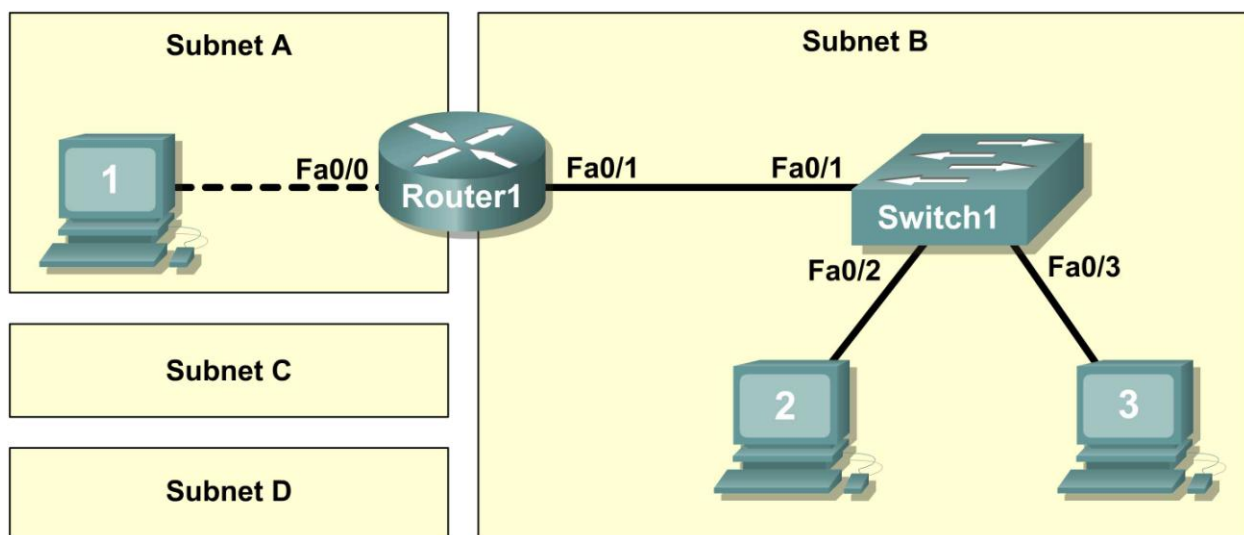
Subnet Number	Subnet Address	First Usable Host Address	Last Usable Host Address	Broadcast Address
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				

Reflection

What information is needed when determining an appropriate addressing scheme for a network?

Lab 10.6.1: Creating a Small Lab Topology

Topology Diagram



Learning Objectives

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

- Design the logical network.
- Configure the physical lab topology.
- Configure the logical LAN topology.
- Verify LAN connectivity.

Background

Hardware	Qty	Description
Cisco Router	1	Part of CCNA Lab bundle
Cisco Switch	1	Part of CCNA Lab bundle
*Computer (host)	3	Lab computer
Cat-5 or better straight-through UTP cables	3	Connects Router1 and computers Host1 and Host2 to Switch1
Cat-5 crossover UTP cable	1	Connects computer Host1 to Router1

Table 1. Equipment and Hardware for Lab

Gather the necessary equipment and cables. To configure the lab, refer to the equipment and hardware listed in Table 1.

Scenario

In this lab you will create a small network that requires connecting network devices and configuring host computers for basic network connectivity. SubnetA and SubnetB are subnets that are currently needed. SubnetC and SubnetD are anticipated subnets, not yet connected to the network. The 0th subnet will be used.

Note: Appendix 1 contains a subnet chart for the last IP address octet.

Task 1: Design the Logical Network.

Given an IP address and mask of 172.20.0.0 / 24 (address / mask), design an IP addressing scheme that satisfies the following requirements:

Subnet	Number of Hosts
SubnetA	2
SubnetB	6
SubnetC	47
SubnetD	125

Host computers from each subnet will use the first available IP address in the address block. Router interfaces will use the last available IP address in the address block.

Step 1: Design SubnetD address block.

Begin the logical network design by satisfying the requirement of SubnetD, which requires the largest block of IP addresses. Refer to the subnet chart, and pick the first address block that will support SubnetD.

Fill in the following table with IP address information for SubnetD:

Network Address	Mask	First Host Address	Last Host Address	Broadcast

What is the bit mask in binary? _____

Step 2: Design SubnetC address block.

Satisfy the requirement of SubnetC, the next largest IP address block. Refer to the subnet chart, and pick the next available address block that will support SubnetC.

Fill in the following table with IP address information for SubnetC:

Network Address	Mask	First Host Address	Last Host Address	Broadcast

What is the bit mask in binary? _____

Step 3: Design SubnetB address block.

Satisfy the requirement of SubnetB, the next largest IP address block. Refer to the subnet chart, and pick the next available address block that will support SubnetB.

Fill in the following table with IP address information for SubnetB:

Network Address	Mask	First Host Address	Last Host Address	Broadcast

What is the bit mask in binary? _____

Step 4: Design SubnetA address block.

Satisfy the requirement of SubnetA. Refer to the subnet chart, and pick the next available address block that will support SubnetA.

Fill in the following table with IP address information for SubnetA:

Network Address	Mask	First Host Address	Last Host Address	Broadcast

What is the bit mask in binary? _____

Task 2: Configure the Physical Lab Topology.

Step 1: Physically connect devices.

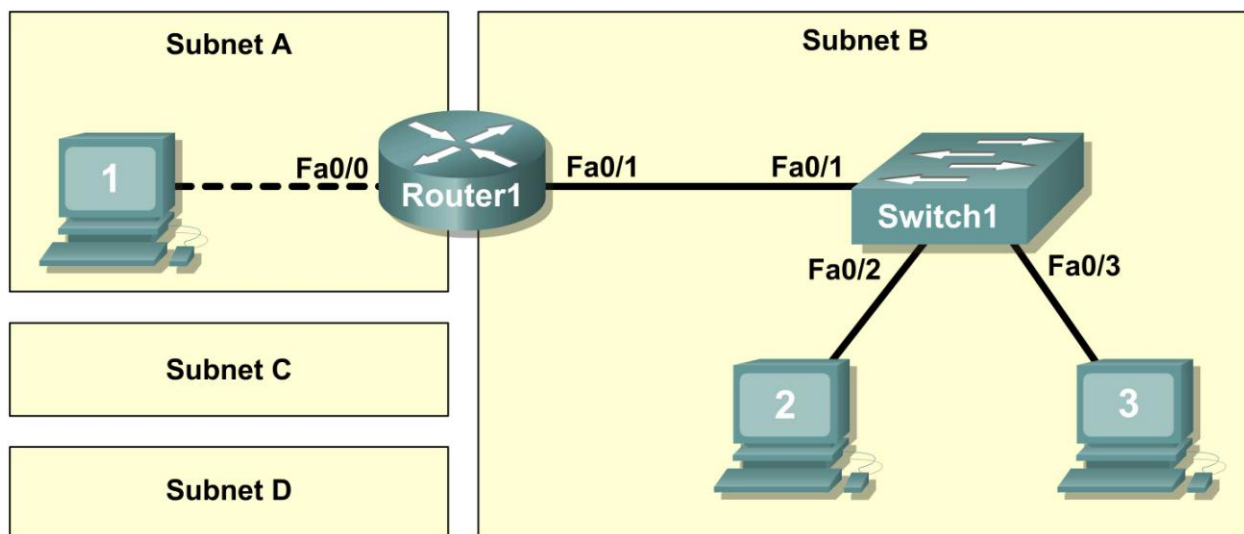


Figure 1. Cabling the Network

Cable the network devices as shown in Figure 1.

What cable type is needed to connect Host1 to Router1, and why? _____

What cable type is needed to connect Host1, Host2, and Router1 to Switch1, and why? _____

If not already enabled, turn power on to all devices.

Step 2: Visually inspect network connections.

After cabling the network devices, take a moment to verify the connections. Attention to detail now will minimize the time required to troubleshoot network connectivity issues later. Ensure that all switch connections show green. Any switch connection that does not transition from amber to green should be investigated. Is the power applied to the connected device? Is the correct cable used? Is the correct cable good?

What type of cable connects Router1 interface Fa0/0 to Host1? _____

What type of cable connects Router1 interface Fa0/1 to Switch1? _____

What type of cable connects Host2 to Switch1? _____

What type of cable connects Host3 to Switch1? _____

Is all equipment turned on? _____

Task 3: Configure the Logical Topology.

Step 1: Document logical network settings.

The host computer Gateway IP address is used to send IP packets to other networks. Therefore, the Gateway address is the IP address assigned to the router interface for that subnet.

From the IP address information recorded in Task 1, write down the IP address information for each computer:

Host1	
IP Address	
IP Mask	
Gateway Address	

Host2	
IP Address	
IP Mask	
Gateway Address	

Host3	
IP Address	
IP Mask	
Gateway Address	

Step 2: Configure Host1 computer.

On Host1, click **Start > Control Panel > Network Connections**. Right-click the **Local Area Connection** device icon and choose **Properties**.

On the **General** tab, select **Internet Protocol (TCP/IP)**, and then click the **Properties** button.

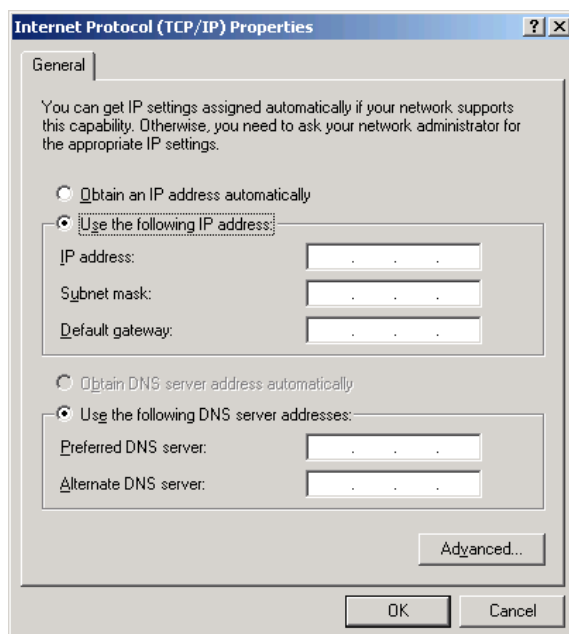


Figure 2. Host1 IP Address and Gateway Settings

Refer to Figure 2 for Host1 IP address and gateway settings. Manually enter the following information, recorded in Step 1, above:

IP address: Host1 IP address
Subnet mask: Host1 subnet mask
Default gateway: Gateway IP address

When finished, close the Internet Protocols (TCP/IP) Properties window by clicking **OK**. Close the Local Area Connection window. Depending on the Windows operating system, the computer may require a reboot for changes to be effective.

Step 3: Configure Host2 and Host3 computers.

Repeat Step 2 for computers Host2 and Host3, using the IP address information for those computers.

Task 4: Verify Network Connectivity.

Verify with your instructor that Router1 has been configured. Otherwise, connectivity will be broken between LANs. Switch1 should have a default configuration.

Network connectivity can be verified with the Windows **ping** command. Open a windows terminal by clicking **Start > Run**. Type **cmd** and press **Enter**.

Use the following table to methodically verify and record connectivity with each network device. Take corrective action to establish connectivity if a test fails:

From	To	IP Address	Ping Results
Host1	Gateway (Router1, Fa0/0)		
Host1	Router1, Fa0/1		
Host1	Host2		
Host1	Host3		
Host2	Host3		
Host2	Gateway (Router1, Fa0/1)		
Host2	Router1, Fa0/0		
Host2	Host1		
Host3	Host2		
Host3	Gateway (Router1, Fa0/1)		
Host3	Router1, Fa0/0		
Host3	Host1		

Note any break in connectivity. When troubleshooting connectivity issues, the topology diagram can be extremely helpful.

In the above scenario, how can a malfunctioning Gateway be detected?

Task 5: Reflection

Review any physical or logical configuration problems encountered during this lab. Be sure that you have a thorough understanding of the procedures used to verify network connectivity.

This is a particularly important lab. In addition to practicing IP subnetting, you configured host computers with network addresses and tested them for connectivity.

It is best to practice host computer configuration and verification several times. This will reinforce the skills you learned in this lab and make you a better network technician.

Task 6: Challenge

Ask your instructor or another student to introduce one or two problems in your network when you aren't looking or are out of the lab room. Problems can be either physical (wrong UTP cable) or logical (wrong IP address or gateway). To fix the problems:

1. Perform a good visual inspection. Look for green link lights on Switch1.

2. Use the table provided in Task 3 to identify failed connectivity. List the problems:

3. Write down your proposed solution(s):

4. Test your solution. If the solution fixed the problem, document the solution. If the solution did not fix the problem, continue troubleshooting.

Task 7: Clean Up.

Unless directed otherwise by the instructor, restore host computer network connectivity, and then turn off power to the host computers.

Carefully remove cables and return them neatly to their storage. Reconnect cables that were disconnected for this lab.

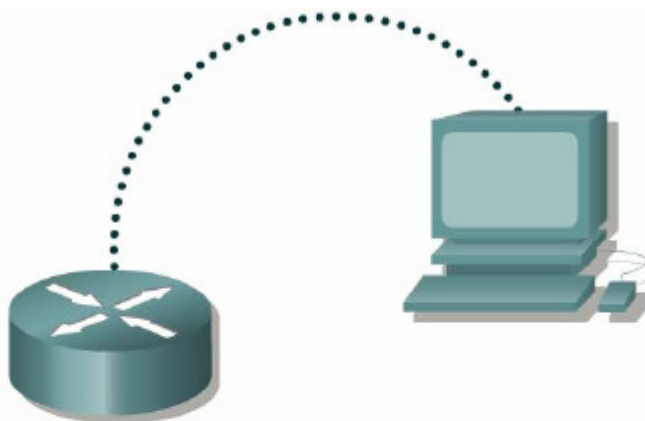
Remove anything that was brought into the lab, and leave the room ready for the next class.

Appendix 1

	/25 (1 subnet bit) 2 subnets 128 hosts	/26 (2 subnet bits) 4 subnets 62 hosts	/27 (3 subnet bits) 8 subnets 30 hosts	/28 (4 subnet bits) 16 subnets 14 hosts	/29 (5 subnet bits) 32 subnets 6 hosts	/30 (6 subnet bits) 64 subnets 2 hosts
.0	.0	.0 (1-.62)	.0 (1-.30)	.0 (1-.14)	.0 (1-.6)	.0 (1-.2)
.4 (5-.6)						
.8 (9-.14)				.8 (9-.10)		
.12 (13-.14)				.12 (13-.18)		
.16 (17-.22)			.16 (17-.18)			
.20 (21-.22)			.20 (21-.22)			
.24 (25-.30)			.24 (25-.26)			
.28 (29-.30)			.28 (29-.30)			
.32 (33-.62)		.32 (33-.46)	.32 (33-.36)	.32 (33-.34)		
			.36 (37-.38)	.36 (37-.38)		
			.40 (41-.46)	.40 (41-.42)		
			.44 (45-.46)	.44 (45-.46)		
		.48 (49-.62)	.48 (49-.54)	.48 (49-.50)		
			.52 (53-.54)	.52 (53-.54)		
			.56 (57-.58)	.56 (57-.58)		
			.60 (61-.62)	.60 (61-.62)		
.64 (65-.94)		.64 (65-.78)	.64 (65-.70)	.64 (65-.66)		
			.68 (69-.70)	.68 (69-.70)		
			.72 (73-.78)	.72 (73-.74)		
			.76 (77-.78)	.76 (77-.78)		
		.80 (81-.94)	.80 (81-.86)	.80 (81-.82)		
			.84 (85-.86)	.84 (85-.86)		
			.88 (89-.94)	.88 (89-.90)		
			.92 (93-.94)	.92 (93-.94)		
.96 (97-.110)	.96 (97-.102)	.96 (97-.98)	.96 (97-.98)			
		.100 (101-.102)	.100 (101-.102)			
		.104 (105-.106)	.104 (105-.106)			
		.108 (109-.110)	.108 (109-.110)			
	.112 (113-.118)	.112 (113-.114)	.112 (113-.114)			
		.116 (117-.118)	.116 (117-.118)			
		.120 (121-.122)	.120 (121-.122)			
		.124 (125-.126)	.124 (125-.126)			
.128 (129-.142)	.128 (129-.134)	.128 (129-.130)	.128 (129-.130)			
		.132 (133-.134)	.132 (133-.134)			
		.136 (137-.138)	.136 (137-.138)			
		.140 (141-.142)	.140 (141-.142)			
	.144 (145-.150)	.144 (145-.146)	.144 (145-.146)			
		.148 (149-.150)	.148 (149-.150)			
		.152 (153-.154)	.152 (153-.154)			
		.156 (157-.158)	.156 (157-.158)			
.160 (161-.174)	.160 (161-.166)	.160 (161-.162)	.160 (161-.162)			
		.164 (165-.166)	.164 (165-.166)			
		.168 (169-.170)	.168 (169-.170)			
		.172 (173-.174)	.172 (173-.174)			
	.176 (177-.182)	.176 (177-.178)	.176 (177-.178)			
		.180 (181-.182)	.180 (181-.182)			
		.184 (185-.186)	.184 (185-.186)			
		.188 (189-.190)	.188 (189-.190)			
.192 (193-.198)	.192 (193-.194)	.192 (193-.194)	.192 (193-.194)			
		.196 (197-.198)	.196 (197-.198)			
		.200 (201-.202)	.200 (201-.202)			
		.204 (205-.206)	.204 (205-.206)			
	.208 (209-.214)	.208 (209-.210)	.208 (209-.210)			
		.212 (213-.214)	.212 (213-.214)			
		.216 (217-.218)	.216 (217-.218)			
		.220 (221-.222)	.220 (221-.222)			
.224 (225-.230)	.224 (225-.226)	.224 (225-.226)	.224 (225-.226)			
		.228 (229-.230)	.228 (229-.230)			
		.232 (233-.234)	.232 (233-.234)			
		.236 (237-.238)	.236 (237-.238)			
	.240 (241-.246)	.240 (241-.242)	.240 (241-.242)			
		.244 (245-.246)	.244 (245-.246)			
		.248 (249-.250)	.248 (249-.250)			
		.252 (253-.254)	.252 (253-.254)			
.252 (253-.254)						

Lab 10.6.2: Establishing a Console Session with HyperTerminal

Topology Diagram



Straight-through cable	—————
Serial cable	—————  —————
Console (Rollover)
Crossover cable	- - - - -

Learning Objectives

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

- Connect a router and computer using a console cable.
- Configure HyperTerminal to establish a console session with a Cisco IOS router.
- Configure HyperTerminal to establish a console session with a Cisco IOS switch.

Background

HyperTerminal is a simple Windows-based terminal emulation program for serial communication that can be used to connect to the console port on Cisco IOS devices. A serial interface on a computer is connected to the Cisco device via a rollover cable. Using HyperTerminal is the most basic way to access a router for checking or changing its configuration. Another popular serial communication utility is TeraTerm Web. Instructions for TeraTerm Web use are contained in Appendix A.

Scenario

Set up a network similar to the one in the Topology Diagram. Any router that meets the interface requirements may be used. Possible routers include 800, 1600, 1700, 2500, 2600 routers, or a combination. The following resources will be required:

- Computer with a serial interface and HyperTerminal loaded
- Cisco router
- Console (rollover) cable for connecting the workstation to the router

Task 1: Connect a Router and Computer with a Console Cable.

Step 1: Set up basic physical connection.

Connect the console (rollover) cable to the console port on the router. Connect the other cable end to the host computer with a DB-9 or DB-25 adapter to the COM 1 port.

Step 2: Power on devices.

If not already powered on, enable power to the computer and router.

Task 2: Configure HyperTerminal to Establish a Console Session with a Cisco IOS Router.

Step 1: Start HyperTerminal application.

From the Windows taskbar, start the HyperTerminal program by clicking **Start > Programs > Accessories > Communications > HyperTerminal**.

Step 2: Configure HyperTerminal.

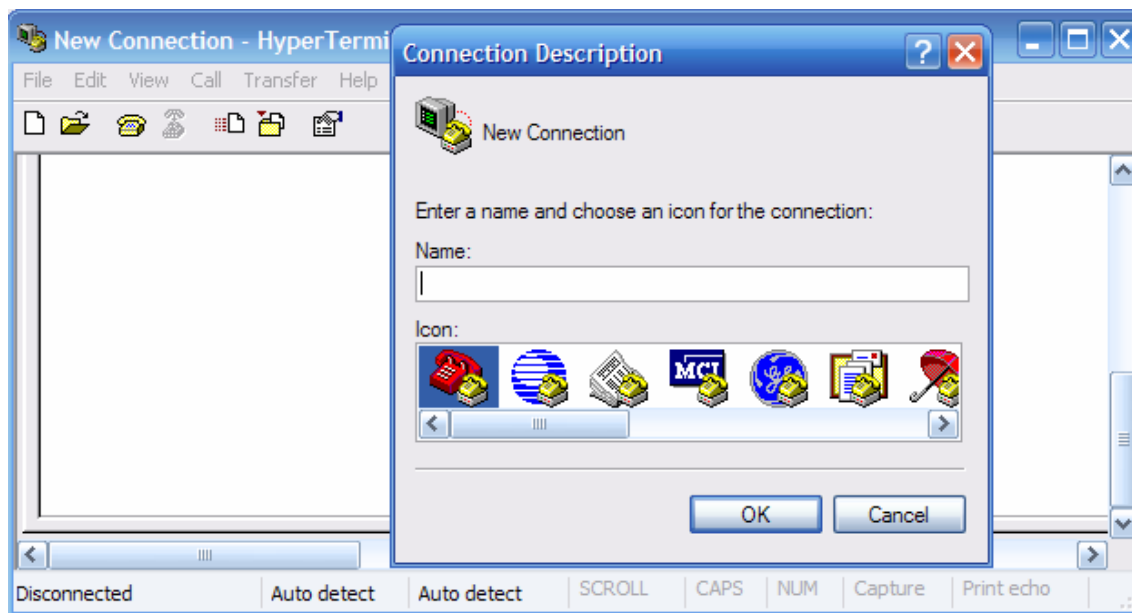


Figure 1. HyperTerminal Name Configuration Window

Refer to Figure 1 for a description of the opening HyperTerminal configuration window. At the Connection Description window, enter a session name in the Name field. Select an appropriate icon, or leave the default. Click **OK**.



Figure 2. HyperTerminal Connection Type

Refer to Figure 2. Enter the appropriate connection type, COM 1, in the Connect using field. Click **OK**.

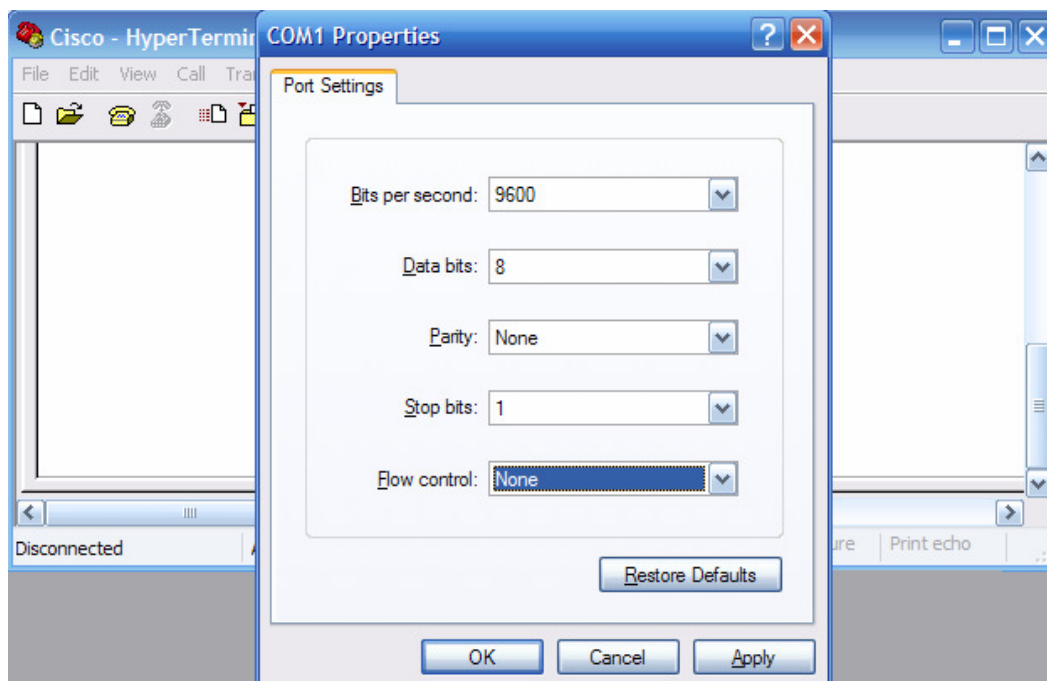


Figure 3. HyperTerminal COM1 Port Settings

Refer to Figure 3. Change port settings to the following values:

Setting	Value
Bits per second	9600
Data bits	8
Parity	None
Stop bits	1
Flow control	None

Click **OK**.

When the HyperTerminal session window comes up, press the **Enter** key. There should be a response from the router. This indicates that connection has been successfully completed. If there is no connection, troubleshoot as necessary. For example, verify that the router has power. Check the connection to the correct COM 1 port on the PC and the console port on the router. If there is still no connection, ask the instructor for assistance.

Step 3: Close HyperTerminal.

When finished, close the HyperTerminal session. Click **File > Exit**. When asked whether to save the session, click **Yes**. Enter a name for the session.

Step 4: Reconnect the HyperTerminal session.

Reopen the HyperTerminal session as described in Task 2, Step 1. This time, when the Connection Description window opens (see Figure 1), click **Cancel**.

Click **File > Open**. Select the saved session and then click **Open**. Use this technique to reconnect the HyperTerminal session to a Cisco device without reconfiguring a new session.

When finished, exit TeraTerm.

Task 3: Configure HyperTerminal to Establish a Console Session with a Cisco IOS Switch.

Serial connections between Cisco IOS routers and switches are very similar. In this task, you will make a serial connection between the host computer and a Cisco IOS switch.

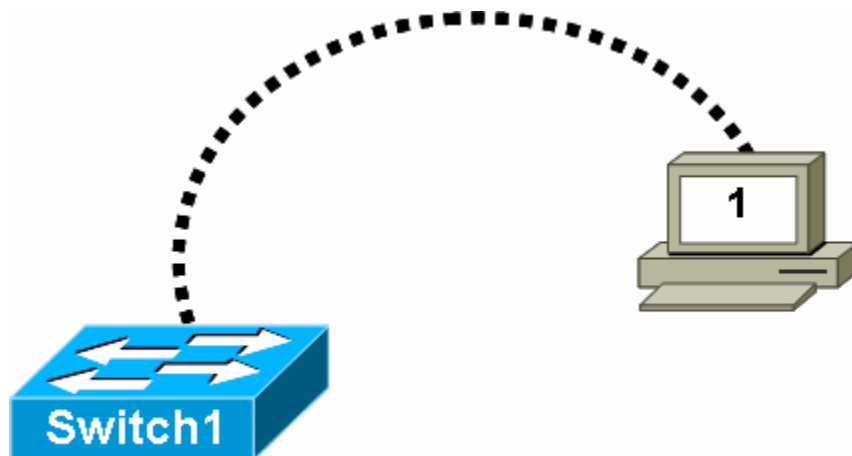


Figure 4. Serial Connection Between a Host Computer and Cisco Switch

Step 1: Set up basic physical connection.

Refer to Figure 4. Connect the console (rollover) cable to the console port on the router. Connect the other cable end to the host computer with a DB-9 or DB-25 adapter to the COM 1 port.

Step 2: Power on devices.

If not already powered on, enable power to the computer and switch.

Step 3: Start HyperTerminal application.

From the Windows taskbar, start the HyperTerminal program by clicking **Start > Programs > Accessories > Communications > Hyper Terminal**.

Step 4: Configure HyperTerminal.

Use the procedure described in Task 2, Step 2, to configure HyperTerminal.

Refer to Figure 1 of the opening HyperTerminal configuration window. At the Connection Description window, enter a session name in the Name field. Select an appropriate icon, or leave the default. Click **OK**.

Refer to Figure 2. Enter the appropriate connection type, COM 1, in the Connect using field. Click **OK**.

Refer to Figure 3. Change port settings to the following values:

Setting	Value
Bits per second	9600
Data bits	8
Parity	None
Stop bits	1
Flow control	None

Click **OK**.

When the HyperTerminal session window comes up, press the **Enter** key. There should be a response from the switch. This indicates that connection has been successfully completed. If there is no connection, troubleshoot as necessary. For example, verify that the switch has power. Check the connection to the correct COM 1 port on the PC and the console port on the switch. If there is still no connection, ask the instructor for assistance.

Step 5: Close HyperTerminal.

When finished, close the HyperTerminal session. Click **File > Exit**. When asked whether to save the session, click **No**.

Task 3: Reflection

This lab provided information for establishing a console connection to a Cisco IOS router and switch.

Task 4: Challenge

Draw the pin connections for the rollover cable and straight-through cable. Compare the differences, and be able to identify the different cable types.

Task 5: Clean Up

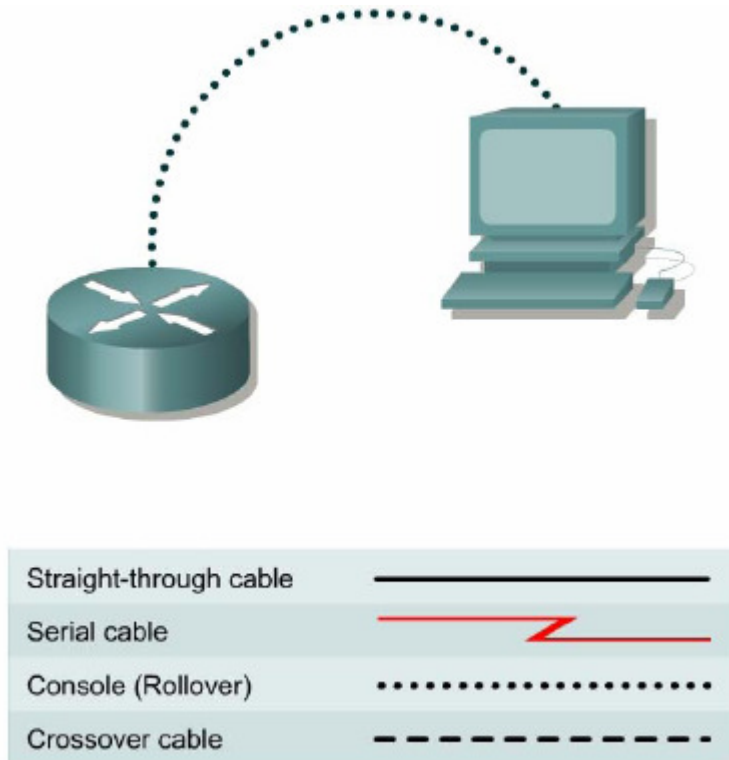
Unless directed otherwise by the instructor, turn off power to the host computer and router. Remove the rollover cable.

Remove anything that was brought into the lab, and leave the room ready for the next class.

Appendix A

Establishing a Console Session with TeraTerm

Topology Diagram



Learning Objectives

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

- Connect a router and computer using a console cable.
- Configure TeraTerm to establish a console session with the router.

Background

TeraTerm Web is another simple Windows-based terminal emulation program for serial communication that can be used to connect to the console port on Cisco IOS devices.

Scenario

Cable a network similar to the Topology Diagram. Any router that meets the interface requirements may be used. Possible routers include 800, 1600, 1700, 2500, 2600 routers, or a combination. The following resources will be required:

- Computer with a serial interface and TeraTerm Pro loaded
- Cisco router
- Console (rollover) cable for connecting the workstation to the router

Task 1: Connect a Router and Computer with a Console Cable.

Step 1: Set up basic physical connection.

Ensure that power is turned off on the computer and Cisco router. Connect the console (rollover) cable to the console port on the router. Connect the other cable end to the PC with a DB-9 or DB-25 adapter to the COM 1 port.

Step 2: Power on devices.

Enable power to the computer and router.

Task 2: Configure TeraTerm Web to Establish a Console Session with the Router.

Step 1: Start TeraTerm Web application.

From the Windows taskbar, start the TeraTerm Web program by opening the TeraTerm Web folder, and starting the TeraTerm Web application, `ttermpro`.

Step 2: Configure TeraTerm Web.

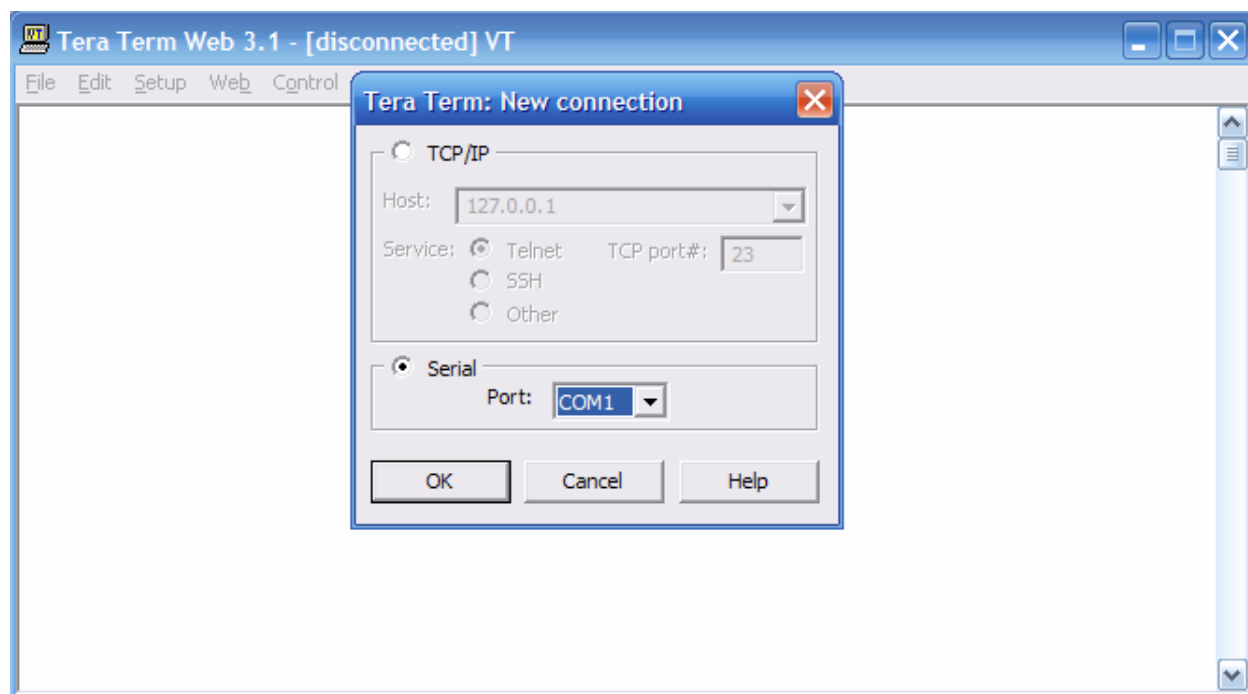


Figure 1. TeraTerm Web Connection Configuration Window

Click **File > New Connection**. Refer to Figure 1. Select the appropriate serial COM port. Click **OK**.

When the TeraTerm Web session window comes up, press the **Enter** key. There should be a response from the router. The connection has been successfully completed. If there is no connection, troubleshoot as necessary. For example, verify that the router has power. Check the connection to the COM 1 port on the PC and the console port on the router. If there is still no connection, ask the instructor for assistance.

Step 3: Close TeraTerm Web.

When finished, close the TeraTerm Web session. Click **File | Exit**. When asked whether to save the session, click **Yes**. Enter a name for the session.

Step 4: Reconnect the TeraTerm Web session.

Reopen the TeraTerm Web session as described in Task 2, Step 1. This time, when the New Description window opens (see Figure 1), click **Cancel**.

Click **File > Open**. Select the saved session and then click **Open**. Use this technique to reconnect the TeraTerm Web session to a Cisco device without reconfiguring a new session.

Task 3: Reflection

This lab provided information for establishing a console connection to a Cisco router. Cisco switches are accessed in the same way.

Task 4: Challenge

Draw the pin connections for the rollover cable and straight-through cable. Compare the differences, and be able to identify the different cable types.

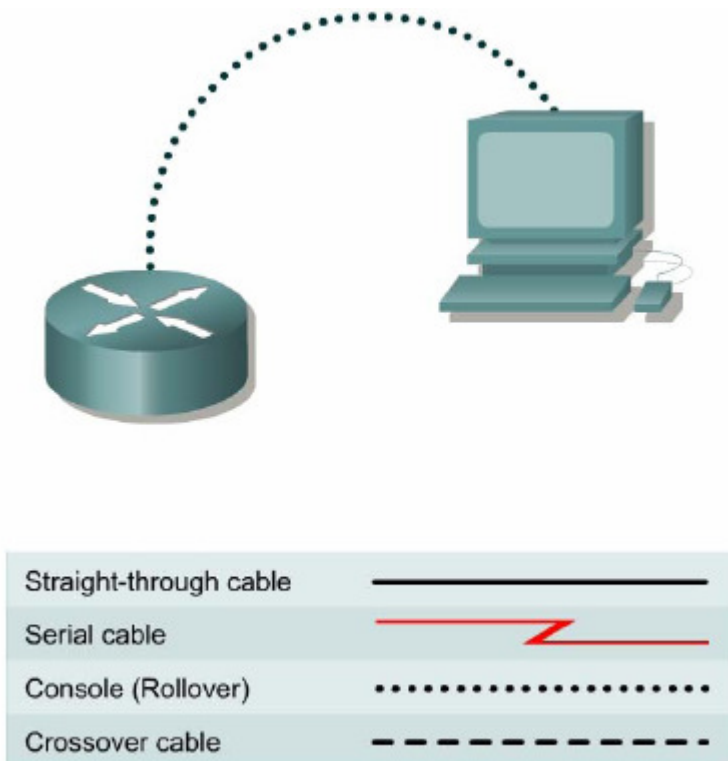
Task 5: Clean Up

Unless directed otherwise by the instructor, turn off power to the host computer and router. Remove the rollover cable.

Remove anything that was brought into the lab, and leave the room ready for the next class.

Lab 10.6.3: Establishing a Console Session with Minicom

Topology Diagram



Learning Objectives

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

- Connect a router and computer using a console cable.
- Configure Minicom to establish a console session with the router.
- Perform basic commands.

Background

Minicom is a text-based UNIX terminal emulation program, similar to the Windows HyperTerminal program. Minicom can be used for many purposes, such as controlling a modem or accessing a Cisco router through the serial console connection. The Linux or UNIX operating system is required.

Scenario

Set up a network similar to the one in the Topology Diagram. Any router that meets the interface requirements may be used. Possible routers include 800, 1600, 1700, 2500, 2600 routers, or a combination. The following resources will be required:

- Linux/UNIX computer with a serial interface and Minicom loaded
- Cisco router
- Console (rollover) cable for connecting the workstation to the router

Task 1: Connect a Router and Computer with a Console Cable.

Step 1: Set up basic physical connection.

Ensure that power is turned off on the computer and Cisco router. Connect the console (rollover) cable to the console port on the router. Connect the other cable end to the PC with a DB-9 or DB-25 adapter to the COM 1 port.

Step 2: Power on devices.

Enable power to the computer and router.

Task 2: Configure Minicom to Establish a Console Session with the Router.

Step 1: Start Minicom application in configuration mode.

Note: To configure Minicom, root access is required. From the Linux command prompt, start **minicom** with the **-s** option. This starts Minicom in the configuration mode:

```
[root]# minicom -s <ENTER>
```

Step 2: Configure Minicom for serial communications.

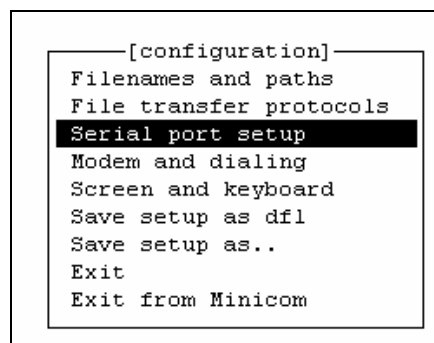


Figure 1. Main Configuration Window

Refer to Figure 1. To configure the serial port, scroll down the configuration list and select **Serial port setup**. Press **Enter**.

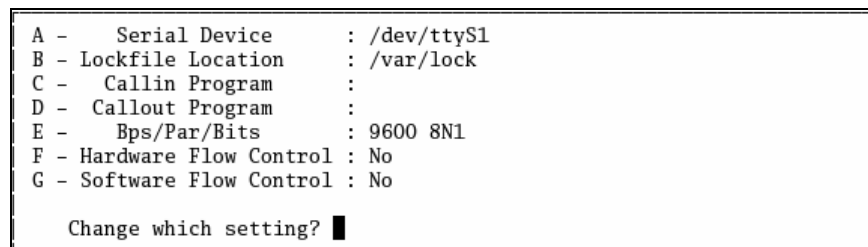


Figure 2. Serial Port Configuration Window

Refer to Figure 2. Use the letter by the field to change a setting. Refer to Table 1 for the correct values.

Option	Field	Value
A	Serial Device	/dev/ttyS0 for COM1 /dev/ttyS1 for COM2
E	Bps/Par/Bits	Bps- 9600 Par- None Bits- 8 Stop bits- 1 (or, select option 'Q')
F	Hardware Flow Control	Toggle- No
G	Software Flow Control	Toggle- No

Table 1. Serial Port Settings

Return to the Configuration menu by pressing **Enter** or **Esc**.

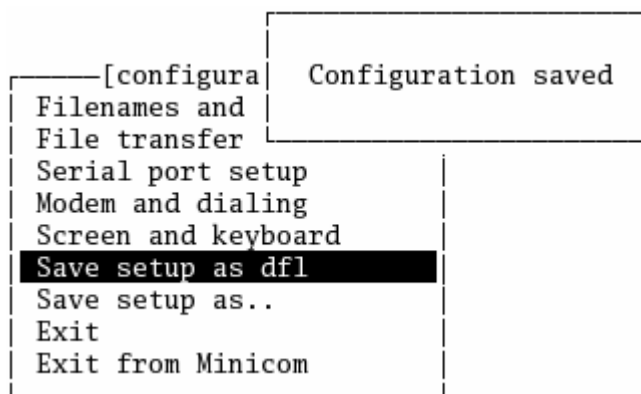


Figure 3. Serial Port Configuration Window

Refer to Figure 3. Select **Save setup as dfl** (default file). When Minicom is restarted, the default values will be reloaded.

Step 3: Close Minicom.

When finished, close the Minicom session. Select **Exit from Minicom**.

Step 4: Restart the Minicom session.

```
[root]# minicom <ENTER>
```

When the session window starts, press the **Enter** key. There should be a response from the router. This indicates that connection has been successfully completed. If there is no connection, troubleshoot as necessary. For example, verify that the router has power. Check the connection to the correct COM1 port on the PC and the console port on the router. If there is still no connection, ask the instructor for assistance.

Task 3: Perform Basic Commands.

Minicom is a text-based, menu-driven, serial communication utility. Basic commands are not intuitive. For example, users communicate with remote devices within the terminal window. However, to control the utility, use **<CTRL> A**. To get help, press **<CTRL> A**, followed by **Z**.

Minicom Command Summary		
Commands can be called by CTRL-A <key>		
Main Functions		Other Functions
Dialing directory..D	run script (Go)....G	Clear Screen.....C
Send files.....S	Receive files.....R	cOnfigure Minicom..O
comm Parameters....P	Add linefeed.....A	Suspend minicom....J
Capture on/off....L	Hangup.....H	eXit and reset....X
send break.....F	initialize Modem...M	Quit with no reset.Q
Terminal settings..T	run Kermit.....K	Cursor key mode....I
lineWrap on/off....W	local Echo on/off..E	Help screen.....Z
		scroll Back.....B
Select function or press Enter for none.█		
Written by Miquel van Smoorenburg 1991-1995		
Some additions by Jukka Lahtinen 1997-2000		
i18n by Arnaldo Carvalho de Melo 1998		

Figure 4. Minicom Command Summary Screen

Refer to Figure 4 for a list of functions and corresponding keys. To quit Minicom, press **<CTRL> A**, followed by either **q** or **x**.

Task 4: Reflection

This lab provided information for establishing a console connection to a Cisco router using Minicom. Cisco switches are accessed in the same fashion.

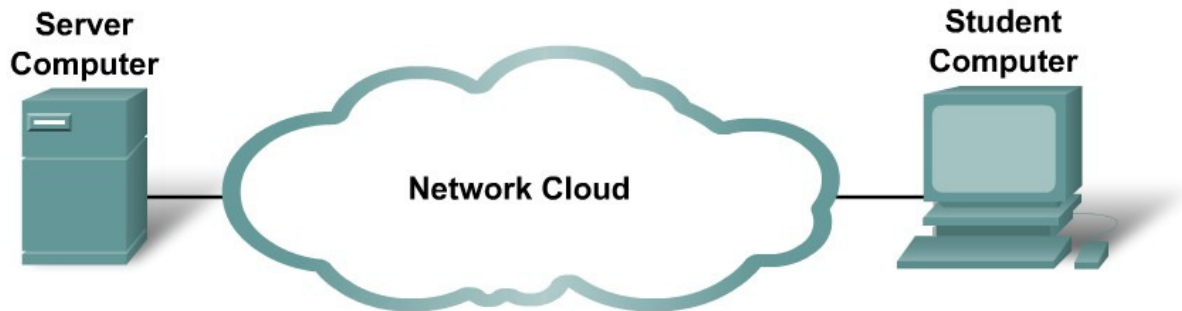
Task 5: Clean Up

Unless directed otherwise by the instructor, turn off power to the host computer and router. Remove the rollover cable.

Remove anything that was brought into the lab, and leave the room ready for the next class.

11.4.3.3: Network Latency Documentation with Ping

Topology Diagram



Learning Objectives

- Use the **ping** command to document network latency.
- Compute various statistics on the output of a **ping** capture.
- Measure delay effects from larger datagrams.

Background

To obtain realistic network latency statistics, this activity must be performed on a live network. Be sure to check with your instructor for any local security restrictions against using the **ping** command on the network.

The destination Server Computer must return ECHO replies, otherwise delay cannot be computed. Some computers have this feature disabled through a firewall, and some private networks block transit ECHO datagrams. For this experiment to be interesting, a sufficiently distant destination should be chosen. For example, destinations on the same LAN or within a few hops may return an unrepresentative low latency. With patience, a suitable destination will be found.

The purpose of this lab is to measure and evaluate network latency over time, and during different periods of the day to capture a representative sample of typical network activity. This will be accomplished by analyzing the return delay from a distant computer with the **ping** command.

Statistical analysis of throughput delay will be performed with the assistance of a spreadsheet application such as Microsoft Excel. Return delay times, measured in milliseconds, will be summarized with through computation of the average latency (mean), noting the latency value at the center of the ordered range of latency points (median), and identification of the most frequently occurring delay (mode). The Appendix contains a chart that can be submitted to the instructor when finished.

Delay will also be measured when the ICMP datagram size is increased.

Scenario

In the topology graphic above, the network cloud represents all of the network devices and cabling between the student computer and the destination Server Computer. It is normally these devices that introduce network latency. Network engineers routinely rely on networks outside of local administration for connectivity to external networks. Monitoring path latency does provide some measure of administrative diligence, which may be used in decision-making when evaluating suitable applications for wide area network (WAN) deployment.

This activity will require five days of testing. On each day, three tests will be performed. Preferably, one test will be made in the early morning, one around mid-day, and one in the evening. The idea is to note and document latency differences that occur during the different periods of the day. When finished there will be a total of 15 sets of this data.

To understand the delay effects from larger datagrams, ICMP datagrams will be sent with increasingly larger datagrams and analyzed.

Task 1: Use the `ping` Command to Document Network Latency.

Step 1: Verify connectivity between Student Computer and destination Server Computer.

To verify connectivity between the Student Computer and destination Server Computer, open a terminal window by clicking on start | run. Enter `cmd`, and then select `OK`. Attempt to ping a suitably distant destination, such as `www.yahoo.com`:

```
C:\> ping -n 1 www.yahoo.com
Pinging www.yahoo-ht3.akadns.net [209.191.93.52] with 32 bytes of data:
Reply from 209.191.93.52: bytes=32 time=304ms TTL=52
Ping statistics for 209.191.93.5:
    Packets: Sent = 1, Received = 1, Lost = 0 (0% loss)
    Approximate round trip times in milli-seconds:
        Minimum = 304ms, Maximum = 304ms , Average = 304 ms
```

Use the `ping /?` command to answer the following questions:

What is the purpose of the `-n` option and argument 1?

What option and argument would change the default size to 100 bytes? _____

Decide on a destination Server Computer, and write down the name: _____

Use the `ping` command to verify connectivity with the destination, and write down the results:

Packets sent	Packets Received	Packets Lost
--------------	------------------	--------------

If there are lost packets, use another destination and retest.

Step 2: Perform a delay test.

Write down the command that will send 100 ECHO requests to the destination:

Use the ping command to send 100 ECHO requests to your destination. When finished, copy the replies into Notepad. Notepad can be opened by clicking on Start | Programs | Accessories, and select Notepad. Save the file using the name format *day-sample#.txt*, where: *day* = the day the test was performed (1-5), and *sample#* = the sample period (1-3).

Alternately, output can be redirected to a file by appending `> day-sample#.txt` to the end of the **ping** command. NOTE: the terminal will remain blank until the command has finished.

Task 2: Compute Various Statistics on the Output of a ping Capture.

Step 1: Bring the text file into the Excel Spreadsheet Application.

If not already opened, start Microsoft Excel. Select menu options File | Open. Use Browse to move to the directory that holds the text file. Highlight the filename and select Open. To format a text file for use within Excel, insure all numeric values are separated from text characters. In the Text Import Wizard, Step 1, select Fixed Width. In Step 2, follow instructions in the window to separate numeric values from text values. Refer to Figure 1.

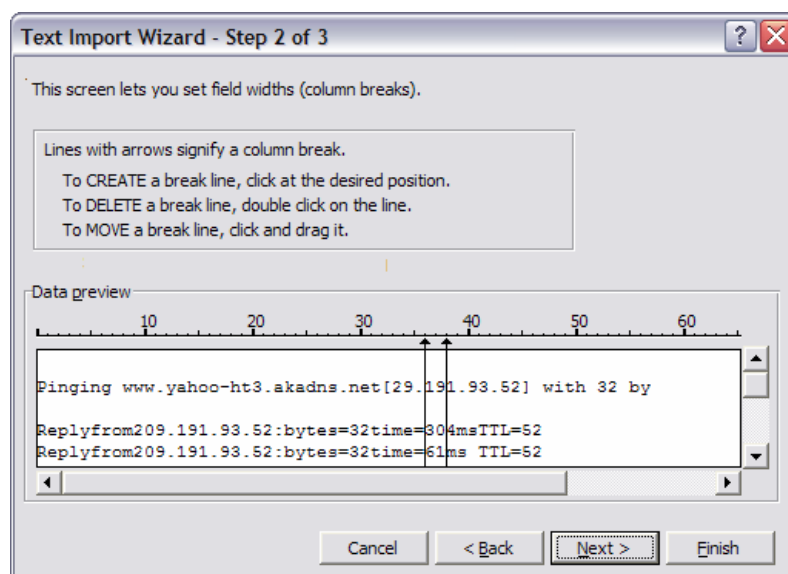


Figure 1. Excel Text Import Wizard.

Step 2. Compute mean, median and mode delay values.

When input formatting is satisfactory, select **Finish**. If the spreadsheet has numbers in different fields, manually fix the numbers. After the spreadsheet has been opened, format the columns so they are more readable. When complete, you should have a spreadsheet that looks similar to Figure 2.

	A	B	C	E	G	I
1				Bytes	Delay (ms)	TTL
2	Reply from	209.191.93.52:		32	304	52
3	Reply from	209.191.93.52:		32	61	52
4	Reply from	209.191.93.52:		32	56	52
5	Reply from	209.191.93.52:		32	54	52
6	Reply from	209.191.93.52:		32	65	52
7	Reply from	209.191.93.52:		32	55	52
8	Reply from	209.191.93.52:		32	57	52

Figure 2. Partial spreadsheet correctly formatted.

Record the number of dropped packets in your chart, column Dropped Packets. Dropped packets will have a consistently large delay value.

Finally, the delay values must be ordered (sorted) when computing the median and mode values. This is accomplished with the Data | Sort menu options. Highlight all of the data fields. Figure 3 shows a partial spreadsheet highlighted and the Data | Sort menu opened. If a header row was highlighted, click on the Header row radio button. Select the column that contains the Delay values, in Figure 3 it is Column G. When finished click OK.

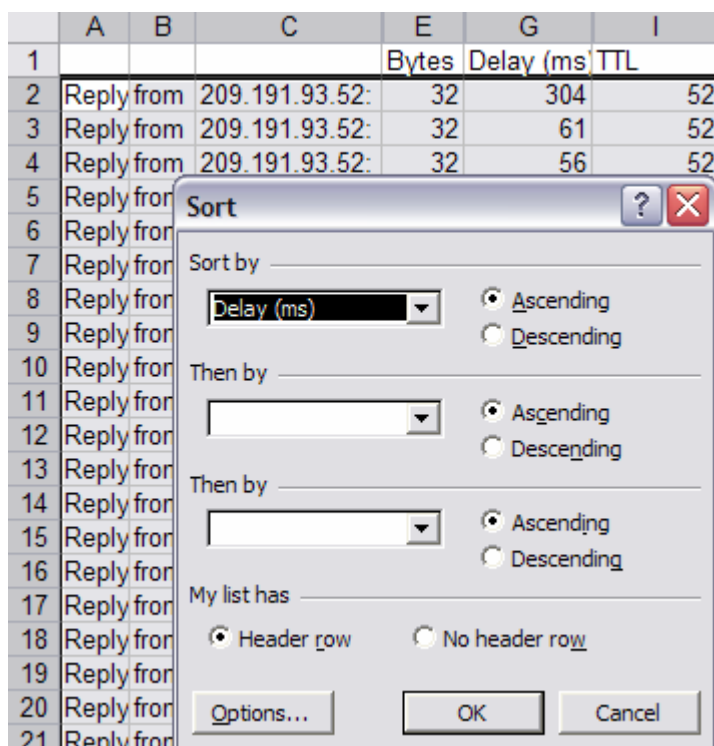


Figure 3. Ordering on the Delay column.

The formula used to compute the mean, or average, delay is the sum of the delays, divided by number of measurements. Using the example above, this would equate to the formula in cell G102:

=average(G2:G101). Perform a visual 'sanity check' to verify your mean value is approximately the value shown. Record this number in your chart, under column Mean.

The formula used to compute the median delay, or the delay value in the center of the ordered range, is similar to the average formula, above. For the median value, the formula in cell G103 would be

`=median(G2:G101)`. Perform a visual 'sanity check' to verify your median value is similar to what is shown midway in the data range. Record this number in your chart, under column Median.

The formula used to compute the modal delay, or the delay value that is the most frequently occurring, is also similar. For the mode value, the formula in cell G104 would be `=mode(G2:G101)`. Perform a visual 'sanity check' to verify your mode value is the most frequently occurring value in the data range. Record this number in your chart, under column Mode.

The new spreadsheet file may be saved or discarded as desired, but the data text file should be retained.

Task 3: Measure Delay Effects from Larger Datagrams.

To determine if larger datagrams affect delay, increasingly larger ECHO requests will be sent to the destination. In this analysis, 20 datagrams will be incremented by 100 bytes per **ping** request. A spreadsheet will be created with the reply results, and a chart that plots size vs. delay will be produced.

Step 1: Perform a variable sized delay test.

The easiest way to accomplish this task is to use the Windows built-in FOR loop command. The syntax is:

```
FOR /L %variable IN (start,step,end) DO command [command-parameters]
```

The set is a sequence of numbers from start to end, by step amount. So (1,1,5) would generate the sequence 1 2 3 4 5 and (5,-1,1) would generate the sequence (5 4 3 2 1)

In the following command, *destination* is the destination. Issue the command:

```
FOR /L %i IN (100,100,2000) DO ping -n 1 -l %i destination
```

Copy the output into Notepad, and save the file using the name `variablesizedelay.txt`.

To redirect output to a file, use the redirect append operator, `>>`, as shown below. The normal redirect operator, `>`, will clobber the file each time the ping command is executed and only the last reply will be saved. NOTE: the terminal will remain blank until the command has finished:

```
FOR /L %i IN (100,100,2000) DO ping -n 1 -l %i destination >>  
variablesizedelay.txt
```

The output of one line is shown below. All 20 replies are arranged similarly:

```
C:\> FOR /L %i IN (100,100,2000) DO ping -n 1 -l %i www.yahoo.com

C:\> ping -n 1 -l 100 www.yahoo.com

Pinging www.yahoo-ht3.akadns.net [209.191.93.52] with 100 bytes of data:
Reply from 209.191.93.52: bytes=100 time=383ms TTL=52

Ping statistics for 209.191.93.52:
    Packets: Sent = 1, Received = 1, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 383ms, Maximum = 383ms, Average = 383ms
```

Step 2: Bring the text file into the Excel Spreadsheet Application.

Open the new text file in Excel. Refer to Figure 4.

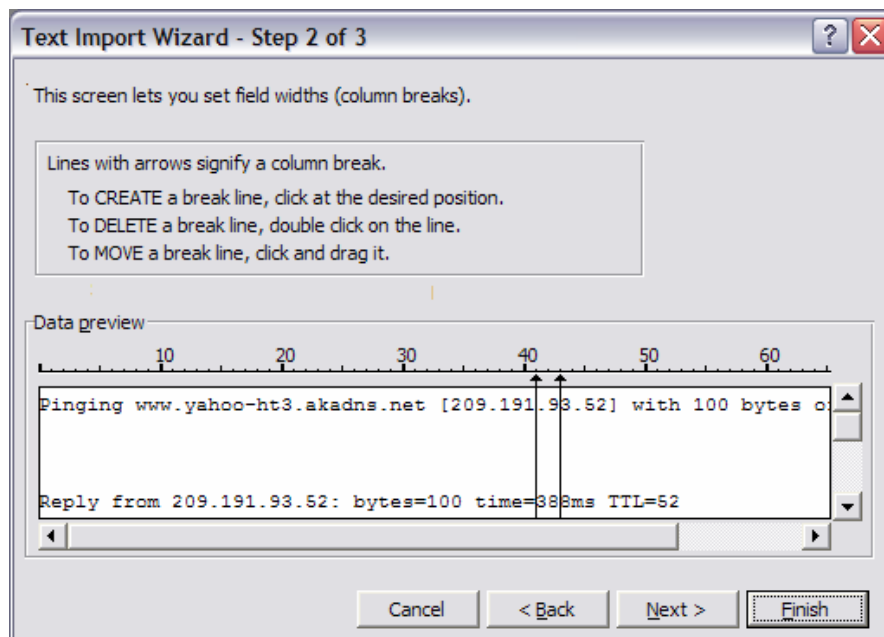


Figure 4. Excel Text Import Wizard.

The difference between this file and the previous file is that the variable size file has much more information than is really needed.

Step 3: Format the spreadsheet.

Clean and organize the spreadsheet data into two columns, Bytes and Delay. When finished, the spreadsheet should look similar to Figure 5.

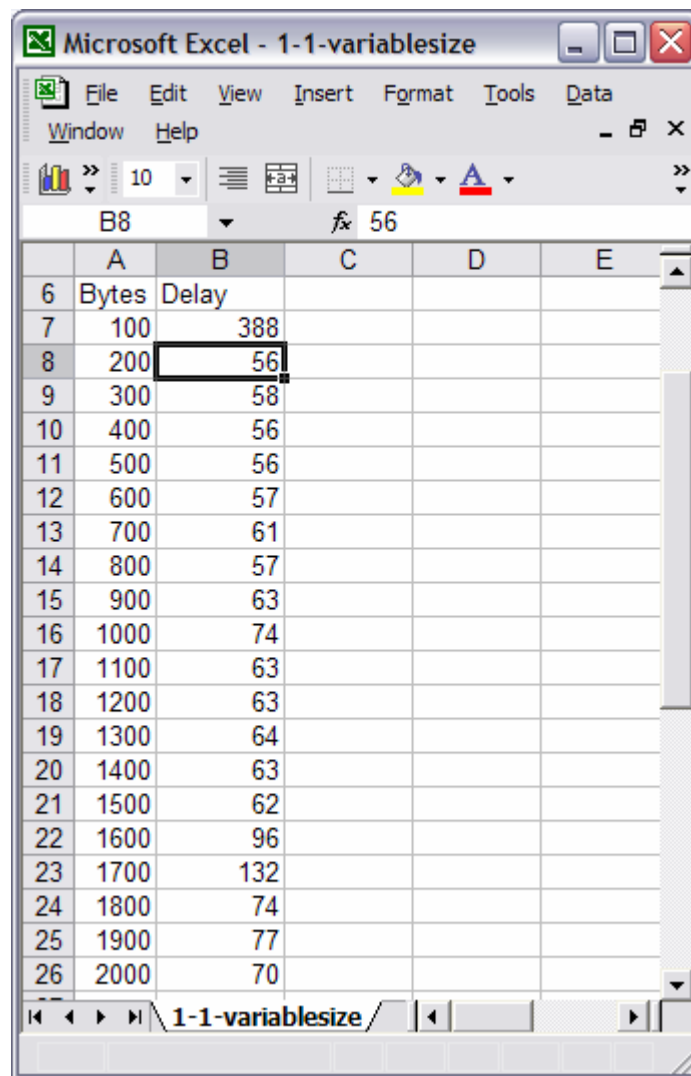
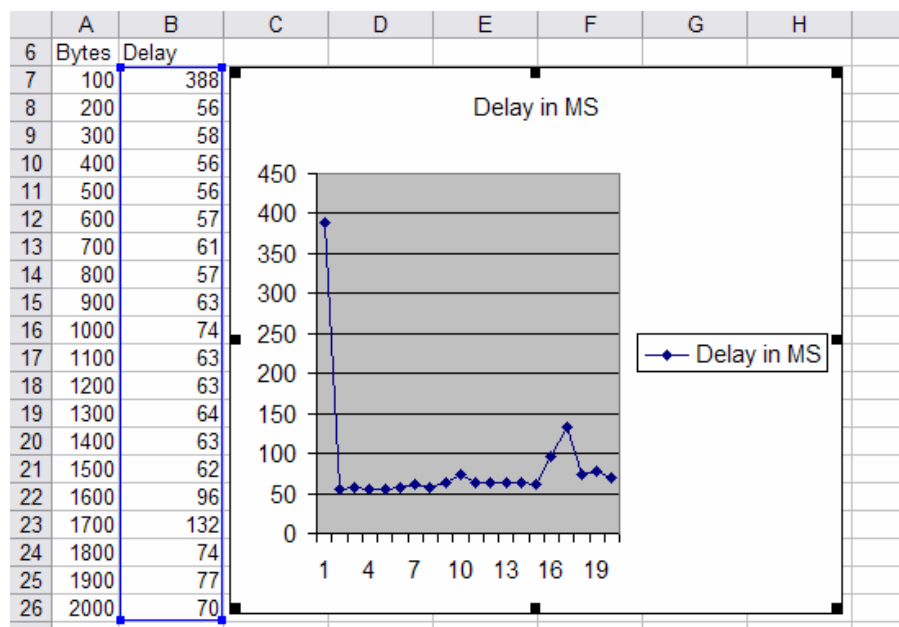


Figure 5. Formatted Spreadsheet.

Step 3: Create a chart of the data.

Highlight the Delay column data. Select menu options Insert | Chart. There are a number of charts that can be used to display delay data, some better than others. While a chart should be clear, there is room for individual creativity. The chart in Figure 6 is a Stacked Line chart.



When finished, save your spreadsheet and chart and submit it to your instructor with the final delay analysis.

Are there any assumptions that can be made regarding delay when larger datagrams are sent across a network?

Task 4: Reflection

The **ping** command can provide important network latency information. Careful delay analysis over successive days and during different periods of the day can alert the network engineer to changes in network performance. For example, network devices may become overwhelmed during certain periods of the day, and network delay will spike. In this case, routine data transfers should be scheduled during off-peak times when delay is less. Also, many users subscribe to peer-to-peer applications such as KaZaA and Napster. When these file-sharing applications are active, valuable bandwidth will be diverted from critical business applications. If delays are caused by events within the organization, network analysis tools can be used to determine the source and corrective action taken. When the source originates from external networks, not under the control of the organization, subscribing with a different or additional Internet service provider (ISP) may prove beneficial.

Task 5: Challenge

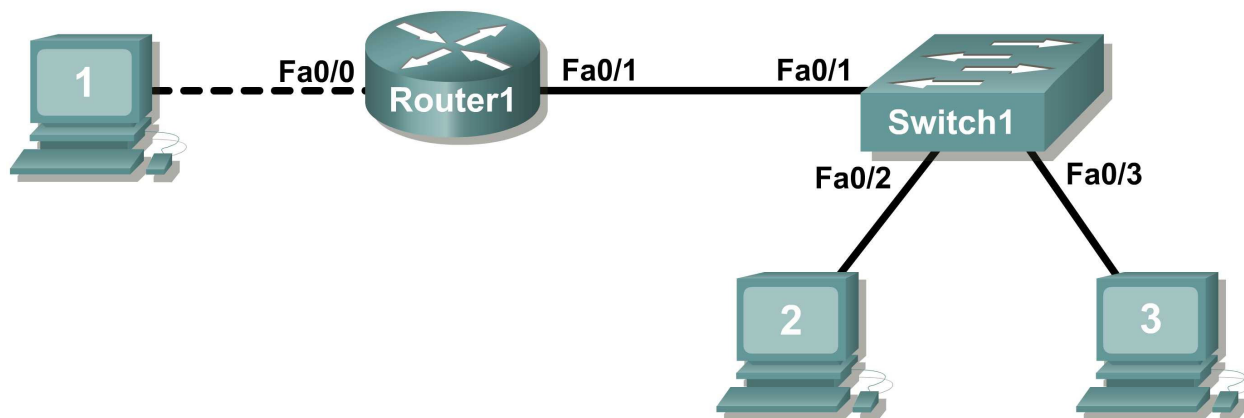
If permitted, download a large file and perform a separate delay test while the file is downloading. Write a one or two paragraph analysis that compares these delay results against a measurement made without the download.

Appendix

NAME: _____			Network Delay Documentation			
Source IP Address: _____			Destination IP Address: _____		TTL: _____	
Statistical Analysis of Network Latency with 32 byte datagrams						
Day (1-5)	Date (mm/dd/yyyy)	Time (hh:mm)	MEAN	MEDIAN	MODE	Dropped Packets
1						
2						
3						
4						
5						

Lab 11.5.1: Basic Cisco Device Configuration

Topology Diagram



Learning Objectives

- Configure Cisco router global configuration settings.
- Configure Cisco router password access.
- Configure Cisco router interfaces.
- Save the router configuration file.
- Configure a Cisco switch.

Background

Hardware	Qty	Description
Cisco Router	1	Part of CCNA Lab bundle.
Cisco Switch	1	Part of CCNA Lab bundle.
*Computer (host)	1	Lab computer.
Console (rollover) cable	1	Connects computer host 1 to Router console port.
UTP Cat 5 crossover cable	1	Connects computer host 1 to Router LAN interface Fa0/0
Straight Through Cable	3	Connects computer hosts to Switch and switch to router

Table 1. Equipment and hardware required for this lab.

Gather the necessary equipment and cables. To configure the lab, make sure the equipment listed in Table 1 is available.

Common configuration tasks include setting the hostname, access passwords, and MOTD banner.

Interface configuration is extremely important. In addition to assigning a Layer 3 IP address, enter a description that describes the destination connection speeds troubleshooting time.

Configuration changes are effective immediately.

Configuration changes must be saved in NVRAM to be persistent across reboot.

Configuration changes may also be saved off-line in a text file for auditing or device replacement.

Cisco IOS switch configuration is similar to Cisco IOS router configuration.

Scenario

In this lab students will configure common settings on a Cisco Router and Cisco Switch.

Given an IP address of 198.133.219.0/24, with 4 bits borrowed for subnets, fill in the following information in the table below.

(Hint: fill in the subnet number, then the host address. Address information will be easy to compute with the subnet number filled in first)

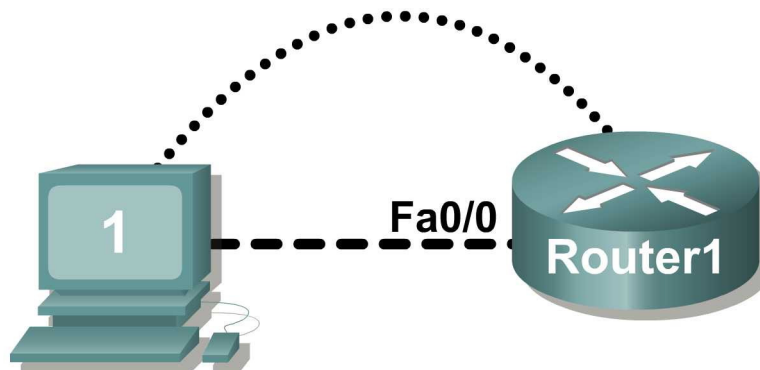
Maximum number of usable subnets (including the 0th subnet): _____

Number of usable hosts per subnet: _____

#	IP Address:		Subnet mask:	
	Subnet	First host address	Last host address	Broadcast
0				

Before proceeding, verify your addresses with the instructor. The instructor will assign subnetworks.

Task 1: Configure Cisco Router Global Configuration Settings.



Straight-through cable



Serial cable



Console (Rollover)



Crossover cable



Figure 1. Lab cabling.

Step 1: Physically connect devices.

Refer to Figure 1. Connect the console or rollover cable to the console port on the router. Connect the other end of the cable to the host computer using a DB-9 or DB-25 adapter to the COM 1 port. Connect the crossover cable between the host computer's network interface card (NIC) and Router interface Fa0/0. Connect a straight-through cable between the Router interface Fa0/1 and any of the switch's interfaces (1-24).

Ensure that power has been applied to the host computer, switch and router.

Step 2: Connect host computer to router through HyperTerminal.

From the Windows taskbar, start the HyperTerminal program by clicking on Start | Programs | Accessories | Communications | HyperTerminal.

Configure HyperTerminal with the proper settings:

Connection Description

Name: **Lab 11_2_11**

Icon: **Personal choice**

Connect to

Connect Using: **COM1** (or appropriate COM port)

COM1 Properties

Bits per second: **9600**
Data bits: **8**
Parity: **None**
Stop bits: **1**
Flow Control: **None**

When the HyperTerminal session window comes up, press the **Enter** key until there is a response from the router.

If the router terminal is in the configuration mode, exit by typing **NO**.

```
Would you like to enter the initial configuration dialog? [yes/no]: no  
  
Press RETURN to get started!  
Router>
```

When in privileged exec command mode, any misspelled or unrecognized commands will attempt to be translated by the router as a domain name. Since there is no domain server configured, there will be a delay while the request times out. This can take between several seconds to several minutes. To terminate the wait, simultaneously hold down the **<CTRL><SHIFT>6** keys then release and press **x**:

```
Router>enabel  
Translating "enabel"...domain server (255.255.255.255) %
```

Briefly hold down the keys <CTRL><SHIFT>6, release and press x

```
Name lookup aborted  
  
Router>
```

From the user exec mode, enter privileged exec mode:

```
Router> enable  
Router#
```

Verify a clean configuration file with the privileged exec command **show running-config**. If a configuration file was previously saved, it will have to be removed. Appendix 1 shows a typical default router's configuration. Depending on router's model and IOS version, your configuration may look slightly different. However, there should be no configured passwords or IP addresses. If your router does not have a default configuration, ask the instructor to remove the configuration.

Step 3: Configure global configuration hostname setting.

What two commands may be used to leave the privileged exec mode? _____

What shortcut command can be used to enter the privileged exec mode? _____

Examine the different configuration modes that can be entered with the command **configure**? Write down the list of configuration modes and description:

From the `privileged exec` mode, enter global configuration mode:

```
Router# configuration terminal  
Router(config)#
```

What three commands may be used to leave the global configuration mode and return to the privileged exec mode?

What shortcut command can be used to enter the global configuration mode? _____

Set the device hostname to `Router1`:

```
router(config)# hostname Router1  
Router1(config)#
```

How can the hostname be removed?

Step 5: Configure the MOTD banner.

In production networks, banner content may have a significant legal impact on the organization. For example, a friendly “Welcome” message may be interpreted by a court that an attacker has been granted permission to hack into the router. A banner should include information about authorization, penalties for unauthorized access, connection logging, and applicable local laws. The corporate security policy should provide policy on all banner messages.

Create a suitable MOTD banner. Only system administrators of the ABC Company are authorized access, unauthorized access will be prosecuted, and all connection information will be logged.

Examine the different banner modes that can be entered. Write down the list of banner modes and description.

Router1(config)# banner ?

Choose a terminating character that will not be used in the message text. _____

Configure the MOTD banner. The MOTD banner is displayed on all connections before the login prompt. Use the terminating character on a blank line to end the MOTD entry:

```
Router1(config)# banner motd %  
Enter TEXT message. End with the character '%'  
***You are connected to an ABC network device. Access is granted to only  
current ABC company system administrators with prior written approval. ***  
  
*** Unauthorized access is prohibited, and will be prosecuted. ***  
  
*** All connections are continuously logged. ***  
  
%  
Router1(config)#
```

What is the global configuration command to remove the MOTD banner?

Task 2: Configure Cisco router password access.

Access passwords are set for the privileged exec mode and user entry point such as console, aux, and virtual lines. The privileged exec mode password is the most critical password, since it controls access to the configuration mode.

Step 1: Configure the privileged exec password.

Cisco IOS supports two commands that set access to the privileged exec mode. One command, **enable password**, contains weak cryptography and should never be used if the **enable secret** command is available. The **enable secret** command uses a very secure MD5 cryptographic hash algorithm. Cisco says "As far as anyone at Cisco knows, it is impossible to recover an enable secret based on the contents of a configuration file (other than by obvious dictionary attacks)." Password security relies on the password algorithm, and the password. . In production environments, strong passwords should be used at all times. A strong password consists of at least nine characters of upper and lower case letters, numbers, and symbols. In a lab environment, we will use weak passwords.

Set the privileged exec password to **cisco**.

```
Router1(config)# enable secret cisco
Router1(config)#
```

Step 2: Configure the console password.

Set the console access password to **class**. The console password controls console access to the router.

```
Router1(config)# line console 0
Router1(config-line)# password class
Router1(config-line)# login
```

What is the command to remove the console password? _____

Step 3: Configure the virtual line password.

Set the virtual line access password to **class**. The virtual line password controls Telnet access to the router. In early Cisco IOS versions, only five virtual lines could be set, 0 through 4. In newer Cisco IOS versions, the number has been expanded. Unless a telnet password is set, access on that virtual line is blocked.

```
Router1(config-line)# line vty 0 4
Router1(config-line)# password class
Router1(config-line)# login
```

There are three commands that may be used to exit the line configuration mode:

Command	Effect
	Return to the global configuration mode.
	Exit configuration and return to the privileged exec mode.

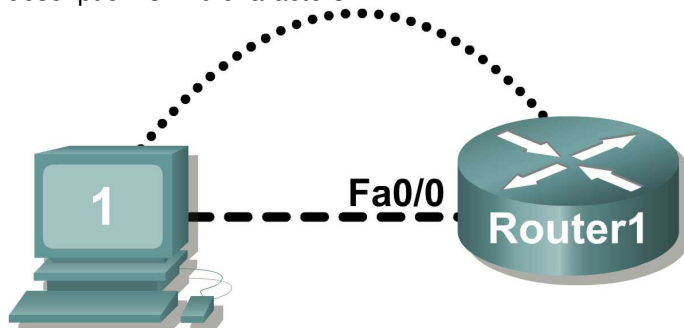
Issue the command **exit**. What is the router prompt? What is the mode?

Router1(config-line)# **exit**

Issue the command **end**. What is the router prompt? What is the mode?

Task 3: Configure Cisco Router Interfaces.

All cabled interfaces should contain documentation about the connection. On newer Cisco IOS versions, the maximum description is 240 characters.



Straight-through cable



Serial cable



Console (Rollover)



Crossover cable



Figure 2. Physical lab topology.

Figure 2 shows a network topology where a host computer is connected to Router1, interface Fa0/0.

Write down your subnet number and mask: _____

The first IP address will be used to configure the host computer LAN. Write down the first IP Address: _____

The last IP address will be used to configure the router fa0/0 interface. Write down the last IP Address: _____

Step 1: Configure the router fa0/0 interface.

Write a short description for the connections on Router1:

Fa0/0 ->

Apply the description on the router interface with the interface configuration command, **description**:

```
Router1(config)# interface fa0/0
Router1(config-if)# description Connection to Host1 with crossover cable
Router1(config-if)# ip address address mask
Router1(config-if)# no shutdown
Router1(config-if)# end
Router1#
```

Look for the interface to become active:

```
*Mar 24 19:58:59.602: %LINEPROTO-5-UPDOWN: Line protocol on Interface
FastEthernet0/0, changed state to up
```

Step 2: Configure the router Fa0/1 interface.

Write a short description for the connections on Router1:

Fa0/1 ->

Apply the description on the router interface with the interface configuration command, **description**:

```
Router1(config)# interface fa0/1
Router1(config-if)# description Connection to switch with straight-through
cable
Router1(config-if)# ip address address mask
Router1(config-if)# no shutdown
Router1(config-if)# end
Router1#
```

Look for the interface to become active:

```
*Mar 24 19:58:59.602: %LINEPROTO-5-UPDOWN: Line protocol on Interface
FastEthernet0/1, changed state to up
```

Step 3: Configure the host computer.

Configure the host computer for LAN connectivity. Recall that the LAN configuration window is accessed through Start | Control Panel | Network Connections. Right-click on the LAN icon, and select Properties. Highlight the Internet Protocol field, and select Properties. Fill in the following fields:

IP Address: The first host address _____
Subnet Mask: The subnet mask _____
Default Gateway: Router's IP Address _____

Click OK, and then Close. Open a terminal window, and verify network settings with the **ipconfig** command.

Step 4: Verify network connectivity.

Use the **ping** command to verify network connectivity with the router. If ping replies are not successful troubleshoot the connection:

What Cisco IOS command can be used to verify the interface status? _____

What Windows command can be used to verify host computer configuration? _____

What is the correct LAN cable between host1 and Router1? _____

Task 4: Save the Router Configuration File.

Cisco IOS refers to RAM configuration storage as running-configuration, and NVRAM configuration storage as startup-configuration. For configurations to survive rebooting or power restarts, the RAM configuration must be copied into non-volatile RAM (NVRAM). This does not occur automatically, NVRAM must be manually updated after any changes are made.

Step 1: Compare router RAM and NVRAM configurations.

Use the Cisco IOS **show** command to view RAM and NVRAM configurations. The configuration is displayed one screen at a time. A line containing “-- more --” indicates that there is additional information to display. The following list describes acceptable key responses:

Key	Description
<SPACE>	Display the next page.
<RETURN>	Display the next line.
Q	Quit
<CTRL> c	Quit

Write down one possible shortcut command that will display the contents of NVRAM.

Display the contents of NVRAM. If the output of NVRAM is missing, it is because there is no saved configuration.:

```
Router1# show startup-config
startup-config is not present
Router1#
```

Display the contents of RAM.

```
Router1#show running-config
```

Use the output to answer the following questions:

How large is the configuration file? _____

What is the enable secret password? _____

Does your MOTD banner contain the information you entered earlier? _____

Do your interface descriptions contain the information you entered earlier? _____

Write down one possible shortcut command that will display the contents of RAM. _____

Step 2: Save RAM configuration to NVRAM.

For a configuration to be used the next time the router is powered on or reloaded, it must be manually saved in NVRAM. Save the RAM configuration to NVRAM:

```
Router1# copy running-config startup-config
Destination filename [startup-config]? <ENTER>
Building configuration...
[OK]
```

Router1#

Write down one possible shortcut command that will copy the RAM configuration to NVRAM.

Review the contents of NVRAM, and verify that the configuration is the same as the configuration in RAM.

Task 5: Configure a Cisco Switch.

Cisco IOS switch configuration is (thankfully) similar to configuring a Cisco IOS router. The benefit of learning IOS commands is that they are similar to many different devices and IOS versions.

Step 1: Connect the host to the switch.

Move the console, or rollover, cable to the console port on the switch. Ensure power has been applied to the switch. In Hyperterminal, press Enter until the switch responds.

Step 2: Configure global configuration hostname setting.

Appendix 2 shows a typical default switch configuration. Depending on router model and IOS version, your configuration may look slightly different. However, there should be no configured passwords. If your router does not have a default configuration, ask the instructor to remove the configuration.

From the user exec mode, enter global configuration mode:

```
Switch> en
Switch# config t
Switch(config)#
```

Set the device hostname to Switch1.

```
Switch(config)# hostname Switch1
Switch1(config)#
```

Step 3: Configure the MOTD banner.

Create a suitable MOTD banner. Only system administrators of the ABC company are authorized access, unauthorized access will be prosecuted, and all connection information will be logged.

Configure the MOTD banner. The MOTD banner is displayed on all connections before the login prompt. Use the terminating character on a blank line to end the MOTD entry. For assistance, review the similar step for configuring a router MOTD banner.

```
Switch1(config)# banner motd %
```

Step 4: Configure the privileged exec password.

Set the privileged exec password to **cisco**.

```
Switch1(config)# enable secret cisco
Switch1(config)#
```

Step 5: Configure the console password.

Set the console access password to **class**.

```
Switch1(config)# line console 0
Switch1(config-line)# password class
Switch1(config-line)# login
```

Step 6: Configure the virtual line password.

Set the virtual line access password to **class**. There are 16 virtual lines that can be configured on a Cisco IOS switch, 0 through 15.

```
Switch1(config-line)# line vty 0 15
Switch1(config-line)# password class
Switch1(config-line)# login
```

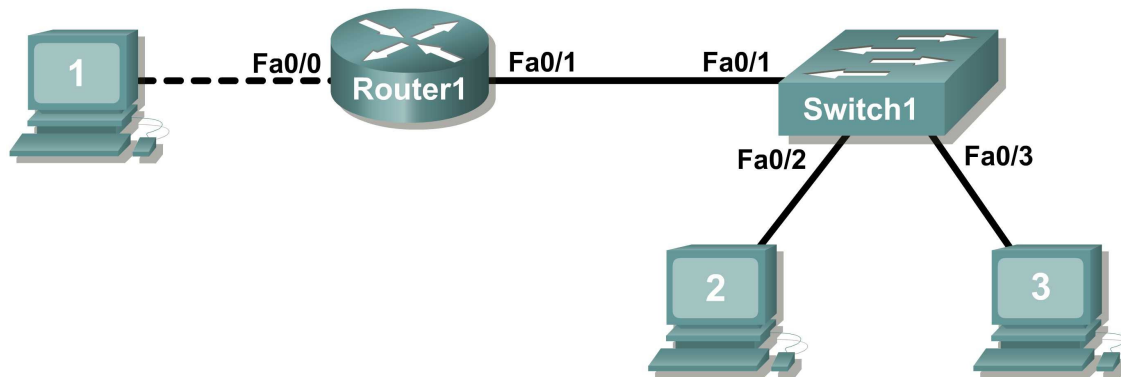


Figure 3. Network topology.

Step 7: Configure the interface description.

Figure 3 shows a network topology where Router1 is connected to Switch1, interface Fa0/1. Switch1 interface Fa0/2 is connected to host computer 2, and interface Fa0/3 is connected to host computer 3.

Write a short description for the connections on Switch1:

Router1 Interface	Description
Fa0/1	
Fa0/2	
Fa0/3	

Apply the descriptions on the switch interface with the interface configuration command, **description**:

```
Switch1(config)# interface fa0/1
Switch1(config-if)# description Connection to Router1
Switch1(config)# interface fa0/2
Switch1(config-if)# description Connection to host computer 2
Switch1(config)# interface fa0/3
Switch1(config-if)# description Connection to host computer 3
Switch1(config-if)# end
Switch1#
```

Step 7: Save RAM configuration to NVRAM.

For a configuration to be used the next time the switch is powered on or reloaded, it must be manually saved in NVRAM. Save the RAM configuration to NVRAM:

```
Switch1# copy run start
Destination filename [startup-config]? <ENTER>
Building configuration...
[OK]
Switch1#
```

Review the contents of NVRAM, and verify that the configuration is the same as the configuration in RAM.

Task 6: Reflection

The more you practice the commands, the faster you will become in configuring a Cisco IOS router and switch. It is perfectly acceptable to use notes at first to help configure a device, but a professional network engineer does not need a 'cheat sheet' to perform common configuration tasks. The following table lists commands covered in this lab:

Purpose	Command
Enter the global configuration mode.	configure terminal Example: Router> enable Router# configure terminal Router(config)#
Specify the name for the router.	hostname name Example: Router(config)# hostname Router1 Router(config)#
Specify an encrypted password to prevent unauthorized access to the privileged exec mode.	enable secret password Example: Router(config)# enable secret cisco Router(config)#

Specify a password to prevent unauthorized access to the console.	password <i>password</i> login Example: Router(config)# line con 0 Router(config-line)# password class Router(config-line)# login Router(config)#
Specify a password to prevent unauthorized telnet access. Router vty lines: 0 4 Switch vty lines: 0 15	password <i>password</i> login Example: Router(config)# line vty 0 4 Router(config-line)# password class Router(config-line)# login Router(config-line)#
Configure the MOTD banner.	Banner motd % Example: Router(config)# banner motd % Router(config)#
Configure an interface. Router- interface is OFF by default Switch- interface is ON by default	Example: Router(config)# interface fa0/0 Router(config-if)# description <i>description</i> Router(config-if)# ip address <i>address mask</i> Router(config-if)# no shutdown Router(config-if)#
Save the configuration to NVRAM.	copy running-config startup-config Example: Router# copy running-config startup-config Router#

Task 7: Challenge

It is often necessary, and always handy, to save the configuration file to an off-line text file. One way to save the configuration file is to use HyperTerminal Transfer menu option Capture.

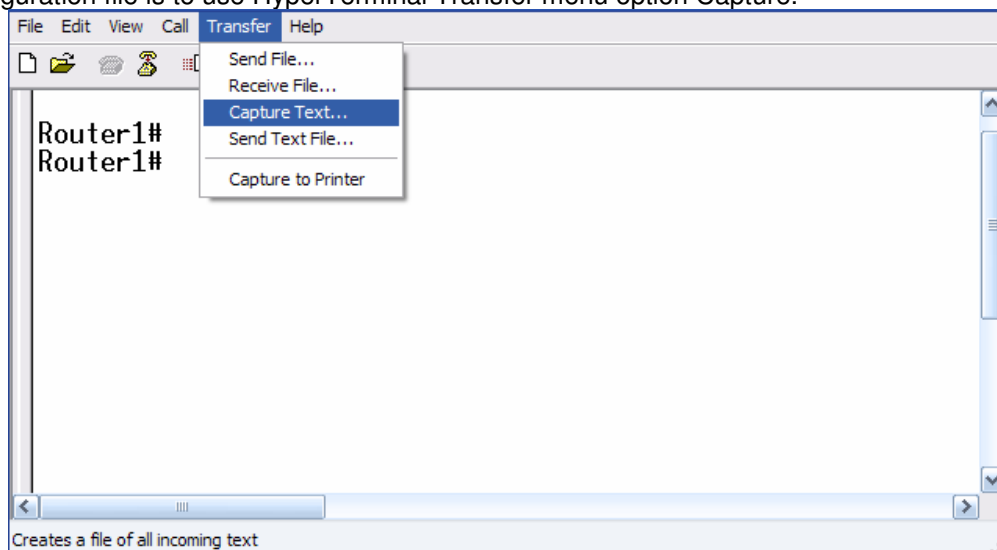


Figure 2. Hyperterminal Capture menu.

Refer to Figure 2. All communication between the host computer and router are saved to a file. The file can be edited, and saved. The file can also be edited, copied, and pasted into a router:

To start a capture, select Hyperterminal menu option Transfer | Capture Text. Enter a path and file name, and select Start.

Issue the privileged exec command **show running-config**, and press the <SPACE> key until all of the configuration has been displayed.

Stop the capture. Select menu option Transfer | Capture Text | Stop.

Open the text file and review the contents. Remove any lines that are not configuration commands, such as the `more` prompt. Manually correct any lines that were scrambled or occupy the same line. After checking the configuration file, highlight the lines and select Notepad menu Edit | Copy. This places the configuration in host computer memory.

To load the configuration file, it is ALWAYS best practice to begin with a clean RAM configuration. Otherwise, stale configuration commands may survive a paste action and have unintended consequences (also known as the Law of Unintended Consequences):

Erase the NVRAM configuration file:

```
Router1# erase start
Erasing the nvram filesystem will remove all configuration files! Continue?
[confirm] <ENTER>
[OK]
Erase of nvram: complete
```

Reload the router:

```
Router1# reload
Proceed with reload? [confirm] <ENTER>
```

When the router reboots, enter the global configuration mode:

```
Router> en
Router# config t
Router(config)#
```

Using the mouse, right-click inside the Hyperterminal window and select Paste To Host. The configuration will be loaded, very quickly, to the router. Watch closely for error messages, each message must be investigated and corrected.

Verify the configuration, and save to NVRAM.

Task 6: Cleanup

Before turning off power to the router and switch, remove the NVRAM configuration file from each device with the privileged exec command **erase startup-config**.

Delete any configuration files saved on the host computers.

Unless directed otherwise by the instructor, restore host computer network connectivity, then turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Appendix 1- default Cisco IOS router configuration

```
Current configuration : 824 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Router
!
boot-start-marker
boot-end-marker
!
no aaa new-model
ip cef
!
interface FastEthernet0/0
  no ip address
  shutdown
  duplex auto
  speed auto
!
interface FastEthernet0/1
  no ip address
  shutdown
  duplex auto
  speed auto
!
interface Serial0/1/0
  no ip address
  shutdown
  no fair-queue
!
interface Serial0/1/1
  no ip address
  shutdown
  clock rate 2000000
!
interface Vlan1
  no ip address
!
ip http server
no ip http secure-server
!
control-plane
!
line con 0
line aux 0
line vty 0 4
  login
!
scheduler allocate 20000 1000
end
```

Appendix 2- default Cisco IOS switch configuration

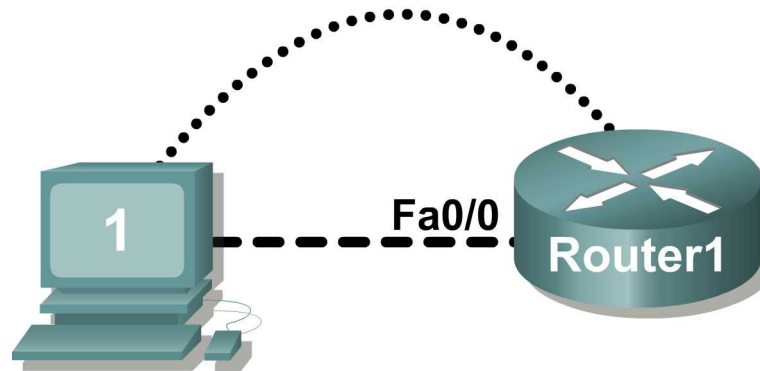
```
Current configuration : 1519 bytes
!
version 12.1
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Switch
!
!
ip subnet-zero
!
!
spanning-tree mode pvst
no spanning-tree optimize bpdu transmission
spanning-tree extend system-id
!
!
interface FastEthernet0/1
  no ip address
!
interface FastEthernet0/2
  no ip address
!
interface FastEthernet0/3
  no ip address
!
interface FastEthernet0/4
  no ip address
!
interface FastEthernet0/5
  no ip address
!
interface FastEthernet0/6
  no ip address
!
interface FastEthernet0/7
  no ip address
!
interface FastEthernet0/8
  no ip address
!
interface FastEthernet0/9
  no ip address
!
interface FastEthernet0/10
  no ip address
!
interface FastEthernet0/11
  no ip address
!
interface FastEthernet0/12
```

```
no ip address
!
interface FastEthernet0/13
no ip address
!
interface FastEthernet0/14
no ip address
!
interface FastEthernet0/15
no ip address
!
interface FastEthernet0/16
no ip address
!
interface FastEthernet0/17
no ip address
!
interface FastEthernet0/18
no ip address
!
interface FastEthernet0/19
no ip address
!
interface FastEthernet0/20
no ip address
!
interface FastEthernet0/21
no ip address
!
interface FastEthernet0/22
no ip address
!
interface FastEthernet0/23
no ip address
!
interface FastEthernet0/24
no ip address
!
interface GigabitEthernet0/1
no ip address
!
interface GigabitEthernet0/2
no ip address
!
interface Vlan1
no ip address
no ip route-cache
shutdown
!
ip http server
!
!
line con 0
line vty 5 15
!
```

end

Lab 11.5.2: Managing Device Configuration

Topology Diagram



Straight-through cable



Serial cable



Console (Rollover)



Crossover cable



Learning Objectives

- Configure network connectivity.
- Use TFTP to save and restore a Cisco IOS configuration.

Background

Hardware	Qty	Description
Cisco Router	1	Part of CCNA Lab bundle.
Computer (host)	1	Lab computer.
Console (rollover) cable	1	Connects computer host 1 to Router console port.
Crossover cable	1	Connects host1 NIC to Router1 Fa0/1

Table 1. Equipment and hardware required for this lab.

Gather the necessary equipment and cables. To configure the lab, make sure the equipment listed in Table 1 is available.

The host computer will be used as a TFTP server. This lab requires the use of SolarWinds TFTP server software. SolarWinds is a free TFTP application for Windows.

Scenario

In this lab, students will configure common settings on a Cisco Router, save the configuration to a TFTP server, then restore the configuration from a TFTP server.

Given an IP address of 10.250.250.0/24, and 6 bits used for subnets. Use the LAST valid subnet. Host1 should use the FIRST valid host address, and Router1 should use the LAST valid host address:

IP Address: 10.250.250.0		Subnet mask:	
Subnet	First host address	Last host address	Broadcast

Task 1: Configure Network Connectivity.

Step 1: Physically connect devices.

Refer to the Topology Diagram. Connect the console, or rollover, cable to the console port on the router and the other cable end to the host computer with a DB-9 or DB-25 adapter to the COM 1 port. Ensure power has been applied to both the host computer and router.

Step 2: Logically connect devices.

Using the IP address information from the scenario, configure the host1 computer.

Step 3: Connect host computer to router through HyperTerminal.

From the Windows taskbar, start the HyperTerminal program by clicking on Start | Programs | Accessories | Communications | Hyper Terminal.

When the HyperTerminal session window opens, press the **Enter** key until there is a response from the router.

Step 4: Configure Router1.

Configure Router1. Configuration tasks for Router1 include the following:

Task- refer to Appendix 1 for help with commands
Specify Router name- Router1
Specify an encrypted privileged exec password- cisco
Specify a console access password- class
Specify a telnet access password- class
Configure the MOTD banner.
Configure Router1 interface Fa0/0- set the description set the Layer 3 address issue no shutdown

NOTE **DO NOT SAVE THE CONFIGURATION IN NVRAM.

Step 5: Verify connectivity.

Verify connectivity between host1 and Router1:

```
Router1# ping 10.250.250.249
```

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 10.250.250.249, timeout is 2 seconds:

..!!!!

Success rate is 80 percent (4/5), round-trip min/avg/max = 1/1/1 ms

```
Router1#
```

Task 2: Use TFTP to Save and Restore a Cisco IOS Configuration.

Step 1: Install SolarWinds TFTP application.

Double click on the SolarWinds TFTP application to begin installation. Select Next. Agree to the license agreement, and accept default settings. After SolarWinds has finished installation, click on Finish.

Step 2: Start TFTP server.

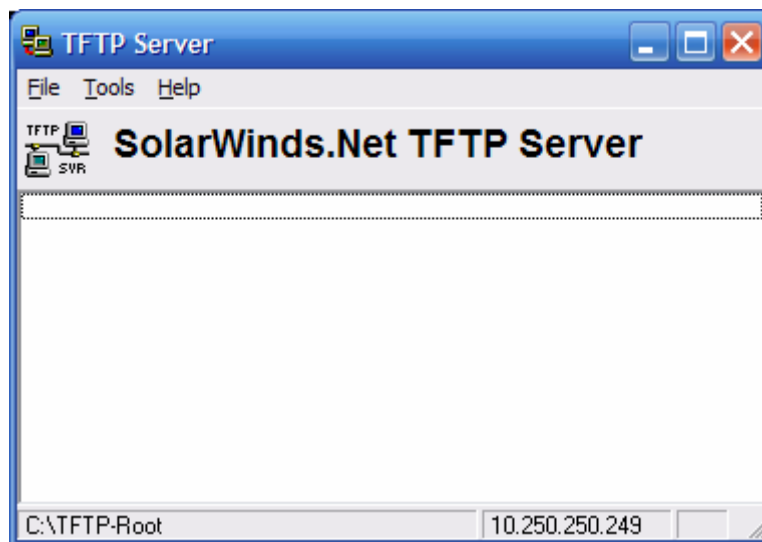


Figure 2. TFTP Server window.

Start the TFTP server by selecting Start | Programs | SolarWinds Free Tools | TFTP Server. Figure 2 shows an active TFTP Server window.

Step 3: Configure the TFTP server.

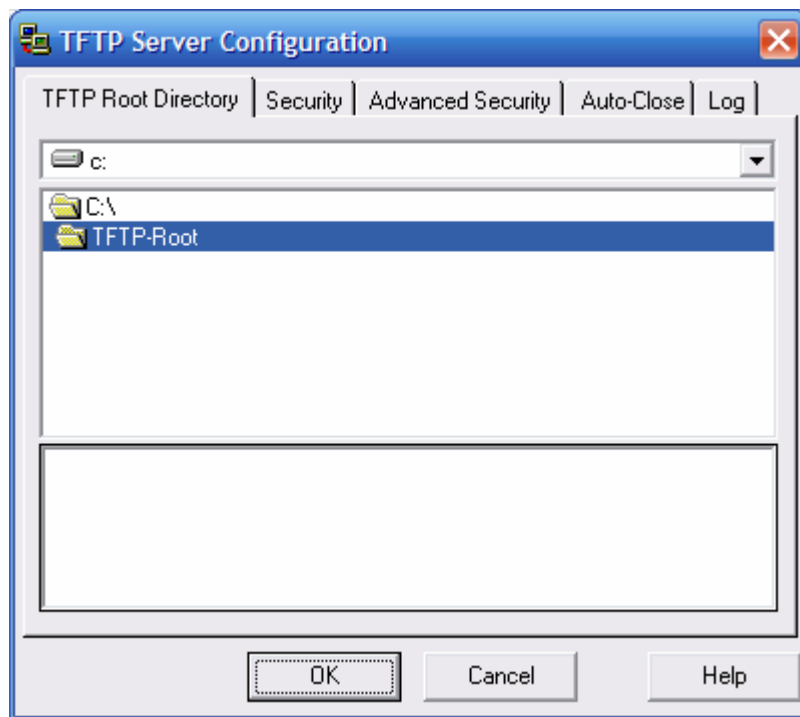


Figure 3. TFTP Server window.

To configure TFTP server, select menu option File | configure. Refer to Figure 3. Verify the following settings:

Setting	Value
TFTP Root Directory:	TFTP-Root
Security	Transmit and Receive Files
Advanced Security	10.250.250.250 To 10.250.250.250
Auto-Close	Never
Log	Enable Log Requests to the Following File. Leave the default file.

When finished, select OK.

Step 4. Save Router1 configuration to TFTP server.

From HyperTerminal, begin a TFTP upload to the TFTP server:

```
Router1#copy running-config tftp:
Address or name of remote host []? 10.250.250.249
Destination filename [router1-config]? <ENTER>
!!
1081 bytes copied in 2.008 secs (538 bytes/sec)
Router1#
```

Verify a successful upload transfer. Open Log file c:\Program Files\SolarWinds\Free Tools\TFTP-Server.txt. Contents should be similar to the following:

```
3/25/2007 12:29 :Receiving router1-config from (10.250.250.250)
3/25/2007 12:29 :Received router1-config from (10.250.250.250), 1081 bytes
```

Verify the transferred file. Use Microsoft Word or Wordpad to examine the contents of file c:\TFTP-Root\router1-config. Contents should be similar to the following configuration:

```
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Router1
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$D02B$AuX05n0HPT239yYRoQ0oE.
!
no aaa new-model
ip cef
!
interface FastEthernet0/0
  description connection to host1
  ip address 10.250.250.250 255.255.255.252
  duplex auto
  speed auto
!
interface FastEthernet0/1
  no ip address
  shutdown
  duplex auto
  speed auto
!
interface Serial0/1/0
  no ip address
  shutdown
  no fair-queue
!
interface Serial0/1/1
  no ip address
  shutdown
  clock rate 2000000
!
ip http server
no ip http secure-server
!
control-plane
!
banner motd
*** ABC COMPANY NETWORK DEVICE ****
*** Authorized access only *****
```

```
*** Logging is enabled ****
!
line con 0
  password class
  login
line aux 0
line vty 0 4
  password class
  login
!
scheduler allocate 20000 1000
End
```

Step 5: Restore Router1 configuration from TFTP server.

Verify that NVRAM is clear, then reboot Router1:

```
Router1# show startup-config
startup-config is not present
Router1# reload
Proceed with reload? [confirm] <ENTER>
```

Connectivity must be established with the TFTP server. Router1 fa0/0 must be configured with an IP address, and the interface enabled:

```
Router> enable
Router# conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# interface fa0/0
Router(config-if)# ip address 10.250.250.250 255.255.255.252
Router(config-if)# no shutdown
Router(config-if)# exit
```

```
*Mar 25 16:43:03.095: %SYS-5-CONFIG_I: Configured from console by console
*Mar 25 16:43:04.967: %LINEPROTO-5-UPDOWN: Line protocol on Interface
FastEthernet0/0, changed state to up
```

Configure the hostname of the router to TEST

```
Router(config-if)#exit
Router(config)#hostname TEST
Router(config-if)#end
TEST#
```

Verify connectivity with the ping command:

```
Router# ping 10.250.250.249
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.250.250.249, timeout is 2 seconds:
.!!!!
Success rate is 80 percent(4/5), round-trip min/avg/max = 1/1/1ms
Router#
```

Download Router1 configuration file from the TFTP server:

```
Router# copy tftp startup-config
Address or name of remote host []? 10.250.250.249
Source filename []? router1-config
Destination filename [startup-config]? <ENTER>
Accessing tftp://10.250.250.249/router1-config...
Loading router1-config from 10.250.250.249 (via FastEthernet0/0): !
[OK - 1081 bytes]

1081 bytes copied in 9.364 secs (115 bytes/sec)
Router1#
*Mar 25 16:55:26.375: %SYS-5-CONFIG_I: Configured from
tftp://10.250.250.249/router1-config by console
Router1#
```

View the configuration in NVRAM to verify an accurate transfer. The configuration should be the same as what was configured in Task 1, Step 4.

Reload the router select no at the prompt that says "Configuration has been modified".
The previous the configuration should be restored and the router's hostname should now be Router1.

Task 3: Reflection

TFTP is a fast, efficient way to save and load Cisco IOS configuration files.

Task 4: Challenge

Similar to uploading a configuration file, the IOS can also be stored off-line for future use. To discover the IOS filename, issue the Cisco IOS command **show version**. The filename is highlighted, below:

```
Router1# show version
Cisco IOS Software, 1841 Software (C1841-ADVIPSERVICESK9-M), Version
12.4(10b),
RELEASE SOFTWARE (fc3)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2007 by Cisco Systems, Inc.
Compiled Fri 19-Jan-07 15:15 by prod_rel_team

ROM: System Bootstrap, Version 12.4(13r)T, RELEASE SOFTWARE (fc1)

Router1 uptime is 17 minutes
System returned to ROM by reload at 16:47:54 UTC Sun Mar 25 2007
System image file is "flash:c1841-advipservicesk9-mz.124-10b.bin"
```

This product contains cryptographic features and is subject to United States and local country laws governing import, export, transfer and use. Delivery of Cisco cryptographic products does not imply third-party authority to import, export, distribute or use encryption. Importers, exporters, distributors and users are responsible for compliance with U.S. and local country laws. By using this product you agree to comply with applicable laws and regulations. If you are unable to comply with U.S. and local laws, return this product immediately.

A summary of U.S. laws governing Cisco cryptographic products may be found at:

<http://www.cisco.com/wwl/export/crypto/tool/stqrg.html>

If you require further assistance please contact us by sending email to export@cisco.com.

Cisco 1841 (revision 6.0) with 174080K/22528K bytes of memory.
Processor board ID FHK110918KJ
2 Serial(sync/async) interfaces
DRAM configuration is 64 bits wide with parity disabled.
191K bytes of NVRAM.
62720K bytes of ATA CompactFlash (Read/Write)

Configuration register is 0x2102

Router1#

The commands to upload the IOS are similar to uploading the configuration file:

```
Router1# copy flash tftp
Source filename []? c1841-advipservicesk9-mz.124-10b.bin
Address or name of remote host []? 10.250.250.249
Destination filename [c1841-advipservicesk9-mz.124-10b.bin]?
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!
22063220 bytes copied in 59.564 secs (370412 bytes/sec)
Router1#
```

Task 5: Cleanup

Before turning off power to the router, remove the NVRAM configuration file if it was loaded. Use the privileged exec command **erase startup-config**.

Remove SolarWinds TFTP server from the host computer. Select Start | Control Panel. Open Add or Remove Applications. Select SolarWinds, then Remove. Accept defaults.

Delete any configuration files saved on the host computers.

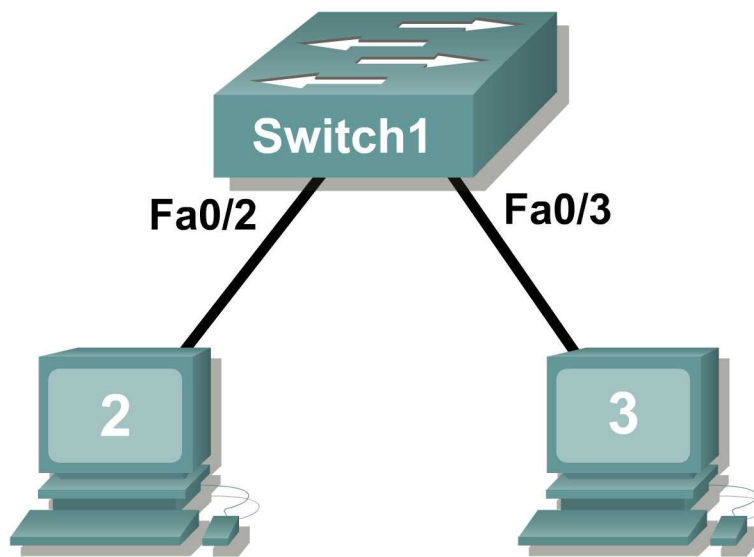
Unless directed otherwise by the instructor, restore host computer network connectivity, then turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Appendix 1

Purpose	Command
Enter the global configuration mode.	configure terminal Example: Router> enable Router# configure terminal Router(config)#
Specify the name for the router.	hostname name Example: Router(config)# hostname Router1 Router(config)#
Specify an encrypted password to prevent unauthorized access to the privileged exec mode.	enable secret password Example: Router(config)# enable secret cisco Router(config)#
Specify a password to prevent unauthorized access to the console.	password password login Example: Router(config)# line con 0 Router(config-line)# password class Router(config-line)# login Router(config)#
Specify a password to prevent unauthorized telnet access. Router vty lines: 0 4 Switch vty lines: 0 15	password password login Example: Router(config)# line vty 0 4 Router(config-line)# password class Router(config-line)# login Router(config-line)#
Configure the MOTD banner.	Banner motd % Example: Router(config)# banner motd % Router(config)#
Configure an interface. Router- interface is OFF by default Switch- interface is ON by default	Example: Router(config)# interface fa0/0 Router(config-if)# description description Router(config-if)# ip address address mask Router(config-if)# no shutdown Router(config-if)#
Save the configuration to NVRAM.	copy running-config startup-config Example: Router# copy running-config startup-config Router#

Lab 11.5.3: Configure Host Computers for IP Networking

Topology Diagram



Learning Objectives

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

- Design the logical lab topology.
- Configure the physical lab topology.
- Configure the logical LAN topology.
- Verify LAN connectivity.

Background

Hardware	Qty	Description
Cisco Router	1	Part of CCNA Lab bundle
Cisco Switch	1	Part of CCNA Lab bundle
*Computer (Host)	3	Lab computer
CAT-5 or better straight-through UTP cables	3	Connects Router1 and computers Host1 and Host2 to switch1

Table 1. Equipment and Hardware for this Lab

Gather the necessary equipment and cables. To configure the lab, make sure the equipment listed in Table 1 is available.

Scenario

In this lab students will create a small network that requires connecting network devices and configuring host computers for basic network connectivity. The Appendix is a reference for configuring the logical network.

Task 1: Design the Logical Lab Topology.

- Given an IP address of 192.168.254.0/24, and 5 bits used for subnets, fill in the following information:

Maximum number of usable subnets (including the 0th subnet): _____

Number of usable Hosts per subnet: _____

IP Address: 192.168.254.0		Subnet mask:		
#	Subnet	First Host address	Last Host address	Broadcast
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

- Before proceeding, verify your addresses with the instructor. The instructor will assign one subnetwork per student or team.

Task 2: Configure the Physical Lab Topology.

Step 1: Physically connect devices.

1. Cable the network devices as shown in Figure 1.

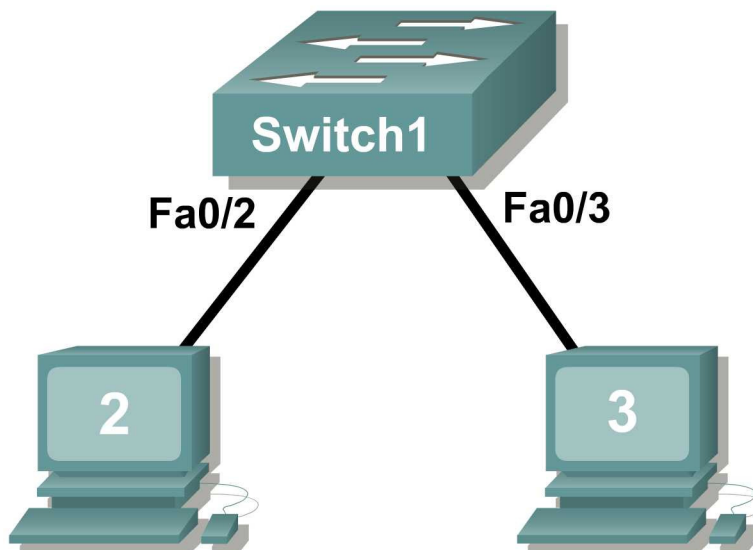


Figure 1. Cabling the Network

Is a crossover cable needed to connect Host computers to the switch? Why or why not?

If not already enabled, turn power on to all devices.

Step 2: Visually inspect network connections.

After cabling the network devices, take a moment to verify the connections. Attention to detail now will minimize the time required to troubleshoot network connectivity issues later.

Task 3: Configure the Logical Topology.

Step 1: Document logical network settings.

1. Host computers will use the first two IP addresses in the subnetwork. Write down the IP address information for each device:

Device	Subnetwork	IP address	Mask
Host1			
Host2			

Figure 2. Logical Topology

- From the information given in Figure 2, write down the IP network addressing for each computer:

Host 1	
IP Address	
IP Mask	

Host 2	
IP Address	
IP Mask	

Step 2: Configure Host1 computer.

- On Computer1, click **Start > Control Panel > Network Connections**. Right-click the LAN icon, and choose **Properties**. On the **General** tab, select **Internet Protocol (TCP/IP)**, and then click the **Properties** button.

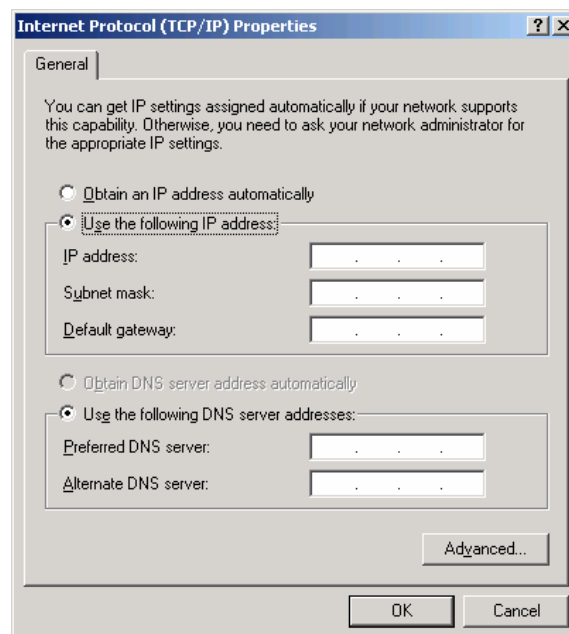


Figure 3. Host1 IP Address and Gateway Settings

- Refer to Figure 3 for Host1 IP address and gateway settings.
- When finished, click **OK**, then click **Close**. The computer may require a reboot for changes to be effective.
- Verify proper configuration of Host1 with the `ipconfig /all` command.

5. Record the output below:

Setting	Value
Ethernet device	
Physical Address	
IP Address	
Subnet Mask	
Default Gateway	

Step 3: Configure Host2.

1. Repeat Step 2 for Host2, using IP address information from the table filled out in Step 1.
2. Verify proper configuration of Host1 with the `ipconfig /all` command.
3. Record the output below:

Setting	Value
Ethernet device	
Physical Address	
IP Address	
Subnet Mask	
Default Gateway	

Task 4: Verify Network Connectivity.

Network connectivity can be verified with the Windows `ping` command.

1. Use the following table to methodically verify connectivity with each network device:

From	To	IP Address	Ping results
Host1	Host2		
Host2	Host1		

2. Take corrective action to establish connectivity if a test fails.

Note: If pings to host computers fail, temporarily disable the computer firewall and retest. To disable a Windows firewall, click **Start > Control Panel > Windows Firewall**, choose **Off**, and then click **OK**.

Task 5: Reflection

Review any physical or logical configuration problems encountered during this lab. Make sure you have a thorough understanding of the procedures used to configure a Windows host computer.

Task 6: Challenge

Ask your instructor or another student to introduce one or two problems in your network when you aren't looking or are out of the lab room. Problems can be either physical (wrong UTP cable) or logical (wrong IP address). To fix the problems:

1. Perform a good visual inspection. Look for green link lights on Switch1.
2. Use the table provided in Task 3, above, to identify failed connectivity. List the problems:

3. Write down your proposed solution(s):

4. Test your solution. If the solution fixed the problem, document the solution. If the solution did not fix the problem, continue troubleshooting.

Task 7: Clean Up

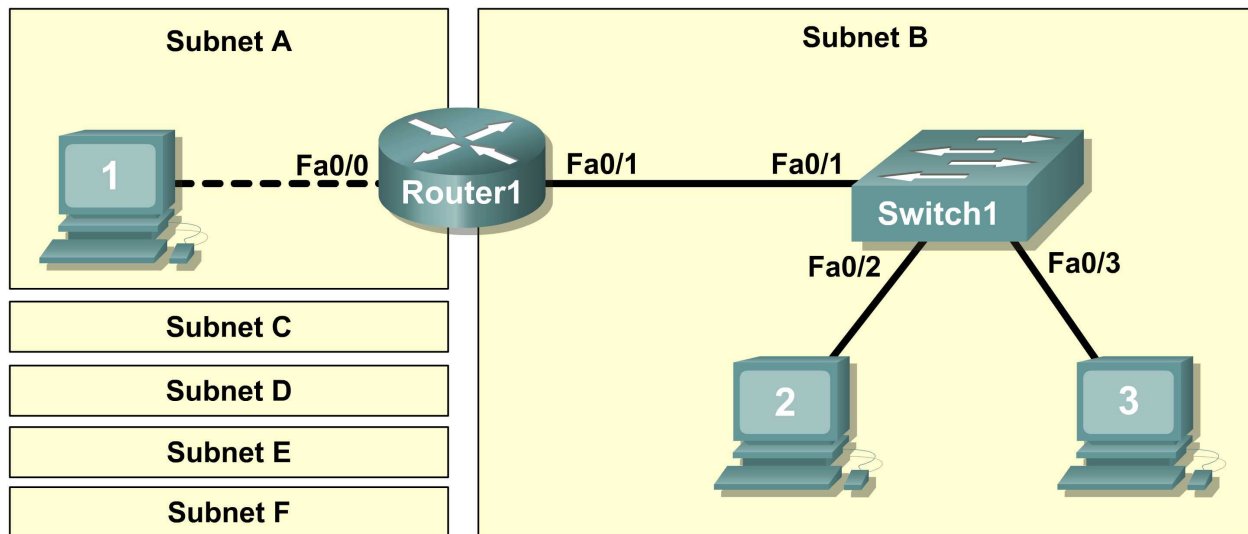
Unless directed otherwise by the instructor, restore host computer network connectivity, and then turn off power to the host computers. Remove anything that was brought into the lab, and leave the room ready for the next class.

Appendix

Subnet addressing for last octet						East Carolina University					
0	128	64	32	16	8	4	2	1	0	0	0
4	128	64	32	16	8	4	2	1	0	0	0
8	128	64	32	16	8	4	2	1	0	0	0
12	128	64	32	16	8	4	2	1	0	0	0
16	128	64	32	16	8	4	2	1	0	0	0
20	128	64	32	16	8	4	2	1	0	0	0
24	128	64	32	16	8	4	2	1	0	0	0
28	128	64	32	16	8	4	2	1	0	0	0
32	128	64	32	16	8	4	2	1	0	0	0
36	128	64	32	16	8	4	2	1	0	0	0
40	128	64	32	16	8	4	2	1	0	0	0
44	128	64	32	16	8	4	2	1	0	0	0
48	128	64	32	16	8	4	2	1	0	0	0
52	128	64	32	16	8	4	2	1	0	0	0
56	128	64	32	16	8	4	2	1	0	0	0
60	128	64	32	16	8	4	2	1	0	0	0
64	128	64	32	16	8	4	2	1	0	0	0
68	128	64	32	16	8	4	2	1	0	0	0
72	128	64	32	16	8	4	2	1	0	0	0
76	128	64	32	16	8	4	2	1	0	0	0
80	128	64	32	16	8	4	2	1	0	0	0
84	128	64	32	16	8	4	2	1	0	0	0
88	128	64	32	16	8	4	2	1	0	0	0
92	128	64	32	16	8	4	2	1	0	0	0
96	128	64	32	16	8	4	2	1	0	0	0
100	128	64	32	16	8	4	2	1	0	0	0
104	128	64	32	16	8	4	2	1	0	0	0
108	128	64	32	16	8	4	2	1	0	0	0
112	128	64	32	16	8	4	2	1	0	0	0
116	128	64	32	16	8	4	2	1	0	0	0
120	128	64	32	16	8	4	2	1	0	0	0
124	128	64	32	16	8	4	2	1	0	0	0
128	128	64	32	16	8	4	2	1	0	0	0
132	128	64	32	16	8	4	2	1	0	0	0
136	128	64	32	16	8	4	2	1	0	0	0
140	128	64	32	16	8	4	2	1	0	0	0
144	128	64	32	16	8	4	2	1	0	0	0
148	128	64	32	16	8	4	2	1	0	0	0
152	128	64	32	16	8	4	2	1	0	0	0
156	128	64	32	16	8	4	2	1	0	0	0
160	128	64	32	16	8	4	2	1	0	0	0
164	128	64	32	16	8	4	2	1	0	0	0
168	128	64	32	16	8	4	2	1	0	0	0
172	128	64	32	16	8	4	2	1	0	0	0
176	128	64	32	16	8	4	2	1	0	0	0
180	128	64	32	16	8	4	2	1	0	0	0
184	128	64	32	16	8	4	2	1	0	0	0
188	128	64	32	16	8	4	2	1	0	0	0
192	128	64	32	16	8	4	2	1	0	0	0
196	128	64	32	16	8	4	2	1	0	0	0
200	128	64	32	16	8	4	2	1	0	0	0
204	128	64	32	16	8	4	2	1	0	0	0
208	128	64	32	16	8	4	2	1	0	0	0
212	128	64	32	16	8	4	2	1	0	0	0
216	128	64	32	16	8	4	2	1	0	0	0
220	128	64	32	16	8	4	2	1	0	0	0
224	128	64	32	16	8	4	2	1	0	0	0
228	128	64	32	16	8	4	2	1	0	0	0
232	128	64	32	16	8	4	2	1	0	0	0
236	128	64	32	16	8	4	2	1	0	0	0
240	128	64	32	16	8	4	2	1	0	0	0
244	128	64	32	16	8	4	2	1	0	0	0
248	128	64	32	16	8	4	2	1	0	0	0
252	128	64	32	16	8	4	2	1	0	0	0

Lab 11.5.4: Network Testing

Topology Diagram



Learning Objectives

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

- Design the logical lab topology.
- Configure the physical lab topology.
- Configure the logical LAN topology.
- Verify LAN connectivity.

Background

Hardware	Qty	Description
Cisco Router	1	Part of CCNA Lab bundle
Cisco Switch	1	Part of CCNA Lab bundle
*Computer (Host)	3	Lab computer
CAT-5 or better straight-through UTP cables	3	Connects Router1, Host1, and Host2 to switch1
CAT-5 crossover UTP cable	1	Connects Host 1 to Router1
Console (rollover) cable	1	Connects Host1 to Router1 console

Table 1. Equipment and Hardware for this Lab

Gather the necessary equipment and cables. To configure the lab, make sure the equipment listed in Table 1 is available.

The Appendix contains Cisco IOS configuration syntax for this lab.

Scenario

In this lab, you will create a small network that requires connecting network devices and configuring host computers for basic network connectivity. SubnetA and SubnetB are subnets that are currently needed. SubnetC, SubnetD, SubnetE, and SubnetF are anticipated subnets, not yet connected to the network. The 0th subnet will be used.

Task 1: Design the Logical Lab Topology.

Given an IP address and mask of 172.20.0.0 / 24 (address / mask), design an IP addressing scheme that satisfies the following requirements:

Subnet	Number of Hosts
SubnetA	As shown in topology diagram
SubnetB	Between 80 – 100
SubnetC	Between 40 – 52
SubnetD	Between 20 – 29
SubnetE	12
SubnetF	5

Note: Always start with the subnet with the largest number of hosts and work your way down. Therefore, you should start with SubnetB and finish with SubnetA.

Step 1: Design SubnetB address block.

Begin the logical network design by satisfying the requirement of SubnetB, which requires the largest block of IP addresses. Using binary numbers to create your subnet chart, pick the first address block that will support SubnetB.

1. Fill in the following table with IP address information for SubnetB:

Network Address	Mask	First Host Address	Last Host Address	Broadcast

2. What is the bit mask? _____

Step 2: Design SubnetC address block.

Satisfy the requirement of SubnetC, the next largest IP address block. Using binary numbers to create your subnet chart, pick the next available address block that will support SubnetC.

1. Fill in the following table with IP address information for SubnetC:

Network Address	Mask	First Host Address	Last Host Address	Broadcast

2. What is the bit mask? _____

Step 3: Design SubnetD address block.

Satisfy the requirement of SubnetD, the next largest IP address block. Using binary numbers to create your subnet chart, pick the next available address block that will support SubnetD.

1. Fill in the following table with IP address information for SubnetD:

Network Address	Mask	First Host Address	Last Host Address	Broadcast

2. What is the bit mask? _____

Step 4: Design SubnetE address block.

Satisfy the requirement of SubnetE, the next largest IP address block. Using binary numbers to create your subnet chart, pick the next available address block that will support SubnetE.

1. Fill in the following table with IP address information for SubnetE:

Network Address	Mask	First Host Address	Last Host Address	Broadcast

2. What is the bit mask? _____

Step 5: Design SubnetF address block.

Satisfy the requirement of SubnetF, the next largest IP address block. Using binary numbers to create your subnet chart, pick the next available address block that will support SubnetF.

1. Fill in the following table with IP address information for SubnetF:

Network Address	Mask	First Host Address	Last Host Address	Broadcast

2. What is the bit mask? _____

Step 6: Design SubnetA address block.

Satisfy the requirement of SubnetA, the smallest IP address block. Using binary numbers to create your subnet chart, pick the next available address block that will support SubnetA.

1. Fill in the following table with IP address information for SubnetA:

Network Address	Mask	First Host Address	Last Host Address	Broadcast

2. What is the bit mask? _____

Task 2: Configure the Physical Lab Topology.

Step 1: Physically connect lab devices.

1. Cable the network devices as shown in Figure 1. Pay special attention to the crossover cable required between Host1 and Router1.

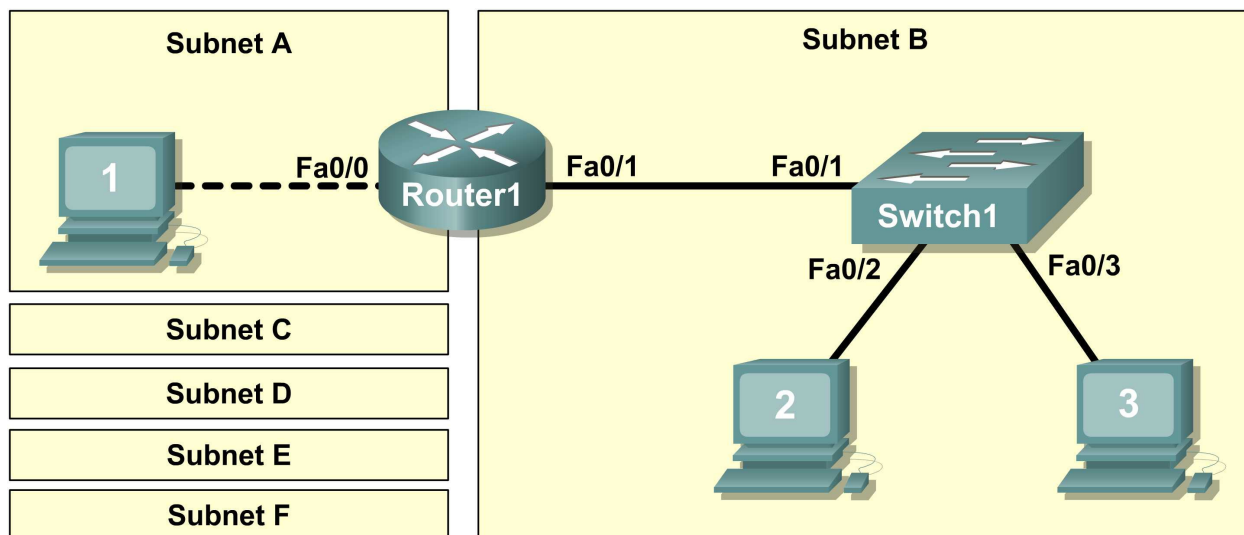


Figure 1. Cabling the Network

2. If not already enabled, turn power on to all devices.

Step 2: Visually inspect network connections.

After cabling the network devices, take a moment to verify the connections. Attention to detail now will minimize the time required to troubleshoot Layer 1 connectivity issues later.

Task 3: Configure the Logical Topology.

Step 1: Document logical network settings.

On SubnetA, Host1 will use the first IP address in the subnet. Router1, interface Fa0/0, will use the last host address. On SubnetB, host computers will use the first and second IP addresses in the subnet, respectively. Router1, interface Fa0/1, will use the last network host address.

To properly route Layer 2 frames between LAN devices, Switch1 does not require Layer 3 configuration. The IP address assigned to Switch 1, interface VLAN 1, is used to establish Layer 3 connectivity between external devices and the switch. Without an IP address, upper-layer protocols such as TELNET and HTTP will not work. The default gateway address permits the switch to respond to protocol requests from devices on distant networks. For example, the IP gateway address extends Layer 3 connectivity beyond Subnet B. Switch1 will use the next-to-last host address.

Write down the IP address information for each device:

Device	Subnet	IP Address	Mask	Gateway
Host1				
Router1-Fa0/0				
Host2				
Host3				

Switch1				
Router1-Fa0/1				

Step 2: Configure host computers.

1. On each computer, in turn, click **Start > Control Panel > Network Connections**. Right-click the LAN icon, and choose **Properties**. On the **General** tab, select **Internet Protocol (TCP/IP)**, and then click the, **Properties** button.
2. Verify that the Host1 Layer 3 IP address is on a different subnet than Host2 and Host3. Configure each host computer using the IP address information recorded in Step 1.
3. Verify proper configuration of each host computer with the **ipconfig** command and fill in the following table:

Device	IP Address	Mask	Default Gateway
Host1			
Host2			
Host3			

Step 3: Configure Router1.

1. From the Windows taskbar, start the HyperTerminal program by clicking **Start > Programs > Accessories > Communications > HyperTerminal**. Configure HyperTerminal for access to Router1. Configuration for Router1 includes the following tasks:

Tasks (Refer to the Appendix for help with commands)
Specify Router name: <code>Router1</code>
Specify an encrypted privileged EXEC password: <code>cisco</code>
Specify a console access password: <code>class</code>
Specify a telnet access password: <code>class</code>
Configure the MOTD banner
Configure Router1 interface Fa0/0: <ul style="list-style-type: none"> • Set the description • Set the Layer 3 address • Issue no shutdown
Configure Router1 interface Fa0/1: <ul style="list-style-type: none"> • Set the description • Set the Layer 3 address • Issue no shutdown

2. Save the configuration in NVRAM.
3. Display the contents of RAM:
4. Write the configuration specifications below:

Hostname: _____

Enable secret password: _____

Console access password: _____

Telnet access password: _____

MOTD banner: _____

5. Display configuration information for interface Fa0/0: **show interface Fa0/0**

FastEthernet 0/0 status (up / down): _____

Line protocol: _____

MAC Address: _____

6. Display configuration information for interface Fa0/1: **show interface Fa0/1**

FastEthernet 0/0 status (up / down): _____

Line protocol: _____

MAC Address: _____

7. Display brief IP address information about each interface: **show ip interface brief**

```
Interface          IP-Address      OK? Method Status  Protocol
FastEthernet0/0
FastEthernet0/1
```

8. Take corrective action with any problems, and retest.

Step 4: Configure Switch1.

1. Move the console cable from Router1 to Switch1.
2. Press **Enter** until a response is received.
3. Configuration for Switch1 includes the following tasks:

Tasks (Refer to the Appendix for help with commands)
Specify Switch name- <code>Switch1</code>
Specify an encrypted privileged exec password- <code>cisco</code>
Specify a console access password- <code>class</code>
Specify a telnet access password- <code>class</code>
Configure the MOTD banner
Configure Switch1 interface Fa0/1: Set the description
Configure Switch1 interface Fa0/2: Set the description
Configure Switch1 interface Fa0/3: Set the description
Configure management VLAN 1 IP address: <ul style="list-style-type: none"> • Set the description • Set the Layer 3 address • Issue no shutdown
Configure default IP gateway address

4. Display the contents of RAM:

5. Write the configuration specifications below:

Hostname: _____

Enable secret password: _____

Console access password: _____

Telnet access password: _____

MOTD banner: _____

Interface VLAN 1: _____

Default IP gateway address: _____

6. Display configuration information for interface VLAN 1: **show interface vlan1**

VLAN 1 status (up / down): _____

Line protocol: _____

Task 4: Verify Network Connectivity.

Step 1: Use the **ping** command to verify network connectivity.

Network connectivity can be verified with the **ping** command. It is very important that connectivity exists throughout the network. Corrective action must be taken if there is a failure.

1. Use the following table to methodically verify connectivity with each network device:

From	To	IP Address	Ping results
Host1	LocalHost (127.0.0.1)		
Host1	NIC IP address		
Host1	Gateway (Router1, Fa0/0)		
Host1	Router1, Fa0/1		
Host1	Switch1		
Host1	Host2		
Host1	Host3		
Host2	LocalHost (127.0.0.1)		
Host2	NIC IP address		
Host2	Host3		
Host2	Switch1		
Host2	Gateway (Router1, Fa0/1)		
Host2	Router1, Fa0/0		
Host2	Host1		
Host3	LocalHost (127.0.0.1)		
Host3	NIC IP address		
Host3	Host2		

From	To	IP Address	Ping results
Host3	Switch1		
Host3	Gateway (Router1, Fa0/1)		
Host3	Router1, Fa0/0		
Host3	Host1		

- Take corrective action to establish connectivity if a test fails.

Note: If pings to host computers fail, temporarily disable the computer firewall and retest. To disable a Windows firewall, click **Start > Control Panel > Windows Firewall**, choose **Off**, and then click **OK**.

Step 2: Use the `tracert` command to verify local connectivity.

- From Host1, issue the `tracert` command to Host2 and Host3.

- Record the results:

From Host1 to Host2: _____

From Host1 to Host3: _____

Step 3: Verify Layer 2 connectivity.

- If not already connected, move the console cable from Router1 to Switch1.
- Press the **Enter** key until there is a response from Switch1.
- Issue the command `show mac-address-table`. This command will display static (CPU) and dynamic, or learned, entries.
- List the dynamic MAC addresses and corresponding switch ports:

MAC Address	Switch Port

- Verify that there are three dynamically learned MAC addresses, one each from Fa0/1, Fa0/2, and Fa0/3.

Task 5: Reflection

Review any physical or logical configuration problems encountered during this lab. Make sure you have a thorough understanding of the procedures used to verify network connectivity.

Task 6: Challenge

Ask your instructor or another student to introduce one or two problems in your network when you aren't looking or are out of the lab room. Problems can be either physical (wrong UTP cable) or logical (wrong IP address or gateway). To fix the problems:

- Perform a good visual inspection. Look for green link lights on Switch1.
- Use the table provided in Task 3, above, to identify failed connectivity. List the problems:

3. Write down your proposed solution(s):

4. Test your solution. If the solution fixed the problem, document the solution. If the solution did not fix the problem, continue troubleshooting.

Task 7: Clean Up

Unless directed otherwise by the instructor, restore host computer network connectivity, and then turn off power to the host computers.

Before turning off power to the router and switch, remove the NVRAM configuration file from each device with the privileged exec command **erase startup-config**.

Carefully remove cables and return them neatly to their storage. Reconnect cables that were disconnected for this lab.

Remove anything that was brought into the lab, and leave the room ready for the next class.

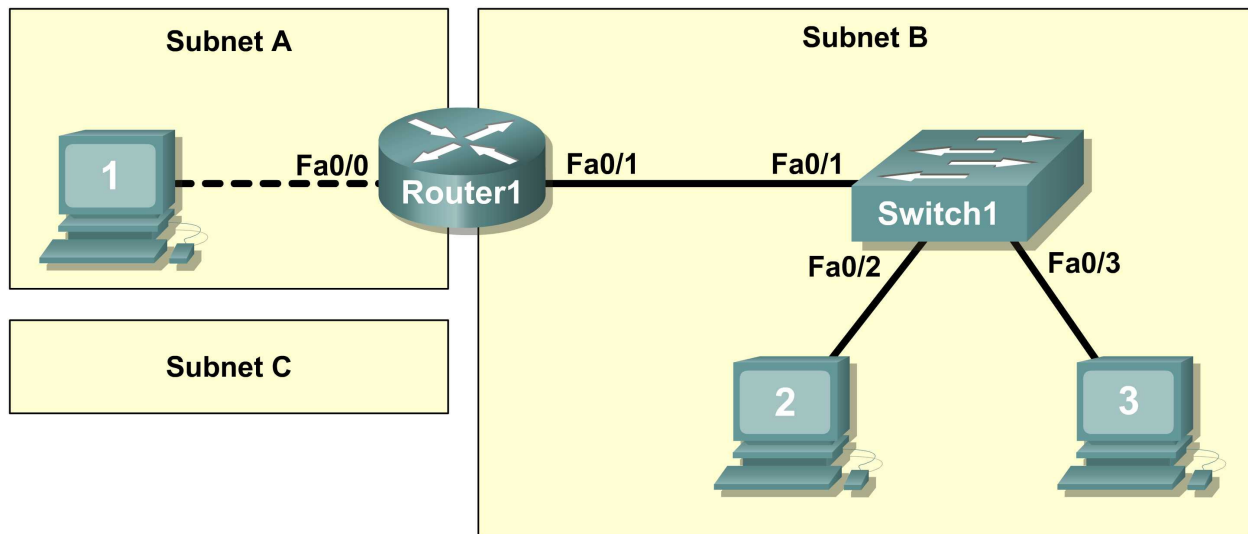
Appendix—List of Cisco IOS commands used in this lab

Purpose	Command
Enter the global configuration mode.	configure terminal Example: Router> enable Router# configure terminal Router(config)#
Specify the name for the Cisco device.	hostname name Example: Router(config)# hostname Router1 Router(config)#
Specify an encrypted password to prevent unauthorized access to the privileged EXEC mode.	enable secret password Example: Router(config)# enable secret cisco Router(config)#
Specify a password to prevent unauthorized access to the console.	password password login Example: Router(config)# line con 0 Router(config-line)# password class Router(config-line)# login Router(config)#
Specify a password to prevent unauthorized Telnet access. Router vty lines: 0 4 Switch vty lines: 0 15	password password login Example: Router(config)# line vty 0 4 Router(config-line)# password class Router(config-line)# login Router(config-line)#
Configure the MOTD banner.	Banner motd % Example: Router(config)# banner motd % Router(config)#
Configure a Router interface. Router interface is OFF by default	Example: Router(config)# interface Fa0/0 Router(config-if)# description description Router(config-if)# ip address address mask Router(config-if)# no shutdown Router(config-if)#
Switch interface is ON by default (VLAN interface is OFF by default)	Example: Switch(config)# interface Fa0/0 Switch(config-if)# description description Switch(config)# interface vlan1 Switch(config-if)# ip address address mask Switch(config-if)# no shutdown Switch(config-if)#
Switch- create a default IP gateway	Switch(config)# ip default-gateway address
Save the configuration to NVRAM.	copy running-config startup-config Example:

	Router# copy running-config startup-config
--	---

Lab 11.5.5: Network Documentation with Utility Commands

Topology Diagram



Learning Objectives

- Design the logical lab topology.
- Configure the physical lab topology.
- Design and configure the logical LAN topology.
- Verify LAN connectivity.
- Document the network.

Background

Hardware	Qty	Description
Cisco Router	1	Part of CCNA Lab bundle.
Cisco Switch	1	Part of CCNA Lab bundle.
*Computer (host)	3	Lab computer.
CAT-5 or better straight-through UTP cables	3	Connects Router1, Host1, and Host2 to switch1.
CAT-5 crossover UTP cable	1	Connects host 1 to Router1
Console (rollover) cable	1	Connects Host1 to Router1 console

Table 1. Equipment and hardware for Eagle 1 lab.

Gather the necessary equipment and cables. To configure the lab, make sure the equipment listed in Table 1 is available.

In this lab router and host output will be copied from the devices and into Notepad for use in network documentation. Appendix1 contains tables that can be used to copy output into, or create your own tables.

Scenario

Network documentation is a very important tool for the organization. A well-documented network enables network engineers to save significant time in troubleshooting and planning future growth.

In this lab students will create a small network that requires connecting network devices and configuring Host computers for basic network connectivity. Subnet A and Subnet B are subnets that are currently needed. Subnet C is an anticipated subnet, not yet connected to the network. The 0th subnet will be used.

Task 1: Configure the logical lab topology.

Given an IP address of 209.165.200.224 / 27 (address / mask), design an IP addressing scheme that satisfies the following requirements:

Subnet	Number of Hosts
Subnet A	2
Subnet B	Between 2 - 6
Subnet C	Between 10 – 12

Step 1: Design Subnet C address block.

Begin the logical network design by satisfying the requirement for Subnet C, the largest IP address block. Using binary numbers to create your subnet chart, pick the next available address block that will support Subnet C.

Fill in the following table with IP address information for Subnet C:

Network Address	Mask	First Host address	Last Host address	Broadcast

What is the bit mask? _____

Step 2: Design Subnet B address block.

Satisfy the requirement of Subnet B, the next largest block of IP addresses. Using binary numbers to create your subnet chart, pick the first address block that will support Subnet B.

Fill in the following table with IP address information for Subnet B:

Network Address	Mask	First Host address	Last Host address	Broadcast

What is the bit mask? _____

Step 3: Design Subnet A address block.

Satisfy the requirement of Subnet A, the smallest IP address block. Using binary numbers to create your subnet chart, pick the next available address block that will support Subnet A.

Fill in the following table with IP address information for Subnet A:

Network Address	Mask	First Host address	Last Host address	Broadcast

--	--	--	--	--

What is the bit mask? _____

Task 2: Configure the Physical Lab Topology.

Step 1: Physically connect lab devices.

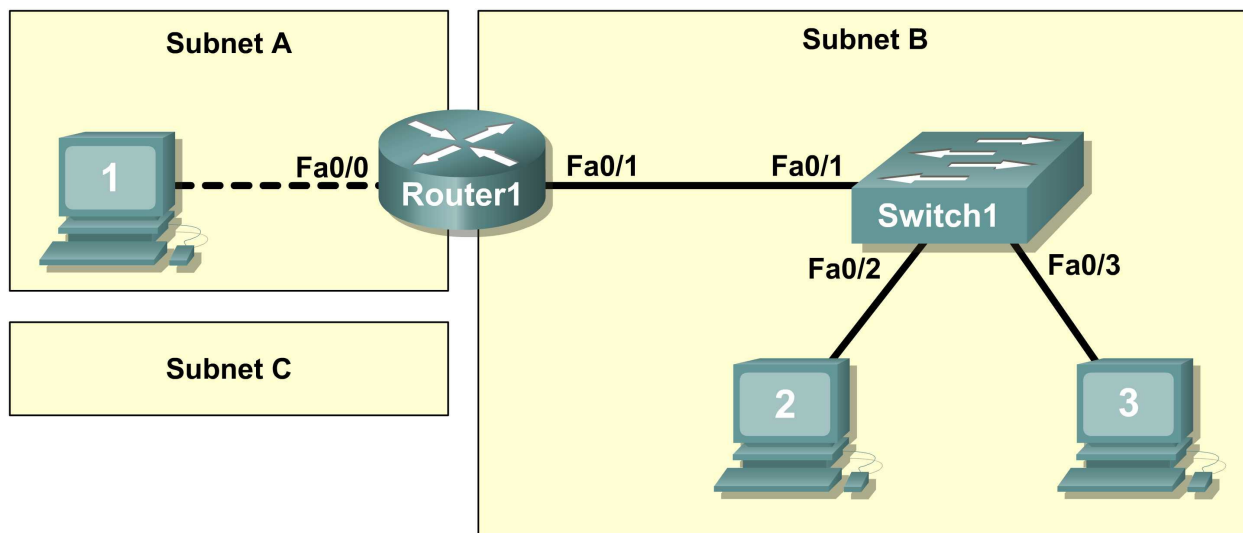


Figure 1. Cabling the network.

Cable the network devices as shown in Figure 1. Pay special attention to the crossover cable required between Host1 and Router1.

If not already enabled, turn power on to all devices.

Step 2: Visually inspect network connections.

After cabling the network devices, take a moment to verify the connections. Attention to detail now will minimize the time required to troubleshoot network connectivity issues later.

Task 3: Configure the Logical Topology.

Step 1: Document logical network settings.

Host computers will use the first two IP addresses in the subnetwork. The network router will use the LAST network host address. Write down the IP address information for each device:

Device	Subnet	IP address	Mask	Gateway
Router1-Fa0/0				
Host1				
Router1-Fa0/1				
Host2				
Host3				
Switch1	N/A	N/A	N/A	N/A

Step 2: Configure host computers.

On each computer in turn, select start | Control Panel | Network Connections. Identify the Local Area Connection device icon. Use the mouse pointer to highlight the icon, right-click, and select properties. Highlight Internet Protocol (TCP/IP), and select Properties.

Verify that the Host1 Layer 3 IP address is on a different subnet than Host2 and Host3. Configure each host computer using the IP address information recorded in Step 1.

Verify proper configuration of each host computer with the **ipconfig /all** command. Record your information in Appendix1, Network Documentation:

Step 3: Configure Router1.

From the Windows taskbar, start the HyperTerminal program by clicking on Start | Programs | Accessories | Communications | HyperTerminal. Configure HyperTerminal for access to Router1. Configuration tasks for Router1 include the following:

Task
Specify Router name- <code>Router1</code>
Specify an encrypted privileged exec password- <code>cisco</code>
Specify a console access password- <code>class</code>
Specify a telnet access password- <code>class</code>
Configure the MOTD banner.
Configure Router1 interface Fa0/0- set the description set the Layer 3 address issue no shutdown
Configure Router1 interface Fa0/1- set the description set the Layer 3 address issue no shutdown

Save the configuration in NVRAM.

Display the contents of RAM:

Copy the output of the configuration into the Router1 configuration table, Appendix 1.

Copy the output of the **show interface fa0/0** and **show interface fa0/1** commands into the Router1 Interface configuration tables, Appendix 1.

Copy the output of the **show ip interface brief** command into the Router1 IP Address configuration table, Appendix1.

Step 4: Configure Switch1.

Move the console cable from Router1 to Switch1. Press Enter until a response is received. Configuration tasks for Switch1 include the following:

Task
Specify Switch name- <code>Switch1</code>
Specify an encrypted privileged exec password- <code>cisco</code>
Specify a console access password- <code>class</code>
Specify a telnet access password- <code>class</code>
Configure the MOTD banner.
Configure Switch1 interface Fa0/1- set the description
Configure Switch1 interface Fa0/2- set the description
Configure Switch1 interface Fa0/3- set the description

Display the contents of RAM:

Copy the output of the configuration into the Switch1 configuration table, Appendix 1.

Copy the output of the `show mac address-table` command into the Switch1 MAC address table, Appendix 1.

Task 4: Verify Network Connectivity.

Step 1: Use the `ping` command to verify network connectivity.

Network connectivity can be verified with the `ping` command. It is very important that connectivity exists throughout the network. Corrective action must be taken if there is a failure.

****NOTE:** If pings to host computers fail, temporarily disable the computer firewall and retest. To disable a Windows firewall, select Start | Control Panel | Windows Firewall, select OFF, and OK.

Use the following table to methodically verify connectivity with each network device. Take corrective action to establish connectivity if a test fails:

From	To	IP Address	Ping results
Host1	LocalHost (127.0.0.1)		
Host1	NIC IP address		
Host1	Gateway (Router1, Fa0/0)		
Host1	Router1, Fa0/1		
Host1	Host2		
Host1	Host3		
Host2	LocalHost (127.0.0.1)		
Host2	NIC IP address		
Host2	Host3		
Host2	Gateway (Router1, Fa0/1)		
Host2	Router1, Fa0/0		
Host2	Host1		
Host3	LocalHost (127.0.0.1)		
Host3	NIC IP address		
Host3	Host2		
Host3	Gateway (Router1, Fa0/1)		
Host3	Router1, Fa0/0		
Host3	Host1		

Step 2: Use the `tracert` command to verify local connectivity.

In addition to connectivity testing, the `tracert` command may also be used as a crude throughput tester for network baselining. That is, with minimal traffic, `tracert` results can be compared against periods of high traffic. Results can be used to justify equipment upgrades or new purchases.

From Host1, issue the `tracert` command to Router1, Host2, and Host3. Record the results in the Host1 Tracert output, Appendix A.

From Host2, issue the `tracert` command to Host3, Router1, and Host1. Record the results in the Host2 Tracert output, Appendix A.

From Host3, issue the `tracert` command to Host2, Router1, and Host1. Record the results in the Host3 Tracert output, Appendix A.

Task 5: Document the Network.

With all the work performed so far, it would seem that there is nothing left to do. The network was physically and logically configured, verified, and command output copied into tables.

The last step in network documentation is to organize your output. As you organize, think what might be needed six months or a year from now. For example:

When was the network created?

When was the network documented?

Were there any significant challenges that were overcome?

Who performed the configuration (talent like this needs to be tracked)?

Who performed the documentation (talent like this needs to be tracked)?

These questions should be answered in the documentation, perhaps in a cover letter.

Be sure to include the following information:

A copy of the physical topology.

A copy of the logical topology.

Prepare your documentation in a professional format, and submit it to your instructor.

Task 6: Reflection

Review any physical or logical configuration problems encountered during this lab. Insure a thorough understanding of the procedures used to verify network connectivity.

Task 7: Challenge

Ask your instructor or another student to introduce one or two problems in your network when you aren't looking or are out of the lab room. Problems can be either physical (cables moved on the switch) or logical (wrong IP address or gateway).

Use your network documentation to troubleshoot and remedy the problems:

1. Perform a good visual inspection. Look for green link lights on Switch1.
2. Use your network documentation to compare what should be to what is:

3. Write down your proposed solution(s):

4. Test your solution. If the solution fixed the problem, document the solution. If the solution did not fix the problem, continue troubleshooting.

Task 6: Cleanup

Unless directed otherwise by the instructor, restore host computer network connectivity, then turn off power to the host computers.

Before turning off power to the router and switch, remove the NVRAM configuration file from each device with the privileged exec command **erase startup-config**.

Carefully remove cables and return them neatly to their storage. Reconnect cables that were disconnected for this lab.

Remove anything that was brought into the lab, and leave the room ready for the next class.

Appendix 1- Network Documentation

Host tables created from Task 3, Step 2:

Host1 Network Configuration	
Host Name	
IP Routing Enabled	
Ethernet adapter	
Description	
Physical Address	
IP Address	
Subnet Mask	
Default Gateway	

Host2 Network Configuration	
Host Name	
IP Routing Enabled	
Ethernet adapter	
Description	
Physical Address	
IP Address	
Subnet Mask	
Default Gateway	

Host3 Network Configuration	
Host Name	
IP Routing Enabled	
Ethernet adapter	
Description	
Physical Address	
IP Address	
Subnet Mask	
Default Gateway	

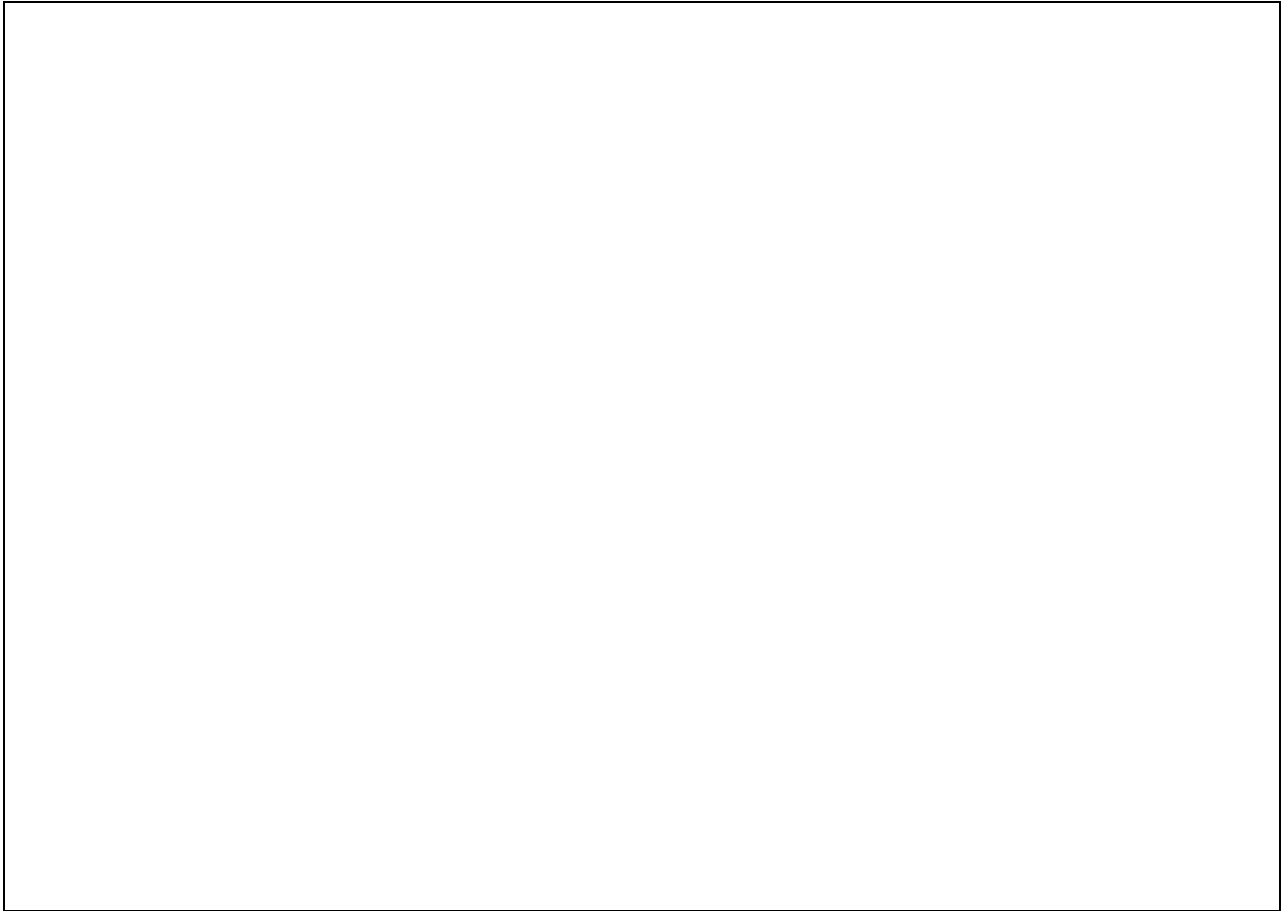
Router1 configuration from Task 3, Step 3:

Router1 Configuration

Router1 Interface Fa0/0 configuration from Task 2, Step 3:

--

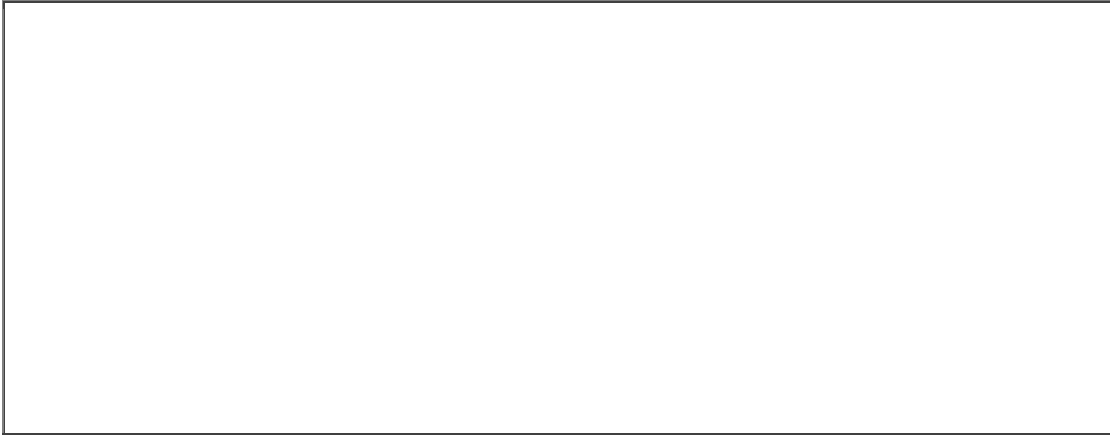
Router1 Interface fa0/1 configuration from Task 3, Step 3:



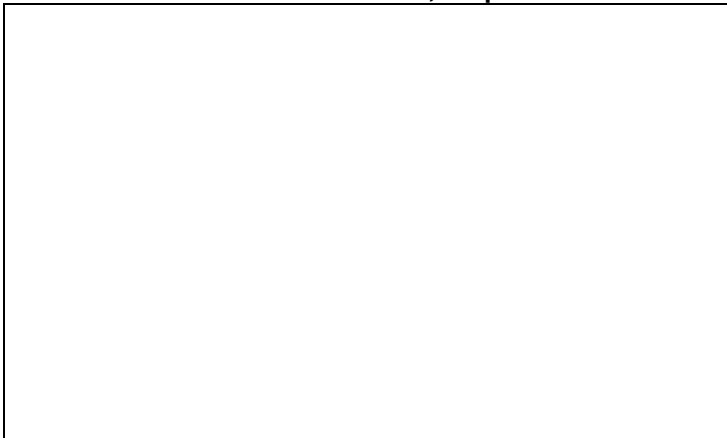
Router1 IP Address configuration from Task 3, Step 3:



Switch1 Configuration from Task 3, Step 4:

A large, empty rectangular box with a thin black border, intended for the configuration of Switch1.

Switch1 MAC address-table from Task 3, Step 4:

A rectangular box with a thin black border, intended for the MAC address-table of Switch1.

Traceroute results from Host1 Task 4, Step 2:

A large, empty rectangular box with a thin black border, intended for the traceroute results from Host1.

Traceroute results from Host2 Task 4, Step 2:

--

Traceroute results from Host3 Task 4, Step 2:

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Lab 11.5.6: Final Case Study - Datagram Analysis with Wireshark

Learning Objectives

Upon completion of this exercise, students will be able to demonstrate:

- How a TCP segment is constructed, and explain the segment fields.
- How an IP packet is constructed, and explain the packet fields.
- How an Ethernet II frame is constructed, and explain the frame fields.
- Contents of an ARP REQUEST and ARP REPLY.

Background

This lab requires two captured packet files and Wireshark, a network protocol analyzer. Download the following files from Eagle server, and install Wireshark on your computer if it is not already installed:

- eagle1_web_client.pcap (discussed)
- eagle1_web_server.pcap (reference only)
- wireshark.exe

Scenario

This exercise details the sequence of datagrams that are created and sent across a network between a web client, PC_Client, and web server, eagle1.example.com. Understanding the process involved in sequentially placing packets on the network will enable the student to logically troubleshoot network failures when connectivity breaks. For brevity and clarity, network packet noise has been omitted from the captures. Before executing a network protocol analyzer on a network that belongs to someone else, be sure to get permission- in writing.

Figure 1 shows the topology of this lab.

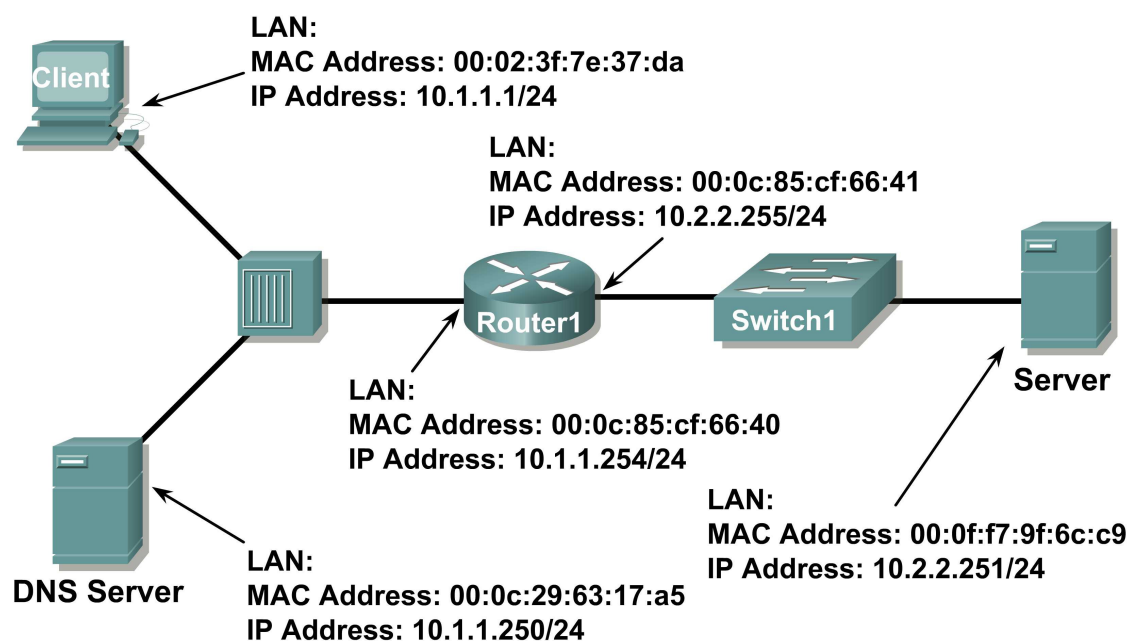


Figure 1. Network Topology.

Using Microsoft® command line tools, IP configuration information and the contents of ARP cache are displayed. Refer to Figure 2.

```
C: > ipconfig / all
Windows IP Configuration
Ethernet adapter Local Area Connection:
    Connection-specific DNS Suffix  . : 
    Description . . . . . : Intel(R) PRO/1000 MT
                             Network Connection
    Physical Address. . . . . : 00:02:3f:7e:37:da
    Dhcp Enabled. . . . . : No
    IP Address. . . . . : 10.1.1.1
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 10.1.1.254
    DNS Servers . . . . . : 10.1.1.250
C: > arp -a
No ARP Entries Found
C: >
```

Figure 2. PC Client initial network state.

A web client is started, and URL eagle1.example.com is entered, as shown in Figure 3. This begins the communication process to the web server, and where the captured packets start.

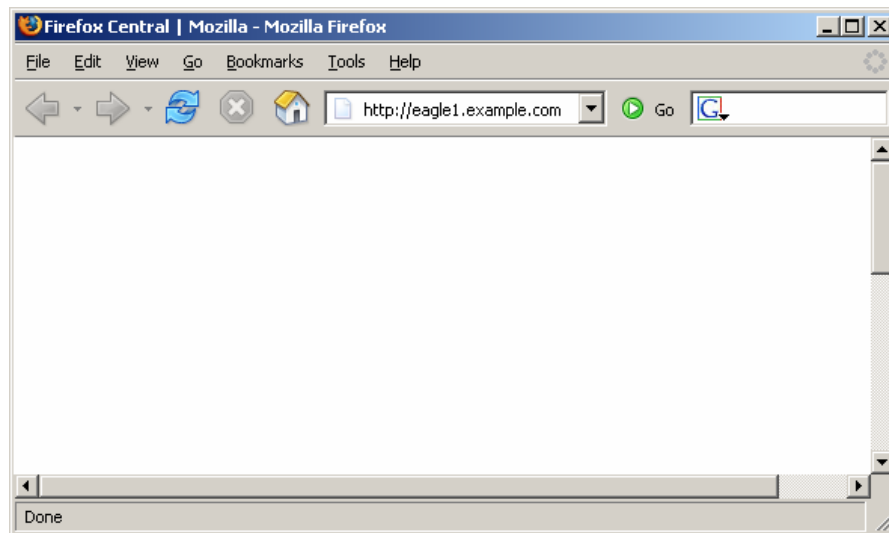


Figure 3. PC Client with web browser.

Task 1: Prepare the Lab.

Step 1: Start Wireshark on your computer.

Refer to Figure 4 for changes to the default output. Uncheck Main toolbar, Filter toolbar, and Packet Bytes. Verify that Packet List and Packet Details are checked. To insure there is no automatic translation in MAC addresses, de-select Name Resolution for MAC layer and Transport Layer.

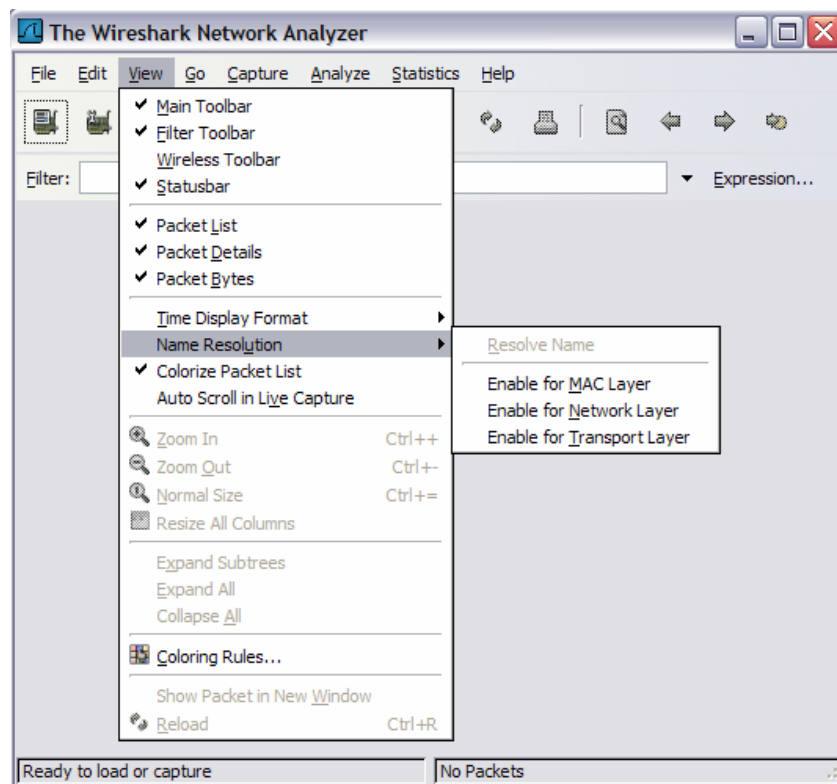


Figure 4. Wireshark default view changes.

Step 2: Load the web client capture, eagle1_web_client.pcap.

A screen similar to Figure 5 will be displayed. Various pull-down menus and sub-menus are available. There are also two separate data windows. The top Wireshark window lists all captured packets. The bottom window contains packet details. In the bottom window, each line that contains a check box, ☒ indicates that additional information is available.

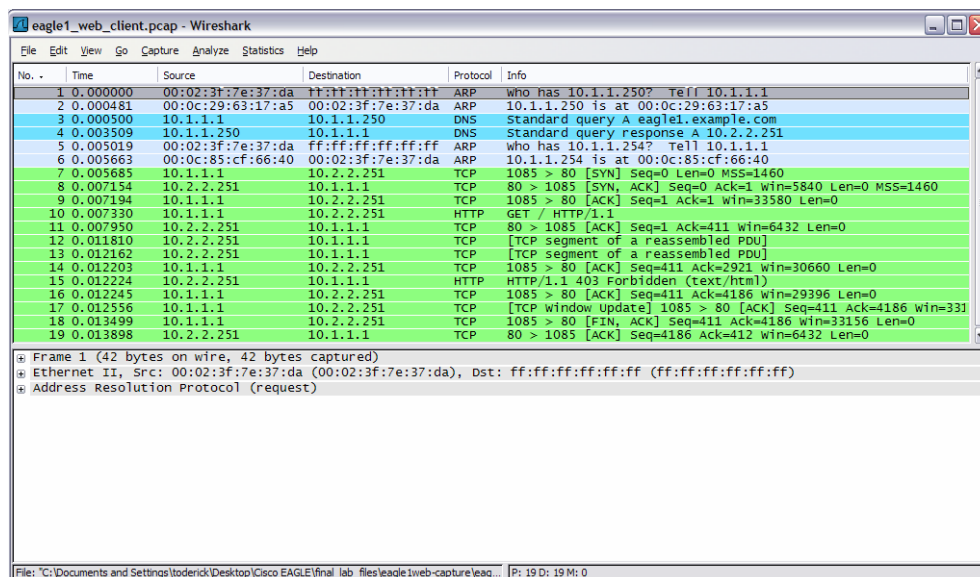


Figure 5. Wireshark with file eagle1_web_client.pcap loaded.

Task 2: Review the Process of Data Flowing through the Network.

Step 1: Review Transport layer operation.

When PC_Client builds the datagram for a connection with eagle1.example.com, the datagram travels down the various network Layers. At each Layer, important header information is added. Because this communication is from a web client, the Transport Layer protocol will be TCP. Consider the TCP segment, shown in Figure 6. PC_Client generates an internal TCP port address, in this conversation 1085, and knows the well-known web server port address, 80. Likewise, a sequence number has been internally generated. Data is included, provided by the Application Layer. Some information will not be known to PC_Client, so it must be discovered using other network protocols.

There is no acknowledgement number. Before this segment can move to the Network Layer, the TCP three-way handshake must be performed.

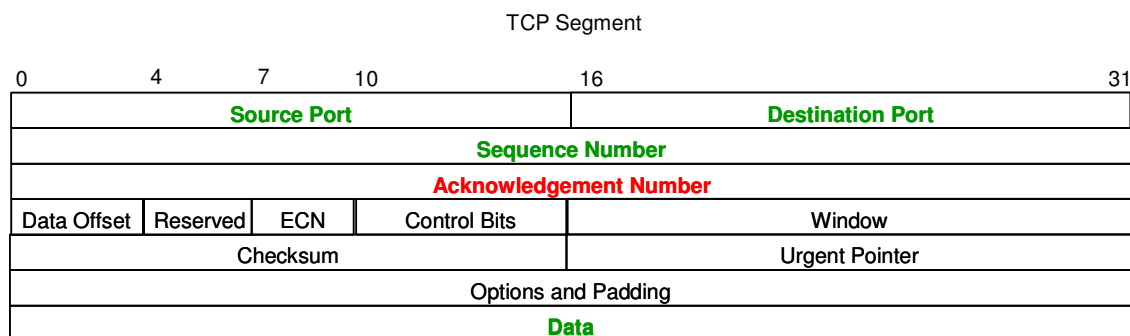


Figure 6. TCP Segment fields.

Step 2: Review Network layer operation.

At the Network Layer, the IPv4 (IP) PACKET has several fields ready with information. This is shown in Figure 7. For example, the packet Version (IPv4) is known, as well as the source IP address.

The destination for this packet is eagle1.example.com. The corresponding IP Address must be discovered through DNS (Domain Name Services). Until the upper layer datagram is received, fields related to the upper layer protocols are empty.

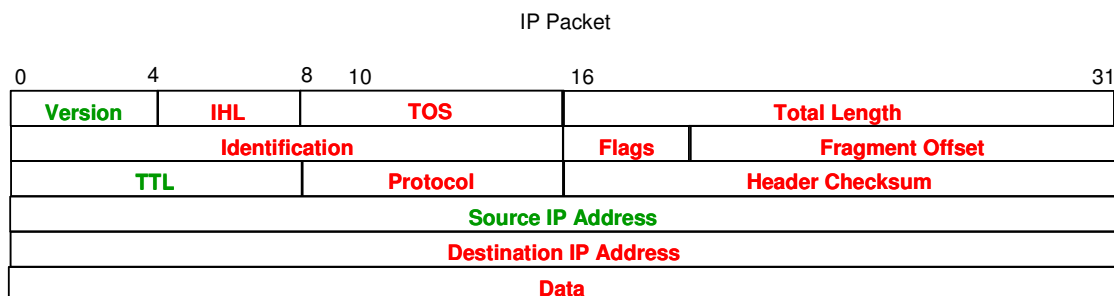


Figure 7. IP Packet fields.

Step 3: Review Data Link layer operation.

Before the datagram is placed on the physical medium, it must be encapsulated inside a frame. This is shown in Figure 8. PC_Client has knowledge of the source MAC address, but must discover the destination MAC address.

The destination MAC address must be discovered.

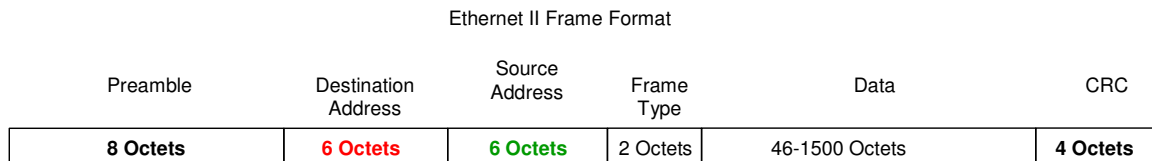


Figure 8. Ethernet II frame fields.

Task 3: Analyze Captured Packets.

Step 1: Review the data flow sequence.

A review of missing information will be helpful in following the captured packet sequence:

- The TCP segment cannot be constructed because the acknowledgement field is blank. A TCP 3-way handshake with eagle1.example.com must first be completed.
- The TCP 3-way handshake cannot occur because PC_Client does not know the IP address for eagle1.example.com. This is resolved with a DNS request from PC_Client to the DNS the server.
- The DNS server cannot be queried because the MAC address for the DNS server is not known. The ARP protocol is broadcast on the LAN to discover the MAC address for the DNS server.
- The MAC address for eagle1.example.com is unknown. The ARP protocol is broadcast on the LAN to learn the destination MAC address for eagle1.example.com.

Step 2: Examine the ARP request.

Refer to Wireshark, Packet List window, No. 1. The captured frame is an ARP (Address Resolution Protocol) Request. Contents of the Ethernet II frame can be viewed by clicking on the check box in the second line of the Packet Details window. Contents of the ARP Request can be viewed by clicking on the ARP Request line in the Packet Details window.

- What is the source MAC address for the ARP Request? _____
- What is the destination MAC address for the ARP Request? _____
- What is the unknown IP address in the ARP Request? _____
- What is the Ethernet II Frame Type? _____

Step 3: Examine the ARP reply.

Refer to Wireshark, Packet List window, No. 2. The DNS server sent an ARP Reply.

1. What is the source MAC address for the ARP Reply? _____
2. What is the destination MAC address for the ARP Request? _____
3. What is the Ethernet II Frame Type? _____
4. What is the destination IP address in the ARP Reply? _____
5. Based on the observation of the ARP protocol, what can be inferred about an ARP Request destination address and an ARP Reply destination address?

6. Why did the DNS server not have to send an ARP Request for the PC_Client MAC address?

Step 4: Examine the DNS query.

Refer to Wireshark, Packet List window, No. 3. PC_Client sent a DNS query to the DNS server. Using the Packet Details window, answer the following questions:

1. What is the Ethernet II Frame Type? _____
2. What is the Transport Layer protocol, and what is the destination port number?

Step 5: Examine the DNS query response.

Refer to Wireshark, Packet List window, No. 4. The DNS server sent a DNS query response to PC_Client. Using the Packet Details window, answer the following questions:

1. What is the Ethernet II Frame Type? _____
2. What is the Transport Layer protocol, and what is the destination port number?

3. What is the IP address for eagle1.example.com? _____
4. A colleague is a firewall administrator, and asked if you thought of any reason why all UDP packets should not be blocked from entering the internal network. What is your response?

Step 6: Examine the ARP request.

Refer to Wireshark, Packet List window, No. 5 and No 6. PC_Client sent an ARP Request to IP address 10.1.1.254.

1. Is this IP address different than the IP address for eagle1.example.com? Explain?

Step 7: Examine the TCP 3-way handshake.

Refer to Wireshark, Packet List window, No. 7, No. 8, and No. 9. These captures contain the TCP 3-way handshake between PC_Client and eagle1.example.com. Initially, only the TCP SYN flag is set on the datagram sent from PC_Client, sequence number 0. eagle1.example.com responds with the TCP ACK and SYN flags set, along with an acknowledgement of 1 and sequence of 0. In the Packet List window, there is an unexplained value, **MSS=1460**. MSS stands for Maximum Segment size. When a TCP segment is transported over IPv4, MSS is computed to be the maximum size of an IPv4 datagram minus 40 bytes. This value is sent during connection startup. This is also when TCP sliding windows are negotiated.

1. If the initial TCP sequence value from PC_Client is 0, why did eagle1.example respond with an acknowledgement of 1?

2. In eagle1.example.com, No. 8, What does the IP Flag value of 0x04 mean?

3. When PC_Client completes the TCP 3-way handshake, Wireshark Packet List No 9, what are the TCP flag states returned to eagle1.example.com?

Task 4: Complete the Final Analysis.

Step 1: Match the Wireshark output to the process.

It has taken a total of nine datagrams sent between PC_Client, DNS server, Gateway, and eagle1.example.com before PC_Client has sufficient information to send the original web client request to eagle1.example.com. This is shown in Wireshark Packet List No. 10, where PC_Client sent a web protocol GET request.

1. Fill in the correct Wireshark Packet List number that satisfies each of the following missing entries:
 - a. The TCP segment cannot be constructed because the acknowledgement field is blank. A TCP 3-way handshake with eagle1.example.com must first be completed. _____

- b. The TCP 3-way handshake cannot occur because PC_Client does not know the IP address for eagle1.example.com. This is resolved with a DNS request from PC_Client to the DNS the server. _____
 - c. The DNS server cannot be queried because the MAC address for the DNS server is not known. The ARP protocol is broadcast on the LAN to discover the MAC address for the DNS server. _____
 - d. The MAC address for the gateway to reach eagle1.example.com is unknown. The ARP protocol is broadcast on the LAN to learn the destination MAC address for the gateway. _____
1. Wireshark Packet List No. 11 is an acknowledgement from eagle1.example.com to the PC_Client GET request, Wireshark Packet List No. 10.
 2. Wireshark Packet List No. 12, 13 and 15 are TCP segments from eagle1.example.com. Wireshark Packet List No. 14 and 16 are ACK datagrams from PC_Client.
 3. To verify the ACK, highlight Wireshark Packet List No. 14. Next, scroll down to the bottom of the detail list window, and expand the [SEQ/ACK analysis] frame. The ACK datagram for Wireshark Packet List No. 14 is a response to which datagram from eagle1.example.com? _____
 4. Wireshark Packet List No. 17 datagram is sent from PC_Client to eagle1.example.com. Review the information inside the [SEQ/ACK analysis] frame. What is the purpose of this datagram?
 5. When PC_Client is finished, TCP ACK and FIN flags are sent, shown in Wireshark Packet List No. 18. eagle1.example.com responds with a TCP ACK, and the TCP session is closed.

Step 2: Use Wireshark TCP Stream.

Analyzing packet contents can be a daunting experience, time consuming and error prone. Wireshark includes an option that constructs the TCP Stream in a separate window. To use this feature, first select a TCP datagram from the Wireshark Packet List. Next, select Wireshark menu options Analyze | Follow TCP Stream. A window similar to Figure 9 will be displayed.

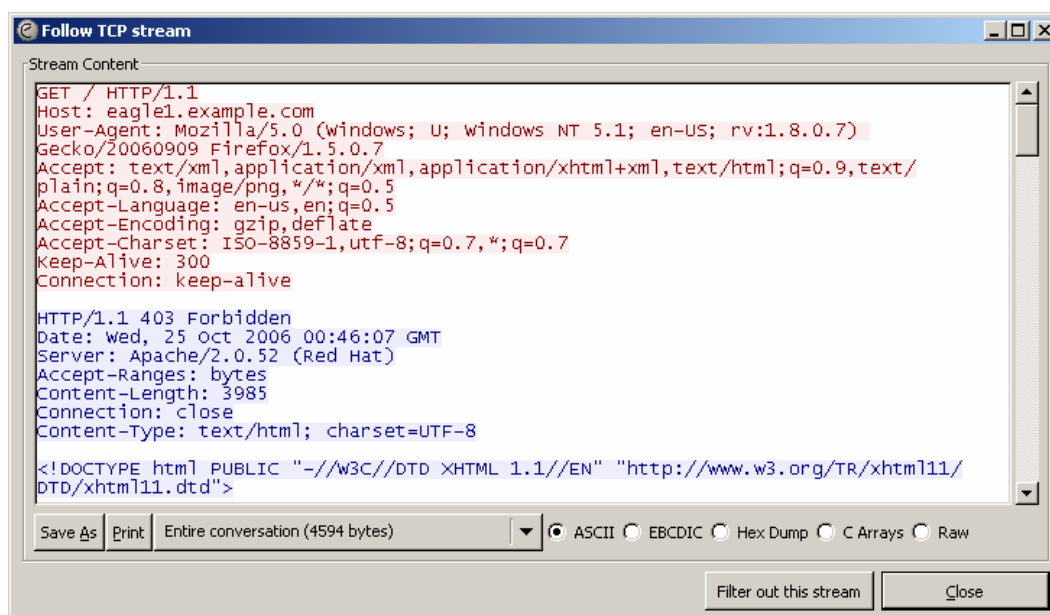


Figure 9. Output of the TCP stream.

Task 5: Conclusion

Using a network protocol analyzer can serve as an effective learning tool for understanding critical elements of network communication. Once the network administrator is familiar with communication protocols, the same protocol analyzer can become an effective troubleshooting tool when there is network failure. For example, if a web browser could not connect to a web server there could be multiple causes. A protocol analyzer will show unsuccessful ARP requests, unsuccessful DNS queries, and unacknowledged packets.

Task 6: Summary

In this exercise the student has learned how communication between a web client and web server communicate. Behind-the-scene protocols such as DNS and ARP are used to fill in missing parts of IP packets and Ethernet frames, respectively. Before TCP session can begin, the TCP 3-way handshake must build a reliable path and supply both communicating ends with initial TCP header information. Finally, the TCP session is destroyed in an orderly manner with the client issuing a TCP FIN flag.