Fachhochschule Darmstadt
University of Applied Sciences

Campus Dieburg

Cisco Networking Academy Program
CISCO SYSTEMS

Computernetze 1

Begleitheft zur Vorlesung

CCNA2

(SS 04)

Inhalt

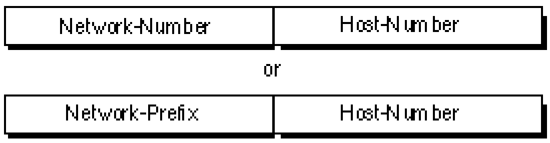
IP-Adressierung

Klassenbasierte Adressierung (classfull ip-adressing)

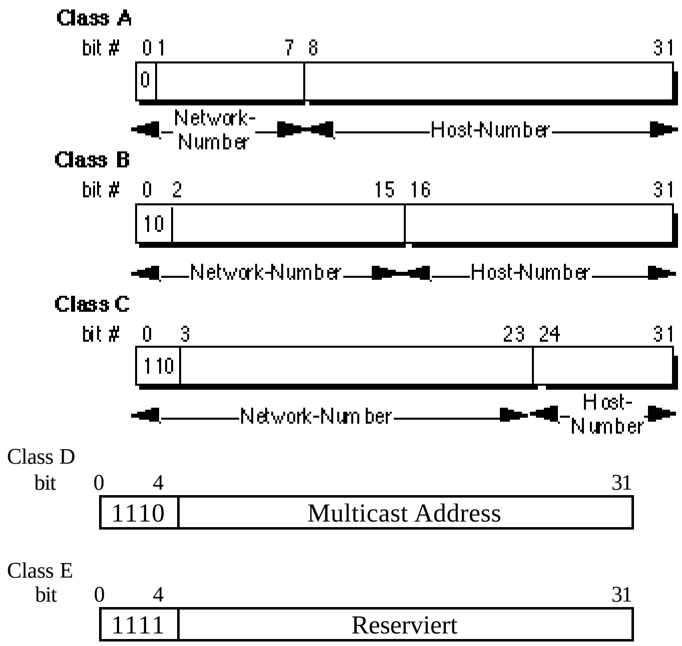
Die Adressierung der Systeme im Internet verwenden eine 32-Bit Adressierung (Ipv4). Folgende RFCs[1] beschreiben die Adressierung:

- RFC 796 Adress Mappings
- RFC 1166 Internbet Numbers
- RFC 1466 Guidelines for Management of IP Address Space
- RFC 1700 Assigned Numbers

Diese 32-Bit-Adressen haben folgende 2-stufige hierarchische Struktur

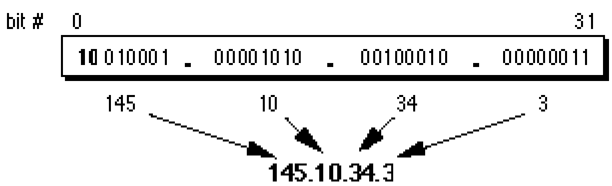


Es werden 5 Klassen (A - E) von Adressen beschrieben (**classfull adressing**):
A, B, C werden als Unicast Adressen benutzt
D für Multicast
E reserviert für zukünftige Anwendungen



Dadurch, dass mit den Bits 1 bis 4 die Klasse festgelegt ist, konnte man in den Anfängen des Internet ohne Netzmaske auskommen. Routingprotokolle, die klassenorientiert arbeiten, wie RIP-1, nutzen diese 4 Bit, um die Länge der Netzwerknummer festzustellen.

Die Schreibweise einer 32-Bit-Adresse in der **gepunkteten Dezimal-Notation** ist nicht nur kompakter, sondern sie bringt auch die hierarchische Adressstruktur besser zum Ausdruck:



[1] RFC - Request for Comments

Über den netzwerkklassenspezifischen Wertebereich der gepunkteten Dezimalnotation informiert die folgende Abbildung

Address Class	Dotted-Decimal Notation Ranges
A (/8 prefixes)	1.xxx.xxx.xxx through 126.xxx.xxx.xxx
B (/16 prefixes)	128.0.xxx.xxx through 191.255.xxx.xxx
C (/24 prefixes)	192.0.0.xxx through 223.255.255.xxx

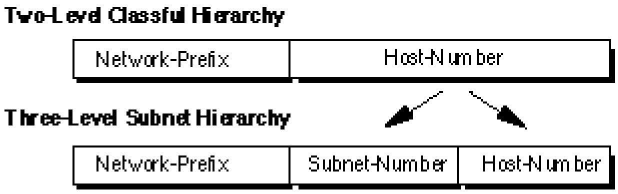
Die Adress-Klasse wird heute auch häufig indirekt über die "/<Netzwerk-Prefixlänge>"- Schreibweise ausgedrückt. Mit der Schreibweise 150.135.19.27/16 für die Class-B-Adresse 150.135.19.27 bringt man zum Ausdruck, daß der Netzwerkpräfix dieser Adresse 16 Bits lang ist, d.h. dass es sich um ein /16-Netzwerk (sprich: slash 16) handelt.

Subnetting (RFC 950)

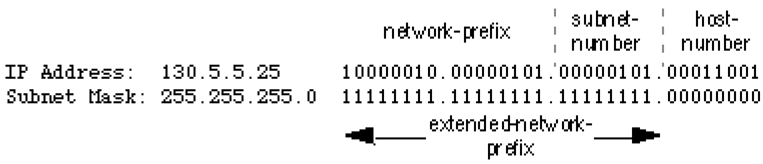
Subnetting wurde 1985 eingeführt, weil die rein klassenorientierte IP-Adressierung mit wachsendem Internet folgende Nachteile hatte:

- Lokale Administratoren mußten sich bei jedem neu installierten Netzwerk eine neue Netzadresse zuweisen lassen.
- Der Adressvorat drohte schnell verbraucht zu werden.
- Die Routingtabellen in den Backbone-Routern drohten unzulässig umfangreich zu werden.
- "Leitweg-Flattern" im privaten Netzbereich wirkt sich auf das gesamte Internet aus.

Das Subnetting unterstützt eine 3-stufige hierarchische IP-Adressstruktur:



Die erweiterte Netzwerknummer setzt sich zusammen aus der Netzwerknummer und der Subnetznummer.

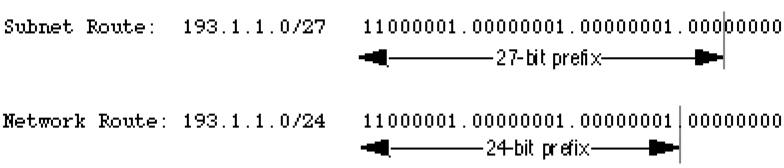


In kompakterer und leichter verständlicher Schreibweise lautet die im Bild genannte Adresse 130.5.5.25/24.

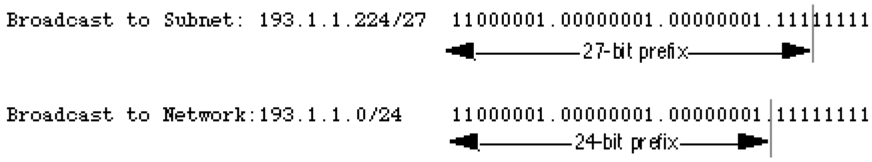
Die Subnetzstruktur ist außerhalb eines privaten Netzwerks völlig unsichtbar. Damit entfallen die oben genannten Nachteile.

Bei Routern, deren Routingtabellen keine Netzpräfixlängen oder Subnetzmasken enthalten (z.B. solche, die RIP-1 benutzen), sind die all-1s- und all-0s-Subnetznummern nicht erlaubt.
Gründe:

- Diese Router können z.B. nicht unterscheiden zwischen Routing-Tabelleneinträgen für die Netze 193.1.1.0/24 und 193.1.1.0/27.



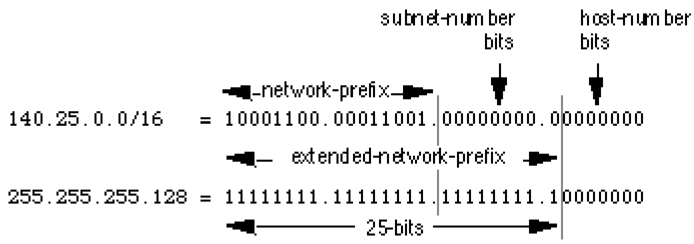
- Solche Router können auch nicht unterscheiden ob mit der Broadcastadresse 192.1.1.255 das gesamte Netzwerk 192.1.1.0/24 gemeint ist oder nur alle Hosts im Subnetz 192.1.1.224/27.



Bei Routern, die den Netzwerkprefix ebenfalls in ihren Tabellen speichern, können auch diese Subnetznummern genutzt werden.

Besteht die binäre Host-Nummer nur aus Einsen, so handelt es sich um die Broadcastadresse des Subnets. Die binäre Hostnummer, die nur aus Nullen besteht, ist für das Subnetz selbst reserviert. Ein Subnet mit einer n Bit langen Hostnummer bietet somit maximal 2^n-2 verwendbare Hostnummern.

Subnet Beispiel: Einer Organisation wurde die Netzwerknummer 140.25.0.0/16 zugewiesen. Dieses Netz soll in Subnetze gegliedert werden. Die Arbeitsgruppen dieser Organisation haben bis zu 60 Hosts.
In diesem Fall würden 6 Hostbits in der IP-Adresse reichen (2^6-2=62 > 60 !). Damit die Organisation noch wachsen kann, entscheidet sich der Netzplaner für eine 7-Bit Hostnummer.



Damit lassen sich 512 (2^9 = 512) /25-Subnetze bilden, die wie folgt numeriert werden:

```
Base Net:  10001100.00011001.00000000.00000000 = 140.25.0.0/16

Subnet #0:   10001100.00011001.00000000.00000000 = 140.25.0.0/25
Subnet #1:   10001100.00011001.00000000.10000000 = 140.25.0.128/25
Subnet #2:   10001100.00011001.00000001.00000000 = 140.25.1.0/25
Subnet #3:   10001100.00011001.00000001.10000000 = 140.25.1.128/25
Subnet #4:   10001100.00011001.00000010.00000000 = 140.25.2.0/25
.
.
Subnet #510: 10001100.00011001.11111111.00000000 = 140.25.255.0/25
Subnet #511: 10001100.00011001.11111111.10000000 = 140.25.255.128/25
```

Für Subnet #3 ergibt sich dieser Hostnummernplan:

```
SubnetAdr: 10001100.00011001.00000001.10000000 = 140.25.1.128/25
Host #1:   10001100.00011001.00000001.10000001 = 140.25.1.129/25
Host #2:   10001100.00011001.00000001.10000010 = 140.25.1.130/25
Host #3:   10001100.00011001.00000001.10000011 = 140.25.1.131/25
Host #4:   10001100.00011001.00000001.10000100 = 140.25.1.132/25
.
.
Host #123: 10001100.00011001.00000001.11111011 = 140.25.1.251/25
Host #124: 10001100.00011001.00000001.11111100 = 140.25.1.252/25
Host #125: 10001100.00011001.00000001.11111101 = 140.25.1.253/25
Host #126: 10001100.00011001.00000001.11111110 = 140.25.1.254/25
Broadcast: 10001100.00011001.00000001.11111111 = 140.25.1.255/25
```

Übungen zur IP-Adressierung

IP-Adress-Übung 1:

IP-Adressformatkonvertierung von 'Binär' -> 'Gepunktet Dezimal'

Binary	128	64	32	16	8	4	2	1	Dezimal
11001100	1	1	0	0	1	1	0	0	128 + 64 + 8 + 4 = 204
10101010									
11100011									
10110011									
00110101									

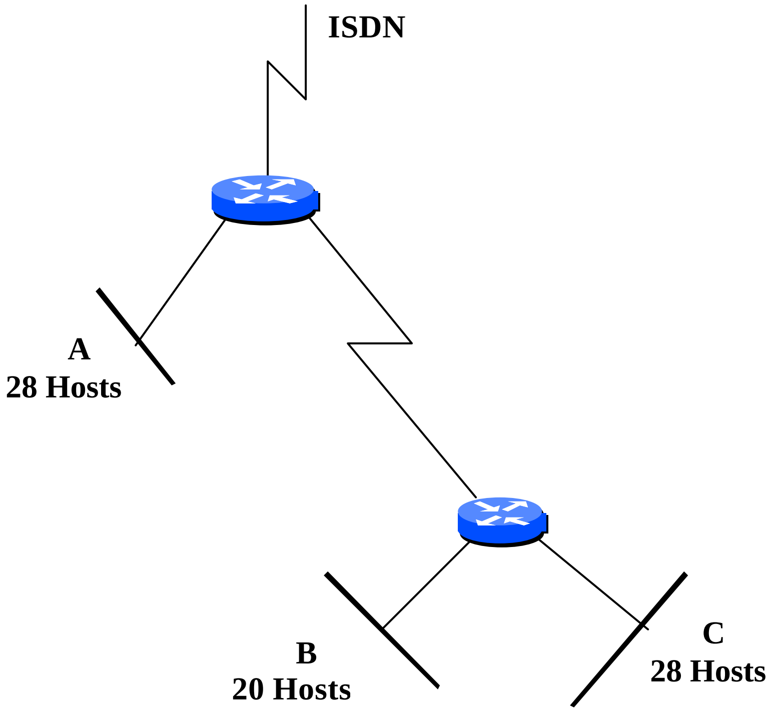
IP-Adress-Übung 2:

IP-Adressformatkonvertierung von 'Gepunktet Dezimal' -> 'Binär'

Dezimal	128	64	32	16	8	4	2	1	Binär
48	0	0	1	1	0	0	0	0	48 = 32 + 16 = 00110000_2
222									
119									
135									
60									

IP-Adress-Übung 3:

Das Netzwerk mit der Adresse **205.19.133.0** soll gemäss Bild in Subnetze aufgeteilt werden.



Fragen:

a) Zu welcher Adressklasse gehört das Netzwerk? ______________________

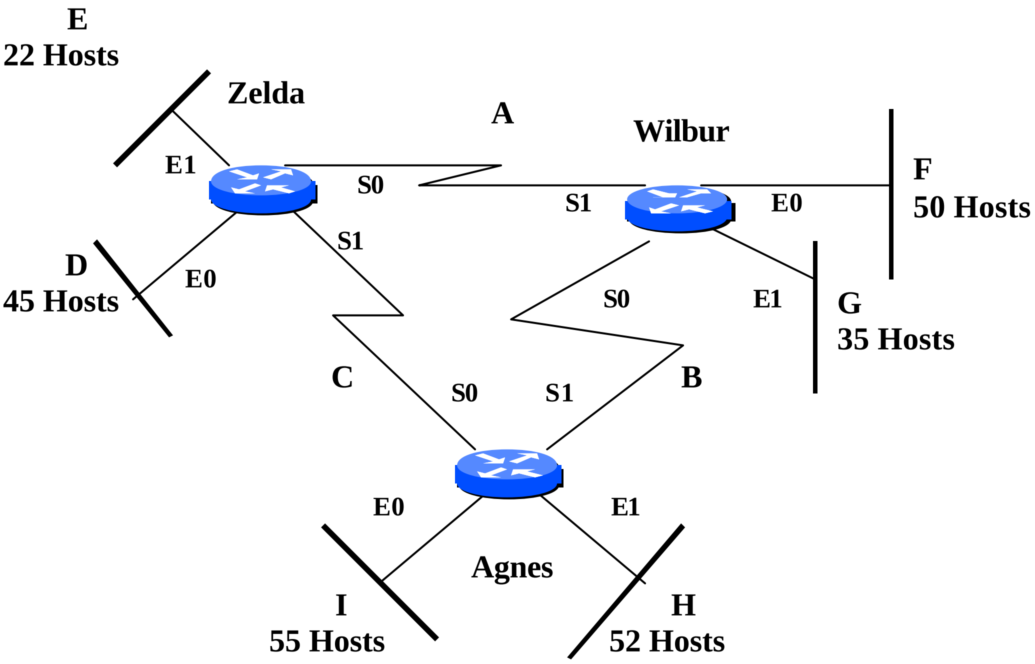
b) Wieviele Subnetze werden benötigt? ______________________

c) Wieviele Hostbits müssen geborgt werden? ______________________

d) Geben Sie zu jedem Subnetz die Subnetzadresse, den Bereich der nutzbaren Hostadressen und die Broadcastadresse an.

Subnetz-Nr.	Subnetzadresse	Nutzb. Hostadressbereich	Broadcastadresse

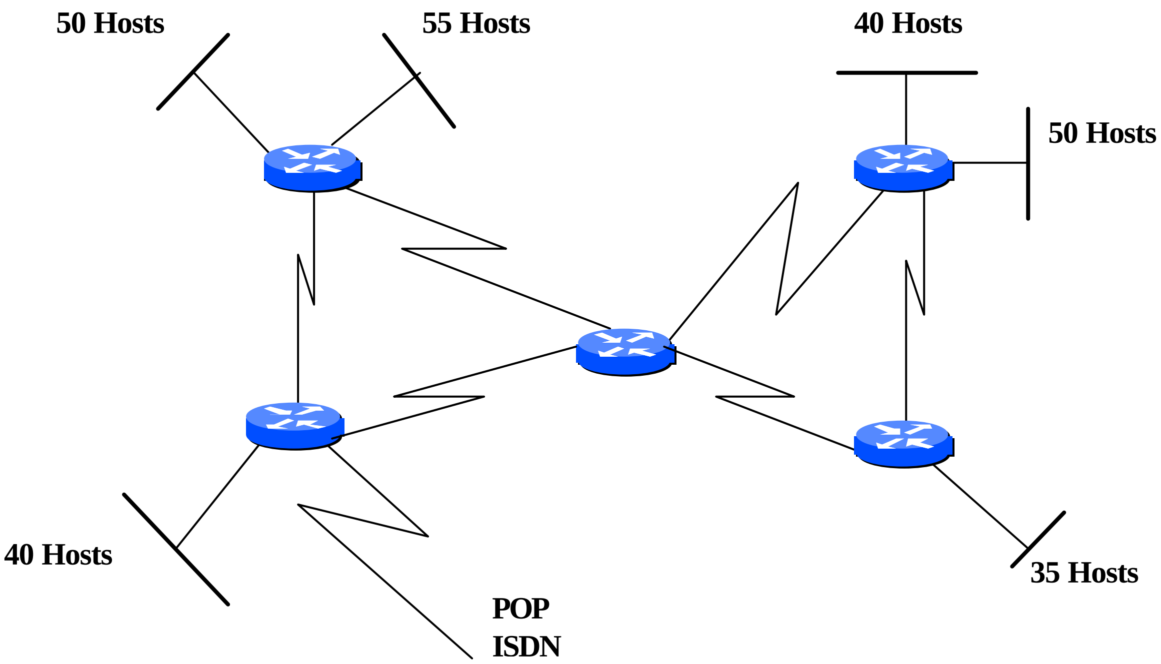
IP-Adress-Übung 4:



	Fragen:	Antworten
a)	Das obige Netzwerk hat die IP-Adresse 10000010.00001010.00000000.00000000 IP-Adresse in dezimaler Punktnotation?	
b)	Die Netzwerkmaske ist 11111111.11111111.11111111.11000000 Netzwerkmaske in dezimaler Punktnotation?	
c)	Wieviele Hostbits sind geborgt?	
d)	Welche IP-Adresse hat Netzwerk A? Nutzen Sie die erstmögliche.	
e)	Welche IP-Adresse hat Port S0 des Routers Zelda? Er nutzt die erste mögliche Hostnummer.	
f)	Welcher IP-Adressbereich steht für Port S1 des Routers Wilbur zur Verfügung?	
g)	Welche IP-Adressbereich haben Sie für Hosts in Netzwerk F. Es ist das 6-te nutzbare Subnetz. Die erste Hostadresse ist für Port E0 reserviert.	
h)	Wieviele Subnetze enthält diese Topoligie?	
i)	Wie lauten die Broadcastadressen für alle diese Subnetze?	
j)	Ist dies ein Netzwerk mit Redundanzen (Reserven bei Leitungsunterbrechungen)?	

IP-Adress-Übung 5:

Das Netz mit der Adresse **130.10.0.0** ist in Subnetze strukturiert (s. Bild).



Fragen:	**Antworten**
IP-Adressklasse des Netzes?	
Subnetzmaske?	
Anzahl geborgter Hostbits?	
Anzahl der Subnetze im Netz?	
Ermitteln Sie die Subnetzadressen und tragen Sie diese ins Bild ein.	-----------------------------------
Wieviele Hosts können maximal an ein Subnetz angeschlossen werden?	

IP-Adress-Übung 6:

Sie haben die Netznummer 132.45.0.0/16 erhalten und möchten 8 nutzbare Subnetze einrichten.

1. **_____ Subnet-Bits werden für die acht Subnets benötigt.**
2. **Geben Sie den Erweiterten-Netzwerk-Präfix in Masken und /xx-Schreibweise an:**

   ____

3. **Geben Sie die 8 Subnetzadressen in den Formaten binär und gepunktet-dezimal an.**

#0 ____

#1 ____

#2 ____

#3 ____

#4 ____

#5 ____

#6 ____

#7 ____

4. **Geben Sie den Hostadressbereich für Subnetz 132.45.96.0/20 an.**

Host#1 ____

Host#2 ____

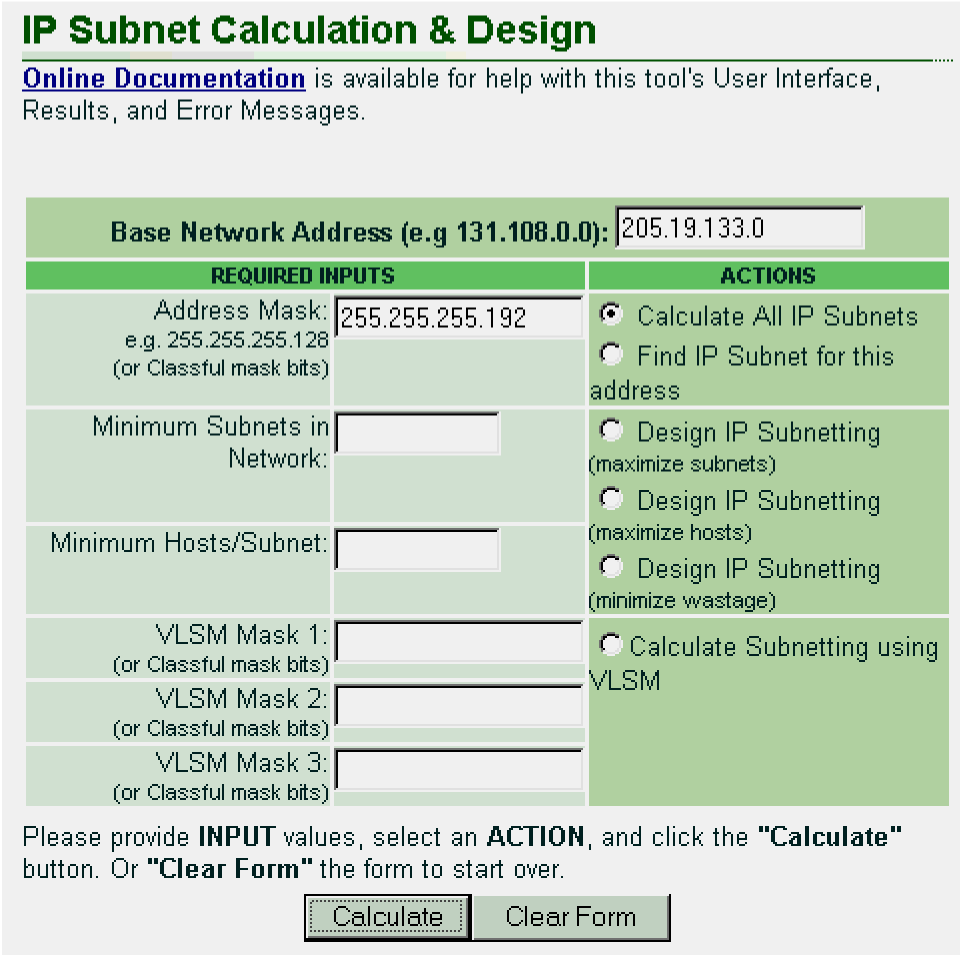
Host#3 ____

Host# (letzter) ____

5. **Wie lautet die Broadcastadresse für Subnetz 132.45.96.0/20?.**

____

IP-Subnetzcalculator von Cisco



Ausgabe des Subnetcalculators

IP Subnet Calculation & Design

```
---------------------------------------------------------------------------
IP Class:        C               IP Address:      205.19.133.0
Mask Bits:       2               Subnet Mask:     255.255.255.192
Subnets:         2+1             IP Major Net:    205.19.133.0
Hosts/Subnet:    62              Major Net Bcast: 205.19.133.255

                  Subnets for Fixed Length Subnet Masking
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
  No.     Subnet           Hosts            Hosts            Broadcast
          Address          From             To               Address
       0  205.19.133.0     205.19.133.1     205.19.133.62    205.19.133.63
       1  205.19.133.64    205.19.133.65    205.19.133.126   205.19.133.127
       2  205.19.133.128   205.19.133.129   205.19.133.190   205.19.133.191
       3  205.19.133.192   205.19.133.193   205.19.133.254   205.19.133.255
Don't use subnet 0 (unless using ip subnet-zero command) and subnet 3.
Address space wasted by subnetting =  51.18% ( 26.77% with ip subnet-zero)
---------------------------------------------------------------------------
```

CCNA Semester 2: LAN-Labor

Ziele

Der Student soll nach dem Versuch

- Eine Netzwerkkarte installieren können
- Die zum Betrieb eines Peer-to-Peer-Netzwerks unter Windows95/98 erforderlichen Dienste und Protokolle kennen und installieren/konfigurieren können
- Das TCP/IP-Protokoll installieren und konfigurieren können
- Resourcen eines PC für das Netzwerk freigeben und verwalten können
- 2 PCs direkt über Netzwerkkarte verbinden und Resourcen gemeinsam nutzen können
- Ein Hub/Switch-basiertes Ethernet-LAN (hier mit 4 Hosts) aufbauen und konfigurieren können.
- Ein Ethernet-LAN mit dem Internet verbinden können
- Einen Browser installieren und konfigurieren können

Netzwerkkarte und Netzwerkarten-Treiber installieren

Vorbereitung:

- Auf eigener Festplatte kontrollieren, ob das Verzeichnis C:\3Com existiert. Wenn nein, dieses Verzeichnis vom Host TNA02 übers Netzwerk auf den eigenen PC kopieren.
- Den Netzwerkkarten-Treiber über *Start/Sytemsteuerung/Netzwerk* entfernen und PC neu booten. Danach sind auch alle Dienste und Protokolle deinstalliert.
- Beim Booten den Hardwareinstallationsassistenten abbrechen.

Durchführung:

- Einbau der Netzwerkkarte entfällt hier weil schon eingebaut.

Hinweis: Bei der NIC-Treiber-Installation werden vom Betriebssystem automatisch einige Protokolle und Dienste installiert. Schauen Sie sich diese unter *Start/Systemsteuerung/Netzwerk* an. Zum Betrieb eines Microsoft Peer-to-Peer-Netzwerks benötigen Sie als Minimalausstattung

  - Client für Microsoftnetzwerke
  - 3ComNetzwerkkartentreiber (3C905B-TX)
  - NetBEUI
  - Datei- und Druckerfreigabe für Microsoftnetzwerke

Sorgen Sie dafür, dass diese Dienste und Protokolle installiert sind. Entfernen Sie alle anderen. Danach muss der PC neu gebootet werden.

PC-PC-Direktverbindung

Das Arbeitsblatt

1. Verbinden Sie die beiden Computer über ein Cross-Connect-Kabel miteinander.

   Warum muss dieser Kabeltyp gewählt werden? ______________________________________

1a Tauschen Sie zwischen den verbundenen PCs Dateien aus, indem Sie
- den Windows-Explorer starten
- ein beliebiges Laufwerk oder Verzeichnis freigeben (rechte Maustaste; beachten Sie auch die Sicherheitsstufen für den Zugriff)

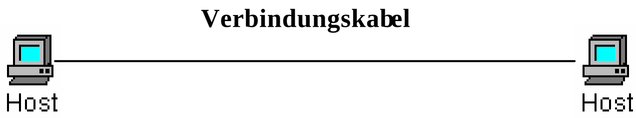
1b Installieren und Konfigurieren des TCP/IP-Protokolls

Zur Auswahl einer geeigneten IP-Adresse beachten Sie folgendes: Sie haben die Netzadresse 192.168.17.0 in 4 Subnetze (0 bis 3) aufgeteilt. Ihr PC soll im 1.nutzbaren Subnetz sein. Tragen Sie die gewählte IP-Adresse in die nachfolgende Tabelle "PC-PC-Direktverbindung" ein.

PC-PC-Direktverbindung

Subnetzadresse: 192.168.17.______

Subnetzmaske: ____.____.____._____



Host-IP-Adresse	**192.168.17.______**	**192.168.17.______**
Subnetzmaske	____.____.____.____	____.____.____.____

Bildschirmausgabe des ping-commands hier eintragen:

Verwenden des Fluke Protokoll-Inspektors

Nach dem Starten präsentiert sich dieser mit der unten abgebildeten Oberfläche. Weitere Infos finden im Web unter http://www.fluke.com/products/home.asp?SID=10&AGID=8&FID=18912

Vorbereitung:

Fahren Sie einen der beiden PCs herunter, starten Sie auf dem anderen PC den Protocol-Inspector, aktivieren Sie den Erfassungsmodus (s.Bild unten) und booten Sie den ersten PC neu. Wenn der Windows-Start abgeschlossen ist wech-seln Sie zur MS-DOS-Eingabeaufforderung und pingen (Eingabeaufforderung: ping *ip-Adresse*) Sie den PC an, auf dem der Protokollanalysator „lauert“. Danach stoppen Sie den Analysator, öffnen Sie das Detailfenster und zeigen Sie die erfassten Frames im capture-view-Fenster an. Bearbeiten Sie folgende Aufgaben:

Skizzieren Sie den allgemeinen Aufbau eines Data Link Control Frames mit Angabe der Feldlängen in Bytes:

Wozu ist das Padding erforderlich?

Skizzieren Sie den allgemeinen Aufbau einer ARP-PDU(PDU: Protocol Data Unit = Header + Daten):

Welchem Zweck dient das ARP?

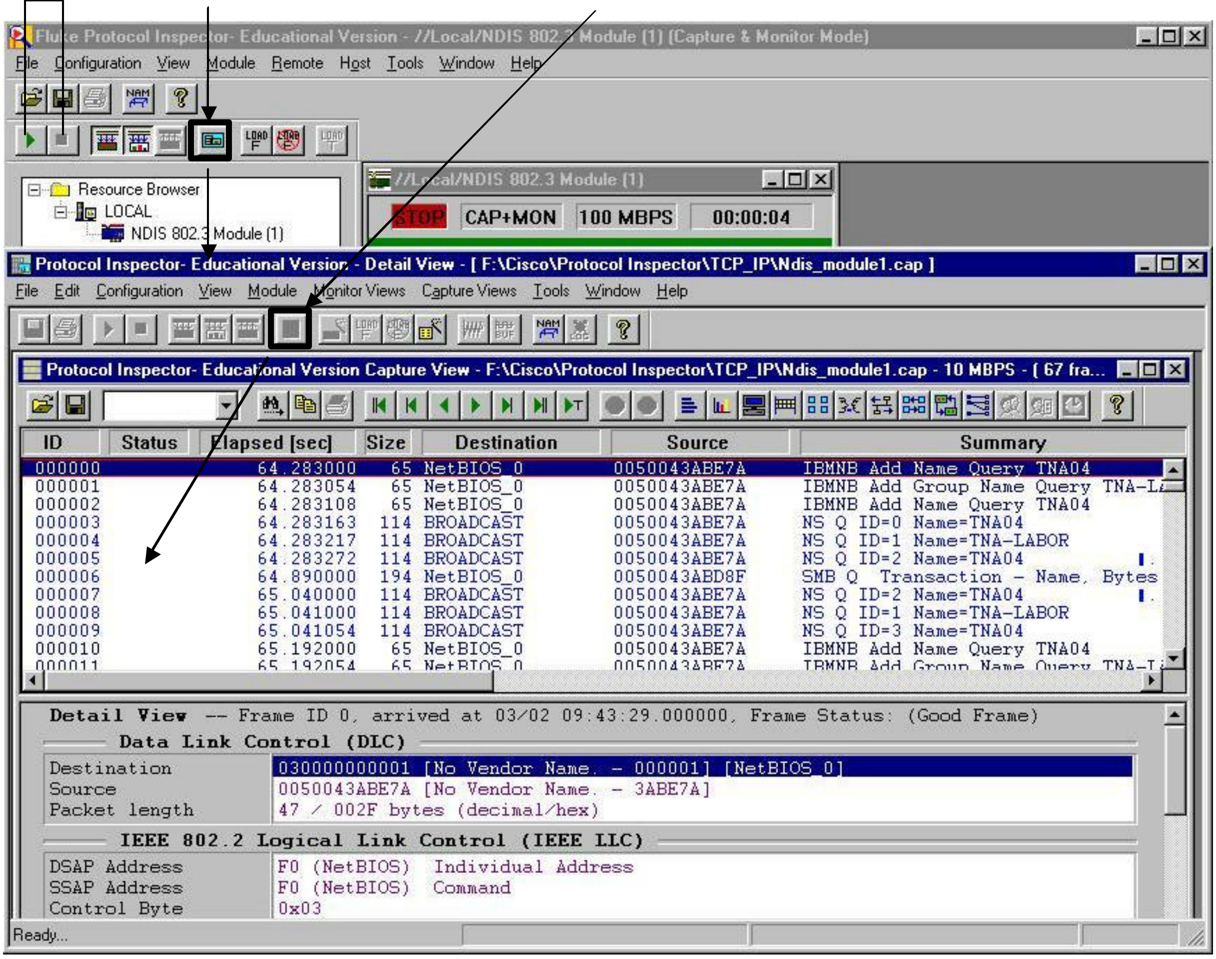
Wie wird zwischen ARP-Request und ARP-Reply unterschieden?

Welches Protokoll benutzt der ping-command?

Geben Sie den allgemeinen Aufbau der PDU dieses Protokolls mit Feldlängen in Bytes an.

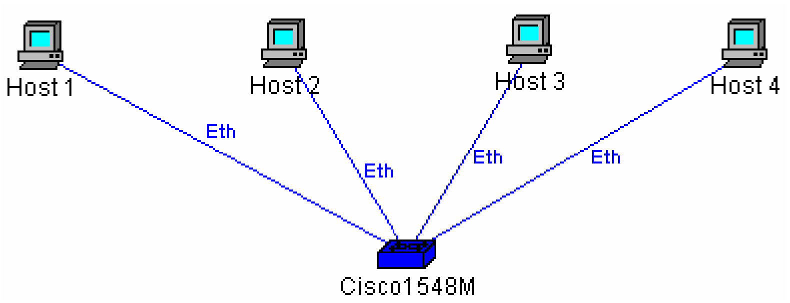
Welche Nachricht ist in den ping-Paketen enthalten?

1. Startet/Stoppt Erfassung
2. Öffnet Detailansichtsfenster
3. Zeigt erfasste Frames (capture view)



LAN mit 1 Switch und 4 Hosts

Verbinden Sie die 4 Hosts einer Tischreihe mit je einem Cisco-Switch 1548M bzw einem Hub.
Tauschen Sie mit mindestens einem anderen Host über das Netzwerk Dateien aus, um die Funktionsfähigkeit festzustellen.

LAN mit 1 Switch und 4 Hosts				
IP-Adresse **Subnetzmaske**				
				

Wie groß ist eine Kollisionsdomäne in Ihrem Netzwerk? Verwenden Sie zur Beantwortung die Befehle **netstat ?, netstat -e** und **ping** in der MS-DOS-Eingabeaufforderung. Überlegen Sie sich eine geeignete Vorgehensweise.

Verbinden eines Ethernet-LANs mit dem Internet

Vorgaben für die IP-Adressierung

Verwenden Sie kein DHCP. Das Labornetz hat die Netzadresse 172.17.4.0/22. In diesem Subnetz stehen Ihnen lediglich die letzten 255 Hostadressen zur Verfügung.

Wie lautet die erste für Sie nutzbare Host-IP-Adresse des Labors: ____

Addieren Sie zur Hostnummer dieser IP Adresse die an Ihrem Rechnergehäuse angegebene Nummer im PC-Namen, um Ihre Hostnummer im Labornetz zu finden.

Nummer im PC-Name: ________________________________

Hostnummer meines PCs ________________________________

IP-Adresse meines Host: ________________________________

Subnetzmaske meines Host: ________________________________

Gateway: tna-gw.tna.fh-darmstadt.de

DNS-Server: tnasrv.tna.fh-darmstadt.de

Durchführung

- Schliessen Sie Ihr Tischreihen-LAN an das Labornetz an. Überlegen Sie zuvor sorgfältig, welches Kabel Sie dazu benötigen.
- Kontrollieren Sie die korrekte IP-Konfiguration mit dem Befehl ***winipcfg*** *bzw.* ***ipconfig /all***

- Testen Sie Ihre Verbindung mit einem ping tnasrv.tna.fh-darmstadt.de auf den LAN-Server des Labornetzes.
- Lassen Sie sich den Inhalt des ARP-Cache anzeigen mit dem Befehl ***arp -a*** in der MS-DOS-Eingabeaufforderung. Weitere Optionen dieses Befehls erhalten Sie mit ***arp -help***.

Dateitransfer mit ftp

Im folgenden verwenden Sie den ftp-client des Betriebssystems Windows 95/98/2000 (wird auf Installations-CD mitgeliefert) der in einem DOS-Fenster läuft und wegen seiner Kommandozeilen-Benutzerschnittstelle nur wenig intuitiv ist. Daneben gibt es Windows-basierte FTP-Freewareprogramme, die wegen ihrer grafischen Benutzeroberfläche selbsterklärend sind. Eines davon finden Sie auf der Begleit-CD im Verzeichnis /Downloads/WS_FTP.
Laden Sie den Netwcape-Browser per ftp vom TNA-Laborserver indem Sie

- ftp über Start/Ausführen/ftp starten
- im sich öffnenden MS-DOS-Fenster folgenden Dialog führen

ftp> **open 172.17.4.5**	stellt Verbindung zur ftp-Serveranwendung im TNA-Laborserver her
user (**172.17.4.5**: (none)): **anonymous**	Passwort für anonymous ftp
Password: [ENTER]	kein Passwort erforderlich
ftp> **cd pub**	Wechsel in das Verzeichnis pub
ftp> **dir**	zeigt Dateien und Unterverzeichnisse in diesem Verzeichnis
ftp> **cd misc**	Wechsel in das Verzeichnis misc
ftp> **binary**	binärer Übertragungsmode wird gewählt, d.h. Bytes werden **nicht** als ASCII-Steuerzeichen interpretiert
ftp> **get cc32e47.exe c:**	Download der Datei in das Root-Verzeichnis. **put** zum Upload verwenden
ftp> **close**	beendet die Verbindng zum TNA-Server
ftp> **quit**	Fenster schliessen

Installation des Netscape Communicators

Da der Microsoft Internet Explorer zu eng mit dem Betriebssystem verflochten ist, sollte er - auch nicht zu Versuchszwecken - deinstalliert werden. Deshalb wird hier der Netscape Communicator zu Übungszwecken installiert.
Nachdem Sie im Rahmen der vorangegangenen Aufgabe den Download der Netscape-Installtionssoftware durchgeführt haben, starten Sie nun diese z.B. mit dem Windows-Explorer. Wählen Sie die Installationsart **"custom"**. Ansonsten wird ihre Realplayer-Software ohne Vorwarnung durch eine ältere Version ersetzt.
Installieren Sie nur folgende Komponenten: **Communicator 4.7** und **Multimedia Support.**

Danach

- starten Sie Netscape und richten ihr User-Profil ein.
- Stellen Sie die Startseite des Browsers auf das Cisco-Curriculum im Verzeichnis **/tna** des TNA-Laborserver ein.
- Untersuchen Sie die Startseite des Curriculums auf etwaige Abweichungen vom gewohnten Bild auf dem Microsoft Internet-Explorer. Solche Abweichungen haben ihre Ursache in der geringfügig unterschiedlichen Interpretation des gleichen html-Codes durch die Browser.

Vielen Dank. Wir hoffen, es hat Spass gemacht!

Glossar

NetBEUI (NetBIOS Extended User Interface) ist ein Protokoll, das in allen Microsoft Netzwerkprodukten enthalten ist. Die Vorteile von NetBEUI sind: geringer Speicherplatzbedarf (wichtig für Computer unter MS-DOS), hohe Übertragungsgeschwindigkeit und die Kompatibilität mit allen Netzwerken von Microsoft. Der wesentliche Nachteil von NetBEUI liegt darin, dass es sich um ein Transportprotokoll handelt und **kein Routing** unterstützen kann. Weiterhin ist seine Verwendung auf Microsoft basierte Netzwerke beschränkt.
NetBIOS (Network Basic Input/Output System) ist kein Protokoll, sondern ein Application Programming Interface (API) der Sitzungsschicht in Microsoftnetzwerken. NetBIOS over IP ist in RFC 1001/2 beschrieben und kann an TCP/IP (sowohl UDP als auch TCP) IPX[2] und NETBEUI) gebunden werden. NetBIOS benötigt mehr Informationen als es vom DNS-Server erhalten kann. Daher hat Microsoft den proprietären NetBIOS Namensservice WINS (Windows Internet Name Service) entwickelt, der dynamisch NetBIOS computer names registrieren kann.
Category 3 cabling is used in 10BaseT networks and can transmit data at speeds up to 10 Mbps (EIA/TIA-568B standard).
Category 4 cabling is used in Token Ring networks and can transmit data at speeds up to 16 Mbps (EIA/TIA-568B standard).
Category 5 cabling is used for running CDDI and can transmit data at speeds up to 1000 Mbps (EIA/TIA-568B standard)

Kollisionsdomäne (collision domain): In Ethernet der Netzwerkbereich, in dem Frames sich ausbreiten und kollidieren können. Repeater und Hubs arbeiten auf Schicht 1 und begrenzen damit nicht die Kollisionsdomäne. Bridges und Switches arbeiten auf Schicht 1 und Schicht 2. Sie begrenzen die Kollisionsdomäne, weil Sie Frames, deren Zieladresse in dem Netzwerk liegt, aus dem sie die Bridge/der Switch empfangen hat, nicht an die anderen Ports weiterleiten.

Peer-to-Peer-Netzwerk: Eine Netzwerkkonfiguration, in der einander gleichgeordnete Geräte Daten austauschen. Es gibt keine dedizierten Server und keine Hierarchie unter den Computern. Jede Station kann als Client oder Server fungieren.

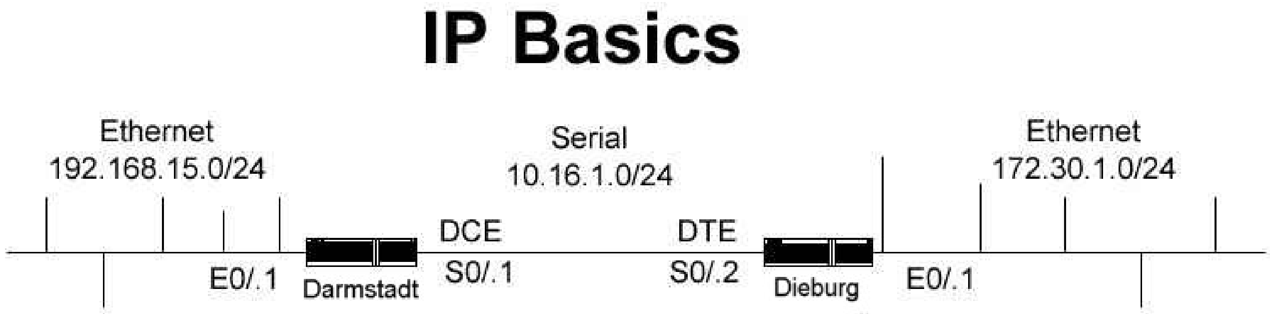
Wir hoffen, es hat Ihnen Spass gemacht und Sie haben etwas dabei gelernt.

[2] Für NetBIOS over IPX müssen Router IP-Bradcasts weiterleiten

Router-Labor

Basic Router Configuration - 8 Steps to Success: IP Basics

The commands listed below are to assist you in setting up your router. **The commands are only examples and do not reflect the configuration of any actual network**. Your actual commands, ip addresses, network addresses, passwords, etc., will depend upon your network design. **Caution**: Some of the show commands may be done in user mode, while others may only be done in privileged mode.
Sample Network: You may wish to configure the network below.



Step 1: Physical Connections

Connect all of the interfaces including:

- **Console**: Connect your PC/terminal to the console port via HyperTerminal **(9600-8-N-1-no flow)**. Use a **rollover cable**.
- **Ethernet**: Connect Ethernet ports to a hub or a switch using a **straight-through cable**. Use a **cross-over cable** if going directly between Ethernet ports on two routers.
- **Serial**: If going directly between two routers, don't forget to connect one port via the DTE cable and the other via the DCE cable. Clock rate must be configured for DTE port

Step 2: Boot up the router

You may use the setup mode (setup dialogue) but this is to help you with configuring the router using the Cisco IOS commands. The setup mode will only allow you to configure the router with the basic features and not with any advanced features.

Step 3: Host Name and Passwords

It is a good idea to begin your configuration with the hostname and passwords. This will remind you what router you are configuring and it is also a good idea to add the security of passwords right away.

Router(config)# **hostname** Darmstadt
`Darmstadt(config)#` **`enable secret`** `class`
`Darmstadt(config)#` **`line vty`** `0 4`

{If you are running EFS, you may increase the number of telnet sessions to more than 5.}

`Darmstadt(config-line)#` **`login`**
`Darmstadt(config-line)#` **`password`** `cisco`
`Darmstadt(config-line)#` **`logging synchronous`**

{debug and other messages will not mess up screen when inputting commands.

`Darmstadt(config)#` **`line con`** `0`
`Darmstadt(config-line)#` **`login`**
`Darmstadt(config-line)#` **`password`** `cisco`
`Darmstadt(config-line)#` **`logging synchronous`**

{debug and other messages will not mess up screen when inputting commands.}

Step 4: Adding IP Addresses
Next lets add the IP addresses, as this is a basic function of configuring routers. Below is an example of configuring both an Ethernet and Serial interface. Don't forget to use the proper subnet mask! For Serial interface with the DCE cable you will need to also add the clocking with the clockrate command.

```
Darmstadt(config)# interface ethernet 0
Darmstadt(config-if)# ip address 192.168.15.1 255.255.255.0
Darmstadt(config-if)# description Engineering Network
Darmstadt(config-if)# no shutdown
Darmstadt(config)# interface serial 0
Darmstadt(config-if)# ip address 10.16.1.0 255.255.255.0
Darmstadt(config-if)# clock rate 56000 {DCE interface only!}
Darmstadt(config-if)# no shutdown
Darmstadt(config-if)# description Network to ISP (to 192.168.15.2)
```

Step 5a: Adding Dynamic Routing: RIP
If this router will be participating in a dynamic routing protocol like RIP or IGRP, you will need to enable the routing protocol along with those directly connected networks that will be participating. Only use the classful network address, not the subnet address of the network!

```
Darmstadt(config)# router rip
Darmstadt(config-router)# network 192.168.15.0 {NOT Subnet Address}
Darmstadt(config-router)# network 10.0.0.0 {NOT Subnet Address}
```

Step 5b: Adding Dynamic Routing: IGRP
If this router will be participating in a dynamic routing protocol like RIP or IGRP, you will need to enable the routing protocol along with those directly connected networks that will be participating. Only use the classful network address, not the subnet address of the network!

```
Darmstadt(config)# router igrp 10 {autonomous-system a.k.a. process-id}
Darmstadt(config-router)# network 192.168.15.0 {NOT Subnet Address}
Darmstadt(config-router)# network 10.0.0.0 {NOT Subnet Address}
```

Step 6: Adding Default and Static Routes
If your router needs a default route (normally on a boundary router) or a static route to another network (normally to a stub network which is not participating in the dynamic routing protocol of Step 5), then you will need to configure these.

```
Darmstadt(config)# ip routing {must be enabled when setting default routes this way}
Darmstadt(config)# ip route 0.0.0.0 0.0.0.0  10.16.1.2 (ip-address-of-next-hop-router)
        { This works without any routing protocol, with RIP but does not work with IGRP.}
Darmstadt(config)# router rip
Darmstadt(config-router)# network 172.30.0.0
Darmstadt(config-router)# default-information originate
        {IOS 12.1 and later you must use this command to advertise a default routewhich is configured using
        a "quad-zero" static route.}
Darmstadt(config)# ip default-network 10.0.0.0
        {A routing table entry for the secified network (static or dynamic) would be flagged as candidate for
        the default route. This works with RIP and IGRP.}
Darmstadt(config)# ip route 172.30.1.0 255.255.255.0  10.16.1.2
        {Configuring a static route: network-address subnet-mask ip-address-of-next-hop-router}
```

Step 7: Testing and Monitoring
At this point it is a good idea to start testing your network using various commands.

```
Darmstadt# show ip route
Darmstadt# show ip interface brief (Great command!)
Darmstadt# show controller s 0 {Shows whether or not the serial cable is DCE or DTE.}
Darmstadt# ping ip-address - Extended ping, press return.
```

```
Darmstadt# traceroute ip-address
Darmstadt# debug ip rip {Remember to turn debug off when done, undebug all}
Darmstadt# terminal monitor
```
{If using debug from a telnet session, otherwise debug output will go to the console. Caution: This will cause the debug output to go to all telnet sessions on this router.}

```
Darmstadt# terminal no monitor        {To un-do the command above.}
```

Be familiar with when you would use these and what they are showing you:

```
Darmstadt# show ip protocols
Darmstadt# show version
Darmstadt# show flash
Darmstadt# show running config
Darmstadt# show startup-config
Darmstadt# show protocol
Darmstadt# show ip protocols
Darmstadt# show interface
Darmstadt# show interface s 0
Darmstadt# show interface e 0
Darmstadt# show controller s 0
Darmstadt# show controller e 0
Darmstadt# show ip interface brief
Darmstadt# show cdp interface
Darmstadt# show cdp neighbor
Darmstadt# show cdp neighbor detail
Darmstadt# show ip route
Darmstadt# show arp
Darmstadt# show version
Darmstadt# show flash
```

More Testing Commands

Here are some commands which may help you troubleshoot the router. Many of the commands might be used while you are speaking with a Tech Support Engineer.

```
Darmstadt# show memory
Darmstadt# show stacks
Darmstadt# show buffers
Darmstadt# show processes
Darmstadt# show processes cpu
Darmstadt# show tech-support
```

Step 8: Adding some extras

Once everything is working you may wish to add some commands to make your work easier.

```
Darmstadt(config)# ip host Monterey 10.16.1.2   {Mapping names and IP addresses.)
Darmstadt(config)# ip name-server ip-address    {Adding a name server.}
Darmstadt(config)# no ip domain-lookup          {When there is no domain server.}
Darmstadt(config)# banner motd # This is the Darmstadt Router #
Darmstadt(config-router)# passive-interface e 0
```
{When you do no want to advertise routing tables out of a specific interface.)

And don't forget to…

```
Darmstadt# show running-config
Darmstadt# copy running-config startup-config
```

Miscellaneous

```
Darmstadt# ?
```
{This command can be used by itself or following at the end of any partial command line.}

```
Darmstadt> enable
Darmstadt# disable
Darmstadt# configure terminal
Darmstadt(config)# exit
Darmstadt(config-if)# control-z
Darmstadt# clock set hh:mm:ss day month year
```

Editing Commands

Control-A: Moves to the beginning of the command line.
Control-E: Moves to the end of the command line.
Esc-B: Moves back one word.
Control-F: Moves forward one character.
Control-B: Move back one character.
Esc-F: Moves forward one word.

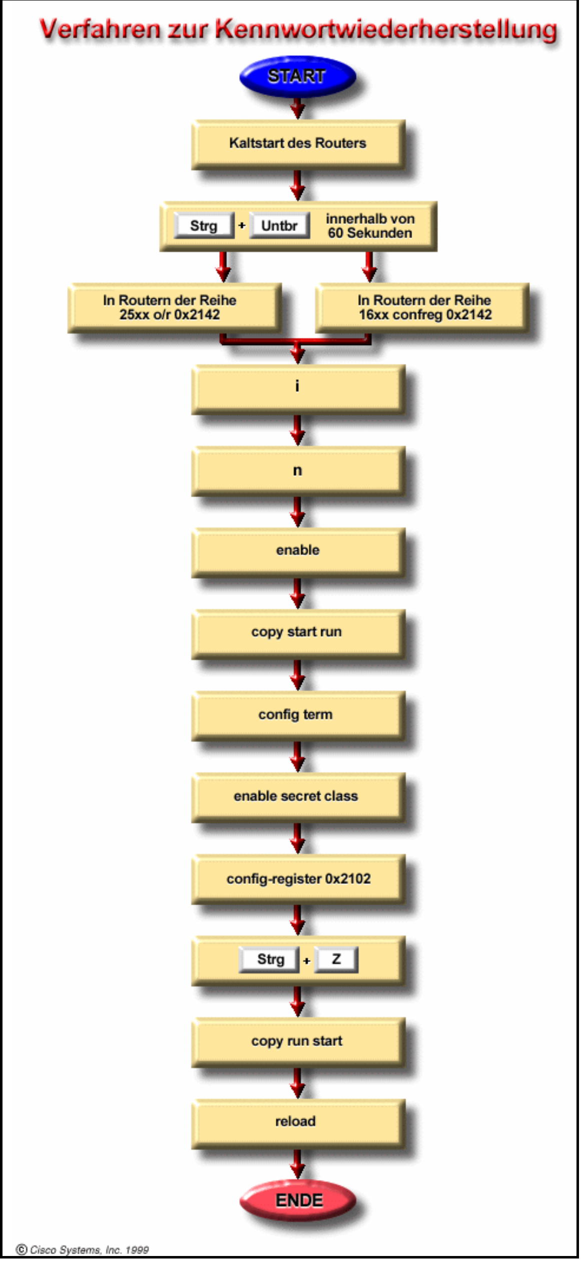
Command History Commands

Control-P or **up arrow ke**y: Recalls last (previous command.
Control-N or **down arrow ke**y: Recalls most recent command
Tab key: completes the entry.

```
Darmstadt# show history
Darmstadt# terminal history
Darmstadt# terminal editing
Darmstadt# no terminal editing
```

CCNA Semester 2 Lab 0: Passwort Recovery

```
// Wenn das Passwort vergessen wurde, kommt man
// nicht mehr in den enable mode und kann daher
// auch das (vergessene)Passwort nicht ändern.
//
// In diesem Fall muss der Router so gestartet
// werden, dass er zwar das IOS-Betriebssystem
// aus dem ROM oder dem Flash-Memory lädt, dann
// aber die im NVRAM gespeicherten Konfigura
// tionsdaten ingnoriert, denn mit dem Laden
// dieser Daten werden auch die Passwörter
// aktiviert.
//
// Um dies zu erreichen, schaltet man den Router
// aus und wieder ein. Unmittelbar danach kann
// man durch Drücken der Tasten [STRG] BREAK
// den Boot-Vorgang abbrechen und der Router
// landet im ROM-Monitor
//
// Hinweis:  Nachfolgend sind die Meldungen der
// Routersoftware auf dem Bildschirm des
// Konsolen-PCs während des Passwort-Recovery in
// chronologischer Reihenfolge aufgelistet
// und kommentiert. Die Kommentarzeilen sind mit
// gekennzeichnet.
// Zeilen die vom Bediener über Tastatur
// einzugeben sind, sind fett formatiert.
//
// Das Cisco-Curriculum beschreibt das Passwort-
// Recovery in Sem 2 / Kap. 8.1.2 und
// illustriert es mit dem Bild rechts:
```




```
// 1. Router ausschalten und wiedereinschalten

System Bootstrap, Version 11.0(10c), SOFTWARE
Copyright (c) 1986-1996 by cisco Systems
2500 processor with 2048 Kbytes of main memory

// Hier wurde [STRG]BREAK gedrückt

Abort at 0x11195C6 (PC)
>

// Jetzt ist der Router im ROM-Monitor
// Welche Kommandos gibt es hier? (Fragezeichen eingeben!)

>?

$             Toggle cache state
B [filename] [TFTP Server IP address | TFTP Server Name]
```

```
              Load and execute system image from ROM or from TFTP server
C [address]  Continue execution [optional address]
D /S M L V   Deposit value V of size S into location L with modifier M
E /S M L     Examine location L with size S with modifier M
G [address]  Begin execution
H            Help for commands
I            Initialize
K            Stack trace
L [filename] [TFTP Server IP address | TFTP Server Name]
             Load system image from ROM or from TFTP server, but do not
             begin execution
O            Show configuration register option settings
P            Set the break point
S            Single step next instruction
T function   Test device (? for help)

Deposit and Examine sizes may be B (byte), L (long) or S (short).
Modifiers may be R (register) or S (byte swap).
Register names are: D0-D7, A0-A6, SS, US, SR, and PC
>

// Was steht im config-register?

>O

Configuration register = 0x2102 at last boot
Bit#    Configuration register option settings:
15      Diagnostic mode disabled
14      IP broadcasts do not have network numbers
13      Boot default ROM software if network boot fails
12-11   Console speed is 9600 baud
10      IP broadcasts with ones
08      Break disabled
07      OEM disabled
06      Ignore configuration disabled
03-00   Boot file is cisco2-2500 (or 'boot system' command)

// config-register enthält 0x2102(binär 0010 0001 0000 0010)
// Diesen Wert muss man sich aufschreiben, weil er nach dem Passwort Recovery wiederher-
// gestellt werden muss.
>
// 2. config-register auf 0x2142 (binär 0010 0001 0100 0010) setzen.

// Danach sind die Optionen
//     -Ignore configuration enabled
//     -Break disabled
//     -Boot from flash enabled (letzte Ziffer =2 !)

>o/r0x2142

// Was steht jetzt im config-register?
// Hinweis: Diese Ausgabe lässt sich tatsächlich erst nach einem
//         Neustart des Routers generieren, weil der Router
//         immer nur den config-register-Inhalt vor dem letzten
//         booten interpretiert

System Bootstrap, Version 11.0(10c), SOFTWARE
Copyright (c) 1986-1996 by cisco Systems
2500 processor with 2048 Kbytes of main memory

Abort at 0x1098FF2 (PC)
>
System Bootstrap, Version 11.0(10c), SOFTWARE
Copyright (c) 1986-1996 by cisco Systems
2500 processor with 2048 Kbytes of main memory

Abort at 0x1098FF2 (PC)
```

```
>o
Configuration register = 0x2142 at last boot
Bit#    Configuration register option settings:
15      Diagnostic mode disabled
14      IP broadcasts do not have network numbers
13      Boot default ROM software if network boot fails
12-11   Console speed is 9600 baud
10      IP broadcasts with ones
08      Break disabled
07      OEM disabled
06      Ignore configuration enabled
03-00   Boot file is cisco2-2500 (or 'boot system' command)

>
```

//3. Jetzt wird (ohne) Konfiguration vom Flash-Memory gebootet

```
>b

%SCHED-2-WATCH: Attempt to set uninitialized watched boolean (address 0).
-Process= "*Init*", ipl= 7
-Traceback= 10EB2EA 1110CBE
Exception: Illegal Instruction at 0x0 (PC)
// Die Bootstrap Software startet jetzt und sucht
// nach dem IOS nach den Vorgaben im config-register
// Bit 0..3 = 0010 bedeutet, dass im Flash-Memory gesucht
// werden soll.
//

System Bootstrap, Version 11.0(10c), SOFTWARE
Copyright (c) 1986-1996 by cisco Systems
2500 processor with 2048 Kbytes of main memory

F3: 6700084+88348+451572 at 0x3000060

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Rights clause at FAR sec. 52.227-19 and subparagraph
(c) (1) (ii) of the Rights in Technical Data and Computer
Software clause at DFARS sec. 252.227-7013.

           cisco Systems, Inc.
           170 West Tasman Drive
           San Jose, California 95134-1706

// Das IOS im Flash-Memory wurde gefunden und wird jetzt geladen
// Wenn das fehlschlagen wäre, würde die Bootsoftware im ROM
// nach einem IOS-Image suchen und von dort booten.

Cisco Internetwork Operating System Software
IOS (tm) 2500 Software (C2500-D-L), Version 12.0(4), RELEASE SOFTWARE (fc1)
Copyright (c) 1986-1999 by cisco Systems, Inc.
Compiled Wed 14-Apr-99 21:21 by ccai
Image text-base: 0x03037C88, data-base: 0x00001000

cisco 2500 (68030) processor (revision N) with 2048K/2048K bytes of memory.

// 2048/2048 bedeutet hier, dass das Primary Memory 2048k und das shared memory ebenfalls
// 2048k hat

Processor board ID 17536212, with hardware revision 00000000
Bridging software.
X.25 software, Version 3.0.0.
1 Ethernet/IEEE 802.3 interface(s)
2 Serial network interface(s)
32K bytes of non-volatile configuration memory.
8192K bytes of processor board System flash (Read ONLY)
```

```
         --- System Configuration Dialog ---

// Da die Konfigurationsdaten nicht geladen wurden bietet der Router
// nun den manuellen Konfigurations-Dialog an.
// Da die Konfigurationsdaten aber nach wie vor im NVRAM gespeichert sind
// und später nachgeladen werden, wird dieser Dialog abgelehnt.

// 4. Initial Configuration Dialog ablehnen
```

Would you like to enter the initial configuration dialog? [yes/no]: no

```
Press RETURN to get started!

00:00:36: %SYS-5-RESTART: System restarted --
Cisco Internetwork Operating System Software
IOS (tm) 2500 Software (C2500-D-L), Version 12.0(4), RELEASE SOFTWARE (fc1)
Copyright (c) 1986-1999 by cisco Systems, Inc.
Compiled Wed 14-Apr-99 21:21 by ccai

Router>

// Da die Konfiguration nicht geladen wurde und damit
// das Passwort auch nicht wirksam ist kann nun ohne
// Passwort in den enable-mode gewechselt werden.

// 5. In den enable mode wechseln
```

Router>ena

```
Router#

// Endlich im enable-mode
// Wie sieht jetzt die (leere) Konfiguration aus?
```

Router#show running-config

```
Building configuration...

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Router
ip subnet-zero
!
interface Ethernet0
 no ip address
 no ip directed-broadcast
 shutdown
!
interface Serial0
 no ip address
 no ip directed-broadcast
 shutdown
!
interface Serial1
 no ip address
 no ip directed-broadcast
 shutdown
!
ip classless
!
line con 0
 transport input none
line aux 0
line vty 0 4
!
end
```

```
Router#
```

```
// Der Router ist also nicht konfiguriert.
// Beachten Sie auch den zurück gesetzten Router-Prompt (Router>).
```

```
// 6. Jetzt die Konfiguration aus dem NVRAM laden
```

Router#configure memory

```
Raum-E#
```

```
// Die Konfigurationsdaten sind jetzt geladen
// Wie sieht die Konfiguration aus?
```

Raum-E#show running-config

```
Building configuration...

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
service udp-small-servers
service tcp-small-servers
!
hostname Raum-E
!
enable secret 5 $1$kf1D$RGTHt/oqlLZGROsjrlmQS/
!
ip subnet-zero
ip host Raum-A 192.5.5.1 205.7.5.1 201.100.11.1
ip host Raum-B 201.100.11.2 219.17.100.1 199.6.13.1
ip host Raum-C 199.6.13.2 223.8.151.1 204.204.7.1
ip host Raum-D 204.204.7.2 210.93.105.1
ip host Raum-E 210.93.105.2
!
interface Ethernet0
 ip address 210.93.105.2 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
 shutdown
!
interface Serial0
 no ip address
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
 shutdown
 clockrate 56000
!
interface Serial1
 no ip address
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
 shutdown
!
router rip
 network 210.93.105.0
!
ip classless
!
!
line con 0
 transport input none
line aux 0
 transport input all
```

```
line vty 0 4
 password cisco
 login
!
end

Raum-E#
```

// Der Router-Prompt hat sich geändert nachdem die Konfiguration geladen wurde.

// 6. Jetzt das (unbekannte) Passwort durch ein neues ersetzen

Raum-E#configure terminal

```
Enter configuration commands, one per line.  End with CNTL/Z.
Raum-E(config)#enable secret ?
  0      Specifies an UNENCRYPTED password will follow
  5      Specifies an ENCRYPTED secret will follow
  LINE   The UNENCRYPTED (cleartext) 'enable' secret
  level  Set exec level password
```

Raum-E(config)#enable secret NeuesPasswort

```
Raum-E(config)#
```

Raum-E(config)#^Z

// Fertig
// Neues Passwort testen

Raum-E#exit

```
Raum-E con0 is now available

Press RETURN to get started.

Raum-E>
```

// Jetzt mit neuem Passwort in enable mode wechseln

Raum-E>enable

```
Password:
```

// Hier wurde natürlich NeuesPasswort eingegeben
// Jetzt wieder Standard-Passwort (class) einrichten

Raum-E#configure terminal

```
Enter configuration commands, one per line.  End with CNTL/Z.

Raum-E(config)#
```

Raum-E(config)#enable secret class

// 7. Configuration Register wieder auf ursprünglichen Wert einstellen.

// Den Wert haben Sie sich in Schritt 1 hoffentlich aufgeschrieben!

Raum-E(config)#config-register 0x2102

```
Raum-E(config)#^Z
Raum-E#00:11:52: %SYS-5-CONFIG_I: Configured from console by console
Raum-E#
```

// 8. Die aktive Configuration im NVRAM speichern.

Raum-E#copy running-config startup-config

// 9. Den Router neu booten, um den korrekten Abschluss der Passwort Recovery Procedure zu testen

Raum-E#reload

// **Anhang:** Jetzt wird noch gezeigt wie vom ROM (ohne Passwort) gebootet werden kann

```
System Bootstrap, Version 11.0(10c), SOFTWARE
Copyright (c) 1986-1996 by cisco Systems
2500 processor with 2048 Kbytes of main memory
```

// Hier wurde wieder **[STRG]BREAK** gedrückt

```
Abort at 0x10CFA12 (PC)
>o
Configuration register = 0x2102 at last boot
Bit#    Configuration register option settings:
15      Diagnostic mode disabled
14      IP broadcasts do not have network numbers
13      Boot default ROM software if network boot fails
12-11   Console speed is 9600 baud
10      IP broadcasts with ones
08      Break disabled
07      OEM disabled
06      Ignore configuration disabled
03-00   Boot file is cisco2-2500 (or 'boot system' command)
```

// Durch folgende Einstellung des config-registers wird der Router
// gezwungen das IOS aus dem ROM zu laden (1 an letzter Stelle)

>o/r0x41

// Jetzt wird gebootet

>b

```
Address Error, address: 0x68DA8 at 0x1098E70 (PC)
save_stack: discarding corrupt frame pointer (0xFFFFFFFF)

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2500 processor with 2048 Kbytes of main memory
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Software clause at DFARS sec. 252.227-7013.
           cisco Systems, Inc.
           170 West Tasman Drive
           San Jose, California 95134-1706
Cisco Internetwork Operating System Software
IOS (tm) 3000 Bootstrap Software (IGS-BOOT-R), Version 11.0(10c), RELEASE SOFTWA
RE (fc1)
Copyright (c) 1986-1996 by cisco Systems, Inc.
Compiled Fri 27-Dec-96 17:33 by loreilly
Image text-base: 0x01010000, data-base: 0x00001000

cisco 2500 (68030) processor (revision N) with 2048K/2048K bytes of memory.
Processor board ID 17536212, with hardware revision 00000000
X.25 software, Version 2.0, NET2, BFE and GOSIP compliant.
1 Ethernet/IEEE 802.3 interface.
2 Serial network interfaces.
32K bytes of non-volatile configuration memory.
8192K bytes of processor board System flash (Read/Write)
         --- System Configuration Dialog ---

At any point you may enter a question mark '?' for help.
Use ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[]'.
```

Would you like to enter the initial configuration dialog? [yes]: no

```
Press RETURN to get started!

%LINEPROTO-5-UPDOWN: Line protocol on Interface Ethernet0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1, changed state to down
%LINK-3-UPDOWN: Interface Ethernet0, changed state to up
%LINK-3-UPDOWN: Interface Serial0, changed state to down
%LINK-3-UPDOWN: Interface Serial1, changed state to down
%SYS-5-RESTART: System restarted --
Cisco Internetwork Operating System Software
IOS (tm) 3000 Bootstrap Software (IGS-BOOT-R), Version 11.0(10c), RELEASE SOFTWA
RE (fc1)
Copyright (c) 1986-1996 by cisco Systems, Inc.
Compiled Fri 27-Dec-96 17:33 by loreilly
%LINEPROTO-5-UPDOWN: Line protocol on Interface Ethernet0, changed state to down

%LINK-5-CHANGED: Interface Ethernet0, changed state to administratively down
%LINK-5-CHANGED: Interface Serial0, changed state to administratively down
%LINK-5-CHANGED: Interface Serial1, changed state to administratively down

// Es wurde die IOS Ver 11.0(10c) aus dem ROM geladen
// Der Router prompt hat sich daher geändert

Router(boot)>

// Ohne Passwort wechseln in den enable mode

Router(boot)>ena
Router(boot)#

// Jetzt kann es weitergehen wie oben

// Alles klar?
```

Anhang zur Passwort Recovery Prozedur

Software Configuration Register

Quelle: http://www.cisco.com/univercd/cc/td/doc/product/access/acs_fix/cis2000/c2000qs/22812.htm

This appendix describes the router software configuration register, the factory default settings, and the procedures for changing those settings.

Software Configuration Register Settings

The router has a 16-bit software register, which is written into the nonvolatile memory. Use the processor configuration register information contained in this appendix to do the following:

- Change software configuration register settings
- Setting and displaying the configuration register value
- Force the system into the bootstrap monitor
- Select a boot source and default boot filename
- Enable or disable the Break function
- Control broadcast addresses
- Set the console terminal baud rate
- Load operating software from ROM
- Enable booting from TFTP server

Table B-1 lists the meaning of each of the software configuration memory bits, and Table B-2 defines the boot field names.

Software Configuration Bit Meanings

Bit No.	Hex	Meaning
00-03	0x0000-0x000F	Boot Field (see Table B-2)
06	0x0040	Ignore NVM contents
07	0x0080	OEM bit enabled
08	0x0100	Break disabled
10	0x0400	IP broadcast with all zeros
11-12	0x0800-0x1000	Console line speed
13	0x2000	Boot default ROM software if network boot fails
14	0x4000	IP broadcasts do not have net numbers
15	0x8000	Enable diagnostic messages and ignore NVM contents

Explanation of Boot Field (Configuration Register Bits 00-03)

Boot Field	Meaning
00	Stays at the system bootstrap prompt
01	Boots system image on EPROM
02-F	Specifies a default netboot filename Enables boot system commands that override default netboot filename1

1 Values of the boot field are 2-15 in the form cisco<n>-processor_name, where 2 < n < 15.

Changing Configuration Register Settings

To change software configuration register settings when the operating system is running, use the config-register command following and restart the server. Configuration register changes take effect only when the server restarts: that is, when you switch the power off and on or when you issue a reload command from the console.

In order to issue the configure or reload commands, you must first enable the privileged mode of operation. At the router> prompt, enter enable. The system will prompt you for the privileged password. After you enter the password, the prompt will change to a pound sign (router#). Enter the user configuration dialogue with the config-terminal command.

To set the contents of the configuration register, use the config-register value configuration command. Value is a hexadecimal number preceded by 0x. The software configuration register is stored in nonvolatile memory. For example, the default switch register contents can be set with the command config-register 0x1. To exit the user configuration dialogue, press the Ctrl-Z key combination. To exit the privileged mode, enter disable at the prompt.

The new value settings will be saved to memory; however, the new settings do not take effect until the system software is reloaded.

To display the configuration register value currently in effect and the value that will be used at the next reload, if the two values are different, use the show version command.

The lowest four bits of the processor configuration register (bits 3, 2, 1, and 0) form the boot field. (See Table B-2.) The boot field specifies a number in binary. If you set the **boot field value to 0**, you must boot the operating system manually by entering the b command at the bootstrap prompt. If you set the **boot field value to 1** (the factory default), the router boots using the default ROM software. If you set the boot field to any other bit pattern, the router uses the resulting number to form a **default boot filename for netbooting**. (See Table B-3.)

Note A boot system configuration command in the router configuration in NVRAM will override the default netboot filename.

The server creates a boot filename as part of the automatic configuration processes. To form the boot filename, the server starts with cisco and links the octal equivalent of the boot field number, a dash, and the processor-type name. Table B-3 lists the default boot filenames or actions for the processor.

Default Boot Filenames

Action/Filename	Bit 3	Bit 2	Bit 1	Bit 0
Bootstrap monitor	0	0	0	0
ROM software	0	0	0	1
cisco2-igs	0	0	1	0
cisco3-igs	0	0	1	1
cisco4-igs	0	1	0	0
cisco5-igs	0	1	0	1
cisco6-igs	0	1	1	0
cisco7-igs	0	1	1	1
cisco10-igs	1	0	0	0
cisco11-igs	1	0	0	1
cisco12-igs	1	0	1	0
cisco13-igs	1	0	1	1
cisco14-igs	1	1	0	0
cisco15-igs	1	1	0	1
cisco16-igs	1	1	1	0
cisco17-igs	1	1	1	1

Bit 8 controls the console Break key. Setting bit 8 (the factory default) causes the processor to ignore the console Break key. Clearing bit 8 causes the processor to interpret Break as a command to force the system into the bootstrap monitor, halting normal operation. A Break can be sent in the first 60 seconds while the system reboots, regardless of the configuration settings.

Bit 10 controls the host portion of the Internet broadcast address. Setting bit 10 causes the processor to use all zeros; clearing bit 10 (the factory default) causes the processor to use all ones. Bit 10 interacts with bit 14, which controls the network and subnet portions of the broadcast address. Table B-4 shows the combined effect of bits 10 and 14.

Configuration Register Settings for Broadcast Address Destination

Bit 14	Bit 10	Address (<net> <host>)
off	off	<ones> <ones>
off	on	<zeros> <zeros>
on	on	<net> <zeros>
on	off	<net> <ones>

Bit 13 determines the server response to a bootload failure. Setting bit 13 causes the server to load operating software from ROM after five unsuccessful attempts to load a boot file from the network. Clearing bit 13 causes the server to continue attempting to load a boot file from the network indefinitely. By factory default, bit 13 is cleared to 0.

Bits 11 and 12 in the configuration register determine the baud rate of the console terminal. Table B-5 shows the bit settings for the four available baud rates. (The factory-set default baud rate is 9600.)

System Console Terminal Baud Rate Settings

Baud	Bit 12	Bit 11
9600	0	0
4800	0	1
1200	1	0
2400	1	1

To enable booting from the standalone bootstrap mode, set bits 3, 2, 1, and 0 to a value between 2 and 15 in conjunction with the software configuration command boot system filename. To disable break and enable the boot system command while in the system software image, enter the following commands at the # prompt:

```
config

conf 0x010F
```

To exit configuration editor, press the CtrL-Z key combination.

If you break to the system bootstrap monitor, use the o/r command, followed by the i command to reboot the router with the default configuration register and ignore NVRAM. This is commonly used as a foolproof method to load an image and set your configuration registers.You do not need to use the write memory command to save the changed configuration register values.

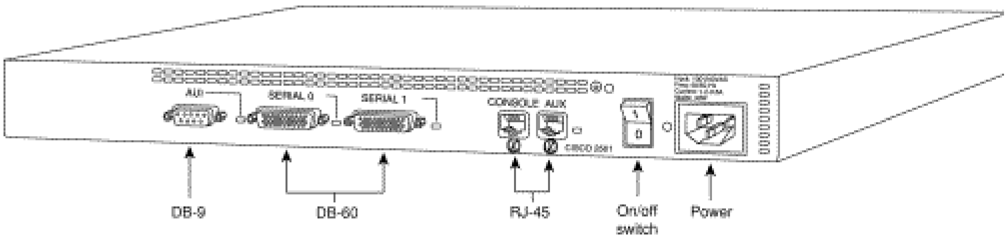
CCNA Semester 2 Lab 1: Router-Logon

Ziele

Einrichten eines Routers und Anmelden über
1. Router-Logon über Konsolenport mit Hyperterminal
2. Router-Logon über LAN-Port mit Telnet
3. Router-Logon über LAN-Port und Web-Server

Hinweis: Ein Logon über einen Router-LAN-Port setzt einen bereits konfigurierten Router voraus. Beim nicht konfigurierten Router ist nur der Logon über den Konsolenport möglich.

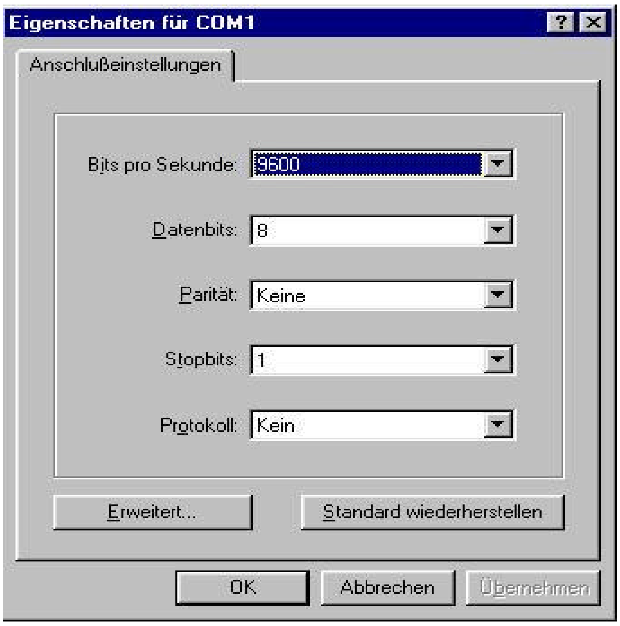
Rückansicht des
Cisco 2501



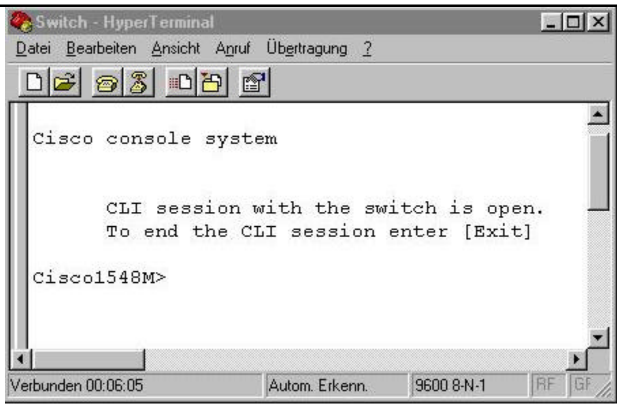
1. Router-Logon über Konsolenport mit Hyperterminal

Werkzeug
- Hyperterminal
- Konsolenkabel (blau)
- Adapter Ethernet RJ45 <-> Com-Port

Schritte
- Verbinden des Konsolenport des Routers mit dem COM-Port des Hosts über ein blaues Rollover-Kabel. Am COM-Port ist ein Adapter Ethernet RJ45 an Seriell mit der Beschriftung "Terminal" erforderlich.
- Starten Sie Hyperterminal über *Start/Programme/Zubehör/Hyperterminal/ Hypertrm.exe*.
- Konfigurieren Sie Hyperterminal wie in den Bildern dargestellt.



- Wenn Sie alles richtig gemacht haben, sehen Sie die rechts dargestellte Meldung im Hyperterminalfenster nachdem Sie **ENTER** gedrückt haben.
- Der Prompt ">" zeigt an, dass sich der Router/Switch im "user mode (Benutzermodus)" befindet. Die auf dieser Benutzerebene verfügbaren Befehle sind ein Teil der Befehle, die auf der privilegierten Ebene zur Verfügung stehen. Mit den meisten dieser Befehle können Sie Informationen anzeigen, ohne die Einstellungen der Router/Switch-Konfiguration ändern zu können. Um auf den gesamten Befehlssatz zugreifen zu können, müssen Sie zunächst den "priviledged mode (Privilegierten Modus)" aktivieren. Geben Sie an der Eingabeaufforderung ">" den Befehl "enable" ein. Bei der Eingabeaufforderung "password" geben Sie das "enable secret"-Kennwort (Default-Kennwort: cisco) ein. Wenn Sie diese Schritte ausgeführt haben, ändert sich die Eingabeaufforderung zu einem Nummernzeichen (#). Auf der privilegierten Ebene können Sie auch den globalen Konfigurationsmodus sowie die anderen spezifischen Konfigurationsmodi aufrufen.
- Um Hyperterminal nicht jedesmal neu konfigurieren zu müssen, empfiehlt es sich, beim Beenden von Hyperterminal die Sitzung zu speichern.



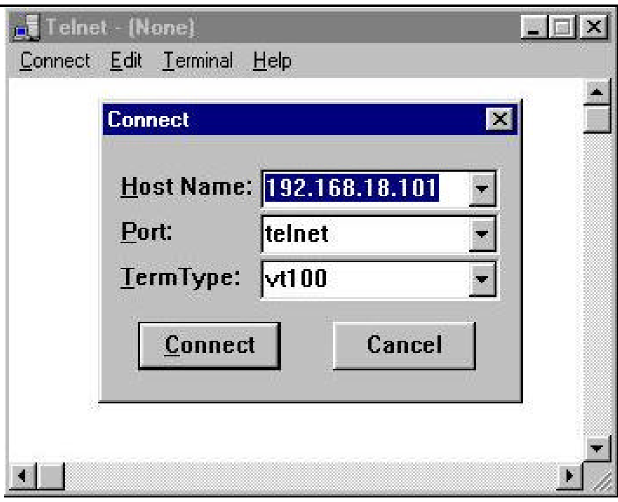
2. Router-Logon über LAN-Port und TELNET

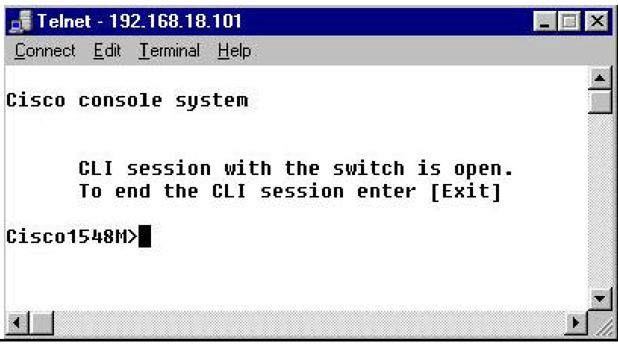
Werkzeug

- Telnet
- PC an Ethernet-LAN

Schritte

- Starten Sie Telnet über ***Start / Ausführen/telnet***.
- Verbinden Sie Telnet mit einem beliebigen Router/Switch-Port, indem Sie dessen IP-Adresse in dezimalgepunkteter Notation eingeben (s. Bild rechts).
- Clicken Sie auf ***Verbinden (Connect)***. Ggf. wird das Telnet-Passwort verlangt (Default: cisco). Danach sollte sich der Router/Switch im Telnetfenster melden (s. Bild unten). Mit dem Befehl ***enable*** können Sie wieder in den priviligierten Mode wechseln.
- Mit dem Befehl ***exit*** kann die Telnetsitzung beendet werden.





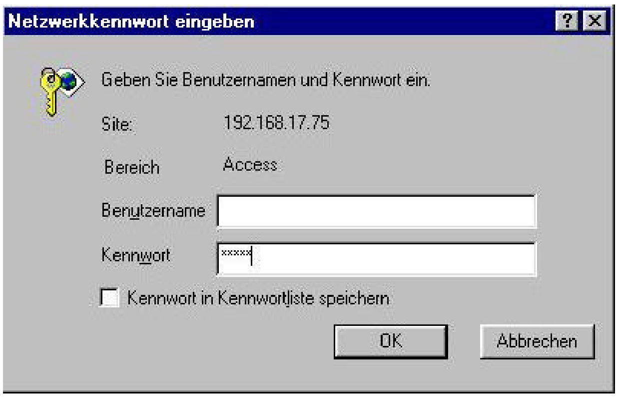
3. Router-Logon über LAN-Port und Web-Browser

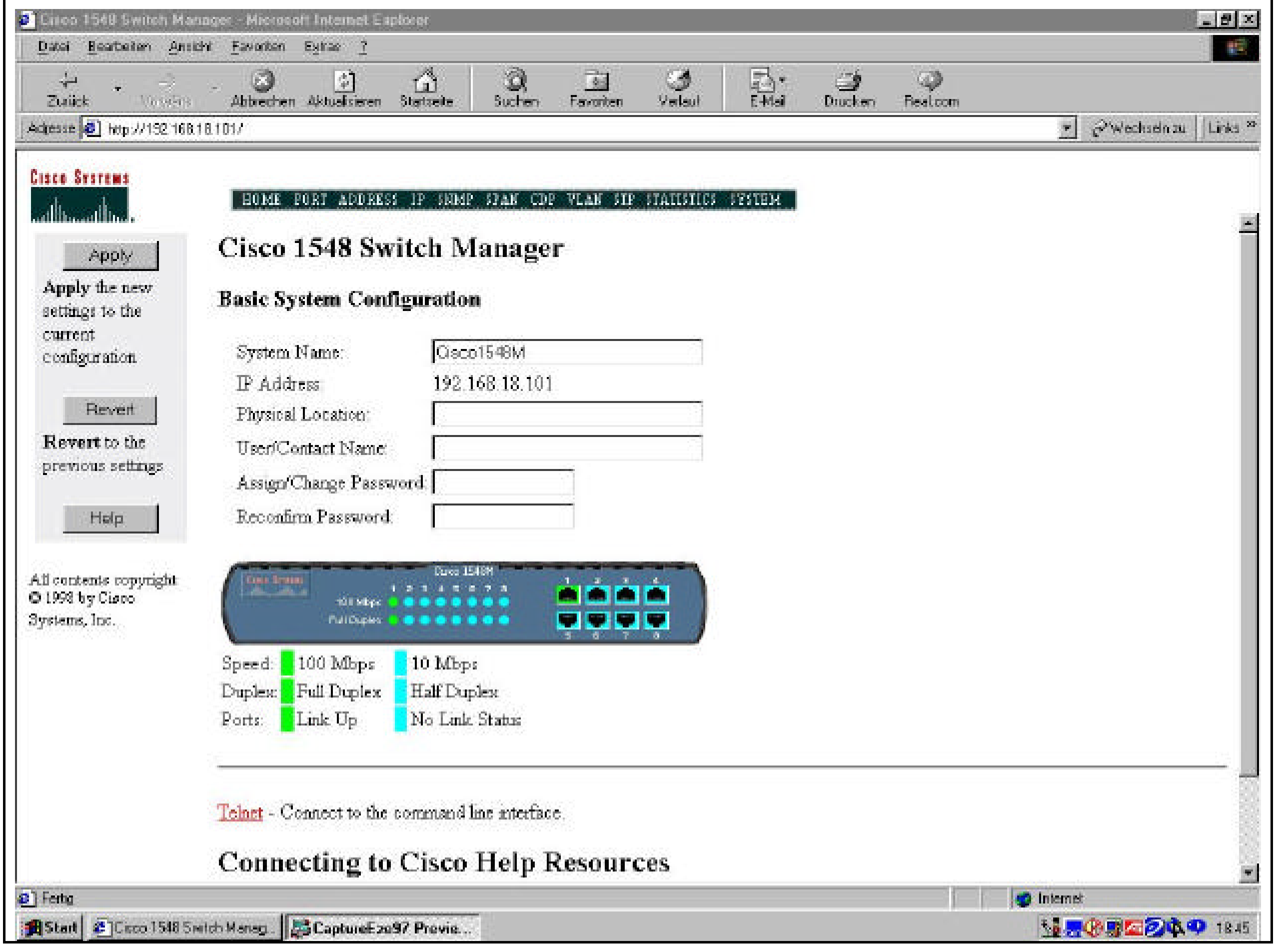
Werkzeug

- Webbrowser
- PC an Ethernet-LAN

Schritte

- Starten Sie den Web-Browser.
- Verbinden Sie sich mit der URL http://xxx.xxx.xxx.xxx wobei Sie die IP-Adresse eines beliebigen Routerports oder die IP-Adresse des Switches angeben können. Wenn auf der Netzwerkkomponente ein http-Server aktiv ist, fragt er nach dem Netzkennwort (s. Bild rechts) Der Benutzername kann frei bleiben, das Default-Kennwort ist **cisco**. Dann erscheint die Homepage der Netzwerkkomponente die eine komfortable Konfiguration erlaubt (s. Bils unten für Cisco 1548M Microswitch)





CCNA Semester 2: Lab 2: Introduction To Using The Router

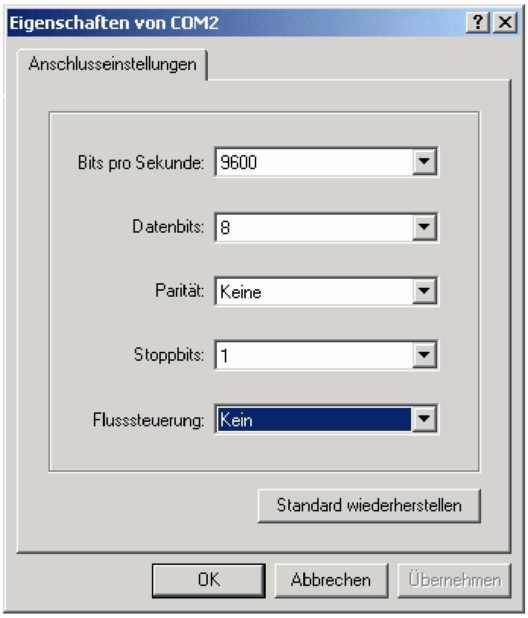
Step 1 – Router Characteristics And Connecting The Cables

- Connect the rollover cable from the serial port on the PC to the console port on the router.
- **Record all router interfaces, connectors and cables:** If the port has a cable attached, identify the cable type, connector and the device attached at the other end. If a port does not have a cable, identify the cable and connector type that would be used. Fill in the following table:

Router Interface / Port	Cable Type	Connector	Device And Port To Which The Cable Is Connected

Step 2 - HyperTerminal

In addition to a serial connection to the router, each workstation will need terminal emulation software in order to communicate with the router. Windows 95/98/2000 comes with a terminal emulation program called HyperTerminal. To start HyperTerminal you can either double click on the shortcut on the desktop or go to the Start Menu, select Programs, select Accessories, select Communications, and select HyperTerminal. A window should open; double-click on the Hyperterm icon.



In HyperTerminal, you must first name your "New Connection." You can use any name you want (just don't save your session when you are done). Second, you will be prompted to select the connection method. In the Cisco lab, the Windows workstations are connected serially to the routers using the COM2 port. Select COM2. Finally, you will be prompted to configure the port settings. The default settings for a console port on a Cisco device are **9600-8-N-1-N.** Your port settings should match the following:

Click OK after the port settings are correctly configured. To begin a console session with a Cisco router, press ENTER.

Now turn on the router!

Step 3 - Bypassing Setup Mode

At this point, your host should have a console session with the Router. Since these routers may, or may not have a pre-existing configuration, what you see after pressing the Enter key may vary.

Possibility #1:

After several lines of information on the screen you should eventually see:

```
Would you like to enter the initial configuration dialog [yes/no]? n
```

If you see such a message, the router is ready to enter Setup Mode. You will enter Setup Mode in a later lab. For now, if you are being prompted to answer a question, answer **“**n” and press return. If you accidentally press “y” and enter Setup Mode, press and hold down the control key and press **C (CTRL-C)**. Wait a few seconds, and then press **Enter**.

On some routers you may see the following message.

```
Would you like to terminate autoinstall? [yes/no]: y
```

Type **“y”** or **yes** to terminate autoinstall. You should eventually see the router prompt: `Router>`

Go to Step 4

Possibility #2

You may see a router prompt, similar to this example:

```
Router>
```

If you see another prompt than “`Router>`” someone has saved a configuration on the router startup-config. Because it is always best to begin our labs without a previous router configuration, you will need to erase the startup-config and reboot the router:

`Router>` **`enable`**

If you are prompted for a password type: class or if that does not work, type cisco

`Router#` **`erase startup-config`**

Now you are in privilege mode indicated by '**#**' in the prompt

Turn off the router and then turn it back on.

Go to Possibility #1,

Step 4 - Basic Commands

You should now be at the User Mode (indicated by ">") with the prompt:

```
Router>
```

User mode will allow you to view the state of the router, but will not allow you to modify it's configuration.

Using help

Use the “?” to view the list of available commands or command options

`Router>` **`?`**

a) Press the Space Bar to scroll a “screen’s worth” of more commands.
b) Press the Enter or Return key to scroll down just one line of the list.
c) Press any other key to halt the list output.

`Router>` **`show ?`**

Displays the next parameter or parameters that can be used with this command.

`Router>` **`show interface ?`**

Displays the next parameter or parameters that can be used with this command.

Try some others!

Privilege Mode

Now lets enter Privilege Mode (or enable mode) which does allow you to modify the router's configuration.

`Router>` **`enable`**

Note: On a production router (and in our labs) there would be a privilege password set where you would have to give the correct password before being able to enter privilege mode. Notice how the prompt changes!

`Router#` **`disable`**	This will take you back to User Mode.
`Router>` **`enable`**	This will take us back to Privilege Mode
`Router>` **`exit`**	Exits the user out of User Mode (more later)
`Router#` **`?`**	Notice how many more commands are available to you in Privilege Mode.

Any commands entered from User Mode can also be entered from Privilege Mode. However, not all Privilege Mode commands can be entered in User Mode.

Using Help and Setting the Clock

`Router#` **`clock set ?`**

Use the clock set command along with the "?" help, to give you the commands the router IOS is expecting. Notice that it leaves the part of the command you already have included. Continue with this command until you have successfully changed the time and date.

`Router#` **`show clock`**

Verify the time and date.

Abbreviated commands

The Cisco IOS will allow you to abbreviate any command or parameter as long as it uniquely identifies the command or parameter.

`Router#` **`sh inter`** *Instead of "show interface".*

Viewing the configuration

To view the current configuration of the router (which resides in RAM) known as the running-config:

`Router#` **`show running-config`**

You will notice that this contains the actual commands that are either default commands or were used to configure the router. When you make changes to the router, those changes are stored in the running-config file.

`Router#` **`show startup-config`**

This will show the saved configuration in NVRAM. If the running-configuration has not been saved, the startup-config file will be empty.

`Router#` **`copy running-config startup-config`**

This will copy the current running-config file (in RAM) to the startup-config file in NVRAM. Now if the router is rebooted (or loses power and powered back up) the changes you made to the router have been saved. The startup-config is copied to the running-config during the reboot process.

`Router# copy run start`

This is an example of abbreviating a command. BE CAREFUL! Do NOT abbreviate the file names incorrectly, i.e. **copy running start-up** as that will have a different affect on the router, in this case overwrite the IOS in flash (later).

`Router#` **`show startup-config`**
`Router#` **`show running-config`**

Notice that the running-config and the startup-config are identical.

Erasing the saved startup-config

During labs it is always a good idea to save your running-config to the startup-config just in case something happens like a power outage. When you are done with every lab, before leaving the routers, you must erase the startup-config file so that the next student is working with an unconfigured router.

`Router#` **`erase startup-config`**

Normally, at this point you would turn-off the router, but for this lab, let us continue.

Rebooting the router

```
Router# reload
```

If you wanted to reset the router, turn it off and back on, you can do that with either the power switch or this reload command. Try it!

Setup Mode

Just like in Step 3, after several lines of information on the screen you should eventually see:

```
Would you like to enter the initial configuration dialog [yes/no]? n
```

Type “n” and press enter.

The reason the router went into Setup Mode is because there was no startup-config as it was erased. If there was a startup-config it would have been copied into the running-config and you would not have seen the above question. Instead you would have been take to the router prompt:

```
Router>
```

At any time, you can enter Setup Mode, but most administrators do not configure the router this way as it is limiting in what it can do. We will have a lab on using the Setup Mode, but after that, never use it again. You can enter Setup Mode by giving the following command:

```
Router# setup
```

Notice that you must be in privilege mode. Now press **control-C** to exit setup mode.

Step 5 - Viewing the output

Lets take a look at some of the show commands and discuss the output with your neighbor (or yourself).

```
Router# show interface
```

Questions:

What does this command show you? Lots if information is shown, some of which we will discuss this semester. Is there any information you recognize?

____

____

____

How many interfaces does your router have and what are there names? ______________________

How would you show a specific interface? ____

```
Router# show ip interface brief
```

What kind of information does this command give you?

____

What is the state of the interfaces? ____

Do they have IP addresses configured yet? ____

No is correct, but why not? ____

Match the interfaces displayed in the previous commands with the physical interfaces on the router.

```
Router# show running-config
```

Does this command show you the name and types of interfaces also? ________________________

Step 6 - Commands Summary

The best way to learn, understand and remember the commands we will be using is by repetition. Here are some of the commands you learned in this lab:

```
Router> enable
Router# disable
Router> exit
Router#> ?
Router# show interface
Router# clock set
Router# show running-config
Router# show startup-config Router# erase startup-config
Router# copy running-config startup-config
Router# reload
Router# show ip interface brief
```

Short-term memory

Question: What do each of the following features do? (Short-term CCNA v2 exam knowledge.)

- CTRL-B ____
- CTRL-F ____
- CTRL-A ____
- CTRL-E ____
- ESC and then B ____
- ESC and then F ____

You can turn off these features by using the command: (this prompt will be explained later)

```
Router(config)# terminal no editing
```

You can turn them back on by typing: (this prompt will be explained later)

```
Router(config)# terminal editing
```

Step 7 - Finishing Up

When you are done in the lab, be sure to erase the startup-config (see below), power-off all routers and power-off the surge-protectors on the rack. Return all cables that you used and please tidy up your work area.

```
Router# erase startup-config
```

When the router prompt returns, power-off the router.

CCNA Semester 2 Lab 3: Basic Router Configuration – Part I

Objectives:

- o Connecting to console port and bringing up the router
- o Entering and leaving different configuration modes
- o using setup-mode

Note: See Lab2 if you need a refresher.

Step 1 – Connecting to the Console Port

- o Using a rollover cable, connect your PC to the router as learned in Lab 1
- o Start Hyperterminal and configure it (just as learned in Lab 1)
- o Now turn on the router

Step 2 – Using the Setup Mode

At this point, your host should have a console session with the Router. Since these routers may, or may not have a pre-existing configuration, what you see after pressing the Enter key may vary.

After several lines of information on the screen you should eventually see:

```
Would you like to enter the initial configuration dialog? [yes/no]: y
```

Using the System Configuration Dialogue can get you into more trouble than it is worth. Answering a question incorrectly may enable or disable something you didn't intend to do. But here is a sample of the questions and how you may answer them for now. Later, we will see how to configure most of these things using the command line interface (CLI). If in doubt, answer "no," and you can always do a control-C to abort this process.

Your output may look something like this: (Don't worry if it doesn't, just do the best you can.)

```
Would you like to enter the initial configuration dialog? [yes/no]: y
At any point you may enter a question mark '?' for help.
Use ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[]'.

Basic management setup configures only enough connectivity
for management of the system, extended setup will ask you
to configure each interface on the system

Would you like to enter basic management setup? [yes/no]: n

First, would you like to see the current interface summary? [yes]: y

Any interface listed with OK? value "NO" does not have a valid configuration
Interface   IP-Address   OK?   Method   Status   Protocol
Ethernet0   unassigned   NO    unset    up       up
Serial0     unassigned   NO    unset    down     down
Serial1     unassigned   NO    unset    down     down

Configuring global parameters:

Enter host name [Router]: myrouter

The enable secret is a password used to protect access to
privileged EXEC and configuration modes. This password, after
entered, becomes encrypted in the configuration.
```

```
Enter enable secret: class

The enable password is used when you do not specify an
enable secret password, with some older software versions, and
some boot images.
Enter enable password: cisco

The virtual terminal password is used to protect
access to the router over a network interface.
Enter virtual terminal password: cisco
Configure SNMP Network Management? [yes]: n
Configure DECnet? [no]: n
Configure AppleTalk? [no]: n
Configure IPX? [no]: n
Configure IP? [yes]: n
Configure bridging? [no]: n

Configuring interface parameters:
Do you want to configure Ethernet0 interface? [yes]: n
Enable all hub ports on this interface? [yes]: n
Enable some hub ports on this interface? [yes]: n

Do you want to configure Serial0 interface? [yes]: n

Do you want to configure Serial1 interface? [yes]: n

The following configuration command script was created:

hostname myrouter
enable secret 5 $1$qaXD$XZk5IPSJV2rC264Tpw3mJ/
enable password cisco
line vty 0 4
password cisco
no snmp-server
!
```

<text omitted>

```
interface Serial0
shutdown
no ip address
!
interface Serial1
shutdown
no ip address
dialer-list 1 protocol ip permit
dialer-list 1 protocol ipx permit
!
end

[0] Go to the IOS command prompt without saving this config.
[1] Return back to the setup without saving this config.
[2] Save this configuration to nvram and exit.

Enter your selection [2]: 2
Building configuration...
Use the enabled mode 'configure' command to modify this configuration.

Press RETURN to get started!
myrouter>
```

You should eventually see the router prompt:

```
myrouter> (or Router> if you did not change the prompt)
```

If you want to re-enter the System Configuration Dialogue you can use the following command:

```
myrouter> enable
Password: class     (if that is what you used above – we will discuss passwords later)
myrouter# setup
```

Again, except for this lab, we will never use the System Configuration Dialogue!

Step 3 – Back to Normal

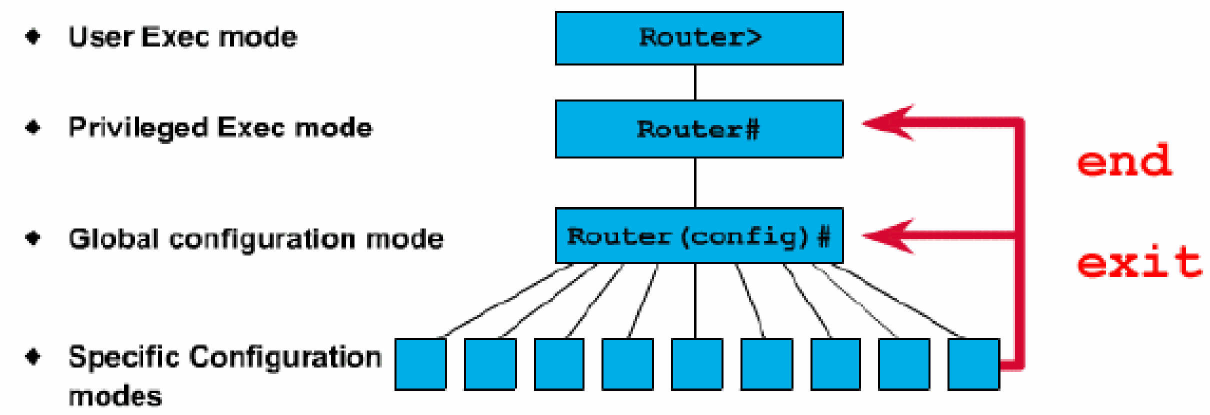
Let's get rid of anything we configured from System Configuration Dialogue and start from the beginning:

```
myrouter> enable
Password: class
      if prompted and that is what you used above – we will discuss passwords later
myrouter# erase startup-config
myrouter# reload
      if prompted to save configuration, answer "n"
```

Do not enter System Configuration Dialogue:

```
Would you like to enter the initial configuration dialog? [yes/no]: n
Router>
```

Step 4 – Configuration Modes



Configuration Mode	Prompt
Interface	Router(config-if)#
Subinterface	Router(config-subif)#
Controller	Router(config-controller)#
Map-list	Router(config-map-list)#
Map-class	Router(config-map-class)#
Line	Router(config-line)#
Router	Router(config-router)#
IPX-router	Router(config-ipx-router)#
Route-map	Router(config-route-map)#

Global Configuration

```
Router>ena
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#?
Configure commands:
      aaa            Authentication, Authorization and Accounting.
      access-list    Add an access list entry
      alias          Create command alias
      appletalk      Appletalk global configuration commands
      arap           Appletalk Remote Access Protocol
      arp            Set a static ARP entry
<text omitted>

Router(config)#exit
00:03:20: %SYS-5-CONFIG_I: Configured from console by console
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#exit
00:03:34: %SYS-5-CONFIG_I: Configured from console by console
Router#
```

Interface Configuration

```
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface ethernet 0
Router(config-if)#?
Interface configuration commands:
      access-expression   Build a bridge boolean access expression
      appletalk           Appletalk interface subcommands
      arp                 Set arp type (arpa, probe, snap) or timeout
      backup              Modify backup parameters
<text omitted>

Router(config-if)#exit       {exits global configuration mode}
Router(config)#exit          {See the changed prompt! Exits to priviledged mode}
Router#
 00:06:11: %SYS-5-CONFIG_I: Configured from console by console
Router#
```

Using the “end” command

```
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int serial 0
Router(config-if)#end        {exits immediately to priviledge mode}
Router# 00:08:58: %SYS-5-CONFIG_I: Configured from console by console
Router#                      {global configuration mode was skipped!}
```

Routing Protocol Mode

```
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router ?
      bgp                     Border Gateway Protocol (BGP)
      egp                     Exterior Gateway Protocol (EGP)
      eigrp                   Enhanced Interior Gateway Routing Protocol (EIGRP)
      igrp                    Interior Gateway Routing Protocol (IGRP)
      isis                    ISO IS-IS
      iso-igrp                IGRP for OSI networks
      mobile                  Mobile routes
      odr                     On Demand stub Routes
      ospf                    Open Shortest Path First (OSPF)
      rip                     Routing Information Protocol (RIP)
      static                  Static routes
      traffic-engineering     Traffic engineered routes

Router(config)#router rip
Router(config-router)#end      {See the changed prompt!}
Router# 00:10:35: %SYS-5-CONFIG_I: Configured from console by console
Router#
```

Step 6 – Commands we used

```
Router# setup
Router# erase startup-config

Router# reload

Router#configure terminal
Router(config)#

Router(config)#exit
Router#

Router(config)#interface ethernet 0
Router(config-if)#

Router(config)#interface serial 0
Router(config-if)#

Router(config-if)#end
Router#

Router(config)#router rip
Router(config-router)#

Router(config-router)#end
Router#

Router(config-if)# exit
Router(config)#exit
Router#
```

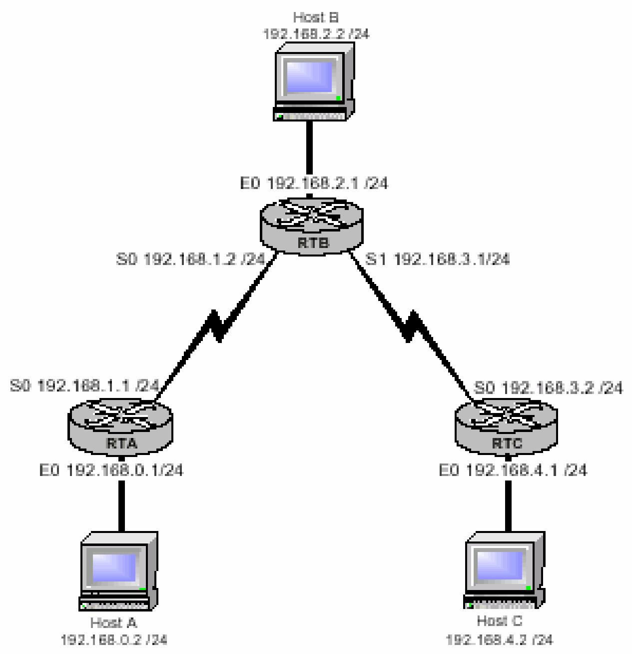
Step 7 - Finishing Up

When you are done in the lab, be sure to erase the startup-config (see below), power-off all routers and power-off the surge-protectors on the rack. Return all cables that you used and please tidy up your work area.

```
Router# erase startup-config
```

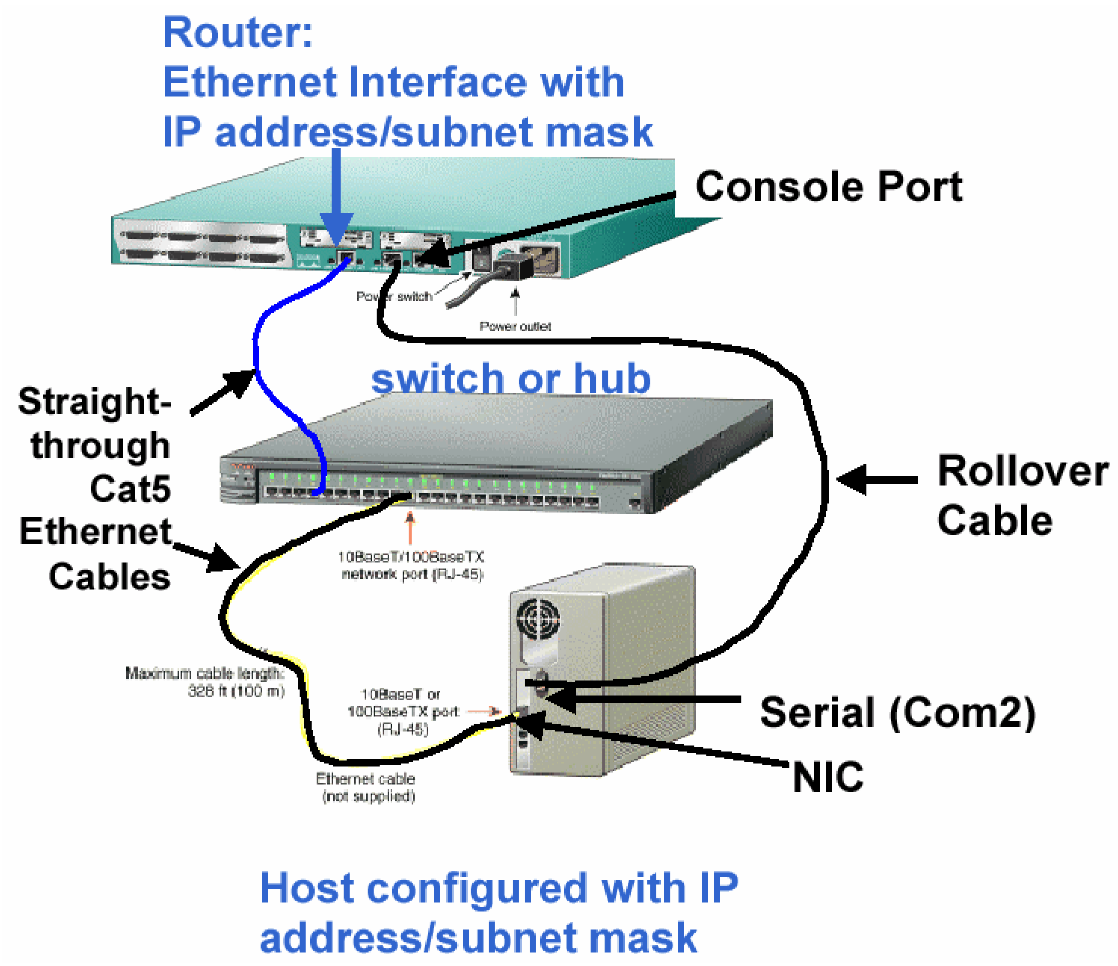
When the router prompt returns, power-off the router.

CCNA Semester 2 Lab 4: Basic Router Configuration – Part II



Connecting the devices

Instructors: Review this with your students.



Objectives

- console in to a Cisco router
- configure hostname and passwords
- configure Interfaces (IP addresses, clock rate and description)
- bringing up and down interfaces
- use basic techniques to test your network's connectivity (ping, telnet)
- using CDP
- ip host command
- Add a banner message-of-the-da
- Debug commands
- Examine show commands

Scenario

Company XYZ would like you to configure a small WAN consisting of three routers. You will start with configuring basic settings including IP addresses. Finally, you will use the ping utility and show commands to test your configuration.

The routers will be able to ping the adjacent neighboring router's interfaces, but because we have not configured any routing, no other connectivity will be working.

Suggestion:

Use your quick reference sheet you are creating and the 8 Steps to Success.

Part I – Configuring Basic Connectivity

Step 1 – Physical Connections

Locate your pod and its corresponding three computers. Cable the network as shown in the diagram above. Be sure to bring the proper cables to the lab. Rollover cables are provided as well as Ethernet cables between the hosts and the switch/hub. Note: If there are not enough switches or hosts, the routers and hosts may share the same switch or hub, as long as there are no duplicate ip addresses.

Step 2 - Booting up the Router

Boot-up the routers. If a router has an existing startup-config, erase the startup-config and reload the router.

Step 3 – Hostname and Passwords

Configure the appropriate hostname for each router:

```
Router(config)#hostname RTB
RTB(config)#
```

Configure the privilege password: (always use class)

```
RTB(config)#enable secret class
```

Configure the console password: (always use cisco)

```
RTB(config)#line console 0
RTB(config-line)#login {enables local authorization with password}
RTB(config-line)#password cisco
```

Configure the vty (telnet) password: (always use cisco)

```
RTB(config)#line vty 0 4
RTB(config-line)#login {enables local authorization with password}
RTB(config-line)#password cisco
```

Step 4 – Adding IP Addresses

Configure the Router IP Addresses
Configure the serial interfaces:

```
RTB(config)#interface serial 0
RTB(config-if)#ip address 192.168.1.2 255.255.255.0
RTB(config-if)#no shutdown
```

Do you need to include this command on this serial interface? Use **show controllers serial 0** or **1** to see if this interface is DCE or DTE.

```
RTB(config-if)#clock rate 64000
```

Configure the Ethernet interfaces:

```
RTB(config)#interface ethernet 0
RTB(config-if)#ip address 192.16.2.2 255.255.255.0
RTB(config-if)#no shutdown
```

Add an appropriate description for each interface:

```
RTB(config)#interface ethernet 0
RTB(config-if)#description Marketing LAN
RTB(config)#interface serial 0
RTB(config-if)#description Serial link to RTA
```

Configure the hosts IP-Addresses
Configure the appropriate IP address, subnet mask and default gateway for each host. You should know how to do this from Semester 1, if not ask your lab partners.

On each PC, configure the following:

- IP address
- Subnet Mask
- Default Gateway: This will be the IP address of the local router's Ethernet interface.

If you are using most versions of Windows 95/98, you will need to reboot the PC.

Step 5&6 – Adding dynamic Routing Protocols
Skip this task. Routing is not necessary for this Lab.

Step 7 – Testing and Monitoring

At this point each device should be able to **ping** its neighbor, those on a common network/subnet. We have not configured any routing yet, so we will not be able to ping beyond the neighboring device(s). The following devices should be able to ping each, both ways. If not, troubleshoot and verify.

- o Host A and Router A'
- o Host B and Router B
- o Host C and Router C
- o Router A and Router B
- o Router B and Router C

Use the following commands to verify connectivity:

```
RTB#show ip interface brief
Interface          IP-Address      OK?       Method    Status      Protocol
Ethernet0          192.16.2.2      YES       manual    up    up
Serial0            192.168.1.2     YES       manual    up    up
Serial1            192.168.3.1     YES       manual    up    up
RTB#
```

This command should display each of your configured interfaces as "**up**" and "**up**".

What might cause your Ethernet interface to be **down**?

____

What might cause your Serial interface to be **down**?

____

What might cause your Serial or Ethernet interface to be **administratively down**?

____

Other commands to test connectivity: (Look at the information carefully, reviewing what we discussed in class!)

•Do you see your interface description? ____

•Do you see the ip address information? ____

•What else do you notice? ____

```
RTB#show interface
RTB#show interface serial 0
RTB#show interface ethernet 0
RTB#show running-config
```

Issue an extended ping command. How did you do that? ______________________________

Do not continue to the next step until:

1. You have all appropriate interfaces "up" and "up" and are able to ping the adjacent routers and hosts.
2. You understand all of the commands you used.
3. This might be a good time to do:

```
RTB#copy running-config startup-config
```

Verifying Passwords

Verify the **console password**:

```
RTB#exit
3d20h: %SYS-5-CONFIG_I: Configured from console by console

RTB con0 is now available

Press RETURN to get started.

User Access Verification

Password: cisco
RTB>
```

Verify the **privilege password**:

```
RTB>enable
Password:class
RTB#
```

From an adjacent router, **verify** the **telnet password**:

```
RTA>telnet 192.168.1.2
Trying 192.168.1.2 ... Open

User Access Verification

Password:cisco
RTB>exit
RTA>
```

Verify the **password information**:

```
RTB#show running-config
```

Questions:

- What is the difference between telnetting into a device and accessing it via the console port?

  ____

  ____

- What must you have configured before telnetting into the router?

  ____

CDP Commands

```
RTB#show cdp
Global CDP information:
Sending CDP packets every 60 seconds
Sending a holdtime value of 180 seconds

RTB#show cdp interface
Ethernet0 is up, line protocol is up
      Encapsulation ARPA
      Sending CDP packets every 60 seconds
      Holdtime is 180 seconds

Serial0 is up, line protocol is up
      Encapsulation HDLC
      Sending CDP packets every 60 seconds
      Holdtime is 180 seconds

Serial1 is up, line protocol is up
      Encapsulation HDLC
      Sending CDP packets every 60 seconds
      Holdtime is 180 seconds

RTB#show cdp neighbor
Capability Codes:  R - Router, T - Trans Bridge, B - Source Route Bridge
                   S - Switch, H - Host, I - IGMP, r – Repeater

Device ID   Local Intrfce     Holdtme     Capability  Platform    Port ID
RTC         Ser 1             175         R           2516        Ser 1
RTA         Ser 0             134         R           2516        Ser 0


RTB#show cdp neighbor detail
-------------------------
Device ID: RTA
Entry address(es):
      IP address: 192.168.1.1
Platform: cisco 2516, Capabilities: Router
Interface: Serial0, Port ID (outgoing port): Serial0
Holdtime : 126 sec

Version : Cisco Internetwork Operating System Software
IOS (tm) 2500 Software (C2500-D-L), Version 12.0(5), RELEASE SOFTWARE (fc1)
Copyright (c) 1986-1999 by cisco Systems, Inc.
Compiled Tue 15-Jun-99 20:08 by phanguye
-------------------------
Device ID: RTB
Entry address(es):
      IP address: 192.168.3.2
<text omitted>

RTB#show cdp entry RTA
-------------------------
Device ID:
RTA Entry address(es):
IP address: 192.168.1.1
<text omitted?
```

Step 8 Adding some Extras

Add an ip host command for the adjacent router(s):

```
RTB(config)#ip host RTA 192.168.1.1
        {This command creates an entry to the local DNS database}
RTB(config)#exit
```

Use the name to ping or telnet to that router:

```
RTB#ping rta

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/38/52 ms
RTB#
```

Add a domain-name server (Doesn't really exist – use a host ip address of you router's LAN interface):

```
RTB(config)#ip name-server 192.168.2.50
```

Verify the ip host information:

```
RTB#show running-config
RTB#show hosts
Default domain is not set
Name/address lookup uses domain service
Name servers are 192.168.2.50
Host      Flags     Age    Type       Address(es)
RTA       (perm, OK)       0          IP   192.168.1.1
RTB#
```

Disable IP Domain Name System hostname translation

```
RTB#dfs
Translating "dfs"...domain server (192.168.2.50)
        {IOS interprets "DFS" as domain name and trys to resolve this name to an IP address by sending an
        unicast (if an domain-name server is configured or broadcast an DNS server request. After the timeout
        (there is no DNS server) IOS shows the message:}
% Unknown command or computer name, or unable to find computer address
RTB#conf t
Enter configuration commands, one per line. End with CNTL/Z.
RTB(config)#no ip domain-lookup
        {this command disables this useless lookup process }
RTB(config)#exit
RTB#dfs Translating "dfs"
% Unknown command or computer name, or unable to find computer address
RTB#
```

Verify the ip domain name-lookup information:

```
RTB#show running-config
```

Add a banner message-of-the-day:

```
RTB(config)#banner motd #
Enter TEXT message. End with the character '#'.
Warning!
Authorized Access Only #
RTB(config)#CTRL-C
```

```
3d20h: %SYS-5-CONFIG_I: Configured from console by console
```

Verify the **banner message-of-the-day**:

```
RTB#exit

RTB con0 is now available

Press RETURN to get started.

Warning!
Authorized Access Only

User Access Verification

Password: cisco
RTB>
```

– Debug Commands

From the Console

Debug command is very useful for displaying what is actually happening on the router. From you console port connection, type:

```
RTB# debug ip packet
```

Now, **from the host**, ping the router's Ethernet interface and examine the debug output on your router's console display (HyperTerminal).

To turn off debugging, issue the following command (this will turn off all debugging):

```
RTB# undebug ip packet
```

Or use:

```
RTB# undebug all
```

Or the even shorter version:

```
RTB# un all
```

From a Telnet Session

By default, debug output goes only to the console (HyperTerminal session). To send debug output to a telnet session, issue the command:

```
RTB# terminal monitor
```

Caution: This will send debug output to all telnet sessions into this router.
Now, re-issue the commands in *From the Console*

To disable debug output to the telnet sessions:

```
RTB# terminal no monitor
```

Always remember to turn off debug when finished, as it will fill up your router's buffers and can disable your router.

```
RTB# undebug all
```

– Examining the show commands

Review the output from the following commands:

```
Router# show running config
Router# show startup-config
Router# show interfaces
Router# show interface s 0
Router# show interface e 0
Router# show controller s 0
Router# show controller e 0
Router# show hosts
```

More show commands:

```
Router# show memory
Router# show stacks
Router# show buffers
Router# show arp and Router# clear arp
Router# show processes
Router# show processes cpu
Router# show tech-support
```

Questions: With the information that the router returns, answer the **questions** below:

What information is stored in the arp table? If there are no entries **ping** some interfaces (ethernet **and** serial) of your network.

Do you find entries for serial interfaces in the arp table?

Wait 2 minutes. What information is now stored in the arp table? Explain

---

Open Window "Eingabeaufforderung" on your Console-PC and type: C:\>arp

Output:

```
Ändert und zeigt die Übersetzungstabellen für IP-Adressen/physikalische
Adressen an, die von ARP (Address Resolution Protocol) verwendet werden.

ARP -s IP_Adr Eth_Adr [Schnittst]
ARP -d IP_Adr [Schnittst]
ARP -a [IP_Adr] [-N Schnittst]

     -a             Zeigt aktuelle ARP-Einträge durch Abfrage der Protokoll-
                    daten an. Falls IP_Adr angegeben wurde, werden die IP- und
                    physikalische Adresse für den angegebenen Computer ange-
                    zeigt. Wenn mehr als eine Netzwerkschnittstelle ARP
                    verwendet, werden die Einträge für jede ARP-Tabelle
                    angezeigt.
     -g             Gleiche Funktion wie -a.
     IP_Adr         Gibt eine Internet-Adresse an.
     -N Schnittst   Zeigt die ARP-Einträge für die angegebene Netzwerk-
                    schnittstelle an.
     -d             Löscht den durch IP_Adr angegebenen Hosteintrag. Die IP-Adr
                    kann mit dem '*'-Platzhalter versehen werden, um alle Hosts
                    zu löschen.
     -s             Fügt einen Hosteintrag hinzu und ordnet die Internetadresse
                    der physikalischen Adresse zu. Die physikalische Adresse wird
                    durch 6 hexadezimale, durch Bindestrich getrennte Bytes
                    angegeben. Der Eintrag ist permanent.
     Eth_Adr        Gibt eine physikalische Adresse (Ethernetadresse) an.
     Schnittst      Gibt, falls vorhanden, die Internetadresse der Schnittstelle
                    an, deren Übersetzungstabelle geändert werden soll.
                    Sonst wird die erste geeignete Schnittstelle verwendet.
```

```
Beispiel:
  > arp -s 157.55.85.212  00-aa-00-62-c6-09 ... Fügt statischen Eintrag hinzu.
  > arp -a                                  ... Zeigt die ARP-Tabelle an.

D:\>
```

What information is stored in the arp table of your PC? If there are no entries **ping** some interfaces (ethernet **and** serial) of your network.

```
D:\>arp -a

Schnittstelle: 172.17.4.11 on Interface 0x2
  Internetadresse       Physikal. Adresse     Typ
  157.55.85.212         00-aa-00-62-c6-09     statisch

Schnittstelle: 192.168.120.254 on Interface 0x1000004
  Internetadresse       Physikal. Adresse     Typ
  192.168.120.1         00-00-c0-a8-78-01     dynamisch
  192.168.120.252       00-00-c0-a8-78-fc     dynamisch
  192.168.120.253       00-00-c0-a8-78-fd     dynamisch
```

Wait 2 minutes. What information is now stored in the arp table? Explain!

– Finishing up

Erase all startup-configs:

```
RTB#erase startup-config
Erasing the nvram filesystem will remove all files! Continue? [confirm]
[OK]
Erase of nvram: complete
RTB#
```

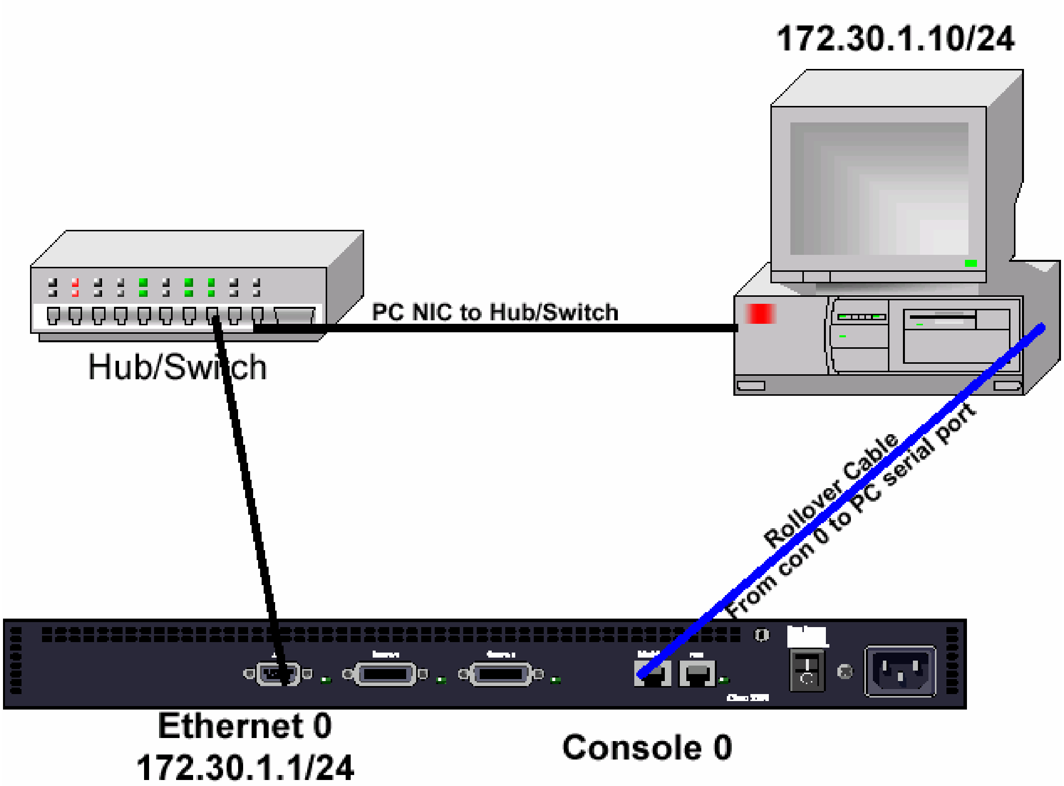
Power-off all routers.

Shutdown and power-off all hosts.

Don't forget your cables!

Clean up your area.

CCNA Semester 2 Lab 5: IOS and the TFTP Server



Objective

In this lab, you will do password recovery, copy the running-config to a TFTP Server, copy the running-config from a TFTP Server, and copy the IOS “image” to a TFTP Server.

Scenario

As a network administrator you need to be able to do password recovery on your equipment. You also need to backup your configuration files and operating system, and be able to recover them when necessary. In this lab you will only be using one router.

Setup

- Use the 8 Steps to Success to help you configure the router.
- Be sure your cabling is correct, as this causes more troubleshooting issues than anything else.
- If the routers have a startup-config already on them, erase it and reboot the routers.
- Be sure to add the correct the IP addresses, Subnet Masks and Default Gateways to the host computer.
- Configure the routers to include hostnames and the proper interface commands including IP addresses, subnet masks, etc. Each router should be able to ping the interface of the host on it’s LAN (Ethernet) interface. Test and troubleshoot as necessary.

Lab 5.1 – Password Recovery (short version)

Step 1 – Wrong Password

At the router type the `show version` command. Record the configuration register setting, which is usually 0x2102. In a real world scenario, if for some reason you cannot log into the router, i.e. someone changed the password, then of course you will not be able to perform this step:

```
Router#show version
Cisco Internetwork Operating System Software
IOS (tm) 2500 Software (C2500-D-L), Version 12.0(5), RELEASE SOFTWARE (fc1)
Copyright (c) 1986-1999 by cisco Systems, Inc.
Compiled Tue 15-Jun-99 20:08 by phanguye
Image text-base: 0x030380DC, data-base: 0x00001000

ROM: System Bootstrap, Version 11.0(10c), SOFTWARE
BOOTFLASH: 3000 Bootstrap Software (IGS-BOOT-R), Version 11.0(10c), RELEASE SOFT
WARE (fc1)

Router uptime is 10 minutes
System restarted by power-on
System image file is "flash:/c2500-d-l_120-5.bin"

cisco 2500 (68030) processor (revision N) with 6144K/2048K bytes of memory.
Processor board ID 06109820, with hardware revision 00000001
Bridging software.
X.25 software, Version 3.0.0.
Basic Rate ISDN software, Version 1.1.
1 Ethernet/IEEE 802.3 interface(s)
2 Serial network interface(s)
32K bytes of non-volatile configuration memory.
8192K bytes of processor board System flash (Read ONLY)

Configuration register is 0x2102
```

Configure the router as per the diagram and configure the privileged password (enable secret) as “class.”

Save the running-config to startup config.

Step 2 – Reboot and Control-Break

Ask your instructor to configure unknown passwords. Now you cant't get into the router! Start the Password Recovery Procedure and reboot the router.

Within 60 seconds press the Break key (control-break on a PC). You may need to press this more than once. You will then see the following prompt:

```
System Bootstrap, Version 5.2(8a), RELEASE SOFTWARE Copyright (c) 1986-
1995 by cisco Systems 2500 processor with 8192 Kbytes of main memory
Abort at 0x10EA82C (PC)
>
```

Step 3 – Breaking in

For the **2500 Series** routers, after the “>” prompt type **o/r 0x42** and press return. (Note, that this is the letter “o,” not the numeral zero.) Then type “i” and press return.

```
Abort at 0x10EA82C (PC)
> o/r 0x42
> i
```

- **o/r 0x42** – This will change the configuration register on the router to ignore the startup-config file during boot-up.
- **i** – This will reboot (reload) the router.

The router will reboot and ask you if you want to go into setup mode. Type **no**.

Step 4 – Recovering the password

At this point the router will boot-up as normal, but ignore the startup-config file.

Questions:

What does the startup-config look like? Why is the startup-config still there?

```
Router> enable
Router# config t
```

Now you are in priviledged mode without any password! Why aren't asked for the password?

If you skip this command, you may need to reconfigure the router. If you want to recover your previous startup-config file issue the following command:

```
Router# copy startup-config running-config
```

Set your enable secret password. class is what we always use!.

```
Router (config)# enable secret class
```

Change the configuration-register back to its proper value.

```
Router (config)# config-register 0x2102
        {Use 0x2102 or whatever the setting was in Step 1 to change the config-register back}
Router (config)# exit
```

Question: What happens the next time you reboot the router if you do not do this?

Copy the running-config with the current privileged password to the startup-config.

```
Router# copy running-config startup-config
```

Step 5 – Verify

IMPORTANT: Do a **show version** command and make sure the configuration register is 0x2102!

Lab 5.2: Uploading/Downloading configuration files with TFTP-Server

Step 1 – TFTP Server Setup

Caution: Do not get confused during this lab. Your PC will be acting as both a TFTP Server on the same LAN segment as the router's Ethernet interface and as a "dumb terminal" using HyperTerminal connected to the console port.

Starting the TFTP Server: On the host, double click on the TFTP icon on the desktop or find it through the Start menu. By default, all files to and from the TFTP server are stored in the following directory (folder):

C:\PROGRAMME\CISCO\CISCO TFTP SERVER

Verfiy connectivity between router and TFTP server: On the host running the tftp server make sure it can ping the router's Ethernet interface.

Step 2 – Copy the running-config to the TFTP Server (Upload)

```
Router#copy running-config tftp
      Address or name of remote host []? 172.30.1.10
      Destination filename [running-config]?
      !!
      568 bytes copied in 5.852 secs (113 bytes/sec)
Router#
```

In the TFTP Window

```
Mon Nov 05 09:06:32 2001: Receiving 'running-config' file from 172.30.1.1 in
binary mode ##
```

Step 3a – Copy the startup-config to the TFTP Server (Upload)

```
Router#copy startup-config tftp
      Address or name of remote host []? 172.30.1.10
      Destination filename [startup-config]? rg-102201-startup-config
      !!
      568 bytes copied in 0.232 secs
Router#
```

In the TFTP Window

```
Mon Nov 05 09:09:30 2001: Receiving 'rg-102201-startup-config' file from
172.30.1.1 in binary mode ## Mon Nov 05 09:09:30 2001: Successful.
Mon Nov 05 09:06:32 2001: Successful.
```

– Verify the copy

Verify that the files did copy to the following TFTP Server directory (folder):

C:\PROGRAMME\CISCO\CISCO TFTP SERVER

Questions:

•What is the difference between copying the running-config to the TFTP server or the startup-config to the TFTP server?

____

•When does it matter which one you choose?

____

Step 3b – Copy the startup-config from the TFTP Server (Download)

First let's modify the current startup-config.

```
Router#conf t Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname ChangedRouter
ChangedRouter(config)#end
ChangedRouter# copy running-config startup-config
Destination filename [startup-config]? Building configuration...
ChangedRouter#show startup-config
Using 575 out of 32762 bytes
!
version 12.0 service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname ChangedRouter
!
<rest omitted>
```

Now, let's copy the old startup-config without the changed hostname. It is a good idea to have some kind of naming convention, such as "your initials – the date – the name of the file."

```
ChangedRouter#copy tftp startup-config
      Address or name of remote host []?  172.30.1.10
      Source filename []? rg-102201-startup-config
      Destination filename [startup-config]?
Accessing tftp://172.30.1.10/rg-102201-startup-config...
Loading rg-102201-startup-config from 172.30.1.10 (via Ethernet0): !
[OK - 568/1024 bytes]
568 bytes copied in 10.772 secs (56 bytes/sec)
ChangedRouter#
```

The startup-config should now be the old version.

```
ChangedRouter#show startup-config
Using 568 out of 32762 bytes
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Router
!
<rest omitted>
ChangedRouter#
```

In the TFTP Window

```
Mon Nov 05 09:11:57 2001: Sending 'rg-102201-startup-config' file to 172.30.1.1 in binary mode
##
Mon Nov 05 09:11:57 2001: Successful.
```

Question:

- When will this version take effect?

____

Lab 5.3a: TFTP Server – Uploading IOS Image files

Step 1 – Verify current IOS in RAM and in FLASH

```
Router#show version
Cisco Internetwork Operating System Software
IOS (tm) 2500 Software (C2500-D-L), Version 12.0(5), RELEASE SOFTWARE (fc1)
Copyright (c) 1986-1999 by cisco Systems, Inc.
Compiled Tue 15-Jun-99 20:08 by phanguye
Image text-base: 0x030380DC, data-base: 0x00001000

ROM: System Bootstrap, Version 11.0(10c), SOFTWARE
BOOTFLASH: 3000 Bootstrap Software (IGS-BOOT-R), Version 11.0(10c), RELEASE SOFT
WARE (fc1)

Router uptime is 23 minutes
System restarted by power-on
System image file is "flash:/c2500-d-l_120-5.bin"

cisco 2500 (68030) processor (revision N) with 6144K/2048K bytes of memory.
Processor board ID 06109820, with hardware revision 00000001 Bridging software.
X.25 software, Version 3.0.0.
Basic Rate ISDN software, Version 1.1.
1 Ethernet/IEEE 802.3 interface(s)
2 Serial network interface(s)
1 ISDN Basic Rate interface(s)
32K bytes of non-volatile configuration memory.
8192K bytes of processor board System flash (Read ONLY)

Configuration register is 0x2102

Router#show flash
System flash directory:
File Length Name/status
1 6830452 /c2500-d-l_120-5.bin
[6830516 bytes used, 1558092 available, 8388608 total]
8192K bytes of processor board System flash (Read ONLY)
```

Questions:

With the information that the router returns, answer the questions below:
What is the IOS version and rev level?

What is the name of the system image (IOS) file?

Where was the router IOS image booted from?

What type of processor (CPU) and how much RAM does this router have?

What kind of router (platform type) is this?

The router backup configuration file is stored in Non-Volatile Random Access Memory (NVRAM). How much NVRAM does this router have?

The router operating system (IOS) is stored in Flash memory. How much flash memory does this router have?

What is the Configuration register set to? What boot type does this setting specify?

Assuming the config-register was currently set to 0x2102, write the configuration mode commands to specify that the IOS image should be loaded from:
Flash:

ROM monitor:

ROM:

---

4. If the router were in ROM monitor mode, what command would manually boot the Cisco IOS software?

To specify a fallback boot sequence, write the configuration command to specify that the IOS image should be loaded from:
Flash:

A TFTP server:

ROM: Will this be a full IOS image?

Step 2 – Copy the IOS from Flash to the TFTP Server (Upload)

```
Router#copy flash tftp
Source filename []? c2500-d-l_120-5.bin
Address or name of remote host []? 172.30.1.10
Destination filename [c2500-d-l_120-5.bin]?
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
<rest omitted>
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
6830452 bytes copied in 157.340 secs (43506 bytes/sec)
Router#
```

```
In the TFTP Window
Mon Nov 05 09:18:52 2001: Receiving 'c2500-d-l_120-5.bin' file from 172.30.1.1
in binary mode
################################################################################
################################################################################
<rest omitted>
####################################################
Mon Nov 05 09:21:29 2001: Successful.
```

Step 3 – Verify the copy

Verify that the files did copy to the following TFTP Server directory (folder):

C:\PROGRAMME\CISCO\CISCO TFTP SERVER

Lab 5.3b: TFTP Server – Downloading IOS Image files

Step 1 – Verify IOS on TFTP Server

***** Perform the next tasks carefully or a lot of problems will overcome you! *******

- Get the IP address of the host running the TFTP server
- Ping the tftp server host to test connectivity
- Look for the IOS file in the TFTP server download directory and remember the file name
- Examine the IOS file length. Make sure that it will fit into flash memory

Step 2 - Copy the IOS image from the TFTP server to the router (Download).

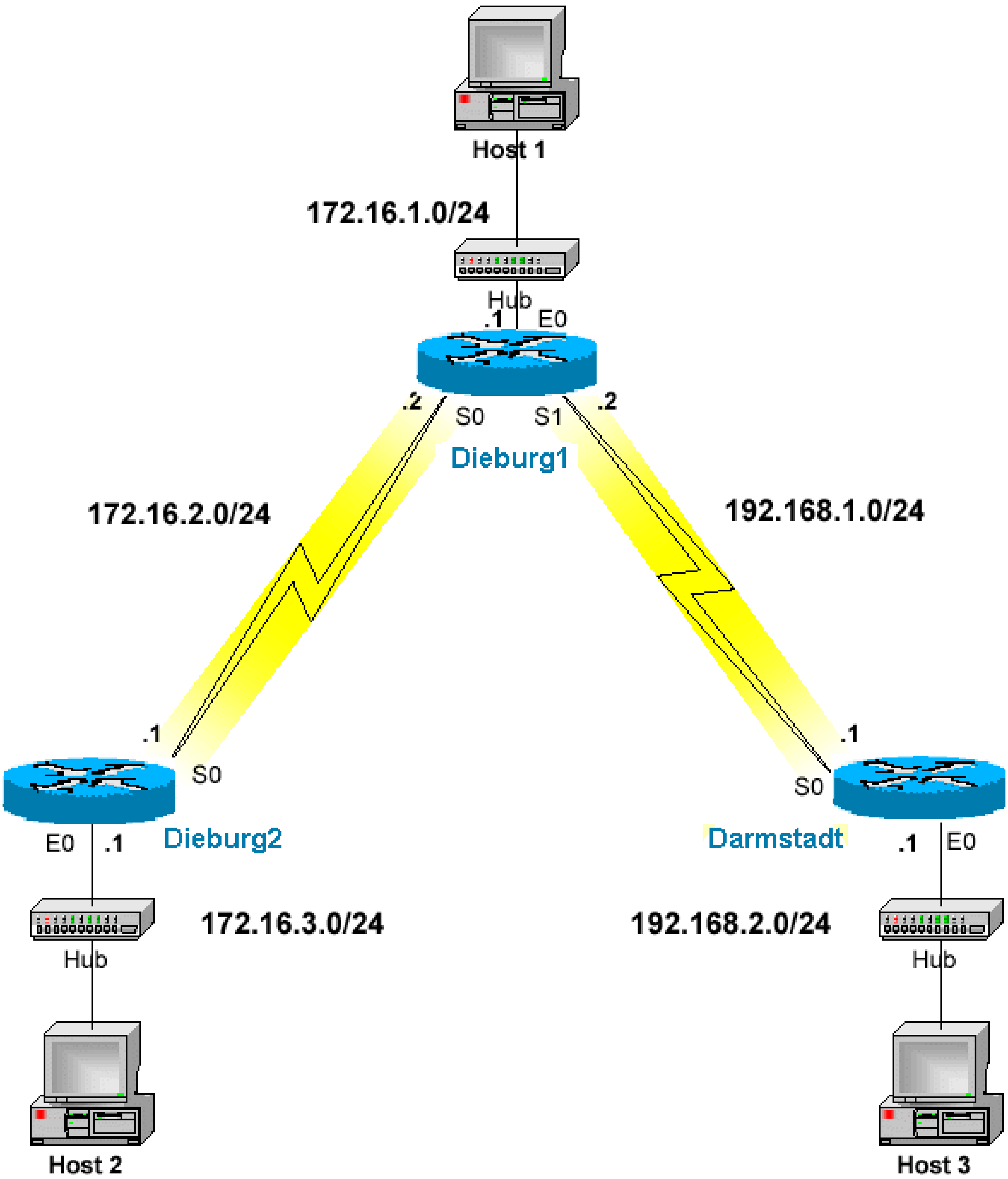
```
Router#copy tftp flash
**** NOTICE ****
Flash load helper v1.0
This process will accept the copy options and then terminate
the current system image to use the ROM based image for the copy.
Routing functionality will not be available during that time.
If you are logged in via telnet, this connection will terminate.
Users with console access can see the results of the copy operation.
---- ******** ----
Proceed? [confirm]
Address or name of remote host []? 172.30.1.10
Source filename []? c2500-d-l_120-5.bin
Destination filename [c2500-d-l_120-5.bin]?
%Warning:There is a file already existing with this name
Do you want to over write? [confirm] yes
Accessing tftp://172.30.1.10/c2500-d-l_120-5.bin...
Erase flash: before copying? [confirm]yes

00:30:33: %SYS-5-RELOAD: Reload requested
%SYS-4-CONFIG_NEWER: Configurations from version 12.0 may not be correctly un-
derstood.
%FLH: c2500-d-l_120-5.bin from 172.30.1.10 to flash ...

System flash directory:
File Length Name/status
  1 6830452 /c2500-d-l_120-5.bin
[6830516 bytes used, 1558092 available, 8388608 total]
Accessing file 'c2500-d-l_120-5.bin' on 172.30.1.10...
Loading c2500-d-l_120-5.bin from 172.30.1.10 (via Ethernet0): ! [OK]

Erasing device... eeeeeeeeeeeeeeeeeeeeeeeeeeeeeeee ...erased
Loading c2500-d-l_120-5.bin from 172.30.1.10 (via Ethernet0): !!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
<rest omitted>
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!! [OK - 6830452/8388608 bytes]

Verifying checksum... OK (0x8530)
Flash copy took 0:03:23 [hh:mm:ss]
%FLH: Re-booting system after download
F3: 6741816+88604+453712 at 0x3000060

Restricted Rights Legend

Use, duplication, or disclosure by the Government is

<rest omitted>
```

```
cisco 2500 (68030) processor (revision N) with 6144K/2048K bytes of memory.
Processor board ID 06109820, with hardware revision 00000001
Bridging software.
X.25 software, Version 3.0.0.
Basic Rate ISDN software, Version 1.1.
1 Ethernet/IEEE 802.3 interface(s)
2 Serial network interface(s)
1 ISDN Basic Rate interface(s)
32K bytes of non-volatile configuration memory.
8192K bytes of processor board System flash (Read ONLY)
Press RETURN to get started!


Router>ena
Router#show flash

System flash directory:
File Length Name/status
1 6830452 /c2500-d-l_120-5.bin
[6830516 bytes used, 1558092 available, 8388608 total]
8192K bytes of processor board System flash (Read ONLY)

Router#
```

In the TFTP Window

```
Mon Nov 05 09:24:46 2001: Sending 'c2500-d-l_120-5.bin' file to 172.30.1.1 in
binary mode
##########
Mon Nov 05 09:24:46 2001: Failed ( State Error ). Mon Nov 05 09:24:46 2001: Sen-
ding 'c2500-d-l_120-5.bin' file to 172.30.1.1 in binary mode
###
Mon Nov 05 09:24:46 2001: Failed ( State Error ).
Mon Nov 05 09:25:18 2001: Sending 'c2500-d-l_120-5.bin' file to 172.30.1.1 in
binary mode
###
Mon Nov 05 09:25:18 2001: Failed ( State Error ).
Mon Nov 05 09:25:40 2001: Sending 'c2500-d-l_120-5.bin' file to 172.30.1.1 in
binary mode
################################################################################
<text omitted>
####################################################
Mon Nov 05 09:28:53 2001: Successful.
```

CNA Semester 2 Lab 6: Static Routing



Objectives

- configure static routes
- configure summary static routes
- configure default static routes
- use basic techniques to test network’s connectivity

Scenario

Three separate classful networks need routing between them and their subnets.

Questions:

- What are the different classful networks?

  ____

- Are there any subnets? If so, what are they?

  ____

Setup

- Use the 8 Steps to Success to help you configure the routers.
- Be sure your cabling is correct, as this causes more troubleshooting issues than anything else.
- If the routers have a startup-config already on them, erase it and reboot the routers.
- Be sure to add the correct the IP addresses, Subnet Masks and Default Gateways to the three host computers.
- Configure the routers to include hostnames and the proper interface commands including IP addresses, subnet masks, etc. Each router should be able to ping the interface of the adjacent (neighboring) router and the host on its LAN (Ethernet) interface. Test and troubleshoot as necessary. Do not configure any routing protocols.

Step 1 – Configuring Static Routes

On each router configure a separate and specific static route for each network or subnet. You do not need to configure static routes for the router's directly connected network(s) because like a host, by configuring the IP address and subnet mask on an interface tells the router that it belongs to that network/subnet.

Dieburg2

```
Dieburg2(config)# ip route 172.16.1.0 255.255.255.0 172.16.2.2
Dieburg2(config)# ip route 192.168.1.0 255.255.255.0 172.16.2.2
Dieburg2(config)# ip route 192.168.2.0 255.255.255.0 172.16.2.2
```

Dieburg1

- Dieburg1(config)# ip route 172.16.3.0 255.255.255.0 172.16.2.1
- Dieburg1(config)# ip route 192.168.2.0 255.255.255.0 192.168.1.1

Darmstadt

```
Darmstadt(config)# ip route 172.16.1.0 255.255.255.0 192.168.1.2
Darmstadt(config)# ip route 172.16.2.0 255.255.255.0 192.168.1.2
Darmstadt(config)# ip route 172.16.3.0 255.255.255.0 192.168.1.2
```

Verify and Validate:

- All hosts and all routers should be able to ping every interface in the network.
- Do a "show running-config" and notice the static routes that you entered.
- Router# **show ip route**

Questions:

- What routes to networks do you see?

____

____

____

____

____

____

- Which routes are static and which routes are directly connected?

  ____

- What is the administrative distance for a static route? ____________________
- What is the administrative distance for a directly connected network? __________
- How does the next-hop-ip-address help with the routing process?

  ____

- Does it give the entire route?

  ____

- What is it actually doing regarding the routing of the packet?

  ____

- How does a packet get from Host 2 to Host 3?

  ____

- Instead of a next-hop-ip-address, what else could you have used?

  ____

- What would you need to do if you added new networks or deleted/modified existing networks?

  ____

- Is there any way to summarize several static routes to multiple subnets into a single static route?

  ____

Outputs

```
Dieburg2#show ip route
Codes:  C - connected, S - static, I - IGRP, 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, E - EGP
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
        U - per-user static route, o – ODR

Gateway of last resort is not set

      172.16.0.0/24 is subnetted, 3 subnets
S           172.16.1.0 [1/0] via 172.16.2.2
C           172.16.2.0 is directly connected, Serial0
C           172.16.3.0 is directly connected, Ethernet0
S     192.168.1.0/24 [1/0] via 172.16.2.2
S     192.168.2.0/24 [1/0] via 172.16.2.2


Dieburg1#show ip route
Codes:  C - connected, S - static, I - IGRP, 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, E - EGP
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
        U - per-user static route, o – ODR

Gateway of last resort is not set

      172.16.0.0/24 is subnetted, 3 subnets
C           172.16.1.0 is directly connected, Ethernet0
C           172.16.2.0 is directly connected, Serial0
S           172.16.3.0 [1/0] via 172.16.2.1
C     192.168.1.0/24 is directly connected, Serial1
S     192.168.2.0/24 [1/0] via 192.168.1.1

Darmstadt#show ip route
Codes:  C - connected, S - static, I - IGRP, 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, E - EGP
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
        U - per-user static route, o – ODR

Gateway of last resort is not set

      172.16.0.0/24 is subnetted, 3 subnets
S           172.16.1.0 [1/0] via 192.168.1.2
S           172.16.2.0 [1/0] via 192.168.1.2
S           172.16.3.0 [1/0] via 192.168.1.2
C     192.168.1.0/24 is directly connected, Serial0
C     192.168.2.0/24 is directly connected, Ethernet0
```

Step 2 – Configuring Summary Static Routes

The configuration of the routers in Step 1 works just great and is a valid way to configure routing on these networks. Earlier, we noticed that the network 172.16.0.0 is divided into several subnets. The Darmstadt router does not really need separate static routes for each subnet, since all of the 172.16.0.0 subnets can be reached via the same next-hop-ip-address, i.e. Dieburg1. Let's reconfigure the static routes on Darmstadt so that it only uses a single static route to reach all of the 172.16.0.0 subnets.

Dieburg2

- No changes

Dieburg1

- No changes

Darmstadt

- First, remove the current static routes:
  - `Darmstadt(config)#` **`no ip route 172.16.1.0 255.255.255.0 192.168.1.2`**
  - `Darmstadt(config)#` **`no ip route 172.16.2.0 255.255.255.0 192.168.1.2`**
  - `Darmstadt(config)#` **`no ip route 172.16.3.0 255.255.255.0 192.168.1.2`**

- Now, add the new summary static route:
  - `Darmstadt(config)#` **`ip route 172.16.0.0 255.255.0.0 192.168.1.2`**

Verify and Validate:

- All hosts and all routers should be able to ping every interface in the network.
- Do a "show running-config" and notice the static routes that you entered.
- Darmstadt# show ip route
  - o What routes to networks do you now see?

Questions:

- o What made this new summary static route work for all subnets?

  ____

- o Why is a single summary static route an advantage regarding the size of the routing table?

  ____

- o Why is a single summary static route an advantage regarding future changes to the 172.16.0.0 network?

  ____

Outputs

```
Darmstadt#show ip route
Codes:  C - connected, S - static, I - IGRP, 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, E - EGP
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
        U - per-user static route, o – ODR

Gateway of last resort is not set

S     72.16.0.0/16 [1/0] via 192.168.1.2
C     92.168.1.0/24 is directly connected, Serial0
C     92.168.2.0/24 is directly connected, Ethernet0
```

Step 3 – Configuring Default Static Routes

Both Step 1 and Step 2 are acceptable ways to configure routing for these networks. We notice that the 172.16.3.0/24 and the 192.168.2.0/24 networks are "stub networks," meaning that there is only one way out (both via Dieburg1).

Dieburg2
•First, remove the current static routes:

```
Dieburg2(config)# no ip route 172.16.3.0 255.255.255.0 172.16.2.2
Dieburg2(config)# no ip route 192.168.1.0 255.255.255.0 172.16.2.2
Dieburg2(config)# no ip route 192.168.2.0 255.255.255.0 172.16.2.2
```

•Now, add the new default static route:

```
Dieburg2(config)# ip route 0.0.0.0 0.0.0.0 172.16.2.2
```

Dieburg1
•No changes

Darmstadt
•First, remove the current static routes:

```
Darmstadt(config)# no ip route 172.16.0.0 255.255.0.0 192.168.1.2
```

•Now, add the new default static route:

```
Darmstadt(config)# ip route 0.0.0.0 0.0.0.0 192.168.1.2
```

Verify and Validate:

All hosts and all routers should be able to ping every interface in the network.
Do a "show running-config" and notice the static routes that you entered.

```
Dieburg2# show ip route
```

o What routes to networks do you now see?

____

```
Darmstadt# show ip route
```

o What routes to networks do you now see?

____

Questions:

- Do you think static routes still used even with dynamic routing (RIP, OSPF, etc.)?

____

- Do you think default static routes still used even with dynamic routing (RIP, OSPF, etc.)?

____

- What is the disadvantage of doing this? How would a default static route be properly used in a real world network? (How would a company's network use a default route when connecting to the Internet?)

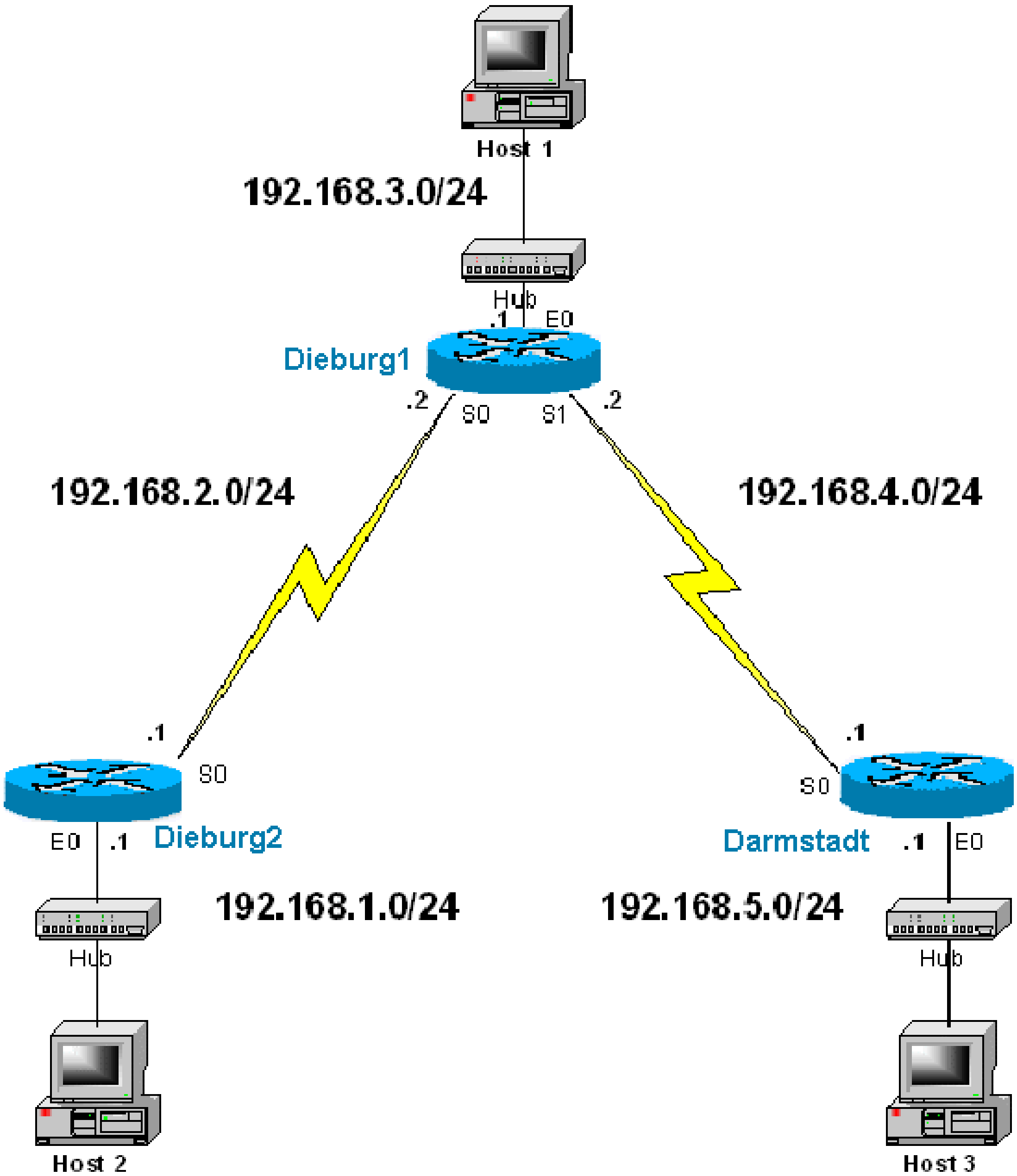
____

Outputs

```
Darmstadt#show ip route
Codes:  C - connected, S - static, I - IGRP, 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, E - EGP
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
        U - per-user static route, o – ODR

Gateway of last resort is 192.168.1.2 to network 0.0.0.0

C     192.168.1.0/24 is directly connected, Serial0
C     192.168.2.0/24 is directly connected, Ethernet0
S*    0.0.0.0/0 [1/0] via 192.168.1.2
```

Congratulations, you are now a static routing expert!

CCNA Semester 2 Lab 7: RIP - Network Discovery



Objective

In this lab, you will configure RIP routing between all three routers. This will allow your routers to route packets so that all routers and all hosts will be able to reach (ping) each other. This is the first RIP lab we have had, so we will discuss many of these items in more detail later. For now we will focus on the RIP update messages being exchanged between the routers.

Instructor note: This lab is under the assumption that students are not yet familiar with configuring RIP. This lab is designed for discussing information about network discovery from the chapter on Routing Theory and Concepts.

Scenario

There are five separate classful networks. After configuring RIP, we want to view the RIP update messages being sent and received by each router.

Questions:

What are the different classful networks?

____

____

Are there any subnets? If so, what are they?

____

Setup

- Use the 8 Steps to Success to help you configure the routers.
- Be sure your cabling is correct, as this causes more troubleshooting issues than anything else.
- If the routers have a startup-config already on them, erase it and reboot the routers.
- Configure the routers to include hostnames and the proper interface commands including IP addresses, subnet masks, etc. Each router should be able to ping the interface of the adjacent (neighboring) router and the host on its LAN (Ethernet) interface. Test and troubleshoot as necessary.

Basic Configurations

- Does not include clock rate, no shutdown and some other necessary commands.
- Note: Even though the networks are in numerical order, obviously this does not need to be the case. We only did this to make it easier to remember where the networks originated from.

Dieburg2

```
hostname Dieburg2
interface ethernet 0
      ip add 192.168.1.1 255.255.255.0
interface serial 0
      ip add 192.168.2.1 255.255.255.0
```

Dieburg1

```
hostname Dieburg1
interface ethernet 0
      ip add 192.168.3.1 255.255.255.0
interface serial 0
      ip add 192.168.2.2 255.255.255.0
interface serial 1
      ip add 192.168.4.2 255.255.255.0
```

Darmstadt

```
hostname Darmstadt
interface ethernet 0
      ip add 192.168.5.1 255.255.255.0
interface serial 0
      ip add 192.168.4.1 255.255.255.0
```

Step 1 – Starting debug ip rip

BEFORE we configure RIP, we want to turn on the debugging of RIP messages. This is not a normally something you would do on a production network unless you are troubleshooting the network. However, the whole purpose of this lab is to view the RIP updates messages sent and received by each router, so we will use the debug command to accomplish this task.

Use the following command on each router to keep the debug out from interfering with you command-line input:

```
Router(config)# line console 0
Router(config-line)# logging synchronous
```

On each router, start the process debug ip rip, which will allow us to view RIP update messages being sent and received. You must be in privileged mode to run debug.

```
Dieburg1# debug ip rip
RIP protocol debugging is on

Dieburg2# debug ip rip
RIP protocol debugging is on

Darmstadt # debug ip rip
RIP protocol debugging is on
```

Step 2 – Starting RIP

We will examine RIP much more closely later (chapter on Routing Protocols), but for now all you need to know is how to start RIP. (There really isn't much more to it than that!)

Now we can start RIP on each router.

From global configuration you will enter the command:

```
Router(config)#router rip
```

Once you are in the Router RIP configuration sub-mode, all you need to do is enter the classful network address for each directly connected network, using the network command.

```
Router(config-router)#network directly-connected-classful-network-address
```

For the best viewing results, I would suggest doing these commands in this order.

Here are the commands for each router:

```
Dieburg2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Dieburg2(config)#router rip
Dieburg2(config-router)#network 192.168.1.0
Dieburg2(config-router)#network 192.168.2.0

Darmstadt#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Darmstadt (config)#router rip
Darmstadt (config-router)#network 192.168.4.0
Darmstadt (config-router)#network 192.168.5.0

Dieburg1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Dieburg1(config)#router rip
Dieburg1(config-router)#network 192.168.2.0
Dieburg1(config-router)#network 192.168.3.0
Dieburg1(config-router)#network 192.168.4.0
```

You will immediately begin to see:

Dieburg2

```
01:03:27: RIP:  sending v1 update to 255.255.255.255 via Ethernet0 (192.168.1.1)
01:03:27:       network 192.168.2.0, metric 1
01:03:27: RIP:  sending v1 update to 255.255.255.255 via Serial0 (192.168.2.1)
01:03:27:       network 192.168.1.0, metric 1
```

Darmstadt

```
01:02:37: RIP:  sending v1 update to 255.255.255.255 via Ethernet0 (192.168.5.1)
```

```
01:02:37:       network 192.168.4.0, metric 1
01:02:37: RIP:  sending v1 update to 255.255.255.255 via Serial0 (192.168.4.1)
01:02:37:       network 192.168.5.0, metric 1
```

Dieburg1

```
01:07:14: RIP:  sending v1 update to 255.255.255.255 via Ethernet0 (192.168.3.1)
01:07:14:       network 192.168.4.0, metric 1
01:07:14:       network 192.168.2.0, metric 1
01:07:14: RIP:  sending v1 update to 255.255.255.255 via Serial0 (192.168.2.2)
01:07:14:       network 192.168.4.0, metric 1 01:07:14: network 192.168.3.0, metric 1
01:07:14: RIP:  sending v1 update to 255.255.255.255 via Serial1 (192.168.4.1)
01:07:14:       network 192.168.2.0, metric 1
01:07:14:       network 192.168.3.0, metric 1
```

Step 3 – Understanding the debug ip rip output

Because we have RIP protocol debugging on (debug ip rip) we will begin to see network discovery, as each router:

SENDING RIP MESSAGES
Each router will begin to send RIP update message out each interface belonging to one of the network statements.

```
Dieburg2(config)#router rip
Dieburg2(config-router)#network 192.168.1.0
Dieburg2(config-router)#network 192.168.2.0
```

- For example, Dieburg2 to will send out RIP update messages on Ethernet 0 because that interface has an IP address that belong to the network 192.168.1.0, and on Serial 0 because that interface has an IP address that belongs to the network 192.168.2.0.
- Just because a router has a directly connected network does not mean it will automatically include that network in its routing updates to neighboring routers. The network command also tells the RIP to include these networks in its updates to adjacent neighbors.

Dieburg2

```
01:03:27: RIP:  sending v1 update to 255.255.255.255 via Ethernet0 (192.168.1.1)
01:03:27:       network 192.168.2.0, metric 1
01:03:27: RIP:  sending v1 update to 255.255.255.255 via Serial0 (192.168.2.1)
01:03:27:       network 192.168.1.0, metric 1
```

LISTENING FOR RIP MESSAGES
Routers will also listen for RIP messages on each interface belonging to one of the network statements.

•For example, Dieburg2 to will listen for RIP update messages on Ethernet 0 because that interface has an IP address that belong to the network 192.168.1.0, and also listen for RIP update messages on Serial 0 because that interface has an IP address that belongs to the network 192.168.2.0.

- As RIP messages are received router, will add those networks in the messages to their routing tables:
  - If the RIP message contains a network not currently in the routing table.
  - If the RIP message contains a network with a better metric (fewer hops) than an entry currently in the routing table.

Dieburg2

```
01:10:56: RIP:  received v1 update from 192.168.2.2 on Serial0
01:10:56:       192.168.4.0 in 1 hops
01:10:56:       192.168.3.0 in 1 hops
```

NOTE: We will discuss this lab in class, so be sure to review the outputs carefully.

Step 4 – Viewing the debug ip rip output

Remember that Dieburg1 will learn routes to networks from Dieburg2. It will then send that information to Darmstadt, telling Darmstadt that it is the next hop to get to those networks, and incrementing the metric (hop count) by one.

After convergence, each router will continue to send its RIP update messages out the appropriate interfaces every 30 seconds.

Lets look at the debug messages and the routing table for each router:

Dieburg2

```
01:30:45: RIP:  sending v1 update to 255.255.255.255 via Ethernet0 (192.168.1.1)
01:30:45:       network 192.168.4.0, metric 2
01:30:45:       network 192.168.5.0, metric 3
01:30:45:       network 192.168.2.0, metric 1
01:30:45:       network 192.168.3.0, metric 2
01:30:45: RIP:  sending v1 update to 255.255.255.255 via Serial0 (192.168.2.1)
01:30:45:       network 192.168.1.0, metric 1

Dieburg2#
01:30:50: RIP:   received v1 update from 192.168.2.2 on Serial0
01:30:50:        192.168.4.0 in 1 hops
01:30:50:        192.168.5.0 in 2 hops
01:30:50:        192.168.3.0 in 1 hops

Dieburg2#
Dieburg2#show ip route
Codes:  C - connected, S - static, I - IGRP, 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, E - EGP
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
        U - per-user static route, o – ODR

Gateway of last resort is not set

R     192.168.4.0/24 [120/1] via 192.168.2.2, 00:00:10, Serial0
R     192.168.5.0/24 [120/2] via 192.168.2.2, 00:00:10, Serial0
C     192.168.1.0/24 is directly connected, Ethernet0
C     192.168.2.0/24 is directly connected, Serial0
R     192.168.3.0/24 [120/1] via 192.168.2.2, 00:00:10, Serial0
Dieburg2#
```

Dieburg1

```
01:33:05: RIP:  received v1 update from 192.168.4.1 on Serial1
01:33:05:       192.168.5.0 in 1 hops

Dieburg1#
01:33:07: RIP:  received v1 update from 192.168.2.1 on Serial0
01:33:07:       192.168.1.0 in 1 hops
01:33:08: RIP:  sending v1 update to 255.255.255.255 via Ethernet0 (192.168.3.1)
01:33:08:       network 192.168.4.0, metric 1
01:33:08:       network 192.168.5.0, metric 2 01:33:08: network 192.168.1.0,
metric 2
01:33:08:       network 192.168.2.0, metric 1
01:33:08: RIP:  sending v1 update to 255.255.255.255 via Serial0 (192.168.2.2)
01:33:08:       network 192.168.4.0, metric 1
01:33:08:       network 192.168.5.0, metric 2
01:33:08:       network 192.168.3.0, metric 1
01:33:08: RIP:  sending v1 update to 255.255.255.255 via Serial1 (192.168.4.2)
01:33:08:       network 192.168.1.0, metric 2
01:33:08:       network 192.168.2.0, metric 1
01:33:08:       network 192.168.3.0, metric 1
Dieburg1#

Dieburg1#show ip route
Codes:  C - connected, S - static, I - IGRP, 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, E - EGP
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
        U - per-user static route, o – ODR

Gateway of last resort is not set

C     192.168.4.0/24 is directly connected, Serial1
R     192.168.5.0/24 [120/1] via 192.168.4.1, 00:00:12, Serial1
R     192.168.1.0/24 [120/1] via 192.168.2.1, 00:00:10, Serial0
C     192.168.2.0/24 is directly connected, Serial0
C     192.168.3.0/24 is directly connected, Ethernet0
Dieburg1#
```

Darmstadt

```
01:34:53: RIP:  sending v1 update to 255.255.255.255 via Ethernet0 (192.168.5.1)
01:34:53:       network 192.168.4.0, metric 1
01:34:53:       network 192.168.1.0, metric 3
01:34:53:       network 192.168.2.0, metric 2
01:34:53:       network 192.168.3.0, metric 2
01:34:53: RIP:  sending v1 update to 255.255.255.255 via Serial0 (192.168.4.1)
01:34:53:       network 192.168.5.0, metric 1
Darmstadt#
01:34:56: RIP:  received v1 update from 192.168.4.2 on Serial0
01:34:56:       192.168.1.0 in 2 hops
01:34:56:       192.168.2.0 in 1 hops
01:34:56:       192.168.3.0 in 1 hops
Darmstadt #

Darmstadt #show ip route
Codes:  C - connected, S - static, I - IGRP, 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, E - EGP
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
        U - per-user static route, o – ODR

Gateway of last resort is not set

C 192.168.4.0/24 is directly connected, Serial0
C 192.168.5.0/24 is directly connected, Ethernet0
R 192.168.1.0/24 [120/2] via 192.168.4.2, 00:00:23, Serial0
R 192.168.2.0/24 [120/1] via 192.168.4.2, 00:00:23, Serial0
R 192.168.3.0/24 [120/1] via 192.168.4.2, 00:00:23, Serial0
Darmstadt #
```

NOTE: At this point all routers should be able to ping all networks. We will discuss RIP much more in the chapter on Routing Protocols (RIP).

Step 5 – Turning-off debug

Don't forget to turn-off debug when you are done collecting the output.

```
Router# undebug all
```

or

```
Darmstadt# undebug ip rip
```

Step 6 – Configure default metric, timers basic and split-horizon on Dieburg1

Turn-on rip debugging for Dieburg 1. Shutdown Dieburg2's Ethernet 0 interface. From Dieburg1, watch the routing information and use the **show ip route** command to see how many routing updates it takes to flush out Dieburg2's Ethernet 0 network.

1. How many updates did it take to converge? ______________________________

Change the RIP maximum hop count on router Dieburg1 to 10 (the default is 16). There are timers that can be modified to help avoid routing loops. Aadjust the routing timers and split horizon using the following commands:

```
Dieburg1#conf t
Dieburg1(config)#router rip
Dieburg1(config-router)#default-metric 10
Dieburg1(config-router)#timers basic 15 45 0 60
```

{This will change the timers as follows: 15 seconds between updates, 45 seconds for route expiration, 0 seconds for hold-down, and 60 seconds for flushing the route from the table.}

```
Dieburg1(config-router)#exit
Dieburg1(config)#int s0
Dieburg1(config-if)#ip split-horizon {unnecessary because this is default}
Dieburg1 (config-if)#int s1
Dieburg1 (config-if)#ip split-horizon
Dieburg1 (config-if)#^Z
Dieburg1#
```

Once the network has converged (you see all the WAN's network numbers in the routing table), examine your RIP settings.

Use the command:

```
Dieburg1#show ip protocols
```

How often are RIP updates being sent? ______________________________

When is the next update due? ______________________________

How long will it take for a route to become invalid? ______________________

How long will the router hold down, or wait to accept a new route? ______________

What is the maximum hop count? ______________________________

Turn-on rip debugging for Dieburg 1. Shutdown Dieburg2's Ethernet 0 interface. From Dieburg1, watch the routing information and use the **show ip route** command to see how many routing updates it takes to flush out Dieburg2's Ethernet 0 network.

2. How many updates did it take to converge? ______________________________

3. Compare question 1 and 2 and explain why the network converged faster after changing the default metric, timers and split horizon.

____

____

____

Step 6 – Reflections

In class we will discuss some of the following issues with network discovery and RIP update messages:

- Split horizon
- Split horizon with poison reverse (This is Cisco's implementation, however this information is not displayed with debug ip rip.)
- RIP update messages and the routing tables.
- Do the routers need to send RIP messages out its stub Ethernet interfaces? ______________

Once again, congratulations!
Your understanding of this information will help you go a long way in understanding other aspects of networking and routing.

Understanding Timers.

Update:
The time between routing updates sent by a router.

Invalid:
The term invalid is used for routes that have not been heard from for the period of time that the invalid timer is set for. This means, for example, if the invalid timer is set to 60, and an advertisement for a route from the router it was learned from has not been received for 61 seconds, the invalid timer expires and the route is considered invalid.

Hold down:
The term hold down refers to routes that have been marked invalid but are not yet capable of being replaced with a new route of a higher metric. This timer determines how long the route is kept under hold down. While in hold down state, the router will keep sending updates about the route, and will keep forwarding packets via that route until the hold down expires.

Flush:
The flush timer restarts every time an update is received for a route from the router that it is learned from. The flush and invalid timers restart at the same time and run concurrently. When the flush timer expires for a route, the route is removed from the routing table. For RIP, the flush timer expires before the hold down timer can expire.

Routing Loop Prevention Techniques

Split Horizon:
Split Horizon disables the router from sending information about a route in the routing table through the same interface that it learned about the route from. For example, if *Dieburg1* sends information about *Dieburg2* to *Darmstadt* via its Ethernet 0. *Darmstadt* will not send information about *Dieburg2* via Ethernet 0 back to *Dieburg1*.

Poison Reverse:
This is when a router informs its neighbors that routes that they were once capable of reaching via a particular interface is no longer available because the interface has gone down. Routers react to a poison reverse message by **immediately** placing the poisoned routes **into hold down** instead of waiting for the invalid timer to expire. This saves convergence time, as much as 180 seconds (default invalid timer), depending on how soon after a regular update a poison reverse update arrives.

Defining Default Metrics:
Default metrics are set to disable counting to infinity. Counting to infinity causes routing loops by incrementing a route that it cannot reach, but believes its neighbor can. So every time a route that is not reachable by one router is sent to its neighbors, routers that have not converged yet, that routes metric increases by one. That keeps happening over and over again until the routers finally converge. Default metric sets a metric count, where a route is allowed to propagate the network a certain number of times before it is removed from the routing table.