



Session 4D

Static Routing

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Session 4D: Focus

- Routing Mechanisms
- Directly Connected Interfaces
 - Routing Table Entries
- Static Routing
 - An Example
 - For a WAN Link
 - Upstream and Downstream Routers
 - Configuring Static Routes
 - Issues with Static Routing

**Course page where the course materials will be posted
as the course progresses:**



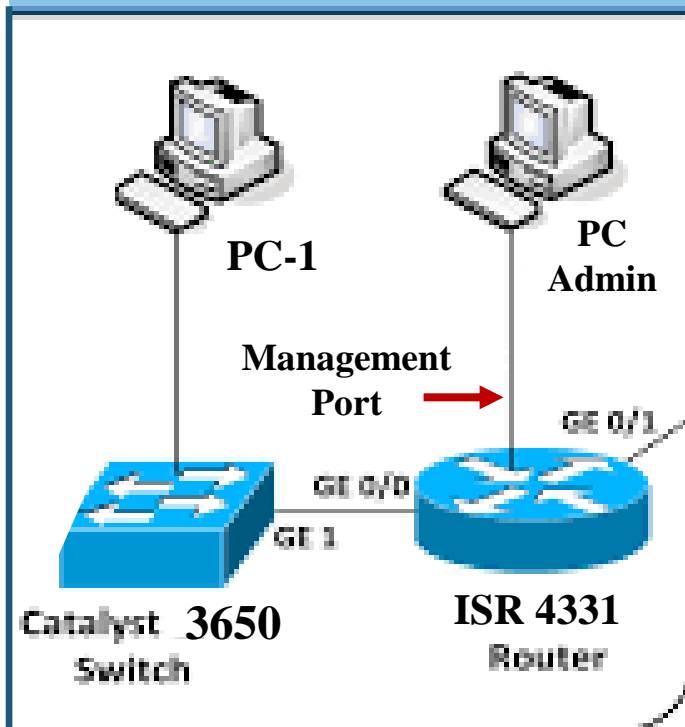
Routing Mechanisms

New Reference: Ref5: **IP Routing Primer Plus** By Heather Osterloh
Chapters 3 & 4: **IP Routing** and **RIP**

Routing Mechanisms

- Routers learn about paths (routes) to destinations through several routing mechanisms.
- Typically, routers use a combination of the following **routing methods** to **build** router's **route table**:
 - Directly connected interface
 - Static
 - Default
 - Dynamic
- Although there are specific advantages and disadvantages for implementing them, they are not mutually exclusive.

Directly Connected Interfaces



ISR: Integrated Services Router
Catalyst 3650: 48 Port L3 Switch
Catalyst 2960: 24 Port L3 Switch

GE0/0 and GE0/1: Gigabit Ethernet Interfaces on the Router.

Note: Referred to as **GigE Interface**
GE: GigE port on the **Switch** side.

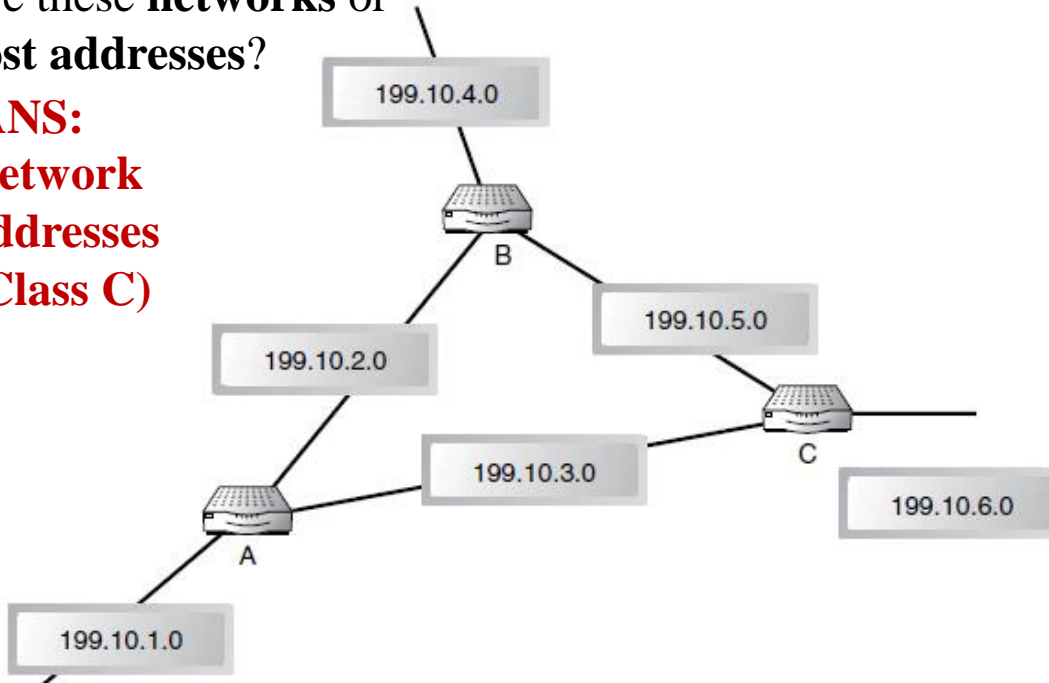
Note that a GigE Interface can also be connected to other lower speed (**FE** or 10 Mbps) ports. The ports share their capabilities with each other and negotiate to finally choose the lower speed, for exchanging frames between them.

- Directly connected interfaces are routes that are local to the router.
- That is, a router normally has interfaces that are directly connected to one or more networks or subnets. How many **Interfaces** are in the **Router**? **ANS: 2**
- These networks are inherently known to the routers by configuring the interfaces attached to the networks, **Management port:** **For configuring the device and not for traffic.**
FE: Fast Ethernet, speed 100 Mbps.

Directly Connected Interfaces

Are these **networks** or **host addresses**?

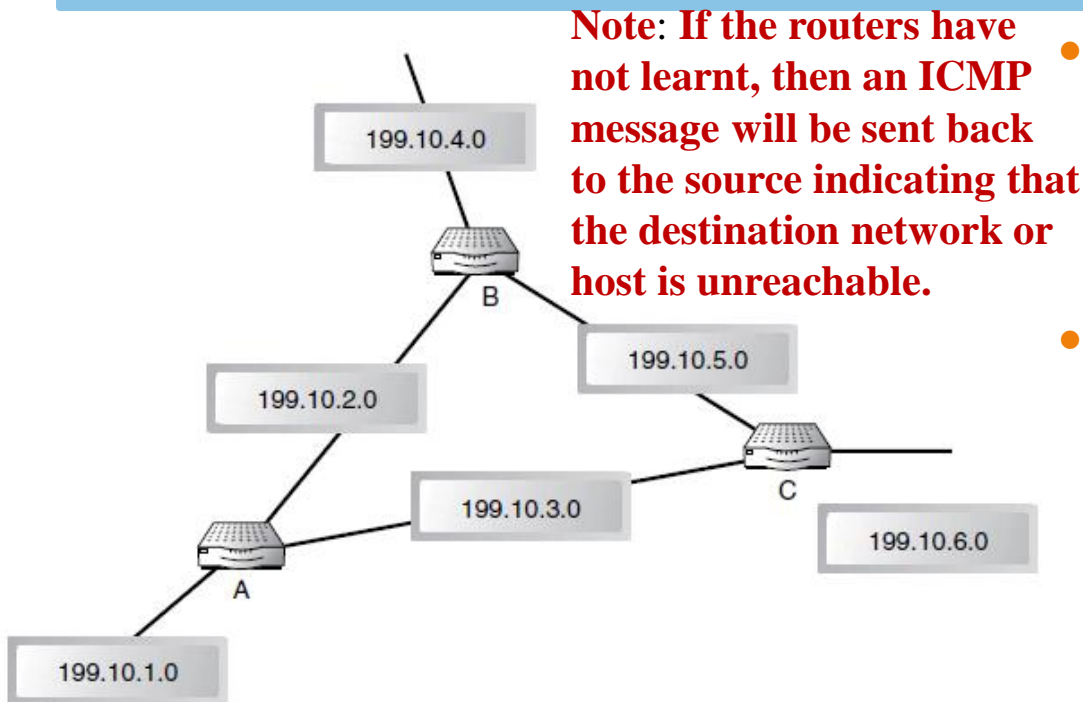
ANS:
Network
addresses
(Class C)



- This network has three Routers (A, B, and C).
- These networks are immediately recognizable by the routers which are connected directly to them.
- Traffic directed to these networks can be forwarded by them without any help from routing protocols.

- How many directly connected networks does each router has? **ANS: 3**
- For example, Router A is directly connected to networks 192.10.1.0, 192.10.2.0, and 192.10.3.0 through local interfaces.
- All the router's interfaces are configured with the network addresses they are connected to.

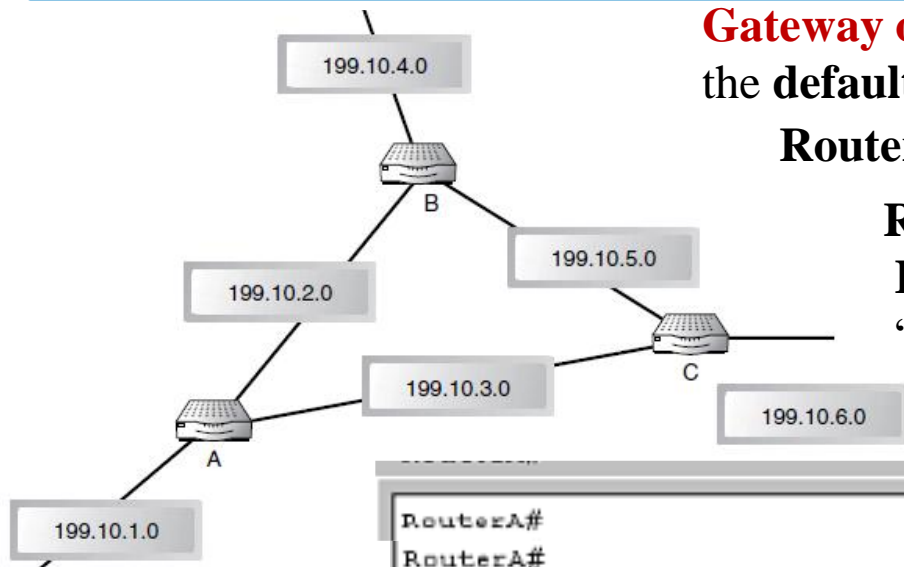
Directly Connected Interfaces



- Datagrams received by Router A destined for any of these attached networks will be forwarded without assistance.
- Does the **Router A** know how to reach **199.10.5.0** without a specific entry in its **routing table**? **ANS: NO**

- What are the networks that **Router A** needs entries in its Routing table to forward datagrams destined to them?
 - **ANS:** For the networks that are not directly connected to Router A, 199.10.4.0, 199.10.5.0, and 199.10.6.0.
- Router A needs to learn about these networks to forward traffic to them, since they are not directly connected to it.

Router A: Routing Table Entries



Gateway of last resort not set, indicates that the **default route** is **not set** in the **Routing Table (RT)**.

RouterA prompt shows the **name** of the **router**.

RouterA#, the hash symbol indicates **privileged EXEC mode** in which commands like “**show ip route**” can be executed.

Message on a CISCO router:

```
RouterA#
RouterA#
RouterA#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

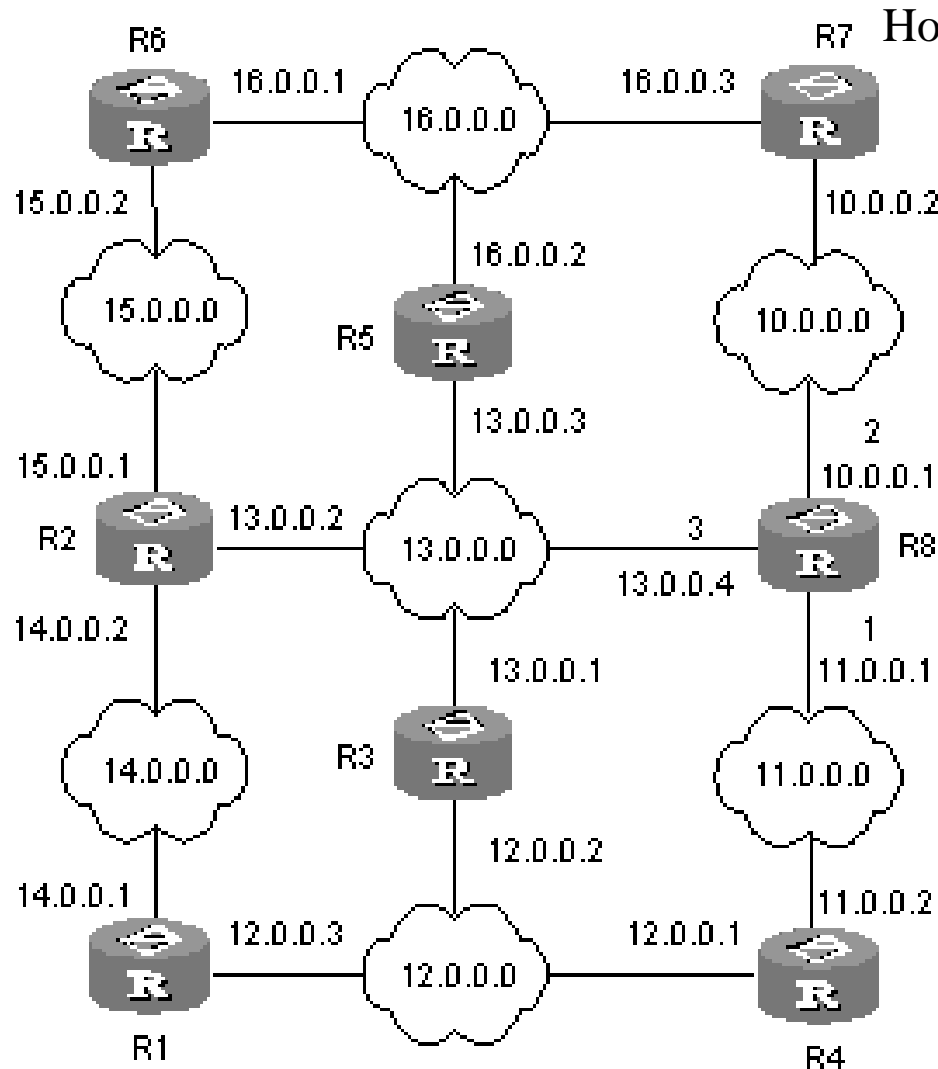
C    199.10.3.0/24 is directly connected, Serial1
C    199.10.2.0/24 is directly connected, Serial0
C    199.10.1.0/24 is directly connected, Ethernet0
RouterA#
RouterA#
RouterA#
```

Network names are given for each of the networks as well.



Static Routing

Static Routing: An Example



How many entries on RT on each Router? **ANS: 7**

Routing table of router R8

Entry Type	Destination network	Next hop	Interface
C	10.0.0.0	10.0.0.1	2
C	11.0.0.0	11.0.0.1	1
S	12.0.0.0	11.0.0.2	1
C	13.0.0.0	13.0.0.4	3
S	14.0.0.0	13.0.0.2	3
S	15.0.0.0	13.0.0.2	3
S	16.0.0.0	10.0.0.2	2

C: Directly Connected (router adds based on the interface configurations)

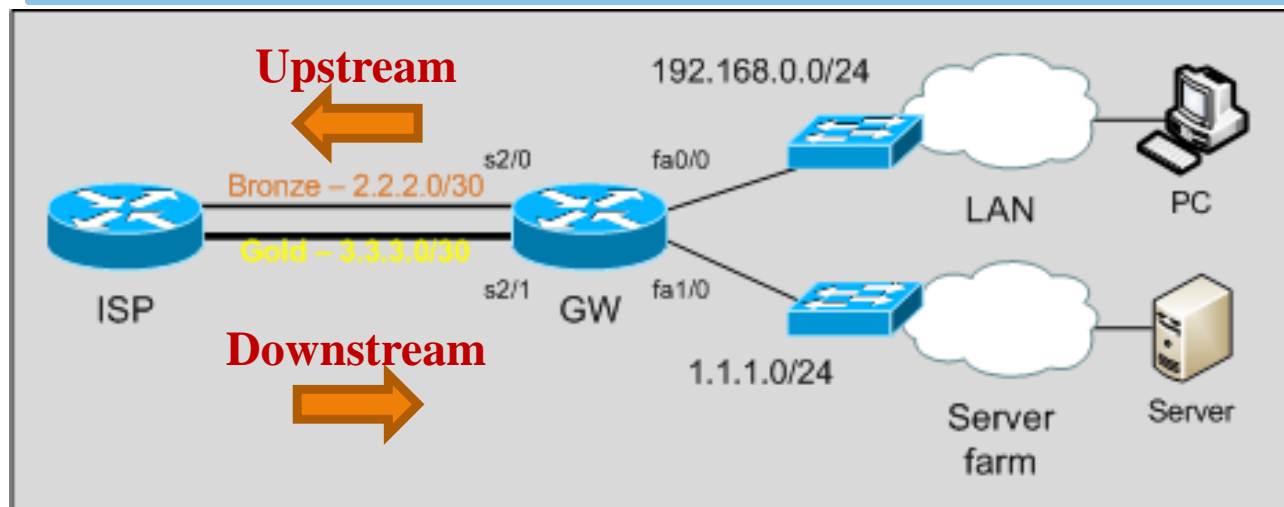
S: Static Entry, manually made

Homework: Practice making RT entries for other routers in the network.

Static Routing

- Static routes are routes to destination hosts or networks that an administrator has manually entered into the router's route table.
- Static routes define the IP address of the next hop router and local interface to use when forwarding traffic to a particular destination.
- Because this type of route has a static nature, it does not have the capability of adjusting to changes in the network.
- If the router or interface defined fails or becomes unavailable, the route to the destination fails.
- This type of routing method has the advantage of eliminating all traffic related to routing updates.
- Static routing tends to be ideal where the **link is temporary** or **bandwidth is an issue**, so this method is used for dial-up networks or point-to-point WAN links.
- Static routes in conjunction with other routing methods are implemented to use backup links when the primary links implementing dynamic routing protocols have failed.

Static Routing for WAN Links



Ref: Bronze and Gold WAN links

Bronze Link: Unreliable low speed Connection

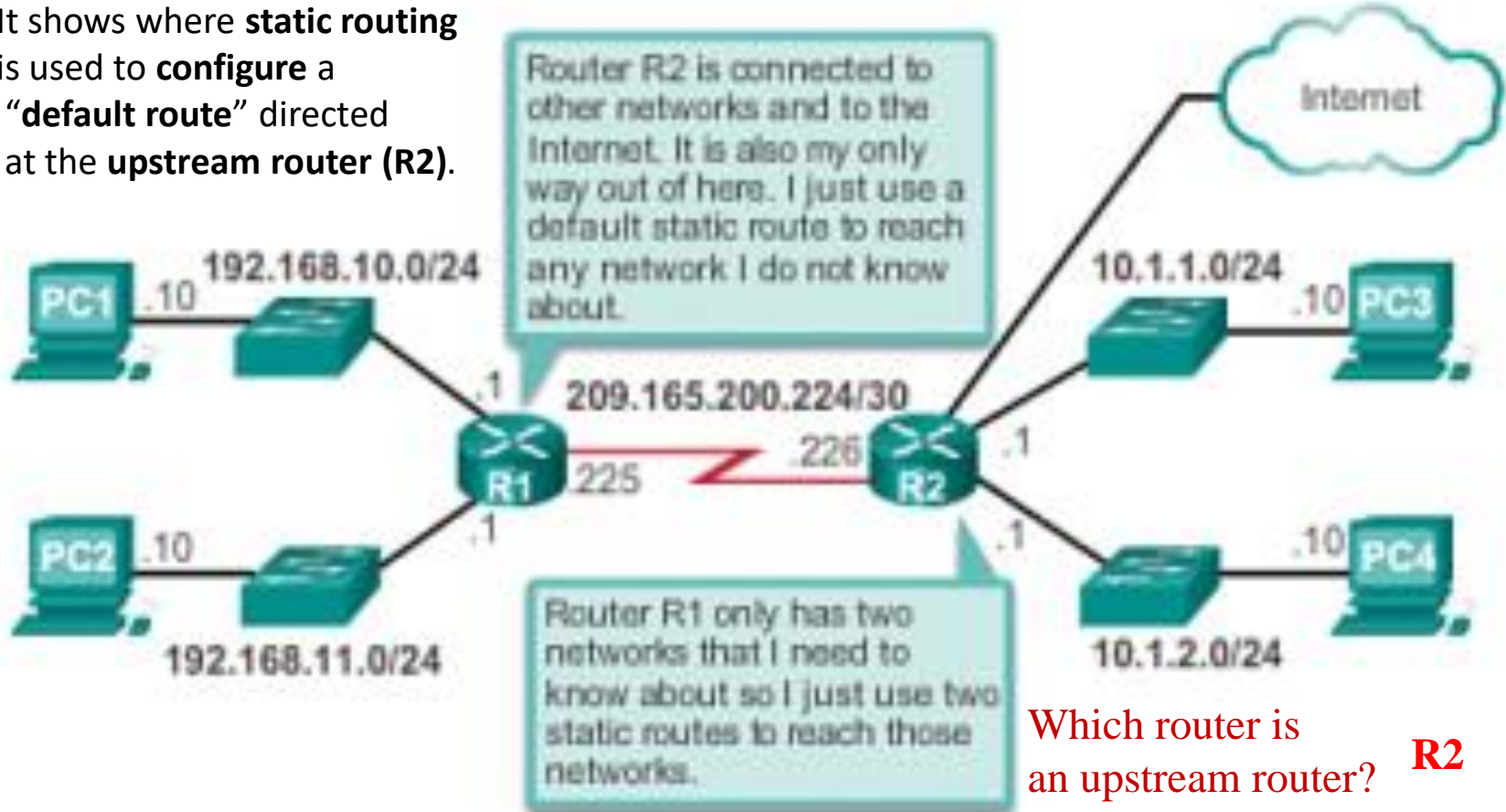
Gold Link: Reliable high speed Connection

Upstream: The link direction connecting a larger network (Internet) with a small LAN.

- Static routes are also ideal for a stub network providing a single dedicated point-to-point WAN connection outside the network to an **upstream** ISP (Internet Service Provider) providing Internet access.
- Generally, there is no reason to advertise your company's internal subnetworks out to the world through this connection, as most companies are concerned about having their network hacked into by intruders.
- The connection should only provide internal users access to Internet resources and traveling users with the capability to access network resources and e-mail via the Internet.

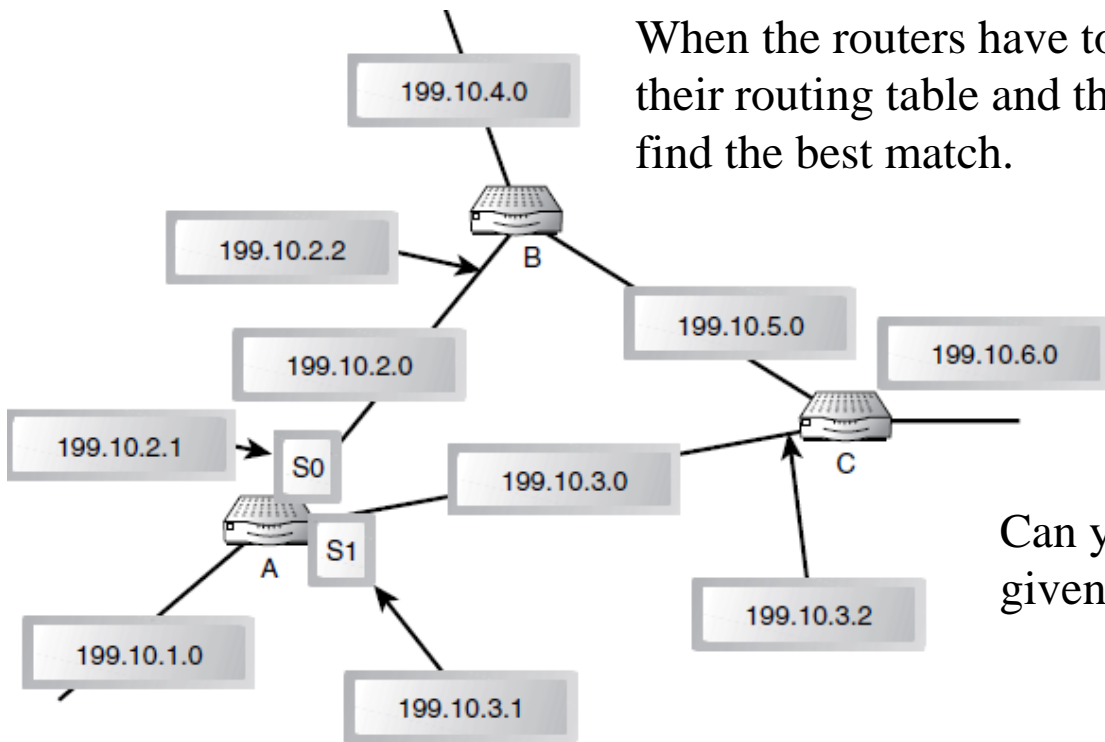
Another Example Network

It shows where **static routing** is used to **configure** a “**default route**” directed at the **upstream router (R2)**.



- The numbers mentioned with a **dot** are the IP addresses. **.1** means **host ID** is **1** in that IP address.
- For example, **R2's** lowest interface IP address: **10.1.2.1/24**

Configuring Static Routes



When the routers have to forward packets, they will check their routing table and they use longest prefix matching to find the best match.

If it doesn't have a best match then the router will use a default route (if you have one in RT). Otherwise, the packet will be dropped and an ICMP msg is generated.

Can you **identify** these **commands** are given on which **router**? **ANS: RA**

Commands to set up Static routes are shown below.

```
ip route 199.10.4.0 255.255.255.0 199.10.2.2
ip route 199.10.5.0 255.255.255.0 199.10.2.2
ip route 199.10.6.0 255.255.255.0 199.10.3.2
!
```


Issues with Static Routing

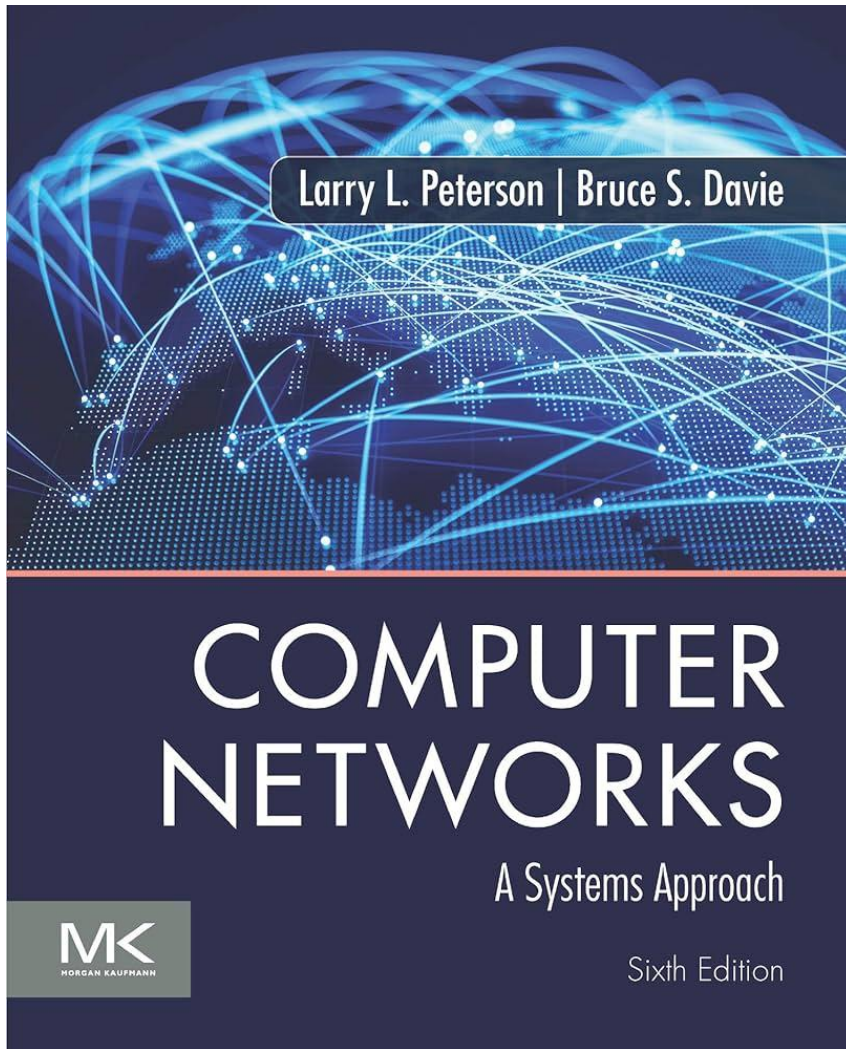
- Designing an entire network with only static routing method requires that entries are made on every router for each network they are not directly attached to, which is highly impractical.
- In addition, if a link or a router within the internetwork fails or is added, you would have to reconfigure each router, removing the failed route or adding a new route.
- Meanwhile, until the routing tables are updated manually, the routers obviously cannot forward traffic to those destinations because the original paths have become invalid.
- Static routing can have an extreme amount of overhead in the form of intense administrative hours spent getting the network up and keeping it going.
- Dynamic routing algorithms are versatile and adapts to network changes
 - Whereas, static routes conserve bandwidth because they do not cause routers to generate route update traffic.

Session 4D: Summary

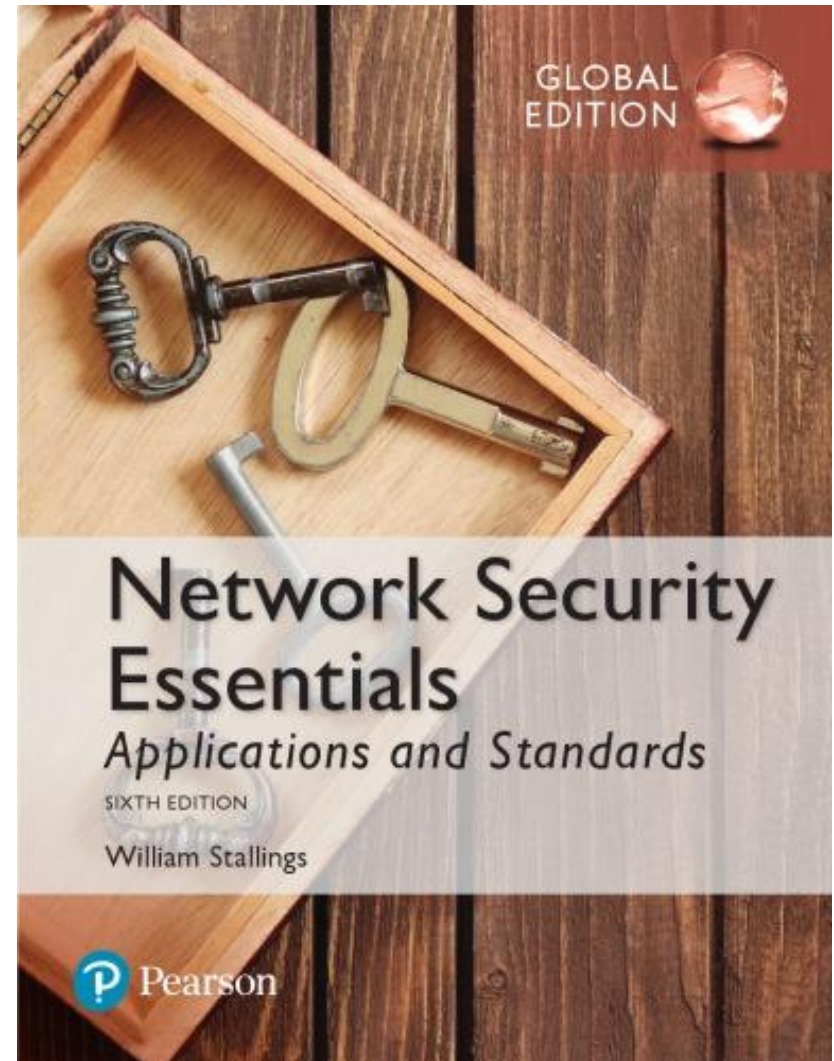
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Textbooks

Textbook 1

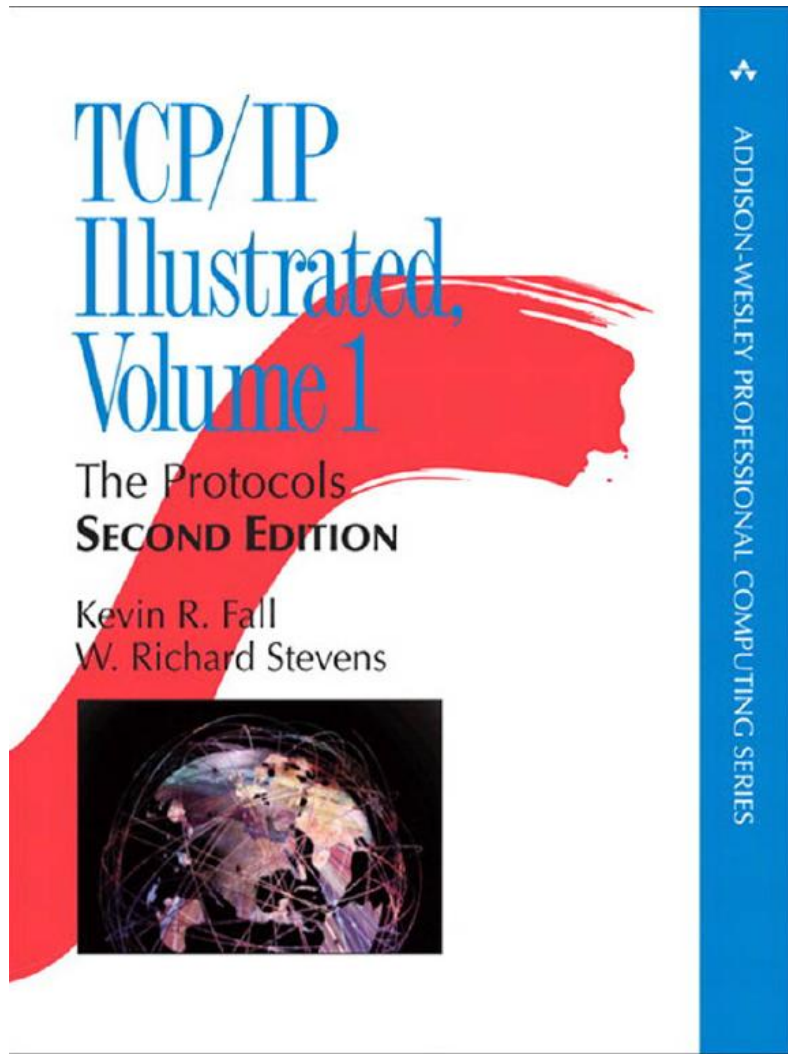


Textbook 2



References

Ref 1



Ref 2

TCP Congestion Control: A Systems Approach

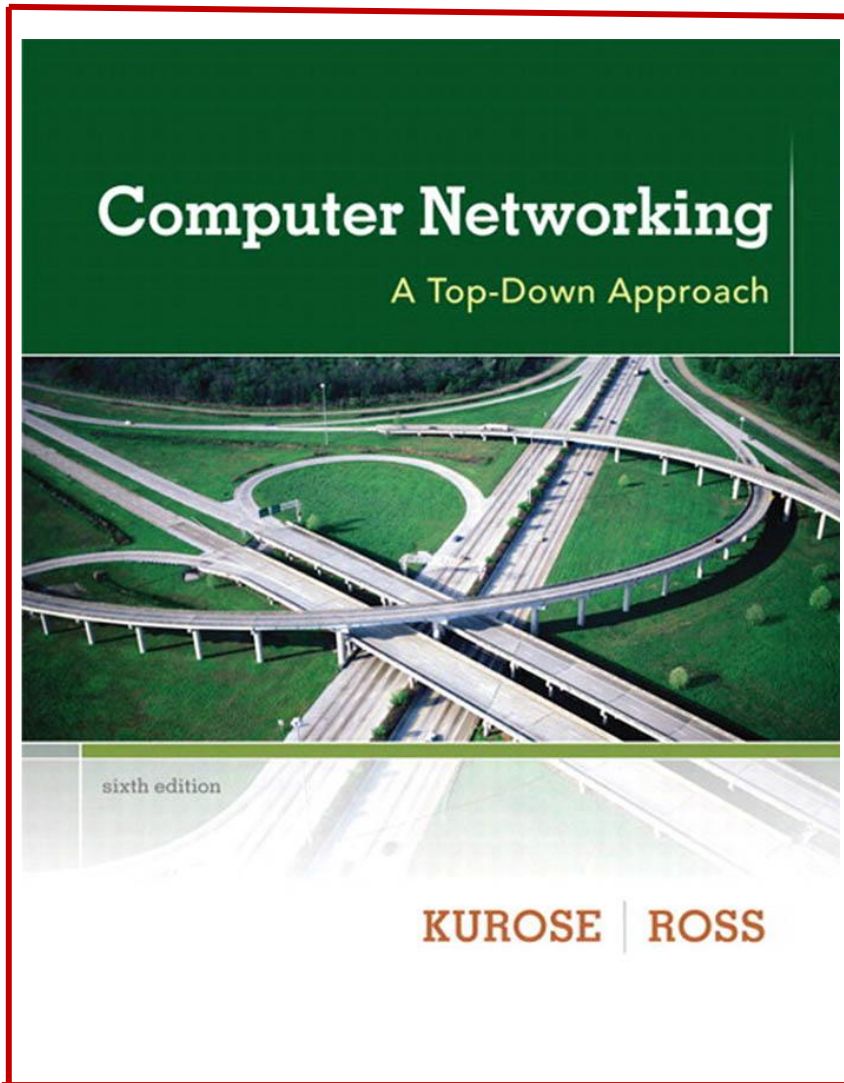


TCP Congestion Control: A Systems Approach

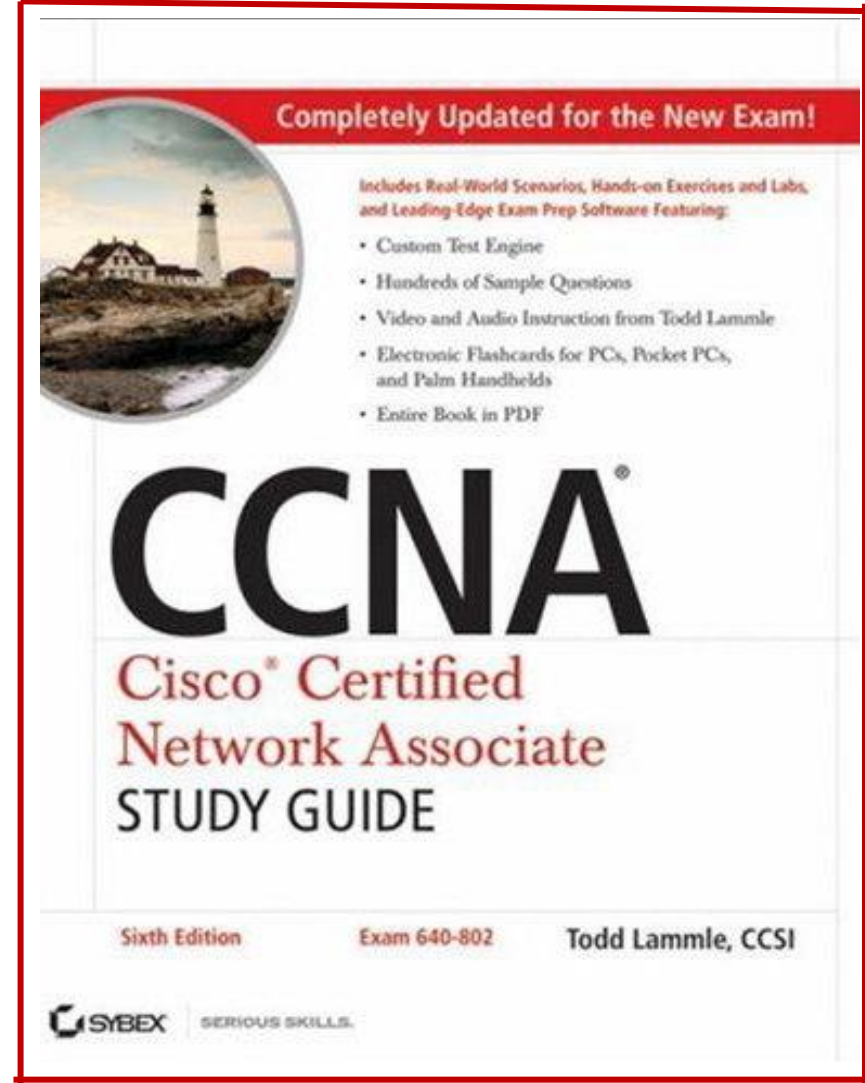
Peterson, Brakmo, and Davie

References

Ref 3



Ref 4



References

Ref 5

