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Chapter 06

Connecting Devices And Virtual LANs

Data Communications and Networking, With TCP/IP protocol suite
Sixth Edition
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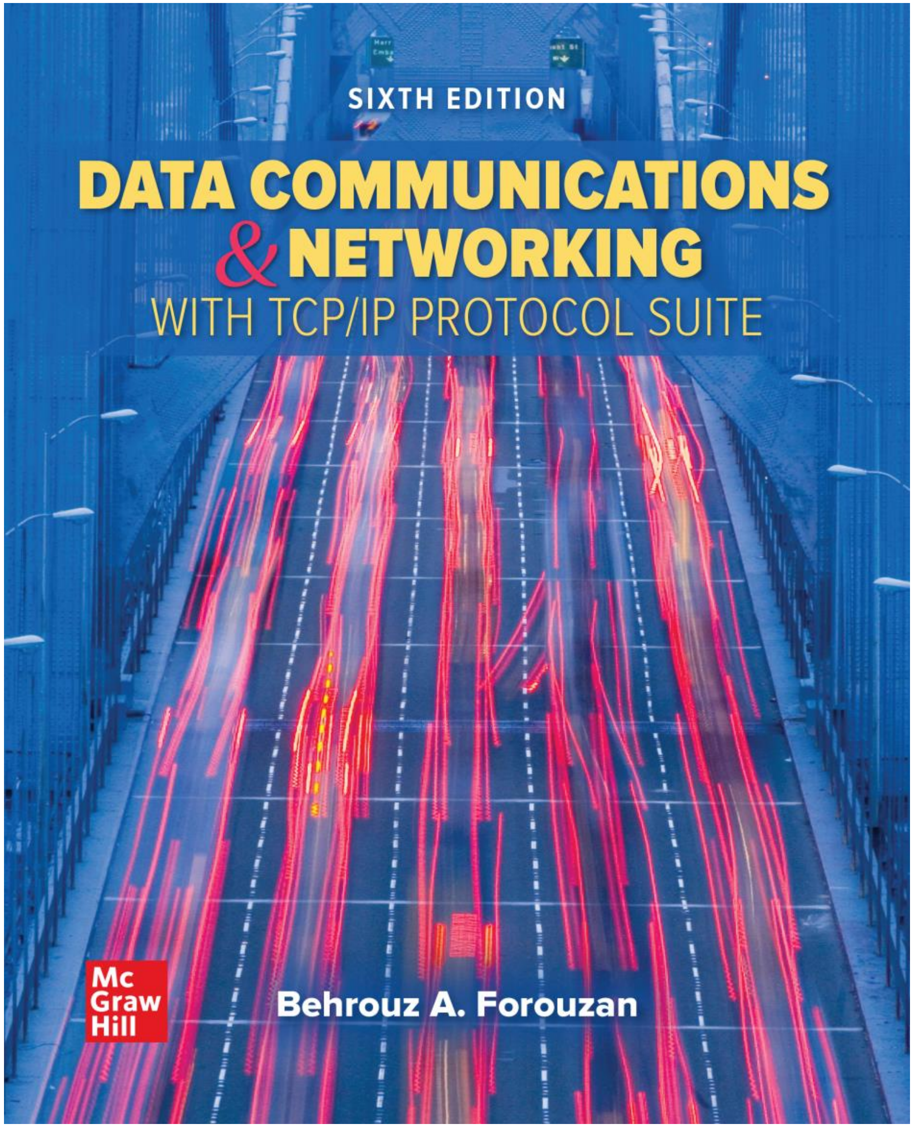


Chapter 6: Outline

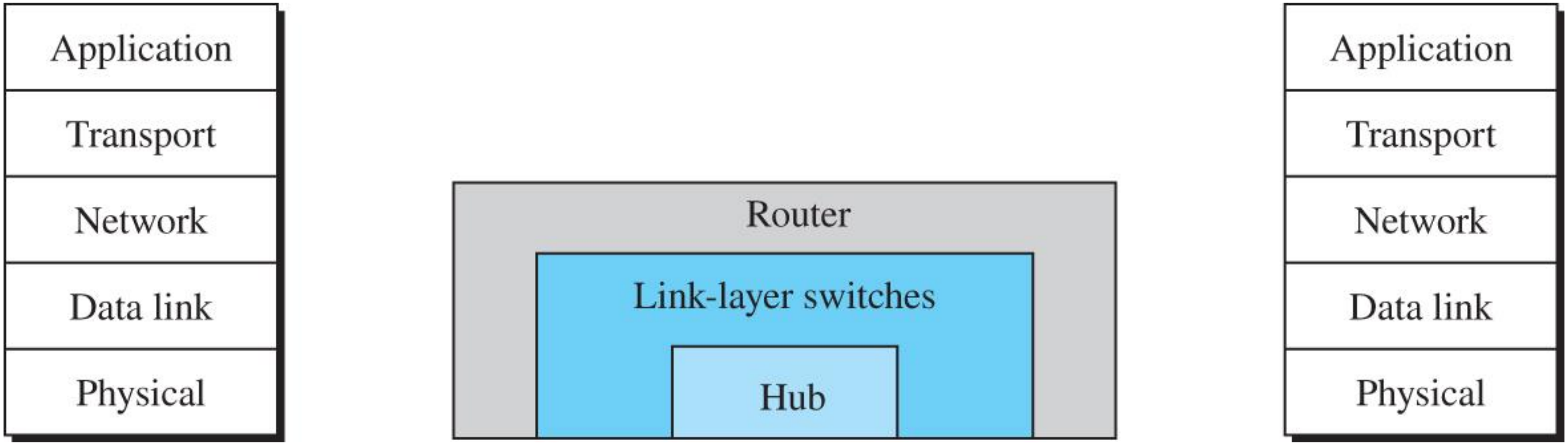
6.1 Connecting Devices

6.2 Virtual LANS

6-1 CONNECTING DEVICES

Hosts and networks do not normally operate in isolation. We use connecting devices to connect hosts together to make a network or to connect networks together to make an internet. Connecting devices can operate in different layers of the Internet model. We discuss three kinds of connecting devices: hubs, link-layer switches, and routers.

Figure 6.1 Three categories of connecting devices



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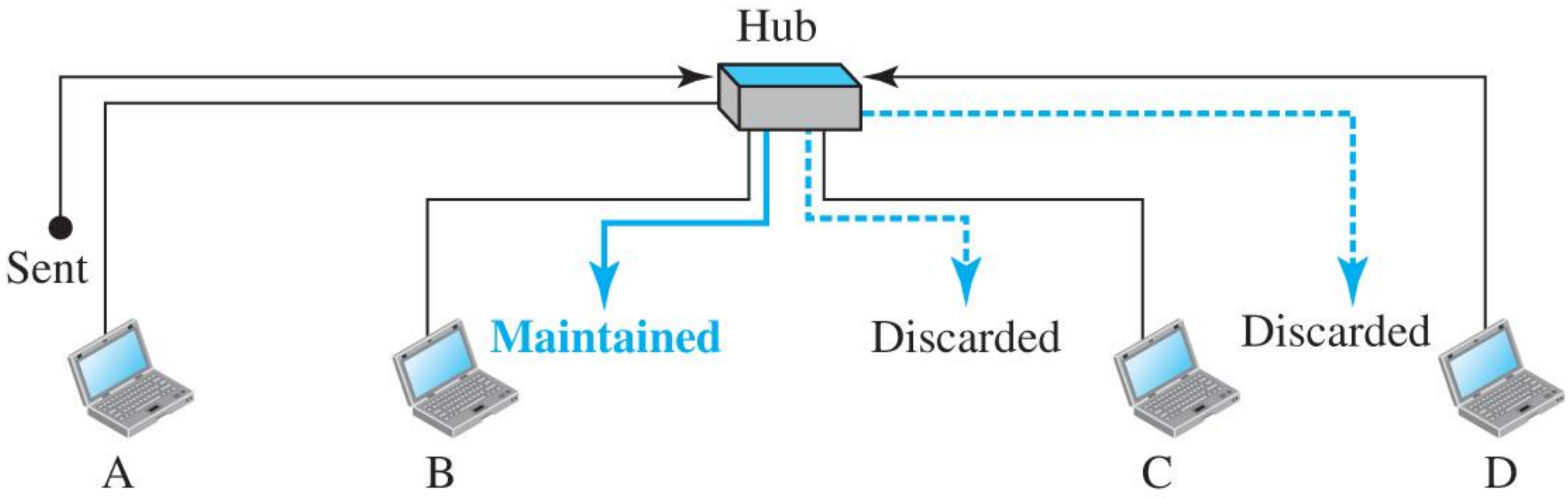
6.1.1 Hubs

A hub is a device that operates only in the physical layer. Signals that carry information within a network can travel a fixed distance before attenuation endangers the integrity of the data. A repeater receives a signal and, before it becomes too weak or corrupted, regenerates and retimes the original bit pattern.

Figure 6.2 A hub



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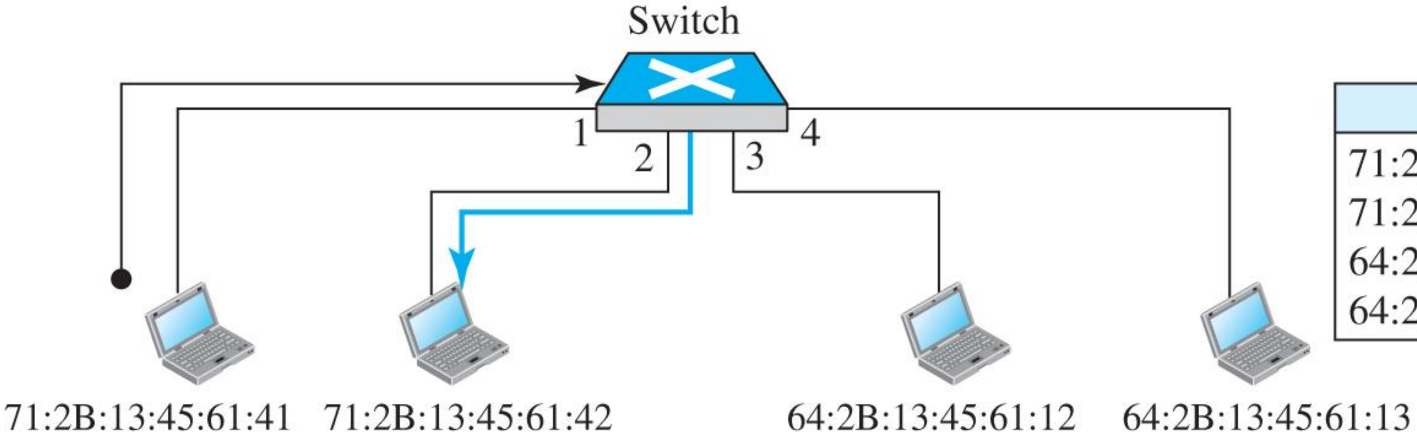
6.1.2 Link-Layer Switches

A link-layer switch (or switch) operates in both the physical and the data-link layers. As a physical-layer device, it regenerates the signal it receives. As a link-layer device, the link-layer switch can check the MAC addresses (source and destination) contained in the frame.

Filtering

One may ask what is the difference in functionality between a link-layer switch and a hub. A link-layer switch has filtering capability. It can check the destination link-layer address of a frame and can decide from which outgoing port the frame should be sent.

Figure 6.3 Link-layer switch



Address	Port
71:2B:13:45:61:41	1
71:2B:13:45:61:42	2
64:2B:13:45:61:12	3
64:2B:13:45:61:13	4

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Transparent Switches

A transparent switch is a switch in which the stations are completely unaware of the switch's existence. If a switch is added or deleted from the system, reconfiguration of the stations is unnecessary.

Figure 6.4 Learning switch

Gradual building of table

Address	Port

a. Original

Address	Port
71:2B:13:45:61:41	1

b. After A sends a frame to D

Address	Port
71:2B:13:45:61:41	1
64:2B:13:45:61:13	4

c. After D sends a frame to B

Address	Port
71:2B:13:45:61:41	1
64:2B:13:45:61:13	4
71:2B:13:45:61:42	2

d. After B sends a frame to A

Address	Port
71:2B:13:45:61:41	1
64:2B:13:45:61:13	4
71:2B:13:45:61:42	2
64:2B:13:45:61:12	3

e. After C sends a frame to D

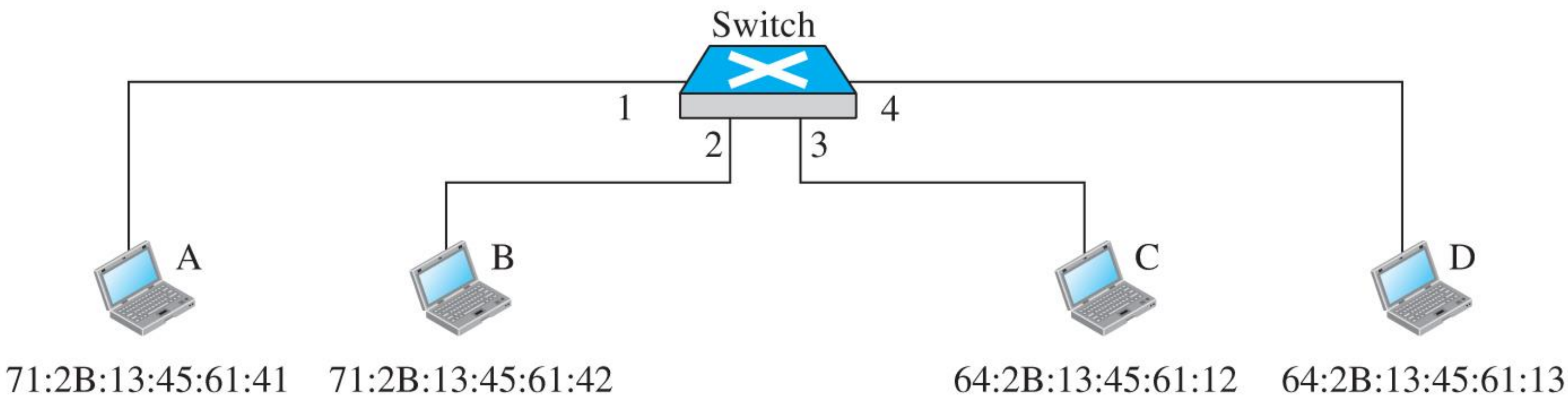

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Figure 6.5 Loop problem in a learning switch (Part a)

a. Station A sends a frame to station D

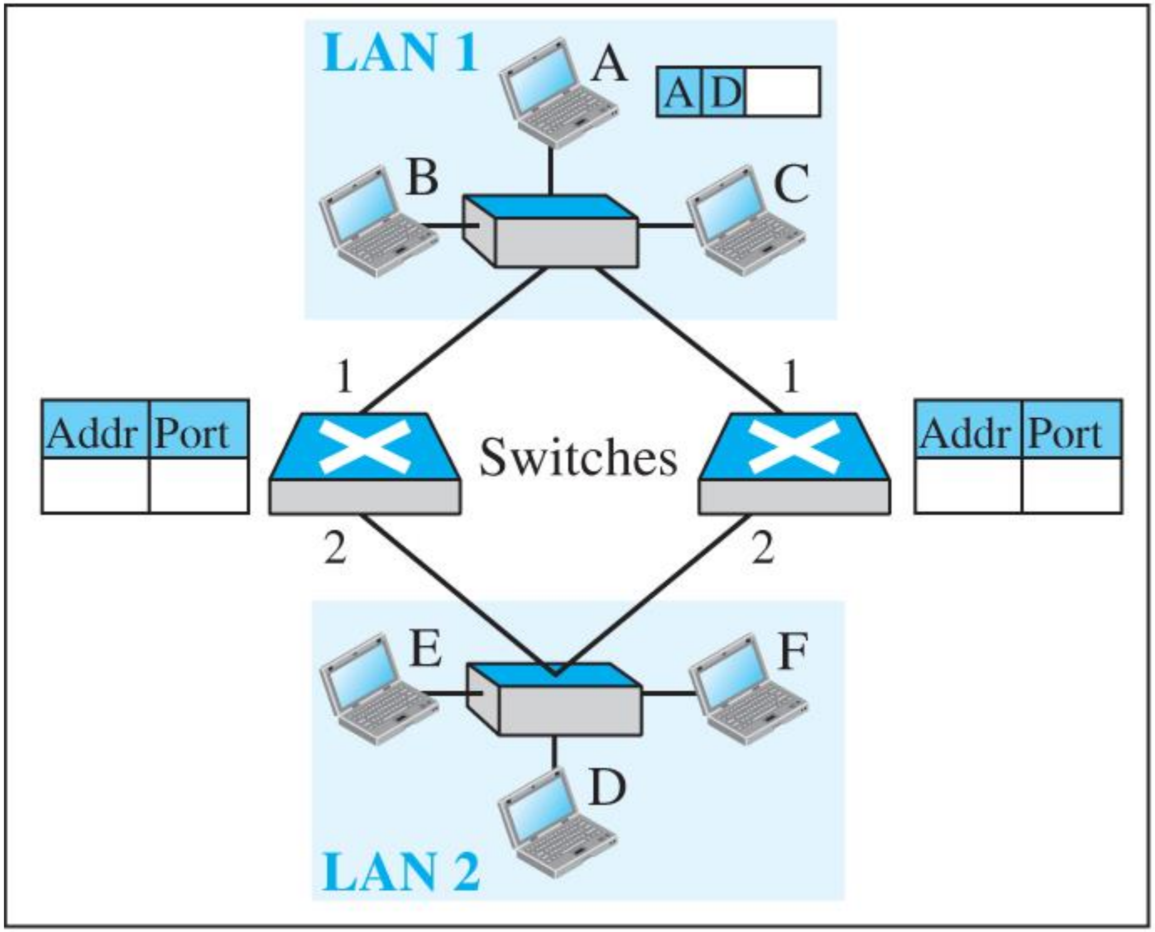

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Figure 6.5 Loop problem in a learning switch (Part b)

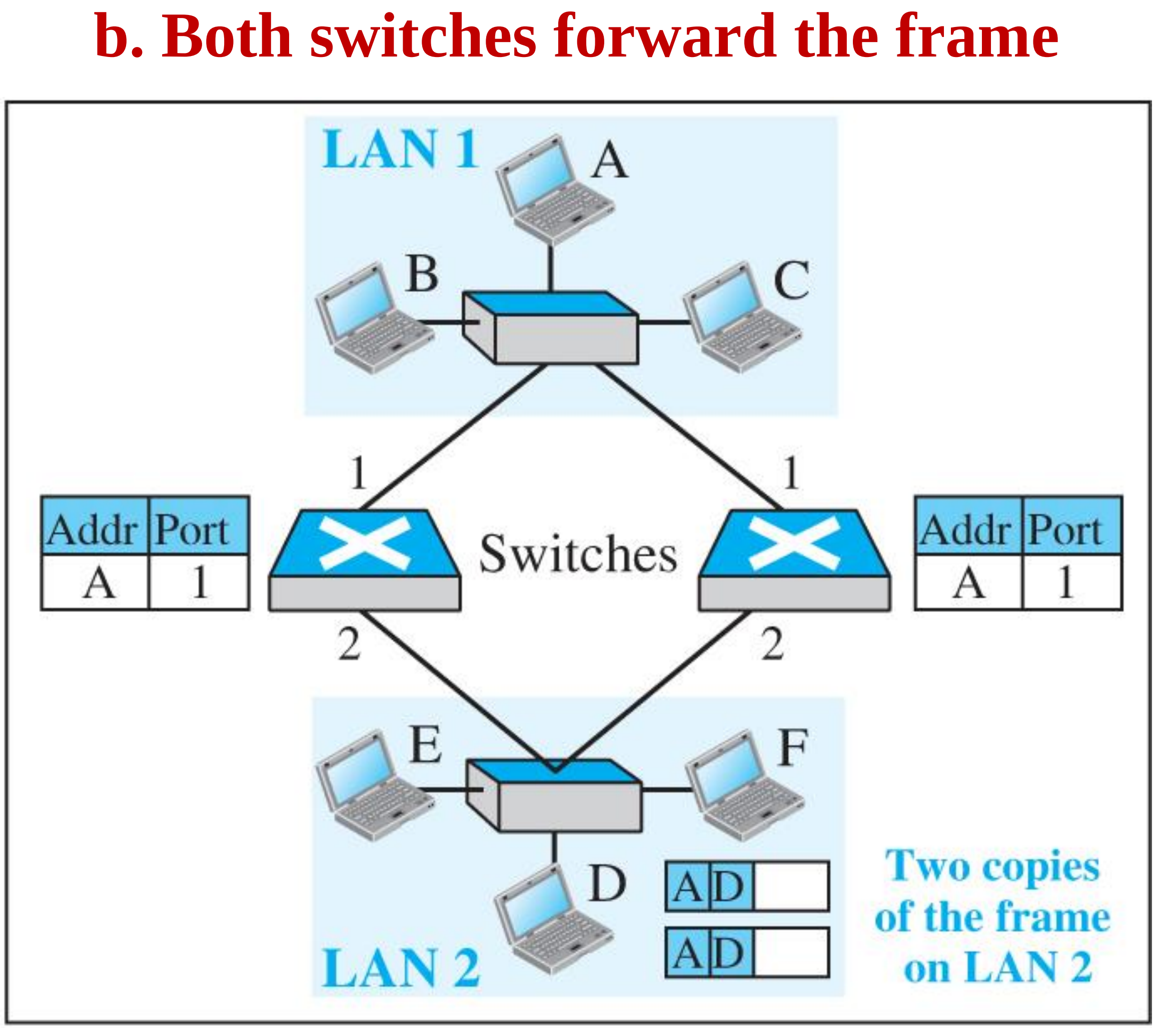

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Figure 6.5 Loop problem in a learning switch (Part c)

c. Both switches forward the frame

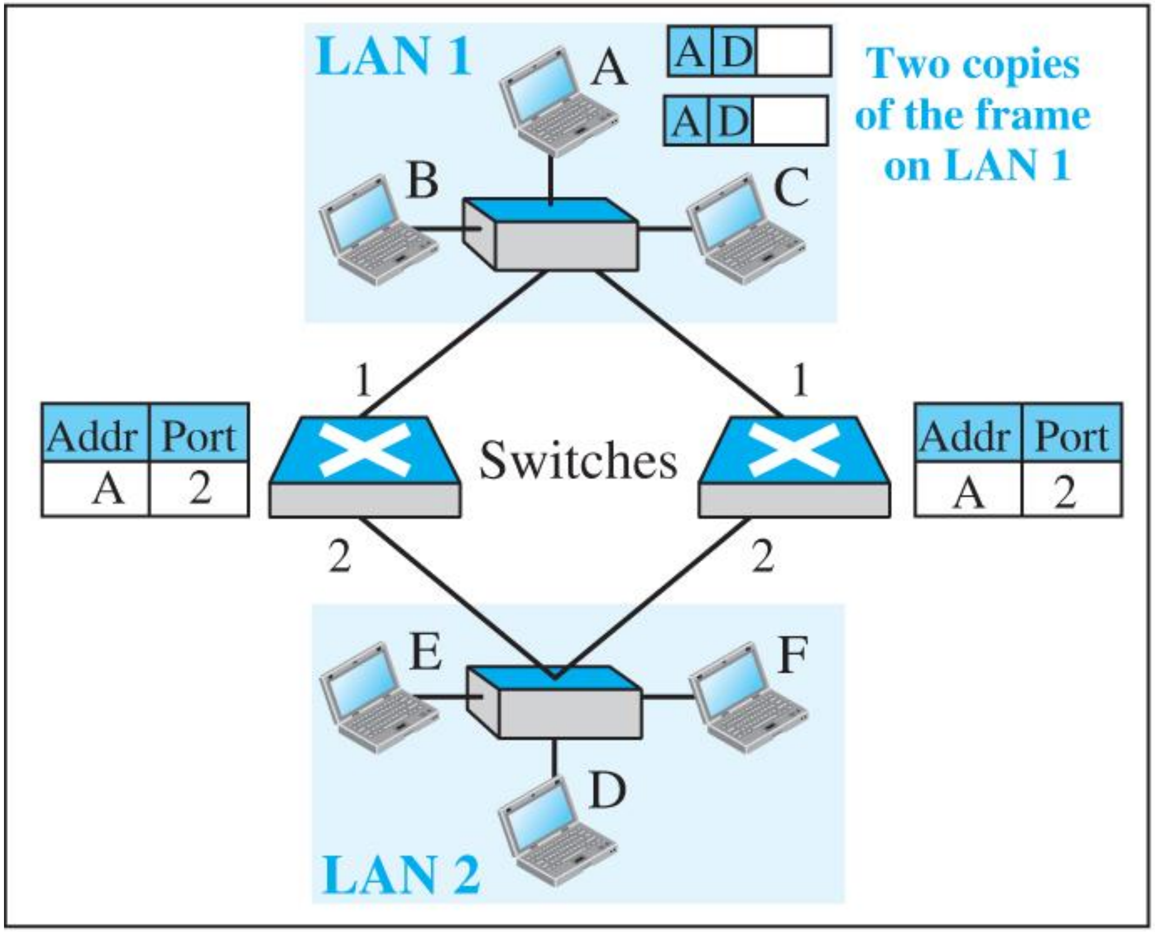

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Figure 6.5 Loop problem in a learning switch (Part d)

d. Both switches forward the frame

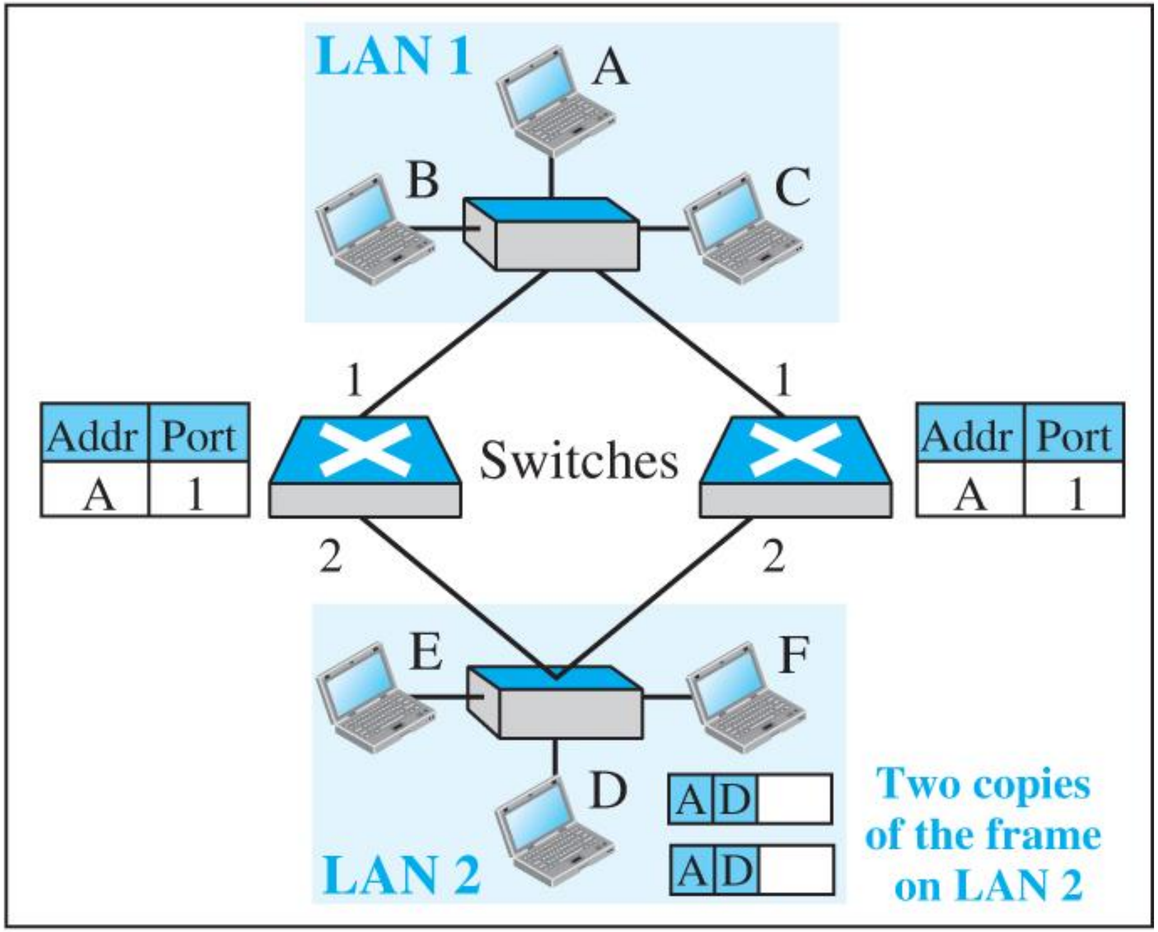

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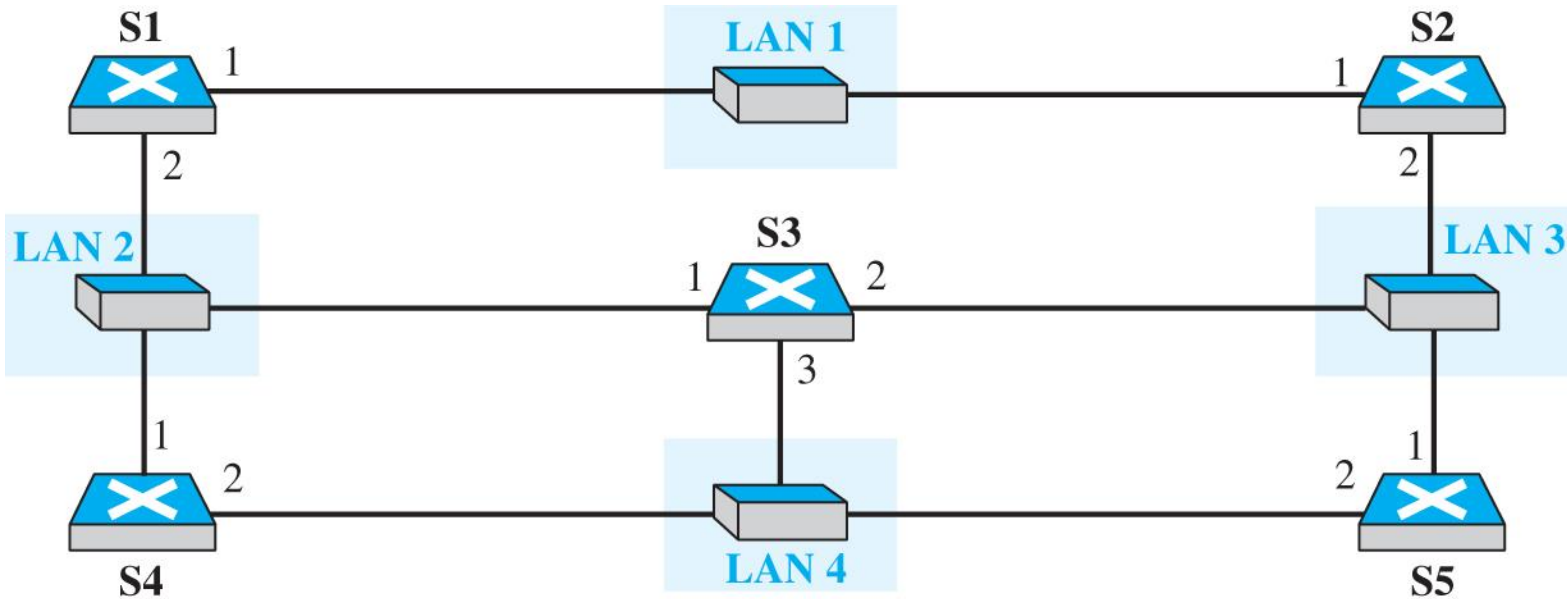
Figure 6.6 A system of connected LANs and its graph (Part a)



a. Actual system

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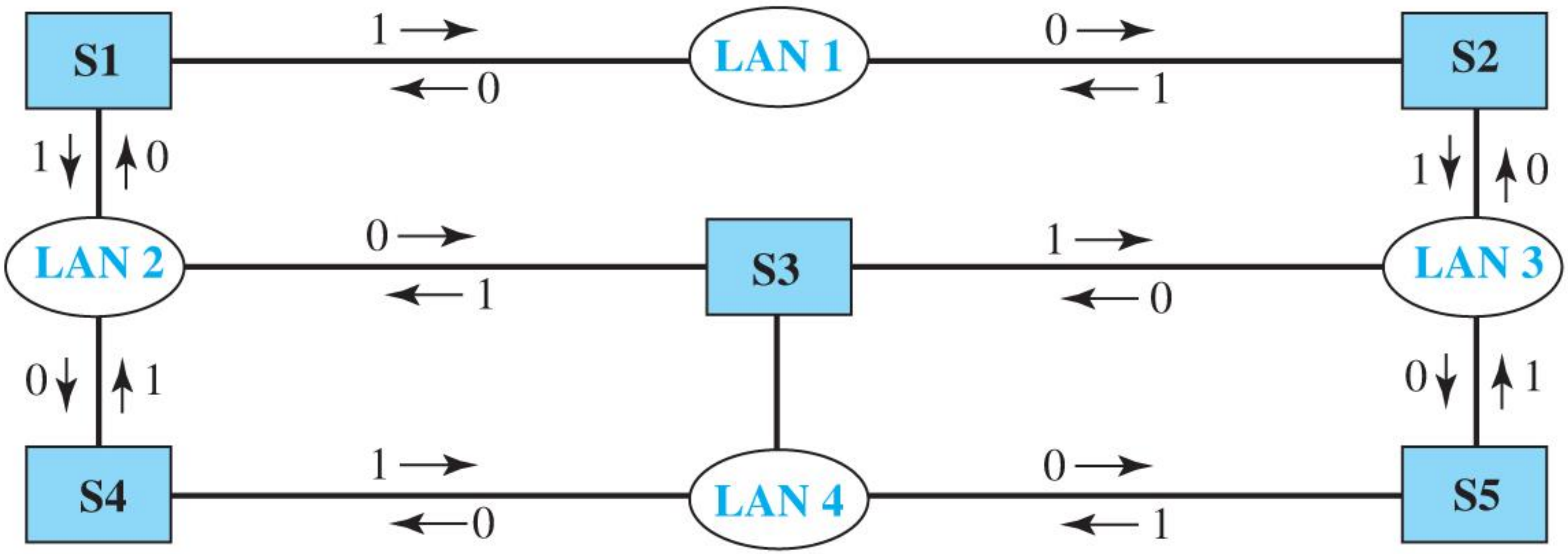
Figure 6.6 A system of connected LANs and its graph (Part b)



b. Graph representation with cost assigned to each arc

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Figure 6.7 Finding the shortest path and the spanning tree for a switch.

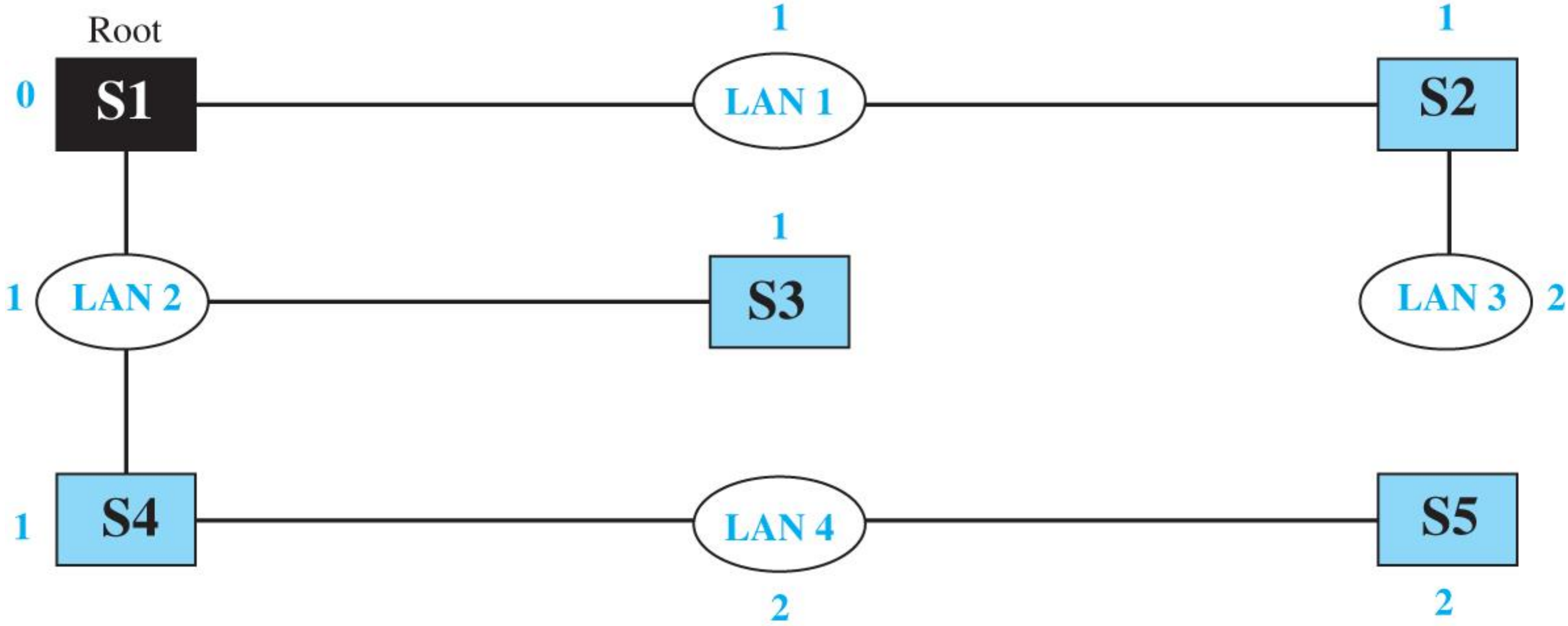

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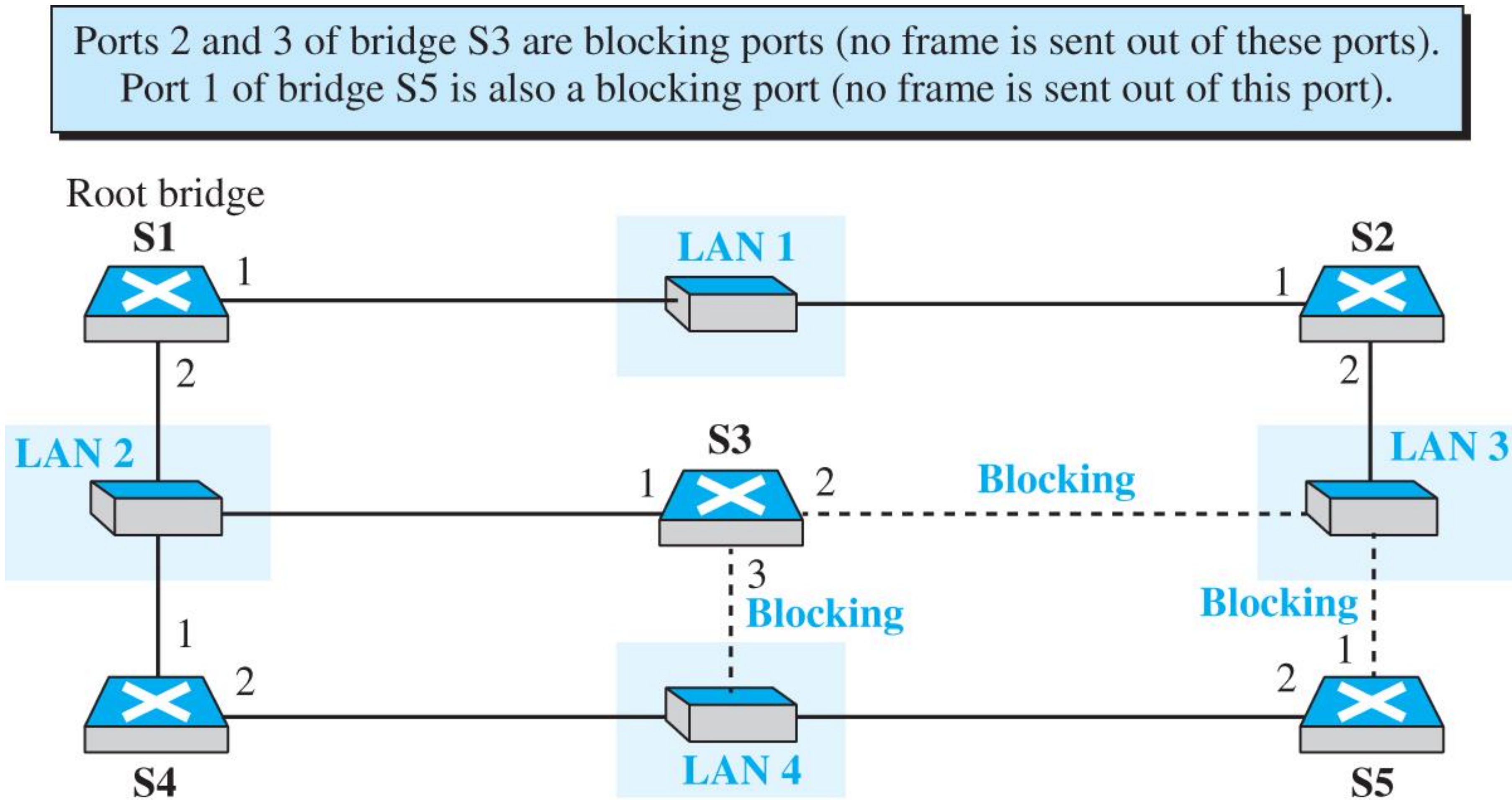
Figure 6.8 Forwarding and blocking ports after using spanning tree algorithm



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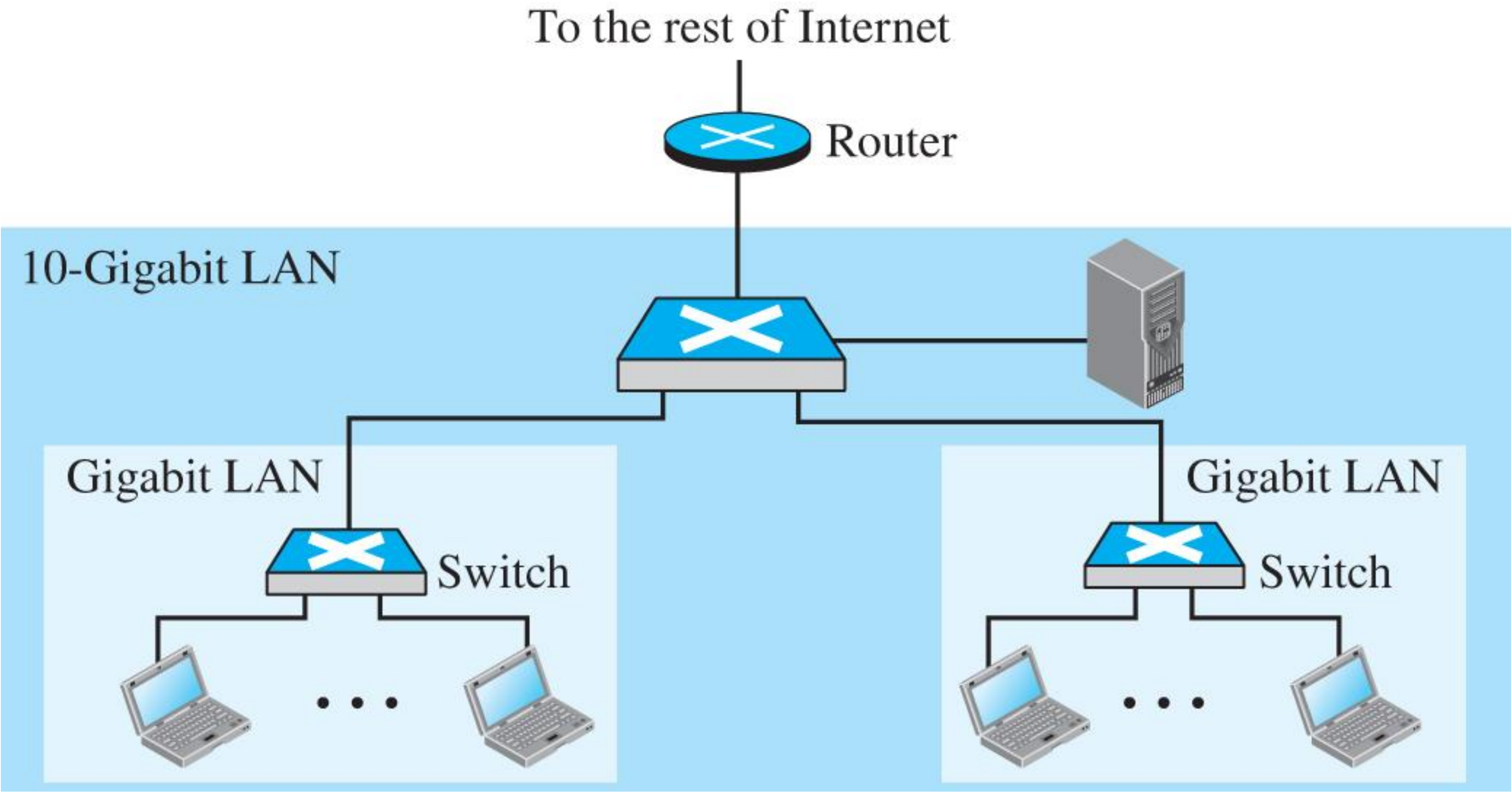
Advantages of Switches

A link-layer switch has several advantages over a hub. We discuss only two of them here: collision elimination and connecting heterogenous routers.

6.1.3 Routers

We will discuss routing in a future chapter when we discuss the network layer. In this section, we mention routers to compare them with a two-layer switch and a hub. A router is a three-layer device; it operates in the physical, data-link, and network layers.

Figure 6.9 Routing example



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6-2 VIRTUAL LANS

A station is considered part of a LAN if it physically belongs to that LAN. The criterion of membership is geographic. What happens if we need a virtual connection between two stations belonging to two different physical LANs? We can roughly define a virtual local area network (VLAN) as a local area network configured by software, not by physical wiring.

Figure 6.10 A switch connecting three LANs

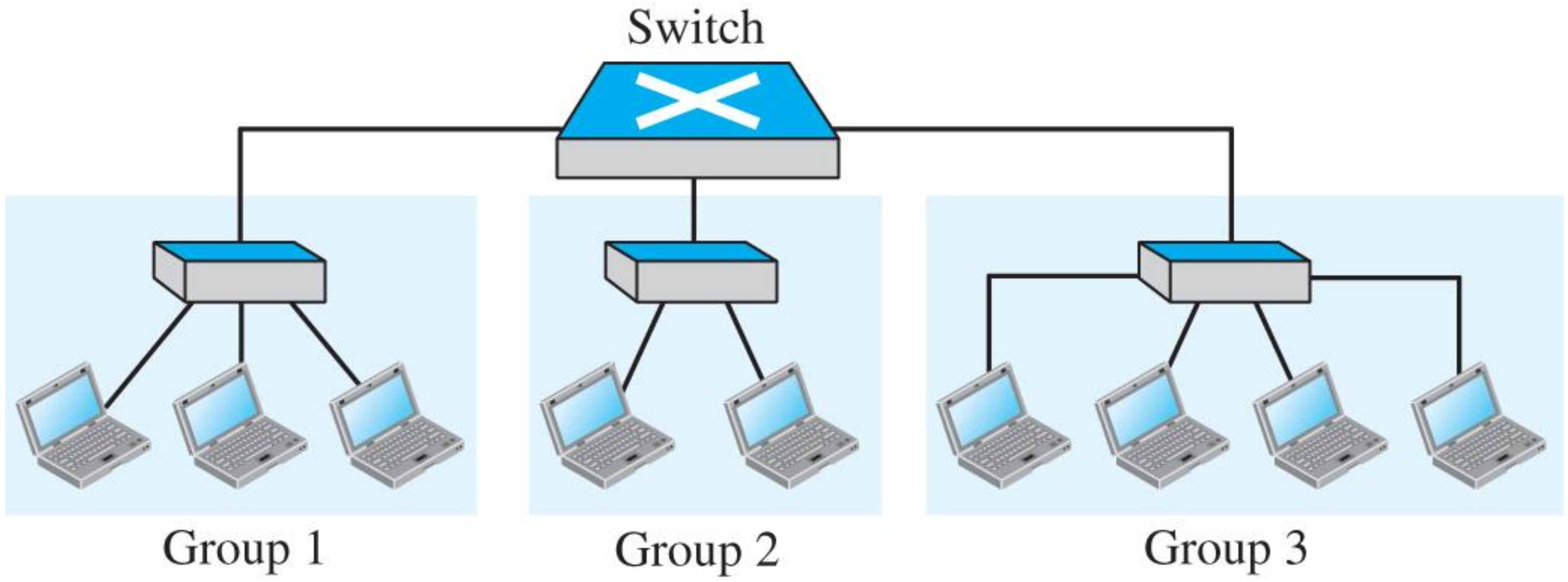

Figure 6.11 A switch using VLAN software

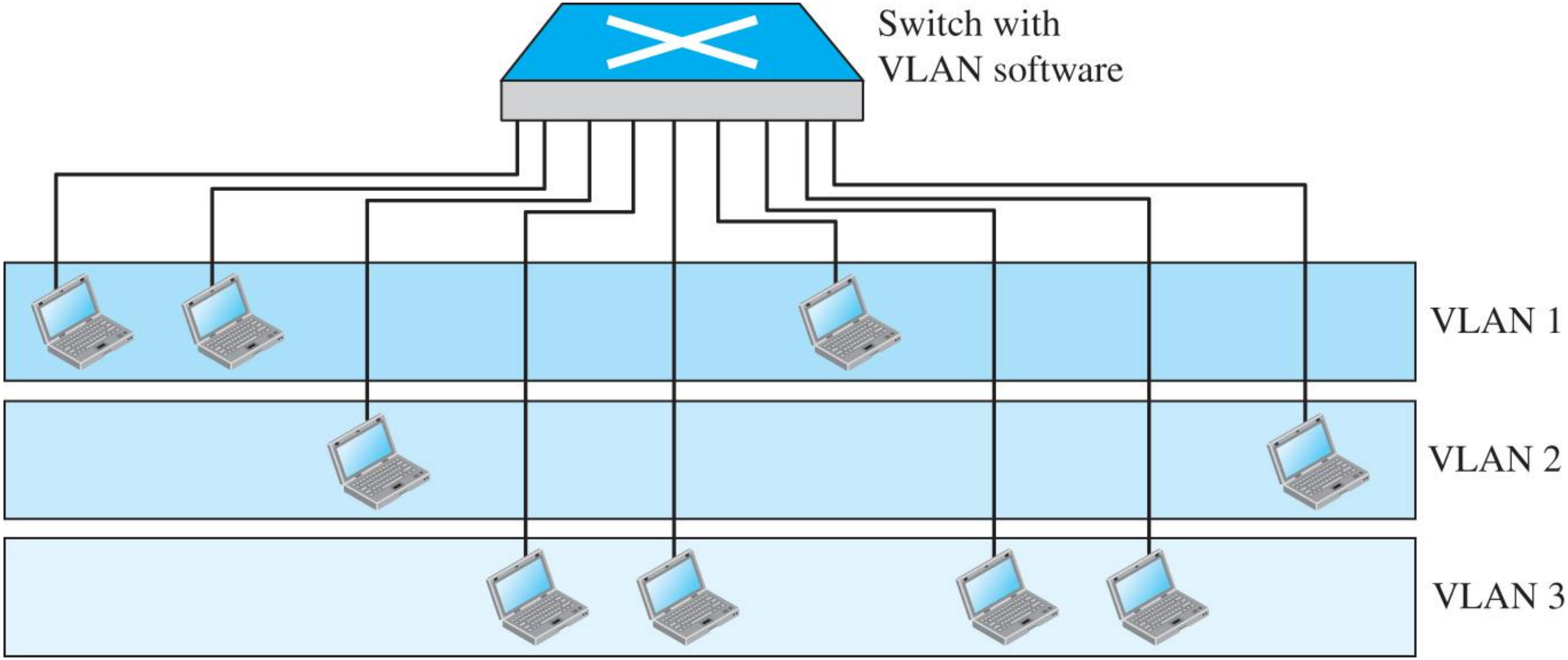

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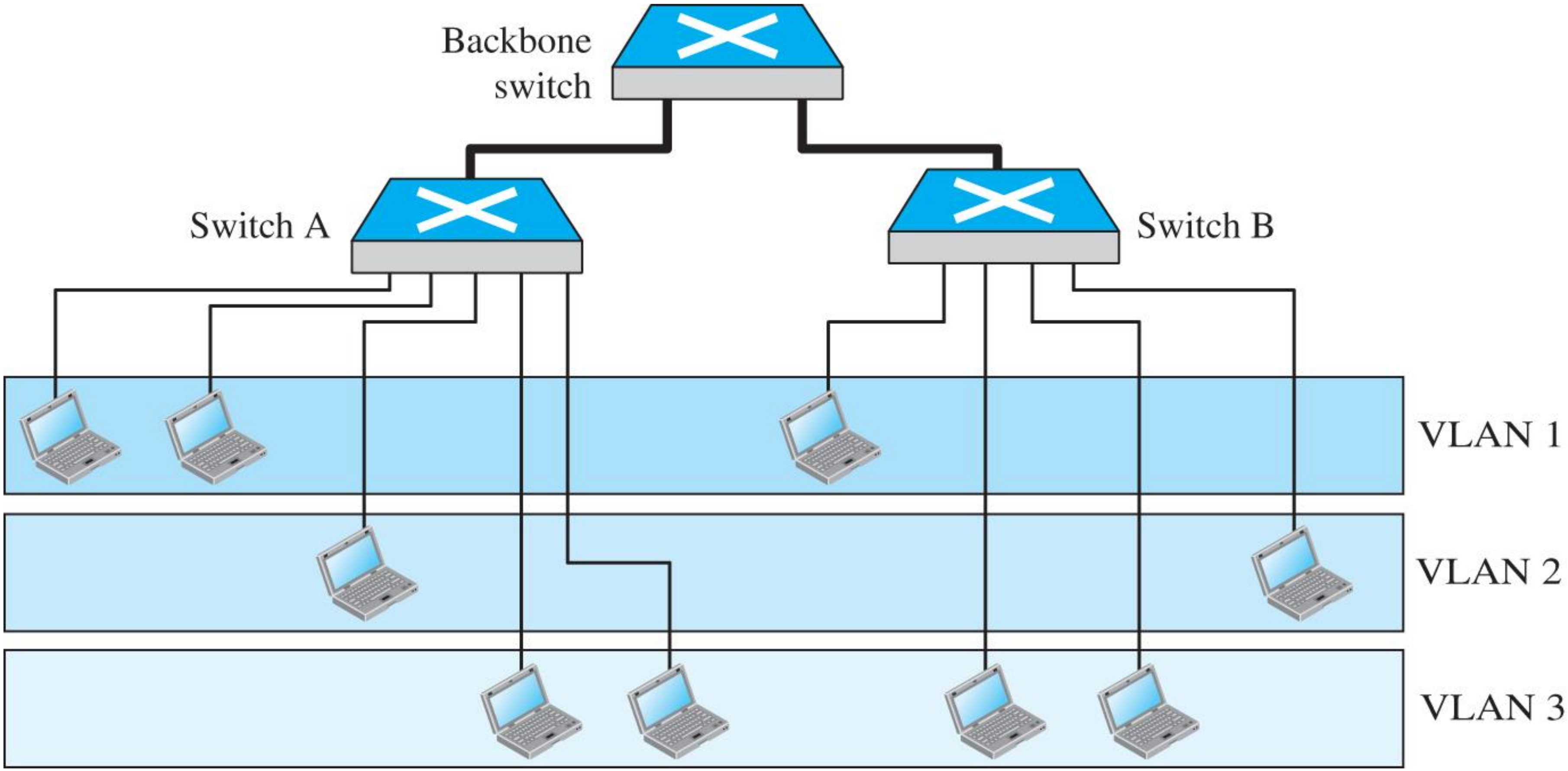
Figure 6.12 Two switches in a backbone using VLAN software



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6.2.1 Membership

What characteristic can be used to group stations in a VLAN? Vendors use different characteristics such as interface numbers, port numbers, MAC addresses, IP addresses, IP multicast addresses, or a combination of two or more of these.

Interface Numbers

Some VLAN vendors use switch interface numbers as a membership characteristic. For example, the administrator can define that stations connecting to ports 1, 2, 3, and 7 belong to VLAN 1; stations connecting to ports 4, 10, and 12 belong to VLAN 2; and so on.

MAC Addresses

Some VLAN vendors use the 48-bit MAC address as a membership characteristic. For example, the administrator can stipulate that stations having MAC addresses E2:13:42:A1:23:34 and F2:A1:23:BC:D3:41 belong to VLAN 1

Combination

Recently, the software available from some vendors allows all these characteristics to be combined. The administrator can choose one or more characteristics when installing the software. In addition, the software can be reconfigured to change the settings.

6.2.2 Configuration

How are the stations grouped into different VLANs? Stations are configured in one of three ways: manually, semiautomatically, and automatically.

Manual Configuration

In a manual configuration, the network administrator uses the VLAN software to manually assign the stations into different VLANs at setup. Later migration from one VLAN to another is also done manually. Note that this is not a physical configuration; it is a logical configuration. The term manually here means that the administrator types the port numbers, the IP addresses, or other characteristics, using the VLAN software.

Automatic Configuration

In an automatic configuration, the stations are automatically connected or disconnected from a VLAN using criteria defined by the administrator. For example, the administrator can define the project number as the criterion for being a member of a group. When a user changes projects, he or she automatically migrates to a new VLAN.

Semiautomatic Configuration

A semiautomatic configuration is somewhere between a manual configuration and an automatic configuration. Usually, the initializing is done manually, with migrations done automatically.

6.2.3 Communication between Switches

In a multi-switched backbone, each switch must know not only which station belongs to which VLAN, but also the membership of stations connected to other switches. Three methods have been devised for this purpose: table maintenance, frame tagging, and time-division multiplexing.

Table Maintenance

In this method, when a station sends a broadcast frame to its group members, the switch creates an entry in a table and records station membership. The switches send their tables to one another periodically for updating.

Frame Tagging

In this method, when a frame is traveling between switches, an extra header is added to the MAC frame to define the destination VLAN. The frame tag is used by the receiving switches to determine the VLANs to be receiving the broadcast message.

Time-Division Multiplexing (TDM)

In this method, the connection (trunk) between switches is divided into time-shared channels (such as TDM). For example, if the total number of VLANs in a backbone is five, each trunk is divided into five channels. The traffic destined for VLAN 1 travels in channel 1, the traffic destined for VLAN 2 travels in channel 2, and so on. The receiving switch determines the destination VLAN by checking the channel from which the frame arrived.

IEEE Standard

In 1996, the IEEE 802.1 subcommittee passed a standard called 802.1Q that defines the format for frame tagging. The standard also defines the format to be used in multi-switched backbones and enables the use of multivendor equipment in VLANs. IEEE 802.1Q has opened the way for further standardization in other issues related to VLANs. Most vendors have already accepted the standard.

6.2.4 Advantages

There are several advantages to using VLANs:

- *Cost and time reduction*
- *Creating virtual work groups*
- *Security*

Cost and Time Reduction

VLANs can reduce the migration cost of stations going from one group to another. Physical reconfiguration takes time and is costly. Instead of physically moving one station to another segment or even to another switch, it is much easier and quicker to move it by using software.

Creating Virtual Work Groups

VLANs can be used to create virtual work groups. For example, in a campus environment, professors working on the same project can send broadcast messages to one another without the necessity of belonging to the same department. This can reduce traffic if the multicasting capability of IP was previously used.

Security

VLANs provide an extra measure of security. People belonging to the same group can send broadcast messages with the guaranteed assurance that users in other groups will not receive these messages.

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