Medium Access Control Protocols and Local Area Networks

LAN BRIDGES

Reference

Leon Garcia – 6.11 (Upto 6.11.3)

Introduction

There are several ways of interconnecting Networks

When two or more networks are interconnected at the **physical layer** the type of device is called as a **repeater**.

When two or more devices are interconnected at the **MAC layer or data link layer**, the type of the device is called as a **bridge**

When two or more devices are interconnected at the **network layer**, the type of the device is called as a **router**

The device that interconnects at **higher level** is called as **gateway**, which generally performs some protocol conversion and security functions

Why do we need Bridges

Let us consider a scenario in which a large organization has multiple departmental LAN.

After a certain period of time, a requirement arises in the organization to interconnect the departmental LAN in order to share the resources. But this scenario is complicated by the following factors:

The departmental LANs use different network layer protocols.

The departments may be located in different buildings

The LANs differ in type

These three requirements can be supported by bridges.

As bridges exchange frames in the data link layer, the frames can contain any network layer packets

If necessary the bridges can be connected by point to point link.

Bridges also support frame conversion thus supporting intercommunication between different LANs.

Thus Bridges are used for connecting multiple LANs as shown in the figure.

Bridged LAN or Extended LAN

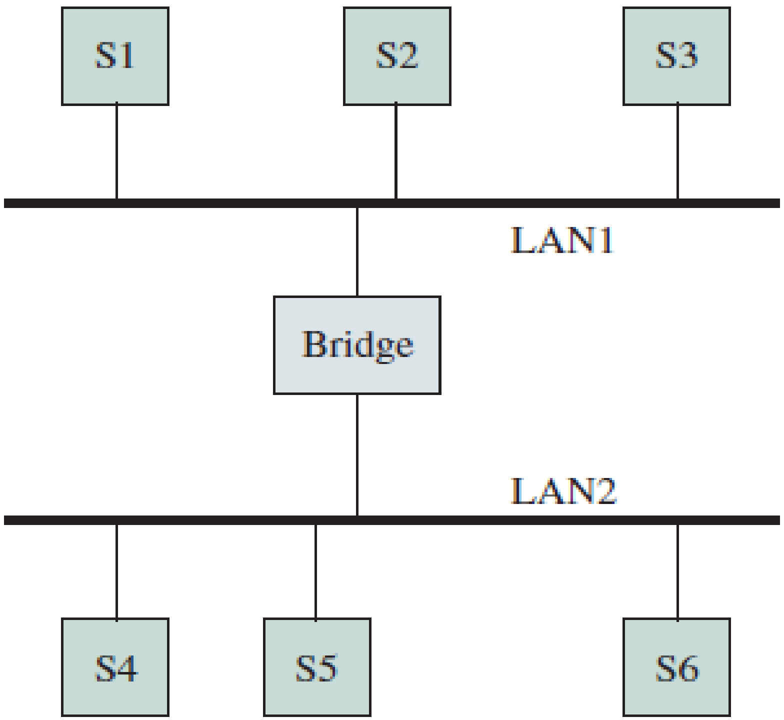
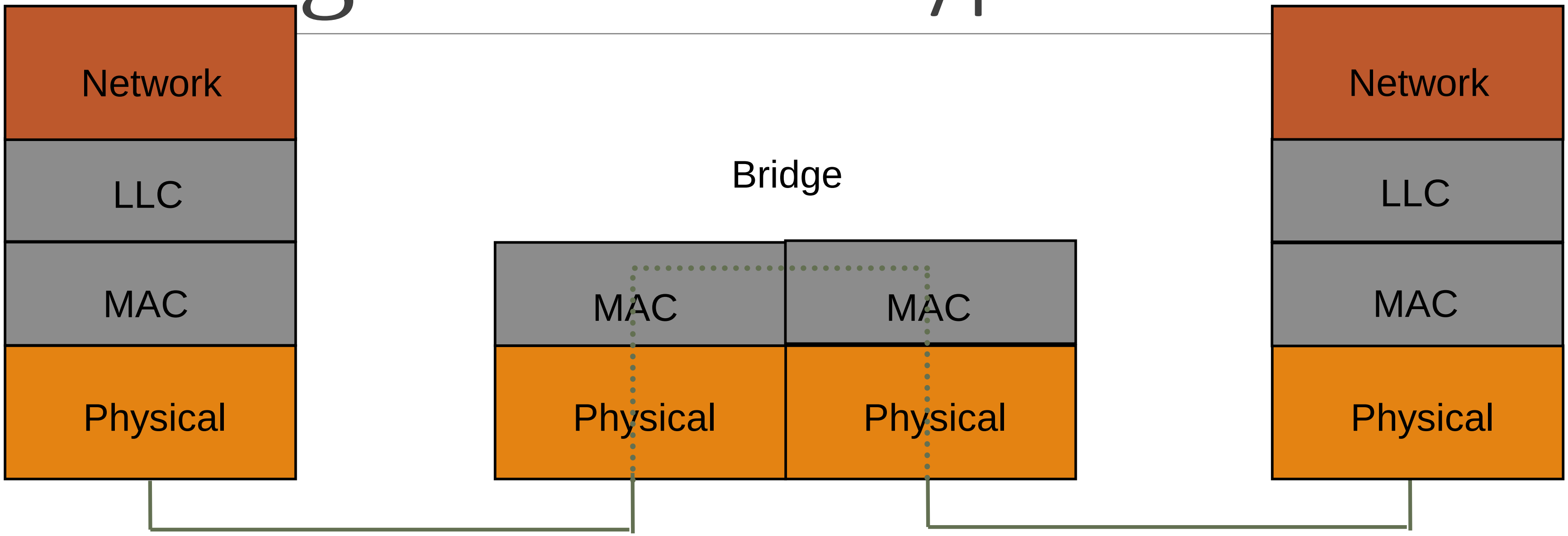


FIGURE 6.79 A bridged LAN

Bridges of Same Type



Bridging is done at MAC level thus operating in the data link layer

To have frame filtering capability , a bridge has to monitor MAC address of each frame.

Types of Bridges

There are two types of bridges which are widely used:

- Transparent Bridges: These bridges are widely used in Ethernet LANs
- Source Routing Bridges: These bridges are widely used in Token Ring LANs and FDDI networks

Transparent Bridges

- These bridges were defined by the 802.1d committee.
- The term transparent refers to the fact that the stations are completely unaware of the presence of the bridges in the network
- Thus introducing a bridge doesn't require the stations to be configured.
- Following are the functions of the transparent bridges:
  - Forward Frames from one LAN to another
  - Learn which stations are attached to a given LAN
  - Avoid Loops in the topology

Bridge Learning

When frame arrives on one of the ports of the bridge, the bridge has to decide whether it has to forward the frame.

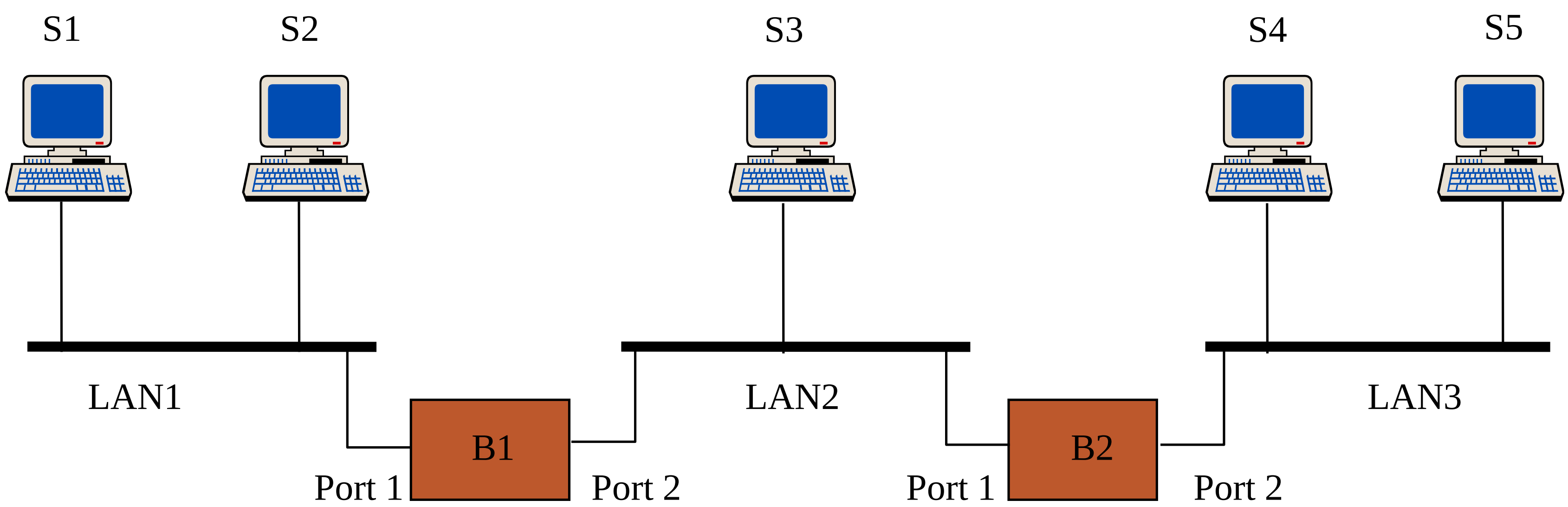
To do so it needs to maintain a table called as the forwarding table or forwarding database

Use table lookup, and

- discard frame, if source & destination in same LAN
- forward frame, if source & destination in different LAN
- use flooding, if destination unknown

Use backward learning to build table

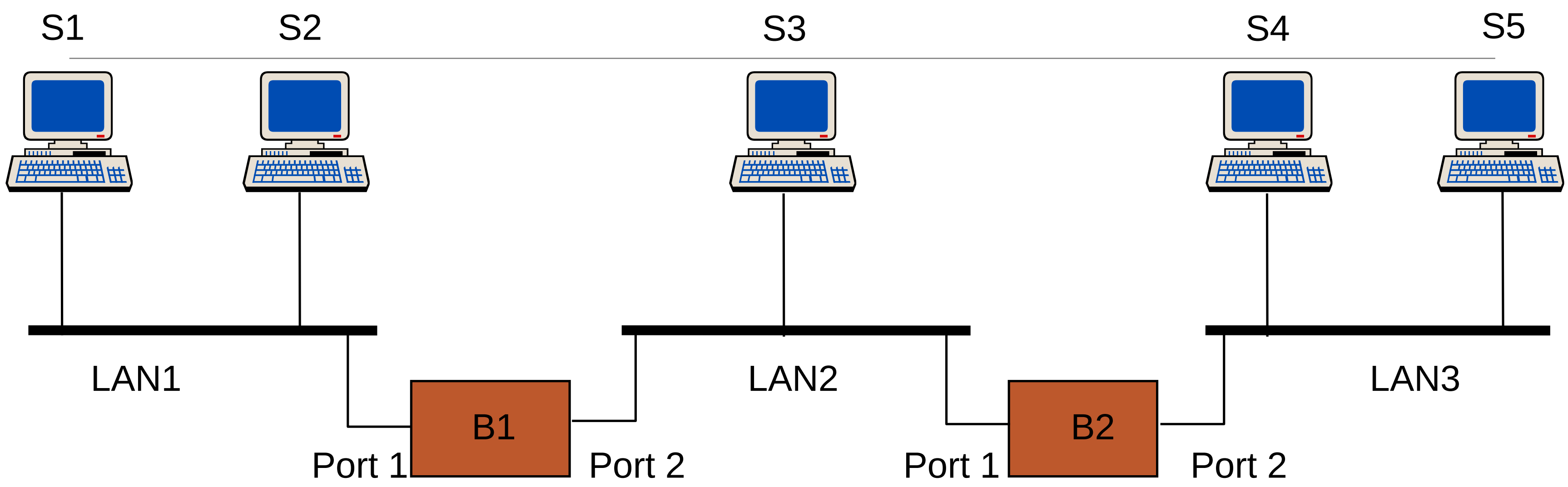
- observe source address of arriving LANs
- handle topology changes by removing old entries



Address	Port

Address	Port

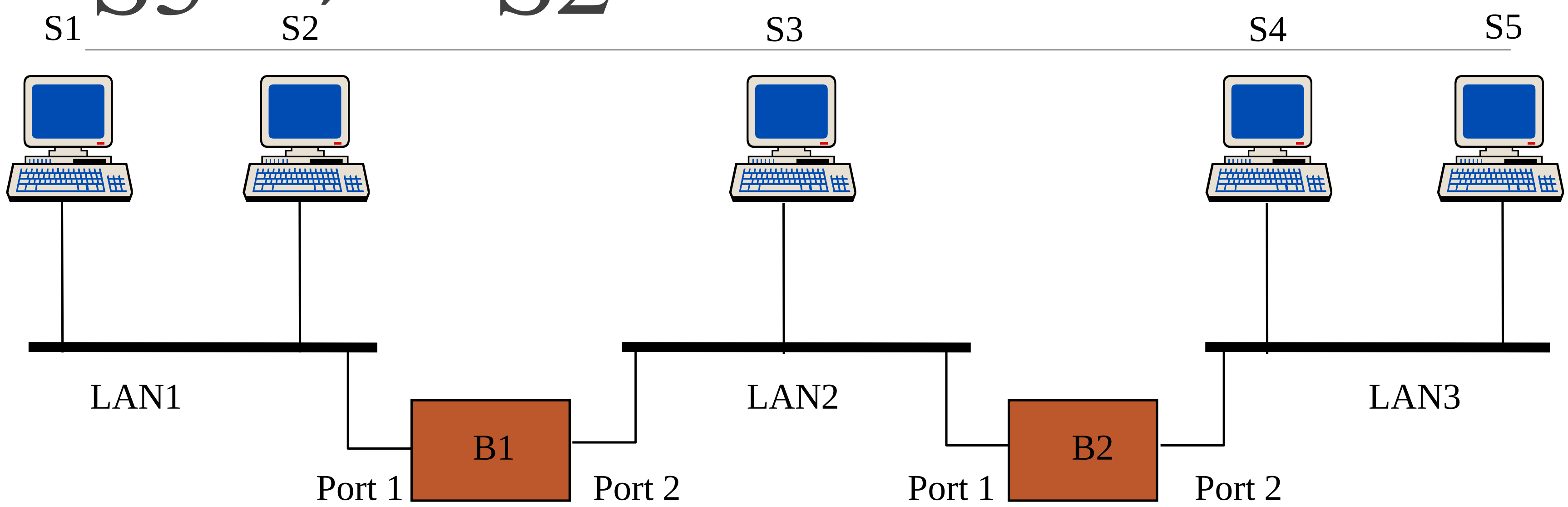
S1 → S 5



Address	Port
S1	1

Address	Port
S1	1

S3 → S2

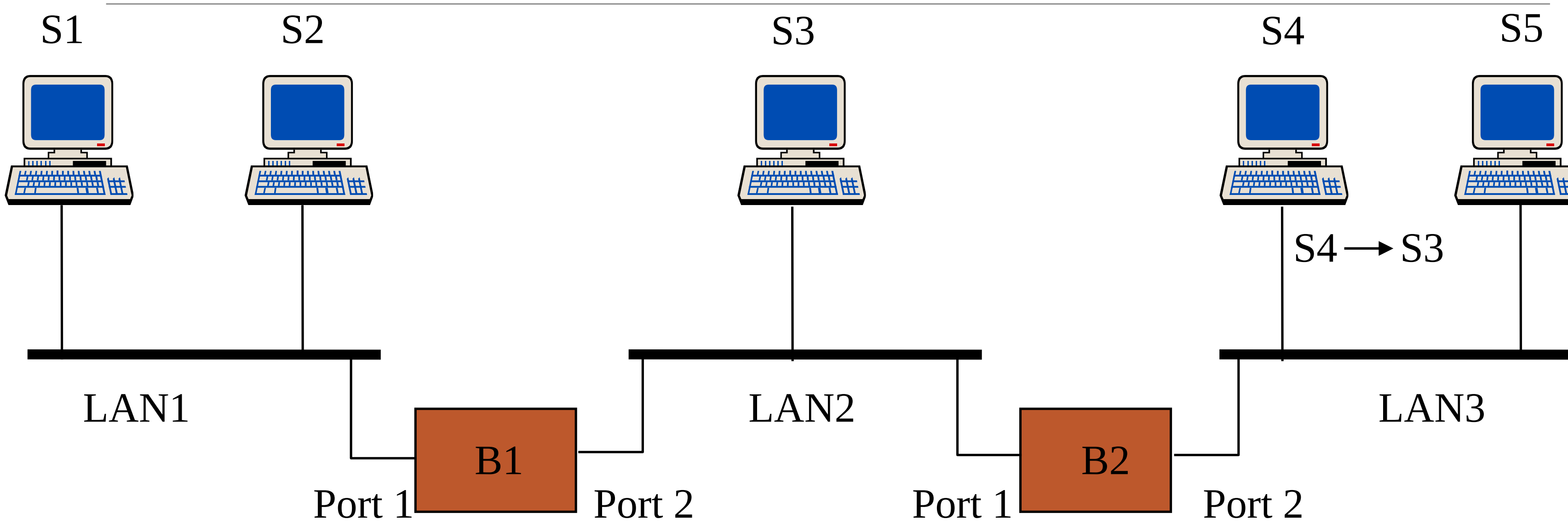


Address	Port
S1	1
S3	2

Address	Port
S1	1
S3	1

S4→ S3

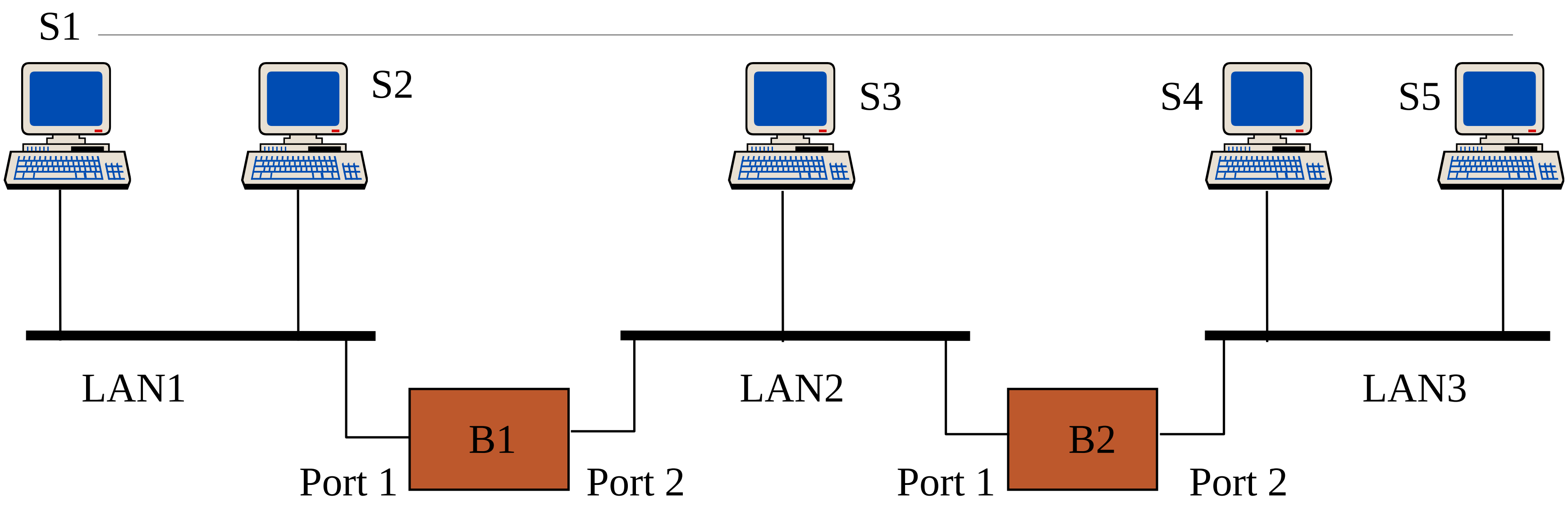
Details of S4 will be recorded in both B1 and B2 because S3 and B1 are connected in bus topology, therefore if a packet is forwarded it is received by all the nodes connected to the LAN



Address	Port
S1	1
S3	2
S4	2

Address	Port
S1	1
S3	1
S4	2

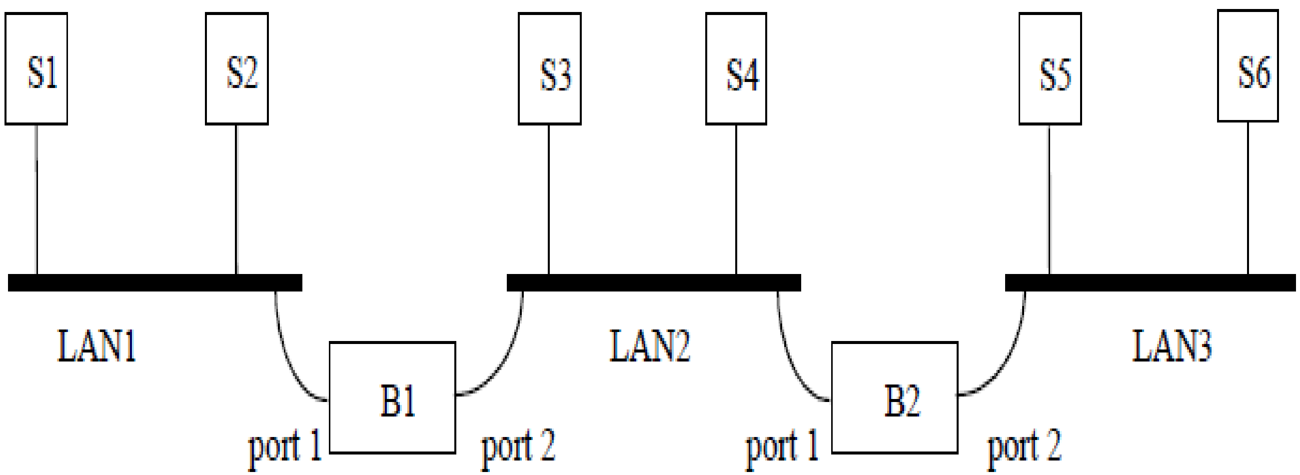
S2→ S1



Address	Port
S1	1
S3	2
S4	2
S2	1

Address	Port
S1	1
S3	1
S4	2

52. Six stations (S1-S6) are connected to an extended LAN through transparent bridges (B1 and B2), as shown in the figure below. Initially, the forwarding tables are empty. Suppose the following stations transmit frames: S2 transmits to S1, S5 transmits to S4, S3 transmits to S5, S1 transmits to S2, and S6 transmits to S5. Fill in the forwarding tables with appropriate entries after the frames have been completely transmitted.



Station	Port

Station	Port

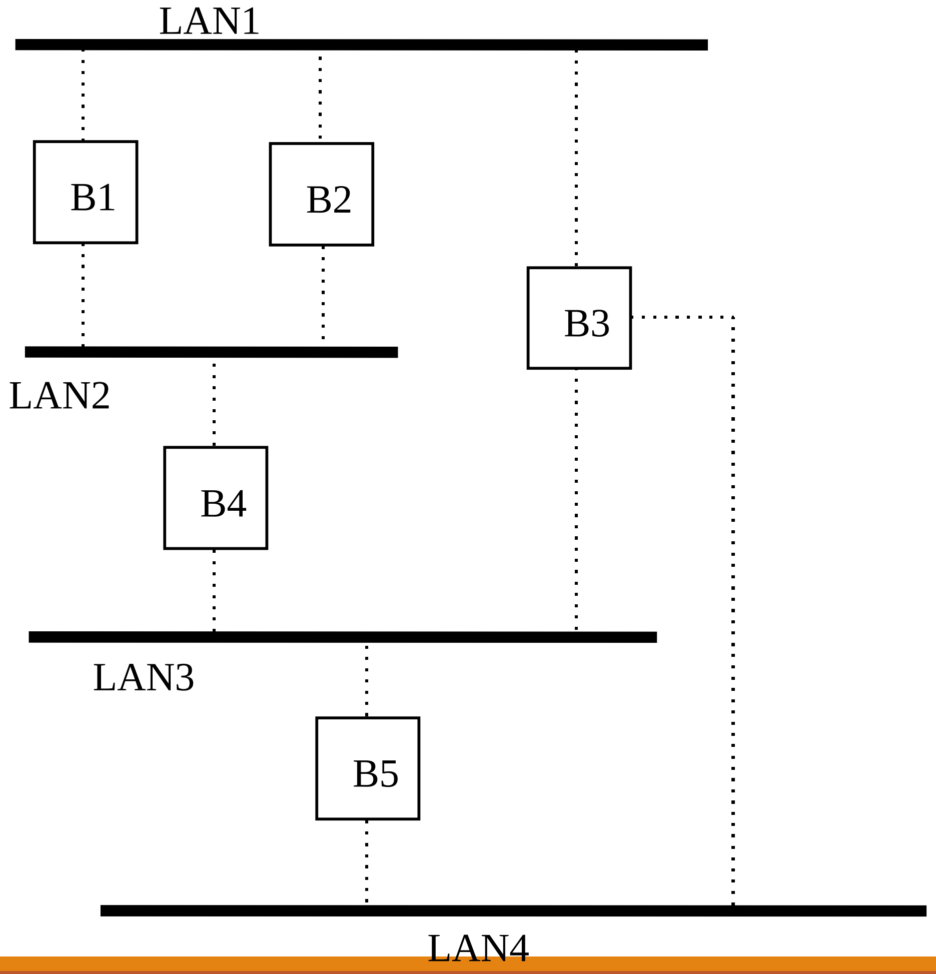
Solution:

Station	Port
S2	1
S5	2
S3	2
S1	1

Station	Port
S2	1
S5	2
S3	1
~~S1~~	~~1~~
S6	2

Delete the entry

Loops in the Network



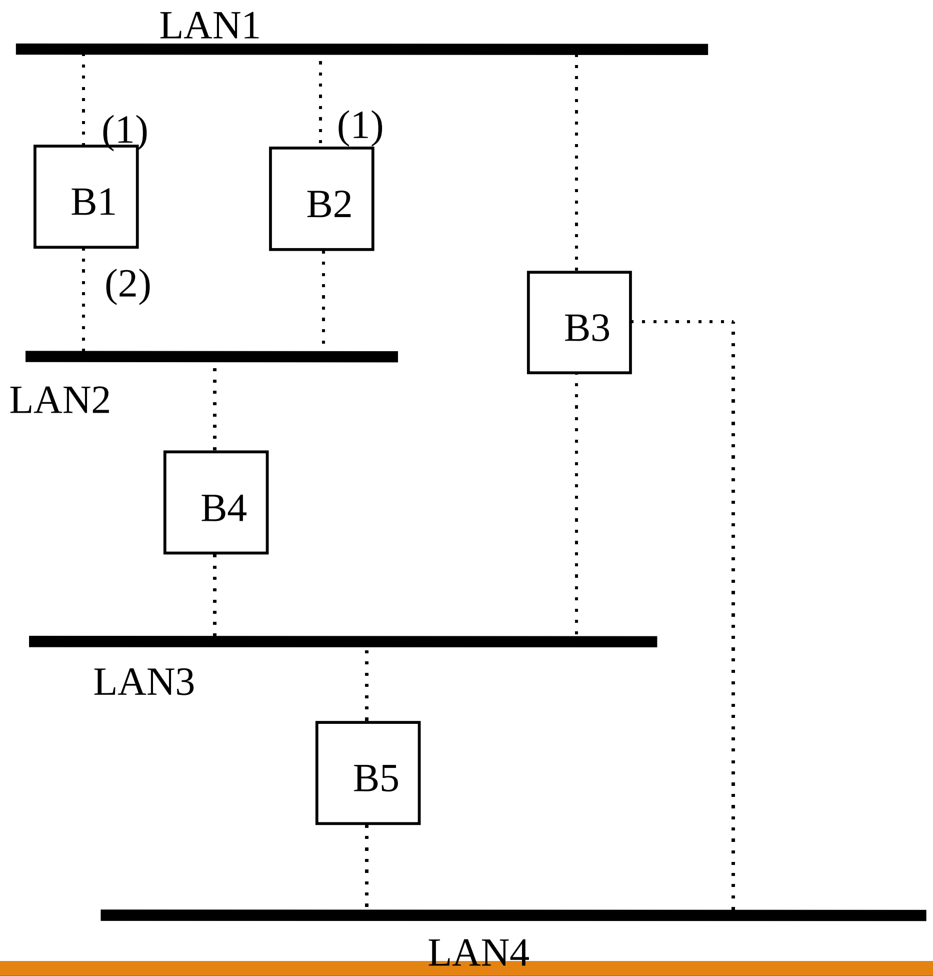
Spanning Tree

The learning process described works as long as the network doesn’t contain loops, which means only one path exists between the two LANs

To remove loops in the network, the IEEE 802.1 committee came up with an algorithm called as spanning tree

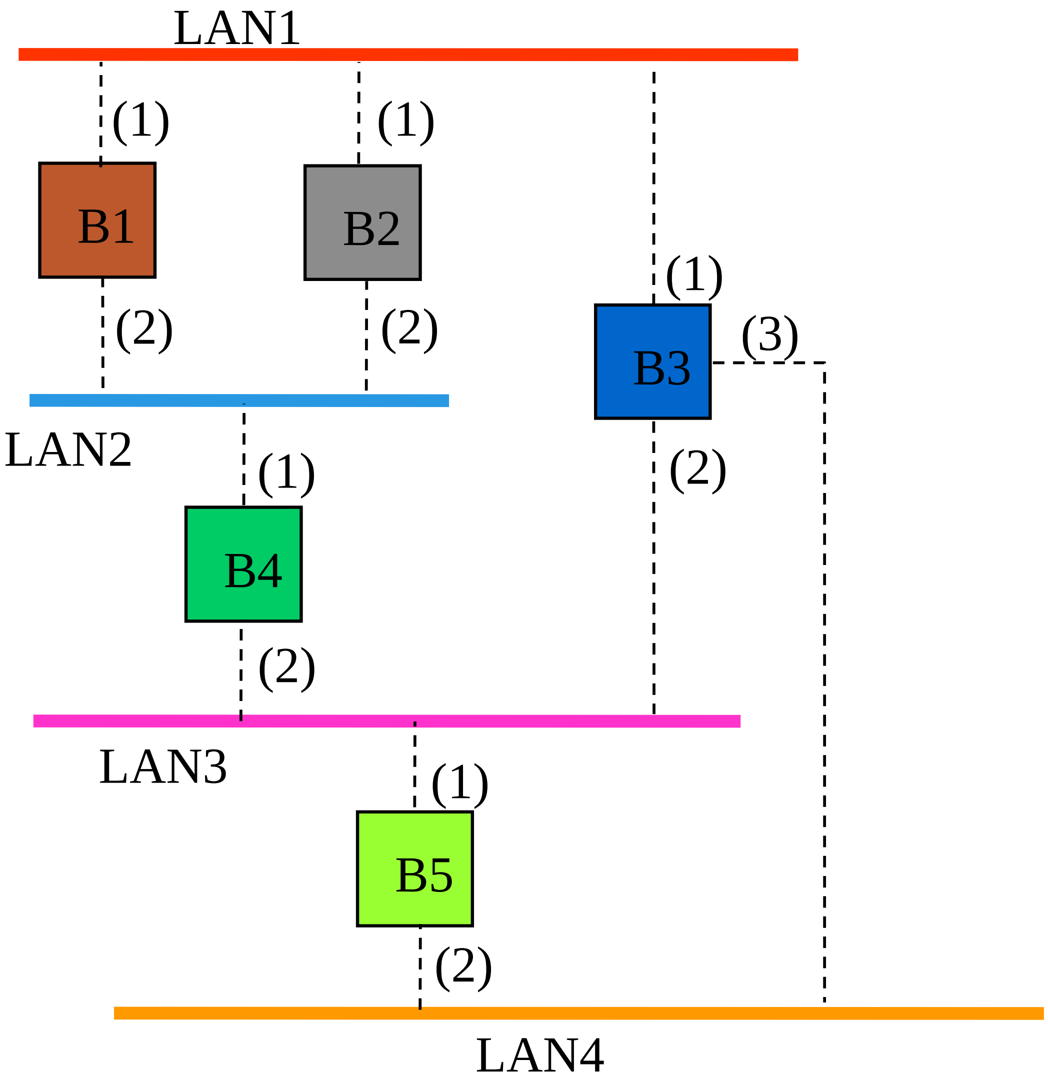
The spanning tree algorithm requires every bridge to have a unique ID, each port within a bridge to have a unique port ID and all bridges on the LAN to have a MAC address

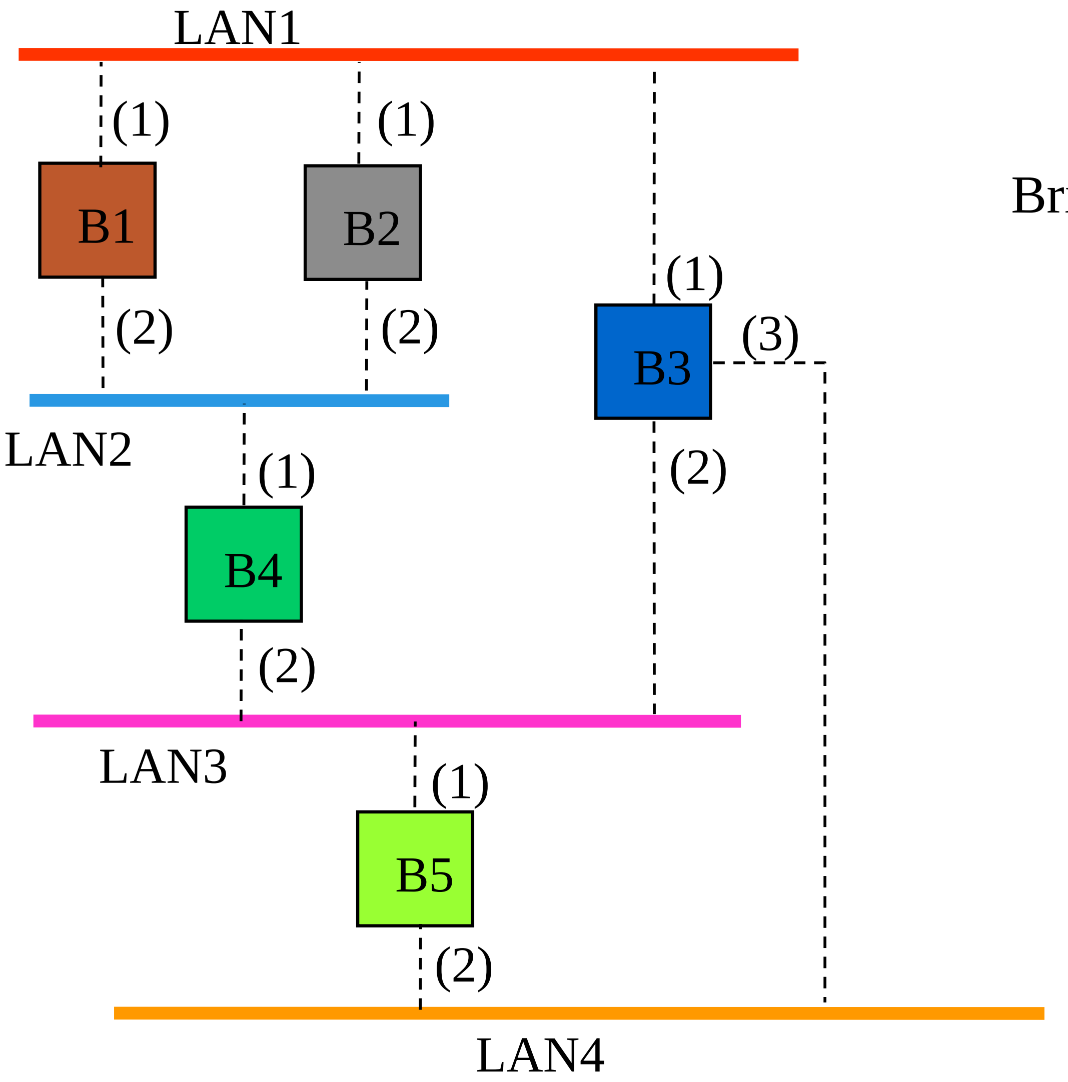
Avoiding Loops



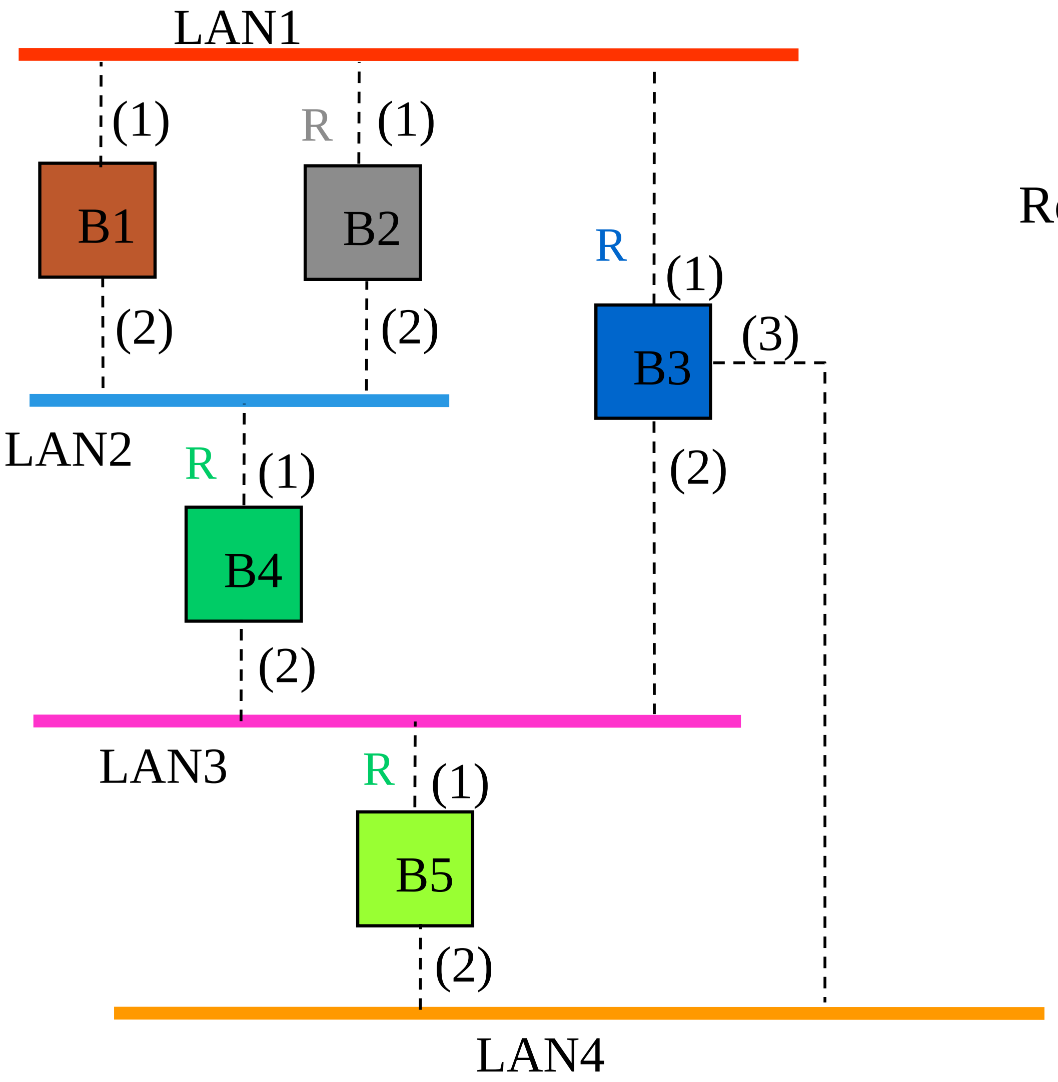
Spanning Tree Algorithm

1. Select a *root bridge* among all the bridges.
    - root bridge = the lowest bridge ID.
2. Determine the *root port* for each bridge except the root bridge
    - root port = port with the least-cost path to the root bridge
3. Select a *designated bridge* for each LAN
    - designated bridge = bridge has least-cost path from the LAN to the root bridge.
    - *designated port* connects the LAN and the designated bridge
4. All root ports and all designated ports are placed into a "forwarding" state. These are the only ports that are allowed to forward frames. The other ports are placed into a "blocking" state.

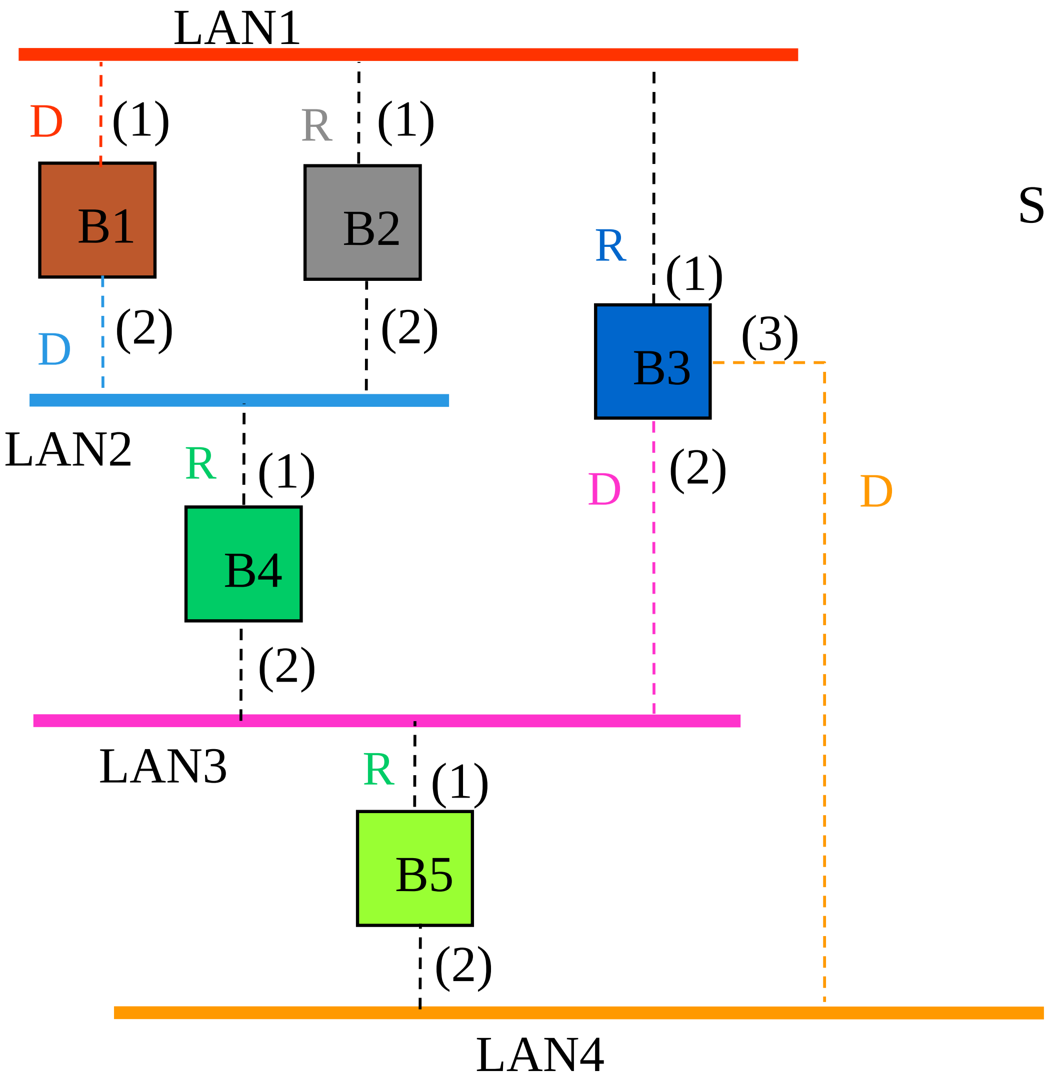

LAN1
(1)
(1)
B1
B2
(1)
(2)
(2)
(3)
B3
LAN2
(1)
(2)
B4
(2)
LAN3
(1)
B5
(2)
LAN4



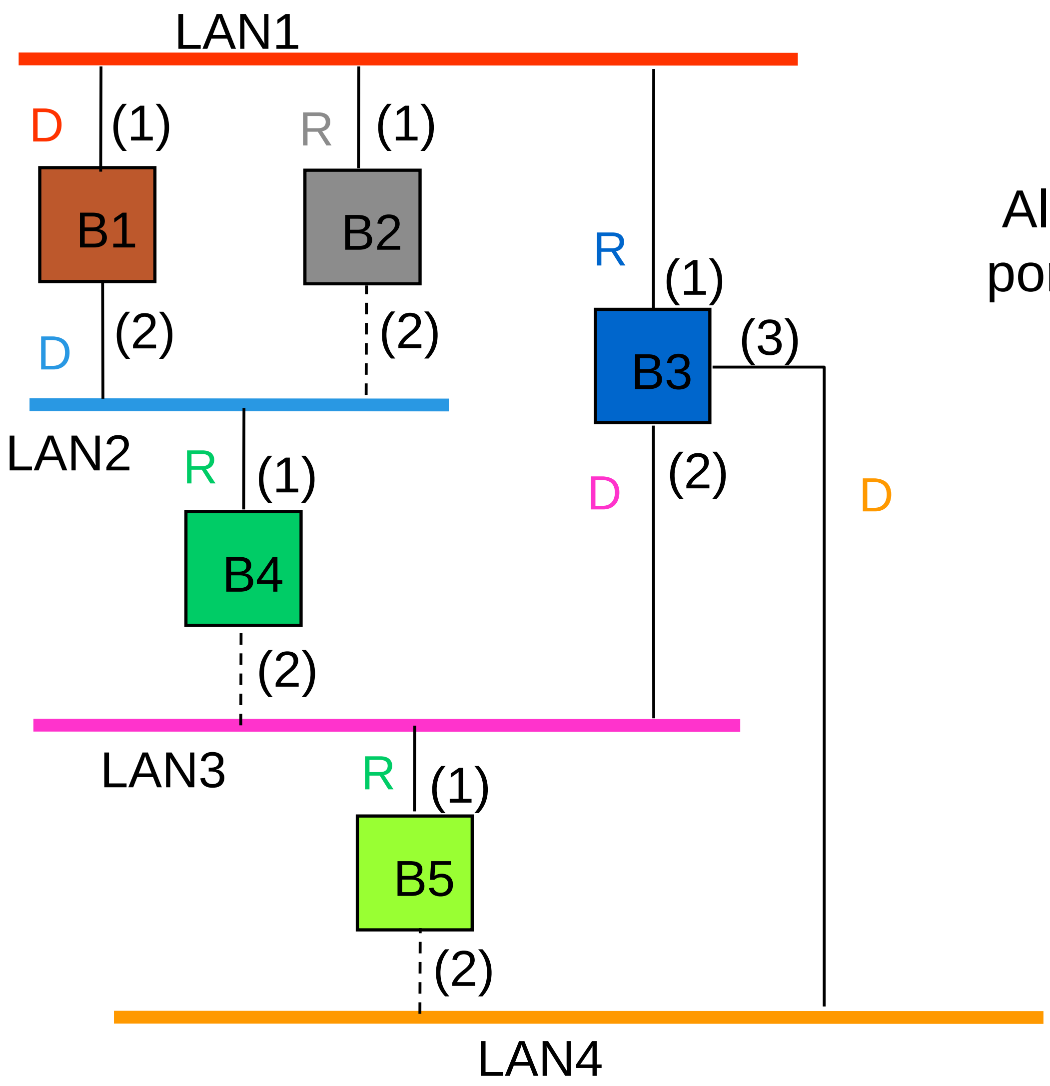
Bridge 1 selected as root bridge



Root port selected for every bridge except root port



Select designated bridge for each LAN



All root ports & designated ports put in forwarding state

Adaptive Learning

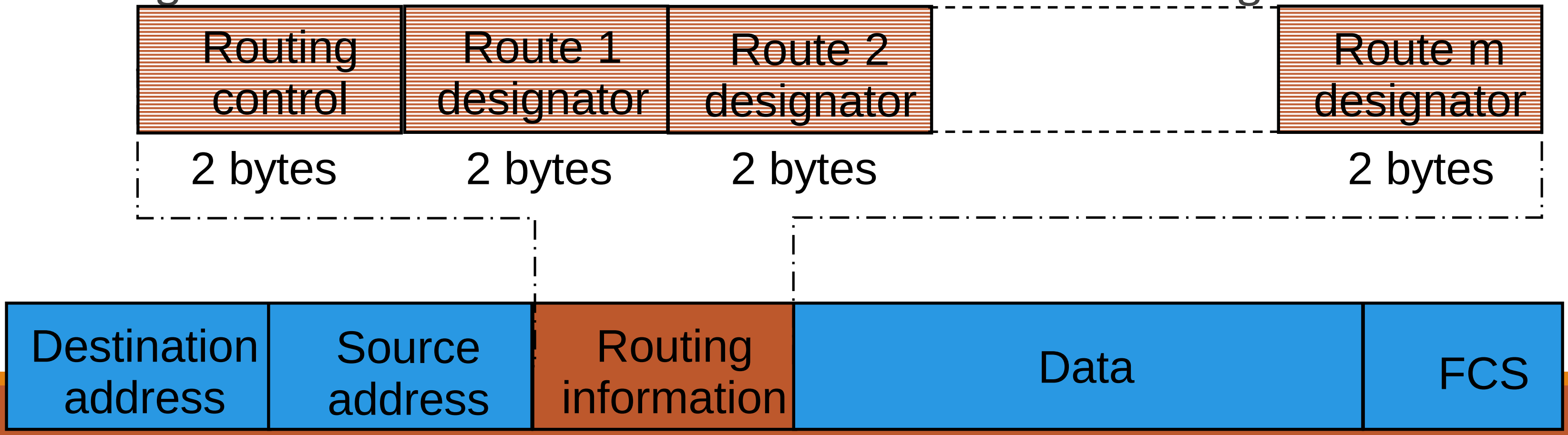
In a static network, tables eventually store all addresses & learning stops

In practice, stations are added & moved all the time

- Introduce timer (minutes) to age each entry & force it to be relearned periodically
- If frame arrives on port that differs from frame address & port in table, update immediately

Source Routing Bridges

- To interconnect IEEE 802.5 token ring networks.
- Presence of routing information field is indicated by I/G bit source address field. 1= present. 0 indicates destination is in the same LAN.
- Each source station determines route to destination
- Routing information inserted in frame if and only if the two stations are on different LANs
- The routing control field defines the type of the frame, the length of the routing information, the direction of route (i.e. L2R or R2L) and the largest frame supported by the path
- The route designator contains a 12 bit LAN number and a 4 bit bridge number.



Route Discovery

To discover route to a destination each station broadcasts a *single-route broadcast frame*

Frame visits every LAN once & eventually reaches destination

Destination sends *all-routes broadcast frame* which generates all routes back to source

Source collects routes & picks best

Detailed Route Discovery

Single-route broadcast

Bridges must be configured to form a spanning tree

Source sends *single-route frame* without route designator field

Bridges in first LAN add incoming LAN #, its bridge #, outgoing LAN # into frame & forwards frame

Each subsequent bridge attaches its bridge # and outgoing LAN #

Eventually, *one* single-route frame arrives at destination

Detailed Route Discovery
All-routes broadcast

When destination receives single-route broadcast frame it responds with *all-routes broadcast frame* with no route designator field

Bridge at first hop inserts incoming LAN #, its bridge #, and outgoing LAN # and forwards to outgoing LAN

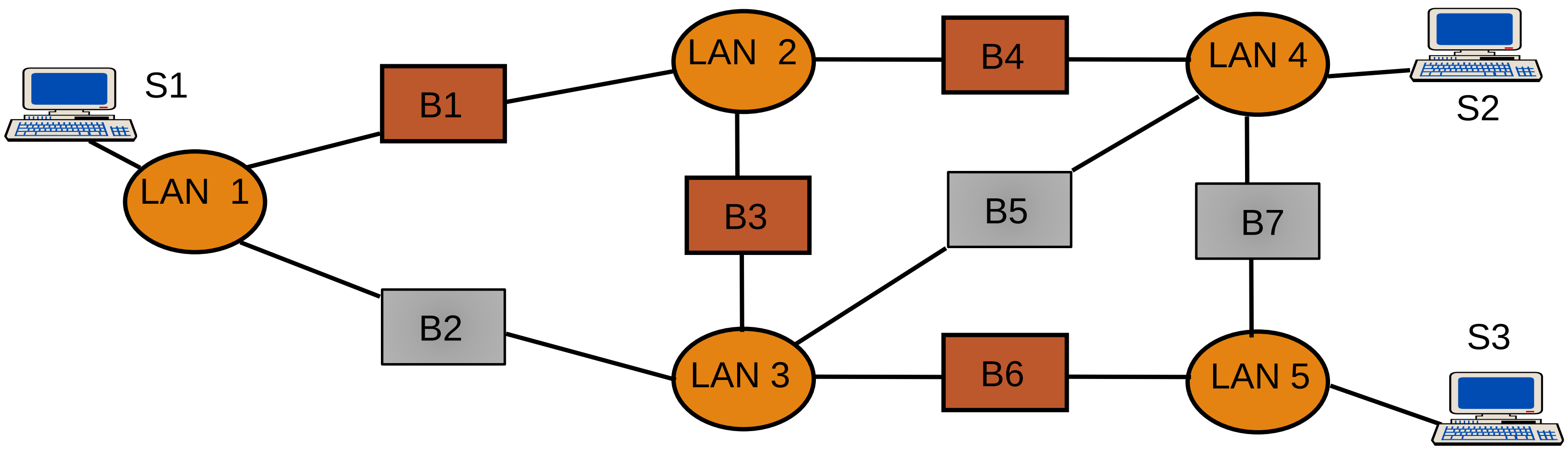
Subsequent bridges insert their bridge # and outgoing LAN # and forward

Before forwarding bridge checks to see if outgoing LAN already in designator field

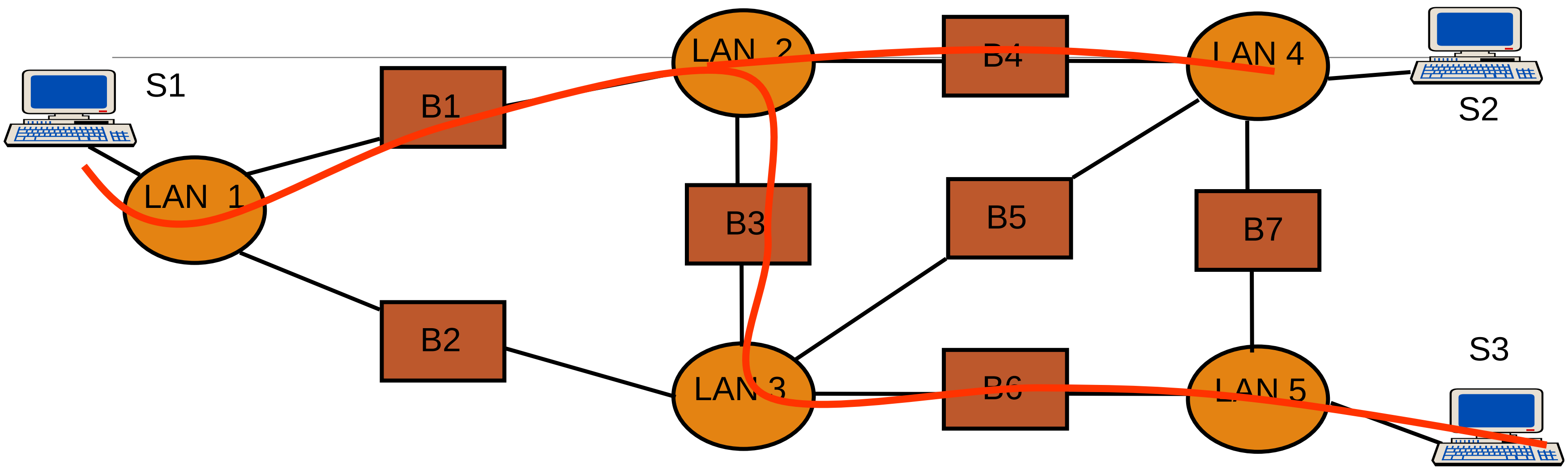
Source eventually receives all routes to destination station

Discover the route from S1 to S3 using source routing bridges

Assume B1, B3, B4, B6 are part of spanning tree



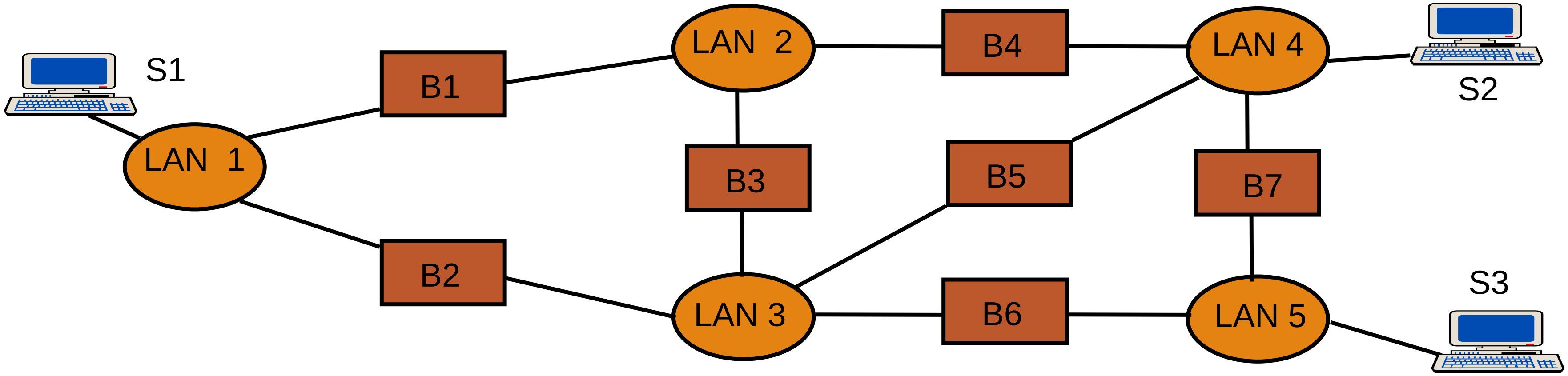
Find routes from S1 to S3



Assume B1, B3, B4, B6 are part of spanning tree

LAN1 → B1 → LAN2 → B3 → LAN3 → B6 → LAN5

LAN1 → B1 → LAN2 → B4 → LAN4



Find the mistake !!

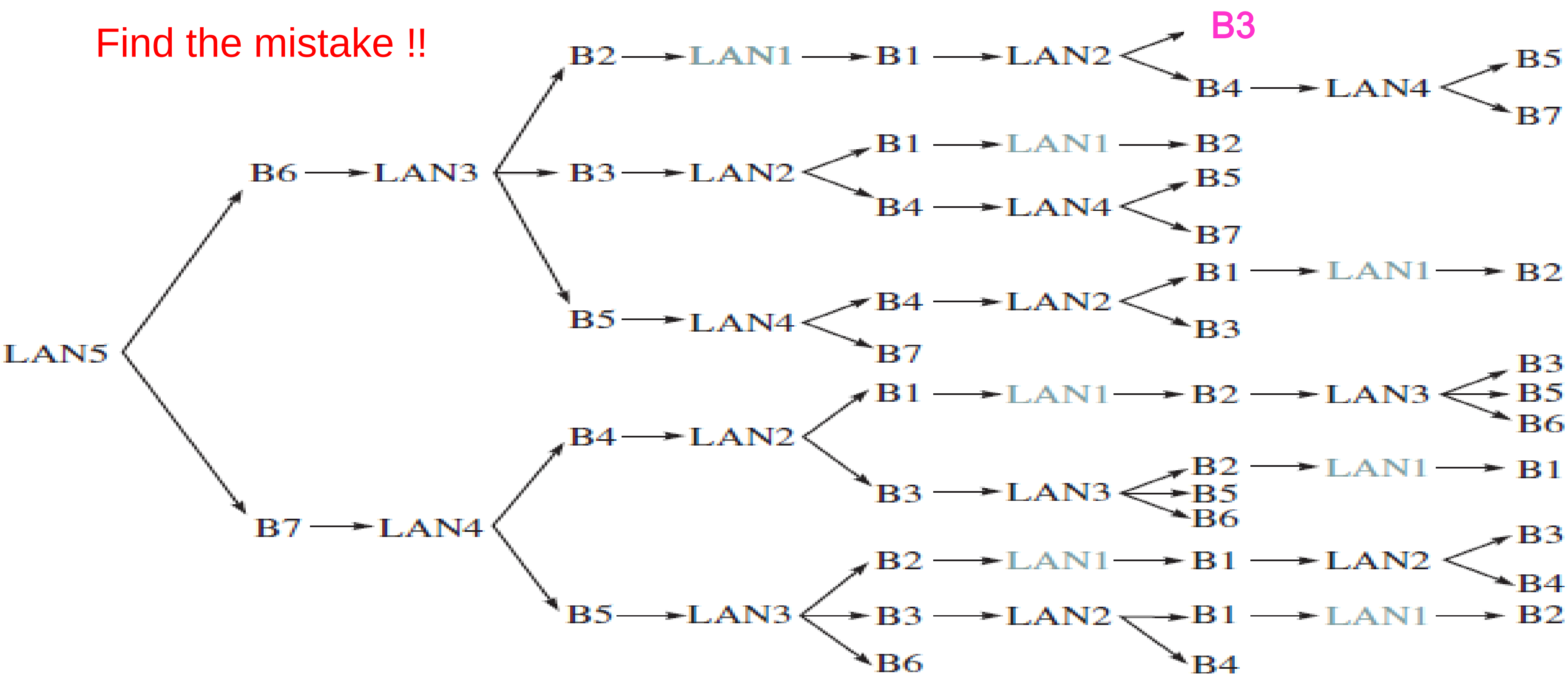
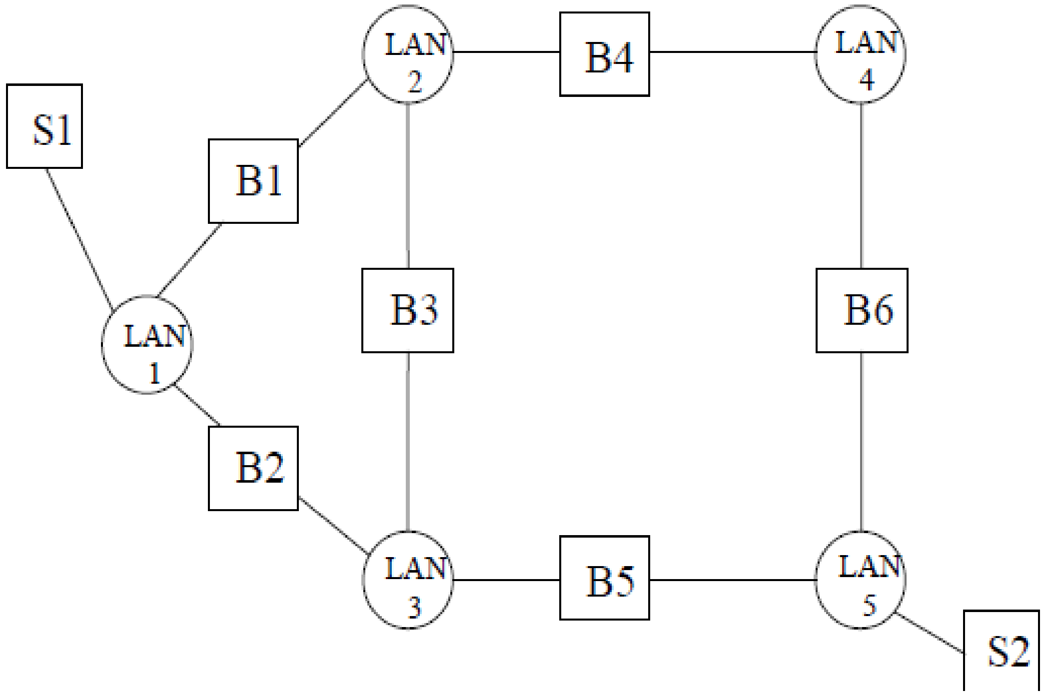


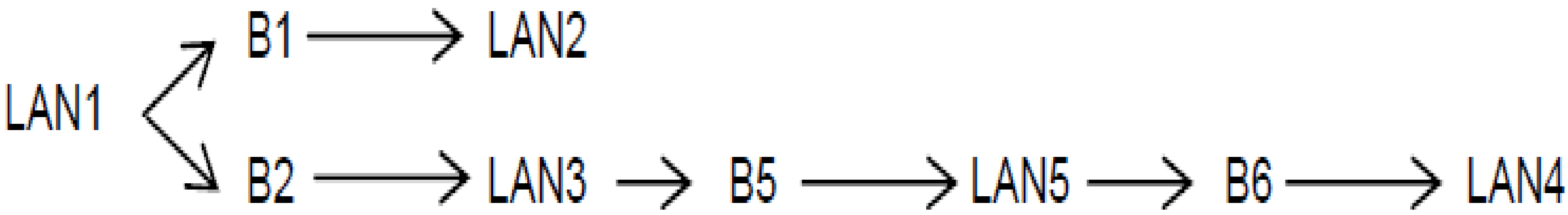
FIGURE 6.91 Routes followed by all-routes broadcast frames

Five LANs are connected using source routing bridges. Assume that the bridges 3 and 4 are not part of the initial spanning tree.

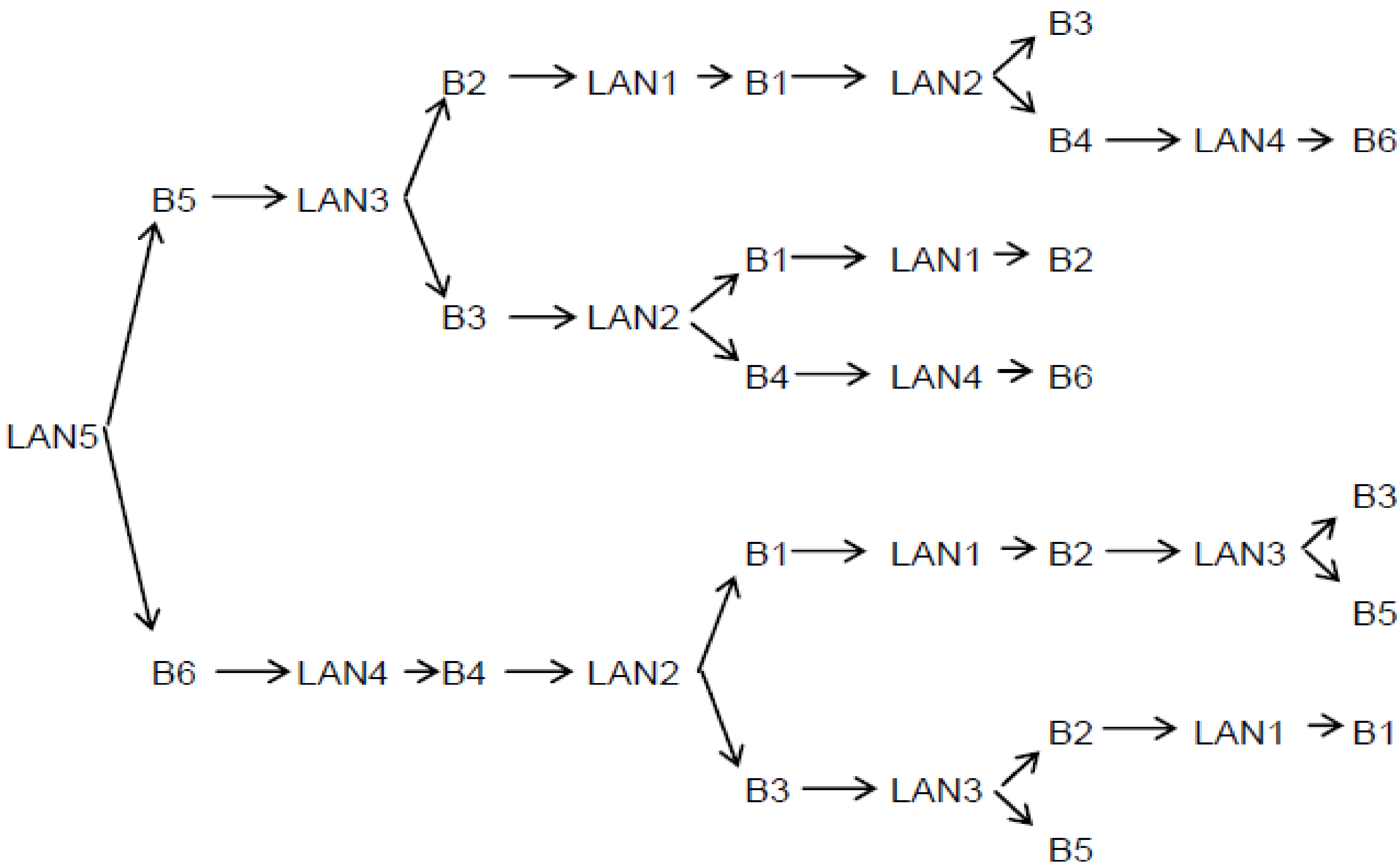
1. show the single route broadcast frames when S1 wants to learn the route to S2
2. Show the path to all routes broadcast frames returned by S2.
3.List all possible routes from S1 to S2 from part (2)
4. How many LAN frames are required to learn the possible routes



1.



2.


LAN5
B5
LAN3
B2
LAN1
B1
LAN2
B3
B4
LAN4
B6
B3
LAN2
B1
LAN1
B2
B4
LAN4
B6
B6
LAN4
B4
LAN2
B1
LAN1
B2
LAN3
B3
B5
B3
LAN3
B2
LAN1
B1
B5

3. List all possible routes from S1 to S2 from part (2)

LAN1 → B2 → LAN3 → B5 → LAN5
LAN1 → B1 → LAN2 → B3 → LAN3 → B5 → LAN5
LAN1 → B1 → LAN2 → B4 → LAN4 → B6 → LAN5
LAN1 → B2 → LAN3 → B3 → LAN2 → B4→ LAN4 → B6 → LAN5

4. How many LAN frames are required to learn the possible routes?

Four frames.