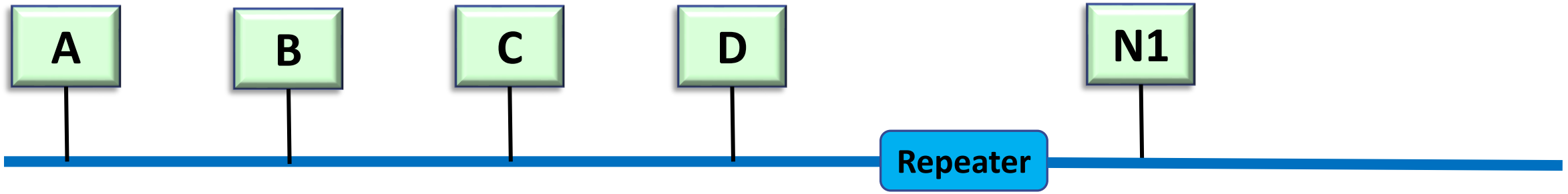
Bridges

ICT 2156

BRIDGES: A means of interconnecting networks

Layer	Devices
Physical Layer	Repeaters
Data Link / MAC Layer	**Bridges**
Network Layer	Router
Higher Levels	Gateway

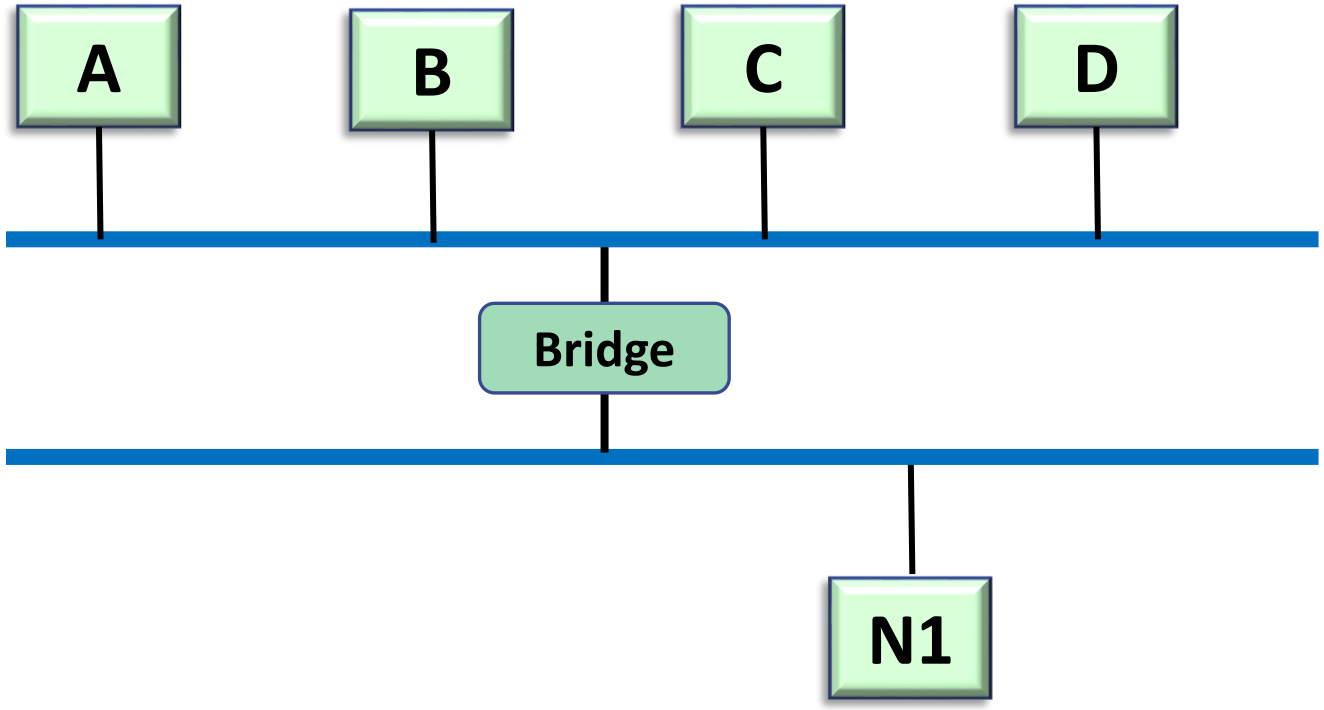
Why Bridges?



Traffic from A to N1?

Traffic from A to B?

Why Bridges?



Traffic from A to N1?

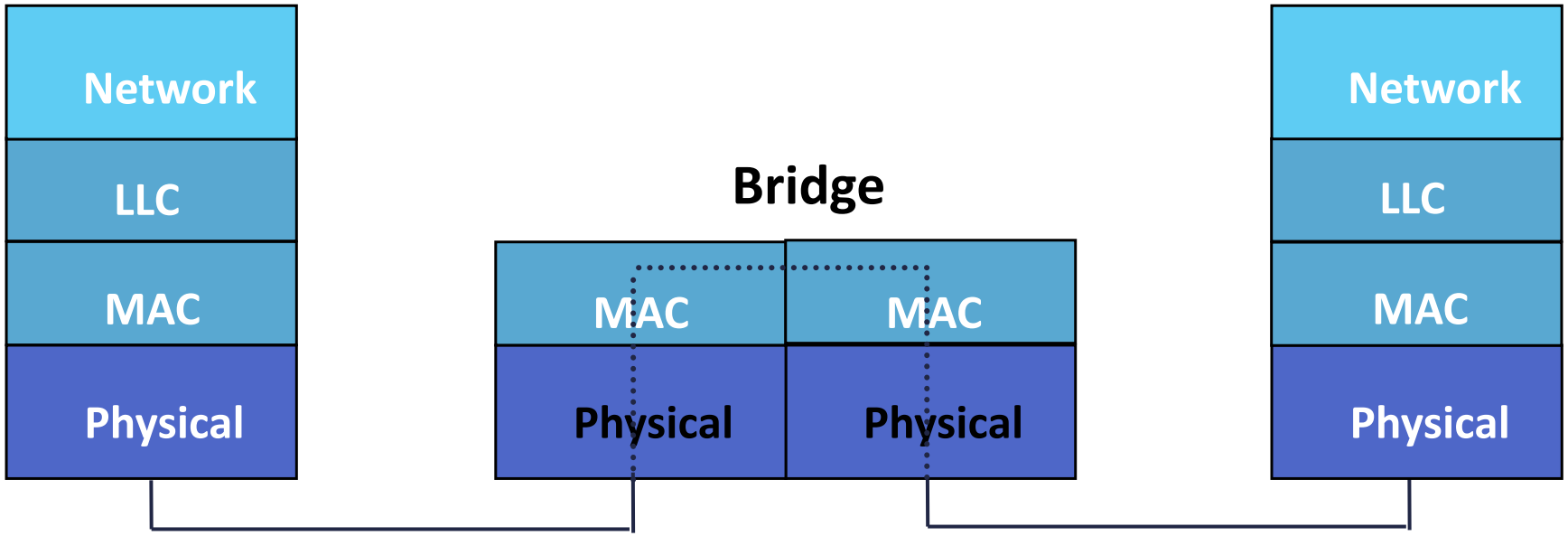
Traffic from A to B?

Why Bridges? : A scenario

- Combine Departmental LANs.
- Factors to consider:
  - Different Network Layer protocols.
  - LANs may be in different buildings.
  - LANs differ in type.
- These 3 requirements can be met by bridges. How?
- Issues: Security and broadcast storm

Interconnection by a Bridge

- To have a frame filtering capability, a bridge must monitor the MAC address of each frame.
- **Why does a bridge function at the MAC layer? (and not PL or NL)**



Types of Bridges

- **Transparent Bridges**
  - Widely used in Ethernet LANs
- **Source Routing Bridges**
  - Widely used in Token Ring LANs and FDDI networks

Transparent Bridges

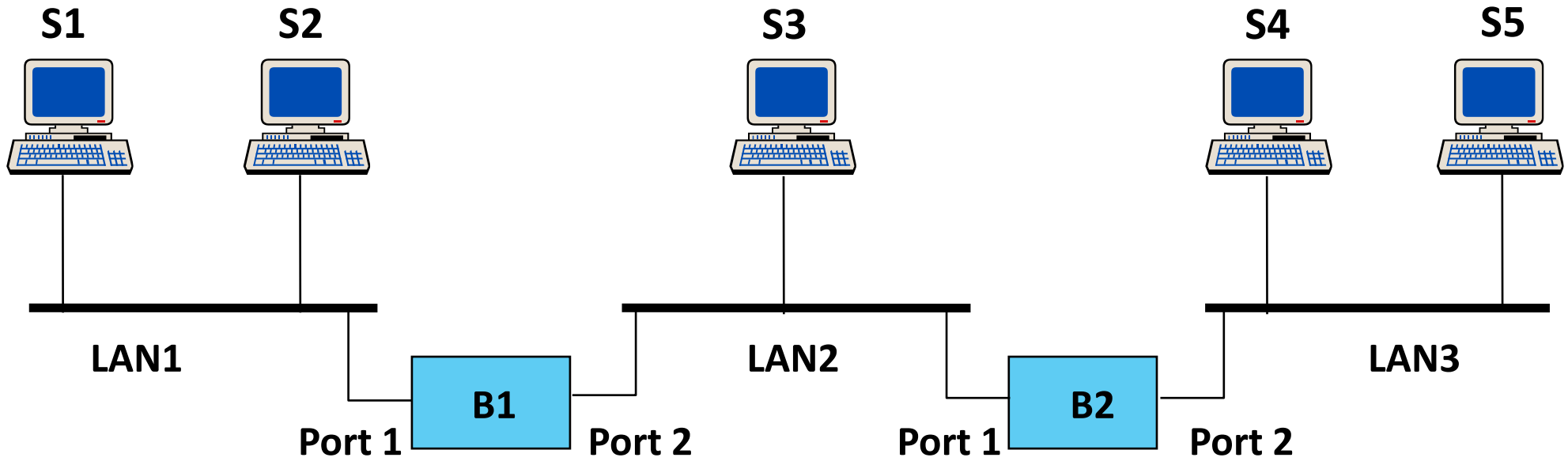
- Defined by the 802.1d committee.
- ***Transparent:*** the stations are completely unaware of the presence of the bridges in the network.
- Thus, introducing a bridge doesn't require the stations to be configured.
- Functions performed by the transparent bridges:
  - **Forward**
  - **Learn**
  - **Prevent**

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.

Forwarding Table/ Forwarding Database

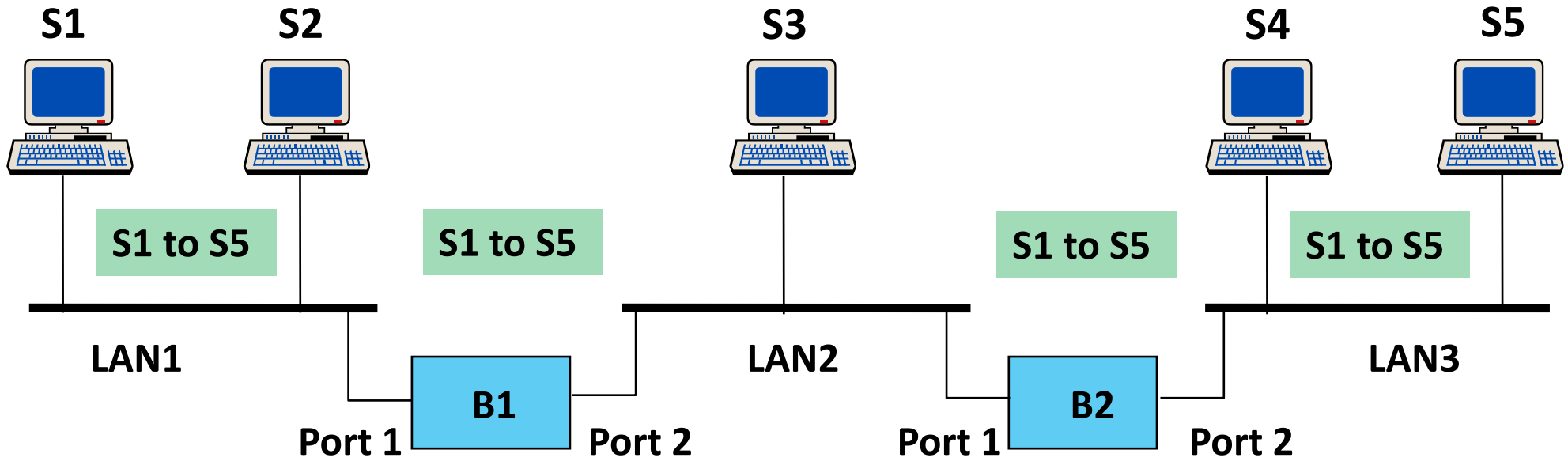
- **Learning Process:**
- Use table lookup, and
  - discard frame, if source & destination in same LAN,
  - forward frame, if source & destination in different LAN,
  - use flooding, if destination unknown.
- Use backward learning to build table
  - observe source address of arriving LANs,
  - handle topology changes by removing old entries.



Address	Port

Address	Port

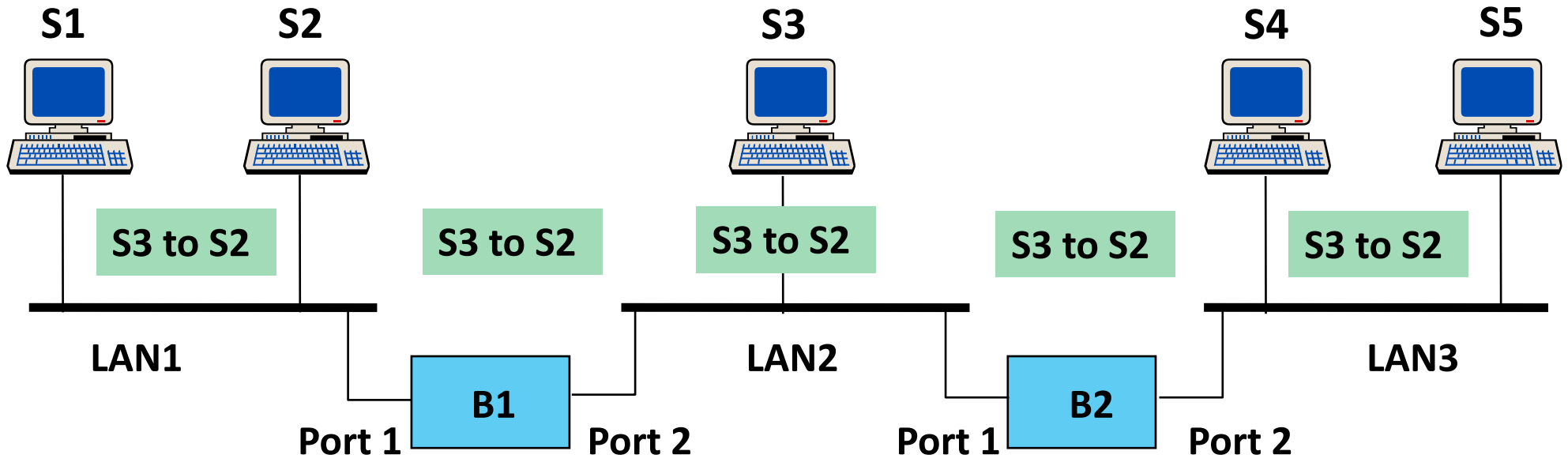
S1→S5



Address	Port
S1	1

Address	Port
S1	1

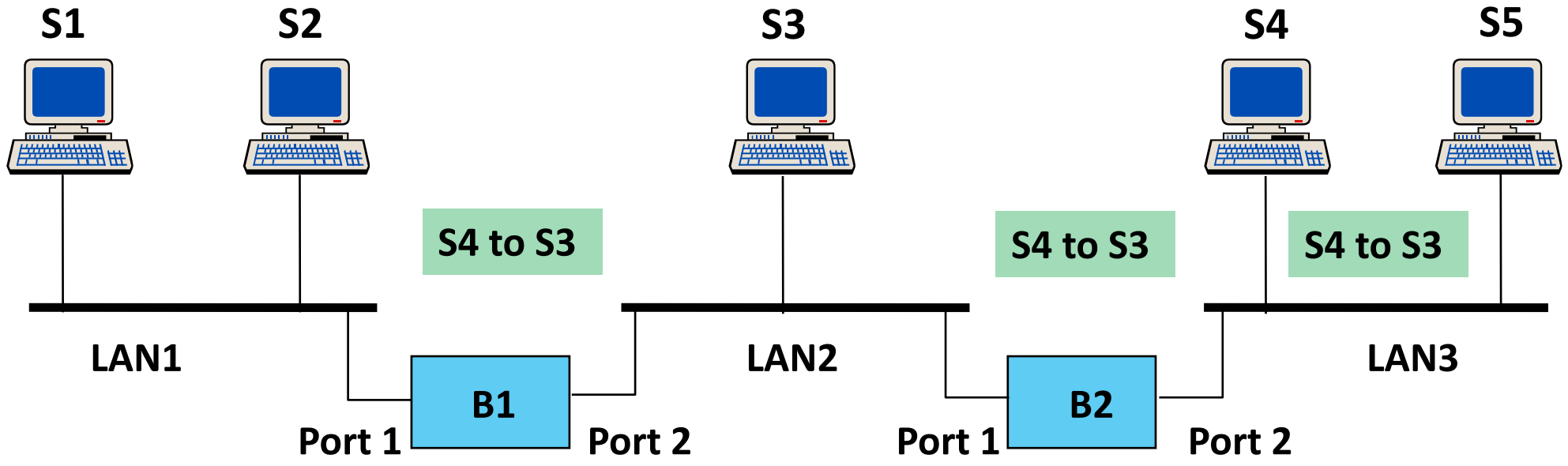
S3→S2



Address	Port
S1	1
S3	2

Address	Port
S1	1
S3	1

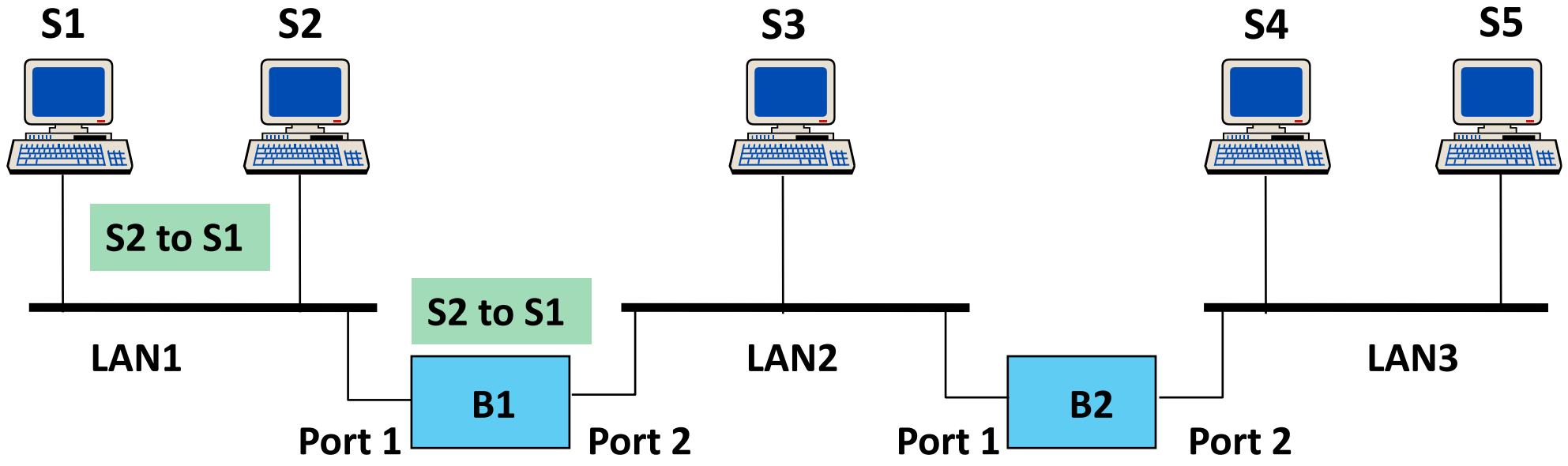
S4→S3



Address	Port
S1	1
S3	2
S4	2

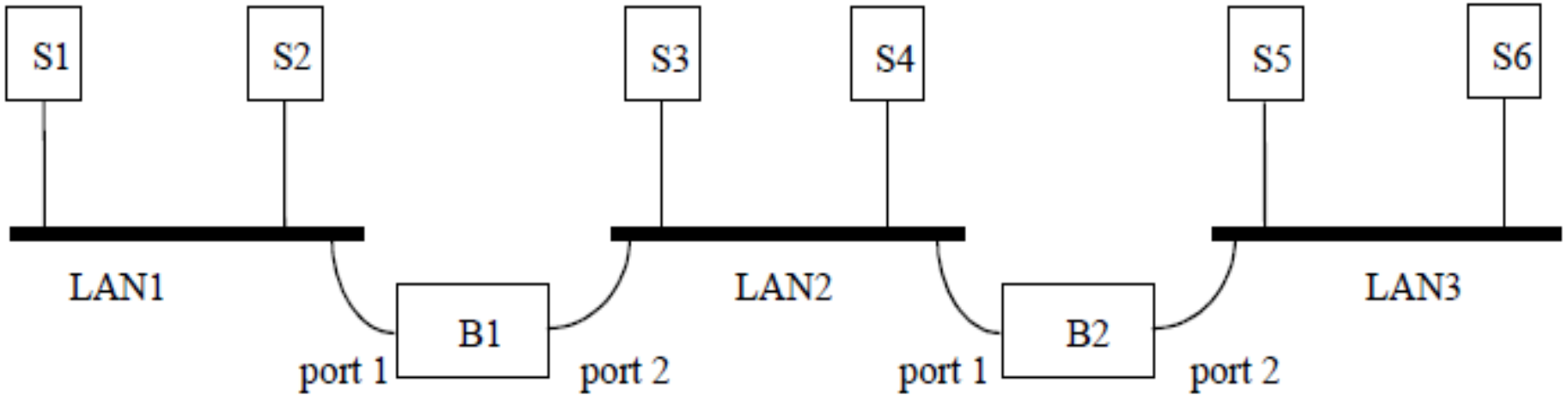
Address	Port
S1	1
S3	1
S4	2

S2→S1



Address	Port
S1	1
S3	2
S4	2
S2	1

Address	Port
S1	1
S3	1
S4	2

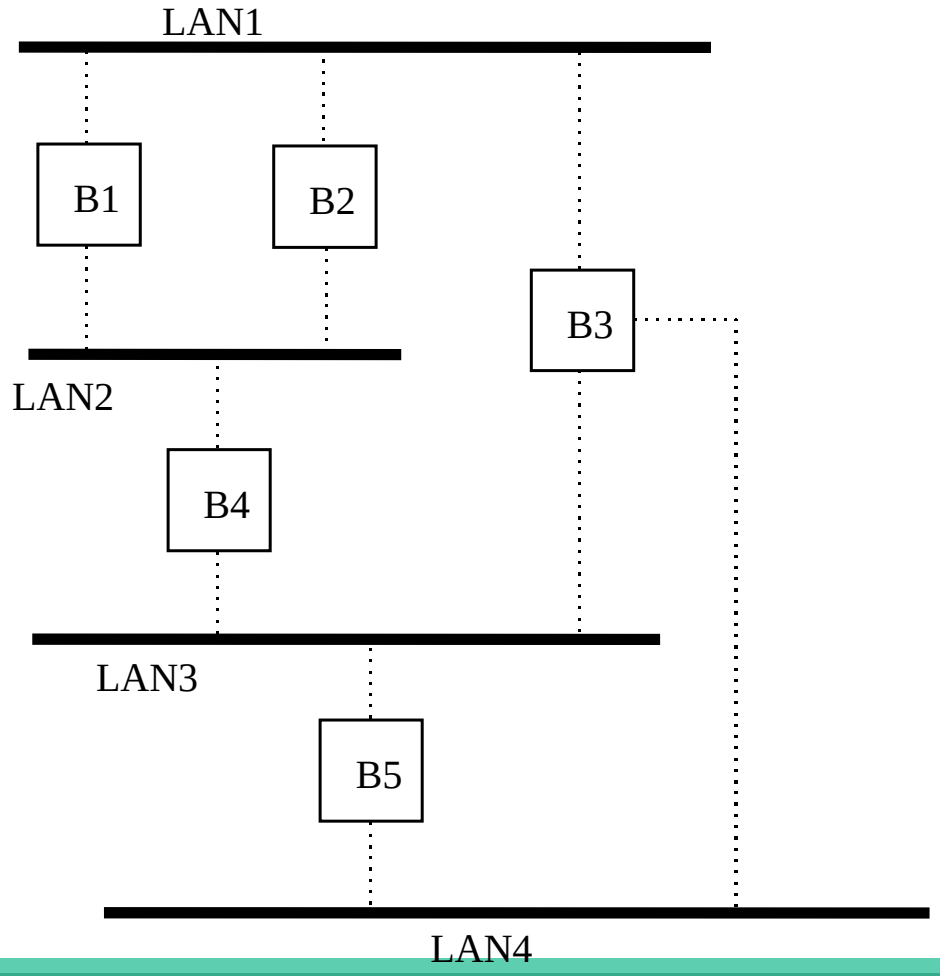


Station	Port

Station	Port

S2→S1
S5→S4
S3→S5
S1→S2
S6→S5

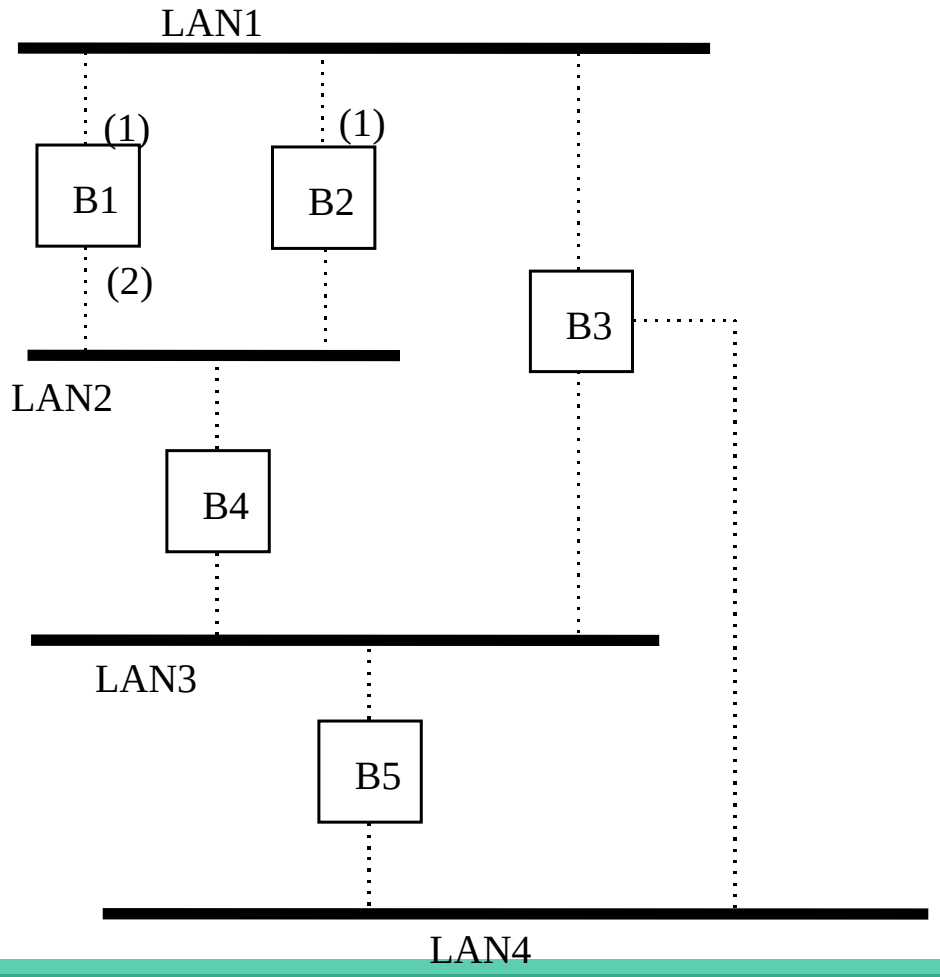
Loops in the Network



Spanning Tree

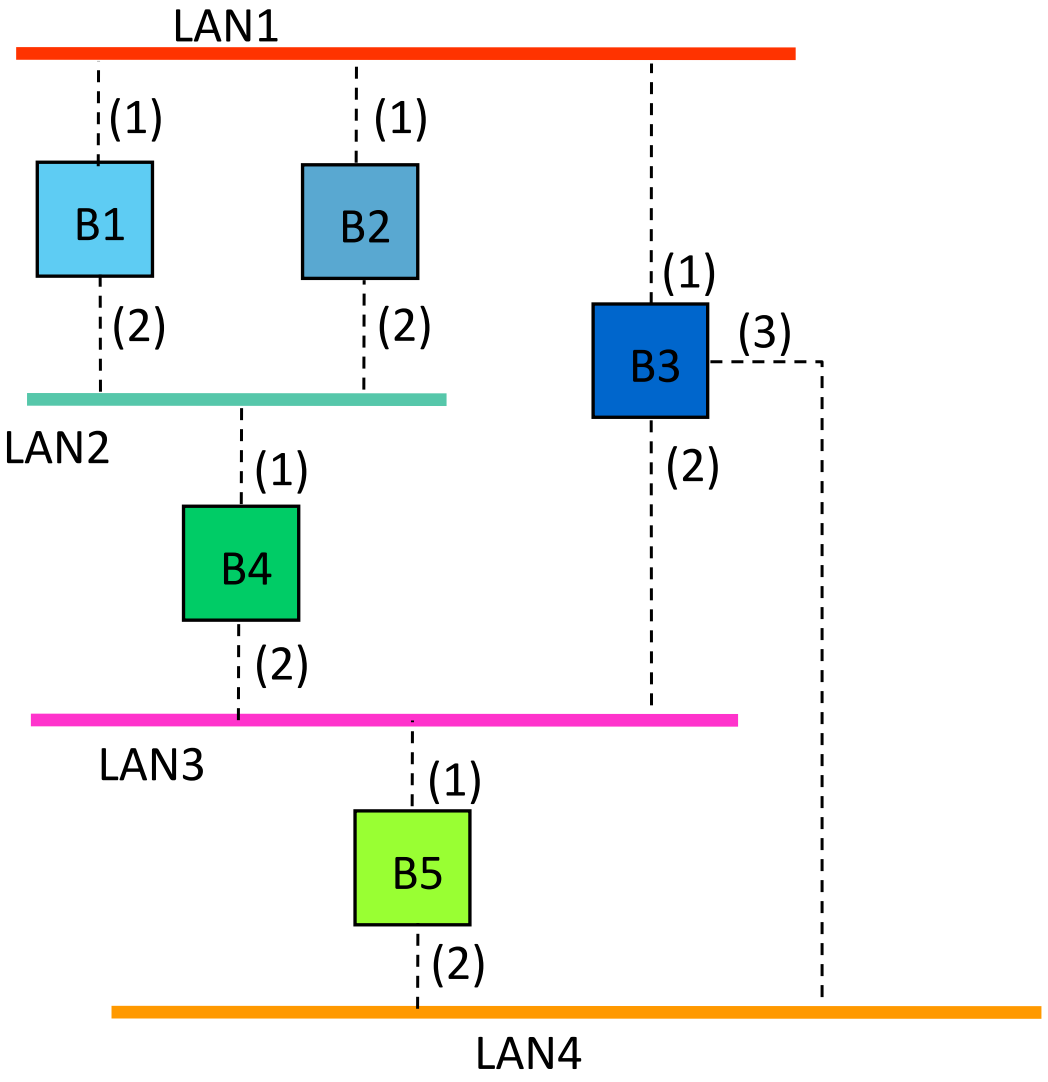
- Spanning Tree: To remove loops in the network.
  - **Why is it necessary?**
- The spanning tree algorithm requires:
  - Every bridge to have a unique ID
  - Each port within a bridge to have a unique port ID
  - All bridges on the LAN to have a MAC address.

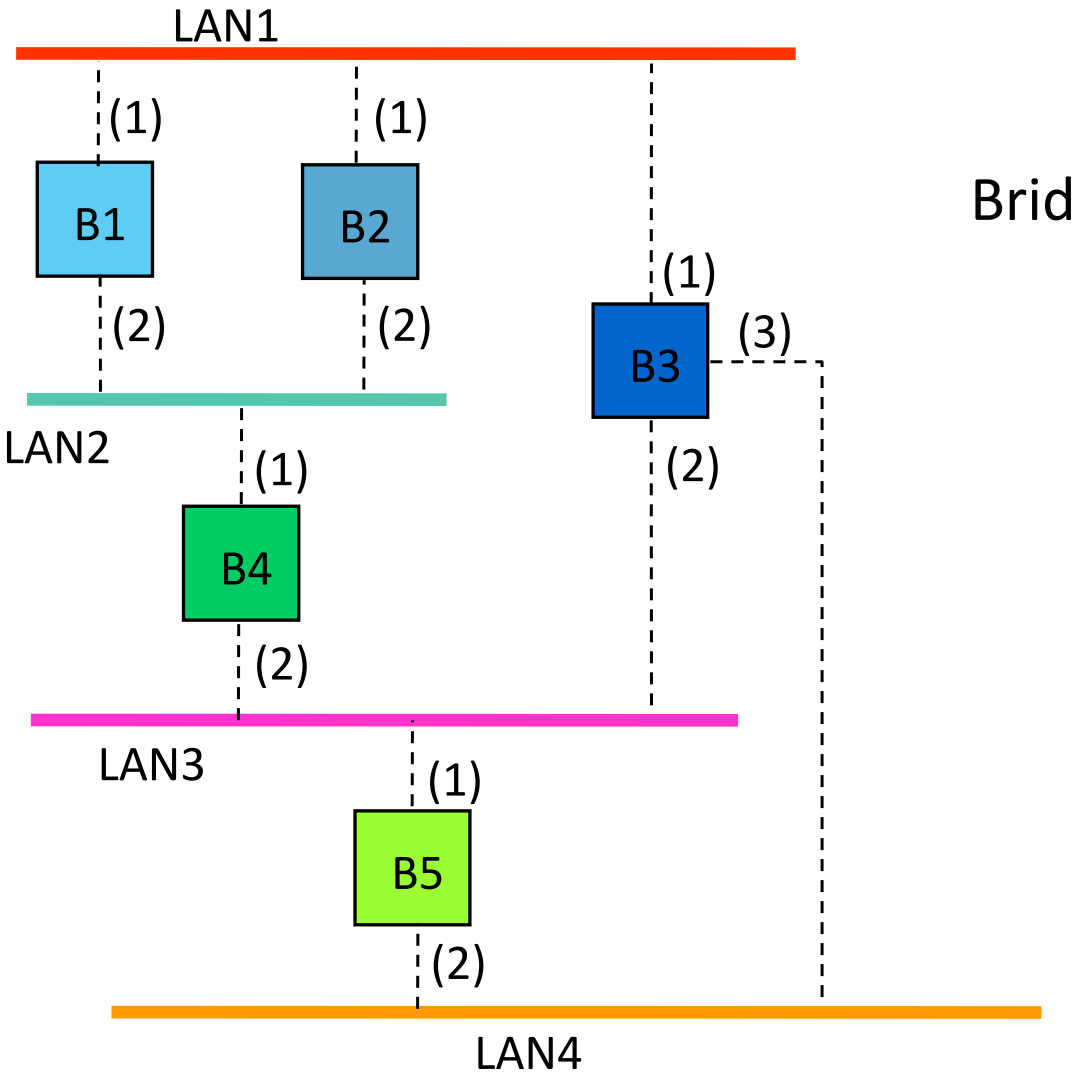
Avoiding Loops



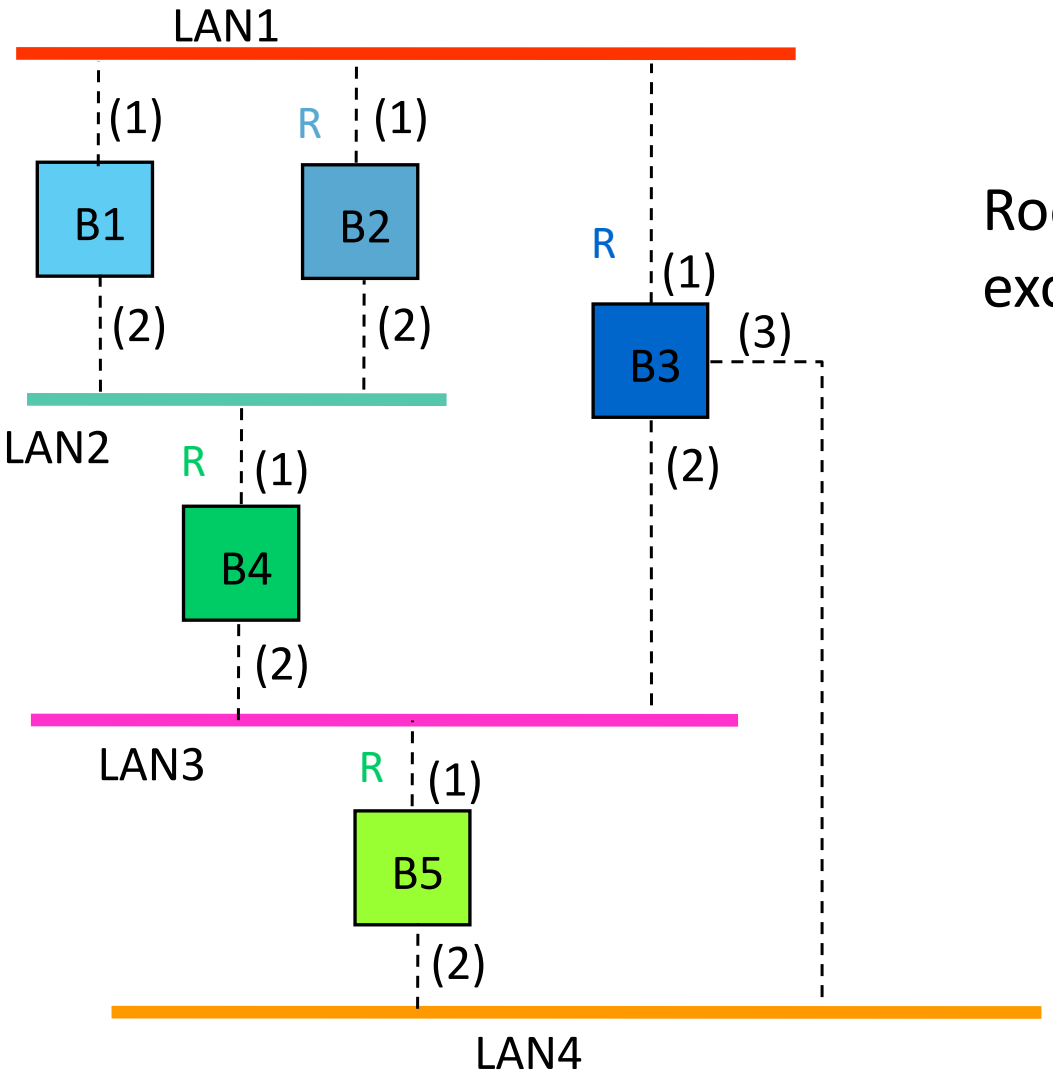
Spanning Tree Algorithm

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.

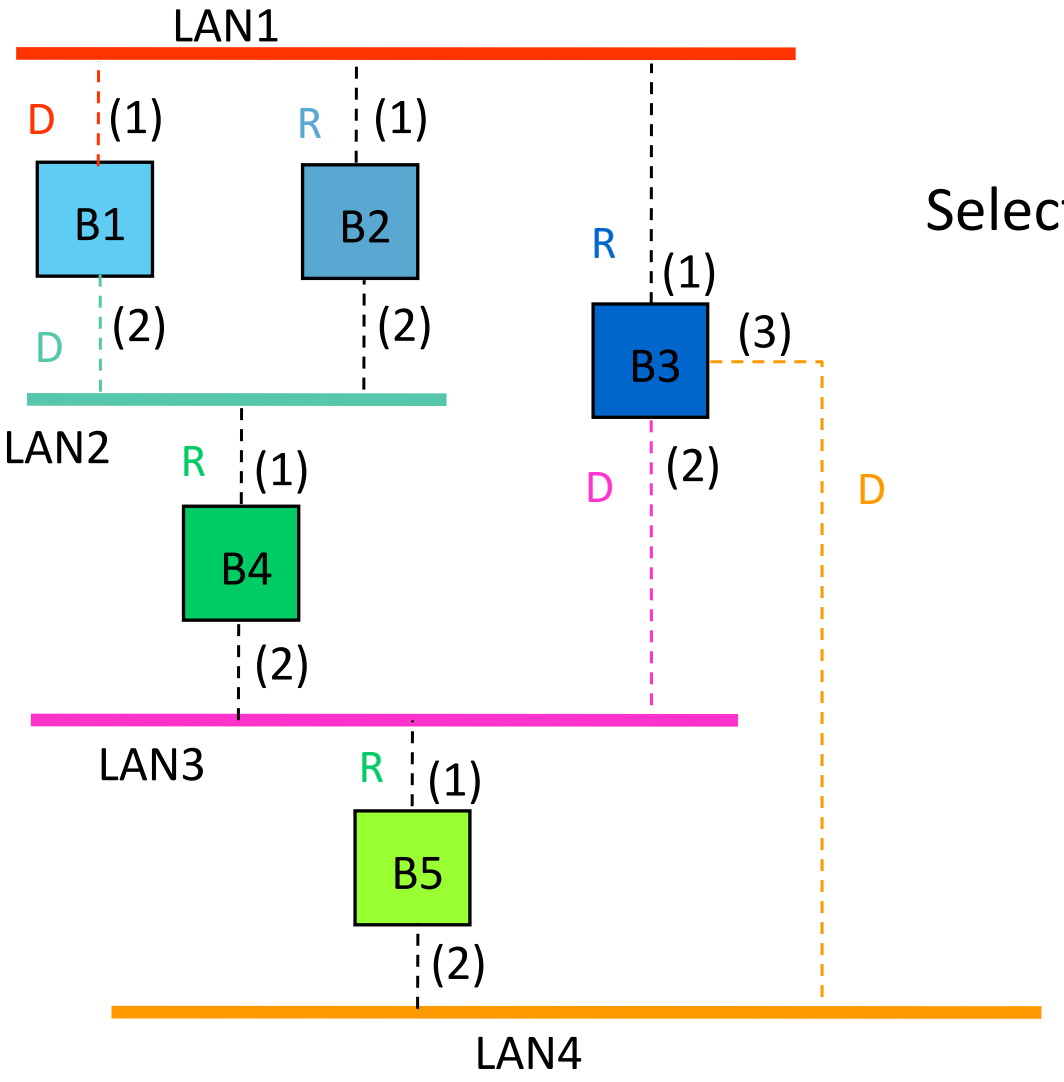

LAN1
(1)
(1)
B1
B2
(1)
(2)
(2)
B3
(3)
LAN2
(1)
B4
(2)
(2)
LAN3
(1)
B5
(2)
LAN4



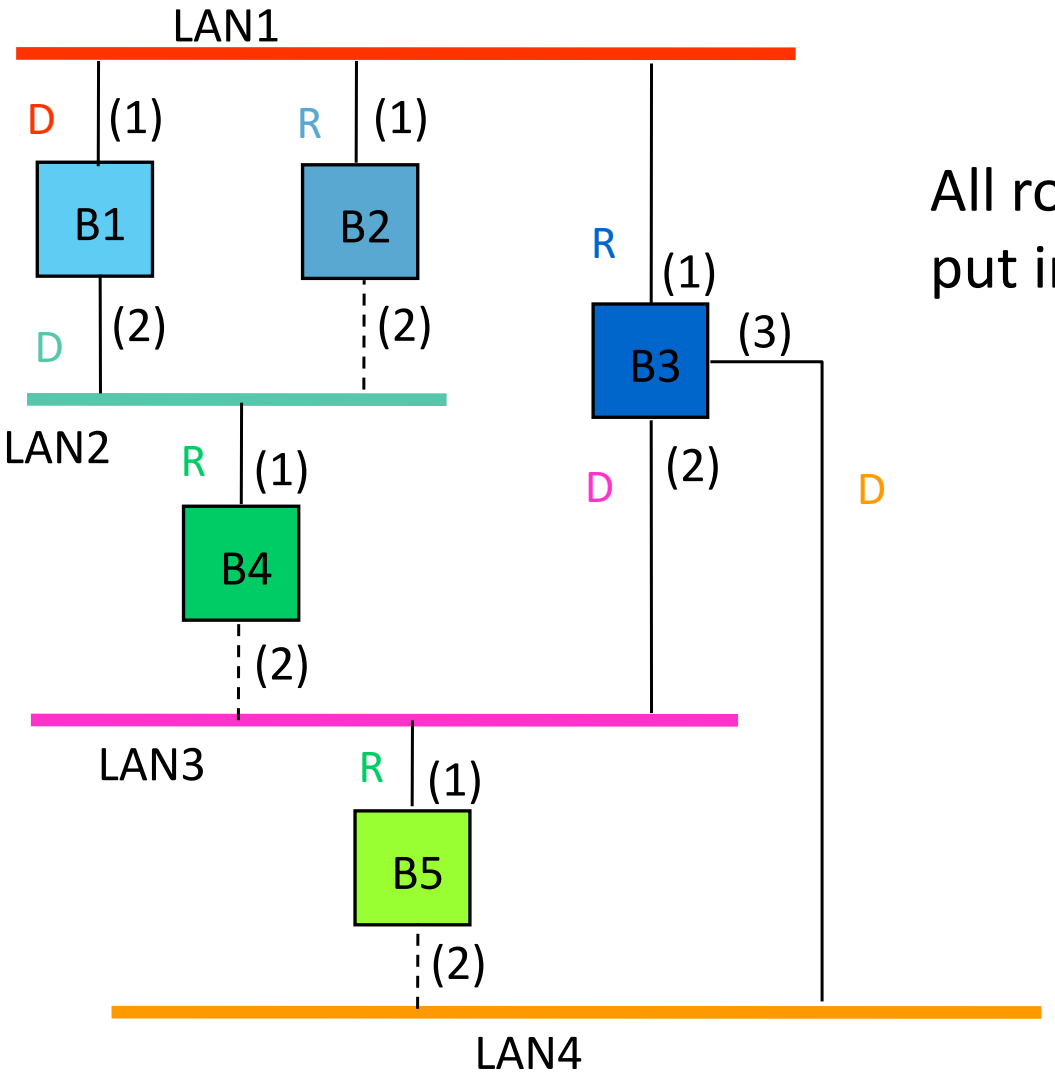
Bridge 1 selected as root bridge.



Root port selected for every bridge except root port.



Select designated bridge for each LAN.



All root ports & designated ports put in forwarding state.

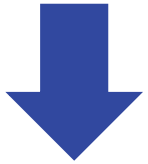
- How is it implemented?
- By using a Distributed algorithm.
- Configuration BPDUs :
  - Transmitting bridge id.
  - Root bridge id.
  - Cost of least-cost path.
- Best BPDU!!
- Timer to detect bridge failure.

Adaptive Learning

- Stations are added & moved all the time.
  - Introduce timer (minutes)
  - If frame arrives on port that differs from frame address & port in table, update immediately.

Source Routing Bridges

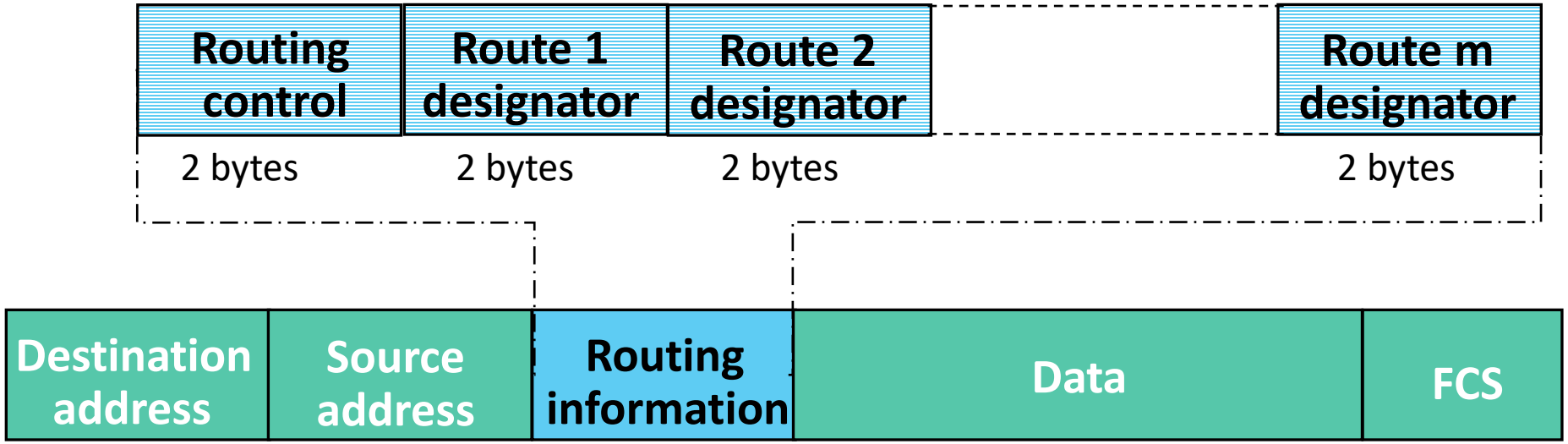
- Main Idea: Each station should determine the route to the destination when it wants to send a frame.
- The routing information is included in the header of the frame.



Find good routes efficiently.

Frame format for Source Routing

- **Routing information** : Inserted **only if** the two communicating station are on **different LANs**. (**I/G** bit in source address =1).



- **Routing Control**: Type of frame, length of information field, direction of route, and the largest frame supported over the path.
- **Route Designator**: 12-bit LAN number and a 4-bit bridge number.

Route Discovery

- Single-route broadcast frame
  - Sent from source to destination
- All-routes broadcast frame
  - Sent from destination to source in response to single-route broadcast frame.
- Source collects all routes, chooses the best route and saves it.

Detailed route discovery: Single-route broadcast

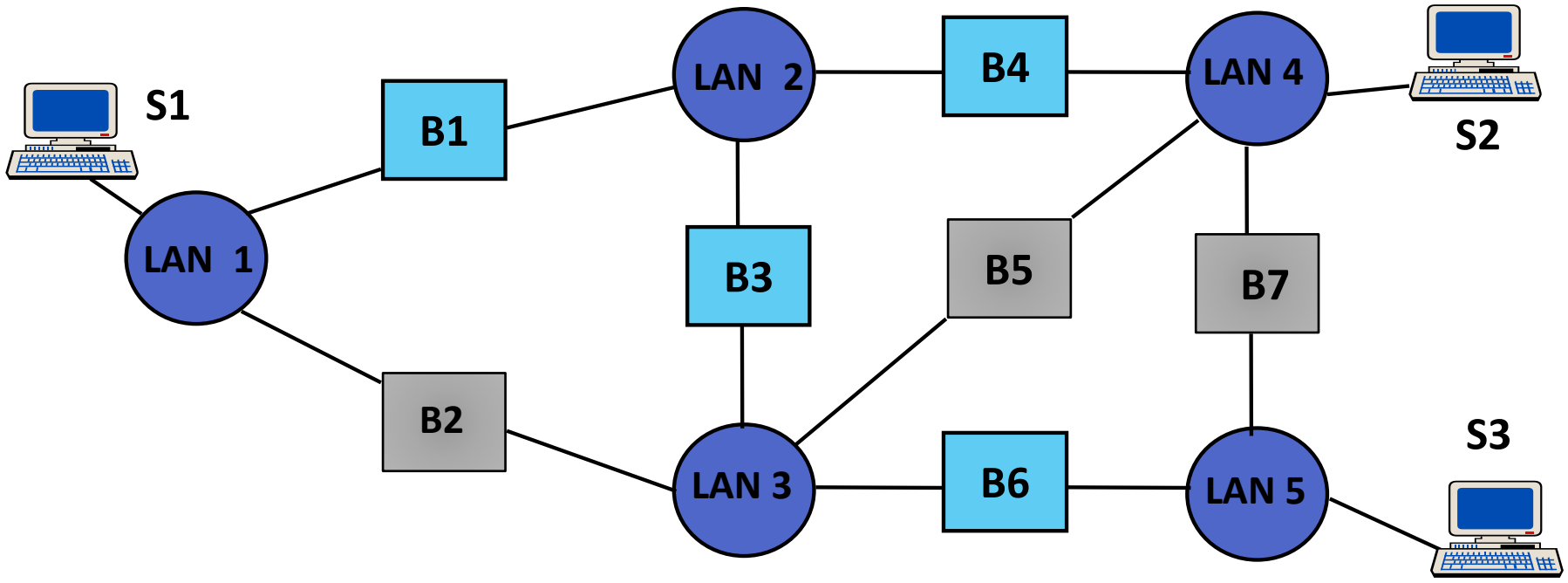
- Selected bridges are configured to form a spanning tree, done manually or automatically.
- Source transmits the broadcast frame on its LAN without any route designator fields.
- When a selected bridge at the first hop receives a single-route frame, the bridge inserts the following fields to the routing information field and forwards the frame:
  - an incoming LAN number,
  - its bridge number, and
  - the outgoing LAN number
- Non-selected bridges ignore the broadcast frame.

Detailed route discovery: All-routes broadcast

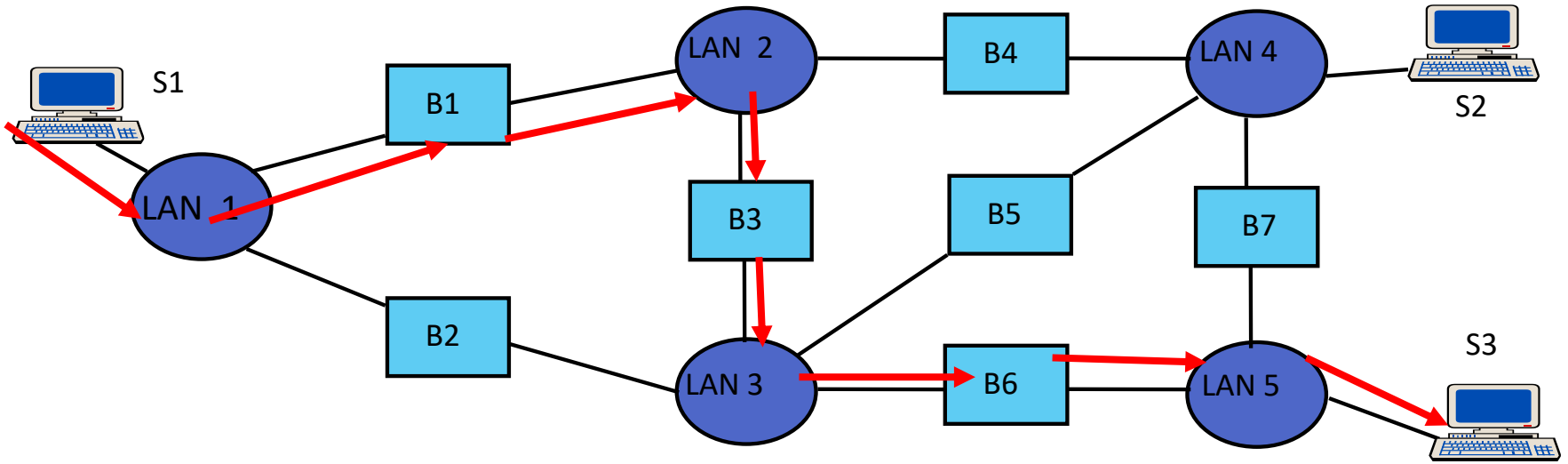
- When destination receives single-route broadcast frame it responds with *all-routes broadcast frame* with no route designator field.
- Bridge at first hop inserts incoming LAN #, its bridge #, and outgoing LAN # and forwards to outgoing LAN.
- Subsequent bridges insert their bridge # and outgoing LAN # and forward.
- Before forwarding bridge checks to see if outgoing LAN already in designator field. **Why?**
- 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



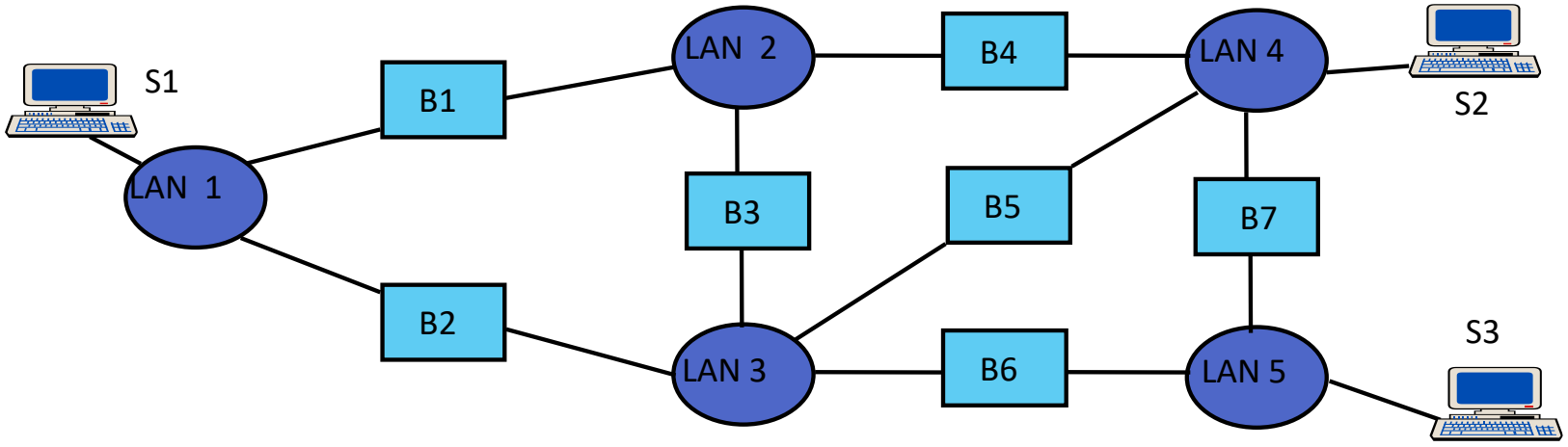
Find routes from S1 to S3



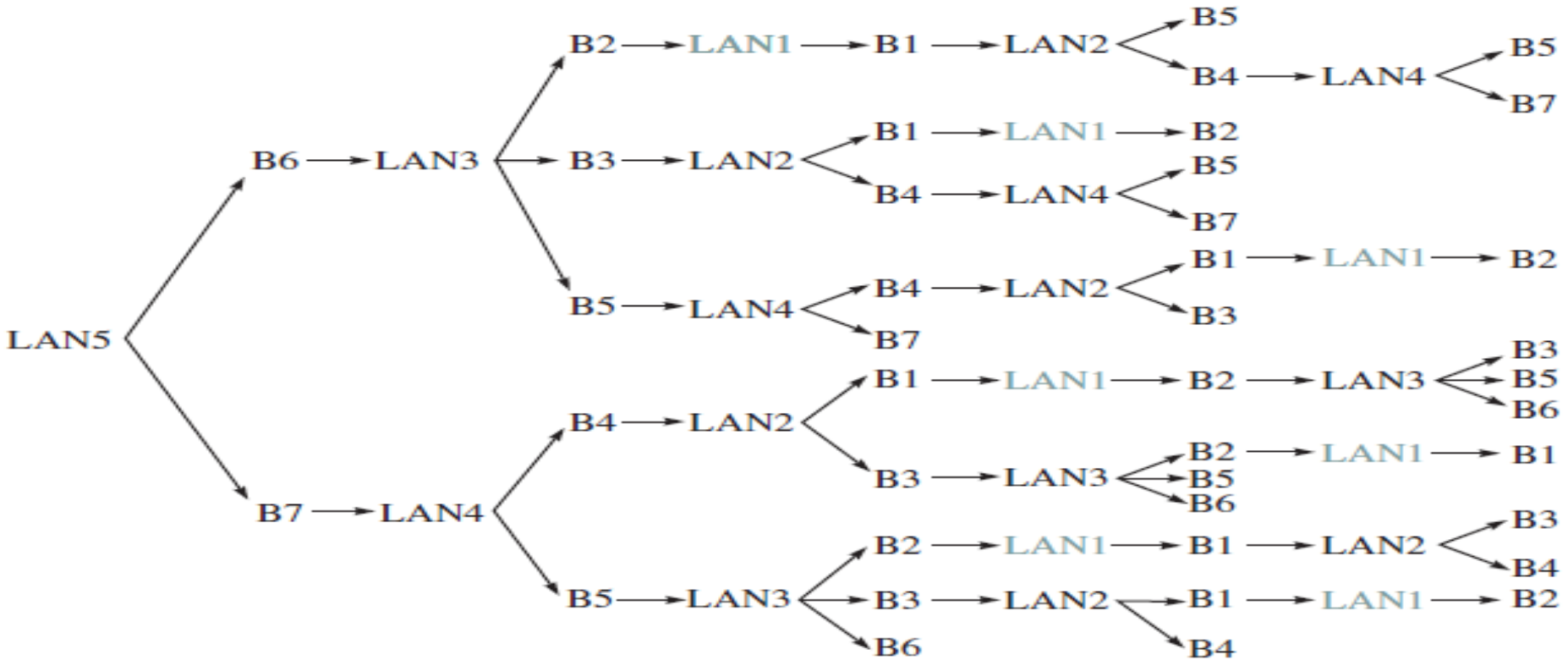
Assume B1, B3, B4, B6 are part of spanning tree

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

LAN1 → B1 → LAN2 → B4 → LAN4

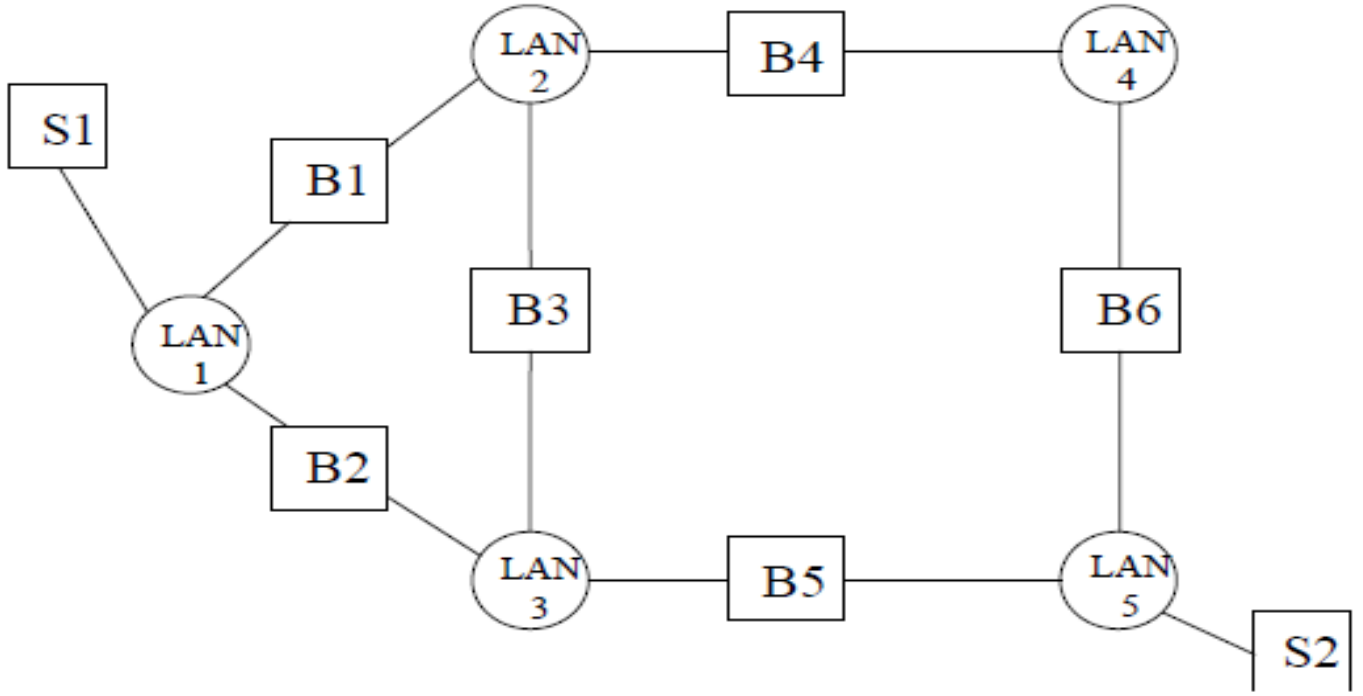


Correction Needed!



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



Books

1. Behrouz Forouzan, “Data Communications and Networking”, 4th ed. , Chapter:13: 13.1, 13.2
2. Leon Garcia – Chapter 6 (6.7.3 – 6.7.6)