Chapter4 Medium Access Control Sublayer(3)

王昊翔 hxwang@scut.edu.cn

School of Computer Science & Engineering ,SCUT

Communication & Computer Network key-Lab of GD

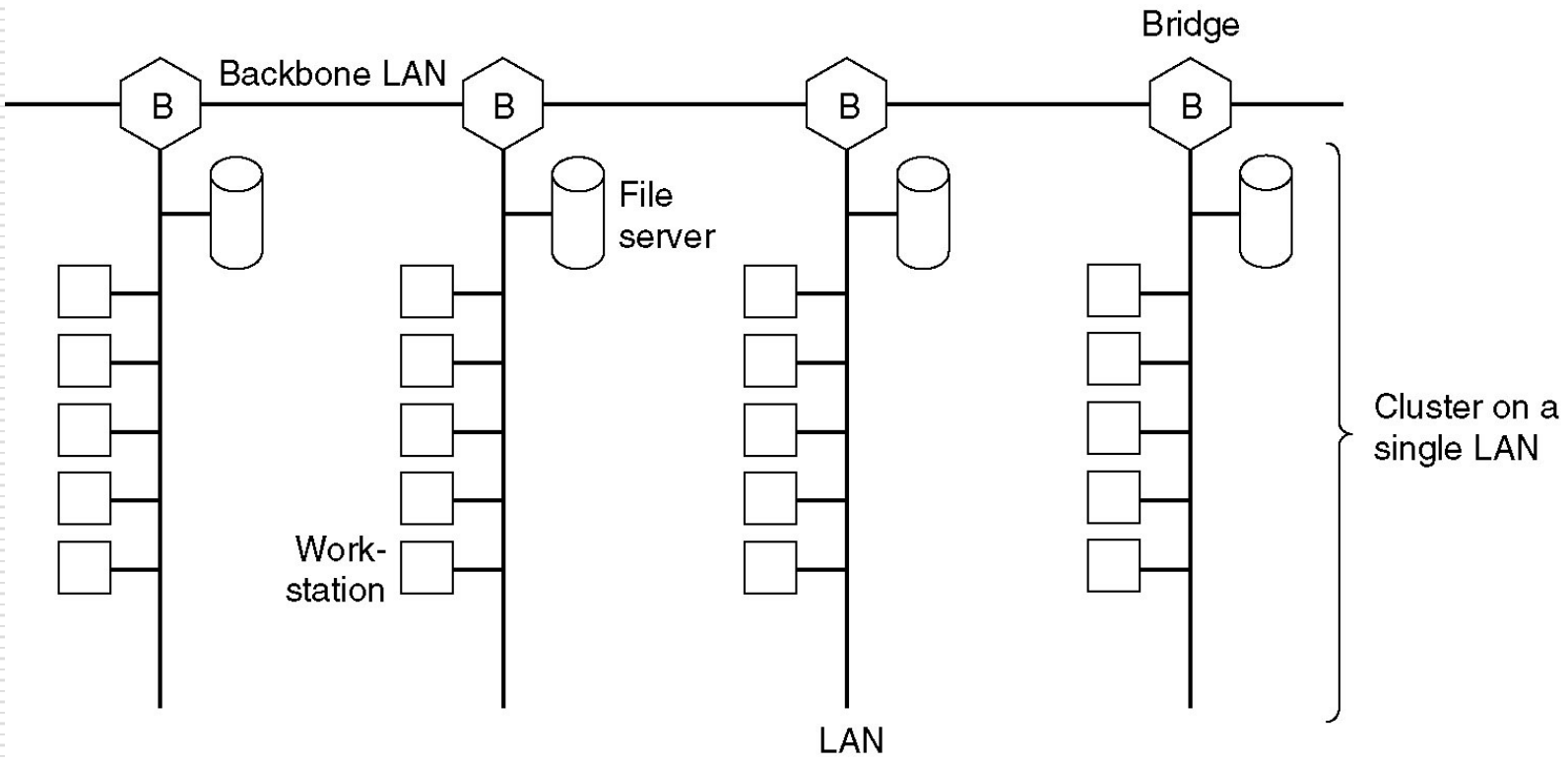
Contents of this lecture

- Learn basic idea of frame switch (L2 switching)
- Master basic principle of L2 switch
- Learn bridge
- Learn switch

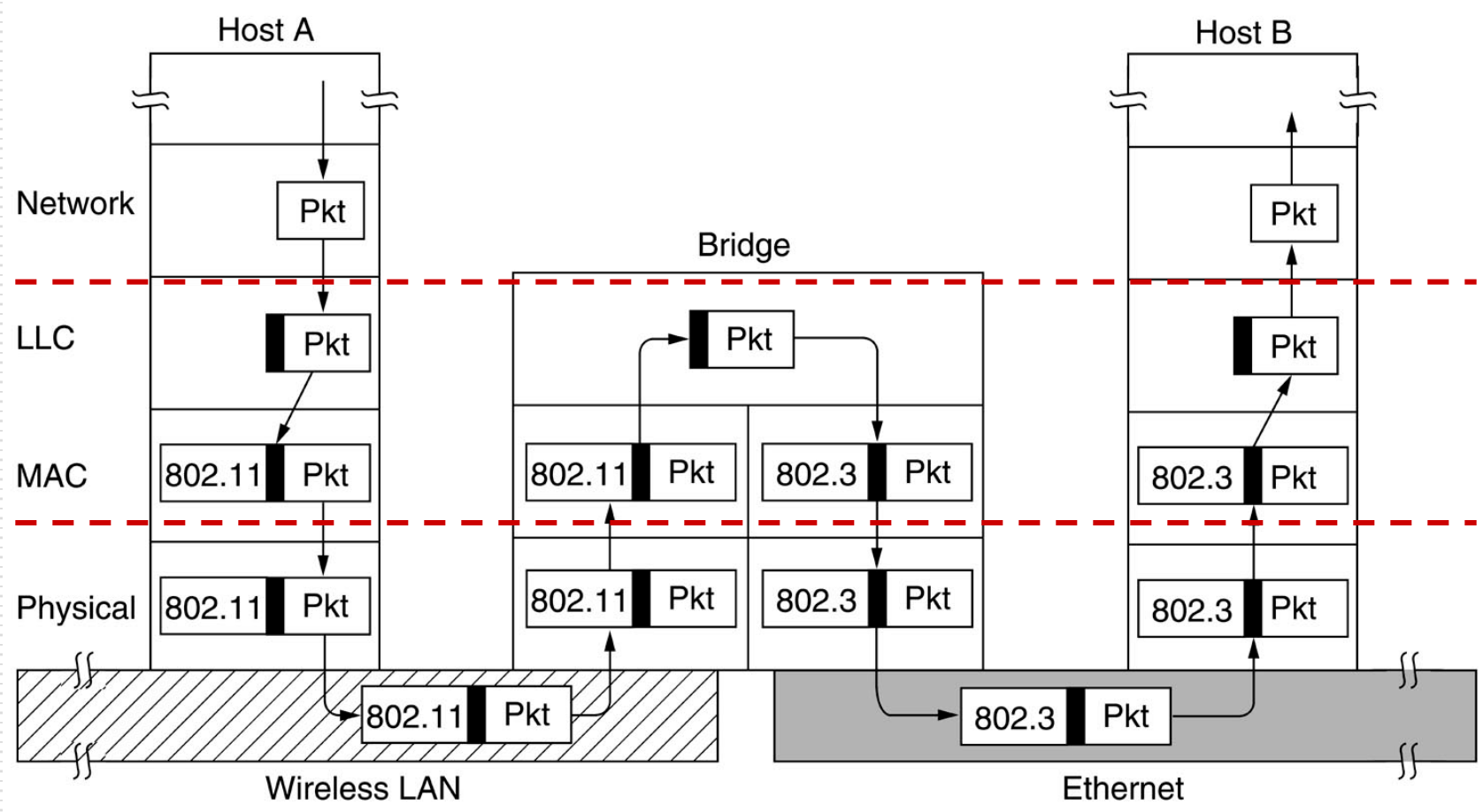
Why are there multiple LANs?

- Goal of each department may be different
- May be geographically spread over several building
- May be necessary to split into separate LANs to accommodate the load
- Physical distance between the most distant machines may be too great
- In order to improve performance
- Bridges can contribute to organization's security

Provide a higher load



Bridge-operation from 802.11 to 802.3



Bridge from 802.X to 802.Y

- **Problem:**
  - **Different frame format – re-encapsulation**
  - **Different transmission speed - Buffering.**
  - **Different the most frame length （如， 802.3 1526 字节, 802.11 2346 字节）**
  - **Different security policy**
  - **Different QoS policy**

Local internetworking

- Multiple LANs connected by transparent bridges do not need any change on their hardware and software.
- Transparent bridges operate in promiscuous mode (混杂模式), accepting every frame transmitted on all the LANs to which it is attached.
- When a frame arrives, a bridge must decide whether to discard or forward it, and if the latter, on which LAN to put the frame.
- The decision is made by looking up the destination address in a big (hash) table inside the bridge.

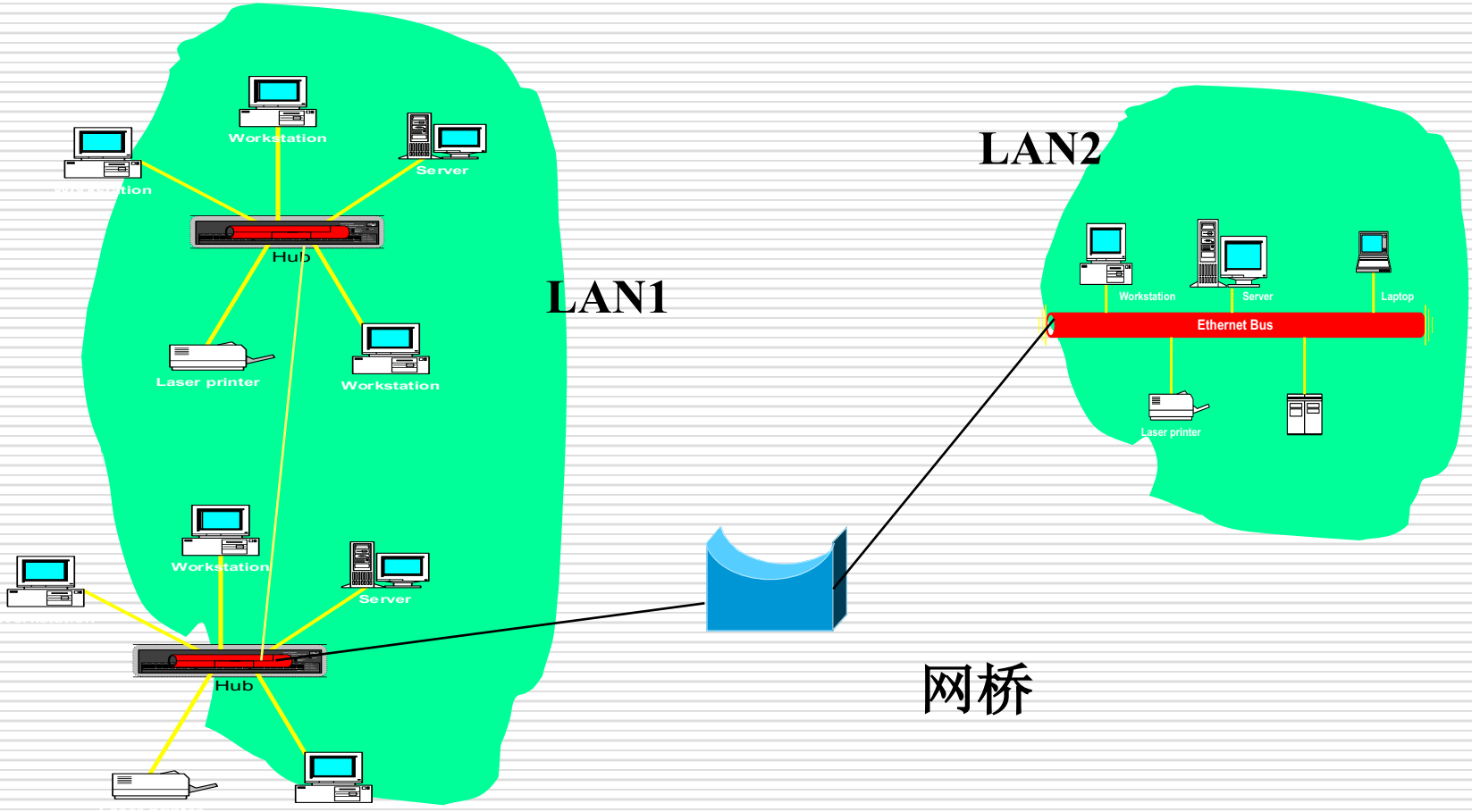
Local internetworking(cont'd)

- A bridge maintains a table of destination addresses and the corresponding output line as follows:
- Initially all the hash tables are empty.
- flooding algorithm:(泛洪)
  - Every incoming frame for an unknown destination is output on all the LANs to which the bridge is connected except the one it arrived on.
- backward learning （逆向学习）
  - By looking at the incoming frame's source address, a bridge is able to know which machine is accessible on which LAN, so it make an entry in its hash table linking the source machine with the incoming LAN.
- How to handle dynamic topologies?
  - Whenever a hash table entry is made, the arrival time of the frame is noted in the entry.
  - The entry time is updated whenever a frame from the address in that entry arrives.
  - Periodically, a process in the bridge scans the hash table and purges(清除) all entries more than a few minutes old.

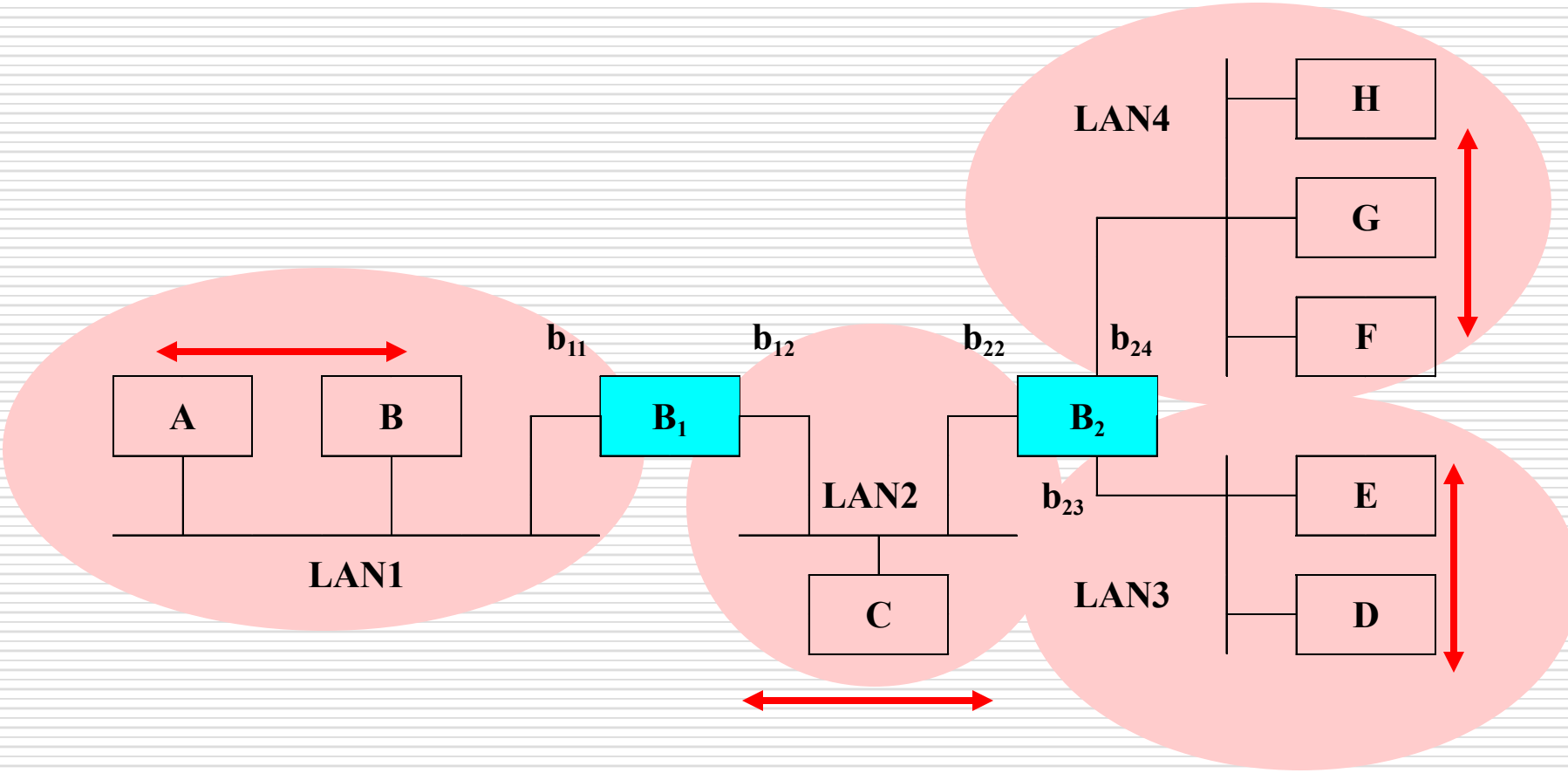
Principle of bridge

- Routing procedure for an incoming frame:
  - If destination and source LANs are the same, discard the frame.
  - If the destination and source LANs are different, forward the frame.
  - If the destination LAN is unknown, use flooding.
- As each frame arrives, the above algorithm must be applied.
- Special purpose VLSI chips exist to do the lookup and update the table entry, all in a few microsecond.

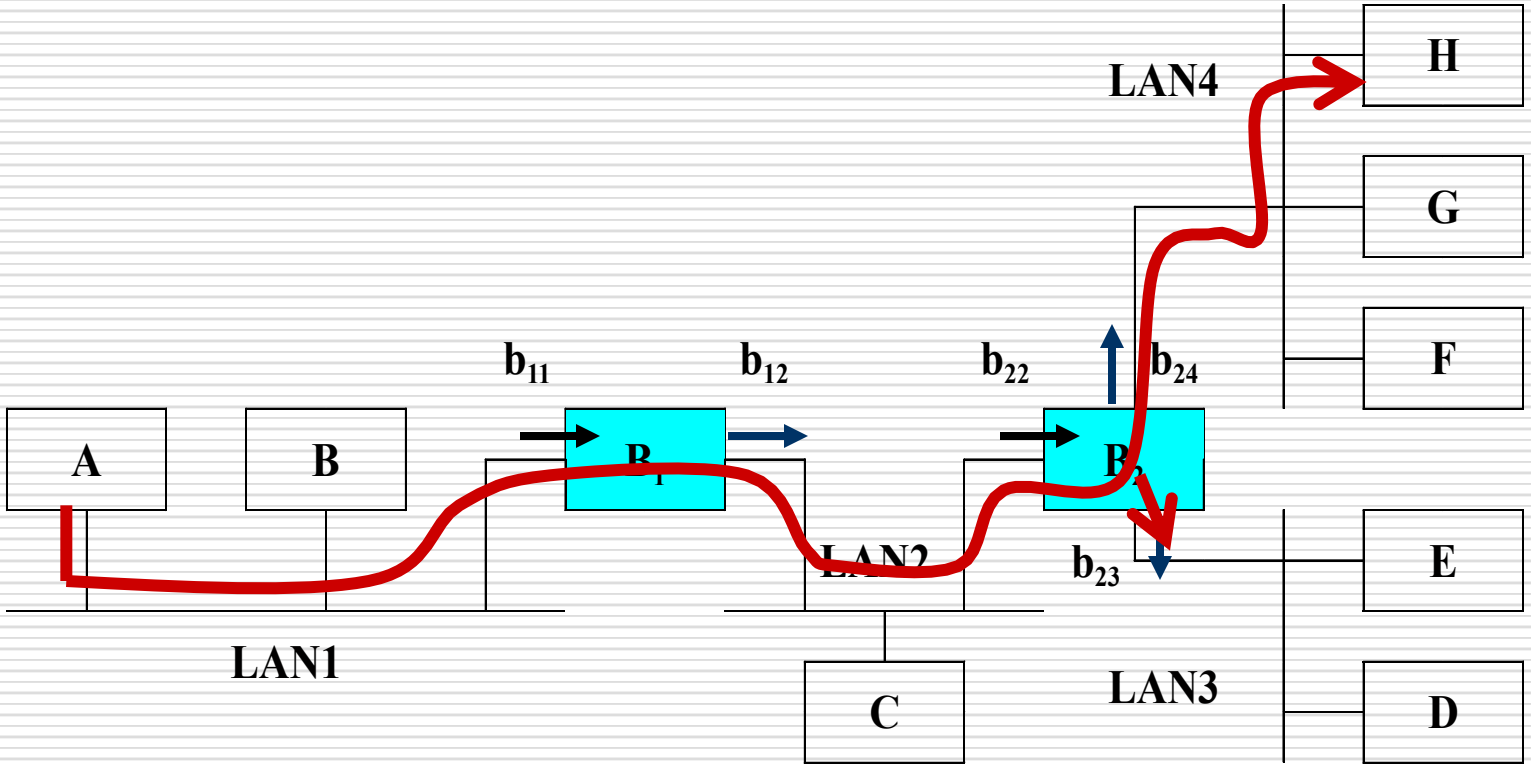
Bridge can segment collision-domain



Transparent bridge



Flooding（扩散、泛洪）

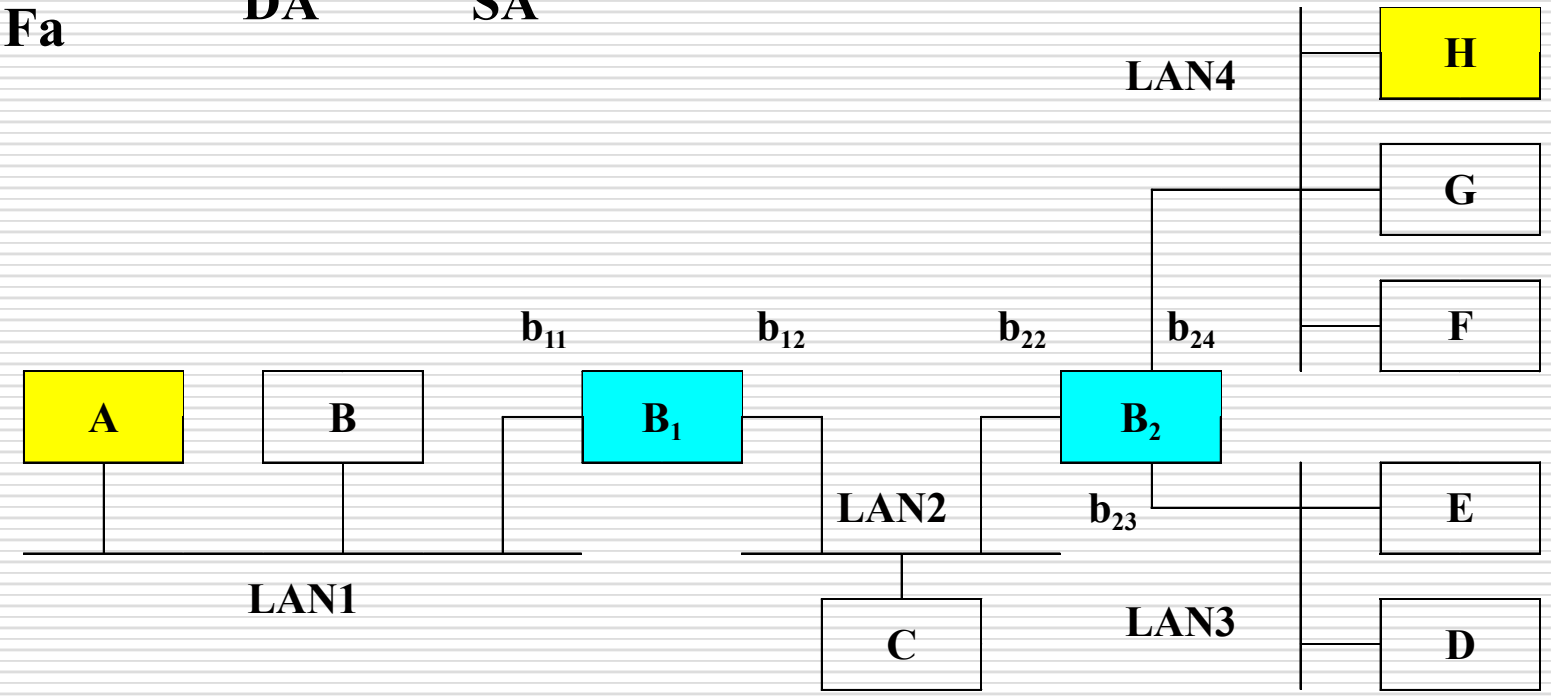


Step 1: A send Fa to H

先导	11	H	A	类型	数据	校验和

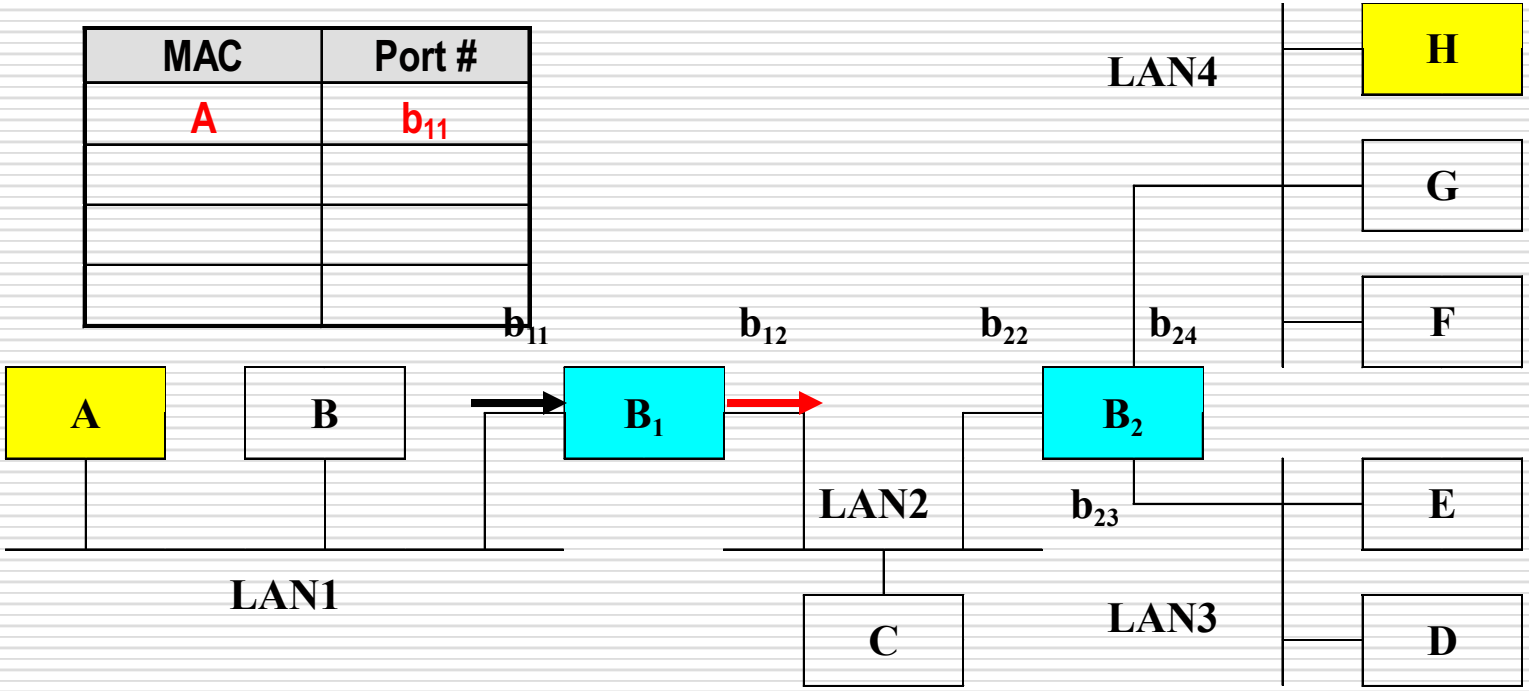
DA SA

Frame: Fa



Step 2: bridge B1

- B1 receives Fa from b11，flooding Fa to b12（LAN2）
- B1 learns source addr. of Fa



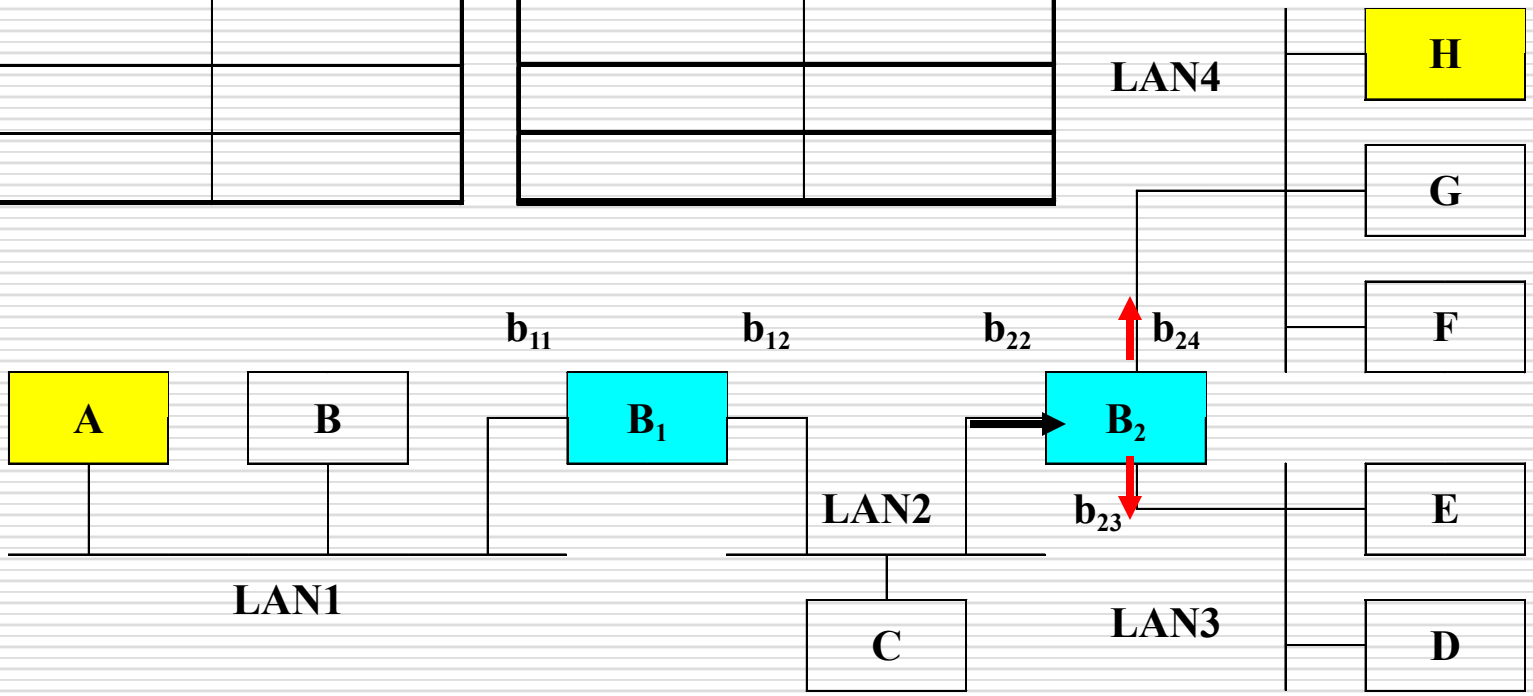
Step 3: Bridge B2

B_1

MAC	Port #
A	b_{11}

B_2

MAC	Port #
A	b_{22}

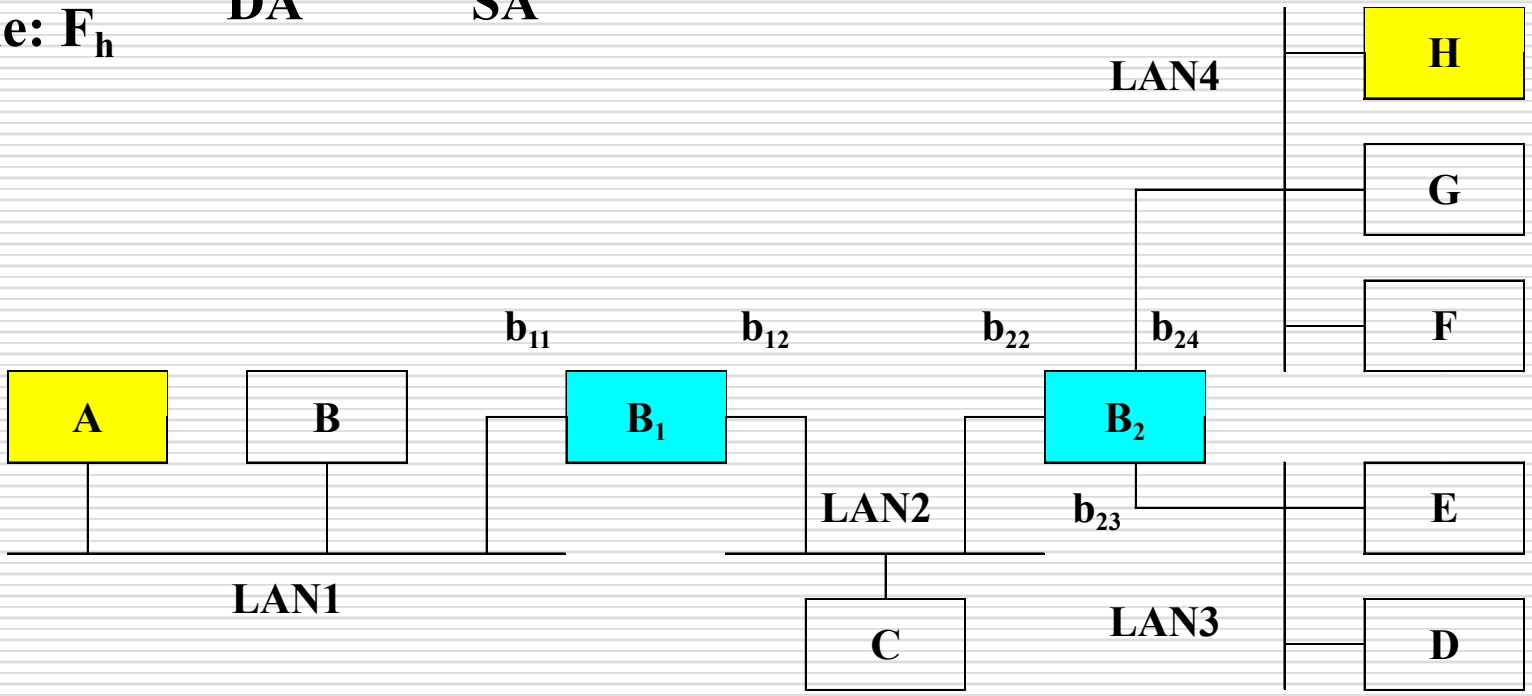


Step4: H send F_h back to A

先导	11	A	H	类型	数据	校验和

DA SA

Frame: F_h



Step 5: Bridge B2 (forword F_h)

B_1

MAC	Port #
A	b_{11}

B_2

MAC	Port #
A	b_{22}
H	b_{24}

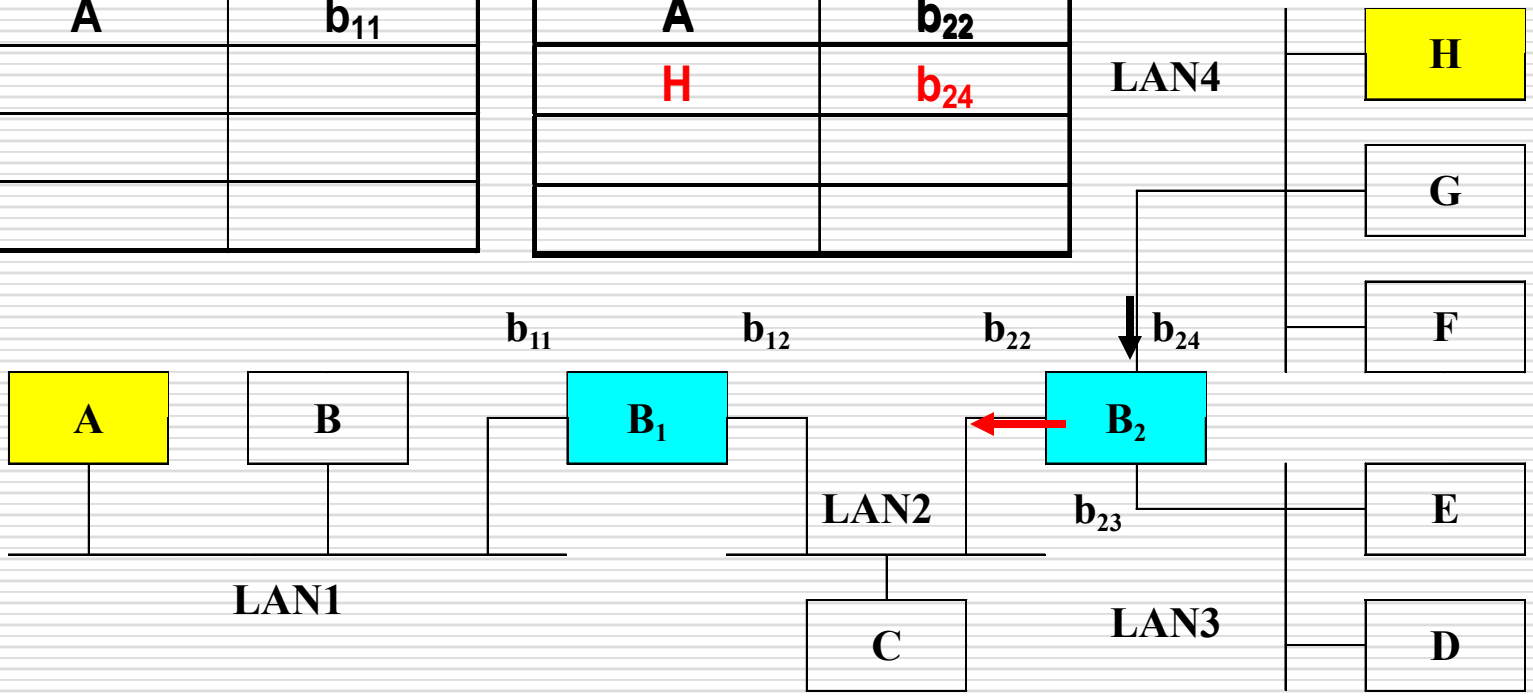
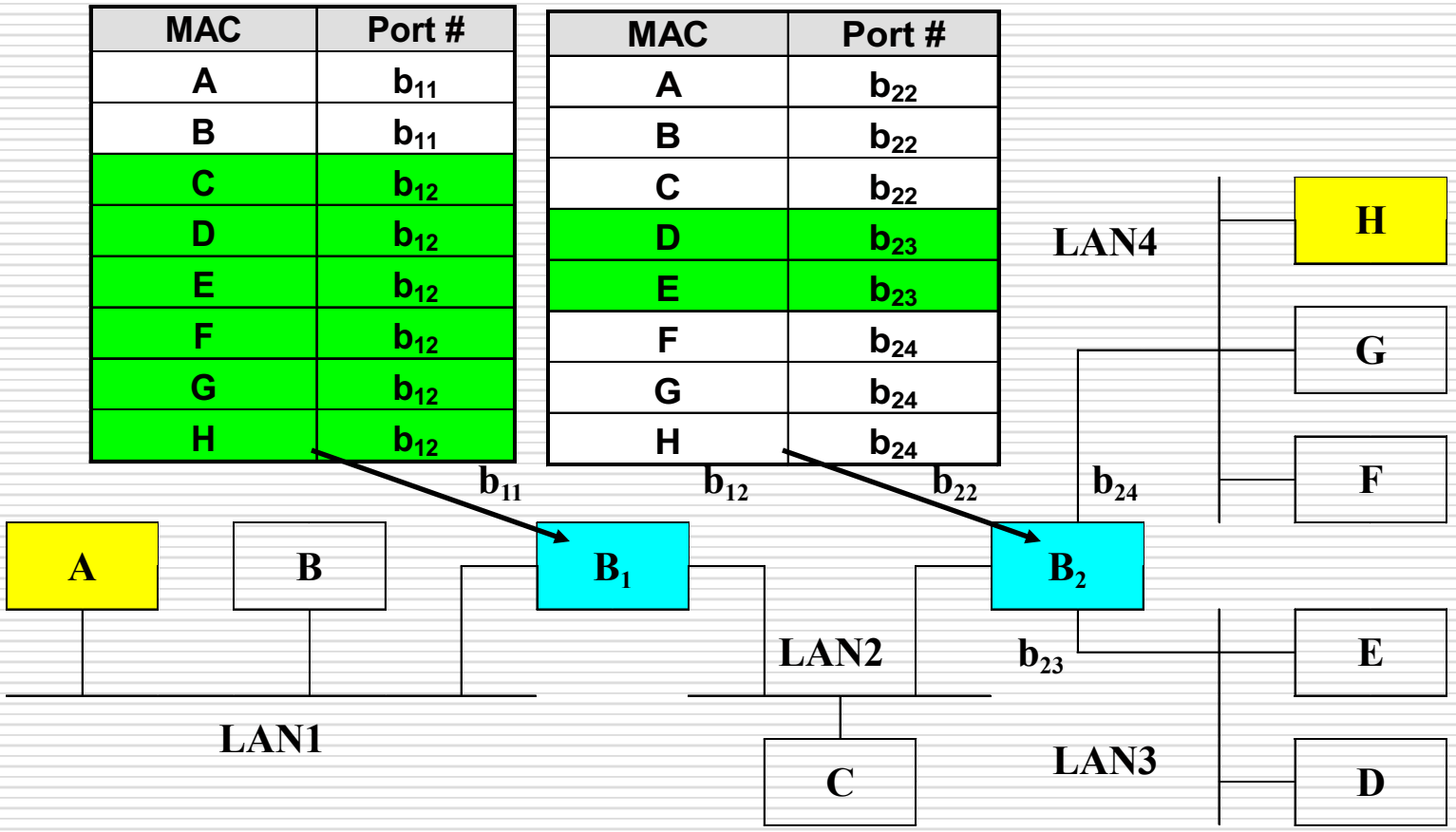
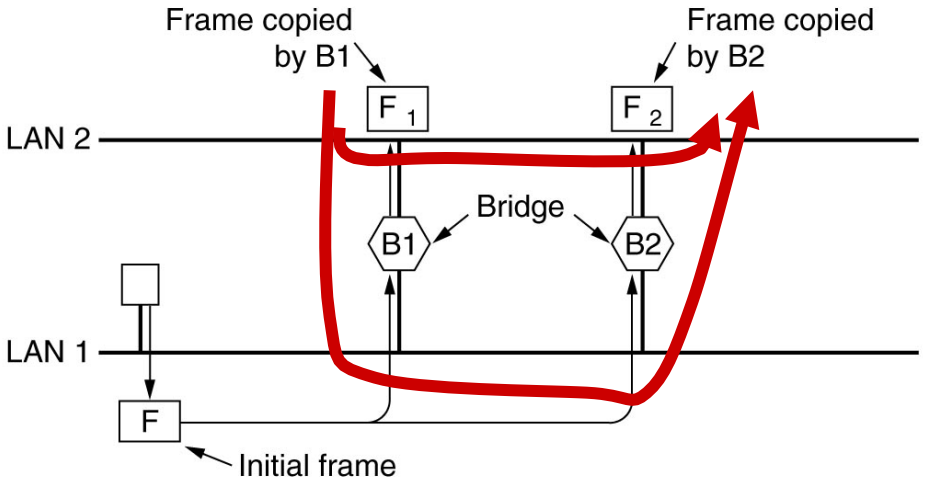


Table show


MAC
Port #
A
B
C
D
E
F
G
H
b_{11}
b_{12}
b_{22}
b_{23}
b_{24}
LAN4
LAN2
LAN1
LAN3
B_1
B_2

Spanning tree bridge

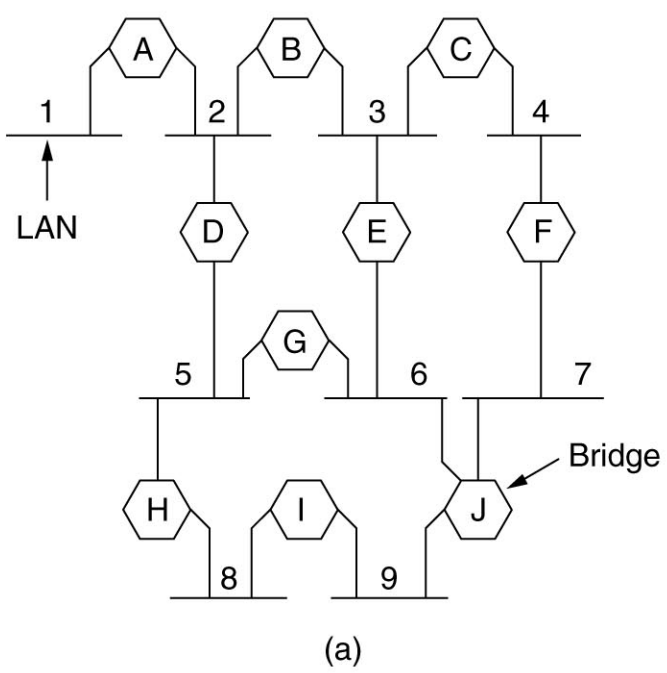
- To increase reliability, some sites use two or more bridges in parallel between pairs of LANs. This arrangement creates loops in the topology.
- What happens if a frame with an unknown destination arrives ?

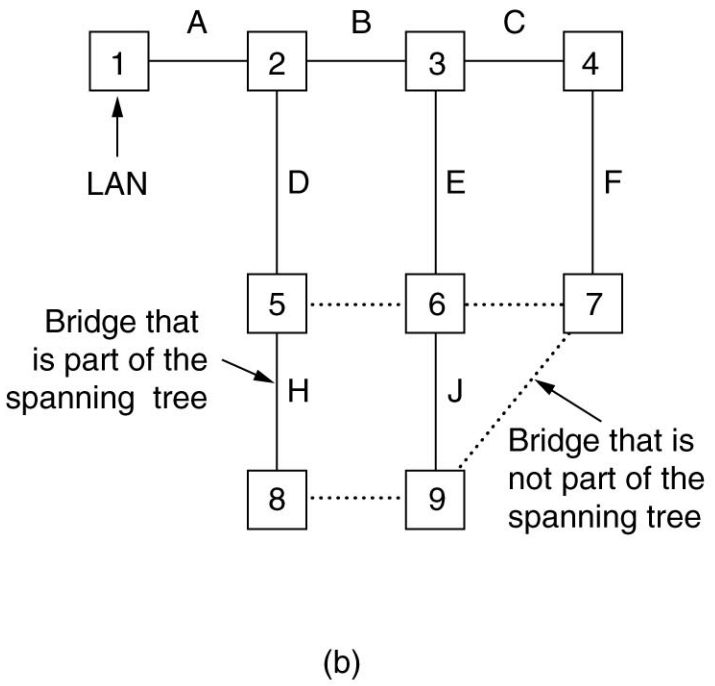


Spanning Tree Bridges (cont'd)

- The solution is for the bridges to communicate with each other and overlay the actual topology with a spanning tree that reaches every LAN.
- In a spanning tree, there is a unique path from each source to each destination, loops are impossible.
- To build the spanning tree
  - Choose one bridge to be the root of the tree
    - The bridge with the lowest serial number becomes the root.
  - A tree of shortest paths from the root to every bridge and LAN is constructed.
  - If a bridge or LAN fails, a new spanning tree is computed.

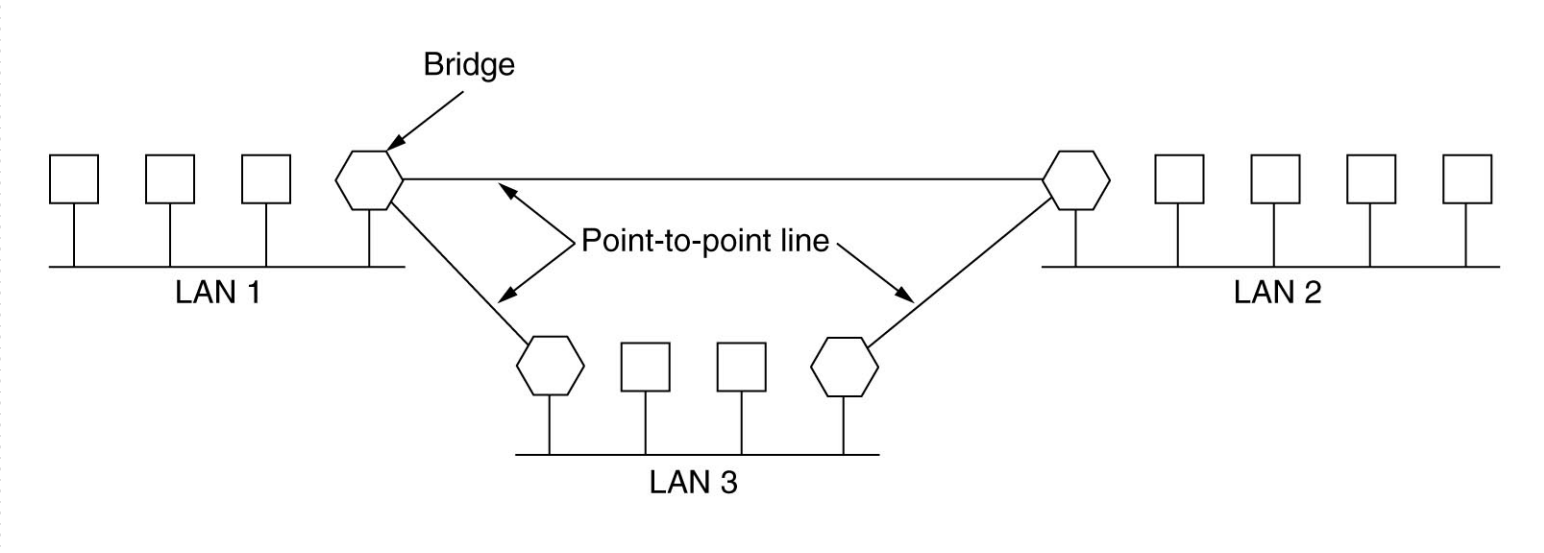
Spanning Tree Bridges (cont'd)



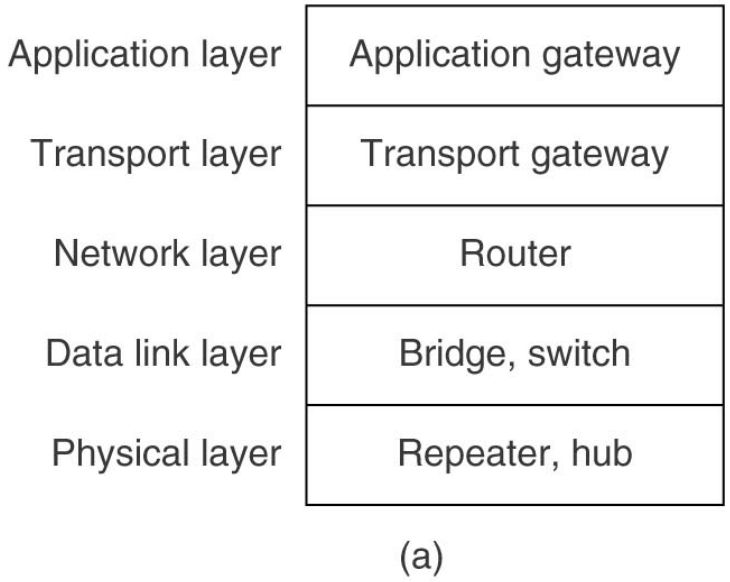


Remote Bridges

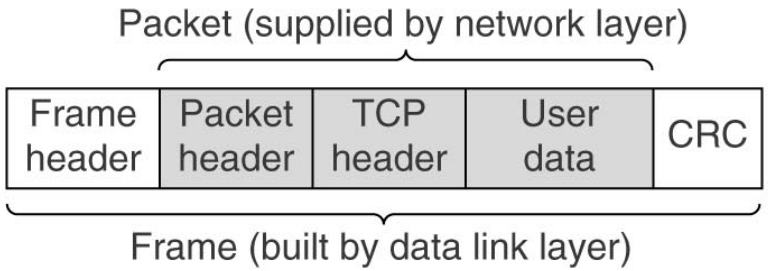
- **Remote bridges can be used to interconnect distant LANs.**
  - **Putting a bridge on each LAN**
  - **Connecting the bridges pairwise with point-to-point lines.**



Network Devices



(a)



(b)

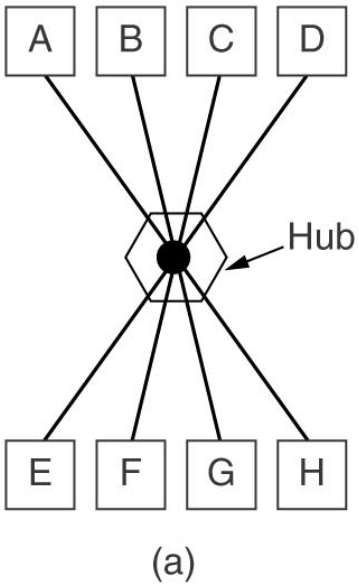
Network Devices (cont'd)

- **Repeaters**
  - Are analog devices to connect two cable segments.
  - A signal appearing on one segment is amplified and put out on the other segment.
  - Can not understand frames, packets, or headers, but understand volts.
- **Hubs**
  - Frames arriving on any of the lines are sent out on all the others.
  - The entire hub forms a single collision domain.
  - All the lines coming into a hub must operate at the same speed.
  - Do not amplify the incoming signals and are designed to hold multiple line cards each with multiple inputs (one collision domain).
  - Do not examine the 802 addresses or use them in any way.
- **Bridge.**
  - A bridge connects two or more LANs.
  - When a frame arrives, software in the bridge extracts the destination address from the frame header and looks it up in a table to see where to send the frame.
  - A bridge may have line cards (like a hub) for different network types and speeds.
  - Each line forms its own collision domain.

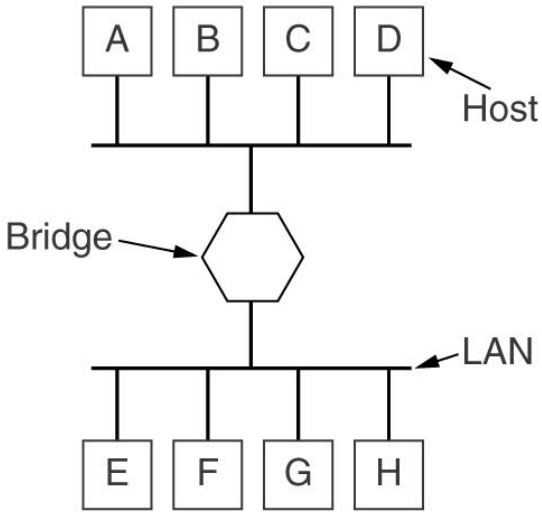
Network Devices (cont'd)

- **Switches**
  - A switch is similar to bridge in its routing on frame addresses.
  - Switches are often used to connect individual computers (no collision).
  - Switches must have space for many more line cards.
  - Each line card provides buffer space for frames arriving on its ports.
  - Each port forms its own collision domain.
- **Routers**
  - When a packet comes into a router, the frame header and trailer are stripped off and the packet located in the frame's payload field is passed to the routing software.
  - The routing software uses the packet header to choose an output line.
  - For an IP packet, the packet header will contain a 32-bit (IPv4) or 128-bit (IPv6) address, but not a 48-bit 802 address.
- **Gateways**
  - **Transport gateway**
    - Connect two computers that use different connection-oriented transport protocols
    - Copy the packets from one connection to the other, reformatting them as need be.
  - **Application gateway**
    - understand the format and contents of the data
    - translate messages from one format to another.

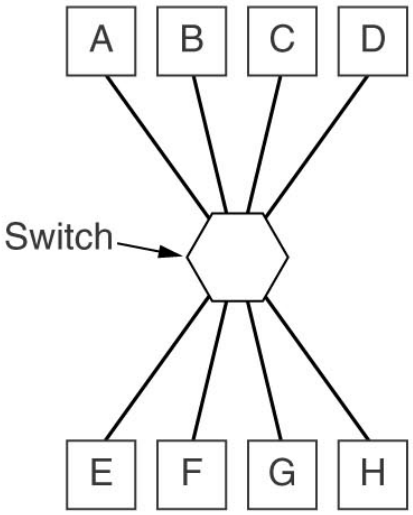
Network Devices (cont'd)



(a)



(b)



(c)

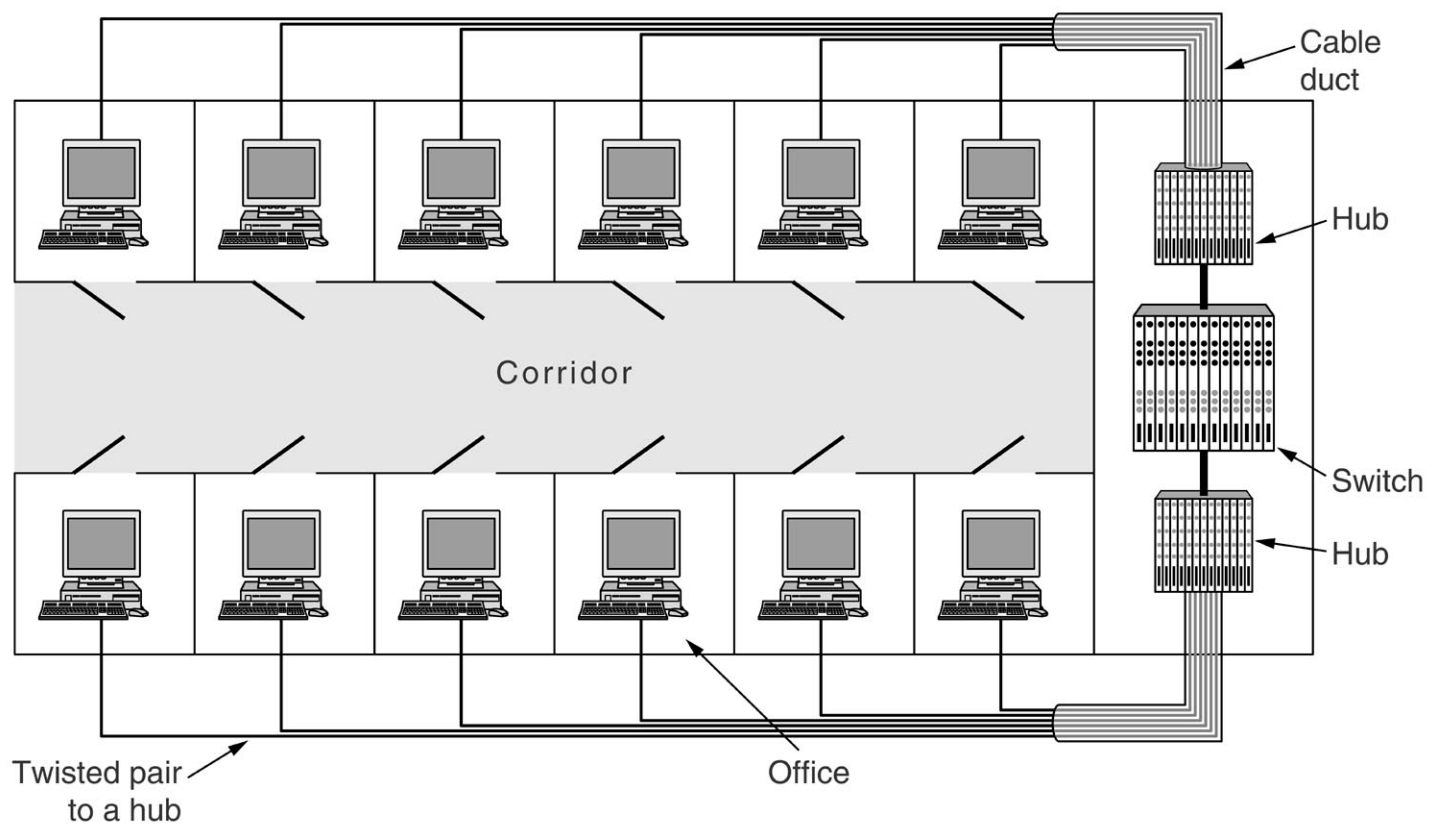
L2 (data link layer) devices

- **Network interface card (NIC)**
- **Bridge**
- **Switch**

Virtual LAN (虚拟局域网)

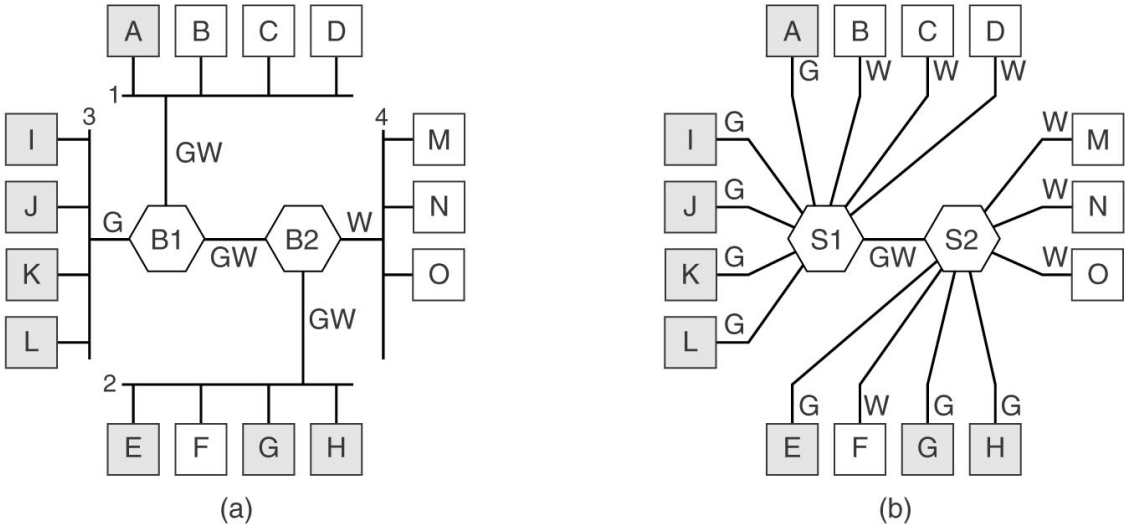
- Network administrators like to group users on LANs to reflect the organizational structure rather than the physical layout of the building.
  - Security
  - Load
  - Broadcasting
- Stage 1
  - All the people in adjacent offices were put on the same LAN whether they belonged together or not.
  - Geography trumped logic.
- Stage 2
  - By carefully choosing which connectors to plug into which hubs, a LAN can be chosen in a way that makes organizational sense, without too much regard to geography.
  - Organizational changes occur all the time, system administrators spend a lot of time pulling out plugs and pushing them back in somewhere else.
- Stage 3
  - Looking for a way to rewire buildings entirely in software -- VLAN (Virtual LAN).

Virtual LANs (cont'd)



Virtual LANs (cont'd)

- VLANs are based on specially-designed VLAN-aware switches.
- To set up a VLAN-based network, the network administrator decides how many VLANs there will be, which computers will be on which VLAN, and what the VLANs will be called.
- VLAN configuration tables tell which VLANs are accessible via which ports (lines).



Methods Of Vlans Partition

- VLAN based on ports
  - All machines on a port belong to the same VLAN.
- VLAN based on MAC addresses
  - The bridge or switch has a table listing the 48-bit MAC address of each machine along with the VLAN that machine is on.
- VLAN based on protocol types
  - e.g. classify all IP machines as belonging to one VLAN and all AppleTalk machines as belonging to another.
  - Have to examine the payload field of the frame, which violates the most fundamental rule of networking: independence of the layers.

Summary

- Learn basic idea of frame switch (L2 switching)
- Master basic principle of L2 switch
- Learn bridge
- Learn switch