LLC and Bridges

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- Logical Link Control
- Bridges
- Path determination: Spanning tree, source routing

IEEE 802

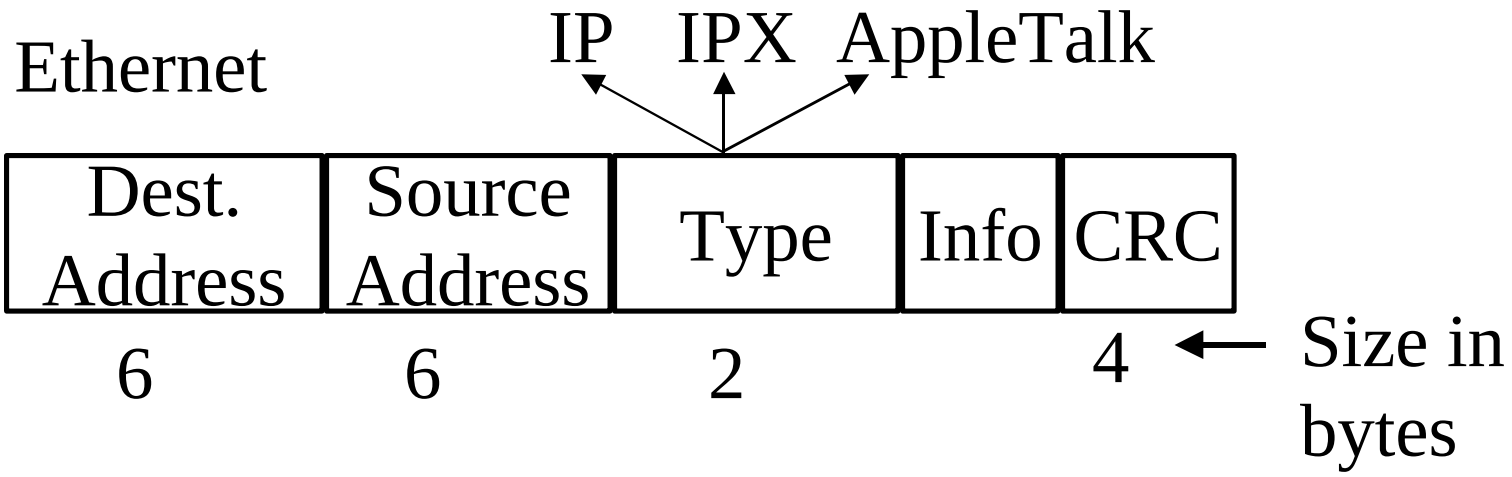
- 802.1 Network management and bridging
- 802.2 Logical link control
- 802.3 Ethernet (CSMA/CD)
- 802.4 Token Bus
- 802.5 Token Ring
- 802.6 DQDB
- 802.7 Broadband technical advisory group
- 802.8 Fiber-optic technical advisory group
- 802.9 Integrated data and voice
- 802.10 Security and privacy

IEEE 802 (Cont)

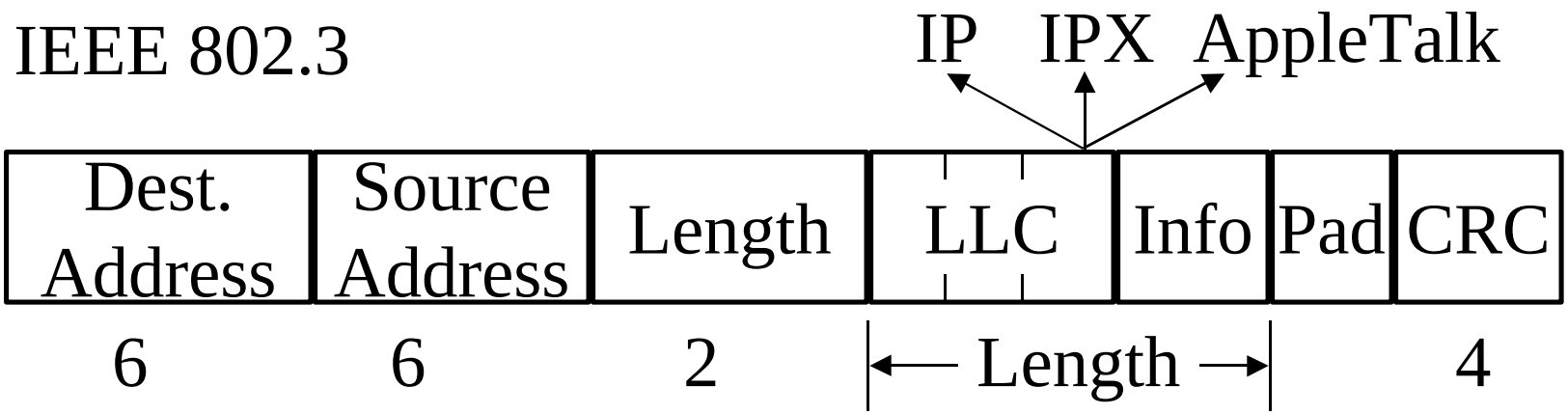
- 802.11 Wireless LANs
- 802.12 100VG-AnyLAN
- 802.13 ?Bad Luck
- 802.14

Frame Format

- Ethernet



- IEEE 802.3



LLC Type 1

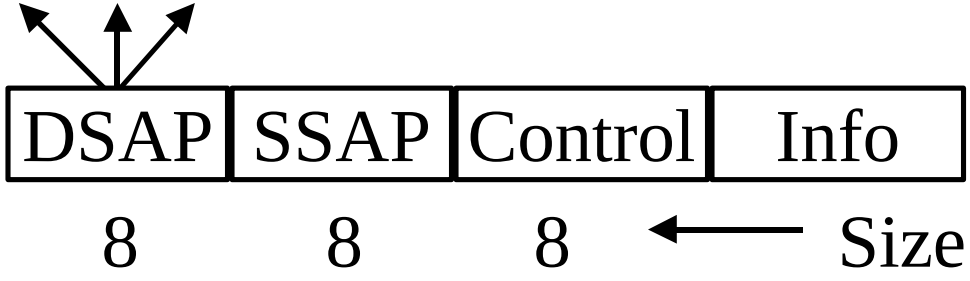
- Unacknowledged connectionless (on 802.3)
  No flow or error control.
  Provides protocol multiplexing.
  Uses 3 types of protocol data units (PDUs):
  UI = Unnumbered informaton
  XID = Exchange ID
  = Types of operation supported, window
  Test = Loop back test

LLC Type 2, 3

- Type 2: Acknowledged connection oriented (on 802.5)
  Provides flow control, error control. Uses SABME (Set asynchronous balanced mode), UA (unnumbered ack), DM (disconneced mode), DISC (disconnect)
- Type 3: Acknowledged connectionless
  Uses one-bit sequence number
  AC command PDUs acked by AC response PDUs

LLC Multiplexing

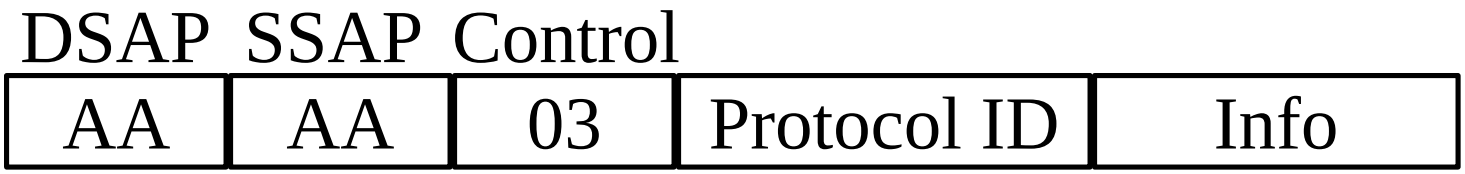
- Multiplexing allows multiple users (network layer protocols) to share a datalink
- Each user is identified by a "service access point (SAP)"



- Eight-bit SAP
  ⇒ Only 256 standard values possible
- Even IP couldn't get a standard SAP.
  Use Subnetwork Access Protocol SAP (SNAP SAP)

SNAP SAP

- SubNetwork Access Protocol Service Access Point
- When DSAP=AA, SSAP=AA, Control=UI, protocol ID field is used for multiplexing



- Protocol ID is 40 bit long. The first 24 bits are Organizationally Unique Identifiers (OUI). OUI of 0 is used. The Ethernet type values are used in the last 16 bits.

  Protocol ID = 00-00-00-xx-xx

Bridges

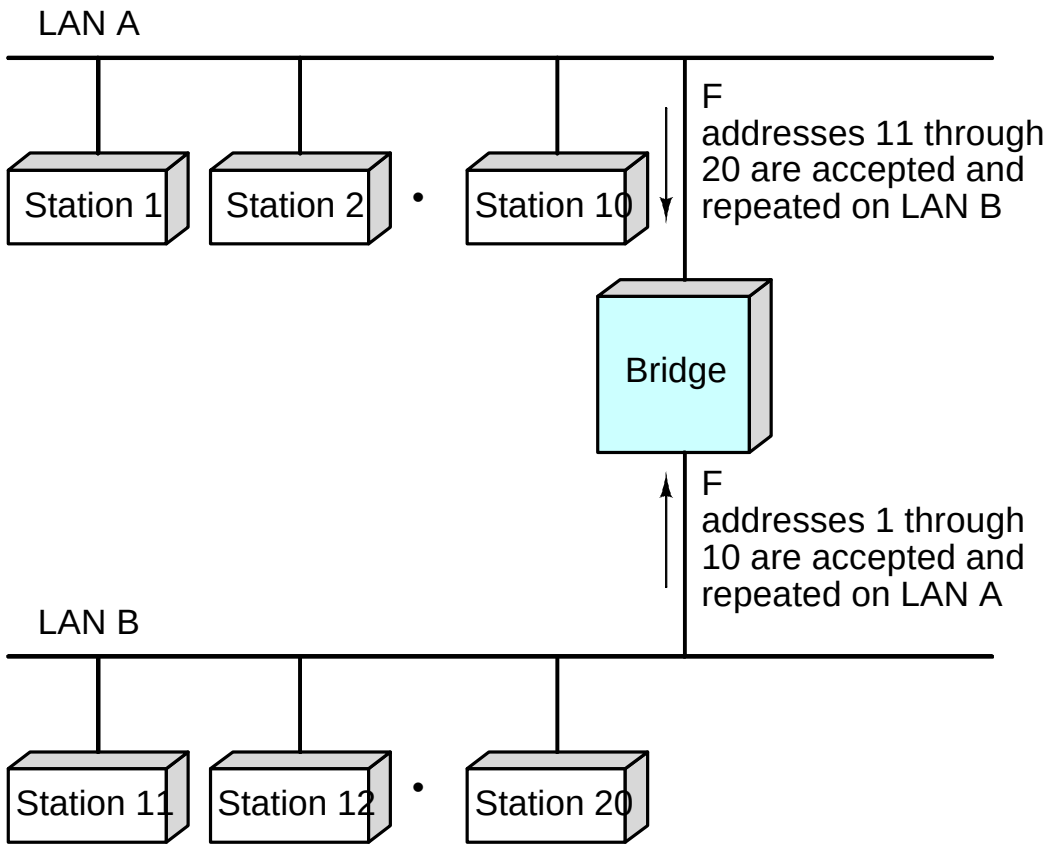


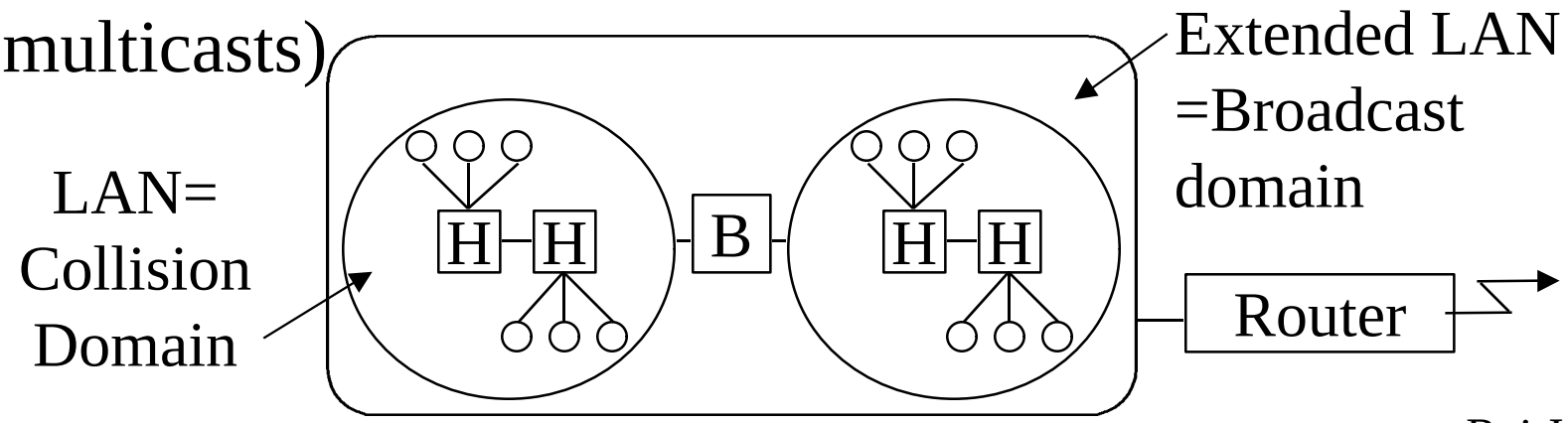
Fig 14.1

Bridge: Functions

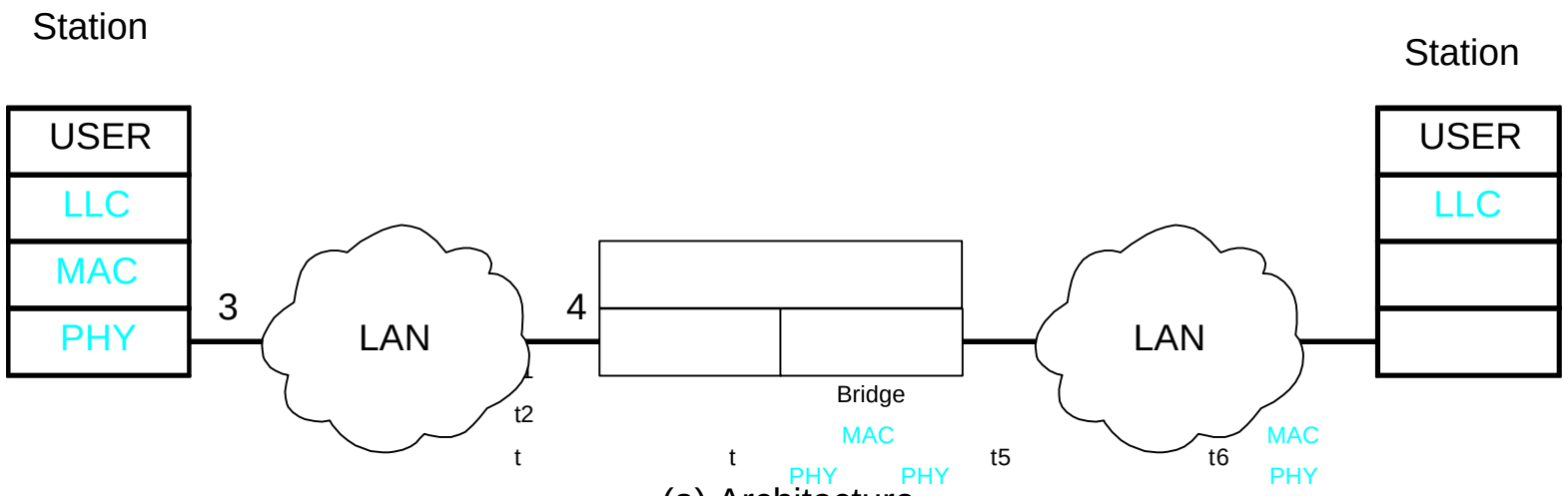
- Monitor all frames on LAN A
- Pickup frames that are for stations on the other side
- Retransmit the frames on the other side
- Knows or learns about stations are on various sides
- Makes no modification to content of the frames.
  May change headers.
- Provides storage for frames to be forwarded
- Improves reliability (less nodes per LAN)
- Improves performance (more bandwidth per node)
- Security (Keeps different traffic from entering a LAN)
- May provide flow and congestion control

Interconnection Devices

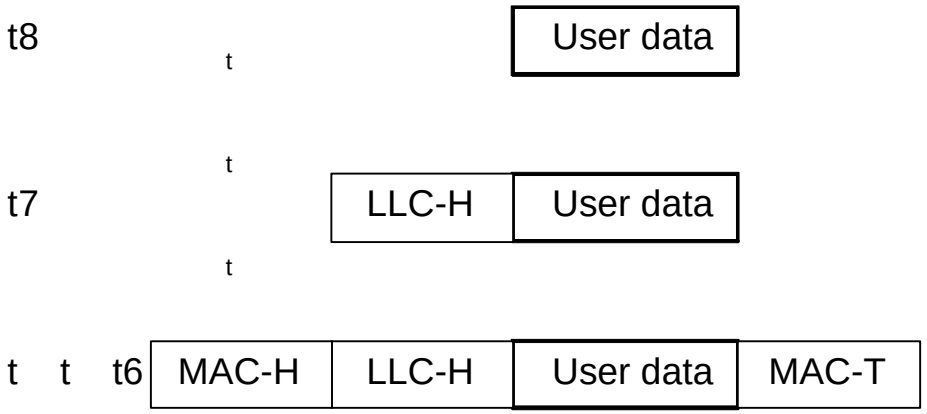
- **Repeater**: PHY device that restores data and collision signals
- **Hub:** Multiport repeater + collision detection, notification and signal broadcast
- **Bridge:** Datalink layer device connecting two or more collision domains
- **Router:** Network layer device (does propagate MAC multicasts)



Data Encaptulation by Bridges

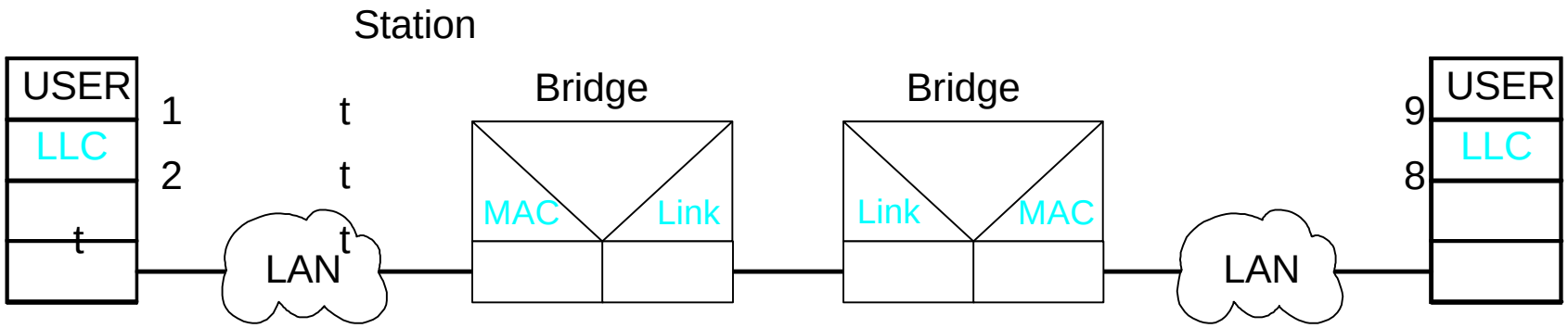


(a) Architecture

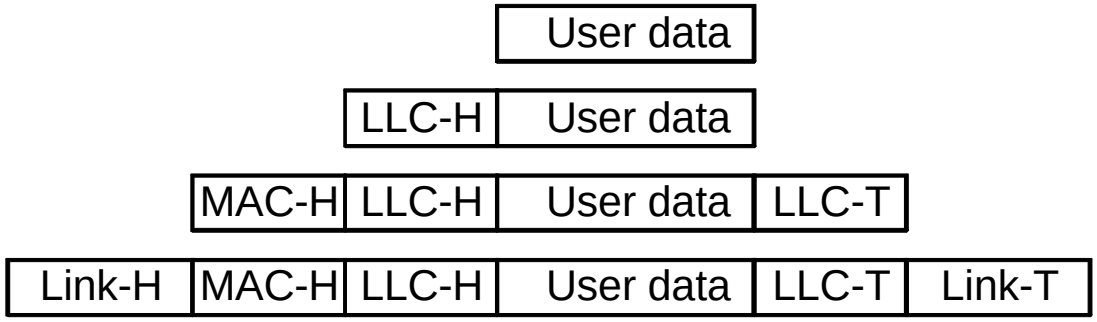


(b) Operation

Bridges for Point-to-point links



(a) Architecture



(b) Operation

Fig 14.3

Path Determination By Bridges

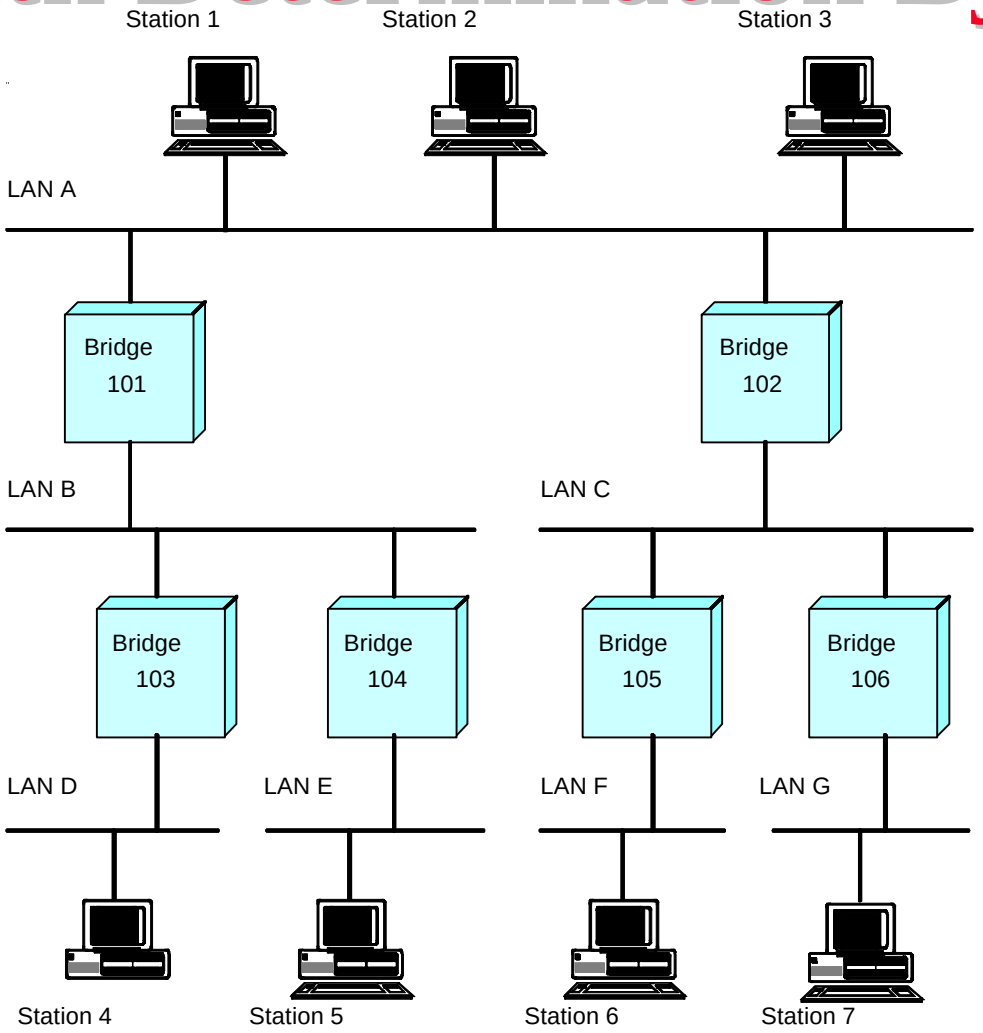


Fig 14.5

1. Fixed Routing

Central Routing Matrix

Source LAN \ Destination LAN	A	B	C	D	E	F	G
A	–	101	102	101	107	102	102
B	101	–	101	103	104	101	101
C	102	102	–	102	102	105	106
D	103	103	103	–	103	103	103
E	107	104	107	104	–	107	107
F	105	105	105	105	105	–	105
G	106	106	106	106	106	106	–

Bridge 101 table

from LAN A		from LAN B	
Dest	Next	Dest	Next
B	B	A	A
C	–	C	A
D	B	D	–
E	–	E	–
F	–	F	A
G	–	G	A

Bridge 102 table

from LAN A		from LAN C	
Dest	Next	Dest	Next
B	–	A	A
C	C	B	A
D	–	D	A
E	–	E	A
F	C	F	–
G	C	G	–

Bridge 103 table

from LAN B		from LAN D	
Dest	Next	Dest	Next
A	–	A	B
C	–	B	B
D	D	C	B
E	–	E	B
F	–	F	B
G	–	G	B

Bridge 104 table

from LAN B		from LAN E	
Dest	Next	Dest	Next
A	–	A	–
C	–	B	B
D	–	C	–
E	E	D	B
F	–	F	–
G	–	G	–

Bridge 105 table

from LAN C		from LAN F	
Dest	Next	Dest	Next
A	–	A	C
B	–	B	C
D	–	C	C
E	–	D	C
F	F	E	C
G	–	G	C

Bridge 106 table

from LAN C		from LAN G	
Dest	Next	Dest	Next
A	–	A	C
B	–	B	C
D	–	C	C
E	–	D	C
F	–	E	C
G	G	F	C

Bridge 107 table

from LAN A		from LAN E	
Dest	Next	Dest	Next
B	–	A	A
C	–	B	–
D	–	C	A
E	E	D	–
F	–	F	A
G	–	G	A

Fig 14.7

2. Spanning Tree

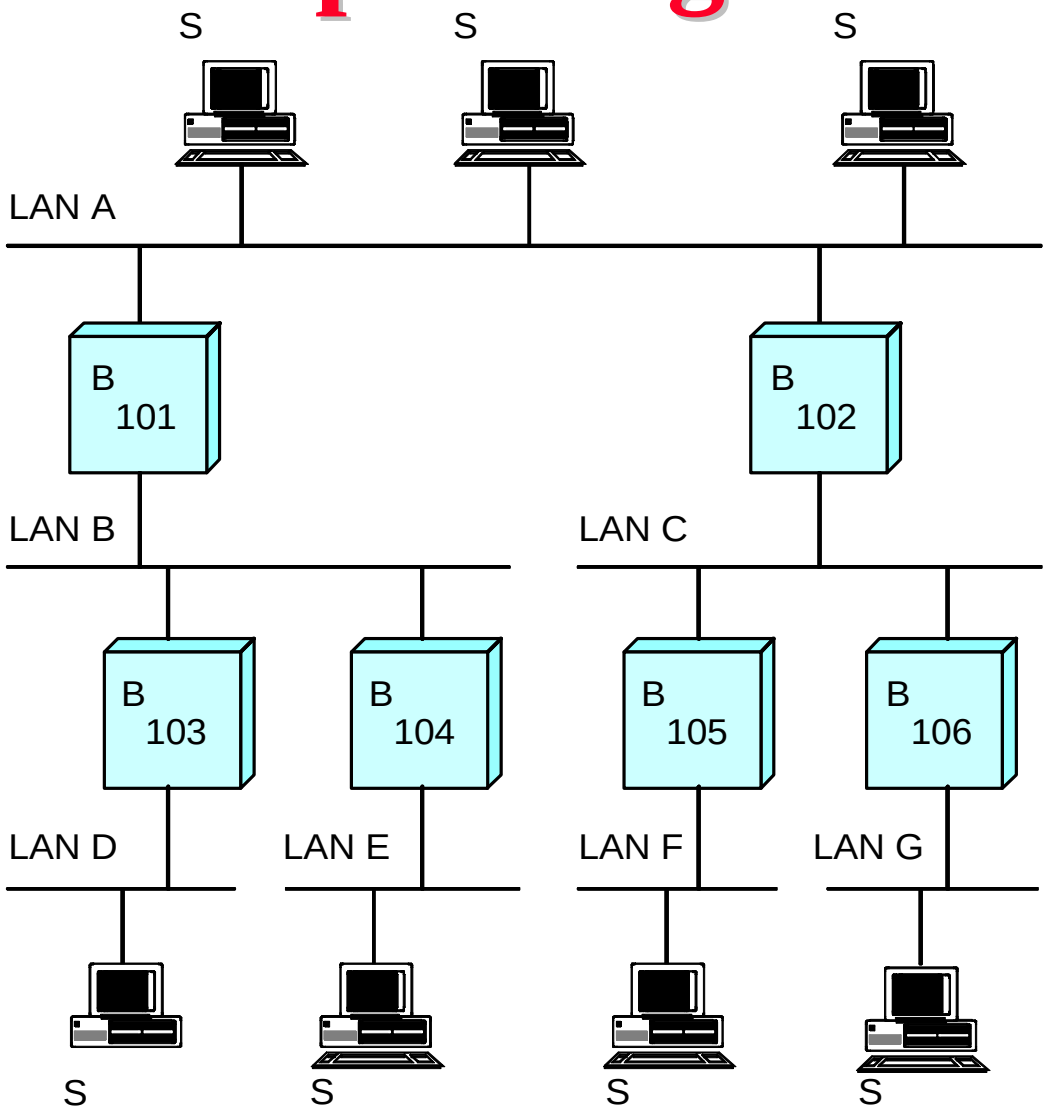


Fig 14.5

Spanning Tree (Cont)

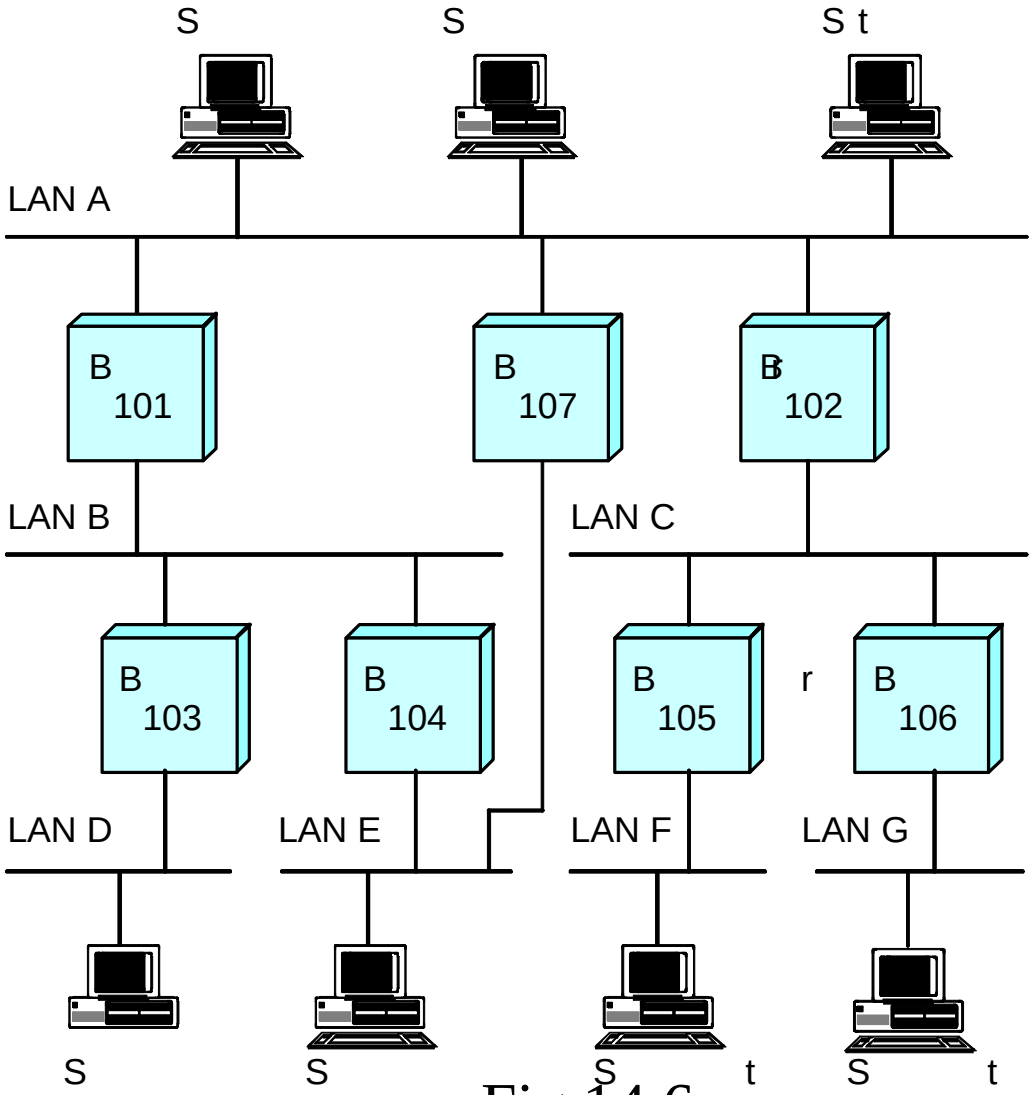


Fig 14.6

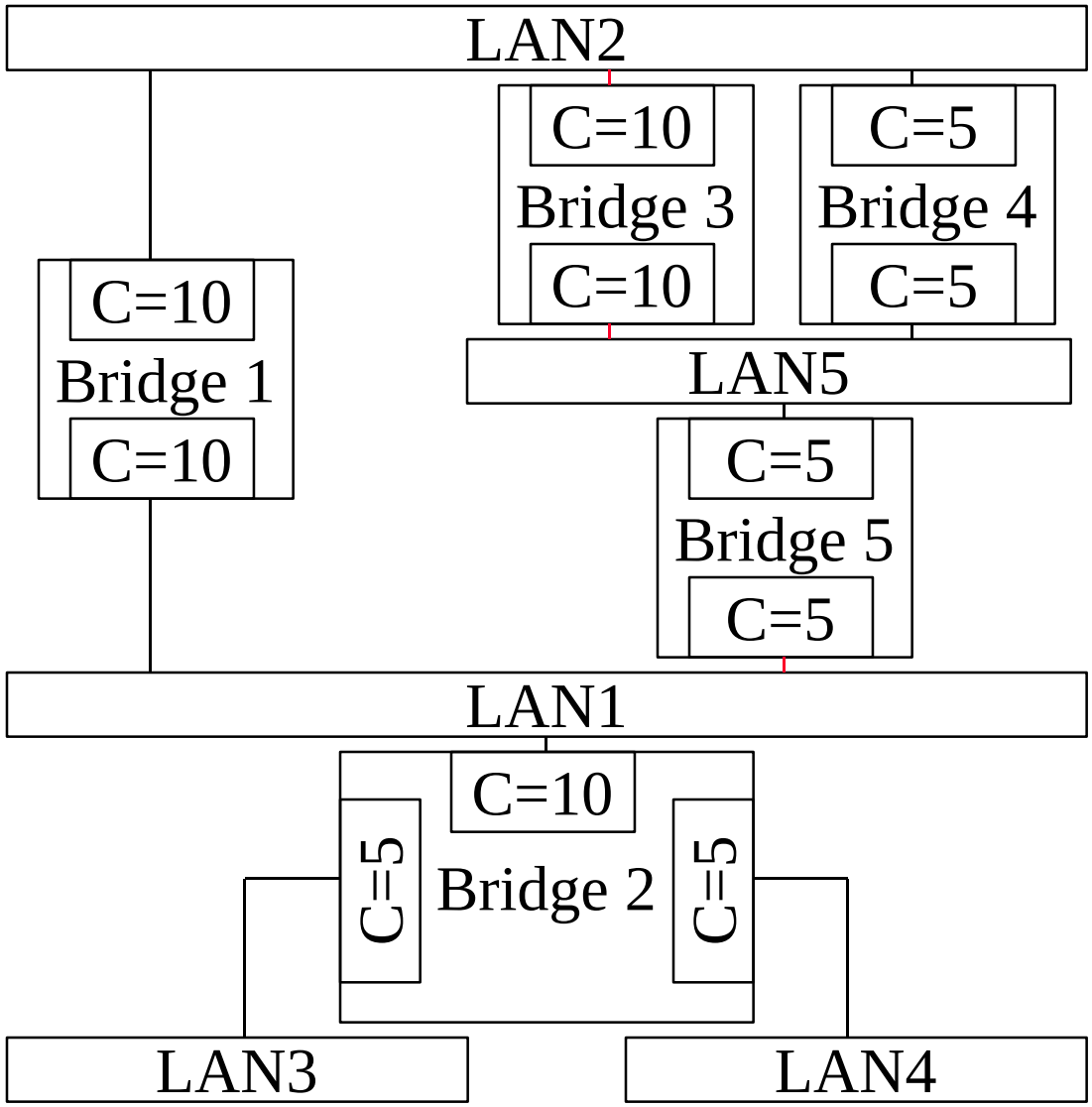
Spanning Tree: Terminology

- Bridge Identifier: MAC address plus a priority level
- Port identifier: For each port of a bridge
- Path cost: Cost transmitting through a port
- Root Bridge: The bridge with the lowest identifier
- Root port: Port with minimum cost to the root bridge
- Root path cost: Cost of the path to the root bridge
- Designated bridge: One per LAN. Provides minimum cost path from the LAN to the root bridge.
- Designated Port: Connects designated bridge to LAN

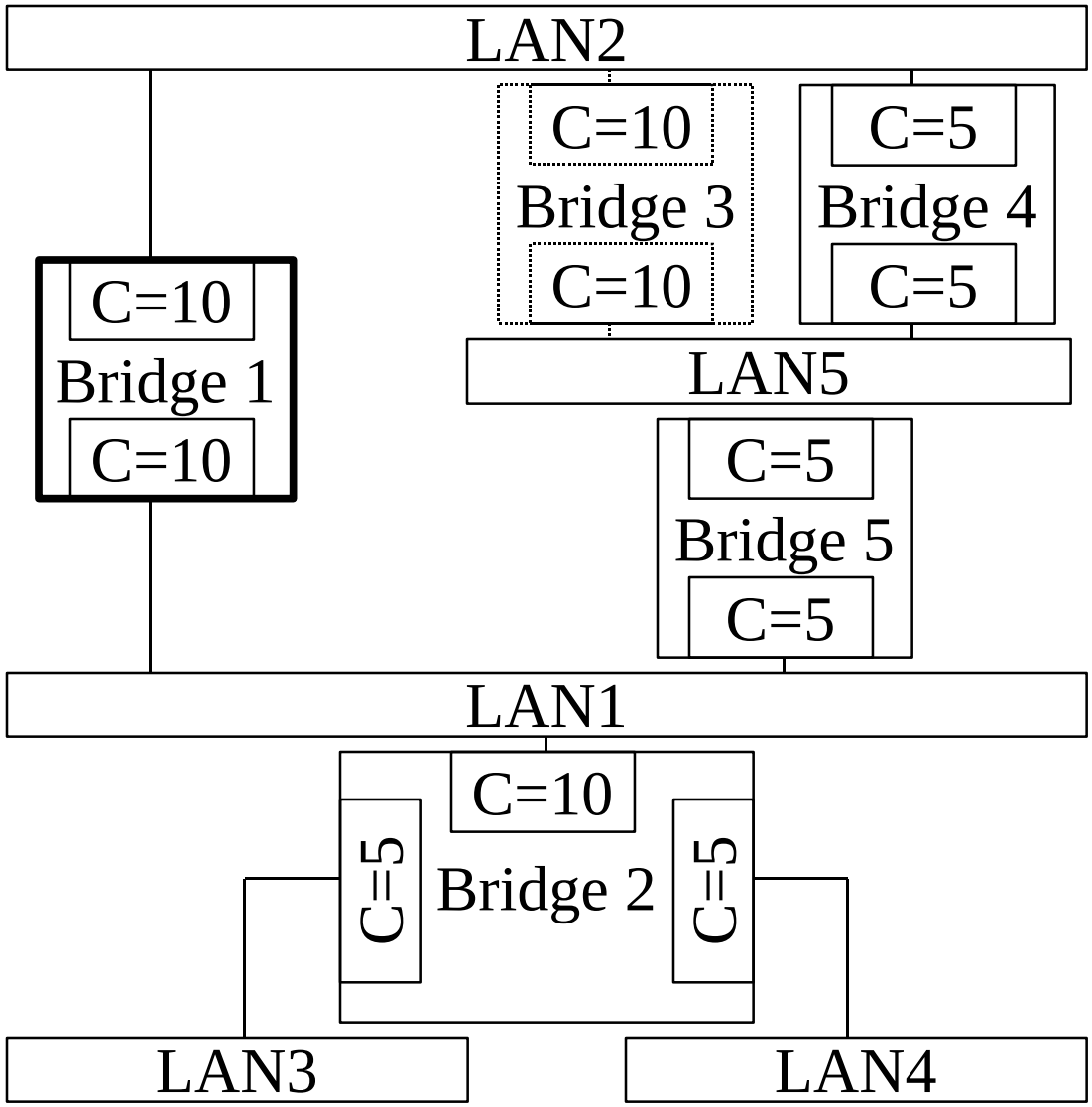
Spanning Tree Algorithm

- All bridges multicast to "All bridges"
  - My ID
  - Root ID
  - My cost to root
- The bridges update their info using Dijkstra's algorithm and rebroadcast
- Initially all bridges are roots but eventually converge to one root as they find out the lowest Bridge ID.
- On each LAN, the bridge with minimum cost to the root becomes the Designated bridge
- All ports of all non-designated bridges are blocked.

Spanning Tree Example



Spanning Tree Example (Cont)



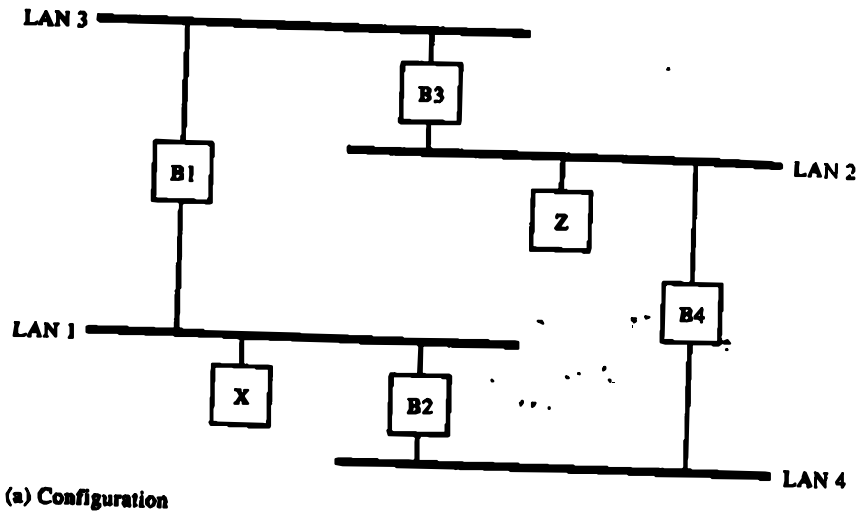
3. Source Routing

- The frame header contains the complete route:
  LAN 1 - Bridge B1 - LAN 3 - Bridge B3 - LAN 2 - Dest
- Bridges are simple, end systems do the routing
- Four types of destination addressing:
  - Null: Destination on the same LAN
  - Non-broadcast: Includes a route to destination
  - All-route Broadcast: Flooded.
    Bridges record route in the frame.
  - Single-route Broadcast: Once and only once on each LAN. Spanning tree used for broadcast

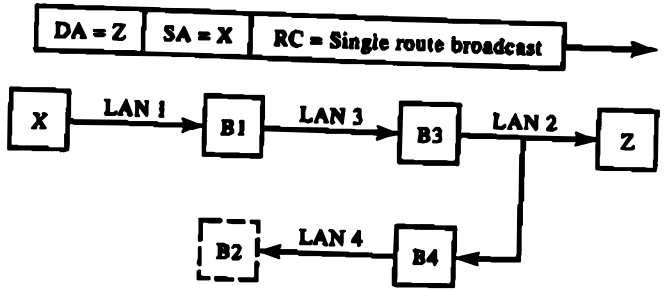
Route Discovery

- Manually on small internets
- Route server
- Dynamic route discovery
  - Transmit "All-route request frame" to destination The destination sends back "non-broadcast response" on each frame. Source knows all routes to the destination. Selects one.
  - Transmit "single-route request frame" to dest. The destination responds with one "All-routes response." The source receives many responses and discovers all routes.

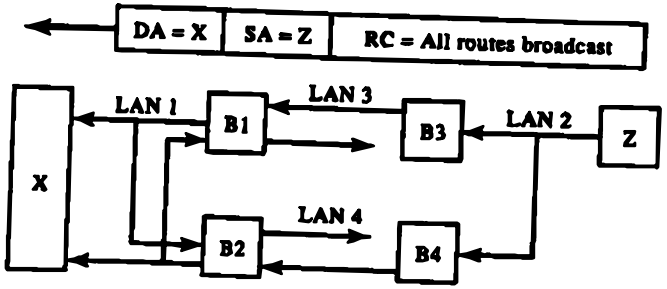
Example



(a) Configuration



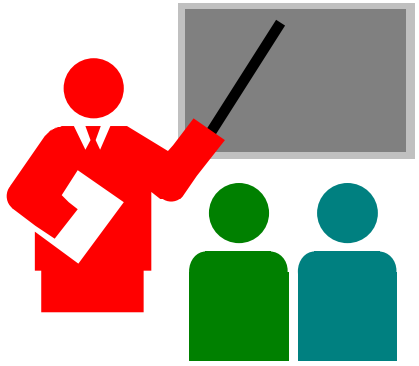
(b) Single-route broadcast request



(c) All-routes broadcast response

Fig 14.12

Summary



- Ethernet bridges learn source addresses
- Spanning tree algorithm
- Token ring bridges use source route

Homework

- Read chapter 14.1, 14.2

Thank You!