

High-Speed LANs

Part III:

LLC and Bridging

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These slides are available on-line at:

<http://www.cse.wustl.edu/~jain/cse473-05/>



- q Logical Link Control
- q Bridges
- q Path determination: Spanning tree
- q Layer 2 switches
- q Layer 3 switches

Logical Link Control

q IEEE 802 Datalink:

	Logical Link Control		
Media	802.3	802.4	802.5
Access	CSMA?CD	Token Bus	Token Ring

q Logical Link Control Functions:

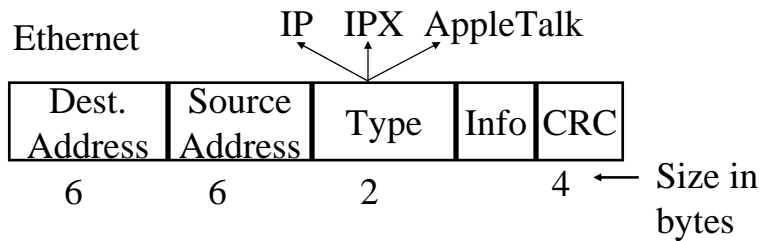
- q Upper layer Protocol multiplexing
- q Flow control (Windows)
- q Error Control (Retransmissions)

q Several different types of LLC's: Type 1, 2, 3, ...

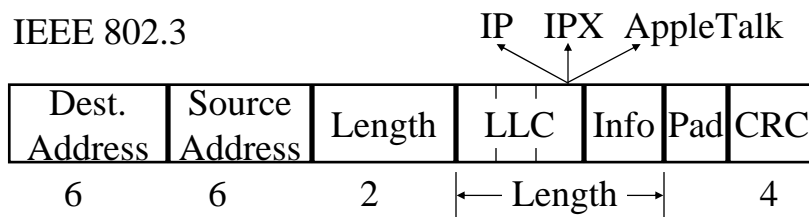
q Based on HDLC

Protocol Multiplexing

q Ethernet



q IEEE 802.3



LLC Types

- q Type 1: Unacknowledged connectionless (on 802.3)
No flow or error control.
Provides protocol multiplexing.
- q Type 2: Acknowledged connection oriented (on 802.5)
Provides flow control, error control. Uses
SABME (Set asynchronous balanced mode), UA
(unnumbered ack), DM (disconnected mode), DISC
(disconnect)
- q Type 3: Acknowledged connectionless
Uses one-bit sequence number
AC command PDUs acked by AC response PDUs

LLC Header

- q Multiple network layer protocols can share a datalink
- q Each protocol is identified by a “service access point (SAP)”



- q First bit of DSAP indicates Individual/Group
- q First bit of SSAP indicates command/response
- q Eight-bit SAP \Rightarrow Only 256 standard values possible
- q Even IP couldn't get a standard SAP.
Use Subnetwork Access Protocol SAP (SNAP SAP)

SNAP SAP

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

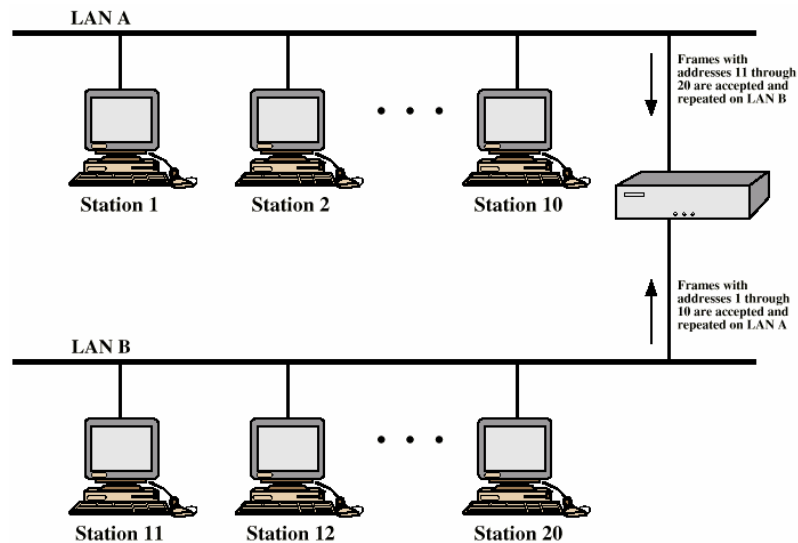
DSAP	SSAP	Control	Protocol ID	Info
AA	AA	03	Protocol ID	Info

40 bits

- q 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

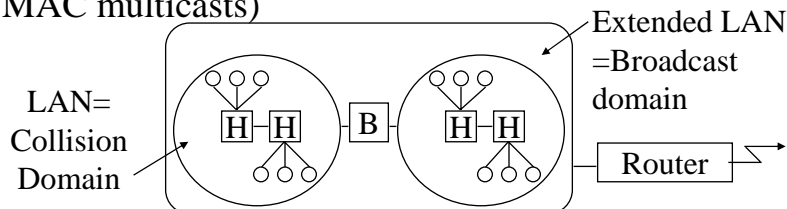


Bridge: Functions

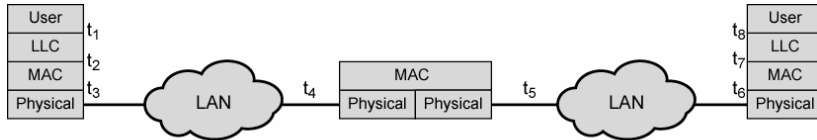
- q Monitor all frames on LAN A
- q Pickup frames that are for stations on the other side
- q Retransmit the frames on the other side
- q Knows or learns about stations are on various sides
- q Makes no modification to content of the frames.
May change headers.
- q Provides storage for frames to be forwarded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

Interconnection Devices

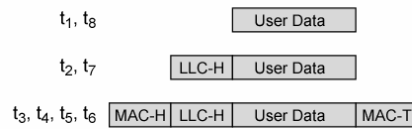
- q **Repeater:** PHY device that restores data and collision signals
- q **Hub:** Multiport repeater + fault detection, notification and signal broadcast
- q **Bridge:** Datalink layer device connecting two or more collision domains (Switch = Multi-port Bridge)
- q **Router:** Network layer device (does not propagate MAC multicasts)



Bridge Protocol Architecture

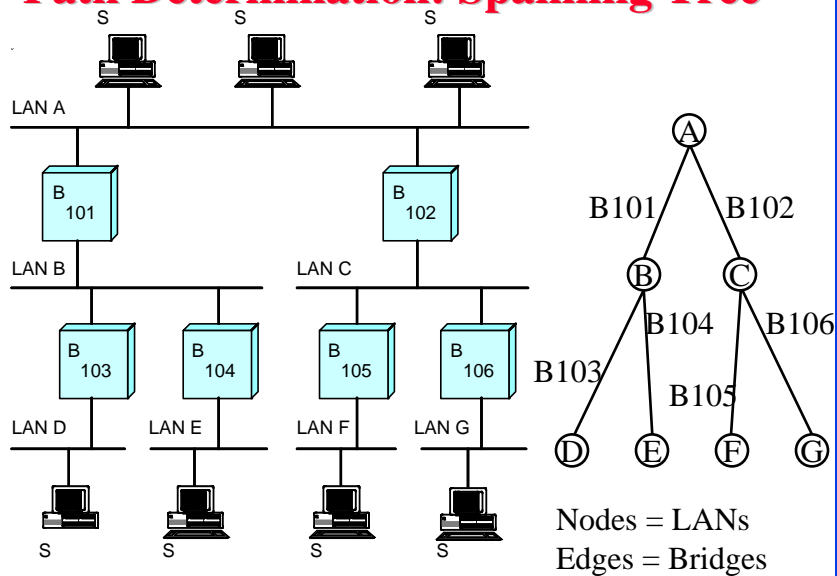


(a) Architecture

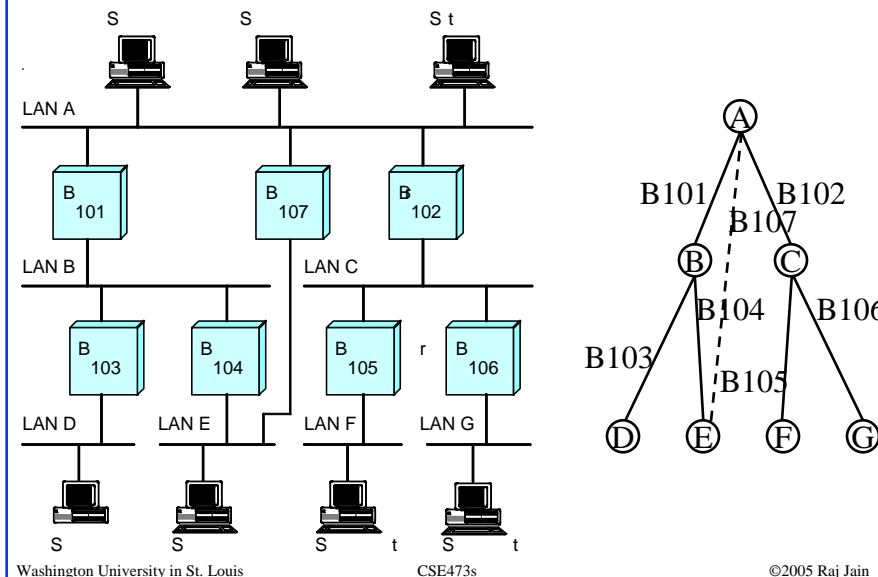


(b) Operation

Path Determination: Spanning Tree



Spanning Tree (Cont)



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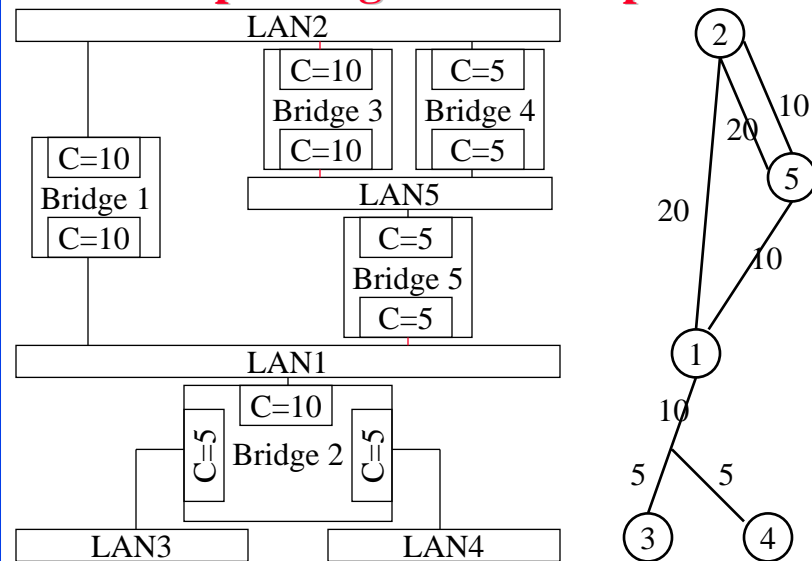
Spanning Tree: Terminology

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

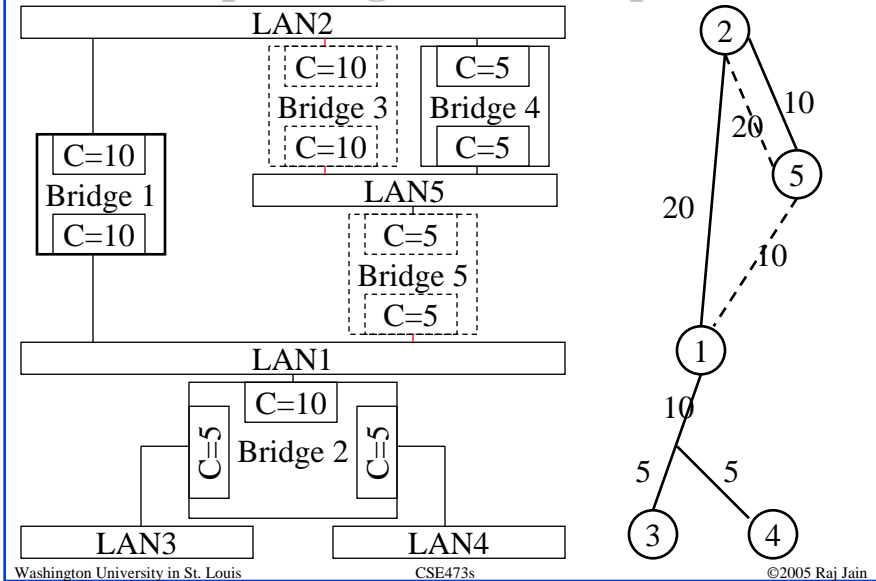
Spanning Tree Algorithm

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

Spanning Tree Example



Spanning Tree Example



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Layer 2 Switches

- q Switches = Multi-port bridges with packet forwarding in hardware
- q Store-and-forward switch
 - q Accepts complete frame on input line
 - q Buffers it briefly,
 - q Then routes it to appropriate output line
 - q Delay between sender and receiver
- q Cut-through switch
 - q Switch begins repeating frame onto output line as soon as it recognizes destination address
 - q Highest possible throughput
 - q Risk of propagating bad frames
 - : Switch unable to check CRC prior to retransmission

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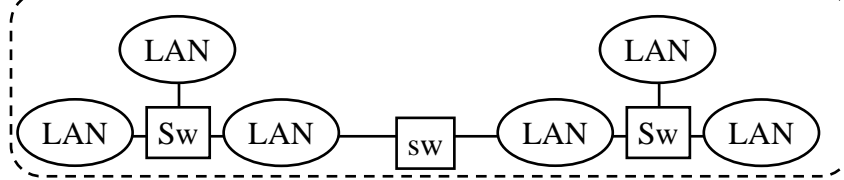
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Problems with Switched Networks

- q Broadcast Storms:
 - q Broadcast frames are forwarded by bridges on all other ports
 - q In large network, broadcast frames can create big overhead
 - q Malfunctioning device can create broadcast storm
- q Spanning Tree \Rightarrow Only one path between any two devices
 - q No parallel paths \Rightarrow Limits performance and reliability.



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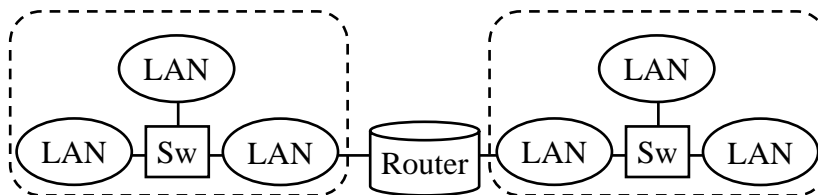
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Solution: Layer 3 Routing

- q Solution: Break up network into subnetworks connected by routers
- q MAC broadcast frame limited to devices and switches contained in single subnetwork
- q Routers employ sophisticated routing algorithms



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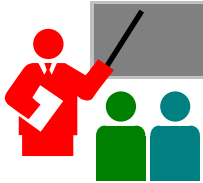
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Layer 3 Switches

- q Routers do all IP-level processing in software
 - q High-speed LANs and high-performance layer 2 switches pump millions of packets per second
 - q Software-based router only able to handle well under a million packets per second
- q Solution: layer 3 switches
 - q Implement packet-forwarding and address lookup logic of router in hardware

Summary



- q LLC provides protocol multiplexing, flow control, and error control
- q Ethernet bridges learn station locations from source addresses
- q Spanning tree algorithm is used to avoid loops
- q Large switched networks can have broadcast storms
- q Layer 3 switches implement routing in hardware

Reading Assignment

- q Read Sections 15.3, 15.4, and 15.5 of Stallings' 7th edition
- q Ensure that you can answer all review questions.

Homework

- q Submit answer to Exercise 15.6 from Stallings' 7th Edition
- q For the following extended LAN, determine the spanning tree and indicate which bridges will be deactivated. All bridges have the same cost of 1 on all ports. When there are two equal cost paths, select the paths with lower numbered bridge or LAN.

