Virtual LANs

Raj Jain

Professor of Computer and Information Sciences

The Ohio State University

Please download and print the handouts from:

http://www.cis.ohio-state.edu/~jain/cis788-97/

or

http://www.netlab.ohio-state.edu/~jain/cis788-97/

MBone Instructions

❑ Handouts for the class are available on-line:
http://www.cis.ohio-state.edu/~jain/cis788-97/index.html or
http://www.netlab.ohio-state.edu/~jain/cis788-97/index.html or
ftp://netlab.ohio-state.edu/pub/jain/cis788-97/

❑ The schedule keeps changing. Please always check current schedule at:
http://www.cis.ohio-state.edu/~jain/cis788-97/schedule.html

Instructions (Cont)

❑ Please email your positive and negative feedback about the quality of the reception as well as the content with a subject field of "Feedback" to mbone@netlab.ohio-state.edu

❑ If you are not able to receive the program due to some technical difficulties, please email "Feedback" to mbone@netlab.ohio-state.edu

❑ Please email technical questions with the subject field "Question" to mbone@netlab.ohio-state.edu. We will try to answer selected questions live.

Overview

❑ What is a LAN and what is a Virtual LAN?

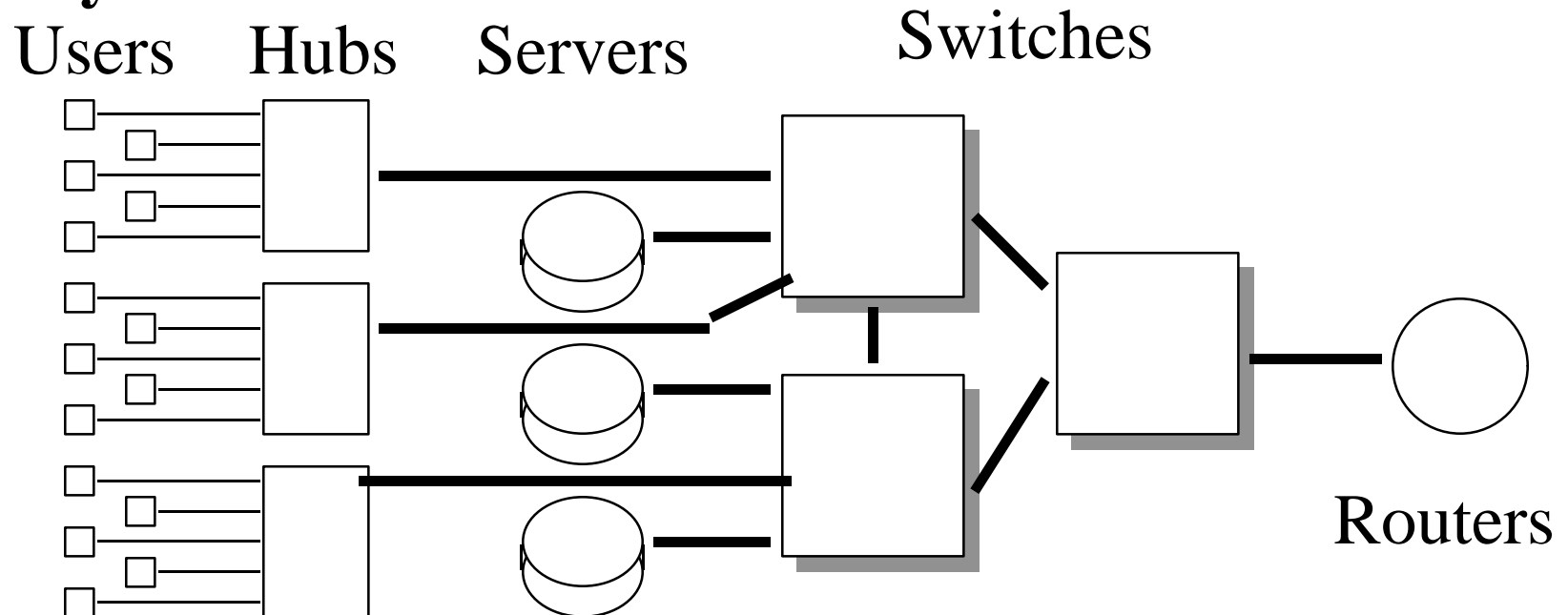❑ Types of Virtual LANs

❑ IEEE 802.1Q standard

What is a LAN?

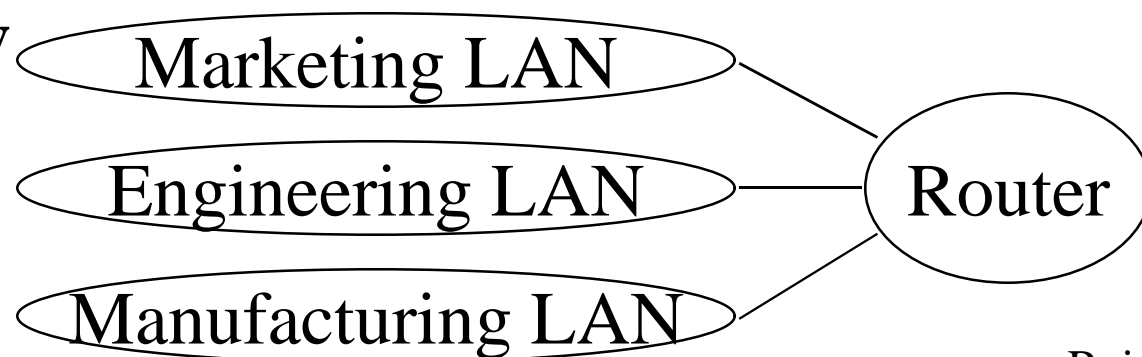| Server	Client 1	Bridge	Client n	Router

LAN 1   LAN 2

Router
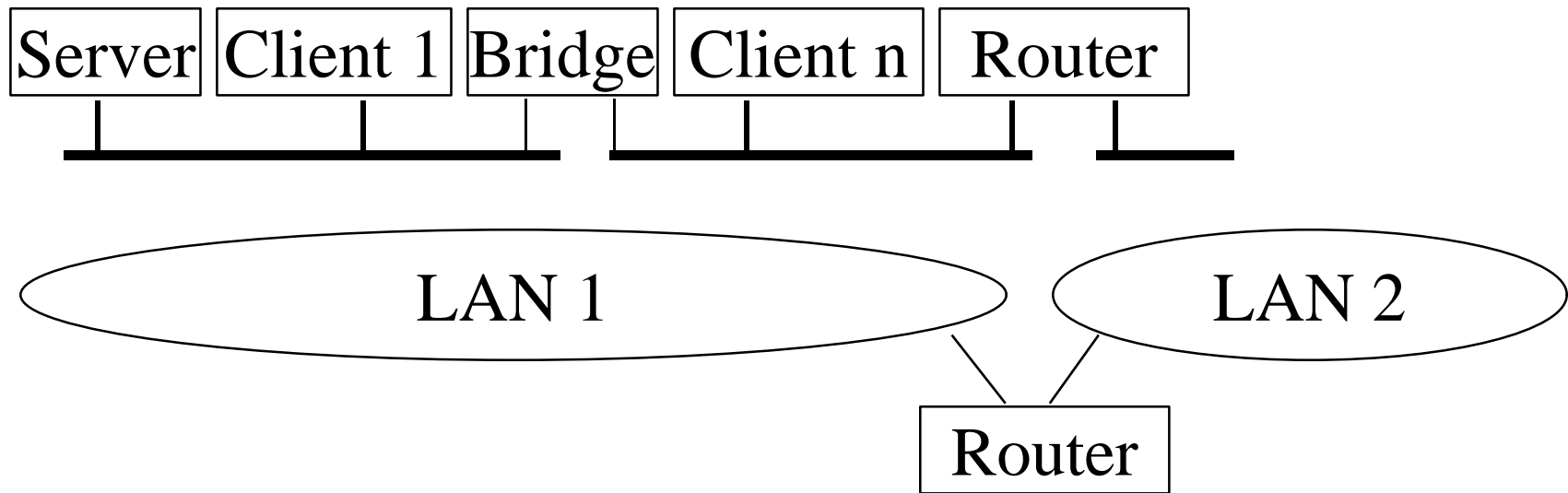
❑ LAN = Single broadcast domain = Subnet

❑ No routing between members of a LAN
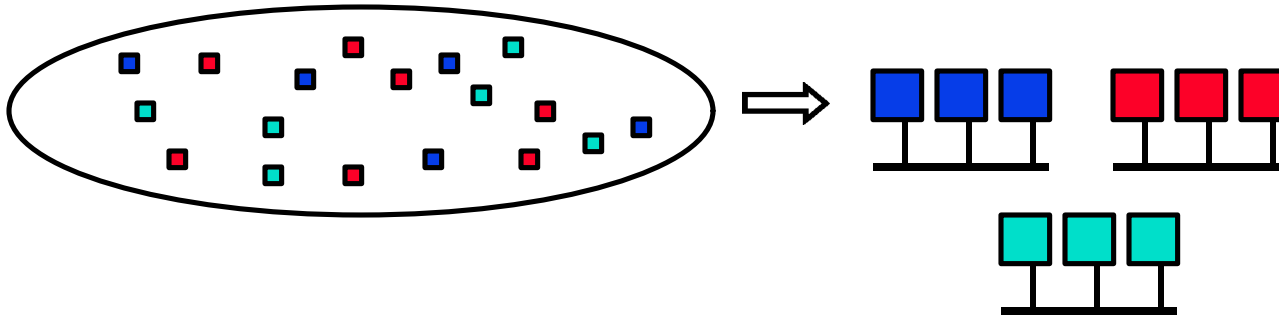
❑ Routing required between LANs

What is a Virtual LAN

❑ **Physical View**

Users   Hubs   Servers   Switches

Routers

❑ **Logical View**

Marketing LAN

Engineering LAN   Router

Manufacturing LAN

Virtual LAN

❑ Virtual LAN = Broadcasts and multicast goes only to the nodes in the virtual LAN

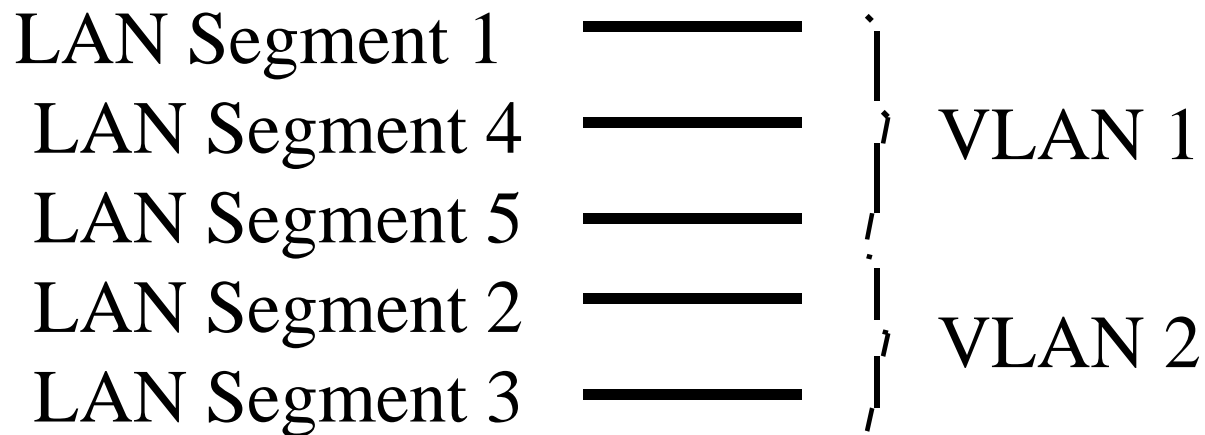❑ LAN membership defined by the network manager $\Rightarrow$ Virtual

VLAN: Why?

❑ Virtual is Better than Real

- ❍ Location-independent
  $\Rightarrow$ Marketing LAN can be all over the building

- ❍ Users can move but not change LAN

- ❍ Traffic between LANs is routed
  $\Rightarrow$ Better to keep all traffic on one LAN

- ❍ Switch when you can, route when you must
  $\Rightarrow$ Do not VLAN over expensive WAN links

- ❍ Better security

Types of Virtual LANs

❑ Layer-1 VLAN = Group of Physical ports

❑ Layer-2 VLAN = Group of MAC addresses

❑ Layer-3 VLAN = IP subnet

Switch Port	VLAN 1	VLAN 2
A1	√	
A2		√
A3	√	
B1		√
B1	√	

VLAN1	VLAN2
A1B234565600	21B234565600
D34578923434	634578923434
1345678903333	8345678903333
3438473450555	9438473450555
4387434304343	5387434304343
4780357056135	6780357056135
4153953470641	9153953470641
3473436374133	0473436374133
3403847333412	8403847333412
3483434343143	8483434343143
4343134134234	0343134134234

VLAN1

23.45.6

VLAN2

IPX

Raj Jain

8-9

Layer-1 VLANs

LAN Segment 1 ———

LAN Segment 4 ——— } VLAN 1

LAN Segment 5 ———

LAN Segment 2 ———

LAN Segment 3 ——— } VLAN 2

❑ Also known as port switching

❑ Can be used to provide security and isolation

❑ Does not allow user mobility.

❑ Moved user has a new subnet $\Rightarrow$ new IP address
$\Rightarrow$ May go through a router to access the old server

Layer-2 VLANs

❑ LANs defined by a list of MAC addresses

❑ Provides full user movement

❑ Clients and server always on the same LAN regardless of location

❑ Problem: Too many addresses need to be entered and managed

0234786890
Is that a marketing node?
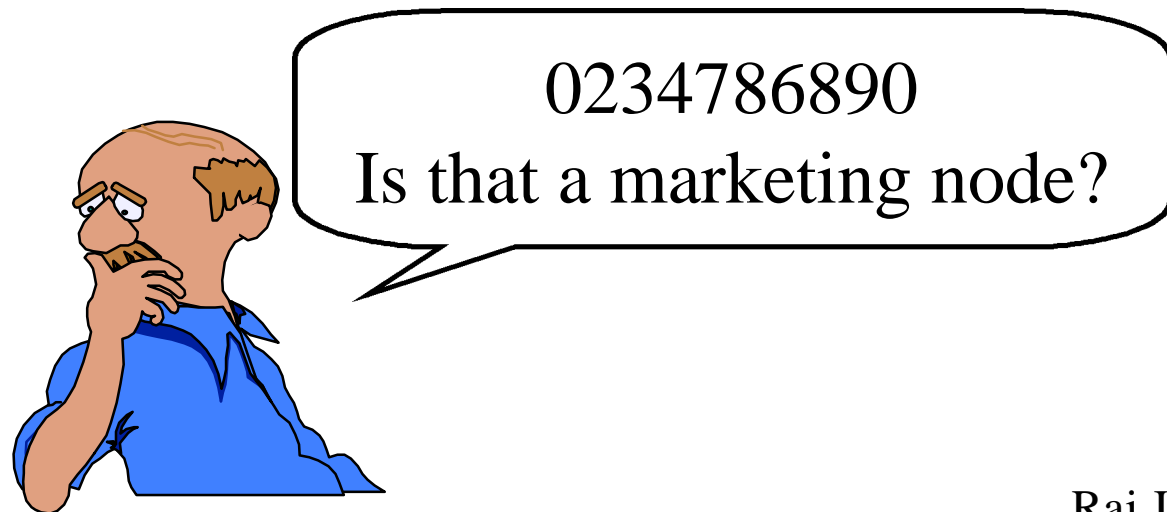
Layer-2 VLANs (Cont)

❑ Notebook PCs change docking stations
   ⇒ MAC address changes

❑ Alternative: Membership implied by MAC protocol
   type field. VLAN1 = IP, VLAN2 = LAT, ...

Ethernet

Dest. Address	Src. Address	Protocol Type	

802.3

Dest. Address	Src. Address	Length	

	AA	AA	03	Protocol Type	

Layer-3 VLANs

Dest. Addr	Src. Addr	**Protocol Type**

	IP Dest. Addr	**IP Source Addr**

- ❏ Also known as virtual subnet
- ❏ VLAN membership implied by MAC-layer protocol type field and subnet field 123.34.*.*
- ❏ VLAN configuration is learned by the switches
- ❏ Stations do not belong to VLANs, packets do.
- ❏ Multiprotocol stations are put into multiple VLANs

Higher Layer VLANs

❏ Different VLANs for different applications:
  ❍ FTP
  ❍ Multimedia

❏ Service based VLANs: All workstations using Email server are on the EMAIL-VLAN, all workstations using employee database sever are on the HR-VLAN,..

❏ IP Multicast address based VLANs

❏ General policy based: VLAN membership can be based on a combination of incoming port, MAC address, subnet, or higher layer info, time of day.

VLAN Tagging

Dest. Addr	Src. Addr	VLAN Tag	Prot. Type

- ❏ First switch adds tag containing VLAN id to all incoming packets
- ❏ Intermediate switches do not recompute the VLAN id
- ❏ Last switch removes tags from all outgoing packets
- ❏ Tag is <u>not</u> swapped at every hop like VC Id or labels

End Station — Switch — Bridged LAN — Switch — End Station

Raj Jain
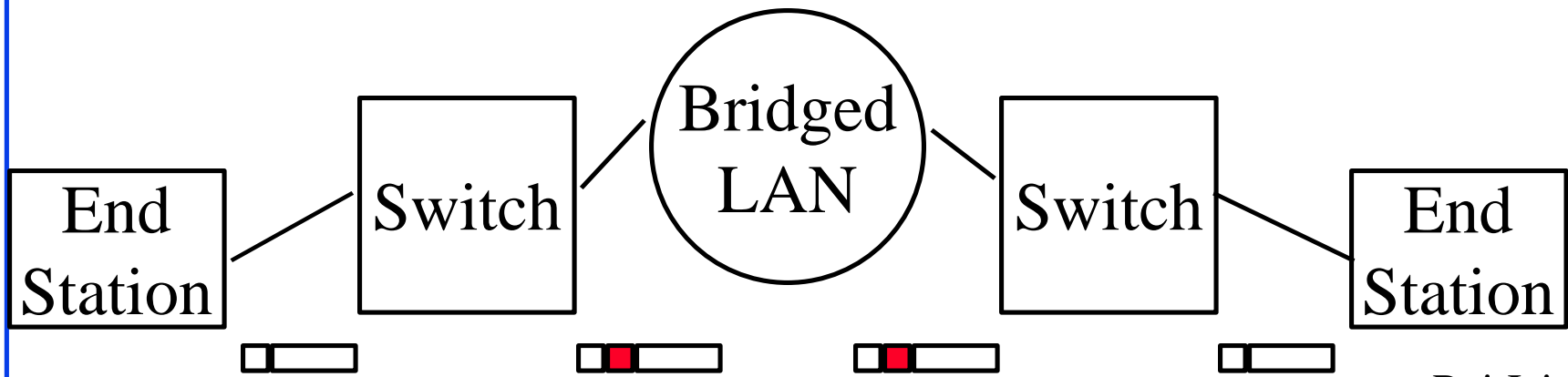
Synonyms

- ❑ Tag
- ❑ Label
- ❑ Mark
- ❑ Sticker
- ❑ Brand

IEEE 802.1Q: Features

❑ Allows up to 4095 VLANs

❑ Allows port based, MAC address based, and higher-layer VLANs

❑ Upward compatible with existing VLAN-unware hubs and bridges

❑ Supports both shared-media and switched LANs

❑ Allows mixing legacy bridges and VLAN-aware bridges

❑ Retains plug and play mode of current LAN bridges

Features (Cont)

- Extends 802.1p priority mechanism to priority based on VLAN membership
- Allows priority associated with each VLAN
- VLAN-based priority takes precedence over other priority considerations
- Allows signaling priority information on non-priority (CSMA/CD) LANs
- Allows both local/universal MAC addresses
- Operation with/without explicit VLAN header in the frame

Features (Cont)

❏ Supports static and dynamic configurations for each VLAN

❏ Allows intermixing different IEEE 802 MACs and FDDI

❏ Allows signaling source routing information on CSMA/CD LANs

❏ Each VLAN is a subset of a "single" physical spanning tree
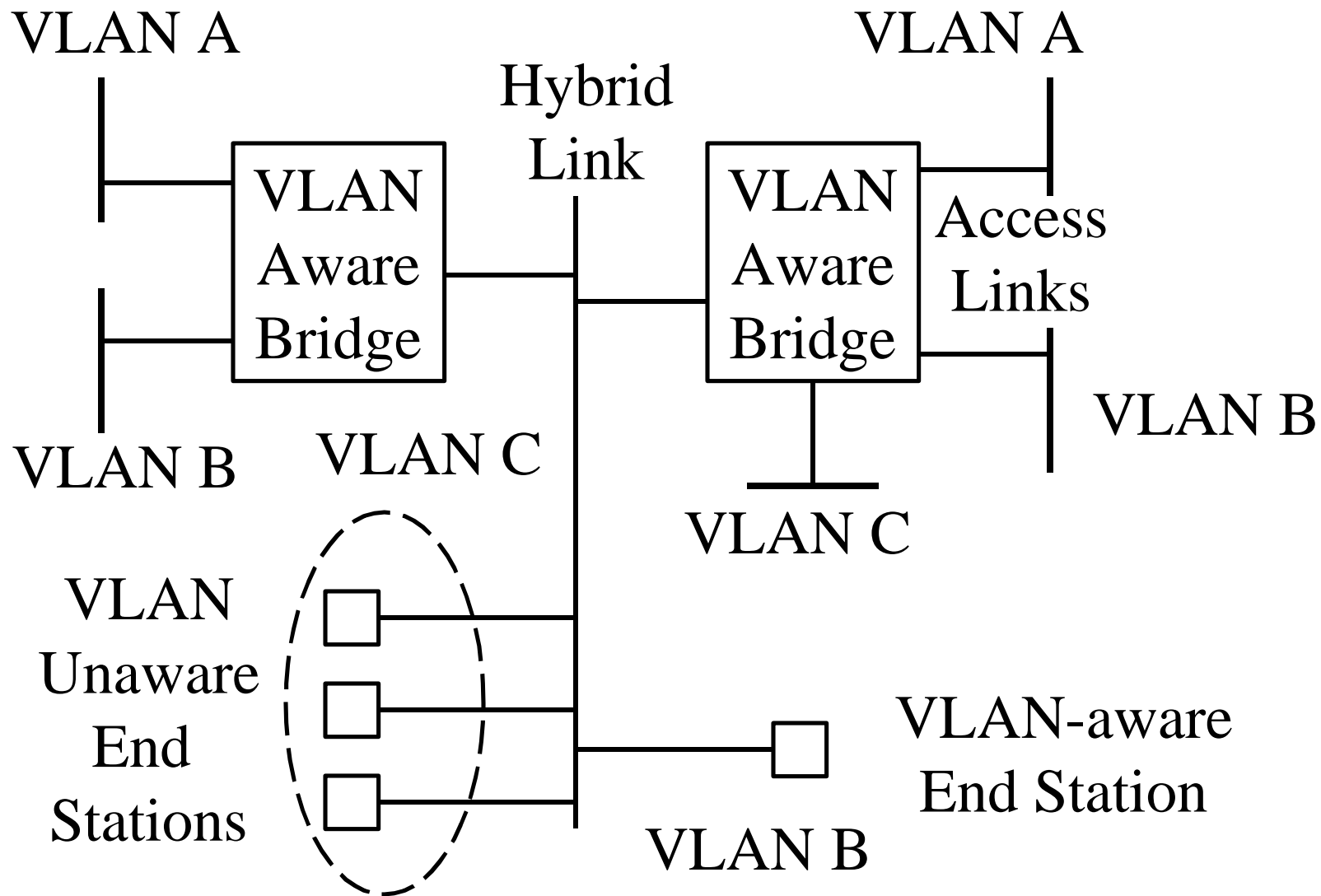Does not preclude future extensions to multiple spanning trees

Features (Cont)
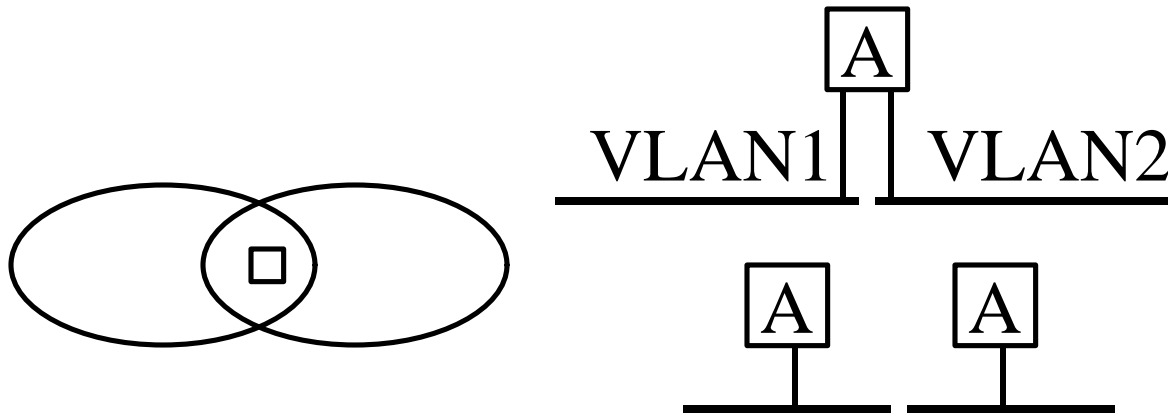
❑ Overlapping VLANs:

   ❍ Multiple stations with same individual address

   ❍ One station with multiple interfaces using the same address

   ❍ Restriction: One station or interface per VLAN

Tagging Rules

VLAN A   VLAN A

Hybrid Link

VLAN Aware Bridge   VLAN Aware Bridge

Access Links

VLAN B   VLAN C

VLAN B

VLAN C

VLAN Unaware End Stations

VLAN-aware End Station

VLAN B

Tagging Rules (Cont)

❑ On a given LAN segment for a given VLAN, all frames should be either implicitly or explicitly tagged.

❑ Different VLANs on the same segment may use different options.

❑ Access Link: Contain VLAN unaware devices
All frames on access links are untagged

❑ Hybrid Link: Contains both VLAN-aware and VLAN-unaware devices

   ❍ All frames for some VLANs are tagged

   ❍ All frames for other VLANs are untagged

Tagged Frame Format

❑ **Tag Header:**

16b	3b	1b	12b
TPID	User Priority	CFI	VLAN Id

❑ **Ethernet Frame:**

6B	6B	4B	2B	0-30B		4B
DA	SA	Tag	PT	[RIF]	Data	FCS

❑ **802.3 Frame:**

6B	6B	4B	2B	0-30B		42-1470B	4B
DA	SA	Tag	Length	[RIF]	LLC	Data	FCS

Frame Format (Cont)

❑ TPID = Tag Protocol ID

❑ CFI = Canonical Format Indicator
= Bit order of address info in TR/FDDI frames
= Presence/absence of RIF in 802.3/Ethernet frames

❑ RIF = Routing Information Field

  ○ New routing type: 01 = Transparent frame
  $\Rightarrow$ No routing info.

❑ DA = Destination Address, SA = Source Address
PT = Protocol Type, LLC = Logical Link Control
FCS = Frame Check Sequence

❑ Largest data size = 1470 on 802.3

Frame Format (Cont)

❑ **Token Ring:**

1B	6B	6B	0-30B	10B			4B
AC	DA	SA	[RIF]	Tag	[LLC]	Data	FCS

❑ **FDDI:**

1B	6B	6B	0-30B	10B			4B
FC	DA	SA	[RIF]	Tag	[LLC]	Data	FCS

GVRP

- ❑ GARP VLAN registration protocol
- ❑ GARP = Generic attribute registration protocol
- ❑ Register VLAN Ids and port filtering modes
- ❑ Both end-stations and bridges can be GARP participants
- ❑ GARP Participants issue/revoke membership declaration $\Rightarrow$ Creates entries in the databases
- ❑ VLAN-aware bridges propagate VLAN membership changes on all active ports

Raj Jain

GVRP (Cont)

❑ VLAN-aware end stations can
"source prune" traffic for VLANs that
have no other members

❑ Initially, all ports on all bridges are set to a default
"Port VLAN ID"

GMRP in VLANs

❑ Original GMRP is designed for one LAN
$\Rightarrow$ One one context or base spanning tree context

❑ With VLANs, multicast addresses are registered a particular VLAN context
$\Rightarrow$ Filtering behavior in a VLAN does not affect other VLANs

VLAN Filtering Database

❑ Two Types of Entries:

    ❍ VLAN Registration entries

    ❍ Group Registration entries

❑ Both types can static or dynamic

    ❍ Static VLAN Entries: via Management

    ❍ Dynamic Filtering Entry:

        ❑ via learning or registration

        ❑ Learnt entries are aged out

❑ Port Map for each VLAN: Whether frames should be tagged or untagged

Communication Between VLANs

❑ Need routers

❑ Can use 1-armed VLAN-aware router

❑ VLAN-aware switches can route between VLANs

❑ Such switches can be placed in the core, in the edges, or everywhere

VLAN Aware Switch

VLAN Aware/Unaware Core

VLAN Aware Router
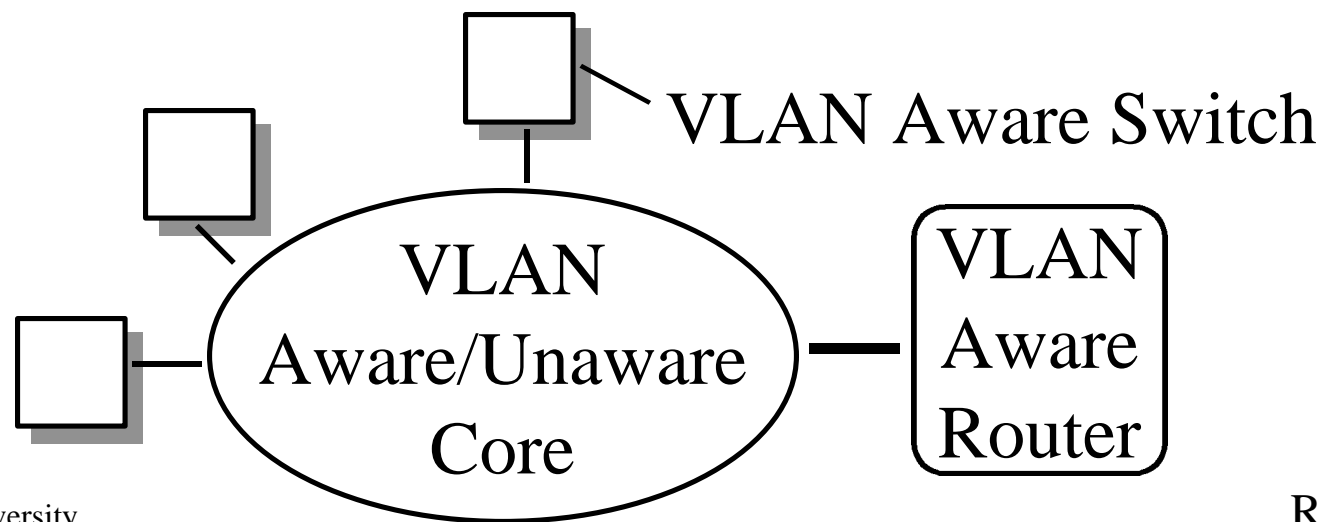
Summary
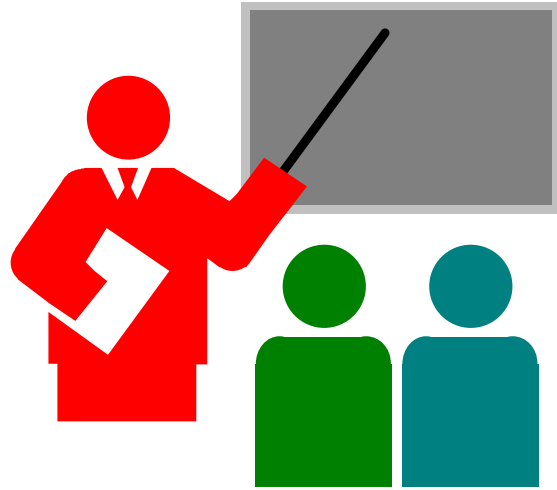
- Virtual LANs $\Rightarrow$ Location independent LAN Groups
- Layer-1, Layer-2, Layer-3, higher layer VLANs
- IEEE 802.1Q allows both explicit and implicit tagging
- Need routing between VLANs

References

❑ For a detailed list of references, see http://www.cis.ohio-state.edu/~jain/refs/lsw_refs.htm

❑ Email list: p8021-request@hepnrc.hep.net
Mail archive: http://www.hep.net/mail/p8021.html

❑ Draft Standard for Virtual Local Area Networks, IEEE P802.1Q/D6, May 16, 1997.

Other Related Standards

○ Traffic Class Expediting and Dynamic Multicast Filtering, IEEE P802.1p/D6, April 28, 1997.

○ 802.1D MAC bridges

○ 802.1G Remote MAC Bridging

○ 802.1H Ethernet V2.0 and 802 bridging

Current Schedule

7/17/97 Priority and Multicasting on LANs

7/22/97 No Class

7/24/97 Virtual LANs

7/29/97 Gigabit Ethernet

7/31/97 Quiz 2 (No MBone transmission)

8/5/97 Residential broadband: Cable Modems, xDSL

8/7/97 Multimedia: Compression Standards

8/12/97 Multimedia over IP: RSVP, RTP

8/14/97 Wireless LANs and WANs

8/19/97 Quiz 3 (No MBone transmission)

Credits

This MBone transmission was made possible by:

❏ Mark Fullmer, OSU/UTS

❏ Mike Iverson, OSU/UTS

❏ Mike Douglas, OSU/UTS

❏ Jayaraman Iyer, OSU/CIS

❏ Sohail Munir, OSU/CIS