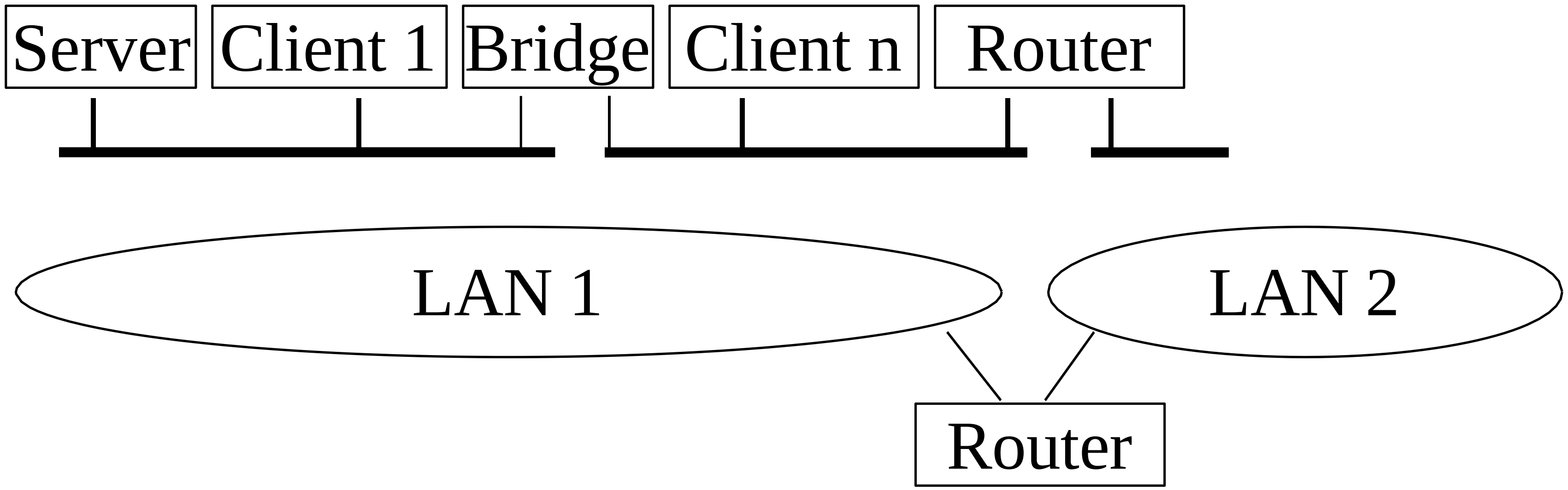
Virtual LANs

Overview

- What is a LAN ?
- LAN Problems
- Introduction to VLAN: Types of Virtual LANs
- Access and Trunk Ports of L2 Switch
- VLAN Tagging Rules
- IEEE 802.1Q standard
- VLAN L2 Routing
- VLAN Benefits

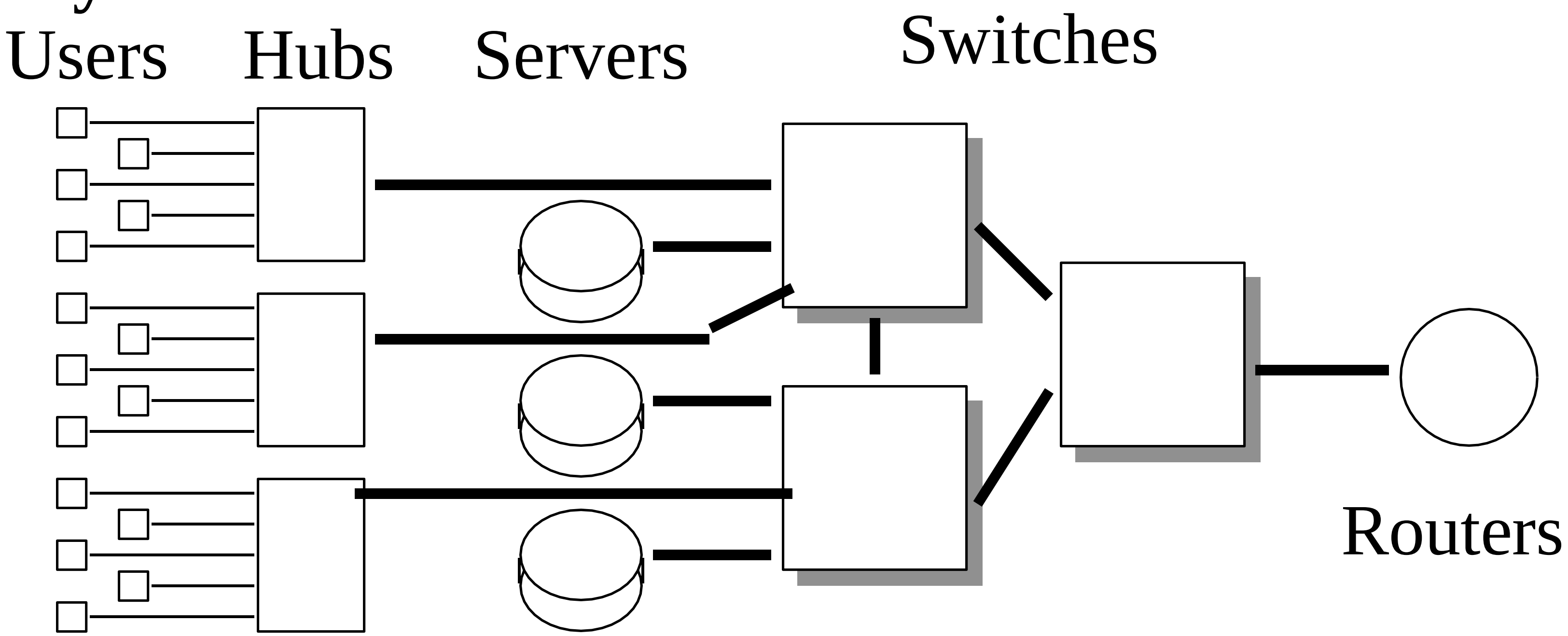
What is a LAN?



- LAN = Single broadcast domain = Subnet
- No routing between members of a LAN
- Routing required between LANs
- Immobility
- Security

What is a Virtual LAN

- **Physical View**



Users

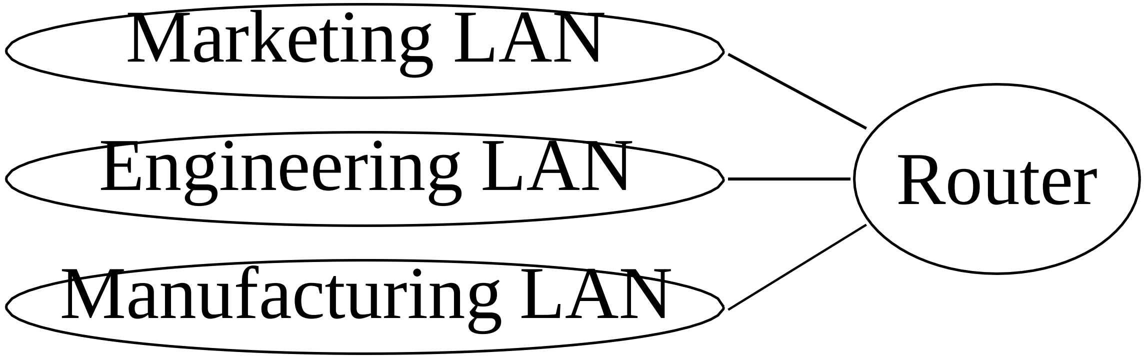
Hubs

Servers

Switches

Routers

- **Logical View**



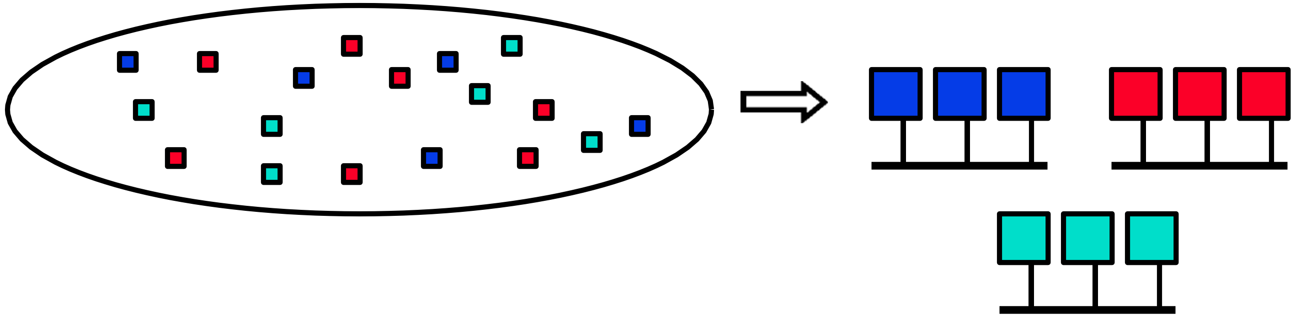
Marketing LAN

Engineering LAN

Manufacturing LAN

Router

Virtual LAN



- Virtual LAN = Broadcasts and multicast goes only to the nodes in the virtual LAN
- LAN membership defined by the network manager ⇒ Virtual

VLAN: Why?

- Virtual is Better than Real
  - Location-independent
    ⇒ Marketing LAN can be all over the building
  - Users can **move** but not change LAN
  - Traffic between LANs is routed
    ⇒ Better to keep all traffic on one LAN
  - Switch when you can, route when you must
    ⇒ 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	2
A1	√	
A2		√
A3	√	
B1		√
B2	√	

VLAN1	VLAN2
A1B234565600	21B234565600
D34578923434	634578923434
1345678903333	8345678903333
3438473450555	9438473450555
4387434304343	5387434304343
4780357056135	6780357056135
4153953470641	9153953470641
3473436374133	047343637413

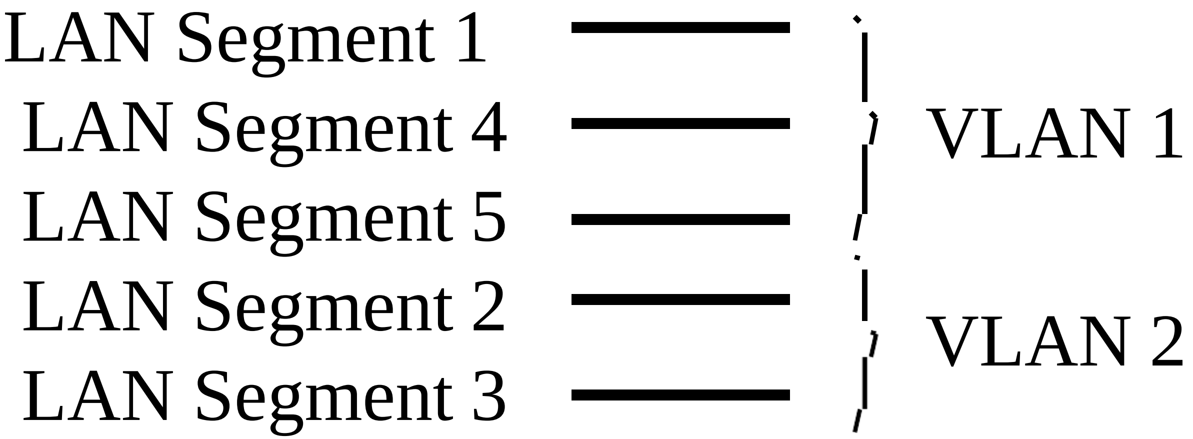
VLAN1

23.45.6

VLAN2

IPX

Layer-1 VLANs



LAN Segment 1

LAN Segment 4

LAN Segment 5

LAN Segment 2

LAN Segment 3

VLAN 1

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 ⇒ new IP address
  ⇒ 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 = , ...

Ethernet

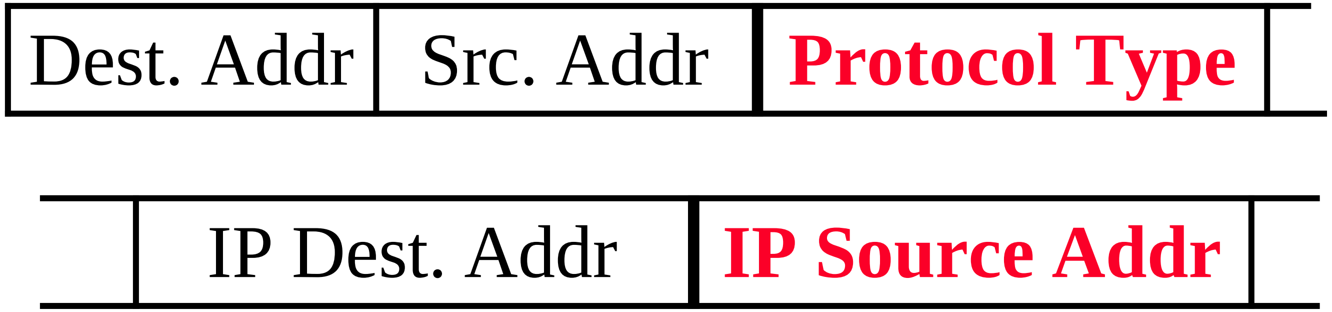
Dest. Address	Src. Address	Protocol Type	

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

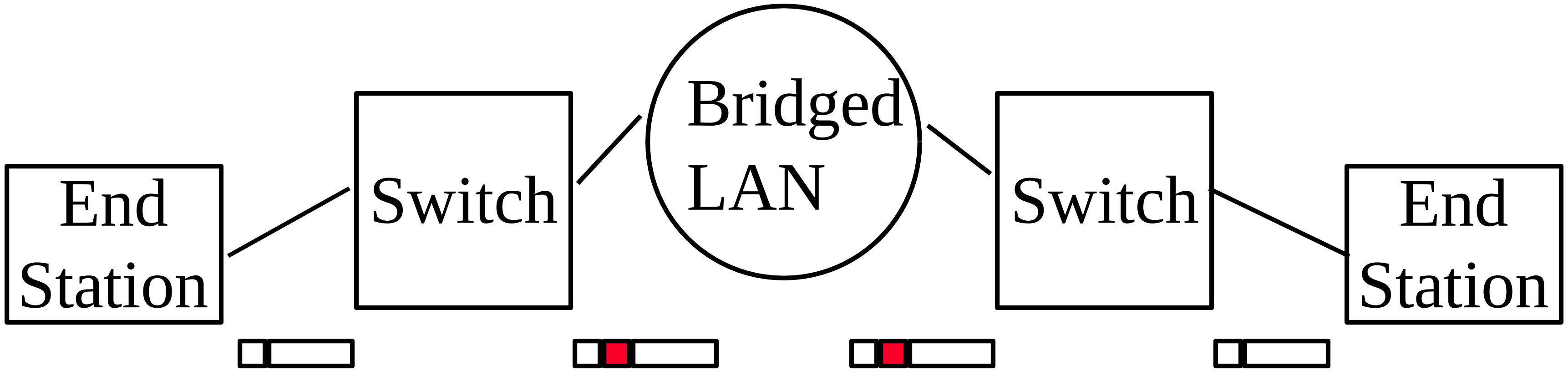
Higher Layer VLANs

- 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 not swapped at every hop like labels



IEEE 802.1Q: Features

- Allows up to 4095 VLANs **(0 to 4095 =4096**): 4094
- 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)

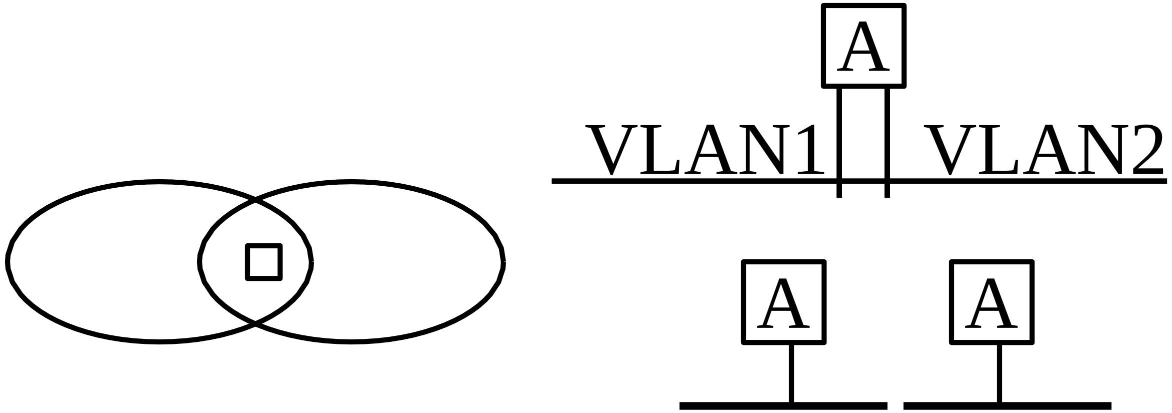
- Extends 802.1p priority mechanism to priority based on VLAN membership
- Allows priority associated with each VLAN
- VLAN-based priority takes precedence over other priority considerations
- Allows signaling priority information on non-priority (CSMA/CD) LANs
- Allows both local/universal MAC addresses
- 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

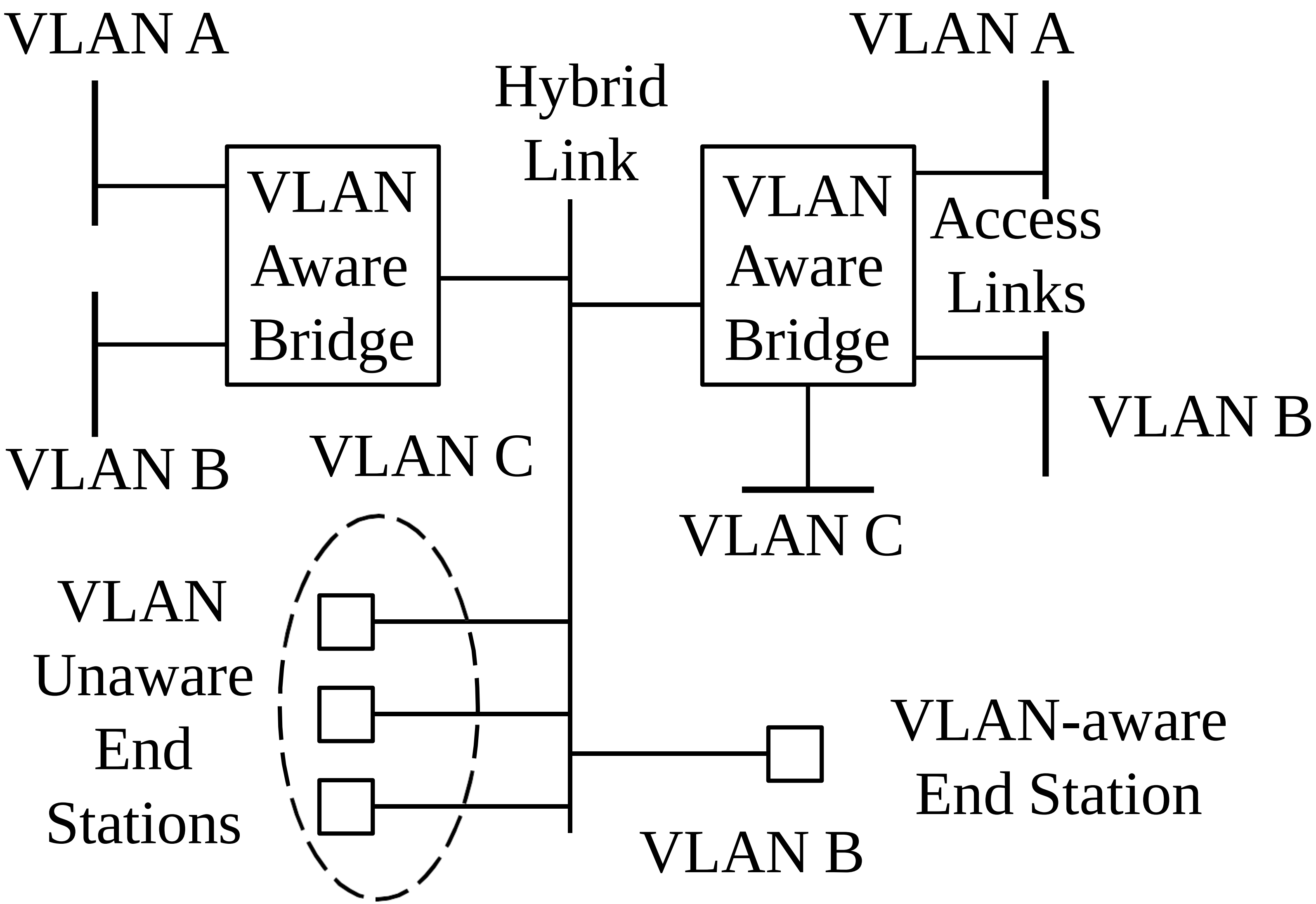
  Does not preclude future extensions to multiple spanning trees

Features (Cont)



- Overlapping VLANs:
  - Multiple stations with same individual address
  - One station with multiple interfaces using the same address
  - Restriction: One station or interface <u>per VLAN</u>

Tagging Rules



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:**

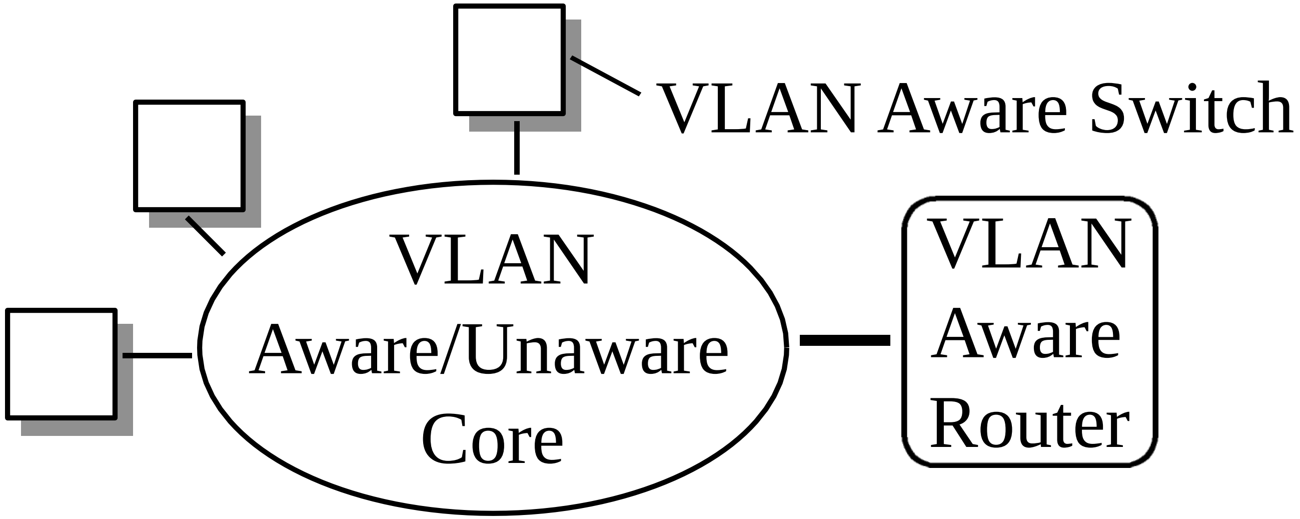
6B	6B	4B	2B	0-30B		42-1470B	4B
DA	SA	Tag	Length	[RIF]	LLC	Data	FCS

Frame Format (Cont)

- TPID = Tag Protocol ID
- CFI/DEI = 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
    ⇒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

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

VLAN Benefits

- Segmentation,
- Resolve Thrashing,
- Reduced Broadcast Domain
- Mobility

Summary

- Virtual LANs ⇒ 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

- Computer Networking: A Top Down Approach 6th edition Jim Kurose, Keith Ross Addison-Wesley March 2012.
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- Draft Standard for Virtual Local Area Networks, IEEE P802.1Q/D6, May 16, 1997.
- Data Communications and Networking, Forouzan