

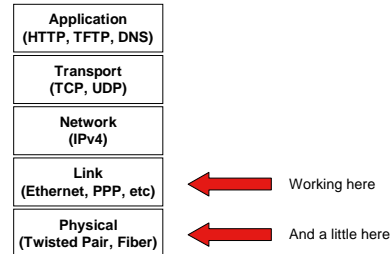
COMP312-09A Communications and Systems Software

Lecture 16 – Advanced Ethernet



20 April 2009

Overview



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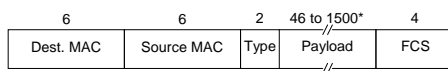
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Ethernet Reminder

- Shared access medium widespread in LAN environments

- CSMA/CD
- Frames



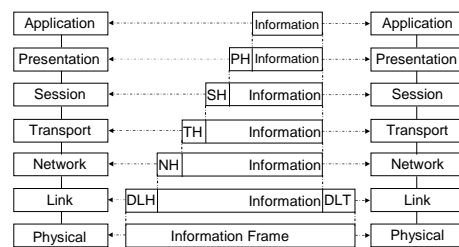
Ethernet II Frame Format

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Encapsulation



- Information is encapsulated inside of headers
- Kind of like how a sub-class extends features of another class by adding something to the class
- Product is a 'Frame'

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Ethernet Reminder: Flat address space

00:ab:13:43:2a:ff
0a:30:4f:a1:b4:11
04:12:11:ab:fe:ed
03:31:f3:89:40:ff
0f:35:72:19:aa:f1
09:99:22:21:1a:6a

MAC addresses are wired in (flat)

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Ethernet

- Ethernet parts are cheap
- Ethernet is fairly simple
 - but can be extended
- Ethernet is ubiquitous (everywhere)
- Ethernet can carry many different Layer-3 (network) protocols
 - IPv4
 - IPv6
 - IPX
 - PPP
 - ...

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Today's lecture

- PHY types
- Link Aggregation
- VLANs
- Quality of Service

Ethernet PHY

- Ethernet Physical Layer (PHY)
- Layer 1 in OSI model
- Wide and varied PHY standards
 - Common Ethernet frame format
 - Coax / Category 5 Twisted Pair / Wireless / Fiber Optic
 - Fiber Optics == Lasers
 - CSMA/CD, CSMA/CA
 - Coding method: Manchester, 4B/5B, 8B/10B, 64B/66B
 - Full duplex vs. half duplex
 - etc

Ethernet PHY

- Relatively short distances
 - 100baseT – up to 100m
 - 100baseFX – up to 4km full duplex
 - GigE over Fiber – up to 100km
 - 10GigE over Fiber – up to 40km

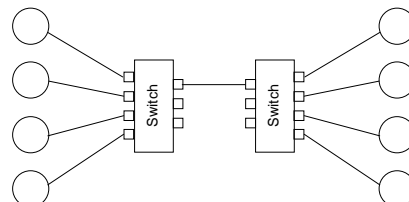
802.3ad link aggregation

- aggregate multiple physical ports into single logical link
- increase capacity (volume of data that can be carried)
 - Two ports == 2x capacity
 - Four ports == 4x capacity
 - Aggregate links to reach capacities that are currently not possible with current Ethernet protocols (e.g. 100Gbps Ethernet)
 - Or, aggregate links to reach a capacity not possible without otherwise spending lots more money
- fault tolerance
 - If any link between a pair of ports is broken, traffic continues to flow over available ports

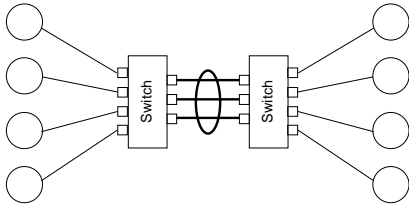
802.3ad link aggregation

- Link Aggregation
- “Trunking”
- “Bonding”
- “Teaming”
- “Bundling”

802.3ad link aggregation



802.3ad link aggregation



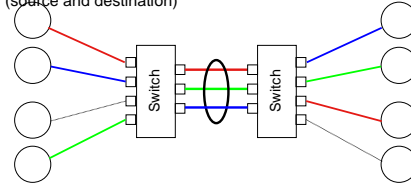
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802.3ad link aggregation

- Does not change Ethernet frame format
- Does not reorder packets in a given conversation
 - Conversation defined as occurring between two MAC addresses (source and destination)



- Does not necessarily provide N times more capacity unless Ethernet-layer traffic is diverse

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Ethernet Conversations

- A conversation is defined as occurring between two Ethernet addresses.
 - Defined this way so that Ethernet packets could not be reordered inside a single conversation
- Link Aggregation trade-off: needs to be generic enough to be able to carry any type of network traffic
- This definition does not allow multiple TCP flows belonging to the same Ethernet "conversation" to take different links through an aggregator

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802.3ad link aggregation

- Can not just take a pair of ordinary cheap switches and aggregate ports between them
- Requires protocol support from switch
 - switch sees same source MAC address arrive on multiple ports
 - otherwise would get quickly confused
- Link Aggregation Control Protocol (LACP)
 - Uses EtherType 0x8809
- Aggregator advises switch which ports it is aggregating
- LACP automatically handles aggregation; not something that you generally need to configure, beyond turning on protocol support in your switch

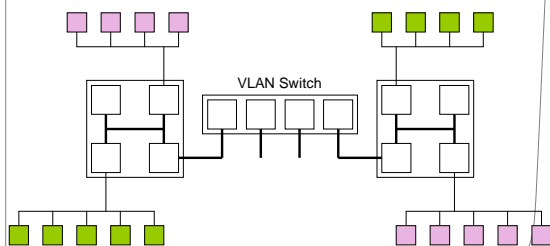
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802.1Q Virtual LANs (VLANs)

- Allow multiple networks to share same physical Ethernet link



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802.1Q VLANs

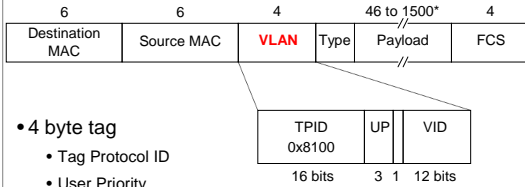
- Want to do this without introducing security concerns
- Ethernet has a flat address space
 - Want to do this in a scalable way

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802.1Q VLANs



• 4 byte tag

- Tag Protocol ID
- User Priority
- Canonical Format Indicator (set to zero)
- VLAN ID

- FCS is recalculated on VLAN tag insertion

802.1Q VLANs

- VLAN IDs: 2^{12} possible identifiers: 4096
- Switch is configured to insert specific VLAN ID for a given port
- Ethernet switches route VLAN frames based on VLAN ID
- Ethernet switches may prioritise traffic based on the User Priority field
 - Defined in 802.1p

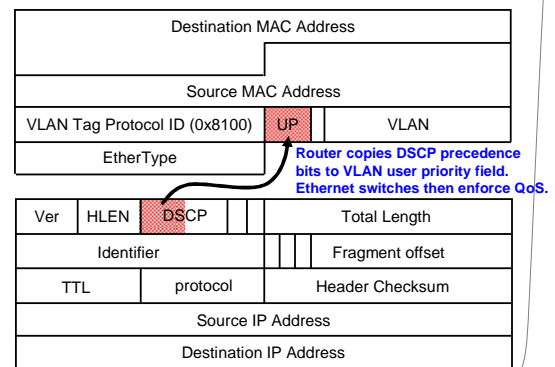
802.1p Traffic Class Expediting

- 802.1p provides *recommended* actions for 3 User Priority bits in VLAN tag.

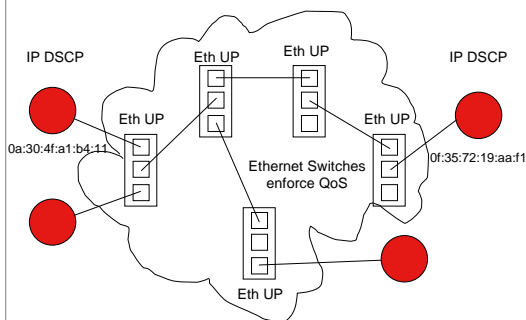
- 0, BE, Best Effort (default)
- 1, BK, Background
- 2, EE, Excellent Effort
- 3, CA, Critical Applications
- 4, VI, Video < 100ms latency + jitter
- 5, VO, Voice < 10ms latency + jitter
- 6, IC, Internetwork Control
- 7, NC, Network Control

- Approximately maps to first DSCP precedence

Source: 802.1Q-2005.pdf, page 282



IP DSCP and Ethernet 802.1p



Summary

- Ethernet is fairly simple, but has many useful standardised extensions
 - Link aggregation
 - VLANs
 - QoS
- Ethernet physical layer has changed significantly over the years
 - 1000s of times faster than when first devised
 - Can span hundreds of kilometers (fiber optics), tens of kilometers (wireless) or hundreds of meters (twisted pair)