

INF3190 – Group lecture 5

L2 – The data link layer

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Agenda

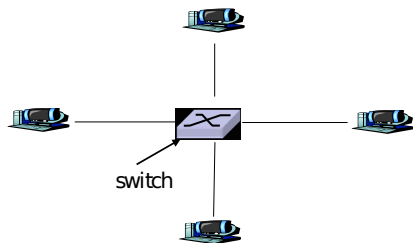
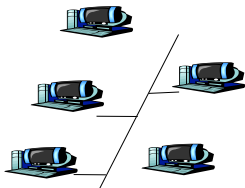
Layer 2 — The data link layer

- 1 Overview
 - Data links
 - The data link layer
- 2 Media Access Control
 - Addressing
 - Multiple access
 - Collision detection
 - Collision avoidance
- 3 Hardware devices
 - Hubs
 - Switches
- 4 Protocols
 - Ethernet
 - 802.11

Data links

Layer 2

- Point-to-point (single cable)
- Broadcast link (shared cable, wireless)
- Switched link



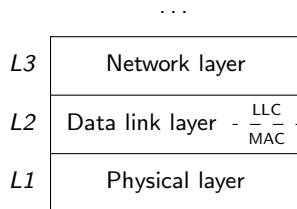
Services and functions

Layer 2

- Often divided into two sublayers
 - 1 Media Access Control (MAC)
 - 2 Logical Link Control (LLC)

Key features

- MAC
 - Frame delimiting
 - Addressing of HW stations
 - Control access to physical medium
- LLC
 - Protocol multiplexing
 - Flow and error control (node-to-node)

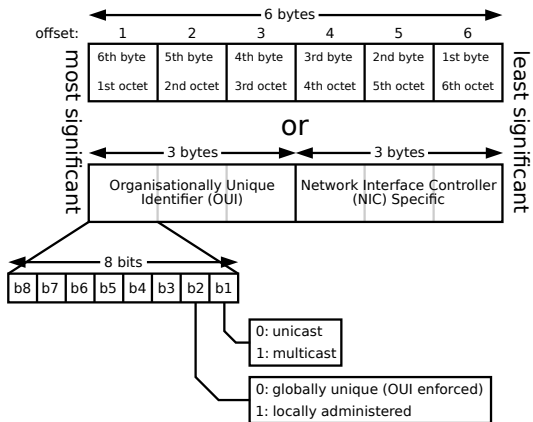


MAC address

- a.k.a. *hardware address, physical address*
 - 48-bits (6 bytes)
 - Colon separated hexadecimal representation
 - 01:23:45:67:89:ab
-
- Globally unique identifier
 - Stored in hardware of NIC ("*burned in*")

Addressing

Layer 2



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Multiple access

Layer 2

Q: How to send and receive on the same interface?

A: Separate physical channels (full duplex)

Q: What about wireless?

A: FDM or TDM on physical layer

Q: But that impacts bandwidth, how can we avoid that?

A: Hmm, need a better *multiple access* scheme

Multiple access

Layer 2

- IP traffic is often bursty
- ...so the channel is silent most of the time
- ...so chances are the channel is free when we want to send
- Basis for *probabilistic* access methods (CSMA)

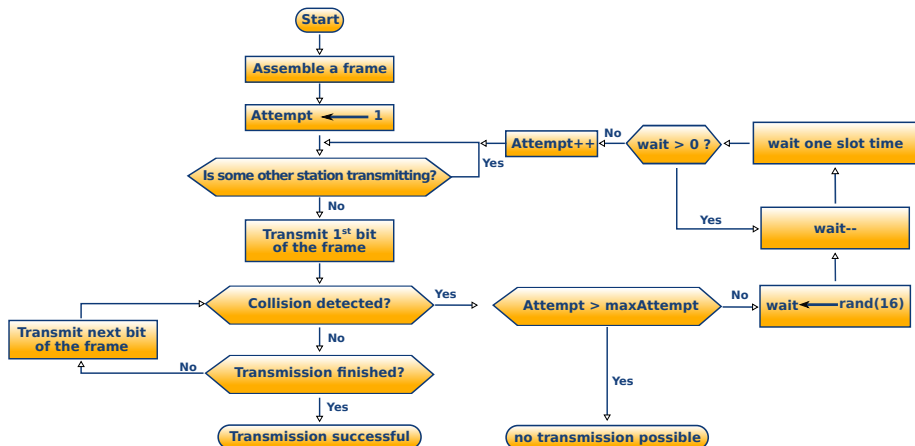
Carrier Sense Multiple Access (CSMA)

Layer 2

- *Listen before send*
- The sender uses the receiver before sending
- If the channel is silent — send
- If the channel busy — wait until silent
 - *1-persistent*
Listen continuously, send immediately when silent
 - *P-persistent*
Listen continuously, send immediately when silent with probability P
 - *Non-persistent*
Wait for some time and listen again

CSMA with collision detection

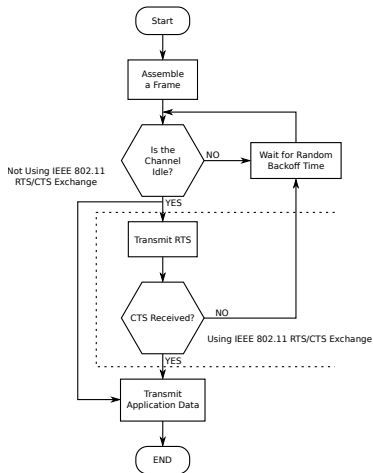
Layer 2



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CSMA with collision avoidance

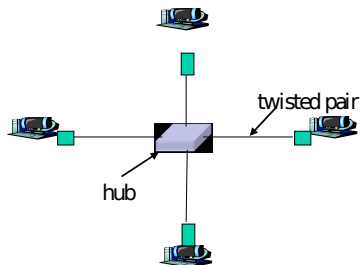
Layer 2



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Hubs

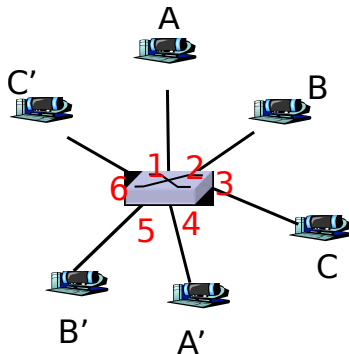
- “Dumb” repeater
- Floods all traffic to all links
- Physical layer device



Switches

Layer 2

- Active link layer device
- Store and forward frames
- Examine MAC address, selectively forward
- Transparent to hosts
- “Plug and play”, self learning
- Multiple switches coupled together

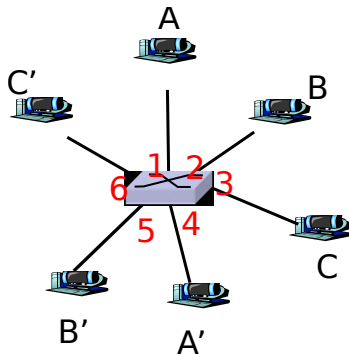


Switches

Layer 2

Self-learning

- 1 Empty table
- 2 Look at MAC address in frame
- 3 Store MAC and interface in table



Ethernet

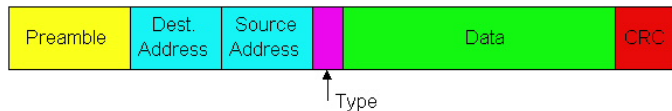
Layer 2

- Dominant wired LAN technology
- Simple and cheap to implement
- Scales well in size and speed
- Originally used CSMA/CD for channel access

Bob Metcalfe's ethernet sketch

Ethernet

Layer 2



Ethernet frame structure

- Dominant protocol set for wireless LANs
- Base version released in 1997
- Cheap home wireless routers
- Constantly evolving
- Uses a variant of CSMA/CA for channel access
- Orthogonal Frequency Division Multiplexing



Linksys WRT54G wireless router. From Wikimedia Commons/Jonathan Zander © ⓘ

Have a great week!

Sources:

- Wikipedia — The Free Encyclopedia
- Slides by Olav Lysne — INF3190, 2013
- Andrew Tanenbaum, *Computer Networks*