

Computer Networks (part 5)

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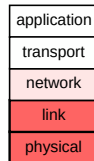
Computer Networks: global overview

1. Introduction to computer networks
2. Networking application layer (HTTP, FTP, DNS, ...)
3. Data transfer layer (UDP, TCP, ...)
4. Network layer (routing, IP, ICMP, NAT, ...)
5. Lower layers, wireless and mobile (Ethernet, ARP, ...)
6. Security (SSL, ...)

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Computer Networks 5: Plan

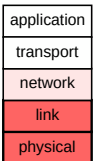
- Goal: lower layers
 - understand lower levels: link layer, physical layer
 - understand the specificities of wireless access
 - understand the challenges of mobility
- Overview
 - Link layer, shared medium, collision
 - MAC addresses, switches, ARP, ethernet
 - Wireless networks
 - Mobility



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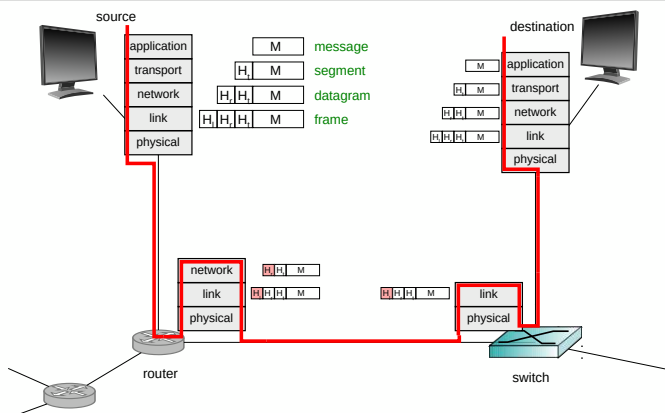
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Routing and Encapsulation: reminder



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Link Layer

- Analogy: a group of tourists
 - 1 IP packet = 1 group of tourists
 - multiple successive means of transportation
 - higher layers = travel agency
- Link layer services
 - access to the link, MAC addressing
 - transfer guarantees?
 - flow control
 - error detection
 - error correction
 - half duplex / full duplex
- Implemented in the network adapter
 - interface between software and hardware
 - produces physical signals

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Error Detection and Correction

- Checksums
 - checksum
 - parity bit
 - CRC
- Error correction
 - 2D parity
 - error-correcting codes
 - can detect errors
 - can correct errors

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Shared Medium

- Shared network cable
 - ethernet cable, etc
 - in half duplex mode
- Wireless network (radio waves)
 - wifi networks, etc
 - satellite network
- Shared air network
 - sound waves
 - people in a same room
 - the "cocktail party" effect
- General shared medium
 - a unique shared communication channel
 - multiple simultaneous transmissions
 - \Rightarrow collisions

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Protocol to Communicate on a Shared Medium?

- Ideally
 - on a link with capacity
 - transmission \Rightarrow throughput of
 - transmissions \Rightarrow each have — in average
 - distributed/decentralized
 - no coordinator
 - no shared clock
 - simple

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Protocols to Communicate on a Shared Medium?

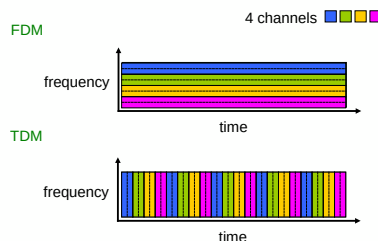
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Communication on a Shared Medium

- Main categories of approaches
 - partition into channels
 - split into channels
 - allocate a channel to each node
 - random access
 - accepts collisions
 - reacts to collisions
 - alternate access
 - communicating "turn by turn"
 - passing a token



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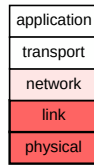
Random Access and Collisions

- Base: CSMA algorithm
 - carrier sense multiple access
 - listens before sending
 - if the channel is busy, wait (a random duration)
 - if the channel is free, send (a frame)
 - \Rightarrow collisions
- CSMA/CD algorithm (collision detection)
 - collision detection
 - interruption in case of collision
 - after n successive collisions
 - wait for a random duration
 - drawn from 0, 1, 2, 4, ..., 2^{n-1}
 - \Rightarrow efficient
 - \Rightarrow simple
 - does not work with wifi

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MAC Addressing

- IP address
 - network layer
 - 4 bytes: e.g., 223.12.1.254
 - logical address
 - hierarchical organization
- MAC address
 - hardware address, unique
 - 6 bytes: 8c:70:e1:5a:78:85
 - local use (sub-network)
 - flat organization
- Interconnection in a sub-network
 - direct cable
 - hub
 - switch



MAC Address Discovery with ARP

- ARP: address resolution protocol
 - (DNS reminder: association name → IP)
 - association IP → MAC
 - table stored in each machine
 - association IP → MAC for all machines on the local net
 - TTL: time to invalidate an entry
 - table maintained automatically
- A wants to send to B
 - if B is in A's table, ok
 - else?
 - else, broadcast « who has IP B ? »
 - (MAC-dst : FF-FF-FF-FF-FF-FF)
 - B receives the request and answers to A
 - A updates its table



ARP : démo



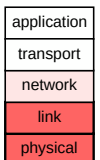
MAC Addresses and Outside Routing

- MAC and ARP: at the sub-network scale
- Routing to the outside
 - sending to the gateway router
 - ...
- MAC addresses change when crossing a router



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The Hidden Terminal Problem

- Typical case
 - A can see B and C
 - B sees only A
 - C sees only A
- Context
 - obstacle between B and C
 - distance between B and C (attenuation)
- ⇒ Collision detection is impossible (and/or expensive)
- Undetectable interference
- CDMA algorithm
 - Code Division Multiple Access
 - (vs CSMA, carrier sense multiple access)
 - sending continuously
 - encoding for each participant
 - Collision Avoidance

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CDMA Coding: you first!

- Sending
 - write down any message of 6 bits
 - use your code to emit, each bit of your message
 - if the bit is "1", send your code
 - if the bit is "0", send the opposite of your code
- You received ...
- Receiving
 - use the code of the next group
 - for each bit to read
 - multiply the beginning of the signal by the code
 - sum the values
 - if the sum is > 0 , decode a "1"
 - if the sum is ≤ 0 , decode a "0"
 - remove the used part of the signal (the beginning)
- Check

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CDMA: Code Division Multiple Access

- CDMA in the example
 - works with mutually orthogonal codes
 - supposes synchronicity between emitter and receiver
 - supposes synchronicity of all emitters
- CDMA in practice
 - use pseudo-noise codes (e.g., Gold codes)
 - interference are, statistically, gaussian noise
 - use time-frequency coding (spread-spectrum)
- Different CDMA "spread-spectrum" techniques
 - Direct-Sequence, Frequency-Hopping, Multi-Carrier, Time-Hopping
- CDMA vs TDMA vs FDMA?
 - near-far effect vs time guard vs frequency guard
 - ^ need to match emitters signal powers
 - better flexibility

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application
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network
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physical

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Mobility, in one Slide

- Types of mobility
 - cellular network
 - mobility in the IP network
- Mobile IP
 - 2 addresses
 - permanent address
 - care-of address
 - IP tunneling
 - actors
 - mobile host
 - home agent
 - foreign agent

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End Of Part