Simple MAC (wireless) Protocols

A Primer for Assignment 2

SPE AY 2018/19

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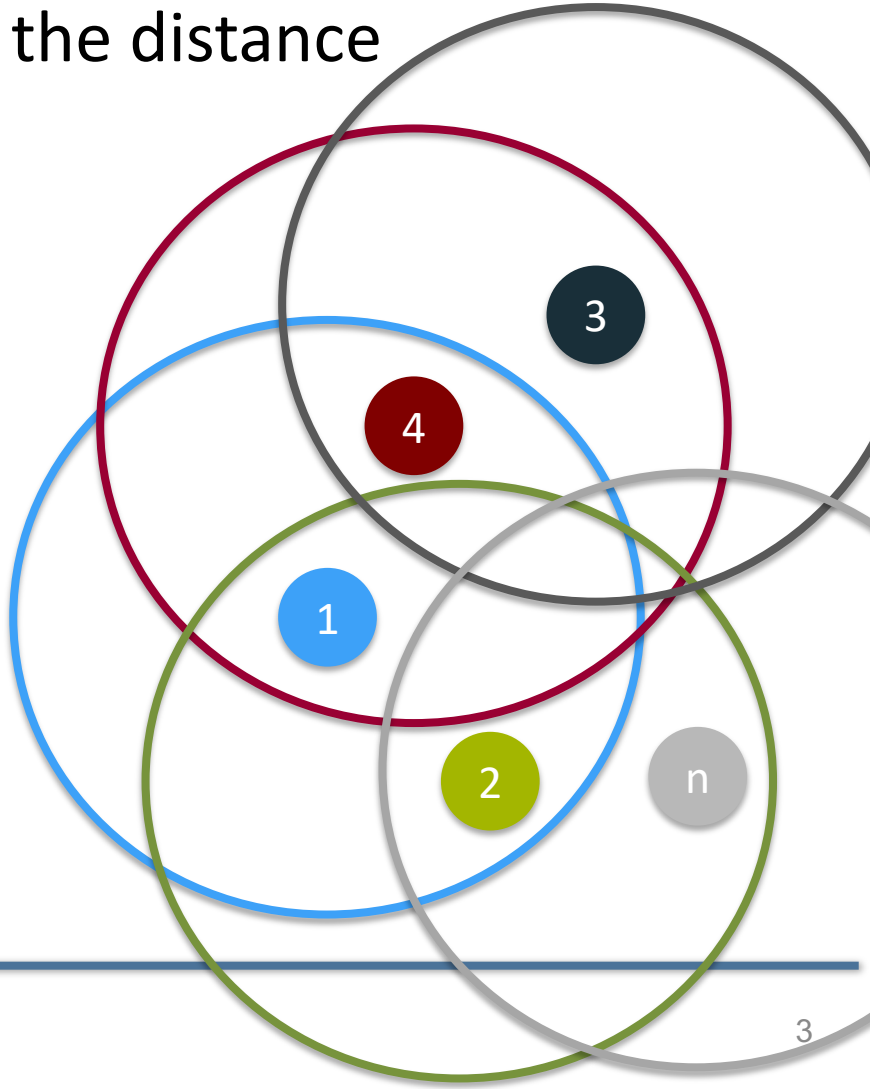
http://disi.unitn.it/locigno/teaching-duties/spe

MAC Protocols

- Medium Access Protocols defines how STAtions (or nodes) access a transmission channel
- Dominant in local networks are contention-based (random access) protocols
  - Aloha, CSMA, Ethernet, 802.11, ...
- In a very simplified view there is one channel with a given capacity C and the MAC defines how STAs access it
  - Given a receiver, only one STA can successfully transmit at any time
  - More packets received at the same time by one STA means a collision and all packets are lost

Channel Assumptions

- The channel is one and all station hear each other
- Reception is not influenced by the distance (absurd in wireless)
- Tx speed is constant and equal to C (Mbits/s)
- Collided packets are lost (not retransmitted)



Aloha

- When a packet arrives ... transmit it!
- There is no coordination at all, apart from the fact that if a station is receiving then it will not transmit
  - Departs from the classical Aloha model
- When a Tx or Rx is finished a short time is needed to "reset" the hardware, then if there is a queued packet it is transmitted
  - Extremely high collision rate at high load if packets are buffered
  - Throughput goes to zero (if packets are buffered)

Aloha: The Model

- Assuming there are infinite (or very many if you prefer) STA, then the packet arrival process is Poisson
  - Each station offers a negligible amount of traffic
  - STA never have queued packets
  - Arrival rate remains constant
- Throughput is given by the well known formula $S = Ge^{-2G}$ where G is the offered load
  - When the number of stations is small this is not a good approximation
  - If stations are “blocked” while receiving the actual performance can be fairly different
- We need a simulation to understand the behavior with few STAs

CSMA

- Carrier Sense Multiple Access
  - Listen before talking
- If the channel is free transmit
- If the channel is occupied wait until the end of the transmission, then transmit with probability p
- While receiving, stations are blocked, when they stop receiving they behave as if the channel was occupied
- The persistency p is fundamental for performance
  - Low p yields stability but very high delays
  - High p leads to instability (like Aloha) but with low delays at low load

CSMA: Models

- There is no trivial model for CSMA
  - Though many Markovian models exist for almost any variation of it
- CSMA comes in many different flavors
  - Collision Detection
  - Collision Avoidance
  - With Binary Backoffs
  - With/wo handshakes
  - …

Simulation Models

- For both Aloha and CSMA we can do many simulation models
- Based on a per-station behavior can give very good insight on the protocol
- Traffic generation can be unicast, so that ACKs can be put in the scenario
- As the state is stored implicitly for each station including details as binary backoff is simple (while it is very difficult in analytical models)
- Including topologic details (distance between transmitter and receiver) is not difficult, so we can “release” the single-channel-everyone-hears-everyone assumption

Simulation Models

- Simulation of real protocols is always a bit more difficult
- E.g., 802.11 (WiFi) is a CSMA/CA protocol with binary backoff, but
  - There are hidden terminals
  - After 7 attempts the packet is discarded
  - The PHY layer has multiple Tx speed (so even C is difficult to define)
  - Queueing buffers are finite
  - Sensing and receiving thresholds can be different one another
  - There can be captures of the channel (two packets collide, but one is received because its power is much higher)
  - There are transmission errors ... need to distinguish between channel errors and collision or not, if yes how?
  - ...

Simulation Assignment

- We'll give you a simple implementation of a more or less realistic Aloha protocol for broadcast transmissions
- You will need to modify it in order to obtain a model of some more realistic (or simply different) protocol
- Modifications with different levels of complexity will be suggested: each one with an "upper bound" to the vote you can get base on the complexity of the task

- The modeling assignment will be based on the simulation results, but will come later on