Nomadic Communications

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http://disi.unitn.it/locigno/index.php/teaching-duties/nomadic-communications

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What do you find on the web site

- Exam Rules
- Exam Details ... should be on ESSE3, but ...
- Generic (useful) information
- Teaching Material: normally posted at least the day before the lesson
- Additional Material and links
- Laboratories groups, rules, description and hints
- News, Bulletin, How to find and meet me and Francesco, etc.

- ...

The web site is work in progress (well as of today working badly, but improving)

and updated frequently (that's at least my intention)

Please don't blame ME if you did't read the last news ☺

- **Why "Nomadic"**
  - Mobile vs. nomadic
  - Cellular vs. HotSpot
  - Local wireless communications
- **Some rehearsal**
  - Access Control Protocols
  - Protocols and architectures
  - Services and primitives
  - IEEE 802 project
  - Nomadic communications positioning

- **WLAN**
  - 802.11 Standard
  - 802.11 MAC
  - 802.11b/g/a/h/n/ac PHY
  - QoS and Differentiation enhancement: 802.11e
  - Mesh networks
  - Other extensions

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- **Ad-Hoc Networks**
  - Stand-Alone WLANs
  - Routing and multi-hop in Ad-Hoc networks
- **Vehicular Networks**
  Problems and scenarios
  - Specific issues
  - 802.11p and WAVE

Laboratories

- Intended to be **experimental** labs
  - Hands on the material (hardware/software)
  - Configuration of devices
  - **Protocols (MAC) manipulation/design** and results interpretation
- Centered on 802.11 (b/g at 2.4GHz)
  - They are not meant to cover all the course material
  - We have bought the OpenWWF enabled boards to play with
  - They are not meant to give you **notions** but a **working methodology**
- **More on Labs Later**

Why Nomadic

- Cellular Networks are widely diffused
  - Expensive
  - Omnipresent (or nearly so…)
- Internet access when not home/at work requires
  - A fast & cheap network
  - Presence in “key places” but not necessarily *everywhere*
  - Rarely need to use it while *moving* (trains, cars, …?*)*

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Wireless Network

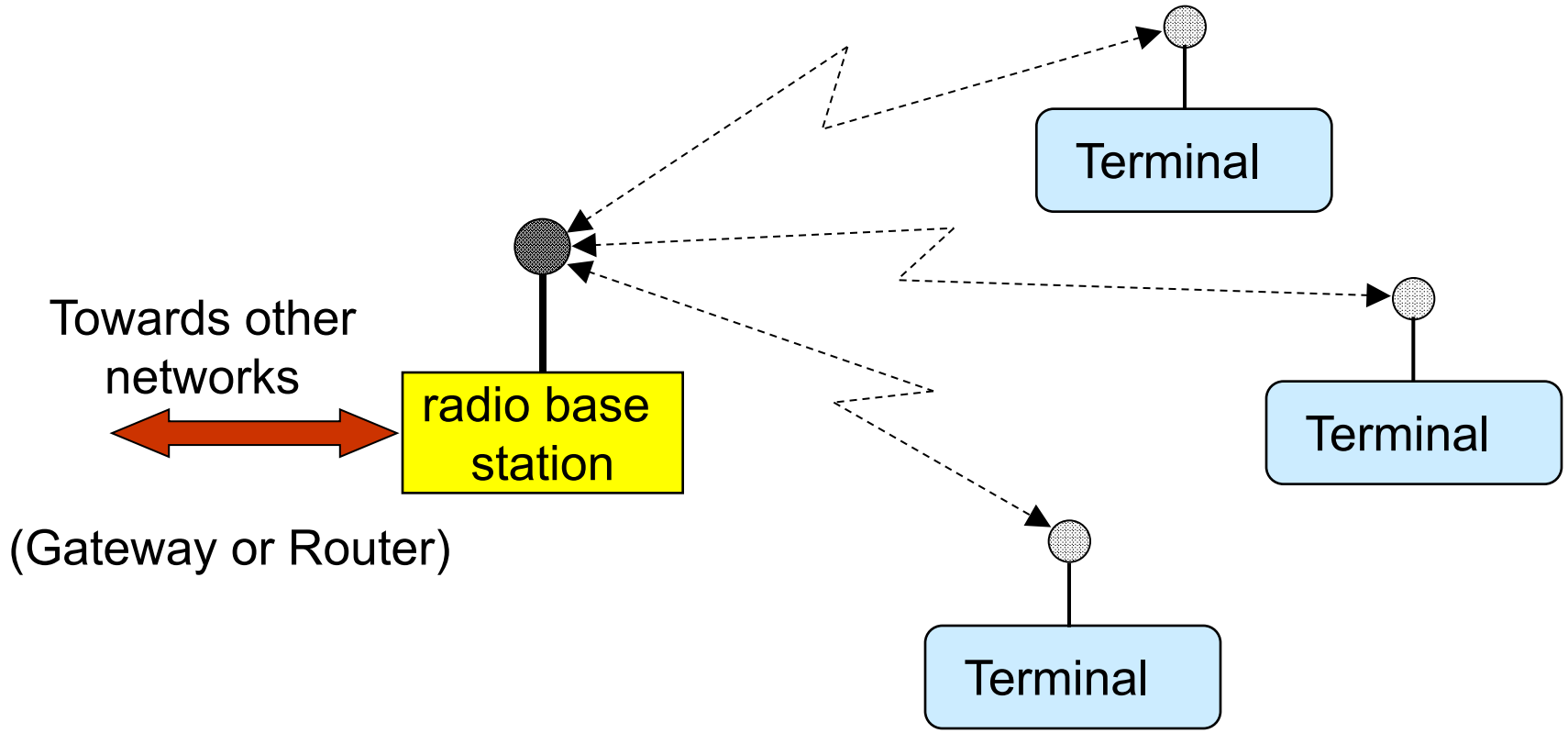
(sub)net where the access is on a

tetherless channel, can be your cordless at home!

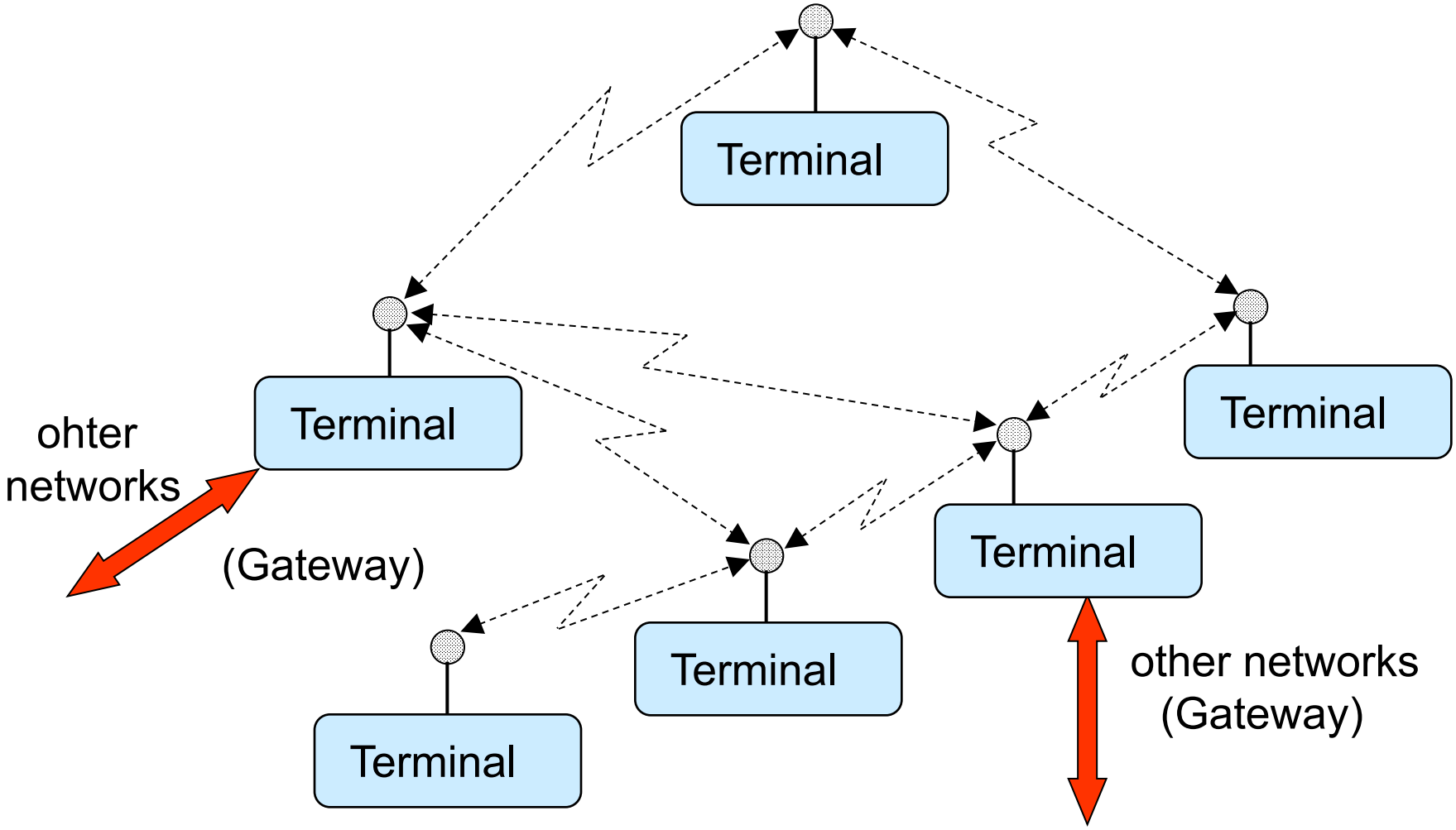
Cellular Network

a global network where the topological coverage is obtained with a set of adjacent or overlapping areas called *cells.* The mobile terminal (user) can move from one cell to the other keeping the communication seamlessly active

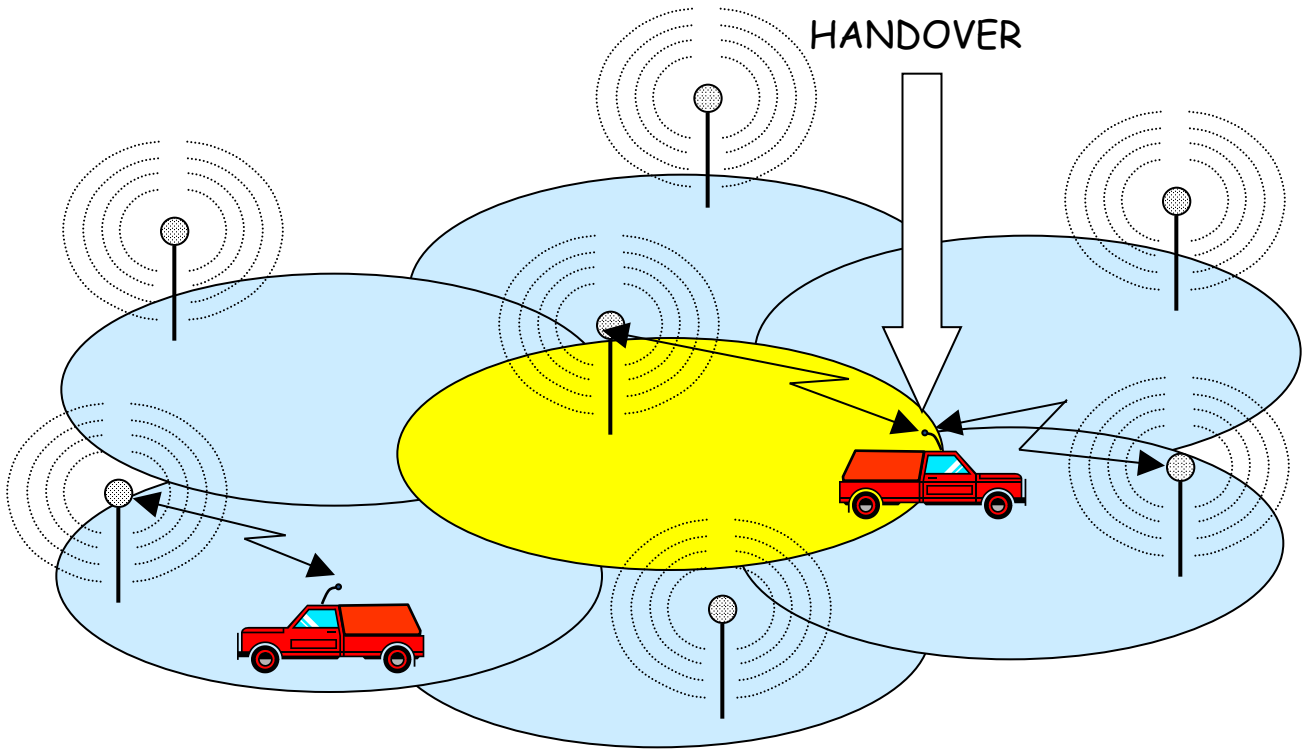
Wireless Network with a Fixed PoA



Ad-Hoc Wireless Network



Cellular Network



Wireless Local Access

- Nomadic communications are characterized by a first (second, third ...) wireless hop, then a connection to the global network
- Short range radio
- Normally shared medium
- Generally Best-Effort
- Need for authentication, identification, authorization (or not??)
- Open Access is sustainable?
- Is it legal? (see FreiFunk in Germany)

Access Protocol Rehearsal

what you *already know* but don't *remember*

what you *should know* but are not *aware of*

☺

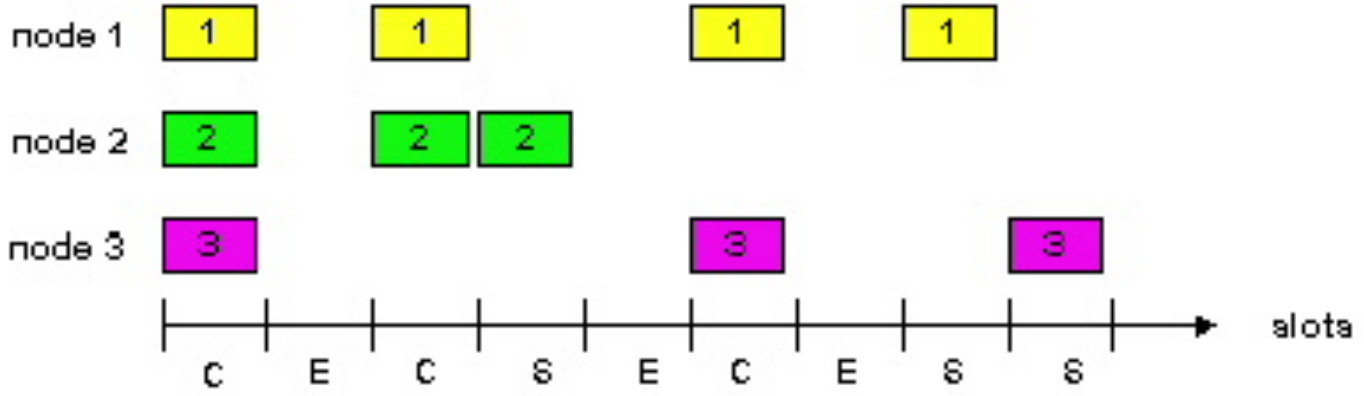
Classification of LAN MAC

- 3 types
  - Contention or Random Access (Aloha, CSMA/CD, Ethernet)
  - Ordered Access (Token Ring, Token Bus, FDDI)
  - Slotted with reservation (DQDB, Res-Aloha)
- Evaluation/Performance Parameters
  - Throughput (capacity and carried traffic)
  - Fairness
  - Delay (access, propagation, delivery)
  - Topology, Resilience, Network dimension, Number of Stations, ...

Random Access Protocols

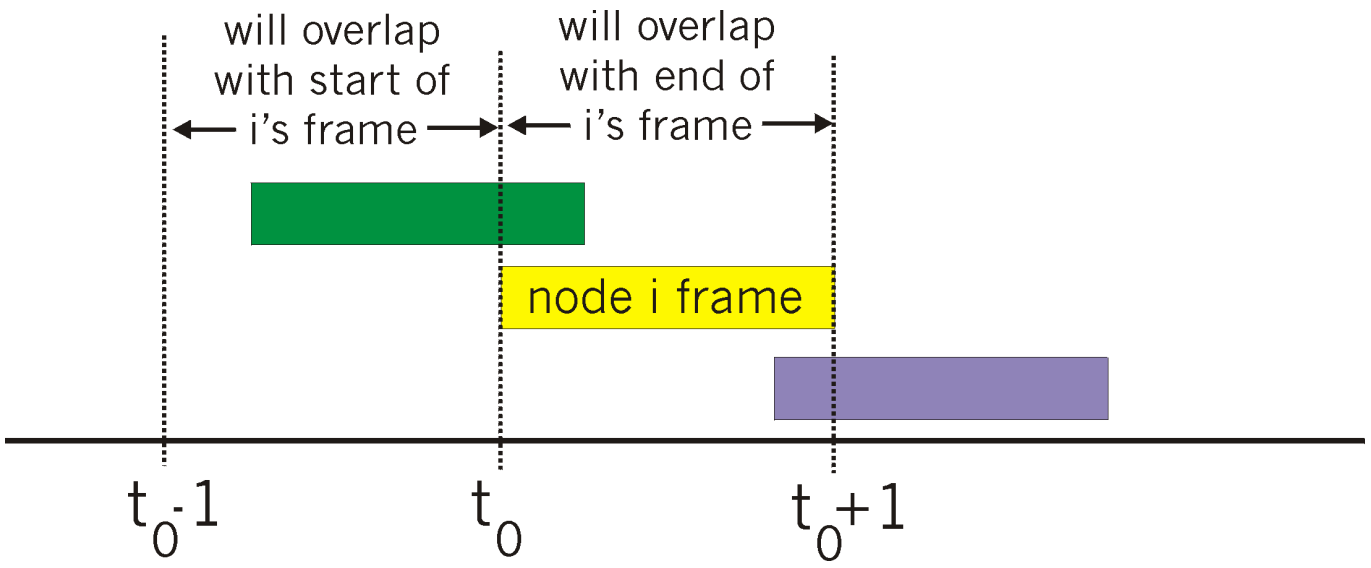
- A node in transmit a packet
  - At line speed R
  - without coordination with others
- If more than one node transmit at the same time ..... $\Rightarrow$ collision
- Random Access (or contention based) MAC protocols specify:
  - How to randomize the initial access
  - How to recognize a collision
  - How to retransmit the packet after a collision

- Time is divided in equal length slots
- Nodes transmit at the beginning of the slot only
- In case of collision retransmit either with probability p in the next slot or after a random delay of n slots until success



Success (S), Collision (C), Empty (E) slots

- Simpler, no slots no synchronization
- Transmission at any time, retransmission too, only random delay possible after collisions
- Collision probability is increased
  - yellow packet collides with other packets in $[t_0-1, t_0+1]$



Comments

- Simple protocols
- Throughput is very limited due to collisions
  - with Poisson arrival hypotheses the maximum efficiency is
    - 18% ALOHA
    - 37% SLOTTED ALOHA
  - With other traffic may be larger/smaller
- Unstable protocols (throughput goes to zero at high loads)!!!
- At low loads access delay is close to zero
- Access delay is not guaranteed nor bounded!!

Aloha: homework

- Compute collision probability and throughput in case of Poisson Arrivals
  - Compare with collision probability and throughput of Aloha and explain differences
- Compare the p-retransmission policy with the delayed retransmission one
  - are they equal? in what conditions?

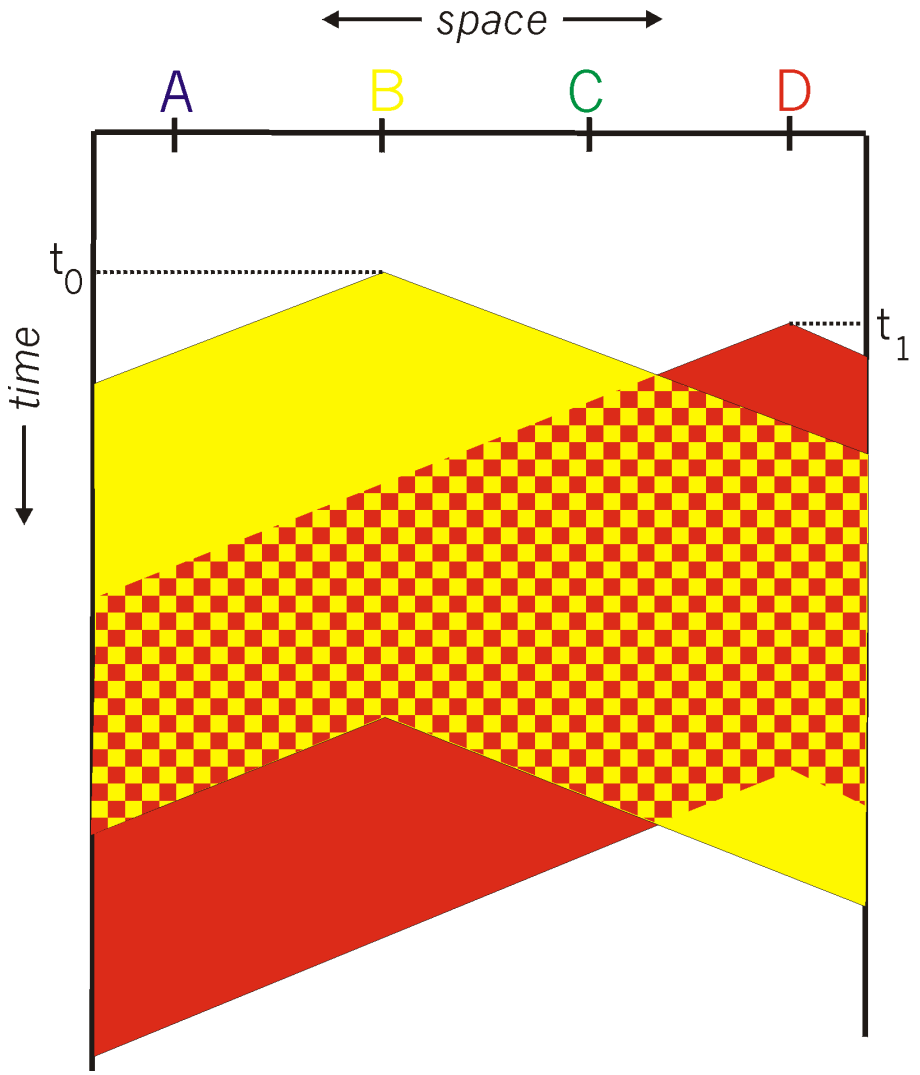
- The homework can be done in 2 or 3, this can be the occasion to start forming groups for labs
  - Homeworks are part of the program … don't blame me if you cannot answer brilliantly about them at the oral

CSMA: Carrier Sense Multiple Access

- Conceived to increase throughput
- Stations listen to the channel before transmitting
  - If channel is free: Transmit Packet
  - If channel is occupied delay transmission
    - 1- persistent CSMA: Immediate transmission on free channel
    - 0-persistent CSMA: Retry after a long random delay
    - p-persistent CSMA:
      - With probability p behaves as 1-persistent
      - With probability (1-p) behaves as 0-persistent

CSMA: collisions???

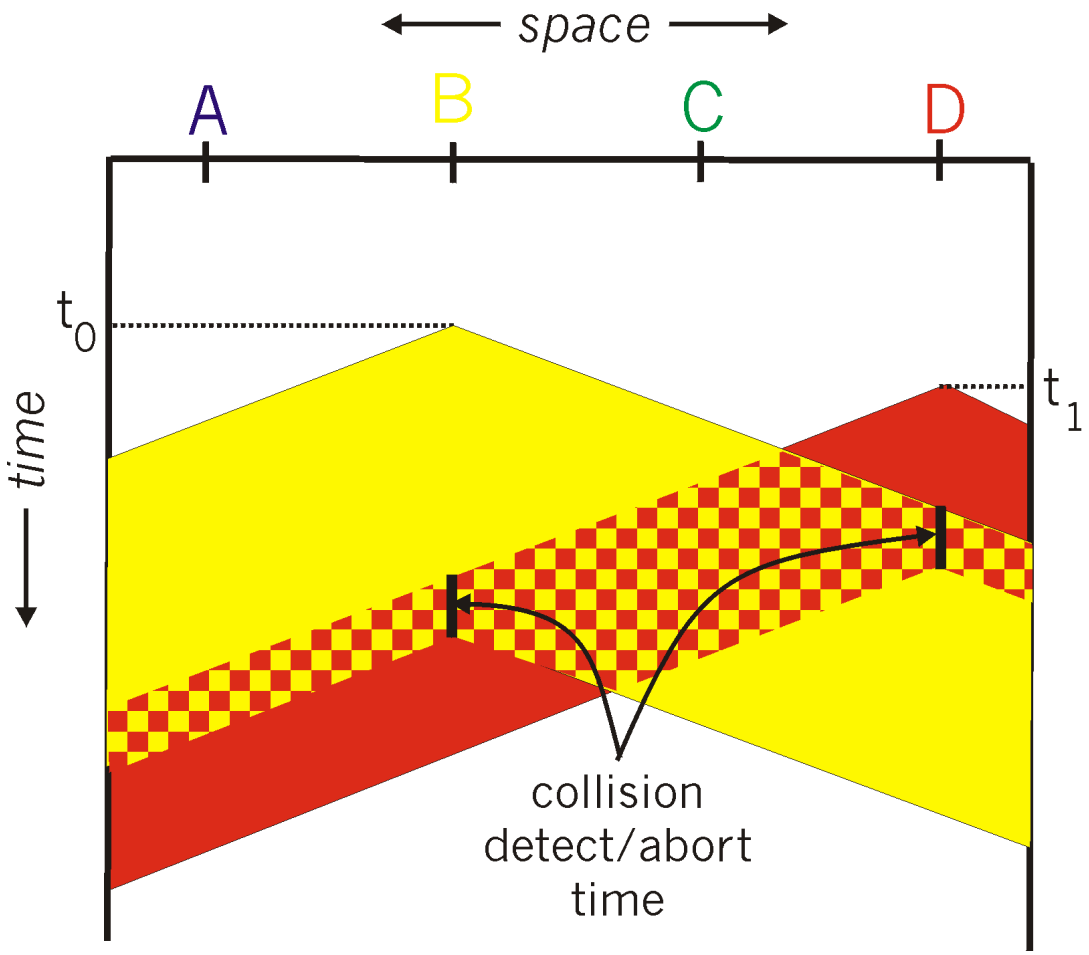
- May happen due to propagation delay
- Transmission time is entirely wasted
- Distance between stations plays a fundamental role in the collision probability



CSMA/CD (Collision Detection)

- CSMA/CD Builds on top of CSMA
  - Try to understand when a collision occurs and stop transmission
  - Wasted time is reduced
- Collision detection:
  - Easy on wired LANs: Simple power measurement with threshold comparison between transmitted and received power
  - Up to now impossible in traditional WLANs
    - Half Duplex
    - Power fluctuation/Power attenuation
  - Full Duplex Radio available in labs since a few years
    - Yet CD seems to be of little help (why?)

CSMA/CD collision detection



- The fundamental parameter is end to end propagation delay
  - More precisely what counts is the ratio between the (average) packet transmission time and the e-t-e propagation delay
- Performances are optimal for small, slow (in terms of transmission speed) LANs with large packet dimension
- There is a minimum packet size required to identify collisions

CSMA/CD: Performances

- The 1-persistent behavior is normally preferred for the low access delay at low loads
- The protocol is instable, just like any contention based protocol without “corrections”
  - Exponential backoff on transmissions to induce stability
  - Dimension and No. of stations limits adapted to backoff
- It’s not easy to introduce traffic differentiation and priority
- **This is Ethernet !!**

Nomadic Communications
&
WLANs

characterized by LAN-like wireless access

typically use Internet upper layers

requires some means to handle portability and local mobility

- Standardization process started in the ’80s by IEEE 802 project:
  - ✓ 802.1: LAN *Internetworking*
  - ✓ 802.2: LLC Sublayer
  - ✓ 802.3: CSMA/CD: *Ethernet* is a small (1-bit in the header) variation of 802.3
  - ✓ 802.4: *Token Bus*
  - ✓ 802.5: *Token Ring*
  - ✓ 802.6: DQDB (for MANs)

LAN Protocols

- Work is still going on in many technical committees and new committees are founded every year (or close to):
  - ✓ 802.7: Broadband Technical Advisory Group
  - ✓ 802.8: Fiber-Optic Technical Advisory Group
  - ✓ 802.9: Integrated Data and Voice Networks
  - ✓ 802.10: Network Security
  - ✓ **802.11: Wireless Networks (/a/b/g/h/f/s/n/p/ac/ax/...)**
  - ✓ 802.12: 100base VG
  - ✓ 802.13: 100base X
  - ✓ **802.15: Personal Area Networks (.1 [Bluetooth] ... .4 (ZigBee))**
  - ✓ **802.16: Wireless MAN (WiMax & Co.)**
  - ✓ ...