ulm university universität ulm

Lecture Computer Networks

Networks for Multimedia Applications

Prof. Dr. H. P. Großmann mit M. Rabel sowie
H. Hutschenreiter und T. Nau | Sommersemester 2012 |
Institut für Organisation und Management von Informationssystemen

Matthias Rabel

Multimedia – minimal requirements

- Multimedia-based information systems
  - internally differentiated systems. Minimal requirements:
    - two from each other independent sensors/actuators for distinct media
    - transformations which connect the distinct information
    - in principal **parallel** recognition, saving, processing and presentation of information must be possible
    - internal networking is multidimensional
  - using the information of one system to control a different one and vice versa
  - can also be understood as communication systems
  - build on several mono medial networks multimedia systems
  - multimedia networks must be modeled multidimensionally

Source Prof. Dr. Michael Giesecke / Uni Erfurt
http://www.michael-giesecke.de/theorie/dokumente/02_information3d/essay/02_multimediale_informationsverarbeitung.htm

Multimedia – misapprehension

- Often: multimedia networks
  - compound of
    - computer networks
    - fieldbusses
    - telecommunication
    - broadcast media (radio / TV)
- Often misunderstood
  - media (data sources) are not linked
- Instead:
  - integration of heterogeneous networks?
    - better, however mostly special,
    - not as normally with IP realized

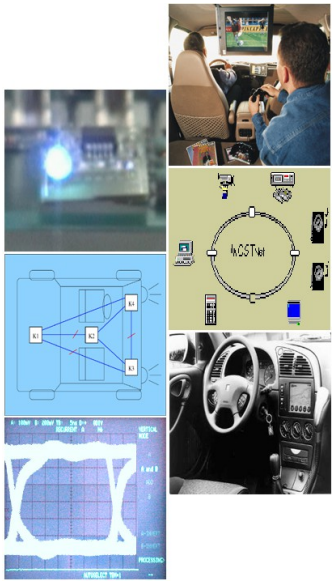
Multimedia & data networks

- Multimedia is only application-related
  - composition (reflection, evaluation)
    - nature different sensors
  - calculation of the result
    - output on nature different actuators
- In this respect: multimedia networks do not exist
- Hence topic:
  - integration of heterogeneous networks for multimedia applications
    - traditional IP stack addresses only a subset of possible applications
      - » Ethernet is therefore sufficient
    - new requirements and possible solutions can be subsumed as QoS and Traffic Engineering
      - » Supported by lower layers (e.g., OSI L2)
      - » But careful: Terms are used with protocols based on IP

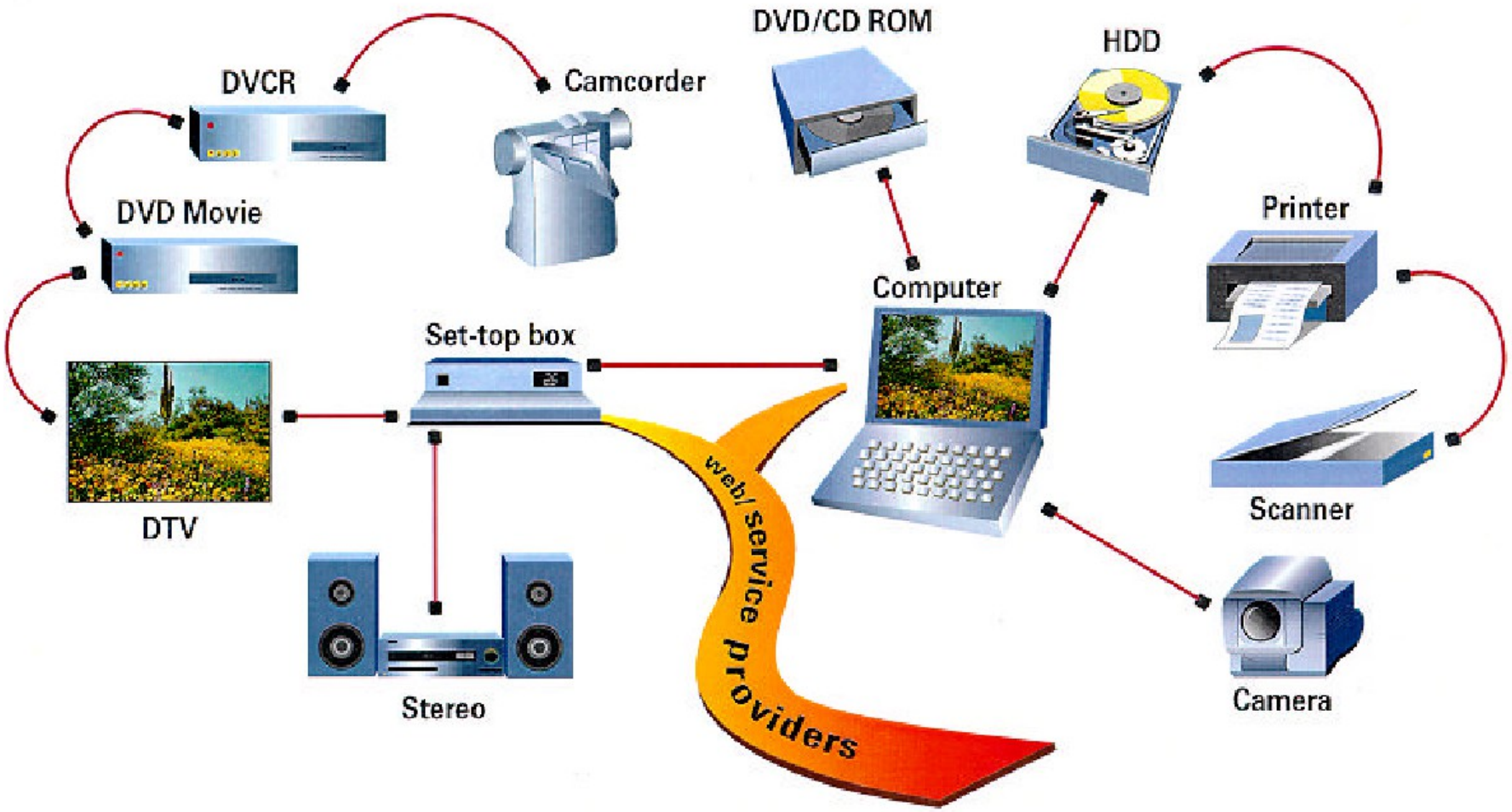
Networks for multimedia applications

- Rough grouping, using OSI Layers
  - Layer 2 – media access
    - USB
      - » (no network: nodes are not equal and not autonomous)
    - Firewire
    - Bluetooth
    - WLAN
    - modified Ethernet (Industrial Ethernet ...)
  - Layer 3 – network
    - Internet Protocol
      - » with DiffServ / IntServ und TE
  - Layer 4 – transport
    - Internet Protocol
      - » Port (=) application-based (through „well-known Ports“)
      - » or higher = only application-based (per application protocol)

Firewire – media access



IEEE 1394 – Übersicht



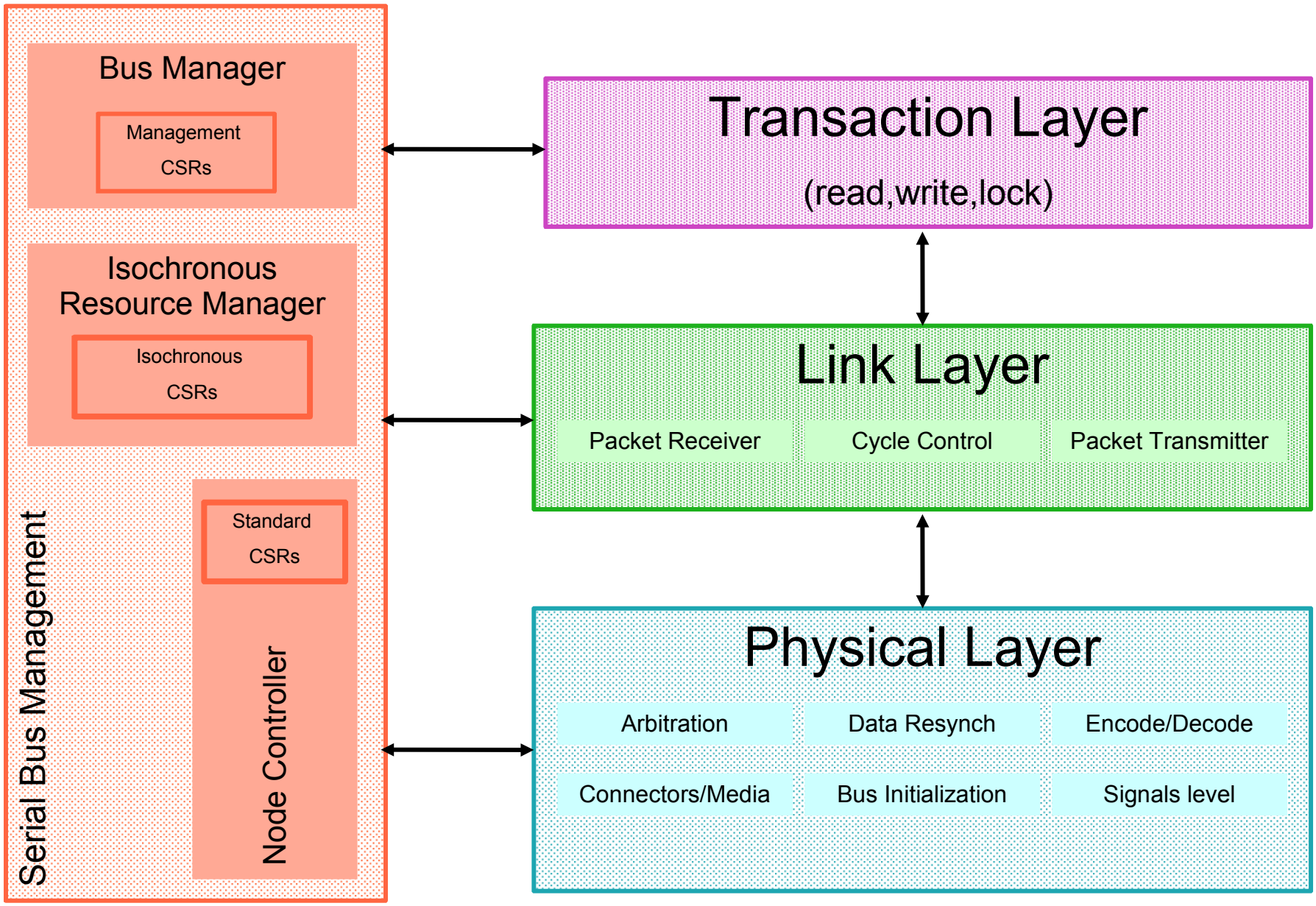
IEEE 1394 – Overview

- What is IEEE 1394 (-1995)?
  - max. 63 nodes
  - automatic assignment of node addresses
  - variable speed data transmission
    - from 25 and 50 Mbit/s for backplanes
    - to 100, 200 and 400 Mbit/s for cable medium
  - the cable medium allows
    - up to 16 physical connections (cable hops)
    - each of up to 4.5 meters
  - a fair bus access mechanism
- IEEE 1394.a – 2001
  - fixes and minor extensions
- IEEE 1394.b
  - redundancy
  - cable hops 100m
  - 800 MBit/s (specified up to 1600 MBit/s)

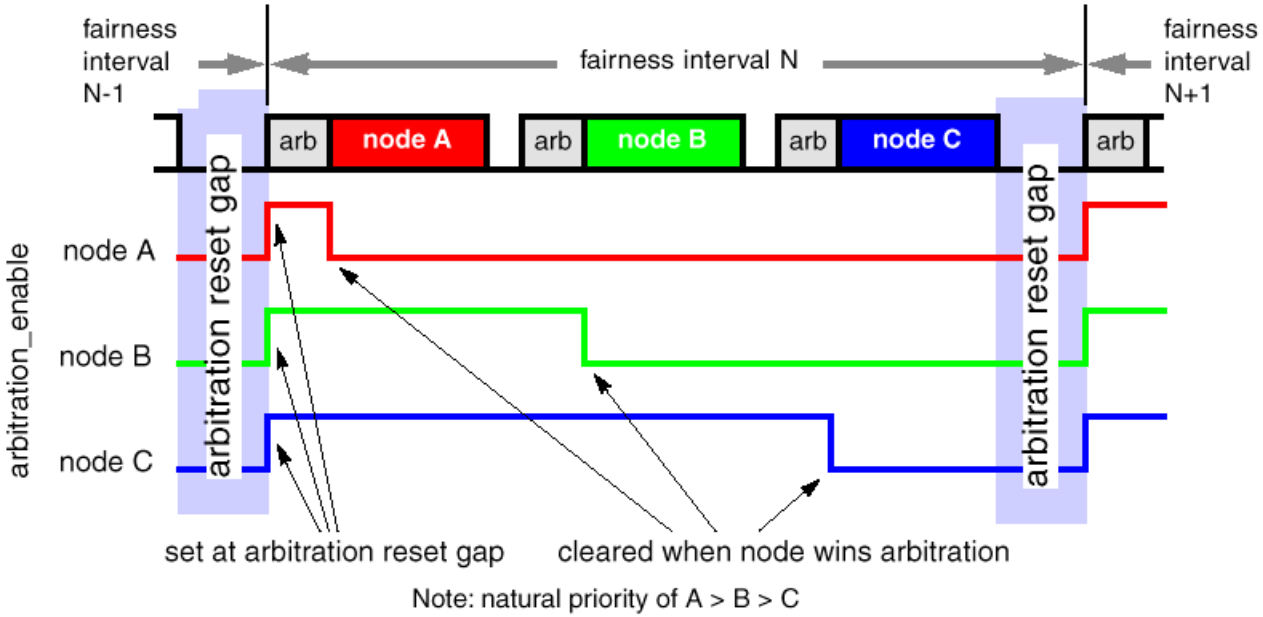
IEEE 1394 – Overview

- Isochronous data transfers
  - guaranteed datarate provided by the bus
  - data is NOT guaranteed to be either valid or arrive at the destination
  - broadcast channel concept (one sender)
- Asynchronous data transfers
  - no guaranteed bandwidth
  - Link Layer guarantees arrival and validation
- Isochronous stream data transfer
  - no guaranteed bandwidth
  - asynchronous arbitrated
  - multiple sending nodes (applications) possible
  - data is NOT guaranteed to be either valid or arrive at the destination

Serial Bus – Layer Model

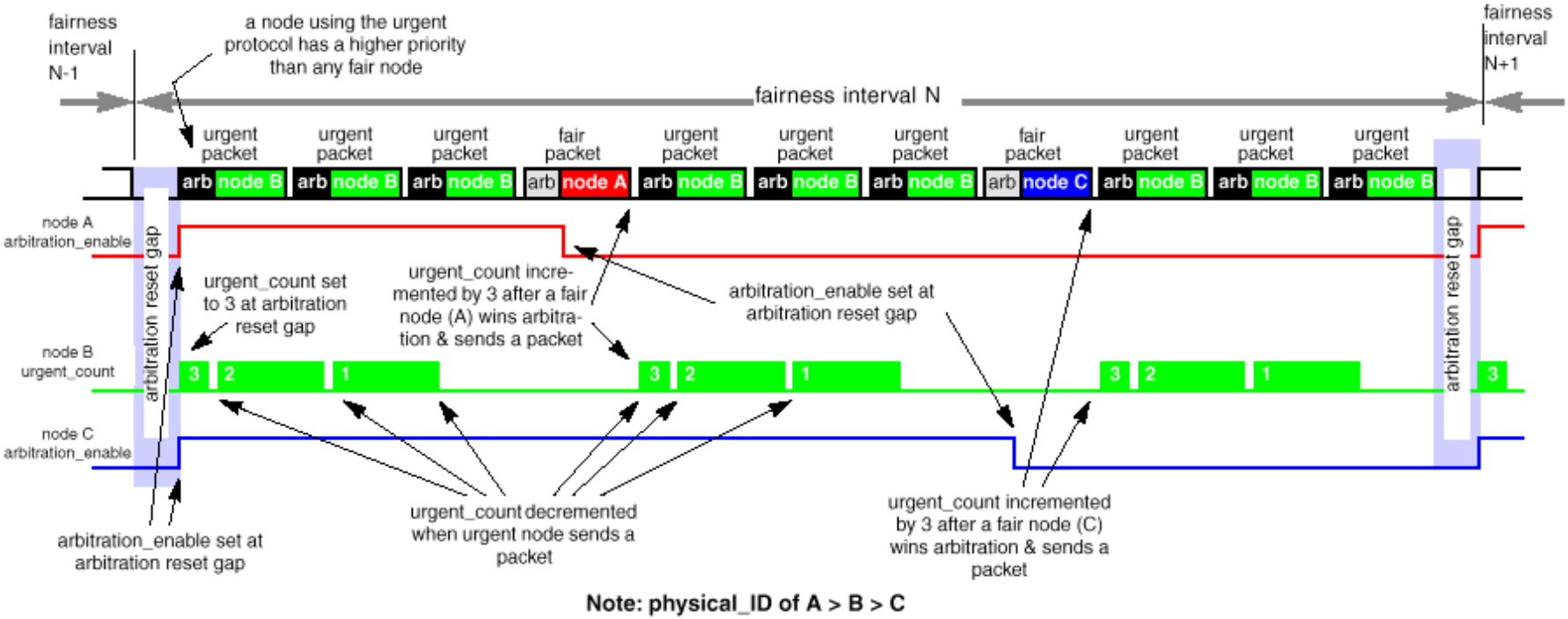


Fair arbitration



- Fair arbitration based on fairness interval
- All nodes arbitrating send a request to the root which grants or denies access
- Isochronous and asynchronous arbitration work the same way
- Isochronous subactions are send immediately

Urgent arbitration

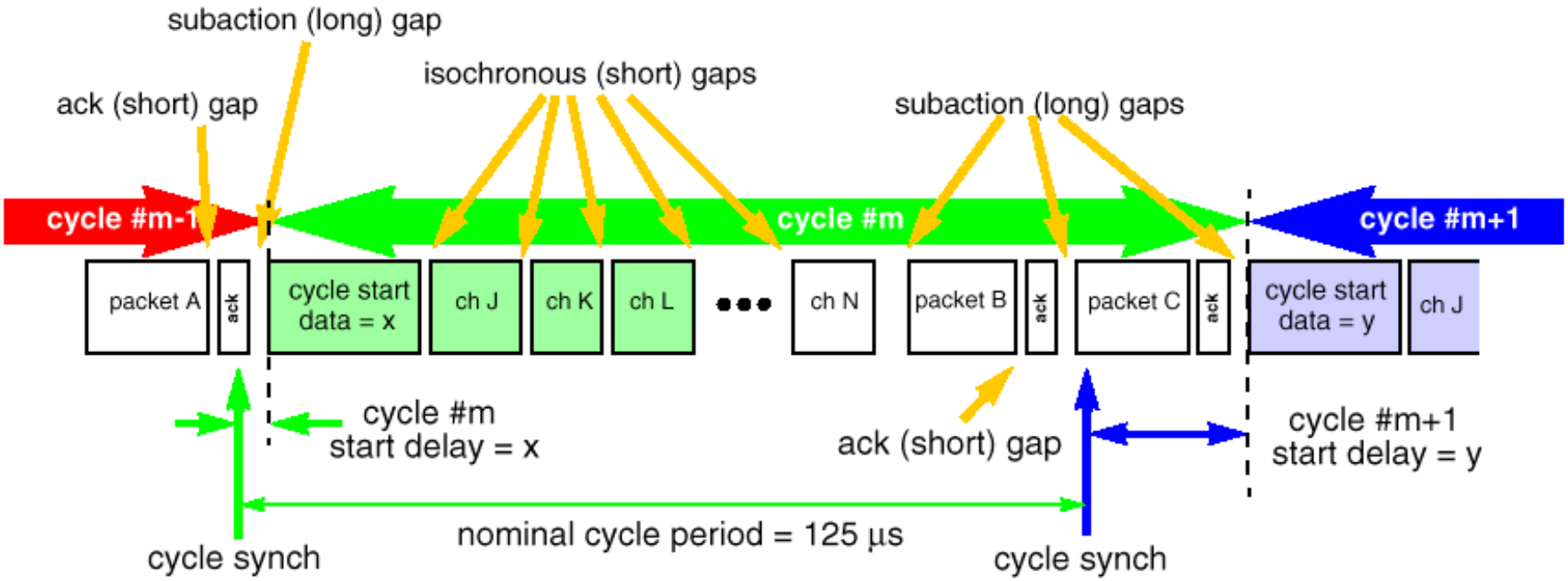


3/4 of cycle time can be used for nodes using urgent arbitration

Note: Urgent arbitration is only used in backplane environment not on the cable media

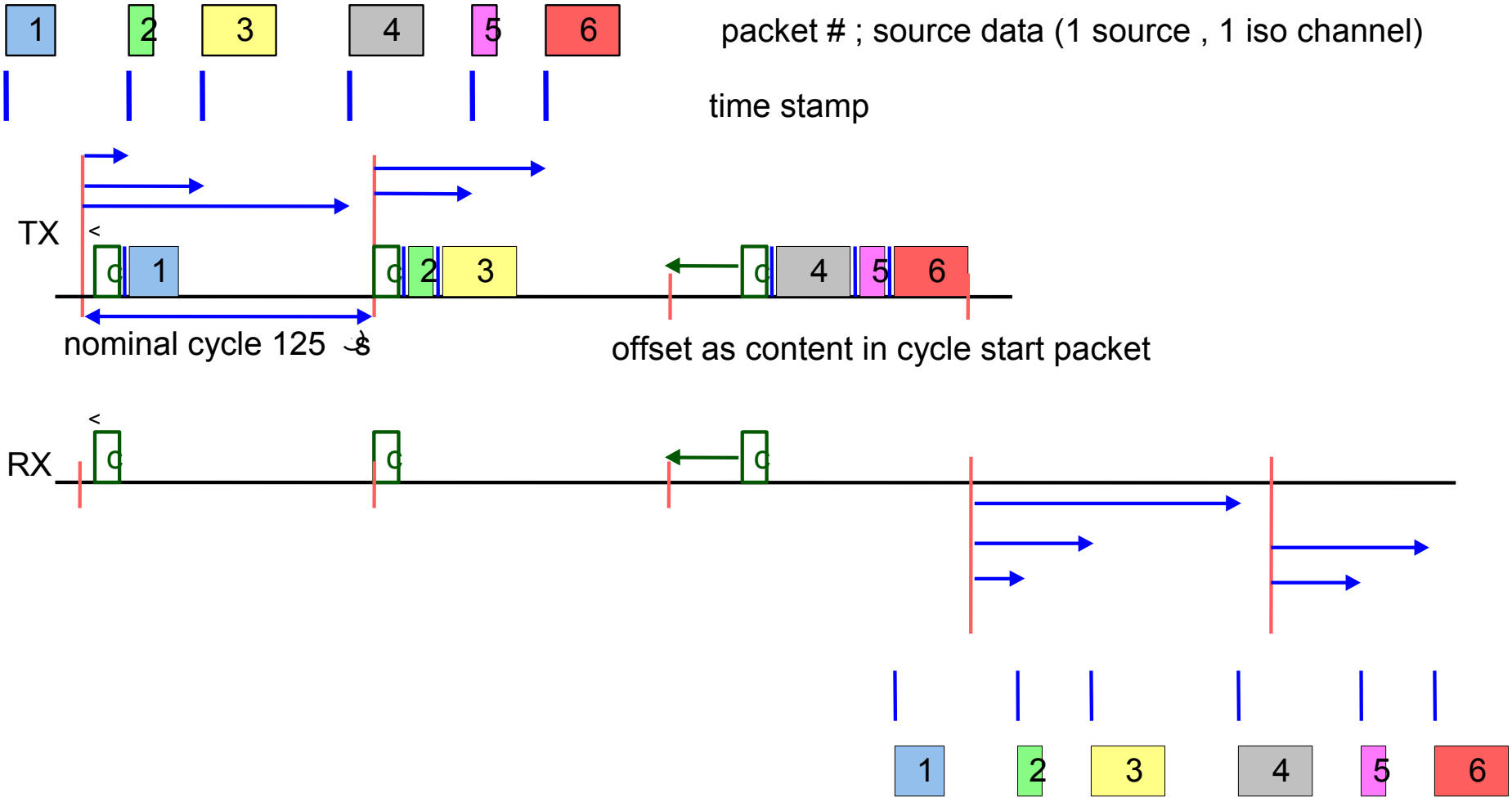
This arbitration is used with small packets, because these packets would enormously increase LATENCY with normal arbitration

Cycle Structure

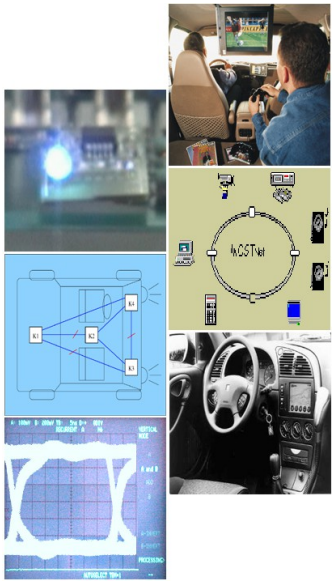


- Cycle master maintains common clock source
  - generates cycle start packets
  - intervals set by a „cycle sync“ source (8 kHz ➡ 125 µs)
- If a transfer is in progress on a cycle sync event, the cycle start packet is delayed

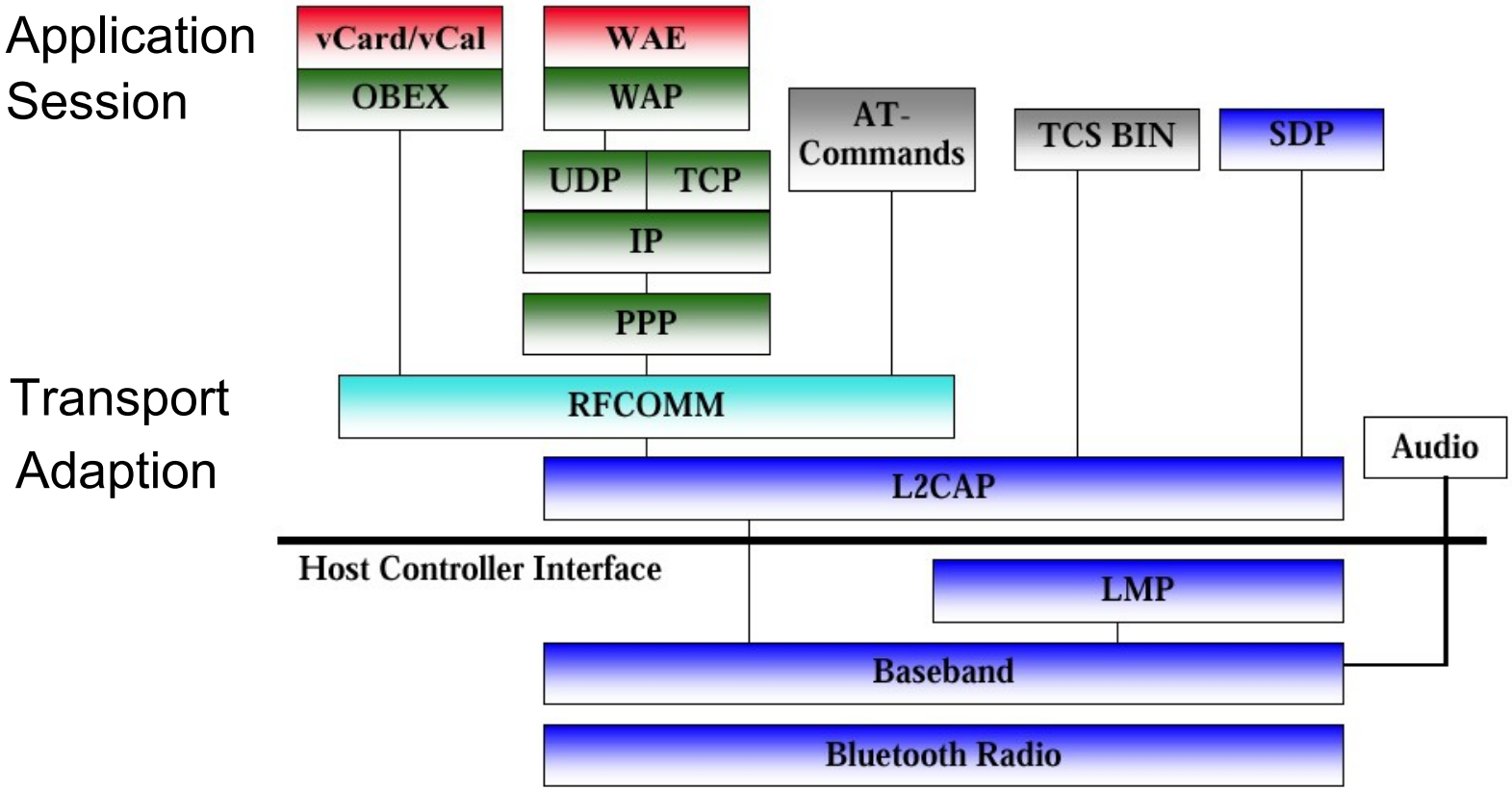
Data Traffic – Timing implementation



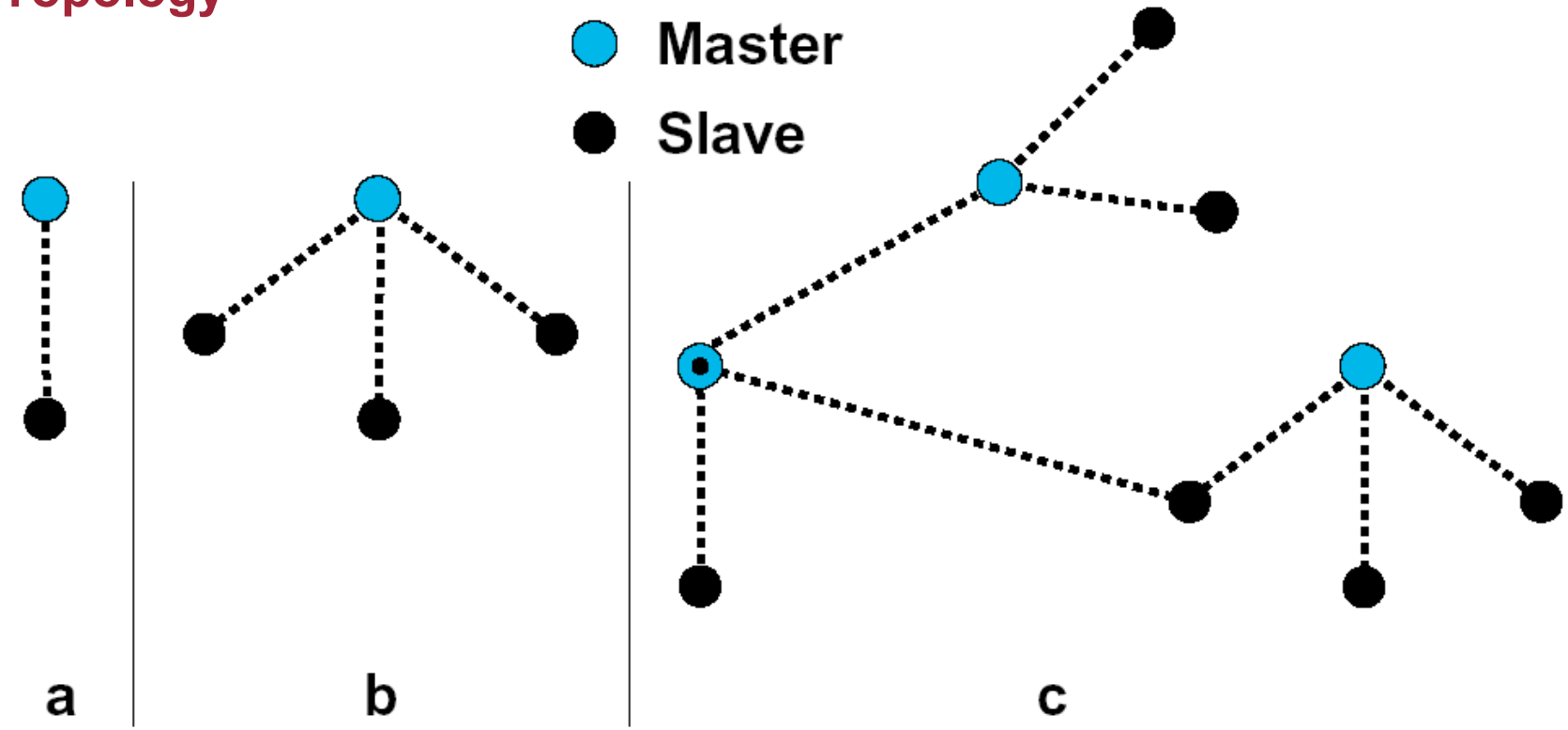
Bluetooth – media access



Layer model


Application
Session
Transport
Adaption
vCard/vCal
OBEX
WAE
WAP
AT-
Commands
TCS BIN
SDP
UDP
TCP
IP
PPP
RFCOMM
L2CAP
Audio
Host Controller Interface
LMP
Baseband
Bluetooth Radio

Topology



Point-to-point

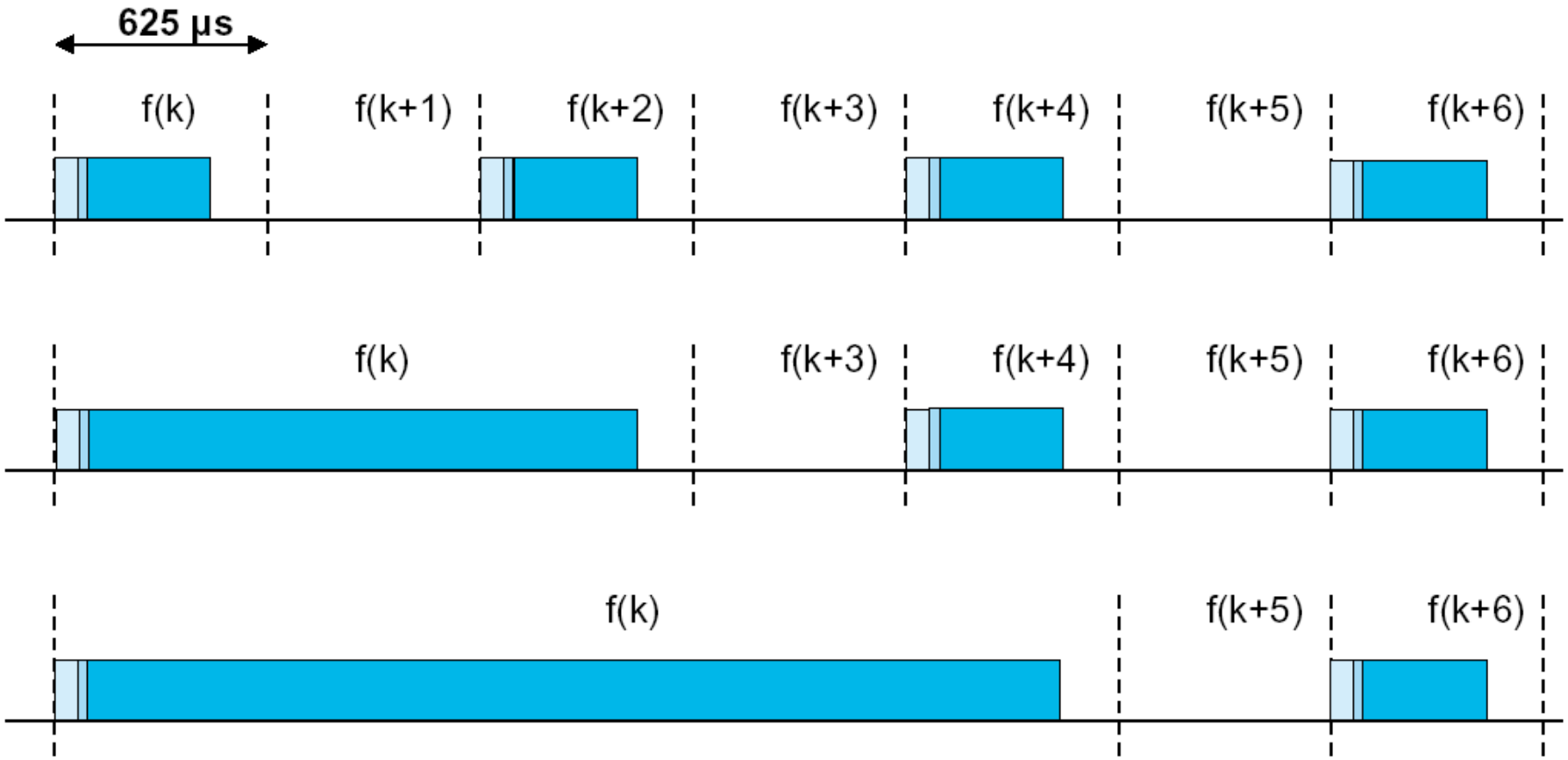
Piconet
(1 master,
up to 7 active slaves)

Scatternet
(overlapped piconets)

Physical Channel

- Hopping sequence
  - Nominal hop rate: 1600 hops/s
  - Pseudo-random sequence
  - Unique for each piconet
  - Determined by device address of master
- Time slots
  - 625 µs in length
  - Numbered according to the clock of the piconet master
  - Slot numbers: Cycle length: 0 bis 2^{27}-1
- Time Division Duplex (TDD) scheme
  - Master transmits in even numbered slots
  - Slaves in odd numbered slots
  - Packets may extend over up to 5 slots

Multi-slot packets



- 1, 3 and 5 Slot packets available
- SCO packets are always only 1 slot long

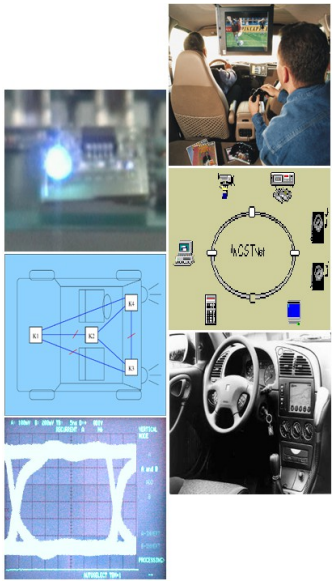
Logical channels

- LC Channel (Link Control)
  - low level link control information like ARQ, flow control, payload characterization
  - mapped onto packet header
- LM Channel (Link Manager)
  - control information exchanged between the link managers of master and slave(s)
- UA Channel (User Asynchronous)
  - L2CAP transparent asynchronous user data
  - data may be transmitted in one or more baseband packets
- UI Channel (User Isochronous)
  - like UA Channel
  - isochronous data channel supported by timing properly at higher levels
- US Channel (User Synchronous)
  - transparent synchronous user data
  - channel is carried over SCO link

LMP

- LMP – Link Manager Protocol
  - Authentication
  - Encryption (start, stop, key size, mode, ...)
  - Clock Offset Request
  - Slot-Offset
  - Supported Features
  - Switch of Master-Slave role
  - Change of Mode
  - Power Control (TX-Power)
  - Link attach and detach
  - ...

WLAN – media access



802.11 MAC

- IEEE802.11
  - DCF – Distributed Coordination Function
    - CSMA-CA
    - collisions can not always be prevented
    - no QoS
  - PCF – Point Coordination Function
    - AP polls stations
    - not implemented
- IEEE802.11e – Introduces Traffic Classes
  - HCF – Hybrid Coordination Function
    - EDCA – Enhanced Distributed Channel Access
      - » Modifies IFS (Inter Frame Spaces) and back off times
    - HCCA – HCF Controlled Channel Access
      - » Divides in contention free and contention period
      - » AP polls during the contention free period
      - » Management aware of jitter / delay / periodicity

Further examples:

IEEE 802.16 (WiMax)
Hiperlan

Thank you!