Overview of HiperLAN/2

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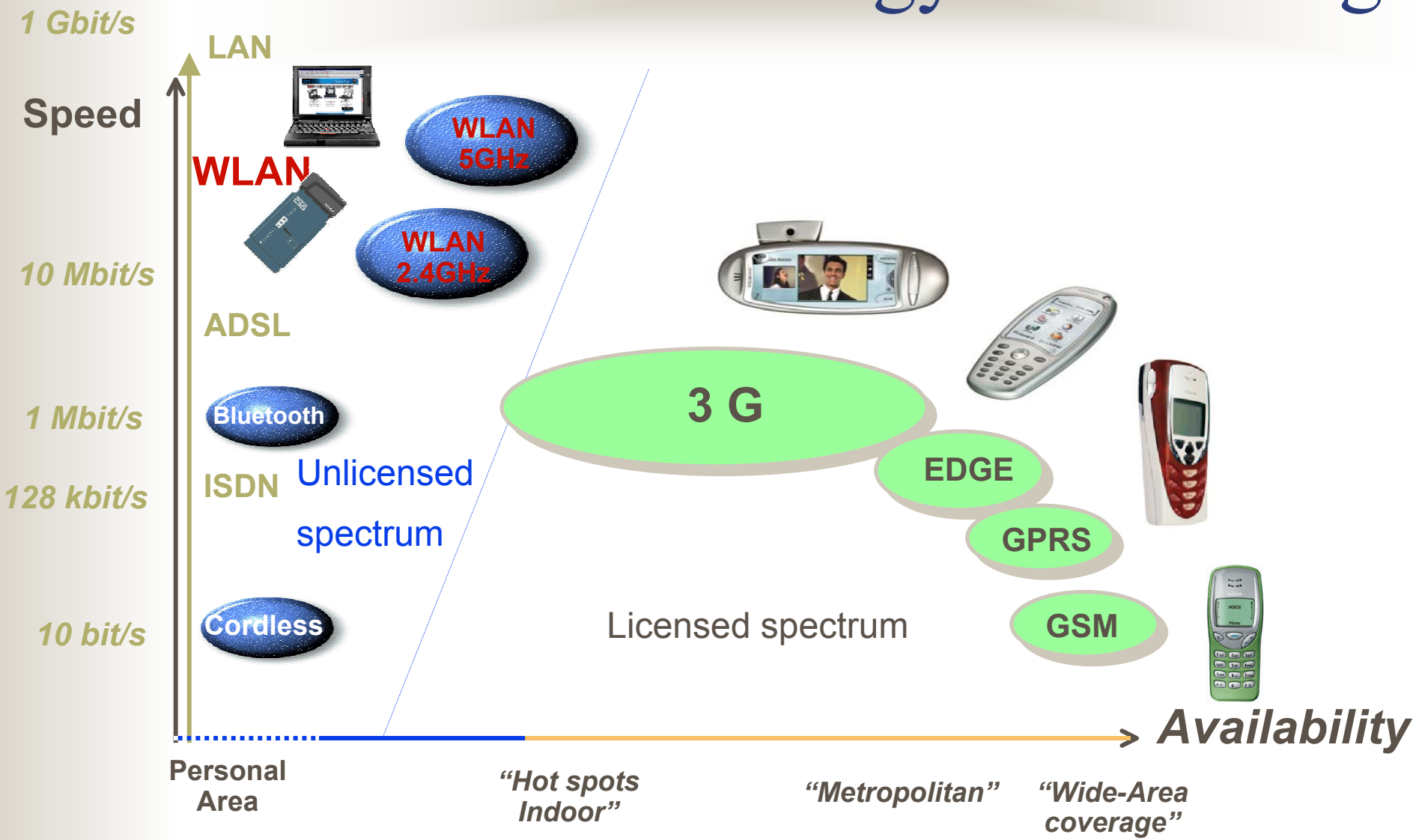
Wireless LAN Technology Positioning



Wireless LAN Standards

There are 3 different standardizing organizations:

1. IEEE (Institute of Electrical and Electronics Engineers Inc.)
   - IEEE 802.11 for Wireless LAN
   - Standards for both 2.4 GHz and 5 GHz band
   - Most widely used Wireless LAN standard
2. ETSI (European Telecommunication Standards Institute)
   - ETSI HiperLAN 1 and 2
   - Standards only for 5 GHz band
3. MMAC (Mobil Multimedia Access Communications)

HiperLAN Background

ETSI (European Telecommunications Standards Institute)

- Developing HiperLAN standards as part of an effort called BRAN (Broadband Radio Access Network)
- Effort includes 4 standards
  - HiperLAN1
  - HiperLAN2
  - HiperLink (Designed for indoor radio backbones)
  - HiperAccess (Designed for fixed outdoor use to provide access to wired infrastructure)
- Both HiperLAN standards are approved standards for European spectrum
- HiperLAN2 has a key advantage over IEEE 802.11a
  - 802.11a products may not be usable in Europe

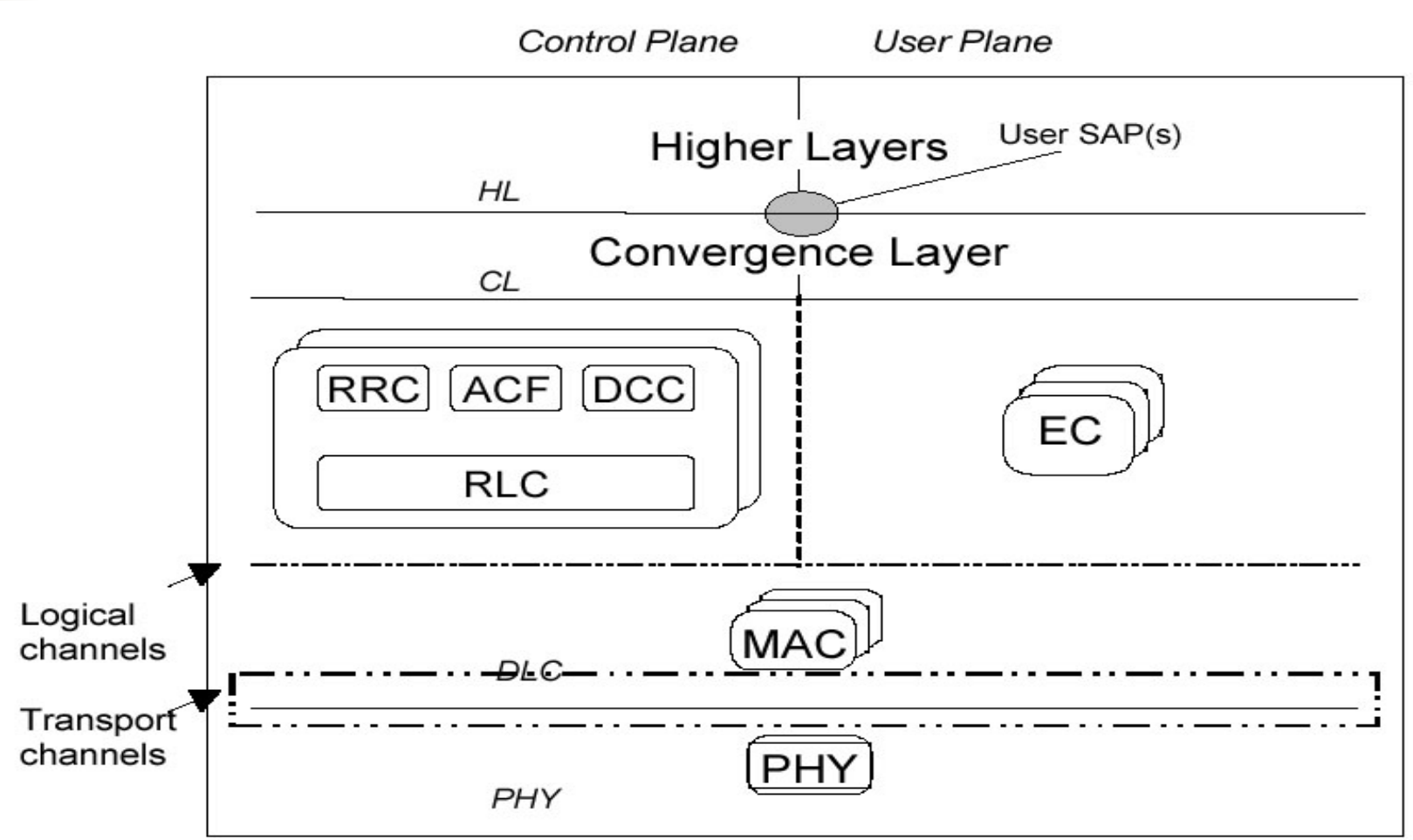
HiperLAN/2 Standard

- A new standard developed by the ETSI Project BRAN for wireless access to very high rate IP and multimedia applications
  - Radio sub-system specifications (physical layer, data link layer and convergence layer)
  - Interoperability standard
  - Conformance test specifications
  - Business and Home applications
- Globally available
- PHY is aligned with IEEE 802.11a
- The Basic specification was ready in 1999
  - Support of Business functions
- The Extensions, including 1394 support was ready in 2000
  - Support of Home specific applications
- Most sophisticated (& technically challenging) wireless LAN technology so far defined
  - Uses a new type of radio technology called Orthogonal Frequency Division Multiplexing (OFDM)

HiperLAN/2 - Features

- Lots of bandwidth, up to 54Mbps
- QoS
- Plug & play radio network
- Service negotiation
- Security, authentication & encryption
- Spectrum availability
- Scalable
- Generic architecture supporting Ethernet, Firewire, ATM, PPP, 3G, etc.
- Considerably cheap

HiperLAN/2 Protocol Reference Model



HiperLAN/2 (IEEE 802.11a) PHY

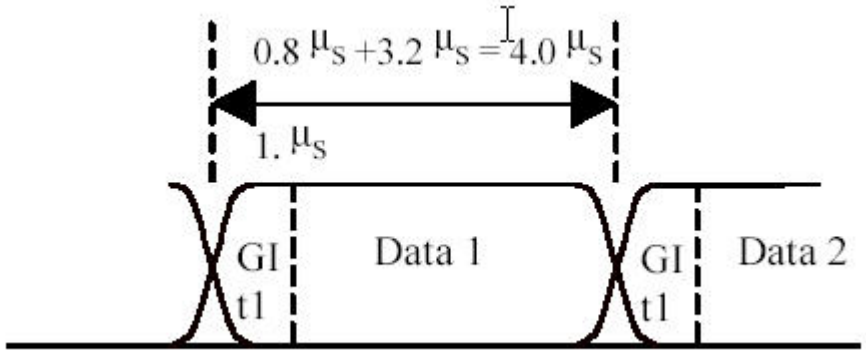
-Main Parameter

Data Rate:	6, 9, 12, 18, 24, 36, 48, 54 Mbit/s
Modulation	BPSK, QPSK, 16-QAM, 64-QAM
Code Rate	½, 9/16, 2/3, ¾
Number of Subscarriers	52
Number of Pilot Tones	4
OFDM symbol duration	4 μ sec
Guard Interval	800η sec, 400η sec (optional)
Subscriber Spacing	312.5kHz
Signal Bandwidth	16.66MHz
Channel Spacing	20 MHz

HiperLAN/2 (IEEE 802.11a) PHY

-OFDM Frame Structure

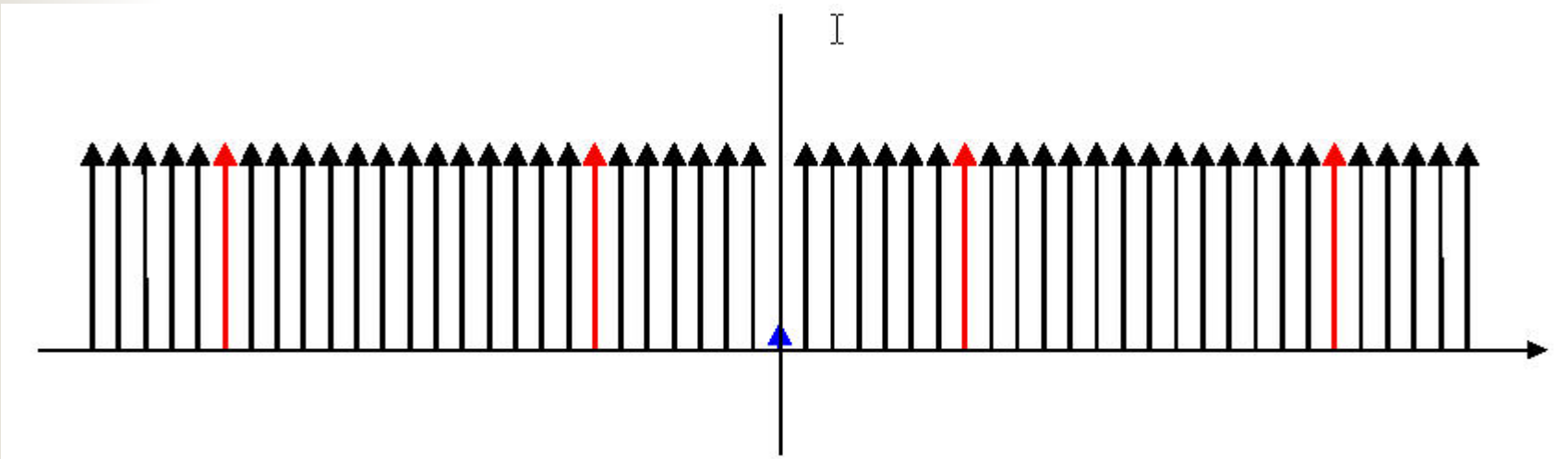
- Carrier spacing is 312.5 KHz
- Fourier transform performed over 3.2 microseconds
- 0.8 microsecond Guard Interval for ISI rejection



HiperLAN/2 (IEEE 802.11a) PHY

- Data and Pilot subcarriers

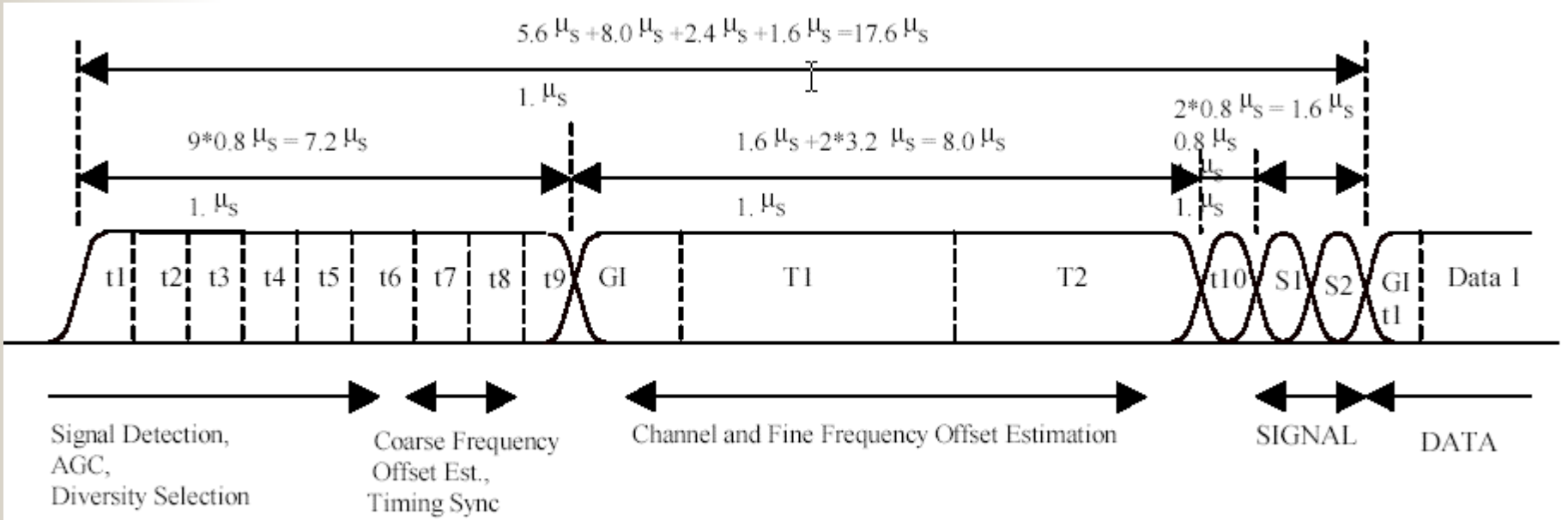
- 52 non zero subcarriers
  - 48 data subcarriers
  - 4 carrier pilot subcarriers
- Center frequency subcarrier not used



HiperLAN/2 (IEEE 802.11a PHY)

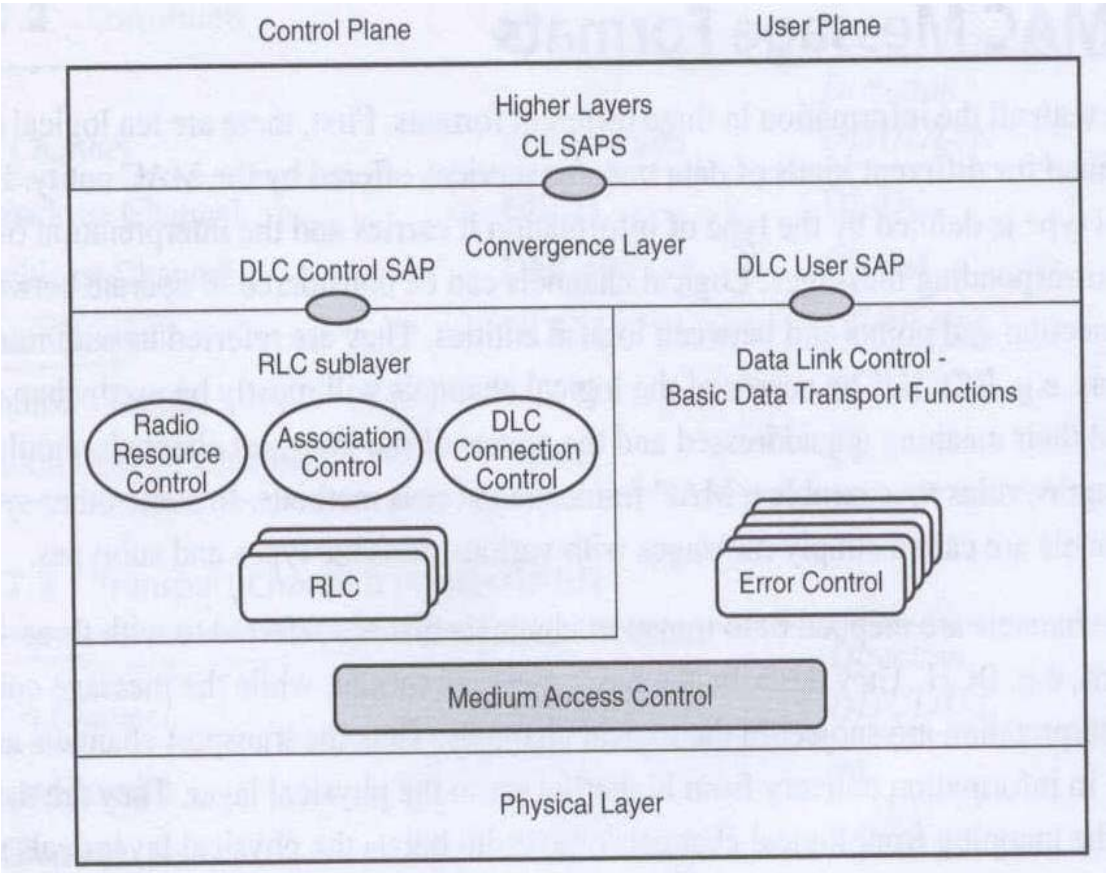
- Preamble Structure

- Nine repetitions of short sequence in the beginning
  - Signal Detection, AGC convergence, Diversity resolution, Timing estimation, Coarse frequency estimation
- Two repetitions of long sequence with Guard Interval
  - Fine frequency estimation, Channel Estimation



HiperLAN/2 -Data Link Control Layer 1/2

- The DLC layer is the logical link between an AP and the MTs. It contains three layers:
  - Medium Access Control (MAC) protocol
  - Radio Link Control (RLC) protocol (also known as RCP) with the associated signaling entities:
    - DLC Connection Control
    - Radio Resource Control (RRC)
    - Association Control Function (ACF)
  - Error Control (EC) protocol (or Logical Link Control, LLC)



HiperLAN/2 – Data Link Control Layer 2/2

- Data-link layer in HiperLAN/2 is connection-oriented differentiating it from other wireless LANs
  - Before a Mobile Terminal transmits data the Data-link layer communicates with the AP in the signaling plane to set-up a temporary connection
    - This allows the negotiation of QoS parameters like bandwidth & delay requirements
    - Assures that other terminals will not interfere with subsequent transmissions

HiperLAN/2 –QoS

- QoS parameters include
  - Bandwidth, bit error rate, latency, jitter
- HiperLAN/2 implements QoS through time slots
  - Original request by a mobile terminal made to send data uses specific time slots allocated for random access
  - Collisions from other mobile terminals can occur in this random-access channel
    - Since messages are brief, this is not a problem

MAC in Different WLAN standards

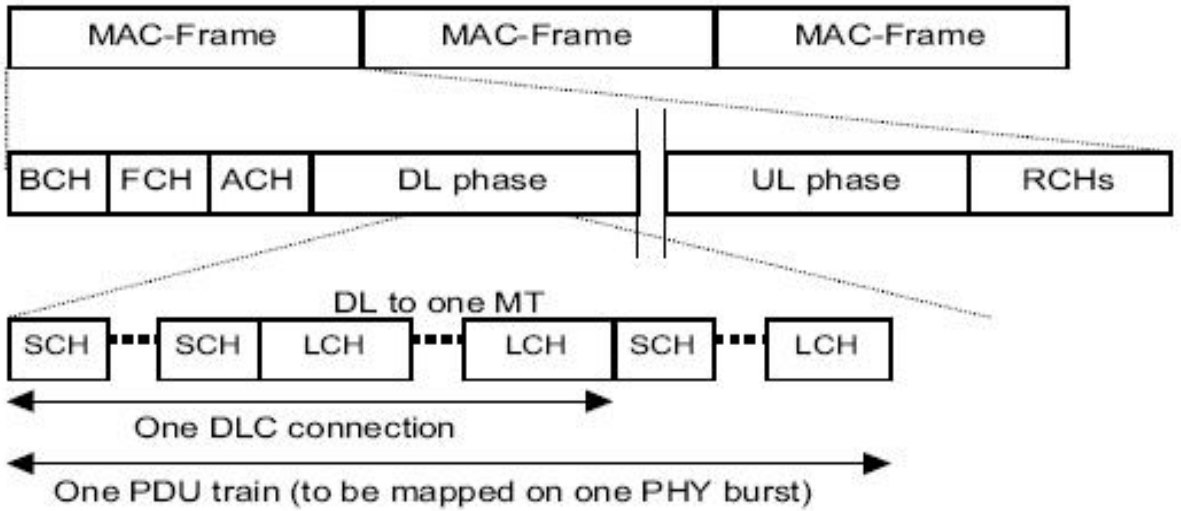
- IEEE 802.11a uses a distributed MAC based on CSMA/CA (Carrier Sense MultiAccess with Collision Avoidance)
- HiperLAN/2 (from ETSI) uses a central and scheduled MAC based wireless asynchronous transfer mode (ATM)
- MMAC supports both of them.

HiperLAN/2 MAC

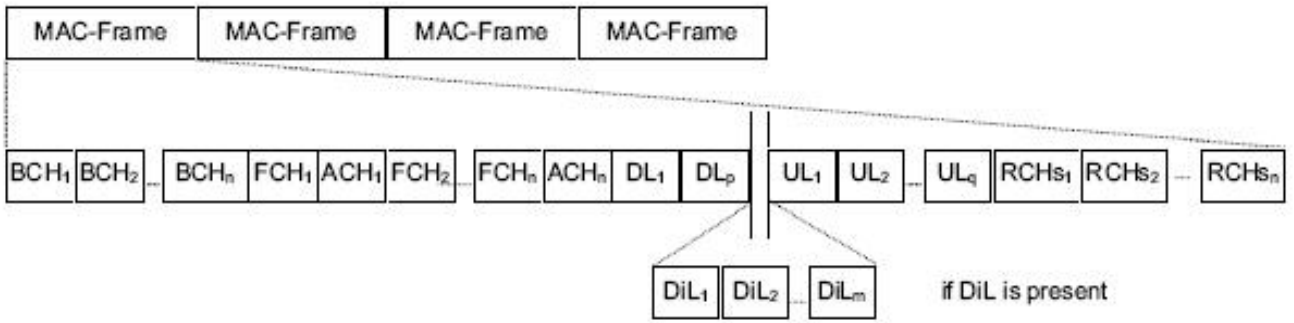
- Supports AT to MT unicast/multicast as well as MT to MT peer-to-peer transmissions
- AP's centralized scheduling (not specified yet ?)
  - – Resource allocation to MT
  - – Dynamic resource distribution to up- and down-links
  - – Could consider QoS and link adaptation
  - – Provision for collision free transmission
- Random access scheme
  - – Defines association/deassociation
  - – Random access from mobile uses slotted ALOHA with exponential backoff and ACK at next frame

Basic MAC Frame Structure

- A single sector system



- A multiple sectors system



Logical Channel

- Logical and Transport channels are used to construct MAC frame
- A generic term for any distinct data path which describes a specific data transfer service offered by the MAC entity
- Defined by the type of information it carries and the interpretation of the value in the corresponding messages
- There are ten logical channels

Logical channel

Logical Channel	Abbreviation	Direction DL/UL/DiL
Broadcast Control Channel	BCCH	DL
Frame Control Channel	FCCH	DL
Random Access Feedback Channel	RFCH	DL
RLC Broadcast Channel	RBCH	DUDiL
Dedicated Control Channel	DCCH	DL/UUDiL
User Broadcast Channel	UBCH	DUDiL
User Multicast Channel	UMCH	DL/DiL
User Data Channel	UDCH	DL/UL/DiL
Link Control Channel	LCCH	DUVUDiL
Association Control Channel	ASCH	UL

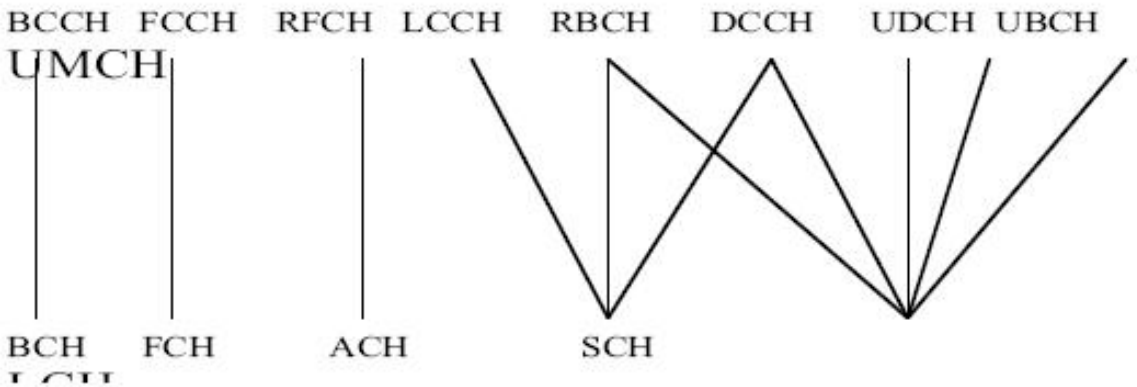
Transport Channel

Logical channels are mapped onto different transport channels which describe the basic message format and are the basic elements for constructing message sequence of each user.

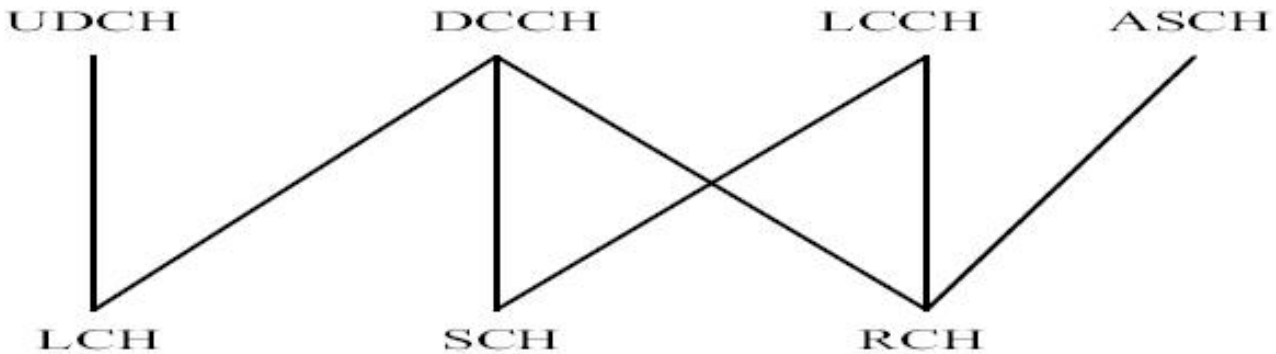
Transport Channel	Abbre	Direction	Explanation
Broadcast Channel	BCH	DL	carries BCCH transmitted once per MAC frame per sector antenna
Frame Channel	FCH	DL	used in downlink for carrying FCCH with variable amount of data
Access feedback Channel	ACH	DL	used in downlink for transporting RFCH
Long Transport Channel	LCH	DL/UL/DiL	used for transporting user data and control information
Short Channel	SCH	DL/UL/DiL	used for transporting short control information
Random Channel	RCH	UL	used in uplink for transmitting resource request or association request

Logical and Transport Channels Mapping

- Downlink



- Uplink



Packet Data Units (PDU) Trains

- PDU trains represent the interface between MAC and PHY, they consist of a sequence of transport channels.
- There are six types of PDU trains:
  - Broadcast PDU train
  - FCH-and-ACH PDU train
  - Downlink with short preamble PDU train
  - Uplink with short preamble PDU train
  - Uplink with long preamble PDU train
  - Direct link PDU train

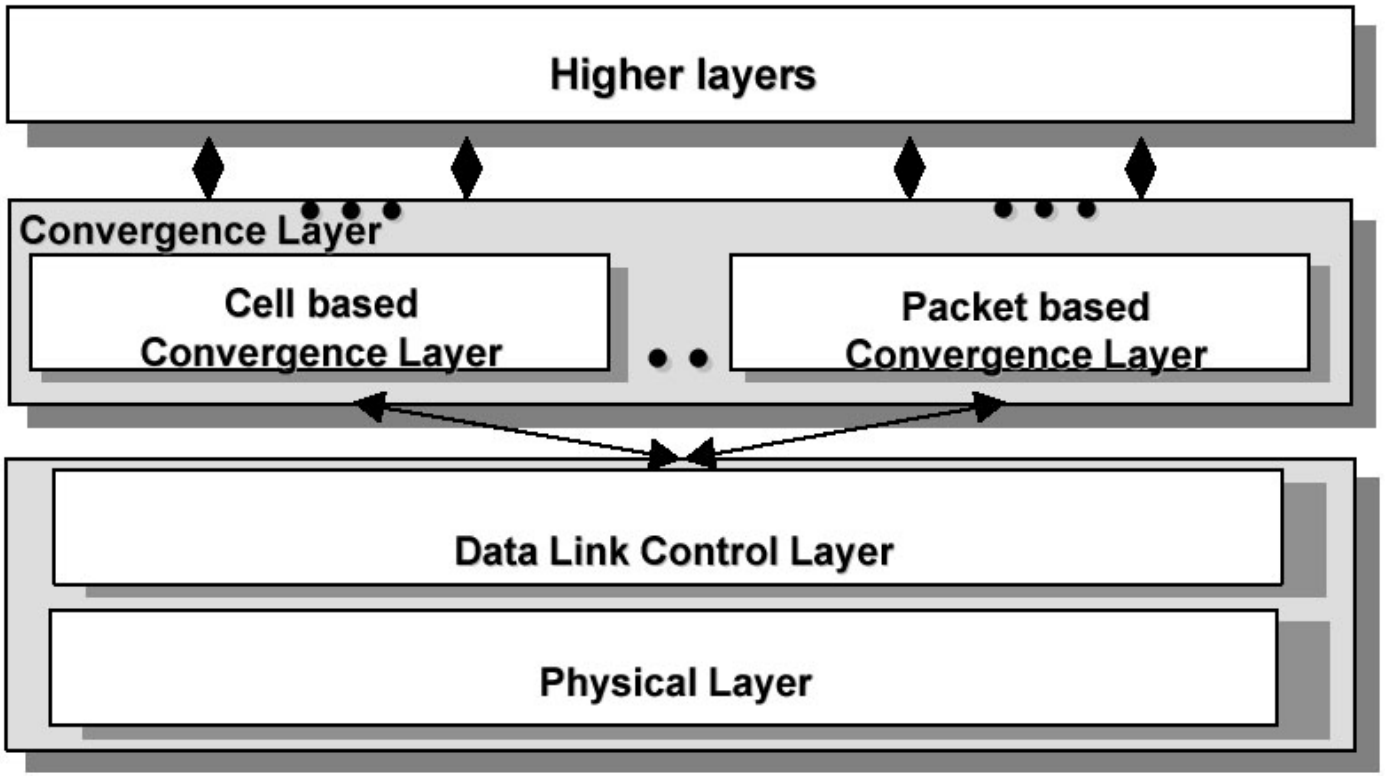
DLC - Error Control

- Link Adaptation
  - Code rate and modulation alphabet adaptive to current propagation and interference environments
  - 7 physical layer modes (modulation alphabet and code rate combinations)
- Automatic Repeat Request (ARQ)
  - Selective repeat
  - Discarding capability
    - efficient for real time applications
  - Short MAC frame allows re-transmission even for voice (2 ms)
- Forward Error Correction
  - Based on a Reed Solomon at a DLC PDU level
  - Using interleaving
  - Discard corrupted data

DLC: Radio Link Control

- Connection handling
  - Setup / release of DLC connections
  - Peer-to-peer (ad-hoc)
  - Multicast
- Security
  - Authentication
  - Encryption key distribution
  - Alternative security negotiation
- Management functions
  - Mobility
    - Association / de-association
    - Handover
    - Location update
  - Radio resource management
    - Dynamic frequency selection
  - Power management
    - Sleep mode
    - uplink and downlink power control

Convergence Layer



Converting the packets from DLC layer to Higher Layer and Vise Versa.

- Cell Based CL: for interconnection to ATM networks
- Packet Based CL: in a variety of configurations depending on fixed network type

Abbreviation

- AP: Access Points
- AGC: Automatic Gain Control
- ATM: Asynchronous Transfer Mode
- BRAN: Broadband Radio Access Networks
- DLC: Data Link Control
- MAC: Medium Access Control
- PDU: Packet Data Units
- RLC: Radio Link Control
- OFDM: Orthogonal Frequency Division Multiplexing
- TDMA/TDD: Time Division Multiple Access/Time Division Duplexing

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Question

- General description for MAC in HiperLAN/2.