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HIPERLAN -

HIgh PErformance Radio
Local Area Network

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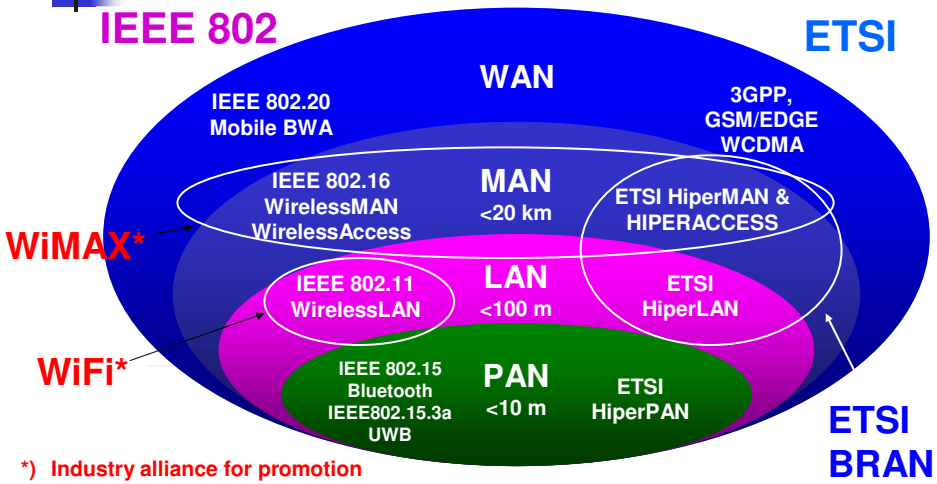
Introduction: Wireless Technologies



*) Industry alliance for promotion and certification

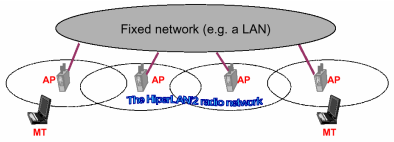
Introduction: Standards for Wireless LANs

Terms: Wireless = radio (infrared, ultrasound or laser) + **LAN (Local Area Network):**
- Purpose: data communication in a spatially limited environment; refer to transmission range that stride across about 100 meters
- Replacement of cabling; the node is replaced by an AP and the radio channel is shared between all terminals and the AP
- Data rates (> 1 Mbit/s)
- Usual use in an office or a building
- Increased flexibility and mobility of devices compared to wired LANs

Main standard families for Wireless LAN:
- **U.S. (IEEE 802.11):**
  - IEEE802.11 originally developed for 2.4 GHz with bit rates up to 2 Mbps (now up to 20Mbps), published in 1996
  - New physical layer in 5 GHz band with increased data rates up to 54Mbps (802.11a)
- **Europe (ETSI Project BRAN = Broadband Radio Access Networks)**
  - Hiperlan (Hiperlan Type 1, Type 2, HiperAccess, HiperLink, similar to 802.11):
    - HIPERLAN1 in 5 GHz developed by RES10 & being maintained by BRAN, data rate 20Mbps
    - HIPERLAN2 in 5 GHz and 17 GHz, data rates up to 54Mbps/155Mbps
      - The first phase (support of business applications) ready in 1999
      - The second phase (support of home applications) ready in early 2000
- **Japan (MMAC = Multimedia Mobile Access Communication)**
  - High-Speed WirelessAccess and Ultra High-Speed Radio LAN:
    - Three standards for high speed applications in 5 GHz
      - a 802.11a like system
      - a HIPERLAN2 like system
      - a system for wireless home applications

The Physical Layer functions of all three standardisation activities have been harmonised and are almost identical.

Introduction: System example with infrastructure



In HIPERLAN/2, the Access Points (AP) take over central tasks and serve as an access to the wired network. They have a wired as well as a wireless interface.

The coverage area of an AP and its associated terminals is called radio cell. In the case of IEEE 802.11, it is called a basic service set, in Bluetooth a scatternet.

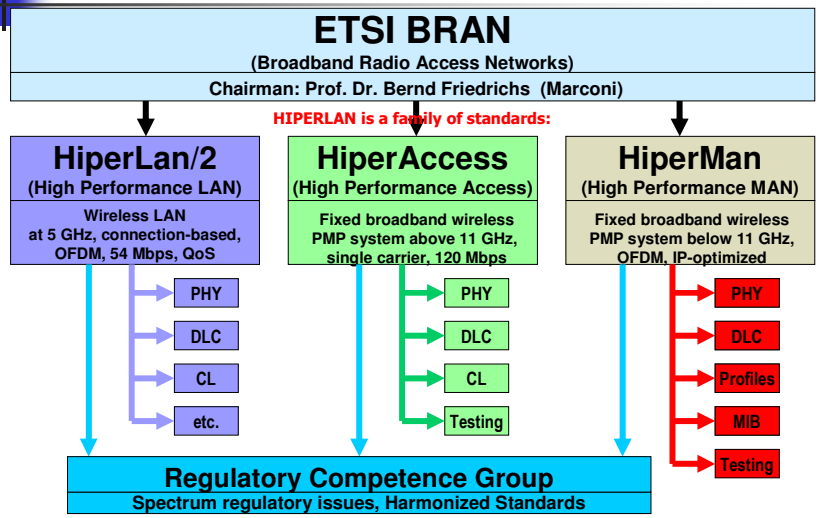
Radio network types:
- Independent networks (networks separated by space or frequency)
- Overlapping networks (same or different frequency)

ETSI EP BRAN (www.etsi.org/bran)

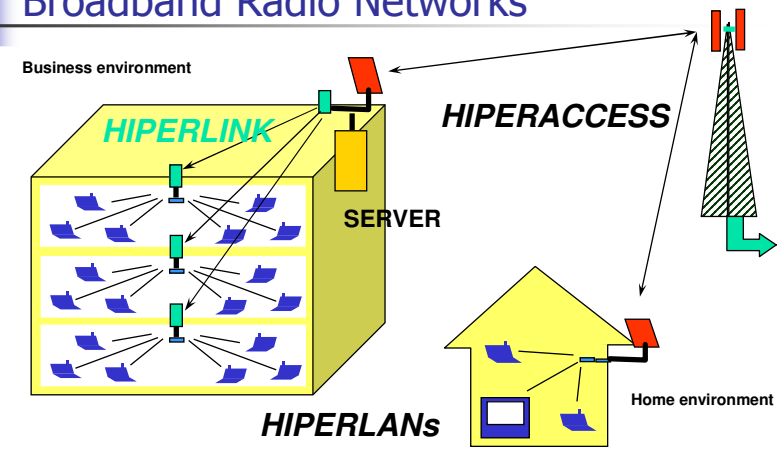
European Telecommunications Standards Institute Project (ETSI EP)
Broadband Radio Access Networks (BRAN)

- successor for former RES10 (Radio Equipment and Systems) and TM4
- established in 1997
- formed in response to growing market pressure for low-cost, high capacity broadband radio systems
  - to develop interoperable standards, independent of existing infrastructures
  - to develop standards and specifications for short range broadband radio access systems (HIPERLAN type 2) with portable or slowly moving terminals that cover a wide range of applications and are intended for different frequency bands. This range of applications covers systems for licensed and license exempt use.
    - for both business and residential environments
  - to develop standards for broadband fixed radio access systems (HIPERACCESS). Fixed wireless access (FWA) systems are intended as high performance (QoS, spectral efficiency), easy to set up, competitive alternatives for wire-based access systems.
  - to support both asynchronous data and time critical services with acceptable QoS
- assists (via ETSI ERM RM) regulatory bodies to define spectrum requirements and radio conformance specifications for new broadband radio networks
- co-ordinates standard development work
  - with core network fora as IETF, ATM Forum, etc.
  - with peer fora as ETSI-UMTS, 3GPP, IEEE, MMAC, etc.

TC BRAN Structure / BRAN Standards



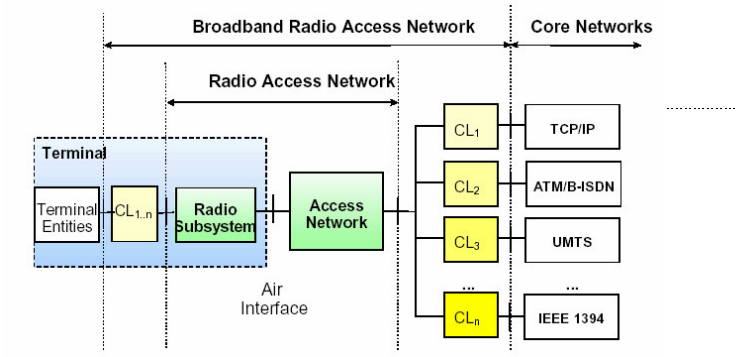
Broadband Radio Networks



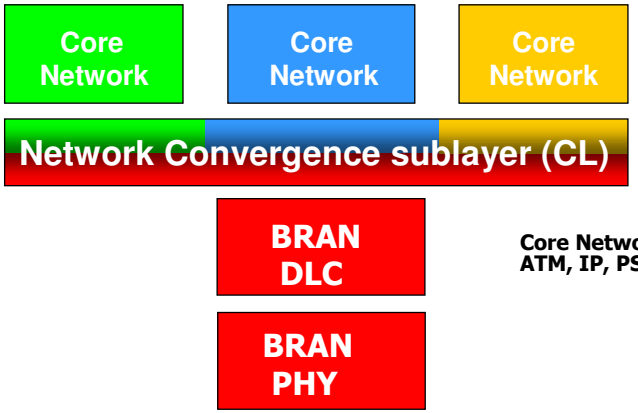
- ***HIPERLAN***

BRAN Reference Model

The basic approach taken by EP BRAN is to standardize only the radio access network and some of the convergence layer functions to different core networks. The core network specific functions are left to the corresponding fora (e.g., ATM Forum, IETF and other ETSI projects).



BRAN Basic Approach



- **Independence:** DLC and PHY layers are independent of the core network!
- **Layered model:** Network convergence sub-layer as superset of all requirements for e.g. IP and ATM.

BRAN External Relations

- Wireless Broadband industry needs GLOBAL standards -> Drive costs down!!!
- ETSI BRAN supports harmonization efforts with other parallel standardization bodies.

IEEE-SA 802.xx (US); especially 802.11 and 802.16

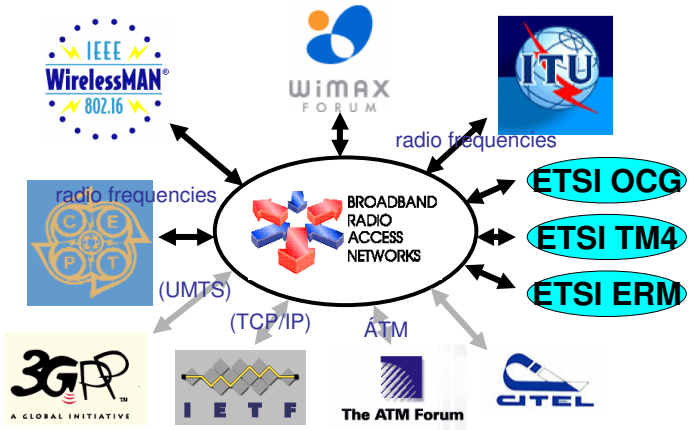
IEEE 802.11a ~ BRAN HL (same PHY layer)

IEEE 802.16+ ~ BRAN HA (harmonization under discussion)

IEEE 802.16a ~ BRAN HM (close co-operation)

MMAC-PC (Japan)

H2GF (HiperLAN/2 Global Forum)



BRAN Technology alliances

Technology alliances:

- HIPERLAN/2 Global Forum (H2GF, http://www.hiperlan2.com) is an open industry forum, a consortium of 50+ companies. It is the commercial counterpart to the standardisation in ETSI. It is a socalled "critical mass generating organisation" that shall pave the way for the market success of HIPERLAN/2.
  - Launched September 1999
  - Marketing and education
  - Interoperability on system level
  - Protect and harmonize spectrum worldwide

Purpose: to promote HiperLAN2 as a global standard with complete interoperability of high-speed wireless LAN products, in order to accelerate its use in business (both private and public) and consumer industries.
Mission statement: drive the adoption of HiperLAN2 as the globally accepted, broadband wireless technology in the 5GHz band, providing connectivity for mobile devices in corporate, public and home environments.

- OFDM Forum (www.ofdm-forum.com): OFDM is the cornerstone technology for high-speed wireless LAN such as HiperLAN.

Industry backers:
Texas Instruments, Dell, Bosch, Ericsson, Nokia, Telia, Xircom…

ETSI BRAN Standards: HiperLAN/1

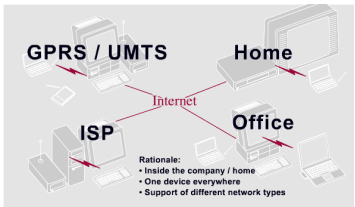
- RLAN standard (ETSI RES10: EN300 652) standardized since 1996
- indoor LAN standard
- provides communications up to 20 Mbps in the 5GHz range
- compatible with wired LANs based on Ethernet and Token Ring standards
- mobility < 10m/s, user mobility supported within the local service area only
- provide ranges up to 50m using omni-directional antenna, connections
  - multi-point-to-multi-point
  - ad-hoc, infrastructure networks
- multimedia application are possible
- distributed MAC protocol, limited QoS support through prioritisation phase
- no commercial success – no products!

ETSI BRAN Standards: HiperLAN/2

- Official name: BRAN HIPERLAN Type 2; H/2, HIPERLAN/2 also used
- Next generation of HiperLAN family, higher speed Wireless LAN: finished activity since 2002.
- Goal: Providing high-speed (data rates from 6 Mbit/s up to 54 Mbit/s, PHY layer) communications access to different broadband core networks and moving terminals; for short range (< 200 m) wireless access to "very" high rate applications
- Radio sub-system specifications (physical layer, data link control layer and convergence layer)
  - Interoperability standard with conformance test specifications
- Original idea was to be compatible with ATM (Asynchronous Transfer Mode)
  - Generic architecture - Core network independent with QoS support (provide interworking with several core networks)
    - Packet based convergence layer for Ethernet and IEEE 1394 networks
    - Cell based convergence layer for ATM networks
- For Business, Public and Home environments
  - Indoor usage
  - Complementary access mechanism in hot spot areas for public mobile network systems
- 5 GHz technology
- Provide transmission ranges of 50-100m using omni-directional antenna
- Mobility < 10m/s, user mobility supported within the local service area only
- Features: high-speed transmission, connection-oriented DLC with QoS (bandwidth reservation, collision avoidance) per connection, robust to errors (ARQ, FEC), automatic frequency allocation (plug-and-play radio network using DFS), security support (authentication & encryption), mobility support, network& application independent, power save
- Close work with IEEE802.11 and MMAC-PC (Japan) to develop a global 5GHz radio; physical layer is aligned with IEEE 802.11a & MMAC
  - HiperLAN2 differs: MAC layer, PHY layer packet formats, offered services (QoS, real time etc.)

ETSI BRAN Standards: HiperLAN/2

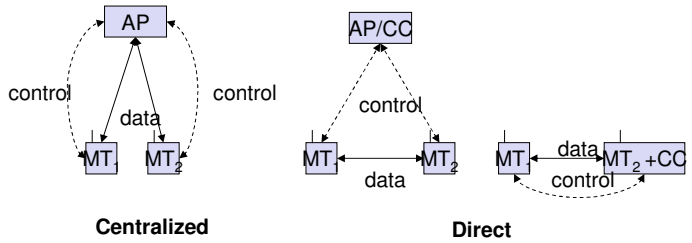
- Affordable technology; low-cost and flexible networking is supported to interconnect wireless digital consumer devices
- HIPERLAN/2 can be used virtually everywhere:
  - office: use case as wired LANs
  - home: ad hoc capability can be added and the network serves as the connection between all kinds of devices, such as video, cameras, TVs and HiFi sets; multimedia applications, real time video services, HiperTV (web browsing), TVBanking (online banking)
  - applied as public networks. Due to the low transmission power allowed, the range will be restricted to app. 50m per AP. Therefore HIPERLAN may be used to cover hot spot areas, such as airports, train stations or fair grounds, where a critical requirement for high speed data communication is met. One can even imagine to have access to an ISP (Internet Service Provider) in some areas.
- In all places mentioned, the same device can be used. It might be the case that in different networks different authentication schemes are being used, e.g. an authentication identifier in a company network, a SIM card in public networks or a far more simple mechanism at home.
- First products released at the end of 2001
- Globally available but not widely used worldwide



HiperLAN/2 modes of operation

Two modes of communications:
- Business environment
- Home environment

Two modes of operation:
- Centralized mode: used to operate HIPERLAN/2 as an access network via a fixed access point.
- Direct mode: used to operate HIPERLAN/2 as an adhoc network without relying on a cellular network infrastructure.



ETSI BRAN Standards: HiperAccess

- **HIPERLAN 3:** Outdoor Broadband Access
- designed for fixed outdoor use to provide access to wired infrastructure
- high speed (25 Mbit/s typical data rate) fixed radio access to customer premises
- allow an operator to rapidly roll out a wide area broadband access network to provide connections to residential households and small businesses.
  - fixed radio links to customers (Wireless Local Loop (WLL) to cover "last mile"), alternative to xDSL or cable modem, point-to-multipoint with directional antenna, quick installation
- can be operated in either licensed or license exempted spectrum (short range)
  - BRAN is not considering the use of HIPERACCESS in the 5 GHz band. Main bands: 40,5 - 43,5 GHz and 31,8 - 33,4 GHz; also: 27,5 - 29,5 GHz and 24,5 - 26,5 GHz.
  - long range up to 5 km
- capable of supporting multi-media applications (other technologies such as HIPERLAN/2 might be used for distribution within the premises)
- supports 3G, ATM and IP networks
- products exist with 155 Mbit/s plus QoS

ETSI BRAN Standards: HiperLINK

- **HIPERLAN 4**
- provides very high speed radio links for static interconnections
  - intermediate link up to 155 Mbit/s data rate
  - provide a fixed point-to-point connection with directional antenna
- connection of HIPERLAN access points or connection between HIPERACCESS nodes
- operation frequency is 17 GHz (17,1 - 17,3 GHz) with radius of tranmission range of 150m, license exempt
- designed for indoor radio backbones
- capable of multi-media applications

HiperLAN/2 Features 1

- **High speed transmission**
  - Using OFDM (physical layer), dynamic TDMA/TDD-based (MAC protocol)
    - 54Mbit/s (physical layer), 35Mbit/s (network layer)
    - OFDM is particularly efficient in time-dispersive environments, i.e. where the radio signals are reflected from many points, e.g. in offices.
- **Connection oriented**
  - Negotiate QoS parameters
  - Time-division-multipoint connection
  - Dedicated Broadcast channel (through which the traffic from an AP reaches all terminals)
- **QoS support**; QoS implemented through time slots
  - Simplistic scheme: only using priorities
  - Specific QoS (parameters: bandwidth, delay, jitter, bit error rate)
    - The original request by a MT to send data uses specific time slots that are allocated for random access.
    - AP grants access by allocating specific time slots for a specific duration in transport channels. The MT then sends data without interruption from other MT operating on that frequency.
    - A control channel provides feedback to the sender.

HiperLAN/2 Features 2

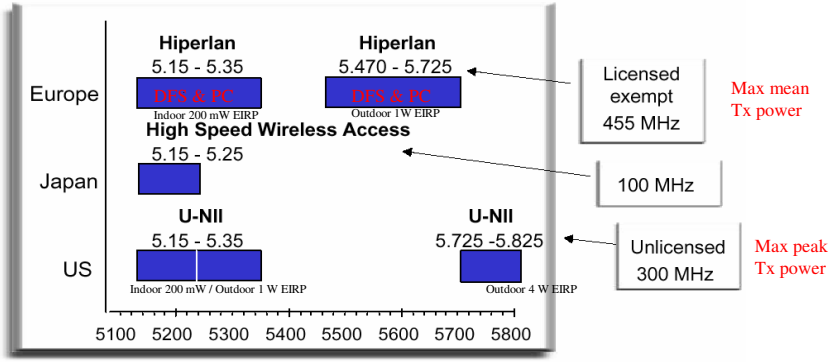
- **Dynamic frequency selection (DFS)**
  - Access points
    - Built-in support: automatically selects an appropriate frequency within their coverage area
    - All APs listen to neighboring APs as well as to other radio sources
    - Best frequency is chosen depending on the current interface level and usage of radio channels
  - No frequency planning required
- **Security support**
  - Strong encryption/authentication
  - Mobile terminal and access point can authenticate each other
  - Additional functions are needed to support authentication
    - Directory services, key exchange schemes
  - All user traffic can be encrypted using DES (56 to 168 bit key encryption), Triple-DES, AES, optional pre-shared or public-key authentication
    - To protect against eavesdropping or man-in-the-middle attacks
    - Each communicating node is given a HIPERLAN ID (HID) and a Node ID (NID). The combination of these two IDs uniquely identifies any station, and restricts the way it can connect to other HIPERLAN nodes. All nodes with the same HID can communicate with each other using a dynamic routing mechanism denoted Intra-HIPERLAN Forwarding.

HiperLAN/2 Features 3

- **Mobility support**
  - Handover scheme is MT initiated, i.e. the MT uses the AP with the best signal as measured for instance by S/N-ratio, and as the user moves around, all established connections move to the AP with the best radio transmission performance, while the MT stays associated to the HIPERLAN/2 network; handover between access points is performed automatically
  - All connections including their QoS parameters will be supported by a net access point after handover
- **Network and application independent**
  - Convergence layers for Ethernet, IEEE 1394, ATM, 3G
  - Interoperation with 3G networks is supported
    - Best effort data is supported
    - Wireless connection
- **Power save modes**
  - Low power consumption by using uplink power control, downlink power setting, sleep mode
    - Based on MT-initiated negotiation sleep periods: short latency requirement, low power requirements
    - Wake-up patterns

Spectrum Allocation at 5 GHz

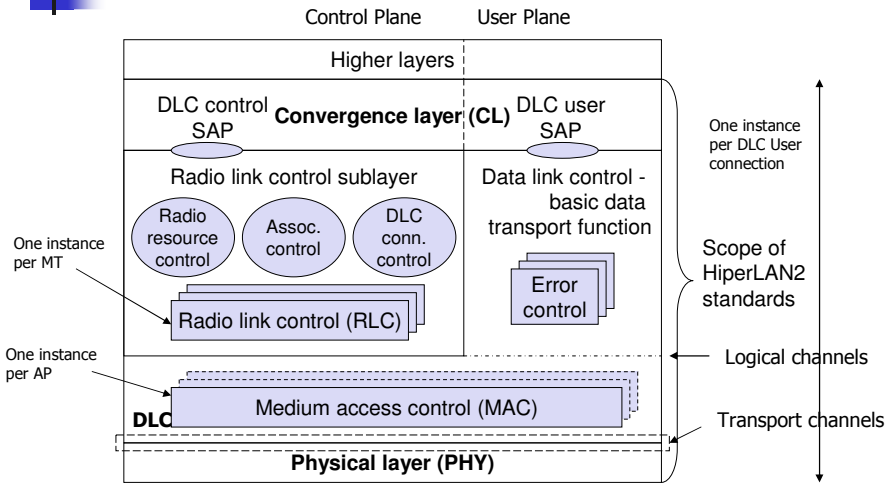
HIPERLAN/2 systems are intended to be operated as private or public systems making use of the 5 GHz frequency range. Specific bands have been assigned to this type of system in Europe by the CEPT (HIPERLAN bands) and in the US by the FCC (U-NII bands).



U-NII: Unlicensed National Information Infrastructure
(FCC: R7O 97-6 on /NII Band Devices)

DFS: Dynamic Frequency Selection
PC: Power Control

HiperLAN/2 protocol stack



HiperLan/2 Physical Layer (PHY)

The PHY layer is responsible to transform bits in the transmitter into analog waveforms and estimates the bits in the transmitter from the received signal. The HIPERLAN/2 PHY specification defines only the transmitting side, even if the receiver was considered during the standardisation process.

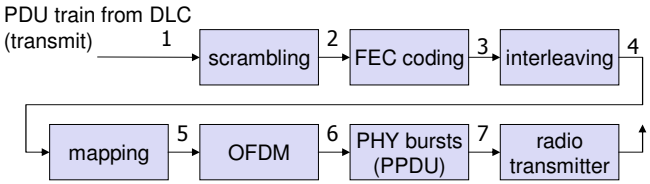
Functions related to modulation, forward error correction, signal detection, synchronization:

- Add a preamble to enable synchronisation in the receiver
- Scrambling, interleaving, channel coding, modulation
  - Scrambling is done to randomise the signal dynamics of the transmit signal and, hence, the distortion due to the nonlinear high power amplifier.
  - Interleaving is strongly connected with channel coding.
  - Channel coding shall enable the receiver to restore bits that have been received with errors: modulation allocates a point in the complex plane for a number of bits which determines the phase and amplitude of some analogue carrier.
- Upconversion and filtering make sure that the signal is transmitted in the correct frequency band.
- Reverse operations are done in the receiver with an additional synchronisation and channel estimation.
- Error control operates on a per-DLC connection basis.

Physical layer reference configuration

The PHY layer offers information transfer services to the DLC. It provides for functions to map different DLC PDU trains into framing formats called PHY bursts appropriate for transmitting and receiving management and user information between an AP/CC and an MT in the centralized mode or between two MTs in the direct mode.

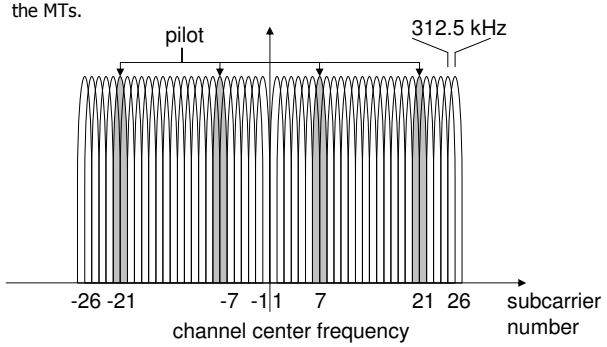
- Data units on physical layer: Burst of variable length, consist of a preamble and a data field.
- Encoding: Involves the serial sequencing of data, as well as FEC.



1: information bits 2: scrambled bits 3: encoded bits 4: interleaved bits
5: sub-carrier symbols 6: complex baseband OFDM symbols 7: PHY bursts

Physical Layer: OFDM in HiperLAN/2 (and IEEE 802.11a)

- Channeling is implemented by OFDM due to its excellent performance on highly dispersive channels.
- Basic idea of OFDM is to transmit data rate information by dividing the data into several interleaved, parallel bit streams, and let each bit stream modulate a separate subcarrier.
- Channel spacing is 20 MHz; 52 subcarriers/channel (48 subcarriers for data + 4 pilot - subcarriers tracking the phase for coherent demodulation)
- Independent frequency subchannels are used for one transmission link between the AP and the MTs.



Physical layer modes

Key feature: Flexible transmission modes

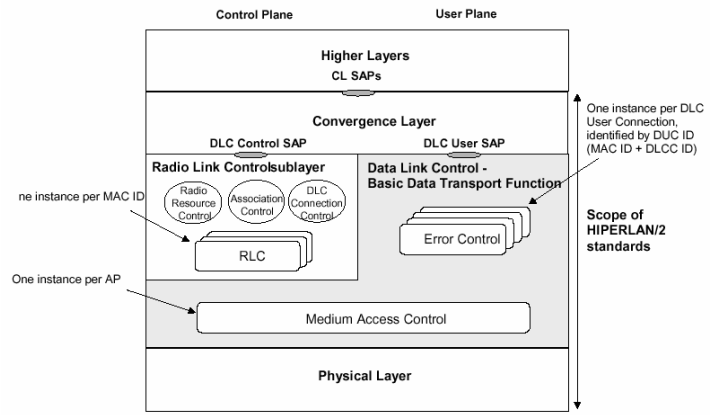
- With different coding rates and modulation schemes
- Modes are selected by link adaptation
- BPSK, QPSK as well as 16QAM (64QAM) supported

OFDM provides flexibility considering the realization of different modulation alternatives.

Mode	Modulation	Code rate	PHY bit rate	bytes/OFDM
1	BPSK	1/2	6 Mbps	3.0
2	BPSK	3/4	9 Mbps	4.5
3	QPSK	1/2	12 Mbps	6.0
4	QPSK	3/4	18 Mbps	9.0
5	16QAM	9/16	27 Mbps	13.5
6	16QAM	3/4	36 Mbps	18.0
7	64QAM	3/4	54 Mbps	27.0

PHY modes defined for HIPERLAN/2.

HiperLAN/2 Data Link Control Layer (DLC)



HiperLAN/2 Data Link Control Layer (DLC)

- Data transport and control functions:
  - Data transport functions (User part):
    - Medium Access Control (MAC) and transmission, Error control (EC or LLC, Automatic Repeat Request)
  - Control functions (Control part):
    - Radio Link Control Protocol (RLC, also known as RCP) with the associated signalling entities: DCC, RRC, ACF.
- Connection-oriented:
  - provides e.g. its own connection setup protocol which is required in order to make it independent from the higher layers. An interoperation between higher layer control and H/2 control functions is not specified but recommended in the standard.
  - after completing association, a mobile terminal may request one or several DLC connections, with one unique DLC address corresponding to each DLC connection, thus providing different QoS for each connection.
- AP comprises several APTs; each APT requires an own MAC instance
- MAC of an AP; assigns each MT a certain capacity to guarantee connection quality depending on available resources

Data Link Control Layer functions

RCP	Radio link Control Protocol	Most control functions in the DLC layer (CC part of an AP). Provides following functions:
DCC (or DUCC)	DLC (User) Connection Control	In charge of DLC connection control, e.g. connection setup and release of user connections, modification, connection monitoring, multicast and broadcast
RRC	Radio Resource Control	In charge of radio resource handling: dynamic frequency selection, channel monitoring, mobile terminal alive/absent, power control, power saving, link adaptation, multibeam antennas, channel selection, handover between APs and within an AP etc.
ACF	Association Control Function	In charge of authentication of new MTs, key management, association, disassociation, encryption, synchronization of the radio cell via beacons.
MAC	Medium Access Control	Is used for access to the medium (the radio link) i.e. to get as much capacity on the air interface as currently required. In charge of sharing of the capacity of the radio link among different MTs and connections. The master scheduling is located in AP (The control is centralized to the AP which inform the MTs, when they are allowed to send data). The air interface is based on time-division duplex (TDD) and dynamic time-division multiple access (TDMA), which allows for simultaneous communication in both downlink and uplink within the same time frame, i.e. the MAC frame.
LLC	Logical Link Control	Provides means to scope with the unreliable radio link by means of error detection and retransmission protocol.

DLC: Radio Link Control (RLC)

The RLC is a transport protocol for the exchange of control information on DLC level

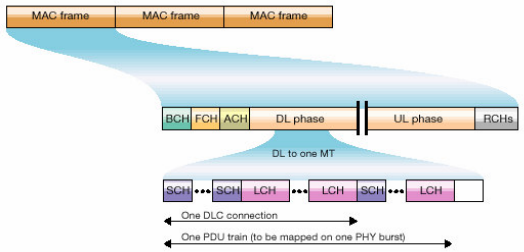
- The functions on top of the RLC are not normative
- The RLC provides a transport service for RLC messages and handles the correct message exchange
  - Assembling of outgoing messages
  - Syntax check of arriving messages
  - Supervision of timers
- The RRC, ACF and DCC trigger and evaluate message exchanges
- The standard contains only a specification for the RLC. The functions were assumed to be there during the specification process but are not normative.
- They need to be developed by each manufacturer and will contain the intelligence that is required to assemble all the informations that need to be put into RLC messages, and to evaluate them on the receiving side. Moreover, the functions determine the time when a certain message exchange is started.

DLC: MAC Layer

- MAC in different WLAN standards
  - IEEE 802.11a uses a distributed MAC based on CSMA/CA (Carrier Sense MultiAccess with Collision Avoidance)
  - HiperLAN/2 uses a central and scheduled MAC based wireless asynchronous transfer mode (ATM)
  - MMAC supports both of them
- MAC protocol defines message formats and rules for the coordinated access to the channel
- MAC scheduler at AP
  - Centralized control
    - Resource requests from terminals
    - Resource grants from Access Point (AP)
  - Supports uniform traffic load
- TDD - TDMA
- Up and Down link slots allocated dynamically based on need
- Data (up/down) transmitted in dedicated slots
- Contention allowed in random access slots

MAC Frame Structure

- Basic frame structure (one-sector antenna)



The MAC frame format consists of 4 elements: Broadcast Channel (BCH), Down Link (DL), Up Link (UL), and Random Access (RA).

Except for the broadcast control, the duration of the fields is dynamically adapted to the current traffic situation.

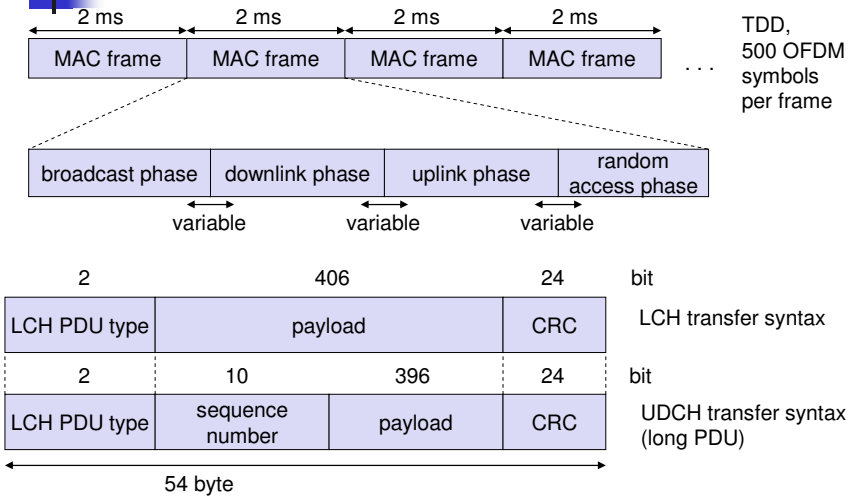
The whole DLC is based on scheduling efficiently MAC frame.

The MAC frame and the transport channels form the interface between the DLC and the PHY.

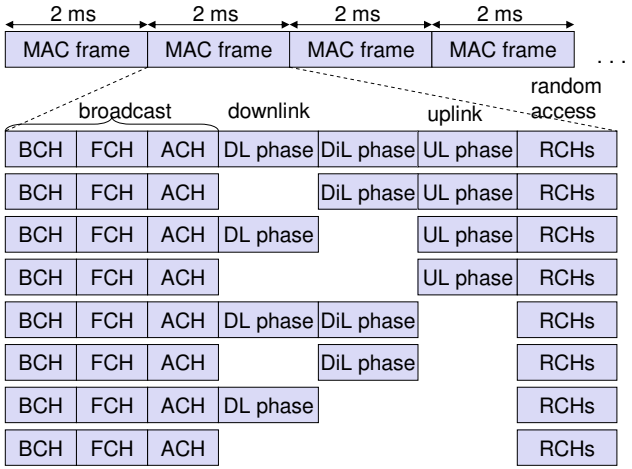
BCH (broadcast channel): enables control of radio resources, miscellaneous header
FCH (frequency channel): details how the DL and UL phases will be allocated
ACH (access feedback channel): feedback on which resource requests were received at random access
RCH: random access resource request

- Multibeam antennas (sectors) up to 8 beams supported
- A connection-oriented approach, QoS guaranteed

Basic structure of HiperLAN2 MAC frames



Valid configurations of HiperLAN2 MAC frames



Valid combinations of MAC frames for a single sector AP

Logical Channel

- Logical and Transport channels are used to construct a 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:

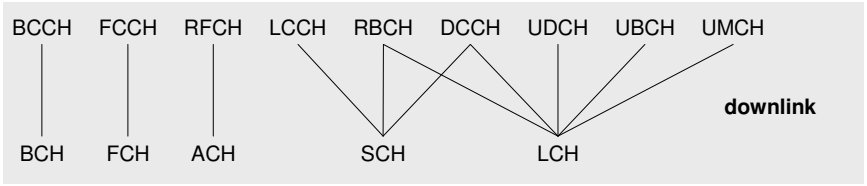
Logical Channel	Abbreviation	Direction DL/UL/DiL
Broadcast Control Channel	BCCH	DL
Frame Control Channel	FCCH	DL
Random Access Feedback Channel	RFCH	DL
RLC Broadcast Channel	RBCH	DUDiL
Dedicated Control Channel	DCCH	DL/UUDiL
User Broadcast Channel	UBCH	DUDiL
User Multicast Channel	UMCH	DL/DiL
User Data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

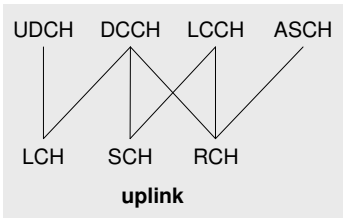
Transport Channel

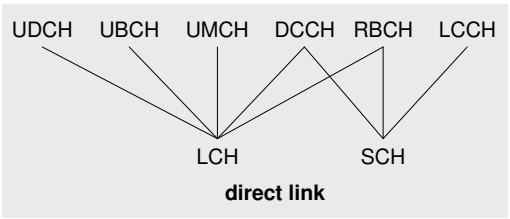
- Logical channels are mapped onto different transport channels which describe the basic message format and are the basic elements for constructing message sequence of each user.

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

Mapping of logical and transport channels







DLC: Error Control (EC)

- Task of EC is to **make sure that packets can be delivered in sequence to the receiving Convergence Layer**
  - Add a sequence number and a CRC (Cyclic redundancy check) in the transmitter
  - Perform error detection in the receiver, request retransmission of erroneous packets
- Operating on a per-DLC connection basis
- Using coding rates of 1/2, 2/3 of ¾
- Acknowledged mode
  - Selective repeat ARQ
  - For user data
- Repetition mode
  - Reliable transmission by repeating data packets
  - Typically used for broadcast
- Unacknowledged mode
  - Unreliable, low latency
  - For user data

DLC: Other features

- QoS support: Appropriate error control mode selected; Scheduling performed at MAC level; link adaptation; internal functions (admission, congestion control, and dropping mechanisms) for avoiding overload

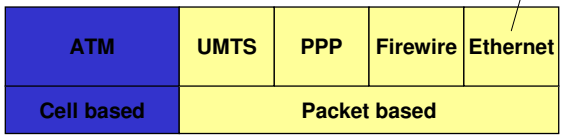
HiperLan/2 Convergence Layer (CL)

- Adapts service requests from higher layers to the services offered by the DLC layer and converts the higher layer packets (SDUs) into a fixed size used within the DLC. -> This function makes it possible to implement DLC and PHY that are independent of the fixed network to which the HIPERLAN/2 network is connected.
  - Adaptation of data format of higher layer to the format the DLC requires:
    - The DLC accepts packets of 49.5 bytes length
    - In the case of packet networks: Segmentation and Reassembly
    - In the case of ATM: Header Compression
  - Acceptance and Delivery of control information from and to the RLC
- Currently two types of CLs defined:
  - cell based; intended for interconnection to ATM networks
  - packet based; used in a variety of configurations depending on fixed network type

HiperLan/2 Convergence Layer (CL)

- Multiple convergence layers
- One single convergence layer active at a time
- Mapping between higher layer connections/priorities and DLC connections/priorities

- **Segmentation and re-assembly to / from 48 bytes packets**
- **Priority mapping from IEEE 802.1p**
- **Address mapping from IEEE 802**
- **Multicast & broadcast handling**
- **Flexible amount of QoS classes**



HiperLAN Security

- Defines an optional encryption-decryption scheme
  - All HiperLAN MAC –entities use a common set of shared keys (HIPERLAN key-set)
    - Each has a unique key identifier
  - Plain text is ciphered by XOR operation with random sequence generated by a confidential algorithm
    - Uses the secret key and an initialization vector sent in every MPDU (MAC Protocol Data Unit) as input
- „Data Encryption Standard" - DES and 3DES

HiperLAN/2 Further issues

- Management Information Base (MIB) for SNMP (Simple Network Management Protocol). SNMP is a protocol which was defined by the IETF and which is broadly used in IP networks. The MIB defines objects which have attributes. Simplified, an object may be a parameter, such as the frequency channels that may be used, and an attribute may be that this channel may be used or not.
- Conformance Test Specifications for CLs, DLC and PHY, which shall ensure that products from different manufacturers do interoperate.
- Home Extension with direct communication between terminals. The most important feature introduced there is the direct communication between terminals, without need to pass the packets via the AP.

The specifications define only what is necessary to achieve interoperability. This means that almost no algorithms have been specified but almost exclusively protocols, i.e. messages, their interpretation and rules for the message exchange sequences. Only at very few places, such as the EC and for random access, algorithms have been specified. The physical layer document defines only the sender side of the PHY. Note also that the interfaces between layers are not formally standardised but only for information.

SUMMARY: HiperLan

	Hiperlan 1	**Hiperlan2**	**HiperAccess**	**HiperLink**
Description	Wireless Ethernet	Wireless ATM	Wireless Local Loop	Wireless Point-to-Point
Environment	Indoor	Indoor	Outdoor	Indoor/Outdoor
Freq. Range	5GHz	5GHz	5GHz	17GHz
PHY Bit Rate	23.5Mbps	6~54Mbps	~25Mbps	~155Mbps
Transmission Range	50m	50m	5km	150m

Comparison of IEEE 802.11 and HiperLan/2

- Wireless Networks in Europa: WLAN, HiperLAN, Bluetooth..
  - No world-wide standard, although harmonization between standards exist
- Main competitor: IEEE 802.11 Family
  - 802.11b vs. HiperLAN Type 1
  - 802.11a vs. HiperLAN Type 2
  - 802.11 is the most frequently used solution for wireless connection, widely accepted standard; very strong distribution on the market
- Pros
  - High rate with QoS support: Suitable for data and multimedia app.
  - Security mechanism
  - Flexibility: different fixed network support, link adaptation, dynamic frequency selection…
- Cons
  - High cost
  - Tedious protocol specification
  - Limited outdoor mobility
  - No commercial success
- Future?

Comparison of IEEE 802.11 and HiperLan/2

	802.11	**802.11b**	**802.11a**	**HiperLAN2**
Spectrum (GHz)	2.4	2.4	5	5
Max PHY rate (Mbps)	2	11	54	54
Max data rate, layer 3 (Mbps)	1.2	5	32	32
MAC (network topology)	CS	CSMA/CA	CSMA/CA	Central resource control/TDMA/TDD
Connectivity	Conn.-less	Conn.-less	Conn.-less	Conn.-oriented
Multicast	Yes	Yes	Yes	Yes
QoS	PCF (Point Control Function)	PCF/ 802.11(e)	PCF/ 802.11(e)	ATM/802.1p/RSVP/Diff Serv (full control)
Frequency selection	Frequency-hopping or DSSS	DSSS	Single carrier	Single carrier with Dynamic Frequency Selection
Authentication	No	No	No	NAI/IEEE address/X.509

Comparison of IEEE 802.11 and HiperLan/2

	802.11	**802.11b**	**802.11a**	**HiperLAN2**
Encryption/Security	40-bit RC4	40-bit RC4	40-bit RC4 and 802.11(e)	DES, 3DES
Handover support	No	No	No	Specified by H2GF
Fixed Network Support	Ethernet	Ethernet	Ethernet	Ethernet, IP, ATM, UMTS, FireWire (IEEE 1394), PPP
Management	802.11 MIB	802.11 MIB	802.11 MIB	HiperLAN/2 MIB
Radio link quality control	No	No	No	Link adaptation

HIPERLAN related abbreviations

3G 3rd generation (UMTS)
3GPP 3rd Generation Partnership Project
ACF Association Control Function
ACH Access feedback Channel
AES Advanced Encryption Standard
AP Access Point
ARQ Automatic Repeat Request
ATM Asynchronous Transfer Mode
BCCH Broadcast Control CHannel
BCH Broadcast Channel
B-ISDN Broadband Integrated Services Digital Network
BPSK Binary Phase Shift Keying
BRAN Broadband Radio Access Network
BWA Broadband Wireless Access
CC Central Controller
CEPT European Conference of Postal and Telecommunications Administrations
CL Convergence Layer
CRC Cyclic Redundancy Check
CSMA/CA Carrier Sense MultiAccess with Collision Avoidance
DCC DLC Connection Control
DES Data Encryption Standard
DFS Dynamic Frequency Selection
DiL Direct Link
DL Downlink
DLC Data Link Control
DSSS Direct-Sequence Spread Spectrum
DUCC DLC (User) Connection Control
DUC ID DLC User Connection ID
EC Error Control
EDGE Enhanced Data rates for GSM Evolution
EIRP Equivalent Isotropic Radiated Power
EP ETSI Project
ETSI European Telecommunications Standards Institute
ETSI ERM RM ETSI Committee on EMC and Radio Spectrum Matters, Working Group for Radio Matters
ETSI OCG Operational Co-ordination Group
ETSI TM4 Technical Committee TM (Transmission & Multiplexing)
FCC Federal Communications Commission (USA)
FCCH Frame Control CHannel
FCH Frequency Channel
FEC Forward Error Correction
FWA Fixed Wireless Access
GPRS General Packet Radio Service
GSM Global System for Mobile Communications
H/2 HiperLAN Type 2
H2GF HIPERLAN/2 Global Forum
HA HiperAccess
HID HIPERLAN ID
HIPERLAN HIgh PErformance Radio Local Area Network
HL HiperLAN
HM HiperMAN
IEEE Institute of Electrical and Electronics Engineers
IEEE-SA Standards Association
IETF Internet Engineering Task Force
IP Internet Protocol
ISP Internet Service Provider
ITU International Telecommunications Union
LAN Local Area Network
LCH Long Transport CHannel
LLC Logical Link Control

HIPERLAN related abbreviations

MAC Medium Access Control
MAN Metropolitan Area Network
MIB Management Information Base
MMAC Multimedia Mobile Access Communication
MMAC-PC Promotion Council
MT Mobile Terminal
NID Node ID
OFDM Orthogonal Frequency Division Multiplexing
PAN Personal Area Network
PC Power Control
PCF Point Control Function
PDU Protocol Data Unit
PHY Physical Layer
PPDU PLCP Protocol Data Unit
PPP Point to Point Protocol
PSTN Public Switched Telephone Network
QAM Quadrature Amplitude Modulation
QoS Quality of Service
QPSK Quadrature Phase Shift Keying
RA Random Access
RC4 Rivest Cipher 4
RCH Random access Channel
RCP Radio link Control Protocol
RES10 Radio Equipment and Systems
RLAN Radio LAN
RLC Radio Link Control
RRC Radio Resource Control
RSVP Resource ReSerVation Protocol
SAP Service Access Point
SCH Short CHannel
SDU Service Data Unit
SIM Subscriber Identity Module
SNMP Simple Network Management Protocol
S/N Signal to Noise Ratio
TC Technical Committee
TCP Transmission Control Protocol
TDD Time Division Duplex
TDMA Time Division Multiple Access
TS Technical Specification
UMTS Universal Mobile Telecommunication System
U-NII: Unlicensed National Information Infrastructure
UL Uplink
UWB Ultra-wideband
WAN Wide Area Network
WCDMA Wideband Code Division Multiple Access
WiFi Wireless Fidelity
WiMAX Worldwide Interoperability for Microwave Access
WLAN Wireless LAN
WLL Wireless Local Loop
xDSL Digital Subscriber Line

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Homework

- Short description of HiperLAN/2 handover scenarios: Sector HO, Radio HO, and Network HO