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Technical Report

**Broadband Radio Access Networks (BRAN);
Functional Requirements for Fixed Wireless Access
systems below 11 GHz: HIPERMAN**

Reference
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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Project Broadband Radio Access Networks (BRAN).

Introduction

The ETSI Broadband Radio Access Networks Project (EP-BRAN) is concerned with:

- Broadband fixed radio access systems called HIPERACCESS;
- Broadband radio local area networks (HIPERLANs); and
- Broadband network-to-network point-to-point radio systems (HIPERLINK).

The present document describes the functional requirements for fixed wireless access systems below 11 GHz, as well as an analysis of the suitability of existing ETSI BRAN standards. The requirements are applicable to HIgh PErformance Radio Metropolitan Area Networks (HIPERMAN).

The present document describes the technologies and techniques that are considered applicable to development of normative specifications for BRAN.

Technical Reports are informative documents resulting from ETSI studies, which are not appropriate for Technical Specification (TS), ETSI Standard (ES) or European Standard (EN) status.

A TR may be used to publish material which is either of an informative nature, relating to the use or application of TSs, ESs or ENs, or which is immature and not yet suitable for formal adoption as a standard.

Being a TR, the present document is not normative. However, vocabulary normally associated with normative documents (including such words as "shall", "must", "may") has been used to minimize the editorial work should the present document be used as the basis for a subsequent Technical Specification (TS) and to emphasize the relative importance of the requirements.

1 Scope

The present document outlines and defines the functional requirements for an interoperable broadband fixed wireless access system operating at radio frequencies between 2 GHz and 11 GHz.

The air interface will be optimized for PMP configurations, but may allow for flexible mesh deployments. It aims to establish whether there is a need for a separate BRAN standard for such systems or whether the existing or proposed HIPERACCESS and/or HIPERLAN2 standards adequately address this sector. It provides requirements for modifications to existing standard(s) or development of an appropriate new standard serving access networks with frequencies below 11 GHz.

For the purposes of the present document, a "system" constitutes the PHY and DLC layers, which are core network independent, and the core network specific Convergence sublayer. It should be noted that to specify a complete system, other specifications, e.g. for the Network layer and higher layers are required. These specifications are assumed to be available or to be developed by other bodies. The implementation includes at least one subscriber unit that communicates with a base station via an interoperable radio air interface, the interfaces to external networks, and services transported by the DLC and PHY protocol layers. So, "functional requirements" describes the properties of typical systems in terms of how they affect requirements of the interoperable standard. The functional requirements describe the system and requirements in broad terms: what they are, but not how they work. The "how part" (i.e. the implementation) would be left to any forthcoming interoperability standard.

2 References

For the purposes of this Technical Report (TR) the following references apply:

[1] ETSI TR 101 177 V1.1.1 (1998): "Broadband Radio Networks (BRAN); Requirements and architectures for broadband fixed radio access networks (HIPERACCESS)".

NOTE: TR 101 177 has served as a base line and platform for the present document.

[2] ETSI TR 101 683 V1.1.1 (2000): "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; System Overview".

[3] IEEE 802.16.3-00/02r: "Functional Requirements for the 802.16.3 Interoperability Standard (2000-04-29), Draft".

[4] CEPT/ERC/REC 13-04: "Preferred frequency bands for fixed wireless access in the frequency range between 3 to 29.5 GHz".

[5] CEPT T/R 13-01 (1993): "Preferred channel arrangements for fixed services in the range 1-3 GHz".

[6] ITU-R Recommendation F.701-2: "Radio-frequency channel arrangements for analogue and digital point-to-multipoint radio systems operating in frequency bands in the range 1 350 to 2 690 GHz (1.5, 1.8, 2.0, 2.2, 2.4 and 2.6 GHz)".

[7] CEPT/ERC/REC 12-05: "Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10.0 - 10.68 GHz".

[8] CEPT/ERC/REC 12-08: "Harmonised radio frequency channel arrangements and block allocations for low, medium and high capacity systems in the band 3600 MHz to 4200 MHz".

[9] CEPT/ERC/REC 14-03: Harmonised radio frequency channel arrangements for low and medium capacity systems in the band 3400 MHz to 3600 MHz.

[10] ETSI ETS 300 019-1-1: "Equipment Engineering (EE), Environmental conditions and environmental tests for telecommunications equipment, Part 1-1:, Classification of environmental conditions; Storage".

[11] ETSI EN 301 489-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements".

[12] ETSI ETS 300 385: "Radio Equipment and Systems (RES); ElectroMagnetic Compatibility (EMC) standard for digital fixed radio links and ancillary equipment with data rates at around 2 Mbit/s and above".

[13] ETSI EN 300 386-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Telecommunication network equipment; ElectroMagnetic Compatibility (EMC) requirements; Part 2: Product family standard".

[14] ETSI EN 301 753: "Fixed Radio Systems; Point-to-Multipoint equipments and antennas; Generic harmonized standard for Point-to-Multipoint digital fixed radio systems and antennas covering the essential requirements under Article 3.2 of the Directive 1999/5/EC".

[15] ETSI EN 301 021: "Fixed Radio Systems; Point-to-multipoint equipment; Time Division Multiple Access (TDMA); Point-to-Multipoint digital radio systems in frequency bands in the range 3 GHz to 11 GHz".

[16] ETSI EG 201 212: "Electrical safety; Classification of interfaces for equipment to be connected to telecommunication networks".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

local access: short range (< 100 m) wireless access to other, possibly wired, networks
This term is used in the telecommunications sense.

remote access: long range (< 10 km) wireless access to other, possibly wired, networks
Remote access networks are also referred to as "local loop networks". This term is used in the telecommunications sense.

Data Link Control (DLC): layer 2 of the ISO/OSI reference model

subscriber: a subscriber means one connected via a HIPERMAN network

Physical Layer (PHY): layer 1 of the ISO/OSI reference model

system: network independent PHY and DLC layer plus one or more core network specific Convergence sublayers

sector: APT in conjunction with an antenna with a 3 dB beam width less than 360°
Typically a number of sectors are co-located, and may share one controller to minimize self-interference. A co-located set of sectors is generally deployed as base-station.

Base Station (BS): network device with direct access to the core network

repeater: device consisting of at most a pair of systems, which solely consists for the purpose of retransmitting the received information
A repeater lacks convergence layers and layers above. Two types of repeaters are recognized; one type, which with minimum delay, directly passes the signal from the RX chain to the TX chain in the PHY layer, and one type, which passes the received data through the DLC layer.

radio link: capability of multiple PHYs to exchange data

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AF	Assured Forwarding
AirI	Air Interface
AP	Access Point
APC	Access Point Controller
APT	Access Point Transceiver
AT	Access Terminal
ATM	Asynchronous Transfer Mode
BER	Bit Error Ratio
BFWA	Broadband Fixed Wireless Access
BRAN	Broadband Radio Access Networks
BES	Best Effort Service
BS	Base Station
CEPT	European Post and Telecommunications Consultative Committee
CL	Convergence Layer
DLC	Data Link Control (layer)
EF	Expedited Forwarding
EMC	ElectroMagnetic Compatibility
FDD	Frequency Division Duplex
FDDI	Fiber Distributed Data Interface
FS	Fixed Service
FSS	Fixed Satellite Service
FWA	Fixed Wireless Access
HIPERACCESS	HIgh PErformance Radio ACCESS networks
HIPERLAN	HIgh PErformance Radio Local Area Networks
HIPERMAN	HIgh PErformance Radio Metropolitan Access Networks
IETF	Internet Engineering Task Force
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
ITU	International Telecommunications Union
LAN	Local Area Network
LOS	Line Of Sight
MIB	Management Information Base
MPEG4	Motion Picture Experts Group type 4
MPLS	Multi-Protocol Label Switching
NLOS	Non Line Of Sight
NMS	Network Management System
OAM	Operations And Maintenance
ODU	OutDoor Unit
OLOS	Obstructed Line Of Sight
OSI	Open System Interconnect
PHY	PHYsical (layer)
PMP	Point-to-Multipoint
POTS	Plain Old Telephone Service
PPP	Point-to-Point Protocol
QAM	Quadrature Amplitude Modulation
QoS	Quality of service
PER	Packet Error Ratio
RF	Radio Frequency
RSVP	Resource ReSerVation Protocol
SLA	Service Level Agreement
SME	Small and Medium Enterprises
SNI	Service Node Interface
SOHO	Small Office/Home Office
SU	Subscriber Unit
TE	Terminal Equipment
TDD	Time Division Duplex

UNI	User Network Interface
USB	Universal Serial Bus
VoD	Video on Demand
xDSL	x (= generic) Digital Subscriber Line

4 Overview

This overview addresses the rationale for developing a separate standard for interoperable broadband fixed wireless access systems to operate at frequencies below 11 GHz. Although the scope of the current HIPERACCESS work item is not radio frequency specific, that work so far has addressed frequencies considerably higher than 11 GHz. It is intended that the present document allow broadband FWA systems to be developed that would compete with other technologies that are expected to be available in the years 2002 to 2005.

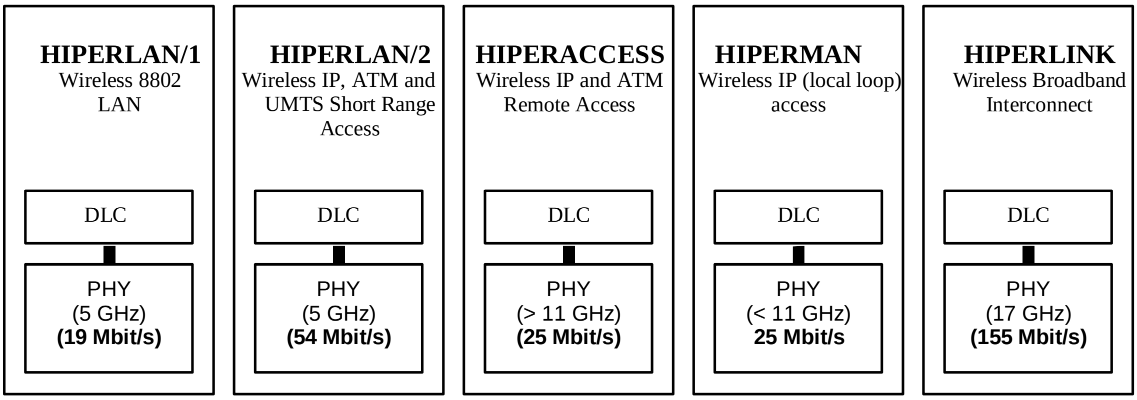

Figure 1: Positioning of HIPERMAN in BRAN standards

A HIPERMAN standard, for which the present document describes the system requirements, fits in the existing BRAN standardization efforts as shown in Figure 1. Although the final aim is principally the same as that of HIPERACCESS, namely providing fixed remote or local loop access, it differentiates itself in the market segments targeted, as well as in the spectrum utilized, since the HIPERACCESS standardization has focused entirely on solutions optimized for above 11 GHz bands.

HIPERMAN complements rather than duplicates the remaining HIPERACCESS efforts. Due to the distinctly different radio channel behaviour, which can be efficiently exploited to improve system performance, as well as the stringent conditions the system has to meet to enable a successful standard for the targeted market segments.

On the other hand, HIPERMAN is differentiated from HIPERLAN/2, in that the present document is principally optimized for indoor LAN usage although it is also used for very short-range outdoor adhoc access purposes. The link ranges required for HIPERMAN are significantly longer raising such important issues as propagation delay mitigation and delay spread tolerance. Further, HIPERLAN/2 addresses specifically the private network applications, whereas HIPERMAN provides access to public and private networks.

4.1 Target markets

Broadband fixed wireless access systems based on HIPERMAN are intended to compete with, and complement other broadband wired access systems, such as xDSL and cable modems. In this context "broadband" means peak rate "above 2 Mbit/s" to provide such services as data, voice and video.

The target markets to be addressed are residential (single family, as well as multitenant dwellings), SME and SOHO locations.

The critical parameters for serving these markets are the combination of cost, coverage and capacity factors. The cost factors are equipment costs, deployability, maintainability, costs associated with the SU installation, and the spectrum efficiency/reuse for economically serving the required number of customer locations with a minimum cost of infrastructure.

4.2 Application and Services

Broadband fixed wireless access (BFWA) networks should support a wide range of applications in use today and be extendable to support future services. The main user applications that can be foreseen today are as follows:

- Internet access;
- LAN bridging and Remote LAN access;
- video-telephony and video conferencing;
- real time video and audio (The degree to which it is economical to offer these services will depend on the required quality, spectrum availability, the economics of the HIPERMAN system and subscriber densities. Therefore these services are unlikely to be extensively supported and are not intended to be the killer applications.);
- computer gaming;
- telephony, voice-band modems and fax.

4.3 Features

The main features for HIPERMAN networks should be:

- User installable terminals.

  Truck-rolls to engineer SU installation pose an undue burden on service initialization. NLOS operation capability, which eases antenna installation, in combination with turnkey SU solutions, enables user installable terminals, which significantly cuts the deployment cost.

- Interoperable air interface.

  Most importantly, the standard should be written such that compliant devices have at least one narrowly well-defined mode, which assures at least interoperability of all compliant devices.

- Very rapid scalable infrastructure deployment.

  Time to market with new broadband services will be crucial for the success of new operators. Through deployment of an efficient new radio access system time-to-market for new services is reduced.

- Efficient spectrum usage.

  New broadband radio technologies have a very efficient use of spectrum, which will allow the operator to offer services requiring high peak bit rates.

- Modular cost-effective growth

  Radio can offer the possibility of selective access, investments not relying on multi-connections. Further it can reach where other technologies can not, where fibre is too expensive to deploy and where xDSL is not suitable. The system allows easy customer installation of SUs and is easily expanded. The radio systems are not subject to disturbance by civil works, which results in frequent interruption of services and in high on-going repair costs for a cabled network. Fiber is expensive to deploy. Copper is expensive to maintain. The main cost of radio access is in the equipment itself. This cost is quickly decreasing with the development of new technology in contrast to digging and maintenance costs. Using the bands below 11 GHz enables significantly less expensive RF solutions than are possible for HIPERACCESS.

  On the system architecture level, the rescalability is the essential factor. The system should allow easy customer installation of SUs and it should be easily expanded. Secondly, no single network topology is suitable for all the deployment scenarios of the presumed customers.

- The system provides packet-based services with QoS support.

All above-mentioned features can be summarized in four main factors, namely; Flexibility, Rapid Deployment, High Performance and Low Provisioning Cost.

4.4 Topologies and deployment Scenarios

This clause presents a high level description of a system model to be used as a framework for standards development.

The system shall support PMP topology and may support mesh topology. In PMP systems, all data traffic shall go through the base station that shall serve as a radio resource supervisor. In mesh systems all data traffic does not necessarily go through the base station(s) (e.g. direct routing is possible). In mesh systems, the base station shall serve as a global radio resource supervisor and SUs serve equally as local radio resource supervisors.

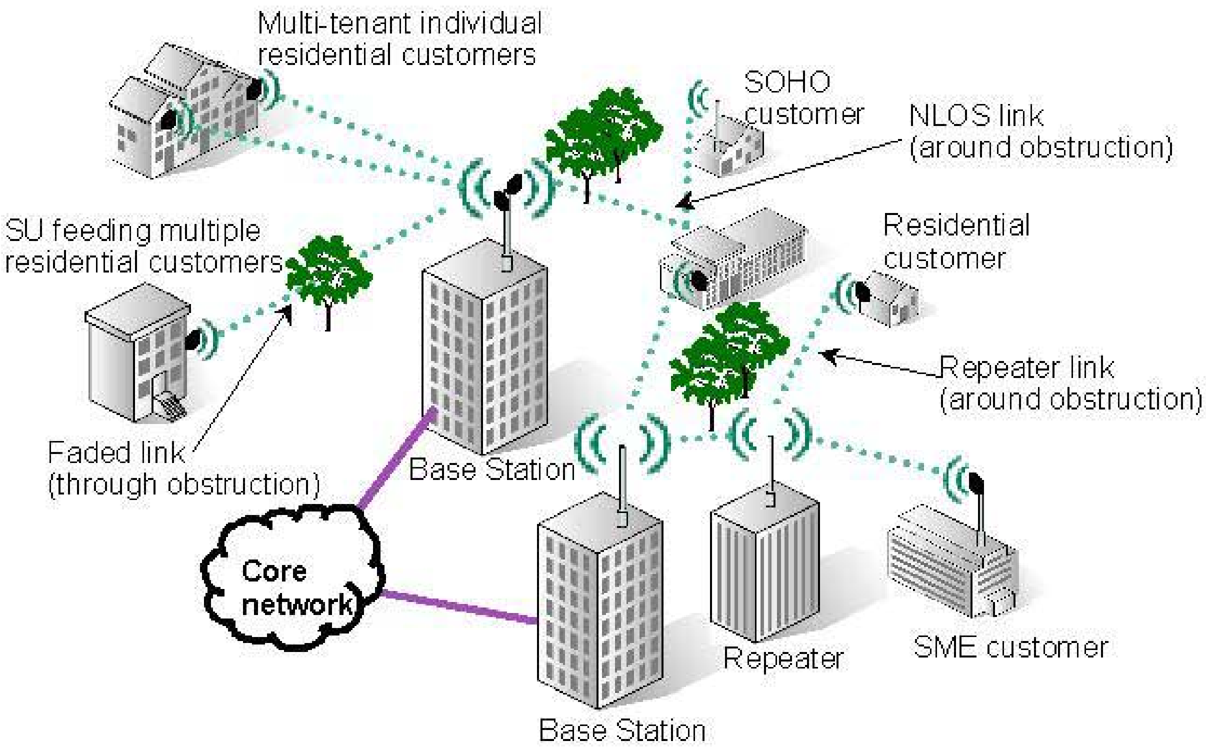

Figure 2: Example network deployment configuration based on mandatory PMP configuration

Figure 2 shows an example deployment configuration. The base station can serve individual buildings, multiple subscribers in multiple buildings (using multiple radio links), or multiple subscribers in a single building by use of a single radio link and further in-building distribution systems. It shows the use of an optional repeater and route diversity in order to provide extended coverage and coverage in difficult areas. This does not imply the use of these features in all systems.

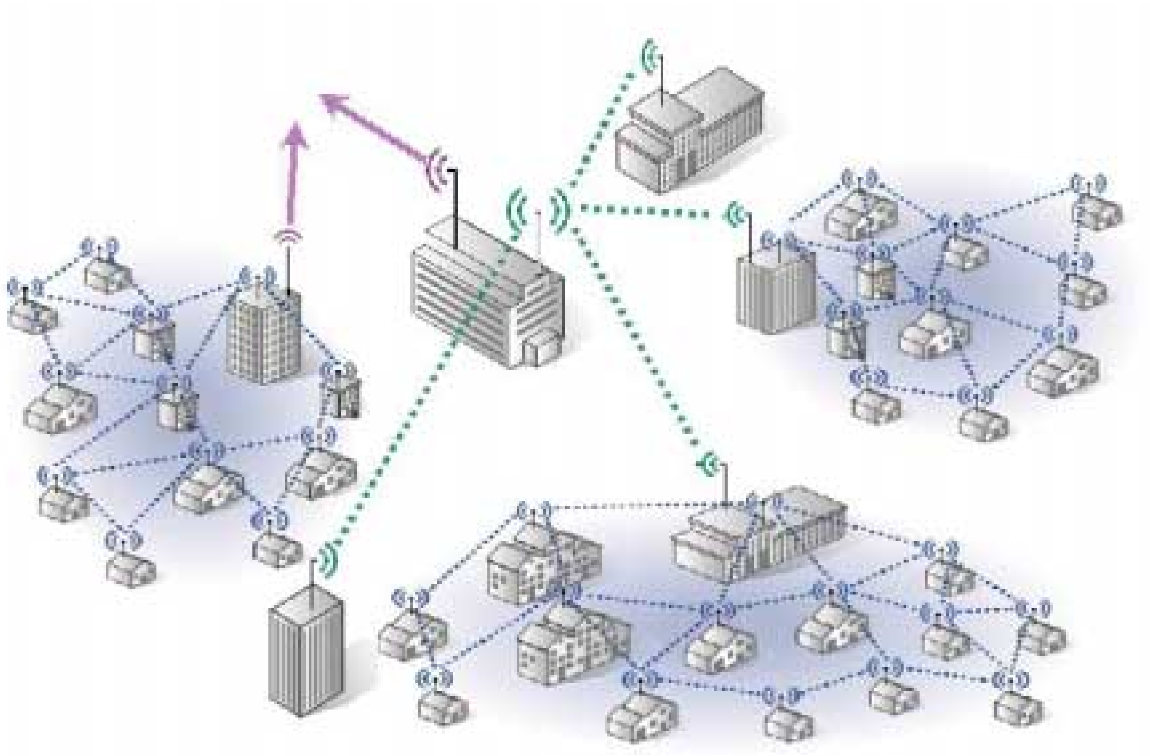

Figure 3: Example network deployment configuration based on optional mesh configuration

Figure 3 shows an example network configuration using both the PMP and optional mesh architecture in a two layer configuration using a Point-to-Point backhaul link.

4.4.1 Large Scale Deployments

To enable large-scale deployments efficiently, PHY and DLC protocols should permit good frequency reuse factors, providing at least 25 Mbit/s/sector. In order to reduce the interference level, the PHY and DLC protocols shall permit power control per subscriber up-link and should permit power control per subscriber downlink. The PHY and DLC protocols shall permit real-time changing of power levels, as function of propagation conditions, in order to use the minimum power needed for the target BER.

4.5 System Reference Model

This clause presents the system reference model to be used as a framework for developing a standard for HIPERMAN. The model describes the main functionalities of the system, and the terminology to be used by the ETSI/BRAN working group in the creation of the standard.

The following is a BFWA system reference model.

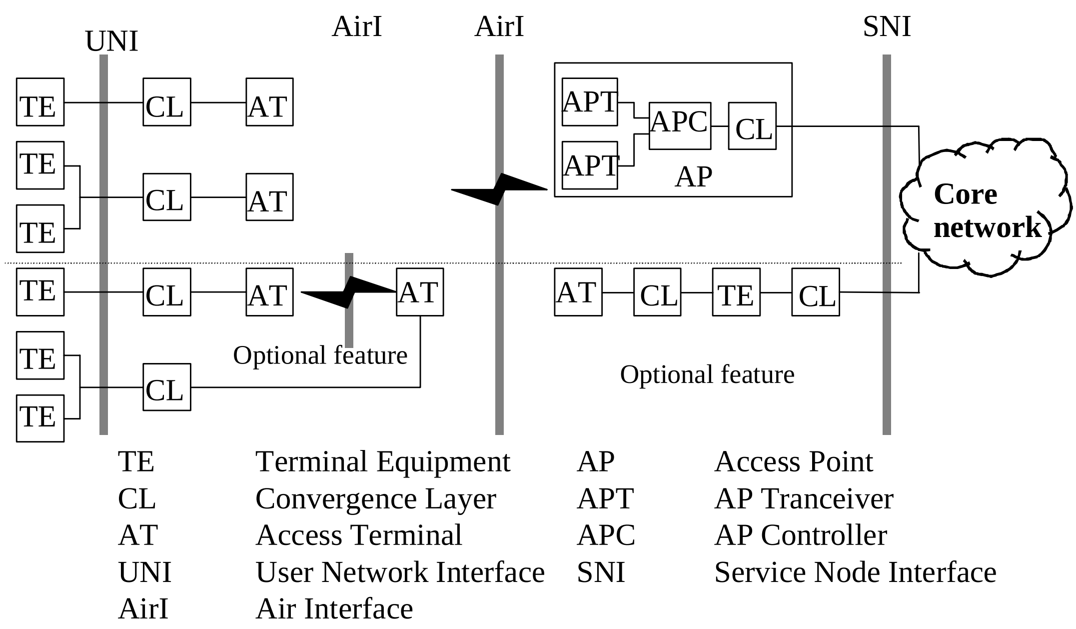

Figure 4: System Reference Model

A subscriber unit (SU) is defined in accordance with Figure 4 as encompassing at minimum the AT and one or more CLs (layer one and two in the ISO reference model), but can also include part of the TE.

A key word is "access". An HIPERMAN access system generally provides connectivity to a core network, and by itself is not intended to form an end-to-end communication system.

In the targeted frequency bands, radio communications can benefit significantly from the ability to operate under OLOS and NLOS conditions. Therefore, NLOS operation shall be supported. Due to the significant multipath propagation inherent in these bands, the system must be robust in adverse channel conditions. The system shall be bandwidth/spectrally efficient, both in single and multi-cell architectures.

To counter channel condition variations and maximize spectral efficiency, the system should be able to trade-off throughput with robustness.

The system should be able to support various convergence sublayers.

4.5.1 Interoperability

Protocols are the heart of the HIPERMAN standard that ought to provision interoperability of multiple vendors' equipment. Interoperability between HIPERMAN systems shall occur at the Air Interface (AirI).

4.6 Spectrum Considerations

4.6.1 Targeted Spectrum

The standard shall be optimized for radio systems in the frequency band 3,4 GHz to 4,2 GHz, but may be applicable to the range from 2 GHz to 11 GHz. (Bands around 2 GHz have been allocated for use by UMTS and will therefore not be available for use by FWA).

[4] identifies "at present a single common harmonized frequency band is not available" recommends that "frequency bands 3,400 GHz - 3,600 GHz, 10,15 GHz - 10,30/10,50 GHz - 10,65 GHz be identified as preferred bands for FWA applications within CEPT". (It also identifies further bands above 11 GHz, which are not within scope of this Report.) . Harmonized channel arrangements for PMP systems in these bands are recommended in [9] and [7]. Although frequencies between 3,6 GHz and 4,2 GHz are not amongst those currently recommended for FWA, CEPT has a Recommendation [8] for channel arrangements for the Fixed Service in that range, intended predominantly for point-to-point application. This recommendation also contains an annex for FWA use within the band 3,6 GHz - 3,8 GHz using either a 50 MHz or 100 MHz duplex spacing.

Such bands are currently occupied within the CEPT region in various ways, but typically they are shared between different systems and services. Some nations have recently deployed FWA services within parts of these bands. Although the Fixed Satellite Service (FSS) is allocated on a co-primary status with the Fixed Service (FS) in the ITU Radio Regulations for use in Region 1, within the bands 3,4 GHz - 3,6 GHz and 3,6 GHz - 4,2 GHz, and the use of these bands for FSS would constrain the development of FWA systems. There are also a large number of fixed point-to-point links deployed using a variety of frequency arrangements that are contained within ITU-R Recommendations in the band 3,6 GHz - 4,2 GHz. It should be demonstrated that the deployment of FWA systems of the FS can coexist with existing services.

Table 1: Existing and anticipated licensing opportunities for Fixed Wireless Access systems in some Countries which might be suitable for deployment of HIPERMAN

Country	Frequency bands licensed (or expected to be licensed) Fixed Wireless Access application
Australia	3,425 GHz - 3,750 GHz
Belgium	3,45 GHz - 3,60 GHz, 7 MHz, 100 MHz duplex spacing 10,15 GHz - 10,65 GHz, 14 MHz, 150 MHz duplex spacing
Denmark	3,41 GHz - 3,59 GHz, 26,5 MHz and 27 MHz, 100 MHz duplex spacing
Finland	3,41 GHz - 3,589 GHz, 19 MHz, 24 MHz and 28 MHz, 100 MHz duplex spacing
France	3,465 GHz - 3,595 GHz, 15 MHz, 100 MHz duplex spacing
Germany	2,54 MHz - 2,67 MHz 3,41 GHz -3,58 GHz, 14 MHz - 28 MHz, 100 MHz duplex spacing
Greece	3,41 GHz - 3,5975 GHz, 14 MHz - 28 MHz, 100 MHz duplex spacing
Sweden	3,40 GHz - 3,6 GHz (GHzconsideration until 4,20 GHz)
UK	Total of 2 x 17 MHz (3,425 GHz - 3,442 GHz paired with 3,475 GHz - 3,493 GHz) is currently under public consultation for re-licensing for use by FWA services in 2001. FWA access is limited in the UK to the bands 3,4 GHz - 3,5 GHz, which has some limited geographical restrictions applied to its use. The band 3,605 GHz - 3,689 GHz paired with 3,925 GHz - 4,009 GHz has a single licensed operator and the deployment of the FWA service is subjected to co-ordination with both FSS and FS (P-P). Three slots of 2 x 30 MHz each (one slot of 2 x 30 MHz is currently under public consultation for award to FWA services in 2001) in the band 10,125 GHz - 10,225 GHz paired with 10,475 GHz - 10,575 GHz.
Luxembourg	3,41 GHz - 3,6 GHz, 18 MHz, 100 MHz duplex spacing
Netherlands	2,52 GHz - 2,67 GHz, 70 MHz 3,5 GHz - 3,58 GHz, 30 MHz, 50 MHz duplex spacing
Norway	3,4135 GHz - 3,6 GHz, 15 MHz, 100 MHz duplex spacing
Portugal	2,4 GHz - 2,438 GHz 3,6 GHz - 3,794 GHz, 28 MHz, 100 MHz duplex spacing
Spain	3,4 GHz - 3,56 GHz, 20 MHz, 100 MHz duplex spacing
Switzerland	3,51 GHz - 3,58 GHz, 17 MHz, 100 MHz duplex spacing

4.6.2 Duplex Mode

The standard shall support systems based on FDD, or TDD, or FDD and TDD efficiently In FDD mode, the base station shall support full-duplex FDD, while the SU should be able to operate in half-duplex FDD to reduce equipment cost. In TDD mode the system should support dynamic variable duration for the Up-link and the Down-link according to the existing traffic.

4.6.3 Channelization

HIPERMAN standards shall adhere to channel plans described in [9] and [8] for 3 400 MHz - 3 600 MHz and 3 600 MHz - 4 200 MHz bands respectively. However, sufficient flexibility must be provided to allow operation in regions where these recommendations are not followed and in other frequency bands below 11 GHz.

Recommended channel plans are to be found in the following CEPT and ITU documents [4], [5], [7], [8], [6].

However, these channel arrangements give considerable degrees of freedom, which have been applied in various ways by different Administrations, and although compliance with any one of the options might be consistent with CEPT Recommendations, compliance with the national variants will also be a practical imperative.

4.6.4 Co-existence considerations

ETSI TM4 has developed a number of standards for different access methods for fixed systems for these bands.

Several European nations have awarded or are expected to award licences allowing operation of Fixed Wireless Access services in these preferred bands, and many of these services are in operation. Equipment used for such services is compliant with the ETSI TM4 coexistence standards and is used mainly for narrow band applications, predominately telephony.

A pragmatic functional requirement of FWA below 11 GHz is that it should be constrained to coexist with the existing services and systems:

- Existing operators may choose to offer broadband services using equipment compliant with FWA standards below 11 GHz standards alongside their existing narrower band services, or:
- New broadband operations will be undertaken by an operator in a band adjacent to another operator offering services under existing ETSI TM4 standards.

The standard should offer a choice of channel arrangements, which allow coexistence with pre-existing systems. The systems should be able to operate flexibly within frequency assignments which are typically offered in the 3,4 GHz and 10,5 GHz bands, and which vary throughout Europe. These may be an integer multiple of 3,5 MHz, 7 MHz or 14 MHz according to [7], [8], [9]

In UK for example, there is a single licence in the 3,5 GHz band with a 2 × 17 MHz assignment and utilizing a 50 MHz duplex spacing. There are three licences in the 10,5 GHz band with a 2 × 30 MHz assignment utilizing a 350 MHz duplex spacing.

5 Services

This clause contains services, which pose requirements on the PHY and DLC layers. The QoS parameters supporting the described services are provided in clause 7.2.3.

5.1 Internet Protocol Services

The system must be optimized to transport variable length IP datagrams. Both IP versions 4 and 6 must be supported. For efficient transport of IPv6, TCP/IP header compression over the air interface should be supported. It should be possible to support the emerging IP-QoS efforts (e.g. MPLS, Diffserv, RSVP).

5.2 Bridged LAN services and Remote LAN access

The protocols should support bridged LAN service and Remote LAN access capabilities.

5.3 Voice services

The system shall support voice communications. The voice access transport shall be packet based. The system must support the QoS requirements of these services.

5.4 Other Services

The system shall facilitate unicast, multicast, as well as broadcast services.

6 External interfaces, and network management

6.1 Network Management

The standard shall define a network management interface based on existing open standard protocols (for example SNMP), which enables the following management aspects:

- Fault and Performance management

  The protocols must enable fault and performance monitoring, as well as provide means for local and remote testing. The management functionality must include reboot, reactivation and shutdown capabilities.

- Configuration and software upgrading management

  The protocols must enable both local and remote configuration including the updating of software in any device in the network without service interruption.

- Security

  The system shall enable centralized authentication and authorization services.

- Service management

  The protocols must permit operators to enforce service level agreements (SLAs) with subscribers by restricting access to the air link, discarding data, dynamically controlling bandwidth available to a user or other appropriate means. The protocols must permit the subscriber to monitor the performance at the SU.

- Interoperability

  The network management system shall enable provisioning and operation of a number of different SUs provided by several suppliers on a BS.

- Accounting and Auditing

  The system management framework, architecture, protocols, and managed objects must allow for operators to effectively administer accounting and auditing, by making available the relevant information to an external billing system. An operator must be able to account for time- and bandwidth utilization (i.e. throughput) and the various QoS parameters for each subscriber.

Any radio relay or repeater function shall be a managed element.

6.2 External Interfaces

6.2.1 User Network Interface (UNI)

A single SU may comprise several UNIs. The DLC convergence layer at the SU shall support IP. It may support other interfaces, e.g. Ethernet, USB, and POTS.

6.2.2 Service Node Interface (SNI)

The BS may comprise several SNIs. The DLC convergence layer at the BS shall be packet-based. It may be IP over Ethernet, Gigabit Ethernet, PPP, FDDI (ISO 8802-5) etc.

7 Transport requirements

Priority information given to the convergence layer shall be used for the QoS mechanism.

7.1 Service independence

A HIPERMAN system shall provide services without requiring information on the type of application.

7.2 Service Support

7.2.1 Quality of Service

The system shall support QoS guarantees to provide the services that shall be transported. Thus, the protocol standards shall define interfaces and procedures that accommodate the requirements of the services with respect to allocation of prioritization of radio resources.

The system shall support different classes for service quality in terms of delay, jitter, packet error ratio and data rates. Jitter generated in the system should be taken into account in the design of the buffers. Jitter automatically impacts the total delay of the system and is therefore included in the Max. Delay.

Figure 5 shows a variety of typical currently available applications and their required bandwidths and dependencies on QoS.

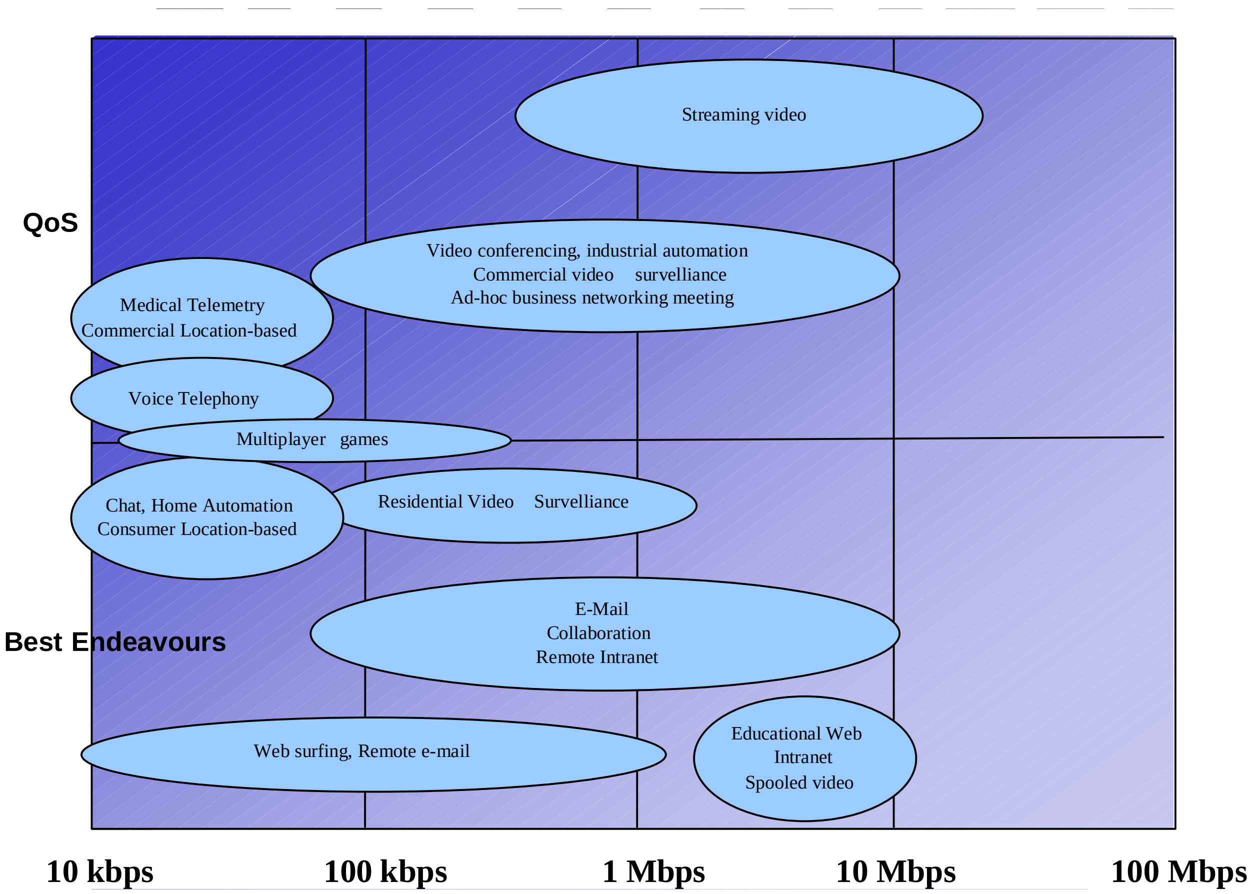

Figure 5: Some currently available applications and their typical bandwidth and QoS requirements

Table 2: Service QoS Requirements

Service	Max. Delay (ms) including jitter, for at least 95 % of the packets (note)	Max. Jitter (ms) for at least 95 % of the packets (note)	Packet Error Ratio (note)	Data rates
Voice	20	10	3 %	≤ 64 kbit/s
Time Critical Data	40	20	0,2 %	≤ 400 kbit/s
Streaming	100	50	1 %	≤ 1 Mbps (Info: Audio: realaudio/mp3 < 96 kbit/s, MPEG4 speech < 24 kbit/s Video: MPEG4 < 4 Mbps for broadcast quality full screen video, Video conferencing quality video with H.26: 100 kbit/s)
Non-Time Critical Data	N/A	N/A	0,1 %	N/A
NOTE: The QoS parameters are specified between two convergence layers on a single radio link.				

7.2.2 Service Classes

Three classes of service are recognized as per IETF recommendations, which shall be supported:

- Expedited Forwarding (EF): This class of service can have a varying bandwidth requirement over time, but tolerance of delay and jitter are limited (example: VoIP).
- Assured Forwarding (AF): Within this class of service, the bandwidth can vary over time within limits, but the tolerance of delay and jitter are higher than EF.
- Best Effort: The bandwidth in this class varies widely and is allowed to burst up to the link capacity not occupied by EF and AF traffic. Delay and jitter tolerance is high.

7.2.3 Service QoS Mappings

The basic mechanism available within the systems for supporting QoS/service class requirements shall be able to allocate various bandwidths to various services. The protocols shall include a mechanism that can support dynamically variable bandwidth channels and paths (such as those defined for IP environments).

Since customer units will contend for capacity to/from one or more base stations, the DLC protocol shall efficiently resolve contention and bandwidth allocation.

This mechanism shall be done as a negotiation between convergence layer and higher layer.

7.3 Channel Conditions

Due to the multipath inherent in the targeted frequency bands, the system should be capable of handling several μs of delay spread with limited performance degradation.

To accommodate changes in the channel characteristics, the PHY and DLC protocols shall specify functions and procedures to adjust parameters such as transmit power and modulation. Note that the function of the DLC layer and/or PHY layer can include error correction.

Although optimized for the 3,4 GHz - 4,2 GHz band, the characteristics of different frequency bands below 11 GHz should be taken into account when defining HIPERMAN parameters. Link distances will vary strongly based on the used frequency band, environment, propagation conditions, antenna gain, etc. The system should be such that it supports typical link distances as listed in Table 3. Because large distances can be expected between terminal and base station, time delay compensation mechanisms should be provided by the standard both at the DLC and the PHY layer.

Table 3: Typical cell-sizes

	Typical cell size (km)
NLOS urban	2
NLOS suburban	2,5
NLOS rural	4
LOS	15

7.4 Flexible Asymmetry

Over a short period of time (e.g. a few seconds) the traffic generated by and for any given user can be highly asymmetric in either way. The system shall efficiently support this type of asymmetric traffic. Over longer periods of time, a given user can need on average more bandwidth in one way than in the reverse way. The system shall therefore enable the operator to grant asymmetric traffic contracts.

The total traffic generated by and for all the users sharing the same radio resource may be instantaneously asymmetric or even asymmetric during a long period of time, depending on the type of users connected to the shared resource. This global asymmetry can be handled differently with TDD and FDD modes. In TDD mode, a global dynamic asymmetry in the range of 10 % upstream, 90 % downstream to 90 % upstream, 10 % downstream should be supported. In FDD mode, the modulation type and coding should be adjustable to maximize total sector capacity and near the capacity asymmetry to the traffic asymmetry.

7.5 Throughput requirements

7.5.1 Target Throughput

To be competitive with wired solutions, it is desirable for the system to support a data rate at the APT of 25 Mbit/s, which is the instantaneous aggregated bit rate (up- plus downstream) between the PHY and the DLC layer, and shall be shared among the users or shall be capable of being allocated to one user. The system shall accommodate different types of SUs with different maximum data rates. This for example allows optimization of the cost-performance ratio for specific markets/customers and operation with longer ranges.

7.5.2 Expected throughput with current spectrum assignments

Achievable peak data rates depend on spectrum assignments, and hence cannot easily be specified. Instead, the systems shall use different modulation and/or coding options for different links to increase the overall system throughput. Thus, subscribers with weak signals will maintain an acceptable radio link quality through link adaptation. Additionally, subscribers will have different interference profiles and propagation characteristics based on their relative position to the BS. For example, with two times 14 MHz spectrum, each channel will be 3,5 MHz or less (as it is assumed that at least 4 channels are needed to provide multi-cell/sector coverage), resulting in an expected throughput per channel of approximately 6 Mbps.

7.5.3 Spectrum requirements to meet target throughput

In order to achieve a continuous large-scale roll out without compromising data rate, the operator needs to have 9 channels in the cell plan. 64 QAM is foreseen as the highest modulation complexity feasible for HIPERMAN. Therefore a bandwidth of at least 10 MHz (note) is required to assure a net bit rate of 25 Mbit/s. That results in a minimum of 90 MHz in each direction. If three operators are allowed, then a minimum of 540 MHz should be allocated in the 3,4 GHz - 4,2 GHz band for Fixed Wireless Access.

NOTE: For example, using 80 % of the bandwidth, the maximum data rate with ¾ rate coding 64 QAM gives 0,8 × 6 bits/symbol × ¾ coding rate ×10 MHz bandwidth = 36 Mbit/s raw throughput. Assuming overhead for equalizer training and PHY/DLC overhead, an assumption of 25 Mbit/s net bit rate is reasonable.

7.6 Radio Link Availability

HIPERMAN based systems should support an availability of at least 99,9 % for the ranges as shown in Table 3. Rain effects may further deteriorate these numbers depending on the targeted spectrum. The system shall permit radio links to be engineered for different link availabilities, based on the preference of the system operator.

7.7 Scalability

The protocols should allow for different capacities and performance for the system instances. The system should support features to maximize the scalability of a deployment.

7.8 Radio specific security requirements

The system shall provide secure means of authentication, authorization and adequate means of encryption to ensure privacy.

7.8.1 Authentication

There are two levels of authentication for the system. The first level of authentication is when the subscriber unit authenticates itself to the access network. This initial authentication shall be strong in order to prevent "enemy" subscriber unit from entering the network or an "enemy" base station from emulating a real base station. Once the initial authentication at this level is complete, subsequent authentication at this level can be a little more relaxed. The DLC layer shall support this level of authentication.

The second level of authentication, between the user and the NMS, should be handled by higher layer protocols.

An additional level of authentication can exist between the two levels above. This additional layer is the authentication of the user with the subscriber unit. This is also beyond the scope of the system. The authentication mechanisms shall be secure so that an "enemy" subscriber unit is not able to gain access to a system, or to the core network. Passwords and secrets shall NOT be passed "in the clear" through the air interface.

7.8.2 Authorization

Authorization is a security process that determines which services an authenticated user is permitted to invoke. Each user has a set of credentials that describe what the user is "allowed" to do. The standard shall identify a standard set of credentials and allow for vendors to extend the defined credentials with non-standard credentials. Some possible credentials are:

- Permission to access the system;
- Permission to request up to a defined QoS profile (bandwidth, delay, etc.);
- Permission to operate certain services (IP, Remote Bridging, Digital Audio/Video, etc.).

User authorization requests and responses shall be transacted securely.

7.8.3 Privacy

Privacy is a security concept that protects transmitted data from being intercepted and understood by third parties (e.g. an "enemy" subscriber unit, base station or passively "listening" radio).

The system should allow a cryptographic algorithm to be employed that is internationally applicable. Facilities shall also be defined in the protocol for the use of alternate cryptographic algorithms that can be supported.

8 Operational requirements

8.1 User density and market penetration

8.1.1 Residential market

Caution has to be taken with figures for "average" household density, as local peaks can be much larger than the average for a large area. Table 4 gives figures for typical household densities in a square kilometre in Europe and the likely range of variations on a smaller scale.

Table 4: Typical household densities in Europe (Households per square km)

Environment:	Rural	Suburban	Urban	City centre
Average household density		1 000	3 000	
Household density range	5 to 500	500 to 3 000	1 000 to 8 000	8 000 to 30 000

In suburban areas HIPERMAN should be able to support at least 20 % penetration of the market, and in urban areas at least 15 %. In dense city centre areas HIPERMAN need only to be able to support at least 10 % penetration.

HIPERMAN systems may be installed both in regions of relatively low household densities (rural areas) and regions with very high household densities (urban areas including city centres). At least in the early rollout stages of a network, only a small fraction of the potential user base within the coverage area may subscribe, which will result in a low-to-medium user density in densely populated areas.

HIPERMAN systems shall therefore allow economic deployment in areas with fairly low user density, but have adequate growth potential to maintain a good grade of service as the user density increases. In rural areas, HIPERMAN systems should target clustered households, such as villages, and not isolated houses.

8.1.2 SOHO and Small Enterprise market

In a business a number of employees can use broadband services simultaneously through a single company subscription (probably sharing the access transceiver through an internal network). Little data seems to be available on the actual *density* of businesses. However, data is available on the proportions of businesses across economies. Table 5 gives data for five EU countries.

From the table it is clear that in each market:

- Approximately 2/3 to 3/4 of all telephone connections are to residences; and
- 96 % of all businesses employ less than 50 employees.

Table 5: Market statistics for Europe

				Enterprises - % - with # of employees:				Number of enterprises
Country	**Households 000s**	**Res. lines 000s**	**Total lines 000s**	**1 to 9**	**10 to 49**	**50 to 249**	**250 +**	
France	22 540	20 737	32 900	83,00	14,00	2,50	0,50	821 900
Germany	35 250	32 136	42 000	80,60	16,40	2,30	0,70	1 430 300
Italy	19 700	17 694	24 542	93,70	5,60	0,60	0,10	2 913 200
Spain	12 000	11 262	15 413	84,50	13,60	1,60	0,30	724 300
UK	22 300	20 739	30 678	79,70	16,60	3,00	0,70	826 600

These figures show that the predominant potential market for access will be for residential and small business premises, with the majority of business premises housing less than 50 employees. It is assumed that all businesses will also have telecommunications service.

HIPERMAN should be designed on the assumption that, in each type of region (suburban, urban, city centre) it should support the same penetration of the SOHO and Small Enterprises customer base as the residential customer base. The density of SOHO and Small Enterprises is assumed to be in proportion to the household density. The number of users per subscription (i.e. per customer) will be distributed according to the distribution of enterprise size. However, it is assumed that only half the employees in each enterprise will have access to broadband services (i.e. on average this is the proportion of employees who use communications in their daily work).

8.2 User reference traffic models

These traffic models are presented for the purposes of understanding the traffic mix and estimating spectrum requirement. They are thought to be reasonable projections or current trends but are not based on specific market research.

8.2.1 Residential users

The main residential user applications that can be foreseen today are as follows:

- Internet access

  It is assumed that 100 % of subscriber households will use Internet access. From statistics gathered within a business environment an average Internet user may download at an average rate of about 24 kbit/s in the busy hour, i.e. a total of about 10 Mbytes. This represents a low average utilization of a packet system at 10 Mbit/s. It is assumed that for future applications the utilization (traffic intensity) will be much higher: 1 % in the busy hour. The upstream data would be smaller, typically "mouse-clicks", email and TCP acknowledgements, at 50 % of the downstream rate.

- LAN bridging and Remote LAN access

  It is foreseen that this will only be used by "homeworkers" and the Small Office/Home Office (SOHO) market. It is assumed that 10 % of subscriber customers fall in this category and that they utilize LANs for only 0,25 % of the busy hour but while accessing they use high data rates.

- Video-telephony and video conferencing

  It is assumed that 10 % of HIPERMAN households will use video conferencing (or similar residential services) at 70 mE in the busy hour at 384 kbit/s duplex.

- Real time video and audio

- Telephony, voice-band modems, fax

Most subscriber households (20 %) will use voice telephony. The working assumption for residential traffic intensity is 70 mE in the busy hour.

Table 6 gives an estimate of the mean upstream and downstream bandwidth per residential user (in kbit/s). These are the best estimates that could be made without formal market research. It is possible that traffic levels could be much higher in the longer term. The residential figures and business figures should not simply be added together as it is expected that busy hours do not correspond for the two categories. The data is intended to give guidance on the average values for channel bandwidth, not the maximum which a user may require.

Table 6: Traffic model for residential subscribers

Service	% Households	% of the time bandwidth is used	Downstream (kbit/s)	Upstream (kbit/s)	Downstream tot. (kbit/s)	Upstream tot. (kbit/s)
Internet access	100	1	20 000	10 000	200	100
LAN bridging and Remote LAN access	10	0,25	25 000	25 000	6	6
Video-telephony and video conferencing	10	7	384	384	2	2
Real time video and audio	50	7	192	0	7	0
Telephony, voice-band modems, fax	20	7	64	64	1	1
				Total	**216**	**109**

8.2.2 Business users

The main business user applications that can be foreseen today are as follows:

- Internet Access:

  It is assumed that 100 % of businesses will have Internet access. The utilization per employee is assumed to be the same inbound as in the residential case, and outbound rates more equal, as a significant number of businesses will have web servers on their premises.

- LAN bridging and Remote LAN access

  In the small business market, it is assumed that the proportion of remote LAN access will be less than the residential market.

- Video-telephony and video conferencing

  It is assumed that 10 % of business users of a HIPERMAN network will use video conferencing at 100 mE in the busy hour at 384 kbit/s duplex.

- Real time video and audio

- Telephony, voice-band modems, fax

  It is assumed that 30 % of business user of a HIPERMAN network will use voice telephony. The working assumption for business user traffic intensity is 100 mE of external traffic in the busy hour.

Table 7 gives an estimate of the mean upstream and downstream bandwidth per business user (in kbit/s). Again it should be emphasized that a number of users in a business may operate through one HIPERMAN connection. The "% of employees" column takes into account the factor of 100 % of employees in each enterprise estimated to have access to broadband services.

Table 7: Traffic model for business subscribers

Service	% of employees, that have access	% of the time bandwidth is used	Downstream (kbit/s)	Upstream (kbit/s)	Downstream tot. (kbit/s)	Upstream tot. (kbit/s)
Internet access	100	5	20 000	10 000	1 000	500
LAN bridging and Remote LAN access	10	0,5	25 000	25 000	12	12
Video-telephony and video conferencing	10	10	384	384	4	4
Real time video and audio	50	7	192	0	7	0
Telephony, voice-band modems, fax	30	10	64	64	2	2
				Total	**1 025**	**518**

8.3 Installation aspects

Environmental concerns mean that a HIPERMAN ODU (if the SU includes an ODU) including antenna on customer premises must be small (less than 45 cm in all dimensions).

End-User installation shall be supported. The HIPERMAN system should allow a design to include any functionality necessary to enable the economical installation of subscriber equipment. For example, to make available Received Signal Strength Indicator (RSSI)/Bit Error Ratio (BER) indications for proper antenna alignment. Easy installation with a minimum of manual configuration should be the goal. Flexibility and an installation that is as automated as possible are highly desirable.

8.4 Capacity

The system capacity requirement is a function of the number of users, their bandwidth requirements and traffic characteristics (contracted service levels with users). This can for example be optimized by radio resources reservation schemes.

In a given system instance, capacity has to be planned to ensure that the user's quality of service guarantees are met.

The time-variant impairments (e.g. interference profiles) are expected to be the most significant contributor to channel impairments and complexity in cell capacity planning.

8.5 Radio range and coverage

The range guidelines, given in Table 3, are aimed at the bands around 3,5 GHz. However, at frequencies around 10 GHz, heavy rain or snow can cause strong attenuation and unavailability events. Additional attenuation will be caused by atmospheric absorption by oxygen, hydroxyl ions, and fog. If a network is deployed in the 10 GHz band, an additional margin needs to be added in the link budget. It should be possible to trade-off service bandwidth against range when deploying a HIPERMAN system.

The system must be technically able, by using coverage overlap, repeaters or other techniques, to improve range and coverage.

8.6 Maintaining QoS

A number of problems can arise during the operation of a network which affect the quality of the service delivered to the SU:

- The radio path may become obstructed, either temporarily or permanently.
- Sporadic co- and adjacent channel interference can arise from within the system or from other systems.
- As the network grows new BSs may be built to increase capacity or extend or "fill-in" coverage.

The system shall incorporate system features to monitor and if possible maintain the QoS in the face of these effects.

8.7 Environmental conditions

HIPERMAN is intended to operate with in- and outdoor equipment. The equipment shall meet appropriate classes defined in ETS 300 019 [10] and should meet other relevant regional standards

8.8 ElectroMagnetic Compatibility (EMC) and safety

The system shall conform to the EMC standards EN 301 489-1 [11], ETS 300 385 [12] and ETS 300 386-2 [13]. The emerging EMC standard EN 301 753 [14] should be taken into consideration. The system shall also conform to the applicable parts of electrical safety document EG 201 212 [16]. This Technical Report has not taken into account radiation safety aspects.

8.9 Standardization requirements

The HIPERMAN standard shall describe the PHY and DLC layers, which shall be core network independent. The core network specific Convergence sublayer(s) shall be specified as part of the standard. It has to be noted that to specify a complete HIPERMAN based system, other specifications, e.g. for the Network layer and higher layers are required. These specifications are assumed to be available or to be developed by other bodies.

The standard, to be developed by ETSI Project BRAN, must support interoperability. The coexistence issues should be handled by ETSI TM4.

9 Comparison with HIPERACCESS and HIPERLAN/2

In order to assess to what extent the existing standards HIPERACCESS and HIPERLAN/2 meet the requirements for HIPERMAN identified in the preceding text, each mandatory, recommended and optional requirement, as abstracted in Table 8, Table 9 and Table 10 respectively, is evaluated.

9.1 Comparison with HIPERACCESS

As HIPERACCESS is under standardization, comparison between HIPERMAN and HIPERACCESS cannot be fully made, yet.

The major differences between HIPERACCESS and HIPERMAN are, that HIPERMAN intends to serve the users in a NLOS environment and that the operating frequencies for HIPERMAN are much lower, resulting in significantly lower cost implementations, which makes addressing the residential market economically viable.

To exploit the channel properties of the bands around 3,5 GHz and address the different spectrum requirements, the physical layers of HIPERMAN and HIPERACCESS will have to be different.

HIPERACCESS has a fixed bandwidth of 28/14 MHz and frame durations of 1ms. HIPERMAN, which has bandwidths of multiples of 3,5 MHz, will need to have longer frame durations. In order to maintain delay requirements (such as for voice packets), HIPERMAN will therefore likely require more stringent QoS algorithms.

Since the DLC layer for HIPERMAN will be optimized for IP, the DLC layer of HIPERMAN will be different from that of HIPERACCESS, also because the physical layer is different.

For details of the comparison with HIPERACCESS see clauses A.1, A.2 and A.3.

9.2 Comparison with HIPERLAN/2

The PHY layer of HIPERLAN/2 is designed for a maximum delay spread of 800 ns, which is insufficient for FWA networks, which typically have much longer delay spreads. The use of 64 FFT in HIPERLAN/2 with such long delay spreads will cause significant PHY overhead. The relatively loose spectral mask of HIPERLAN/2 may also not be sufficient to allow the use of adjacent channels or meet the regulatory band-edge requirements. HIPERLAN/2 does not support FDD nor is designed for bandwidth flexibility. It supports peer-to-peer communication, but does not support mesh topologies.

HIPERLAN/2 has not been designed for multi-cell deployment. The LAN functionality with regards to the NMS system and more generally to the provisioning of services is inadequate to support the functionality required for MAN systems.

For details of the comparison with HIPERLAN/2 see clauses A.1, A.2 and A.3.

9.3 Recommendations for HIPERMAN

Recognizing that a wide diversity exists in regulations, specifically but not limited to bandwidth, spectral mask and duplex spacing, it is recommended that at the outset of the HIPERMAN standardization, a detailed study of the regulations and existing licensing and deployments of individual nations is performed in order to ensure that the standard provides sufficient flexibility to meet this diversity.

The HIPERMAN standard should be compliant with the relevant ETSI TM4 PMP standards. Although a HIPERMAN standard is not strictly needed from a regulatory perspective as co-existence standards have already been developed by ETSI TM4, economically, the interoperability and economies-of-scale created by a standard are extremely attractive. An interoperability standard reduces cost (provisioning cost through vendor competition and component cost through economies-of-scale production), which is an extremely important factor for the targeted markets. However, it is not certain that one standard can address all facets of the market optimally.

There are currently very few examples of successful interoperability standards for Fixed Wireless Access systems. However, there are currently also very few wide scale deployments of FWA systems. The success of mobile standards suggests that interoperability standards may help create and/or expand the market.

From the comparison of the HIPERMAN requirements with HIPERACCESS, it is clear that HIPERACCESS, possibly with further adaptions, can meet many of the requirements related to the DLC layer. However, it fails to meet most of the requirements related to the PHY layer.

Apart from its multipath mitigation properties (which still fall short of those required for a HIPERMAN system), the HIPERLAN/2 PHY has, as discussed in clause 9.2, a number of shortcomings in its applicability to HIPERMAN systems. The DLC of HIPERLAN/2 would need considerable modifications to meet the HIPERMAN requirements.

Recognizing the importance of time-to-market in Europe where much of the 3,5 GHz spectrum has already been licensed, some with deployment requirements, existing standardization efforts outside ETSI BRAN (e.g. [3]) should be examined for their applicability. If these efforts are found to be most suitable, co-operation with these standardization activities would be recommended.

Otherwise, the possibility of modifying HIPERACCESS or HIPERLAN/2 should be examined. On one hand, the HIPERACCESS standard could be modified at the PHY level to improve its multipath capability at low frequencies whilst retaining as much of the DLC and higher-level aspects as possible. On the other hand, the PHY approach of HIPERLAN/2 could be used as a basis.

Annex A: Summary of requirements

This clause contains tabular summaries of requirements found in the text of the present document. Requirements are separated into three categories: required, recommended and optional. Each requirement is numbered for easy reference, indicates the clause from which it is derived, and indicates to which Layer (or aspect) the requirement most applies, be it PHY, DLC, NMS (Network Management System), or SPC (Spectrum), or combinations thereof.

To better discern the meaning and intent of a requirement, please refer to the appropriate clause.

A.1 Mandatory Requirements

Table 8: Mandatory lequirements

#	Clause	Layer	Requirement
M01	**4.4**	**DLC**	**The system shall support PMP topology**
HIPERACCESS			Complies The topology of Hiperaccess is point-to-multipoint.
HIPERLAN/2			Complies The system shall support PMP topology, but it may also support. Direct Mode between terminals. (Direct mode is optional)
M02	**4.4**	**DLC**	**In PMP systems, all data traffic shall go through the base station that shall serve as a radio resource supervisor.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies In PMP systems, the usage of the channel shall be controlled by the base station, but the data traffic in direct link goes from a station to another.
M03	**4.4**	**DLC**	**In [optional] mesh systems, the base station shall serve as a global radio resource supervisor and SUs serve equally as local radio resource supervisors.**
HIPERACCESS			Does not comply Does not support mesh.
HIPERLAN/2			Does not comply Does not support mesh.
M04	**4.5**	**PHY SPC**	**Therefore, NLOS operation shall be supported.**
HIPERACCESS			Does not comply. The use of microwave frequencies makes it necessary for the antenna at the customer premises to be in LOS with the transmitter or a signal repeater. Implementing PHY at 3,5 GHz would not resolve delay spread.
HIPERLAN/2			Does not comply, requires modifications.
M05	**4.5**	**PHY**	**The system must be robust in adverse channel conditions.**
HIPERACCESS			Does not comply. For example large delay spreads as occur around 3,5 GHz are not considered.
HIPERLAN/2			Does not comply, would require modifications.
M06	**4.5**	**PHY DLC**	**The system shall be bandwidth/spectrally efficient, both in single and multi-cell architectures.**
HIPERACCESS			Complies.
HIPERLAN/2			Does not comply, multi-cell architecture is not considered.
M07	**4.6.1**	**SPC**	**The standard shall be optimized for radio systems in the frequency band 3,4 GHz to 4,2 GHz.**
HIPERACCESS			Does not comply, the target spectrum is above 11 GHz.
HIPERLAN/2			Does not comply, standard is optimized for indoor operation in 5 GHz.
M08	**4.6.2**	**PHY DLC SPC**	**The standard shall support systems based on FDD or TDD or FDD and TDD efficiently.**
HIPERACCESS			Complies HIPERACCESS will be based on FDD and a TDD version will be specified based on the FDD standard. Support for H-FDD terminals interoperable with FDD is required. TDD operation would enable usage of unpaired frequency allocations.
HIPERLAN/2			Does not comply. Standard is based on TDD only.

#	Clause	Layer	Requirement
M09	**4.6.2**	**PHY DLC SPC**	**In FDD mode, the base station shall support full-duplex FDD.**
HIPERACCESS			Complies
HIPERLAN/2			Does not comply, standard is based on TDD only.
M10	**4.6.3**	**SPC**	**HIPERMAN standards shall adhere to channel plans described in [9] and [8] (current version E or later) for 3 400 MHz - 3 600 MHz and 3 600 MHz - 4 200 MHz bands respectively. However, sufficient flexibility must be provided to allow operation in regions where these recommendations are not followed and in other frequency bands below 11 GHz.**
HIPERACCESS			Does not comply.
HIPERLAN/2			Does not comply.
M11	**5.1**	**DLC**	**The system must be optimized to transport variable length IP datagrams. Both IP versions 4 and 6 must be supported.**
HIPERACCESS			May not comply. HA is optimized for ATM, because the cell-size is fixed.
HIPERLAN/2			Does not comply. HL/2 is optimized for ATM, because the cell is fixed.
M12	**5.3**	**DLC PHY**	**The system shall support voice communications. The voice access transport shall be packet based. The system must support the QoS requirements of these services.**
HIPERACCESS			Complies, even supports circuit switched voice and ISDN.
HIPERLAN/2			Complies.
M13	**5.4**	**DLC**	**The system shall facilitate unicast, multicast, as well as broadcast services.**
HIPERACCESS			Complies. HIPERACCESS must support unicast and multicast. (broadcast?).
HIPERLAN/2			Complies. The system shall provide user data and control unicast and control broadcast. The system may provide user data multicast and user data broadcast.
M14	**6.1**	**NMS**	**The standard shall define a network management interface based on existing open standard protocols.**
HIPERACCESS			Complies It will follow ITU-T Recommendations. G.902 and M.3010, as well as, ETSI V5 and VB5, where applicable.
HIPERLAN/2			Partly complies. MIB standardized, but incomplete for HIPERMAN type network.
M15	**6.1**	**NMS**	**The [management] protocols must enable fault and performance monitoring, as well as provide means for local and remote testing.**
HIPERACCESS			Complies or very similar.
HIPERLAN/2			Does not comply, not defined.
M16	**6.1**	**NMS**	**The management functionality must include reboot, reactivation and shutdown capabilities.**
HIPERACCESS			Complies or very similar.
HIPERLAN/2			Does not comply, not defined.
M17	**6.1**	**NMS**	**The [management] protocols must enable both local and remote configuration including the updating of software in any device in the network without service interruption.**
HIPERACCESS			Complies or very similar.
HIPERLAN/2			Does not comply, not defined.
M18	**6.1**	**NMS**	**The system shall enable centralized authentication and authorization services.**
HIPERACCESS			Complies.
HIPERLAN/2			Partly complies, centralized authentication (the scope for the authentication is limited to the local WLAN) enabled, but no authorization.
M19	**6.1**	**NMS DLC**	**The [management] protocols must permit operators to enforce service level agreements (SLAs) with subscribers by restricting access to the air link, discarding data, dynamically controlling bandwidth available to a user or other appropriate means.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Does not comply, taking care of on an AP by AP basis: e.g. resource grants, (dis)association.
M20	**6.1**	**NMS**	**The protocols must permit performance monitoring of the provided services by the subscriber at the delivery point.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Does not comply.
M21	**6.1**	**NMS**	**The network management system shall enable provisioning and operation of a number of different SUs provided by several suppliers on a BS.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
M22	**6.1**	**NMS**	**The system management framework, architecture, protocols, and managed objects must allow for operators to effectively administer accounting and auditing, by making available the relevant information to an external billing system.**
HIPERACCESS			Similar.
HIPERLAN/2			Does not comply, not defined.

#	Clause	Layer	Requirement
M23	**6.1**	**NMS**	**An operator must be able to account for time- and bandwidth-utilization and the various QoS parameters for each subscriber.**
HIPERACCESS			Not defined.
HIPERLAN/2			Does not comply, not defined.
M24	**6.1**	**NMS DLC**	**Any radio relay or repeater function shall be a managed element.**
HIPERACCESS			Complies Any radio relay or repeater function should be a managed element. BS does not necessarily know anything about repeaters.
HIPERLAN/2			Does not comply, not defined.
M25	**6.2.1**	**DLC**	**The DLC convergence layer at the BS shall be packet-based.**
HIPERACCESS			Does not comply.
HIPERLAN/2			Does not comply.
M26	**7**	**DLC**	**Priority information given to the convergence layer shall be used for the QoS mechanism.**
HIPERACCESS			Under standardization
HIPERLAN/2			Complies
M27	**7.1**	**DLC**	**A HIPERMAN system shall provide services without requiring information on the type of application.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
M28	**7.2.1**	**DLC**	**The system shall provide Quality of Service (QoS) support as follows (see Table 2).**
HIPERACCESS			Under standardization.
HIPERLAN/2			Partially complies, traffic classification is different (among others).
M29	**7.2.1**	**DLC**	**The protocols shall support QoS guarantees to provide the services that the system shall transport. Thus, the protocol standards shall define interfaces and procedures that accommodate the requirements of the services with respect to allocation of prioritization of bandwidth.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Partially complies The convergence layers do perform mapping from service classes of higher layer protocols onto user connections over radio interface. It is up to the vendor how to realize the QoS. The protocol involved in resource allocation for user connections is RLC.
M30	**7.2.1**	**DLC**	**The system shall support different classes for service quality in terms of delay, jitter, packet error ratio and data rates.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Does not comply, can comply according to implementation.
M31	**7.2.2**	**DLC**	**Three classes of service shall be supported [: Expedited Forwarding, Assured Forwarding, Best Effort].**
HIPERACCESS			Under standardization.
HIPERLAN/2			Does not comply, can comply according to implementation.
M32	**7.2.3**	**DLC**	**The basic mechanism available within the systems for supporting QoS/service class requirements shall be able to allocate various bandwidths to various services. The protocols shall include a mechanism that can support dynamically variable bandwidth channels and paths.** **This mechanism shall be done as a negotiation between convergence layer and higher layer.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Partially complies.
M33	**7.3**	**PHY DLC**	**To accommodate changes in the channel characteristics, the PHY and DLC protocols shall specify functions and procedures to adjust parameters such as transmit power and modulation.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
M34	**7.4**	**DLC**	**The system shall efficiently support [highly] asymmetric traffic.**
HIPERACCESS			Complies HIPERACCESS systems must support both symmetric and asymmetric data flows, which may be duplex or simplex.
HIPERLAN/2			Complies.
M35	**7.4**	**NMS DLC**	**The system shall enable the operator to grant asymmetric traffic contracts.**
HIPERACCESS			Complies.
HIPERLAN/2			Does not comply, not defined.
M36	**7.5.1**	**PHY DLC**	**It is desirable for the system to support a data rate at the APT of 25 Mbit/s, which shall be shared among the users or shall be capable of being allocated to one user.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
M37	**7.5.1**	**DLC**	**The system shall accommodate different types of SUs with different maximum data rates.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.

#	Clause	Layer	Requirement
M38	**7.5.2**	**PHY**	**systems shall use different modulation and/or coding options for different links to increase the overall system throughput.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
M39	**7.6**	**PHY**	**The system shall permit radio links to be engineered for different link availabilities, based on the preference of the system operator.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
M40	**7.8**	**DLC NMS**	**The system shall provide secure means of authentication, authorization and adequate means of encryption to ensure privacy.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
M41	**7.81**	**DLC**	**Initial Authentication [of the subscriber station to the access network] shall be strong. The DLC layer shall support this level of authentication.**
HIPERACCESS			Complies or very similar.
HIPERLAN/2			Complies.
M42	**7.8.1**	**DLC NMS**	**The authentication mechanisms shall be secure.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
M43	**7.8.1**	**DLC**	**Passwords and secrets shall NOT be passed "in the clear" through the air interface.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Complies.
M44	**7.8.2**	**NMS DLC**	**The standard shall identify a standard set of [authorization] credentials and allow for vendors to extend the defined credentials with non-standard credentials.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Does not comply.
M45	**7.8.3**	**DLC**	**Facilities shall also be defined in the [recommended privacy] protocol for the use of alternate cryptographic algorithms that can be supported.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Does not comply. The HiperLAN/2 standard requires DES. Change of security mechanism is not allowed by the standard, but DES and triple DES is provided by the standard, nothing more.
M46	**8.1.2**	**-**	**HIPERMAN systems shall therefore allow economic deployment in areas with fairly low user density, but have adequate growth potential to maintain a good grade of service as the user density increases.**
HIPERACCESS			Does not comply. Coverage limited to 4 km.
HIPERLAN/2			Does not comply.
M47	**8.3**	**-**	**A HIPERMAN ODU (if the SU includes an ODU) including antenna on customer premises must be small (less than 45cm in all dimensions).**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
M48	**8.3**	**-**	**End-User installation shall be supported.**
HIPERACCESS			More difficult.
HIPERLAN/2			Complies.
M49	**8.5**	**PHY DLC NMS**	**The system must be technically able, by using coverage overlap, repeaters or other techniques, to improve range and coverage.**
HIPERACCESS			Complies.
HIPERLAN/2			Does not comply.
M50	**8.6**	**PHY DLC**	**The system shall incorporate system features to monitor and if possible maintain the QoS in the face of [radio path obstruction, sporadic co- and adjacent channel interference, network growth] effects.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies, (radio channel monitoring with DFS, adjacent channel scanning is implemented, C/I is monitored).
M51	**8.7**	**PHY DLC**	**The equipment shall meet appropriate classes defined in ETS 300 019 [10].**
HIPERACCESS			Complies, the equipment must meet ETS 300 019 [10] class 4.1, and may have to meet other regional standards.
HIPERLAN/2			Complies (though do not defined in the standard)
M52	**8.8**	**PHY DLC**	**The system shall conform to the EMC standards EN 301 489-1 [11], ETS 300 385 [12] and ETS 300 386-2 [13].**
HIPERACCESS			HIPERACCESS systems will conform to all applicable EMC standards.
HIPERLAN/2			HIPERLAN/2 systems will conform to all applicable EMC standards.

#	Clause	Layer	Requirement
M53	**8.9**	**-**	**The HIPERMAN standard shall describe the PHY and DLC layers, which shall be core network independent. The core network specific Convergence sublayer(s) shall be specified as part of the standard.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
M54	**8.9**	**NMS PHY DLC**	**The standard, to be developed by ETSI Project BRAN, must support interoperability.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.

A.2 Recommended Requirements

Table 9: Recommended Requirements

#	Clause		Requirement
R01	**4.2**	**DLC PHY**	**Broadband fixed wireless access (BFWA) networks should support a wide range of applications in use today and be extendable to support future services.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies HL/2 is designed for WLAN and for its applications.
R02	**4.3**	**DLC PHY**	**The main features for HIPERMAN networks should be: [User installable terminals, Interoperable air interface, Very rapid scalable infrastructure deployment, Efficient spectrum usage Modular cost-effective growth (The system should allow easy customer installation of SUs and it should be easily expanded.), provision of packet-based services with QoS support.]**
HIPERACCESS			Partially complies, Packet based services with QoS support through CL.
HIPERLAN/2			Partially complies, No terminal installation, but packet based services with QoS support, interoperable air interface.
R03	**4.5**	**-**	**To counter channel condition variations and maximize spectral efficiency, the system should be able to trade-off throughput with robustness.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
R04	**4.5**	**DLC**	**The system should be able to support various convergence sublayers.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
R05	**4.6.1**	**-**	**It should be demonstrated that the deployment of FWA systems of the FS can coexist with existing services.**
HIPERACCESS			
HIPERLAN/2			
R06	**4.6.2**	**PHY DLC**	**The SU should be able to operate in half-duplex FDD to reduce equipment cost.**
HIPERACCESS			Complies.
HIPERLAN/2			Does not comply.
R07	**4.6.3**	**PHY DLC**	**The standard should offer a choice of channel arrangements which allow coexistence with pre-existing narrow band systems.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies. Coexistence problems with already existing satellite and radar systems have been taken into account in the DFS mechanism in the standard, and radio link power as well.
R08	**4.6.4**	**SPC PHY**	**The systems should be able to operate within frequency assignments which are typically offered in the 3,5 GHz and 10,5 GHz bands which are far from consistent throughout Europe and can be as small as 14 MHz.**
HIPERACCESS			Does not comply.
HIPERLAN/2			Does not comply.
R09	**5.1**	**DLC**	**For efficient transport of IPv6, TCP/IP header compression over the air interface should be supported.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Does not comply.
R10	**5.1**	**DLC**	**It should be possible to support the emerging IP-QoS efforts.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Complies.

#	Clause		Requirement
R11	**5.2**	**DLC**	**The protocols should support bridged LAN service and Remote LAN access capabilities.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Complies.
R12	**7.2.1**	**-**	**Jitter generated in the system should be taken into account in the design of the buffers.**
HIPERACCESS			Beyond standard.
HIPERLAN/2			Beyond standard.
R13	**7.3**	**PHY**	**Due to the multipath inherent in the targeted frequency bands, the system should be capable of handling several μs of delay spread with limited performance degradation.**
HIPERACCESS			Does not comply
HIPERLAN/2			Does not comply
R14	**7.3**	**SPC**	**Although optimized for the 3,4 GHz - 4,2 GHz band, the characteristics of different frequency bands below 11 GHz should be taken into account when defining HIPERMAN parameters.**
HIPERACCESS			Does not comply.
HIPERLAN/2			Does not comply.
R15	**7.3**	**PHY**	**The system should be such that it supports typical link distances as listed in Table 4.**
HIPERACCESS			Does not comply.
HIPERLAN/2			Does not comply.
R16	**7.3**	**DLC**	**Because large distances can be expected between terminal and base station, time delay compensation should be provided by the standard.**
HIPERACCESS			Complies.
HIPERLAN/2			Does not comply.
R17	**7.4**	**PHY DLC**	**In TDD mode, a global asymmetry in the range of 10 % upstream, 90 % downstream to 90 % upstream, 10 % downstream should be supported.**
HIPERACCESS			
HIPERLAN/2			Complies.
R18	**7.4**	**PHY DLC**	**In FDD mode, the modulation type and coding should be adjustable to maximize total sector capacity and near the capacity asymmetry to the traffic asymmetry.**
HIPERACCESS			Partially complies.
HIPERLAN/2			Does not comply.
R19	**7.6**	**SPC**	**HIPERMAN based systems should support an availability of at least 99,9 % for the ranges as shown in Table 3. Rain effects may further deteriorate these numbers depending on the targeted spectrum.**
HIPERACCESS			Does not apply.
HIPERLAN/2			Does not comply.
R20	**7.7**	**PHY DLC**	**The protocols should allow for different capacities and performance for the system instances.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
R21	**7.7**	**PHY DLC**	**The system should support features to maximize the scalability of a deployment.**
HIPERACCESS			Complies.
HIPERLAN/2			Does not comply.
R22	**7.8.1**	**-**	**The second level of authentication, between the user and the NMS, should be handled by higher layer protocols.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Complies.
R23	**7.8.3**	**DLC**	**The system should allow a cryptographic algorithm to be employed that is internationally applicable.**
HIPERACCESS			Under standardization.
HIPERLAN/2			Complies.
R24	**8.1.1**	**-**	**In suburban areas HIPERMAN should be able to support at least 20 % penetration of the market, and in urban areas at least 15 %. In dense city centre areas HIPERMAN need only to be able to support at least 10 % penetration.**
HIPERACCESS			Complies.
HIPERLAN/2			Does not comply.
R25	**8.1.2**	**-**	**In rural areas, HIPERMAN systems should target clustered households, such as villages, and not isolated houses.**
HIPERACCESS			Complies.
HIPERLAN/2			Does not comply.

#	Clause		Requirement
R26	**8.1.2**	**-**	**HIPERMAN should be designed on the assumption that, in each type of region (suburban, urban, city centre) it should support the same penetration of the SOHO and Small Enterprises customer base as the residential customer base.**
HIPERACCESS			Complies.
HIPERLAN/2			Does not comply.
R27	**8.3**	**-**	**The HIPERMAN system should allow a design to include any functionality necessary to enable the economical installation of subscriber equipment.**
HIPERACCESS			Partially complies (theoretically possible).
HIPERLAN/2			Not applicable.
R28	**8.3**	**-**	**Easy installation with a minimum of manual configuration should be the goal.**
HIPERACCESS			More difficult
HIPERLAN/2			Partially complies (complies in WLAN scenarios).
R29	**8.5**	**PHY DLC**	**It should be possible to trade-off service bandwidth against range when deploying a HIPERMAN system.**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
R30	**8.7**	**PHY**	**The equipment should meet relevant regional [EMC] standards [other than ETS 300 019 [10]].**
HIPERACCESS			Complies.
HIPERLAN/2			Complies.
R31	**8.8**	**PHY**	**The emerging EMC standard EN 301 753 [14] should be taken into consideration.**
HIPERACCESS			
HIPERLAN/2			
R32	**8.9**	**SPC**	**The coexistence issues should be handled by ETSI TM4.**
HIPERACCESS			Not applicable.
HIPERLAN/2			Not applicable.

A.3 Optional Requirements

Table 10: Optional Requirements

#	Clause	Layer	Requirement
O01	**4.4**	**DLC**	**The system may support mesh topology.**
HIPERACCESS			Does not comply (does not support mesh topology).
HIPERLAN/2			Does not comply (does not support mesh topology).
O02	**4.6.1**	**PHY SPC**	**The standard may be applicable to the range from 2 GHz to 11 GHz.**
HIPERACCESS			Does not comply.
HIPERLAN/2			Does not comply.
O03	**4.6.1**	**DLC**	It may support other interfaces, e.g. Ethernet, USB, and POTS.
HIPERACCESS			Under standardization.
HIPERLAN/2			Partially complies.
O04	**8.1.1**	**-**	**HIPERMAN systems may be installed both in regions of relatively low household densities (rural areas) and regions with very high household densities (urban areas including city centres).**
HIPERACCESS			Partially complies (theoretically possible).
HIPERLAN/2			Not applicable.
O05	**8.6**	**-**	**As the network grows new BSs may be built to increase capacity or extend or "fill-in" coverage.**
HIPERACCESS			Partially complies (theoretically possible).
HIPERLAN/2			Complies (in WLAN scenarios).

History

Document history		
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