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Foreword

This ETSI Technical Report (ETR) has been prepared by the Radio Equipment and Systems (RES) Technical Committee (TC) of the European Telecommunications Standards Institute (ETSI).

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status.

An ETR may be used to publish material which is either of an informative nature, relating to the use or application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or I-ETS.

This ETR contains the specification of the services and facilities of HIgh PErformance Radio Local Area Network (HIPERLAN) systems as well as the operational requirements on which the specification is based. A description of possible applications is also included

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1 Scope

The scope of this ETR is the specification of services and facilities of HIPERLAN (HIgh PErformance Radio Local Area Network) systems as well as the operational requirements on which the specification is based, and a description of possible applications. To clarify the services and facilities specification, a HIPERLAN architecture is outlined. This architecture will be described in detail in a future ETR.

This ETR addresses a new subject area: the intersection of radio systems and information processing systems. HIPERLAN systems are open sub-networks that conform to Open Systems standards where these are available (e.g. for data communications protocols, systems management and security).

HIPERLAN systems will make use of the 5,2 GHz and the 17,1 GHz bands allocated by the CEPT in T/R 22-06, to HIPERLAN systems.

The services and facilities specified in this ETR serve as the basis of, and reference for, the technical specification of HIPERLAN.

This ETR outlines a number of applications of HIPERLAN based systems. Taken as examples of more general areas of endeavour, they cover almost the whole spectrum of business and administrative activity. HIPERLAN is more than a wire substitute. HIPERLAN may, and will, be used as a substitute for wired systems, but will also add a considerable number of new possibilities, features, and versatility to the computing environment. The ETR considers the operational needs of the applications identified here; which are then used as a basis for deriving the required spectrum parameters.

2 Introduction

This Clause examines the context of radio based local area networks, their applications, their relationships to other types of networks, and the markets they could serve.

2.1 What is HIPERLAN?

HIPERLAN refers to a radio-communications sub-system intended for integration with computer systems. It provides high speed, short distance radio links between computer systems. Typically, HIPERLAN will be used for local, in-house, and on-premises networking.

The demand for radio based local networks is a logical consequence of the rapid growth in personal computing and mobile communications in recent years.

Conventional personal computing networks consist of personal computers connected to each other and to more powerful server systems by means of wired local area networks (LANs) based on the ISO 8802 family of standards. Such systems are expected to account for a still rising share of the personal computing market and they account for the majority of new computer systems and applications. The ubiquity of these systems has resulted in personal computer use becoming a part of the daily routine of a wide variety of business and professional occupations.

Since many people use personal computers in their daily routine, the demand for untethered access to computer systems, whether located nearby or remotely, is rising.

The emergence of mobile telephony has freed many businesses and professionals from the limitations of fixed location telephones: voice access to customers, suppliers and peers anywhere and at any time is rapidly becoming commonplace. The introduction of advanced mobile telephony systems with data capabilities promises mobile users access to remote computer systems from cars, trains, public facilities, etc. The data rates supported by these mobile services and the cost of using them limit them to relatively low rate, low volume, intermittent use.

There is a strong parallel demand for untethered access to systems located on premises with the same level of performance as offered by wired local area networks. Rather than be bound to a desktop personal computer, users want to be able to take their lightweight portable computers with them wherever they go, throughout their organisations' premises, while maintaining the ability to interact with, and make use of, other local area networks.

Similarly, the possibility of moving desktop systems without the need for rewiring offices is a significant advantage in today's fast changing working environments. The ability to accommodate change is a major factor behind the drive towards untethered computer access.

Another factor to be considered is the rapid internationalisation of businesses and other organisations, requiring frequent travel and temporary secondments. Again, the people concerned want to be able to take their computers with them and operate them on premises other than their own.

HIPERLANs, radio networks based on the work of ETSI in this field, address on-premises, in addition to off-premises, networking demands by providing a radio based alternative in the case where wired LANs cannot be used, as well as providing the ability to extend wired networks with radio links.

2.2 Applications

The applications of HIPERLANs cover a wide range of business, administrative, and professional uses. The following list provides examples. As HIPERLAN technology becomes widely available other applications will emerge which will further increase HIPERLAN's utilisation.

2.2.1 Office automation

General office automation covers a wide range of administrative applications. Changes in office organisation such as emphasis on work groups lead to demands for flexibility in the location of professional and support staff. In addition, the increased complexity of administrative and management tasks leads to frequent ad-hoc meetings at which people wish to make use of their computers.

2.2.2 Financial services

The financial industry is moving towards a more flexible and fast service specialised to meet individual needs. Untethered computing will provide for the realisation of financial products like flexible cash machines, home-banking directly with the user's equipment and other ad-hoc services.

2.2.3 Medical and hospital systems

In all developed countries medical care and hospitalisation are becoming more expensive. These extra costs are caused in part by the complexity of medical systems, patient care and medication. The efficiency of medical staff can be improved by giving them on the spot, real-time access, wherever they are, to patient data, x-ray images, video recordings and medical records.

2.2.4 Education and training

Computers and networks in particular are being used increasingly in education and training, both in schools and colleges, and in the workplace. HIPERLAN will greatly enhance the services that can be offered as well as the flexibility of their provision. These include the distribution of teaching material, interaction with teachers, sharing of assignments and research results, as well as printing and other services available on wired LANs. Wired systems cannot provide the flexibility needed in educational institutions.

2.2.5 Industrial automation

Industrial systems have been using computers for many years; in many cases the systems concerned were centralised where a few computers controlling a large number of machine tools, conveyor systems, etc. With the increasing use of microprocessor technology and with the trend towards flexible production systems, more computing power will be decentralised. This will be paralleled by an increased need for ad-hoc networking between production floor systems. Radio based networks are ideal for these applications, especially taking into account the ability of HIPERLAN to service moving objects.

2.2.6 Ad-hoc networking

A very important class of HIPERLAN applications are those in which no fixed structure exists. Rather, groups of mobile users (e.g. using laptop computers) may form, dissolve and reform so-called ad-hoc networks as required. For example a number of people may meet at an arbitrary location and decide to network their portable computers temporarily. Such networks may occur in education and training environments where computers are shared between many different tasks, and also in collaborative environments such as meetings, project groups and team problem solving.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETR, the following definitions apply:

Ad-hoc network: applications of HIPERLAN in which no fixed structures exist.

Angular speed: the net angular speed of a node requiring HIPERLAN services whilst in motion.

Asynchronous service: this service is provided by HIPERLAN to support asynchronous traffic between HIPERLAN nodes and traffic between HIPERLAN and some other network.

Asynchronous traffic: data traffic that characteristically has a statistical arrival and delay distribution. This typifies most LAN data traffic.

Channel: an instance of medium use that can coexist with other instances of medium use, with each providing service to a separate set of HIPERLAN nodes.

Co-existence: see HIPERLAN sharing.

Co-location tolerance: the minimum distance between two HIPERLAN nodes that are guaranteed to operate.

Connection set: a sub-set of HIPERLAN nodes (within one or more HIPERLANs) that are in direct radio communication range of each other.

Data confidentiality: provisions for the protection of transmitted data from observation by unauthorised stations or other monitoring means. One measure for doing that is to implement encryption.

Data rate: net user data rate at the MAC/DLC layer interface. This is an average rate over a multi-symbol burst of activity, and not an average over a time-period including several bursts.

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

Encryption: a means of obtaining data confidentiality. See also: Data confidentiality.

Error rate: in HIPERLAN, several error rates are defined:

- Mac Protocol Data Unit (MPDU) detected error rate, which defines the fraction of protocol data units at the MAC layer that have errors that can be detected;
- MPDU undetected error rate, which defines the fraction of protocol data units at the MAC layer that have errors that cannot be detected;
- Mac Service Unit (MSDU) undetected error rate, which defines the fraction of undetectably erroneous MAC service data units.

Forwarding: see Inter-HIPERLAN forwarding and Intra-HIPERLAN forwarding.

Handover: when the path over which messages flow between two communicating HIPERLAN nodes is changed, the process of uninterrupted communications is denoted as handover. HIPERLAN offers uninterrupted communications by means of forwarding.

HID: see **HIPERLAN IDentifier**.

HIPERLAN: HIgh PErformance Radio Local Area Network. The term is also used to denote a situation where nodes with the same HID are forming a network. A HIPERLAN is a set of HIPERLAN nodes that have the same HID, and which have the logical ability to interchange traffic. (See **Sub-network**).

HIPERLAN IDentifier (HID): a HIPERLAN sub-network identifier, used to differentiate HIPERLANs from each other. HIPERLAN nodes that holds a HID is said to be a member of that HIPERLAN.

HIPERLAN management function: the HIPERLAN management function is used - when a new HIPERLAN is created, when a node wants to join an existing HIPERLAN, to maintain unambiguous identifiers, and to maintain other resource management including physical layer management.

HIPERLAN sharing: when two HIPERLAN nodes are able to exchange messages over the radio medium, they are sharing the medium. Nodes that are not in radio contact with each other (either direct or by means of forwarding), are not sharing the medium. If two nodes that are not sharing the medium and have the same HID get within radio range, a HIPERLAN sharing function will resolve the conflict. (See also **Medium**).

Inter-HIPERLAN forwarding: a dynamic routing mechanism that enables a HIPERLAN node to provide connectivity to nodes identified as being members of another HIPERLAN (which has another HID). This connectivity requires an bilateral agreement between the two HIPERLANs.

Interworking: interaction between dissimilar sub-networks, end systems, or parts thereof, providing a functional entity capable of supporting end-to-end communications.

Intra-HIPERLAN forwarding: dynamic routing mechanism that enables a HIPERLAN node to provide connectivity within one single HIPERLAN (i.e. connectivity among nodes with the same HIPERLAN identifier).

Local Area Network (LAN): a group of user stations each of which can communicate with at least one other using a common transmission medium commonly managed.

Latency: a measure of the time taken to respond to a request for service.

Linear speed: the linear speed (relative to another node) of a node requiring HIPERLAN services whilst in motion.

Logical Link Control (LLC): ISO 8802 layer between the network layer and the MAC layer of the IEEE 802 reference model.

MAC Service Data Unit (MSDU): the fundamental unit of data delivery between MAC entities.
See: Service Data Unit.

Management entity: within each HIPERLAN node functions to manage creation of a new HIPERLAN, joining, leaving and maintaining unambiguous identifiers, are embedded in the HIPERLAN Management Entity.

Medium: generally any entity upon which a signal is impressed or from which a signal is received.
In HIPERLAN the term medium is used in a more restrictive sense. HIPERLAN nodes that are in radio contact with each other (either directly or by means of forwarding), are said to share the communications medium. This shared medium is referred to as "the medium". A node that is out of range of other nodes in a HIPERLAN, is in this definition not sharing the medium. If two different HIPERLANs are to share the same medium (some nodes of one HIPERLAN is sharing the medium with some other nodes of the other HIPERLAN), the two HIPERLANs must have different HIDs. If the two HIPERLANs are not sharing the same medium, then they may have the same HID (and still be two different HIPERLANs). To resolve potential conflicts of sharing the medium (for example, to resolve conflicting identifiers), a HIPERLAN sharing function is defined.

Medium Access Control (MAC): the layer of the ISO 8802 reference model between the PHY (see definition) and the LLC (see definition).

Mobility tolerance: the Mobility tolerance of HIPERLAN defines the maximum relative speed at which a HIPERLAN node will operate.

Network address: the network address of a HIPERLAN is logically equivalent to the HIPERLAN identifier. See: **HIPERLAN IDentifier**.

Node: a generic term for a device that can operate in a HIPERLAN sub-network. A node (or HIPERLAN node) is an entity capable of having at least one HIPERLAN identifier (HID), and within the HIPERLAN(s) having at least one unambiguous node identifier (NID). The tuple of (HID, NID) makes the node unique within the medium. (See also **Medium**).

Node IDentifier (NID): an unambiguous identifier that differentiates entities within a single HIPERLAN sub-network.

Normalised systems capacity: HIPERLAN supports a certain system capacity. This capacity normalised over area is defined as the normalised systems capacity.

Protocol Data Unit (PDU): data unit exchanged between entities at the same ISO layer.

Personal Computer Memory Card Interface Association (PCMCIA): HIPERLAN implementations will have the size of a PCMCIA form factor III (85 mm x 54 mm x 10,5 mm).

Physical Layer **(PHY):** Layer 1 of the ISO/OSI reference model. The mechanism for transfer of symbols between HIPERLAN nodes.

Private: HIPERLAN is a private virtual radio sub-network. In this context the term "private" means that the network is user owned and operated. (See HIPERLAN).

Range: the maximum distance separation between two HIPERLAN nodes at which communications with a sufficient quality of service can be offered.

Reduced data rate: at short range HIPERLAN supports communications at full data rate. At longer range the data rate can be reduced. This low data rate is denoted as the reduced data rate.

Resource sharing function: the rules for sharing the radio medium in an equitable way are implemented in a HIPERLAN resource sharing function.
See also: Medium.

Service Data Unit (SDU): data unit exchanged between adjacent ISO layers.

Sub-network: a physical medium (media) or a collection of both equipment and physical media, which form(s) an autonomous whole and which can be used to interconnect systems for the purpose of communications.

Time-bounded services: time-bounded services denotes transfer services with low delay and low delay variance for use with voice and other real-time services.

Unambiguous identifiers: see **Node IDentifier** and **HIPERLAN IDentifier**.

User perceived data rate: see **Data rate**.

3.2 Abbreviations

For the purposes of this ETR, the following abbreviations apply:

DLC	Data Link Control
ERC	European Radio Communications committee
ETR	ETSI Technical Report
FDDI	Fibre Distributed Data Interface
HIPERLAN	HIgh PErformance Radio Local Area Network
HID	HIPERLAN IDentifier
ISDN	Integrated Services Digital Network
LAN	Local Area Network
LLC	Logical Link Control
LME	Layer Management Entity
LLC	Logical Link Control
MAC	Medium Access Control
MSDU	MAC Service Data Unit
MPDU	MAC Protocol Data Unit
MSDU	MAC Service Data Unit
NID	Node IDentifier
OSI	Open Systems Interconnection
PCMCIA	Personal Computer Memory Card Interface Association
PDU	Protocol Data Unit
SDU	Service Data Unit

4 General requirements

4.1 Distributed processing systems, wired LAN extensions and alternatives

HIPERLAN networks are primarily intended to support distributed systems. These systems are characterised by highly variable patterns of interaction between the interconnected systems. The frequency and intensity of interaction is largely a function of the design of the operating software of the computers involved and not so much a function of the demands of the users. The messages exchanged between distributed systems are typically short - of the order of a few hundred bytes - but the message frequency can be quite high - of the order of hundreds per second.

HIPERLAN networks will be used in the majority of applications as extension or replacement of wired LANs. The demands LAN systems place on the network are characterised by short messages generated at high frequency.

4.2 Mixed asynchronous and time-bounded services

The network traffic generated by a given node is often unpredictable and bursty in nature, quite different from the usual patterns of telecommunication where connections are established for a given period of time before they are released again. HIPERLAN networks shall be able to support this bursty traffic pattern efficiently and with short response times.

HIPERLAN networks will be used to support a variety of applications, some of which will handle both data and voice and/or video. Whereas the interchange of computer data, because of its bursty nature, requires asynchronous services, voice and video require services with a low delay variance (nominally time-bounded). HIPERLAN provides for both types of service.

4.3 Multiple networks and criteria for sharing

The typical HIPERLAN user will deploy his radio network with little or no concern for other such systems that may be deployed in the vicinity by other users. These other users may be part of the same organisation but they can also be part of another organisation. In either case, the HIPERLAN-based network is able to share the radio medium with other HIPERLAN-based networks without the need for explicit frequency planning or co-ordination. The sub-networks themselves are able to function adequately in the face of interference from similar systems. This interference will give rise to performance degradation but will not lead to any HIPERLAN becoming inoperable.

4.4 Mobility

Since HIPERLAN networks will frequently be used to provide untethered access to wired LAN systems (typically for user at ambulant speed), a measure of mobility shall be accommodated. The HIPERLAN node shall be able to send and receive information whilst in motion. The speed of movement is typically restricted to walking speed or indoor vehicle speed: a maximum resultant linear speed of 10 m/s (equivalent to 36 km/h) relative to other nodes and a maximum angular speed of 360°/s, will cover most if not all cases.

4.5 Security

Security covers a number of subject areas including authentication of users and systems, access control to systems, services and applications, data confidentiality and data integrity as well as the management of the facilities that implement security functions.

In the case of HIPERLAN the security issues are those of any wired LAN with the addition of those resulting from the use of the radio medium.

HIPERLAN can at least protect its users from casual eavesdropping and data injection in order to provide a level of security comparable to that of a wired LAN. This protection should be contiguous over multiple radio networks that together cover a given area under one administration.

Beyond that level of protection HIPERLAN allows the user to make use of security services defined by other Open Systems standards for information security.

4.6 Power, size and costs

HIPERLAN systems will be used in many applications of portable computers and other battery powered equipment. Therefore, the electrical power consumed by a HIPERLAN communications sub-system should be low relative to that of its host computer.

Size will be a major factor in nearly all HIPERLAN systems: untethered devices will be portable and the size of portable computer systems is still decreasing. A typical size of a PCMCIA Type III form-factor (85 mm x 54 mm x 10,5 mm), excluding antenna system should be kept in mind for the HIPERLAN implementation.

Cost is another constraint placed on HIPERLAN systems: the cost of computer equipment is still coming down rapidly.

4.7 Interoperability

There will be a basic common air interface for all HIPERLAN implementations. Whilst there is an allowance for enhancement, detailed in the HIPERLAN ETS, all nodes will have the ability to inter-operate to the basic common air interface.

4.8 Safety

HIPERLAN will conform to all applicable safety standards.

5 Operating requirements

The main operational parameters of HIPERLAN systems are data rate, latency and delay, systems throughput and capacity and interference. Each will be reviewed in more detail below.

5.1 Data rate

The "instantaneous data rate" describes the speed at which data can be transferred between any two nodes in a HIPERLAN system. The phrase "data rate" should be regarded as the user perceived data rate (the speed at which data is transferred at the MAC interface level to HIPERLAN), not the lower layer data rates, which may be different from the rates perceived by the users. The data rate obtained by the user at the MAC interface level of HIPERLAN is also referred to as the net data rate.

In Local Area Networks where the emphasis is on computer interaction, high data rates are essential in order to reduce delays in processing. The minimum acceptable data rates vary with the areas of application.

In order to support a broad range of LAN applications HIPERLAN will offer asynchronous services with a range of data rates up to 20 Mbit/s. Future developments could require this upper limit to be changed. At distances of up to 800 m a reduced data rate (1 Mbit/s) may be used.

HIPERLAN will support services for connection-oriented time-bounded environments e.g. video phone, by providing at least 64 kbit/s. The maximum data rate to be supported by HIPERLAN for such applications is the ISDN primary rate of 2 048 kbit/s per bearer.

5.2 Latency

Latency is the measure of how quickly the system is able to respond to requests for service. In the case of HIPERLAN the service is the transport of information - sometimes as little as a few bytes - between two nodes. Wired LANs designed for computer interaction requires a latency of less than 1 ms. In the lower range of performance, file transfer between systems or messaging between human operators or systems on a work floor or in a warehouse may tolerate hundreds of milliseconds of latency.

For asynchronous HIPERLAN services, the mean latency of medium access will not exceed 1 ms with the radio channel loaded with up to 30% of its full capacity. For time-bounded services, the latency of service is not defined within the HIPERLAN specification.

5.3 Delay

Allowable delay is an application-dependent parameter. Limits are not defined.

5.4 Delay variance

Certain applications such as those involving real-time interaction impose close tolerances on the variance that transfer delays can take, typically of the order of a few tens of milliseconds. This requirement calls for an approximation to time-bounded services, HIPERLAN systems are able to support a wide range of delay variance requirements.

The allowed delay variance in completing an instance of a service is $(3,0\ \text{ms})^2$ for the time-bounded service. The asynchronous service is not subject to a limit on delay variance.

5.5 Systems throughput and systems capacity

Like the other parameters, systems throughput also shows considerable variance of the requirements imposed by the different applications. A large office system generates many Megabytes/s of network traffic during busy hours although it will be quiet at other times. The throughput will vary with the use made of such facilities as voice and video messaging or interaction. A factory automation network is more likely to operate continuously but at lower overall rates.

A HIPERLAN will support a normalised system capacity of 1 000 Mbit/s per hectare per floor.

5.6 Range

The minimum distance between two HIPERLAN nodes that operate under all conditions is known as the co-location tolerance. This will be 50 cm.

The typical range at full data rate (20 Mbit/s) for a HIPERLAN node will be 50 m.

The typical range at the reduced data rate (1 Mbit/s) for a HIPERLAN node will be 800 m.

5.7 Interference

5.7.1 Non-HIPERLAN interference

The HIPERLAN protocol will maintain better than 80% of maximum throughput under the following types of interference from non-HIPERLAN systems:

- the maximum duration of interference not exceeding 100 ms per instance;

- the aggregated duty cycle of the interfering system(s) not exceeding 1%.

5.7.2 HIPERLAN interference

HIPERLAN systems tolerate co-located HIPERLAN systems operating in an uncoordinated manner without actual loss of service. However, performance on any given channel may be reduced.

5.8 Error rate

At maximum range and with no interference, the MPDU combined detected loss/error rate provided by HIPERLAN will be better than 10^{-3}. Under the same conditions, the MPDU undetected loss/error rate will be better than 8×10^{-8} per octet of MPDU. The MSDU undetected error rate will be better than 5×10^{-14} per octet of MSDU.

5.9 Summary of HIPERLAN parameters

A summary of HIPERLAN parameters is given in table 1.

Table 1: Summary of HIPERLAN parameters

Parameter	Traffic Type	Value
Data rate:	asynchronous:	to 20 Mbit/s.
	time-bounded:	kbit/s to 2 048 kbit/s.
Systems throughput		Mbit/s. 1 000 Mbit/s per hectare per floor
Mean latency	asynchronous:	< 1 ms (at 30% capacity)
Latency of service initiation	time-bounded:	< 3 s
MSDU Delay variance	asynchronous:	no limit
	time-bounded:	$< (3{,}0\ ms)^2$
Range		to 50 m at 20 Mbit/s to 800 m at 1 Mbit/s
MPDU detected loss/error rate:		$< 10^{-3}$
MPDU undetected loss/error rate:		$< 8 \times 10^{-8}$ per octet of MPDU
MSDU undetected loss/error rate		$< 5 \times 10^{-14}$ per octet of MSDU
Co-location tolerance		cm of free space
Mobility tolerance		m/s linear, 360º/s angular
Packet Information Field Maximum Size		kbyte
Physical Size Target (excluding antenna system)		PCMCIA type III 85 mm x 54 mm x 10,5 mm
Power Consumption		few hundred mW

6 HIPERLAN reference model

6.1 Basic principles

6.1.1 Introduction

The HIPERLAN Reference Model defines the components needed to build a Private Virtual Radio sub-network. Private in this context means User owned and operated. A Virtual sub-network is a logical subset of a set of communicating entities each of which is differentiated from the rest by some unambiguous identifier (Node Identifier or NID). Virtual sub-networks are differentiated by an additional level of unambiguous identifier (HIPERLAN Identifier or HID).

The essential difference between a HIPERLAN and any existing standard sub-network is the intrinsic sharing of the communications medium owing to the characteristics of radio transmission, together with the implications of mobility in such an environment. Radio transmission causes implicit sharing of the communications medium owing to its uncontrolled propagation characteristics. The need to support multiple networks sharing the medium sub-networks leads to the above description in terms of virtual networks. In addition, HIPERLAN provides support for mobile entities both within a single HIPERLAN as well as across multiple HIPERLANs.

Any real system will include components, in addition to those defined by HIPERLAN, taken from existing standards or proprietary architectures and applications.

6.1.2 Shared communications medium

The meaning of "shared communications medium" needs precise explanation in order to understand HIPERLAN sharing. The HIPERLAN reference model does not specify any particular radio communication technique, spectrum partitioning strategy or modulation scheme. In general, if the radio resource is partitioned, each partition will be subject to sharing independently from the others. Whatever techniques and strategies are used, the following are true for each partition:

In figure 1 below, HIPERLAN A and HIPERLAN B are unable to establish any communications path.

Figure 1: Non-intersecting HIPERLANs,unable to establish a communications path between themselves

No member of A is within radio transmission range of any member of B and there are no interconnections via any other sub-network. Therefore, HIPERLAN A and HIPERLAN B will be considered to be completely independent. Even though they communicate internally using identical radio frequencies and techniques, they are not considered to be sharing the same communications medium. The HIDs of A & B are unrelated, as are their NIDs. The extent of HIPERLAN A (or that of B) will be the union of the overlapping connection sets (sub-sets of nodes in direct radio communication range) possibly extended by repeaters.

Complete conductivity within a HIPERLAN will be obtained via a dynamic routing mechanism (Intra-HIPERLAN forwarding) consistent with the dynamic nature of connection set membership as a function of the radio propagation environment.

HIPERLAN makes no assumptions about topology. In the general case, all members of a HIPERLAN are simply nodes. Some nodes may provide specific services, such as interworking functions to other HIPERLANs or other networks, and some nodes may be so organised as to provide an infrastructure supported by specific implementations of intra-HIPERLAN forwarding.

In figure 2, some members of HIPERLAN A are within radio communications range of some members of B. A & B employ HIPERLAN Sharing.

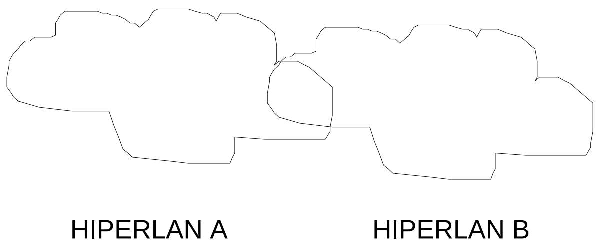

Figure 2: Intersecting HIPERLANs, able to establish a communications path between themselves

A portion of the geographical space occupied by the radio propagation of HIPERLANs A & B will be common to both. Since each member of a given HIPERLAN is able to communicate with all other members of that HIPERLAN (via the intra-HIPERLAN forwarding mechanism), the shared communications medium is said to be the union of A and B. Within the medium, the HIDs of A & B are required to be unique, and consequently, the tuple (HID, NID) will be unique within the medium.

Figure 3 shows the generalisation of this sharing.

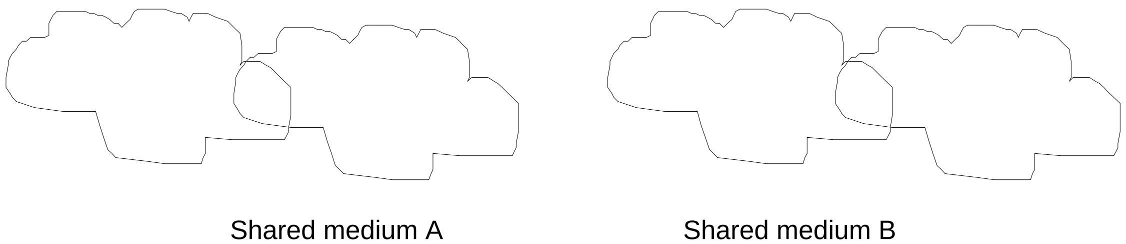

Figure 3: Generalisation of sharing between HIPERLANs

HIPERLAN Reference Model concepts will apply to medium A independently of medium B i.e., it is not required that the HIDs within medium A be unique from those within medium B.

HIPERLAN will provide support for Ad-hoc sub-networks. The dynamic creation of HIPERLANs in the medium requires the dynamic allocation of HIDs. HIPERLAN nodes may be members of several HIPERLANs simultaneously. HIPERLAN will require a function to provide the necessary unambiguous identifiers.

6.1.3 Intersecting media

Owing to the mobile capabilities of HIPERLAN nodes, and also the dynamic nature of the propagation environment, two or more media may be brought into contact. This intersection may cause the previously unrelated sets of identifiers to no longer be unambiguous. HIPERLAN will include a HIPERLAN Sharing Function to detect and resolve such conflicts.

6.1.4 Resource management

HIPERLANs should share the medium's communications capacity (transmission bandwidth) equitably. A set of rules for this resource sharing will be implemented in a resource sharing function.

6.1.5 Mobility

A HIPERLAN node may be mobile. It may move within its HIPERLAN implying that the optimal route to it from any other member of the same HIPERLAN may change as a function of time. The intra-HIPERLAN forwarding scheme must provide the necessary mechanisms for efficient path management within the HIPERLAN in the same way that it should deal with changing connection sets owing to the dynamics of the radio propagation environment.

If a mobile node leaves the range of its HIPERLAN it becomes unreachable. If the node comes into range of another HIPERLAN, before it can return to its own, then it may establish a communications path to its HIPERLAN via the new HIPERLAN if such a path is possible and allowed. In order to do this it should become a member of the new HIPERLAN. It may choose to retain its current membership or to rescind it and replace it with its membership of the new HIPERLAN. In either case this information should be propagated to the original HIPERLAN in order to maintain communications. For this information to be propagated, there should be co-operation between the two HIPERLANs (inter-HIPERLAN forwarding). Inter-HIPERLAN forwarding requires a bilateral agreement (i.e. both HIPERLANs agree) between two HIPERLANs to support forwarding. There may be an arbitrary number of bilateral agreements.

Co-operating HIPERLANs permit the handover of communications between member nodes throughout the union of their HIPERLANs. A co-operation may be temporary (to support a transient node) or permanent to efficiently facilitate organisational needs for mobility.

6.2 Reference model

6.2.1 General

The HIPERLAN Reference Model is a subset of the OSI Reference Model; it consists of the Physical layer and its LME, the MAC sub layer and its LME and the DLC layer and its LME.

These service layers determines the protocol between any two HIPERLAN nodes.

The Layer Management Entity (LME) determines the subsystem management information that is exchanged between HIPERLAN nodes.

6.2.2 Layer functionality

See figure 4 below:

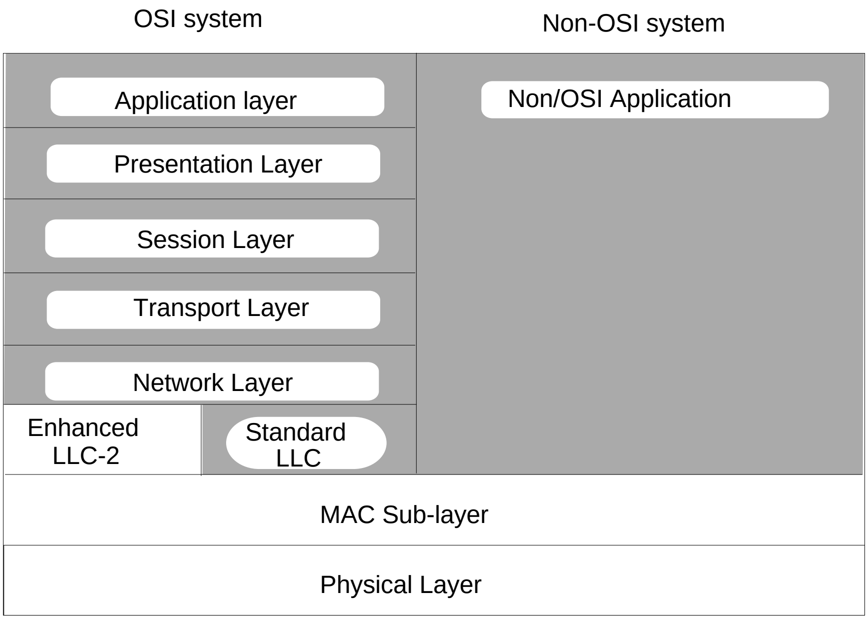

Figure 4: The non-shaded areas are defined by HIPERLAN

6.2.2.1 LLC type 2 enhancements

In order to provide time-bounded services to Open Systems Interconnection (OSI) applications, enhancements will be required to a type 2 connection-oriented Logical Link Control (LLC) protocol at the Data Link Control (DLC) sub layer.

6.2.2.2 MAC sub-layer

The medium access sub-layer of HIPERLAN will provide conventional MAC services as described in ISO 8802, and a time-bounded service.

6.2.2.3 Physical layer

The physical layer of HIPERLAN will provide the interface into the radio medium. It provides the radio transmitters, receivers and other functions that allow bit streams to be exchanged over the air.

6.2.3 HIPERLAN management

The management functions concerned with creating, joining and leaving HIPERLANs and the associated maintenance of unambiguous identifiers, HIPERLAN Sharing, Inter- and Intra-HIPERLAN forwarding and resource management and physical layer management will be embodied in the HIPERLAN Management Function. See figure 5 below:

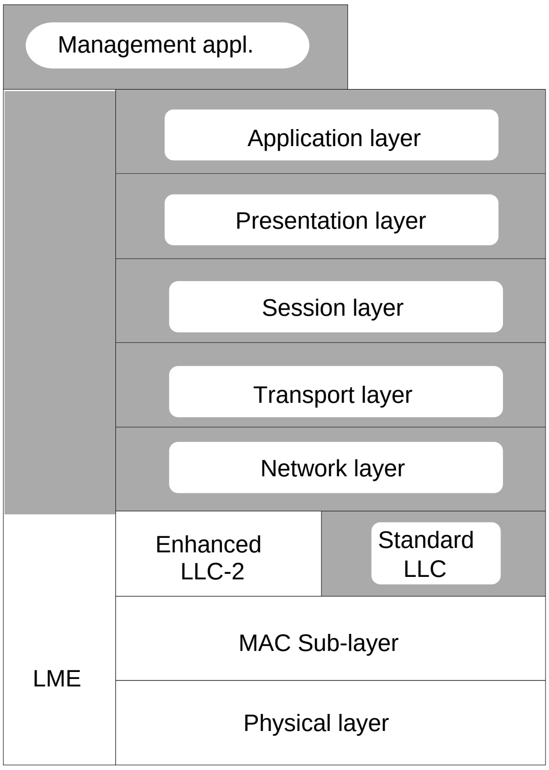

Figure 5: HIPERLAN management in OSI systems

6.2.4 External interfaces

HIPERLAN will provide the following external interfaces: the air interface, the DLC interface, the MAC interface and the interface to the HIPERLAN Management function.

The air interface will be specified in terms including frequencies used, channelisation, modulation, transmitter power levels, receiver performance and general spurious emissions.

The interface to the HIPERLAN Management function will be specified in terms of the Managed Objects and the operations allowed on these objects.

6.3 Interworking

Interworking between HIPERLAN systems and other systems will be possible through the MAC and DLC interfaces.

Examples of networks interworking with HIPERLAN include:

- ISO 8802;
- ISDN;
- PSTN;
- PSPDN;
- FDDI.

6.3.1 MAC level bridging

MAC level bridging will allow HIPERLAN systems to interwork with other sub-networks providing ISO 8802 MAC services (and HIPERLAN specific MAC services). See figure 6 below:

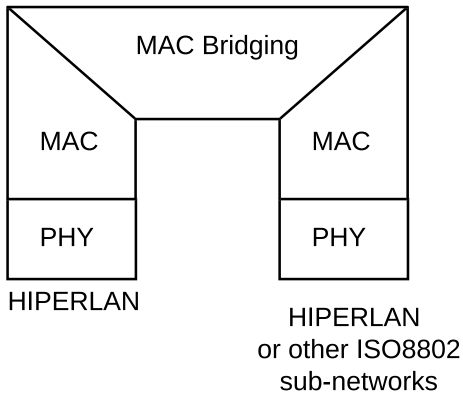

Figure 6: HIPERLAN MAC bridging model

6.3.2 Network level interworking

Network level interworking will allow HIPERLAN-based systems to interwork with other networks to provide a common network service. See figure 7 below:

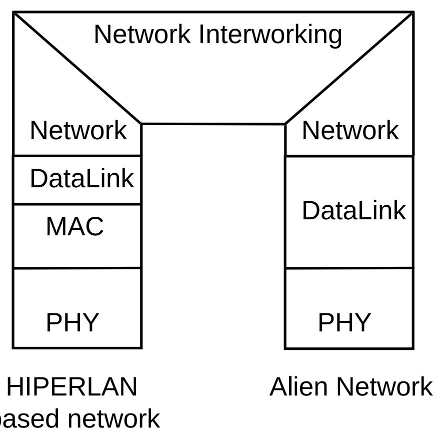

Figure 7: HIPERLAN based network interworking

7 Services

7.1 Asynchronous services

Asynchronous services are services in which there is no fixed timing relationship between the activities of sender and receiver.

HIPERLAN will provide the following asynchronous services:

- asynchronous packet transfer service;

- asynchronous packet broadcast service.

7.2 Time-bounded services

Time-bounded services are services in which there is a nominally fixed timing relationship between the activities of sender and receiver. They require the establishment of a connection between sender and receiver; they rely on connection-oriented communication protocols.

The HIPERLAN standard provides for time-bounded services at user data rates of multiples of 64 kbit/s up to at least 2 048 kbit/s. Provision of higher rates will be the subject of further study. HIPERLAN's implementation of time-bounded services will allow interworking with a variety of circuit-switched networks, notably ISDN.

The inclusion of time-bounded services in a HIPERLAN node will be optional. If included, the maximum available rate at the node can be any multiple of 64 kbit/s. This maximum rate should be usable for transmission, reception, and any time-bounded inter- and intra-HIPERLAN forwarding of which the node will be capable.

Provision of time-bounded services may not be practical under all conditions.

8 Facilities

HIPERLAN will provide a number of facilities that allows the user of the HIPERLAN subsystem to control the operation of the subsystem and to obtain information about the radio environment. The facilities fall into three broad classes:

- Operational control: this will control the creation and membership of HIPERLANs;

- Configuration control: this will control operating parameters of the HIPERLAN;

- Reporting: this will allow the HIPERLAN user (e.g. an application program) to obtain information about other HIPERLAN entities in its vicinity.

The facilities defined here will cause the exchange of management information between HIPERLAN nodes.

8.1 Operational control

8.1.1 Enable/disable HIPERLAN sub-system

This facility will allow a node to enable or disable its services to a given HIPERLAN.

8.1.2 Create HIPERLAN

This facility will allow a node to create a new HIPERLAN with a given set of configuration parameters.

NOTE: Termination of a HIPERLAN is implicit: it occurs when there are no members left.

8.1.3 Join a given HIPERLAN

This facility will allow a node to join (become a member of) a given existing HIPERLAN.

8.1.4 Leave a given HIPERLAN

This will allow a node to leave (rescind membership of) a given HIPERLAN.

8.2 Configuration control

8.2.1 Enable/disable intra-HIPERLAN forwarding

This facility will allow a node to enable or disable forwarding within a given HIPERLAN.

8.2.2 Enable/disable inter-HIPERLAN forwarding

This facility will allow a node to enable or disable forwarding between two given HIPERLANs. The node must be a member of both HIPERLANs.

8.2.3 Enable/disable encryption

This facility will allow a node to enable and disable the encryption of the user data of the frames that node transmits on a given HIPERLAN.

8.2.4 Change encryption key

This facility will allow a node to change the encryption key used on a given HIPERLAN.

8.2.5 Change forward error control

This facility will allow a node to change the forward error control of the user data of the frames that node transmits on a given HIPERLAN.

8.2.6 Change power conservation parameters

This facility will allow a node to change power conservation parameters (e.g. RF partition and listening interval).

8.3 Reporting

8.3.1 Show partitions

This facility will allow a node to find out which RF partitions it can use.

8.3.2 Show HIPERLANs

This facility will allow a node to find out which HIPERLANs are in radio range.

8.3.3 Show nodes

This facility will allow a node to find out which nodes (NIDs) are members of a given HIPERLAN.

8.3.4 Show node configuration

This facility allows a node to find out the configuration parameters of a given node.

8.3.5 Show node statistics

This facility will allow a node to obtain statistical information concerning communications with any HIPERLAN node.

9 Conformance considerations

The HIPERLAN standard will specify different levels of conformance, up to the level of full interoperability.

Annex A (informative): Bibliography

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[8] ISO 10039 (1991): "Information technology - Open systems interconnection - Local Area Networks - Medium Access Control (MAC) service definition".

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History

Document history	
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