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ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

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

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

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1 Scope

CEPT Recommendation T/R 22-06 [1] permits the operation of high speed radio local area networks in the 5,15 to 5,30 GHz and 17,1 to 17,3 GHz frequency bands. These types of radio networks are referred to as HIgh PErformance Radio Local Area Networks (HIPERLANs).

This ETS specifies the technical characteristics of HIPERLAN Type 1 that operates in the 5,15 to 5,3 GHz frequency band and that uses Non-Pre-emptive Priority Multiple Access (NPMA) as the channel access method.

HIPERLAN Type 1 is confined to the lowest two layers of the Open Systems Interconnection (OSI) model: the Physical Layer and the Medium Access Control (MAC) part of the Data Link Layer. Functions of higher layers are required for operation and interworking of a complete systems. These higher layers are outside the scope of this document.

This ETS does not address the requirements and technical characteristics required for type approval and conformance testing. These are covered in a separate HIPERLAN ETS.

Separate ETSI standards address other types of HIPERLAN systems.

2 Normative references

This ETS incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] CEPT Recommendation T/R 22-06: "Relating to the harmonized radio frequency bands for HIgh PErformance Radio Local Area Networks (HIPERLANs) in the 5 GHz and 17 GHz frequency range".

[2] ISO 7 498-1 (1984): "Open systems interconnection - Basic reference model (plus TC1: 1988)".

[3] ISO 7 498-1 ADD (1987): "Open systems interconnection - Basic reference model - Addendum 1: Connectionless data transmission".

[4] ISO 7 498-3 ADD (1989): "Open systems interconnection - Basic reference model - Addendum 3: Naming and addressing".

[5] ISO TR 8 509 (1987): "Open systems interconnection - Service conventions".

[6] IEEE 802.1 (1990): "Overview and Architecture".

[7] ISO 15 802-1: "Local and metropolitan area networks - Common specifications - Part 1: Medium Access Control (MAC) service definition".

[8] ISO 10 038 (1993): "Local and metropolitan area networks - Medium Access Control (MAC) bridges".

[9] ISO 10 646-1 (1993): "In formation technology - Universal Multiple-Octet Coded Character Set (UCS) - Part 1: Architecture and Basic Multilingual Plane".

3 Definitions, abbreviations and symbols

3.1 Definitions

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

3.1.1 Basic reference model definitions

This ETS is based on the concepts developed in the open system interconnect basic reference model and makes use of the following terms defined in ISO 7 498 [2], [3], [4]:

- layer;
- sublayer;
- entity;
- entity title;
- service;
- service access point;
- service access point address;
- quality of service;
- service data unit;
- protocol data unit;
- physical layer;
- data link layer.

3.1.2 Service conventions definitions

This ETS makes use of the following terms defined in ISO TR 8 509 [5]:

- service user;
- service provider;
- service primitive;
- request;
- indication;
- confirm.

3.1.3 Local area network definitions

This ETS makes use of the following terms defined in IEEE 802.1 [6]:

- local area network;
- logical link control;
- medium access control.

3.1.4 Medium access control service definitions

This ETS makes use of the following term defined in ISO 15 802-1 [7]:

- group-MSAP-address.

This ETS makes use of the following term defined in ISO 10 038 [8]:

- MAC service data unit (MSDU).

3.1.5 HIPERLAN definitions

This ETS defines the following definitions:

Channel Access Control (CAC): The sublayer between the MAC sublayer and the physical layer in the HIPERLAN reference model.

Elimination-Yield Non-Pre-Emptive Priority Multiple Access (EY-NPMA): The specific NPMA used to access the HIPERLAN channel.

Non-Pre-Emptive Priority Multiple Access (NPMA): The principle of channel access mechanism which provides hierarchical independence of performance by means of channel access priority.

3.2 Abbreviations

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

3.2.1 General

CAC	Channel Access Control
EY-NPMA	Elimination-Yield Non-Pre-emptive priority Multiple Access
HEU	HIPERLAN Enhancement Unit
HIPERLAN	High Performance Radio Local Area Network, Type 1
LAN	Local Area Network
MAC	Medium access Control
NPMA	Non-Pre-emptive priority Multiple Access
OSI	Open Systems Interconnection
PHY	PHYsical layer
RLAN	Radio Local Area Network

3.2.2 HIPERLAN MAC sublayer general

HM-entity	HIPERLAN MAC entity
HMPDU	HIPERLAN MAC Protocol Data Unit
HMQoS	HIPERLAN MAC Quality of Service
HMS-primitive	HIPERLAN MAC Service primitive
HMS-provider	HIPERLAN MAC Service provider
HMS-user	HIPERLAN MAC Service user
MSAP	MAC Service Access Point
MSAP-address	MAC Service Access Point address
MSDU	MAC Service Data Unit

3.2.3 HIPERLAN CAC sublayer general

CAM	Channel Access Mechanism
HC-entity	HIPERLAN CAC entity
HCPDU	HIPERLAN CAC Protocol Data Unit
HCQoS	HIPERLAN CAC Quality of Service
HCS-primitive	HIPERLAN CAC Service primitive
HCS-provider	HIPERLAN CAC Service provider
HCS-user	HIPERLAN CAC Service user
HCSAP	HIPERLAN CAC Service Access Point
HCSAP-address	HIPERLAN CAC Service Access Point address
HCSDU	HIPERLAN CAC Service Data Unit
HBR-part	High-Bit-Rate part of the HIPERLAN CAC protocol data unit
LBR-part	Low-Bit-Rate part of the HIPERLAN CAC protocol data unit

3.2.4 Physical layer general

BCH	Bose-Chaudhuri-Hocquenghem
CCA	Clear Channel Assessment
EIRPEP	Effective Isotropic Radiated Peak Envelope Power
FSK	Frequency Shift Keying
GMSK	Gaussian Minimum Shift Keying
MADT	Maximum Adaptive Defer Threshold
NTP	Normal Transmitted Power
RF	Radio Frequency
RSSI	Received Signal Strength Indication
SLN	Signal Level Number

3.2.5 HIPERLAN MAC protocol data units

The following HMPDUs are confined to the HIPERLAN MAC protocol specification:

DT-HMPDU	DaTa HIPERLAN MAC Protocol Data Unit
GP-HMPDU	Group-attendance Pattern HIPERLAN MAC Protocol Data Unit
HO-HMPDU	HellO HIPERLAN MAC Protocol Data Unit
IP-HMPDU	Individual-attention Pattern HIPERLAN MAC Protocol Data Unit
LC-HMPDU	Look-up Confirm HIPERLAN MAC Protocol Data Unit
LR-HMPDU	Look-up Request HIPERLAN MAC Protocol Data Unit
TC-HMPDU	Topology Control HIPERLAN MAC Protocol Data Unit

3.2.6 HIPERLAN MAC protocol data unit fields

The following HMPDU fields are confined to the HIPERLAN MAC protocol specification:

ADA	Alias Destination MSAP-Address field
ASA	Alias Source MSAP-Address field
DA	Destination MSAP-Address field
HID	HIPERLAN IDentifier field
HN	HIPERLAN Name field
IV	Initialization Vector field
KID	Key IDentifier field
LI	HMPDU Length Indicator field
ML	MSDU Lifetime field
MSN	Multipoint relay set Sequence Number field
NA	Neighbour HCSAP-Address field
NS	Neighbour Status field
OA	Originator HCSAP-Address field
PI	Practice Interval field
PO	Pattern Offset field
PP	Pattern Period field
PSN	HMPDU Sequence Number field
RL	residual HMPDU Lifetime field
RTI	Relay Type Indicator field
SA	Source MSAP-Address field
SC	Sanity Check field
SMA	Source Multipoint relay HCSAP-Address field
TI	HMPDU Type Indicator field
UD	User Data field
UP	User Priority field

3.2.7 HIPERLAN CAC protocol data units

The following HCPDUs are confined to the HIPERLAN CAC protocol specification:

AK-HCPDU	AcKnowledgement HIPERLAN CAC Protocol Data Unit
CP-HCPDU	channel permission HIPERLAN CAC Protocol Data Unit
DT-HCPDU	DaTa HIPERLAN CAC Protocol Data Unit

3.2.8 HIPERLAN CAC protocol data unit fields

The following HCPDU fields are confined to the HIPERLAN CAC protocol specification:

AID	Acknowledgement IDentifier field
AIDCS	Acknowledgement IDentifier CheckSum field
BLI	Block Length Indicator field
BLIR	Block Length Indicator Replica field
BLIRCS	Block Length Indicator Replica CheckSum field
C3	Channel 3 field
C4	Channel 4 field
CS	CheckSum field
DA	Destination HCSAP-Address field
HDA	Hashed Destination HCSAP-Address field
HDACS	Hashed Destination HCSAP-Address CheckSum field
HI	HBR-part Indicator field
HID	HIPERLAN IDentifier field
PAD	PADding field
PLI	Padding Length Indicator field
SA	Source HCSAP-Address field
TI	HCPDU Type Indicator field
UD	User Data field

3.3 Symbols

For the purposes of this ETS, the following symbols apply:

Int	largest integer less than or equal to
Max	the maximum value among
Mod	modulo
Not	logical inversion
PICS	Protocol Implementation Conformance Statement
dB	decibel
dBm	dB relative to 1 mW
rect	rectangular pulse function

4 Overview

In this ETS, the term "HIPERLAN" is used to refer to HIPERLAN, Type 1.

A HIPERLAN is a Radio Local Area Network (RLAN) in which all nodes communicate using a single shared communication channel. A HIPERLAN has the following properties:

- it provides a service that is compatible with the ISO MAC service definition ISO 15 802-1 [7];
- its operations are compatible with the ISO MAC bridges specification ISO 10 038 [8] for interconnection with other LANs;
- it may be deployed in a pre-arranged or an ad-hoc fashion;
- it supports node mobility;
- it may have a coverage beyond the radio range limitation of a single node;
- it supports both asynchronous and time-bounded communication by means of a Channel Access Mechanism (CAM) with priorities providing hierarchical independence of performance;
- its nodes may attempt to conserve power in communication by arranging when they need to be active for reception.

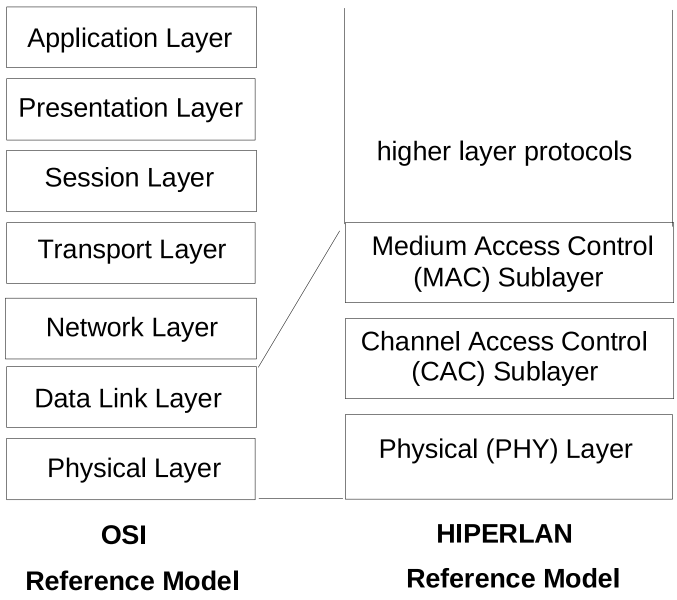


Figure 1: OSI and HIPERLAN reference models

The HIPERLAN reference model is composed of a Medium Access Control (MAC) sublayer, a CAC sublayer and a physical layer. The mapping of the HIPERLAN reference model to the OSI reference model is shown in figure 1. In this layering model, HIPERLAN applications are outlined as higher layer protocols above the HIPERLAN layers.

The HIPERLAN communication model is shown in figure 2.

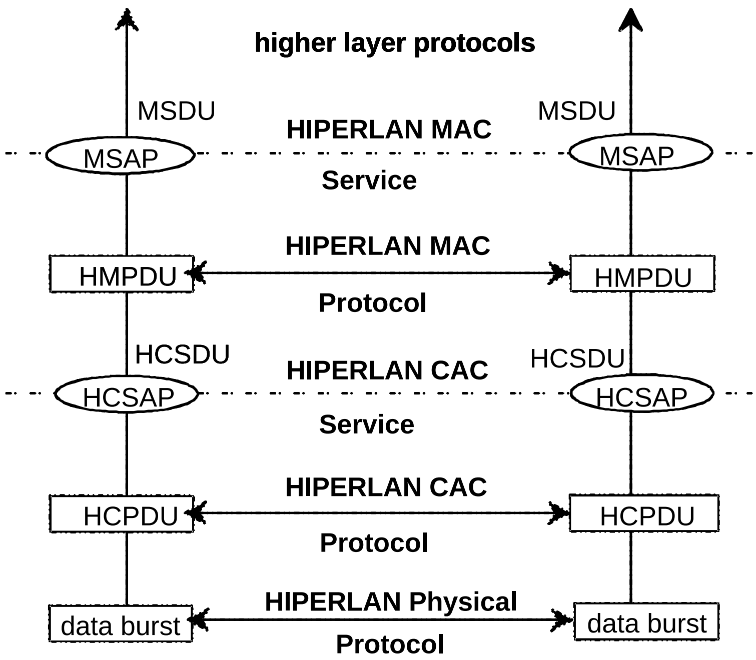


Figure 2: HIPERLAN communication model

The HIPERLAN MAC service:

- is based on, and therefore is compatible with, the ISO MAC service definition;
- defines the communication service over a single HIPERLAN;
- allows the timing requirements of the MSDU transfer to be specified; and
- allows exploration of available HIPERLANs for dynamic HIPERLAN access.

The HIPERLAN CAC service:

- defines the communication service over a single shared communication channel;
- allows the channel access priority requirements of the HCSDU transfer to be specified; and
- frees the HCS-user from the concerns of the characteristics peculiar to any particular communication channel.

The HIPERLAN MAC protocol:

- provides the HIPERLAN MAC service;
- specifies the behaviour of a HM-entity in a given HIPERLAN;
- is compatible with the ISO MAC bridges specification ISO 10 038 [8]; and
- uses the HIPERLAN CAC service.

The HIPERLAN CAC protocol:

- provides the HIPERLAN CAC service;
- specifies, for a particular set of one or more shared radio channels, the appropriate hierarchically independent channel access mechanism used by a HC-entity in a given HIPERLAN; and
- uses the transmission and reception facilities specified by the HIPERLAN physical layer.

The HIPERLAN physical protocol:

- provides the transmission and reception facilities to the HIPERLAN CAC sublayer; and
- specifies, for a particular set of one or more shared radio channels, the techniques of transmission, reception, and channel assessment in a given channel.

4.1 HIPERLAN addressing

The HIPERLAN addressing requirements are elaborated in the following subclauses.

4.1.1 MAC Service Access Point (MSAP) addressing

In order to be compatible with the ISO MAC service definition, the HIPERLAN MAC service uses the 48-bit LAN MAC address for MSAP identification.

A HIPERLAN MAC entity (HM-entity) shall be attached to a single MSAP, through which the HM-entity provides the HIPERLAN MAC service to a single HMS-user; and it shall be attached to a single HIPERLAN CAC Service Access Point (HCSAP), through which the HM-entity uses the HIPERLAN CAC service provided by the HIPERLAN CAC service provider (HCS-provider).

An individual 48-bit LAN MAC address is used, as an individual-MSAP-address, to identify a single MSAP and its attached HMS-user and HM-entity.

On the other hand, a group 48-bit LAN MAC address is used, as a group-MSAP-address, to identify a group of MSAPs and their attached HMS-users.

Individual-MSAP-address and group-MSAP-address assignment is outside the scope of this ETS and is governed by other relevant LAN standards.

4.1.2 HCSAP addressing

A HIPERLAN CAC entity (HC-entity) shall be attached to a single HCSAP, through which the HC-entity provides the HIPERLAN CAC service to a single HCS-user.

As a result, a HC-entity is attached to a single HM-entity. For practical reasons, a HM-entity's attached HCSAP shall also be identified by the same individual 48-bit LAN MAC address assigned to its attached MSAP. Therefore, an individual 48-bit LAN MAC address is inherited, as an individual-HCSAP-address, to identify a single HCSAP and its attached HCS-user and HC-entity.

A group 48-bit LAN MAC address is then used, as a group-HCSAP-address, to identify a group of HCSAPs and their attached HCS-users. The group-HCSAP-address assignment from the entire group 48-bit LAN MAC address space is independent of the group-MSAP-address assignment.

4.2 HIPERLAN MAC sublayer features

Typical features of the HIPERLAN MAC sublayer are elaborated in the following subclauses.

4.2.1 HIPERLAN differentiation

Since a HIPERLAN's shared radio channel is not readily bounded, the HIPERLAN overlap situation may occur, in which multiple HIPERLANs' radio ranges overlap in the same radio channel. While wired LANs are implicitly distinct, the HIPERLAN overlap situation does not make a HIPERLAN implicitly distinct.

On the other hand, due to limited radio range, mobile HIPERLAN nodes and adverse propagation conditions, the HIPERLAN fragmentation situation may occur, in which a HIPERLAN is effectively partitioned into multiple disjoint communication subsets. Therefore, a HIPERLAN needs to be identifiable so that a fragmented HIPERLAN can re-merge automatically whenever the radio environment allows.

Both the HIPERLAN overlap and fragmentation situations call for globally unique HIPERLAN identification or indistinguishably different HIPERLANs may mingle their communication. Unfortunately, globally unique HIPERLAN identification inevitably requires some kind of administrative co-ordination that makes ad-hoc or private HIPERLAN deployments impractical. In contrast, although mingled HIPERLAN communication may raise concerns of communication confidentiality, it does not introduce a particularly new problem because communication confidentiality is always an issue in the radio environment.

Therefore, the HIPERLAN MAC protocol uses a HIPERLAN identification scheme which does not enforce globally unique HIPERLAN identification. This implies that mingled HIPERLAN MAC communication from indistinguishable HIPERLANs may occur, but the HIPERLAN identification scheme ensures that it can be made statistically unlikely.

4.2.1.1 HIPERLAN identification scheme

In the HIPERLAN identification scheme, each HIPERLAN shall be assigned a numerical HIPERLAN identifier and a character-based HIPERLAN name.

The HIPERLAN identifier is used by the HIPERLAN MAC protocol as the means to distinguish between the HIPERLAN MAC communication belonging to different HIPERLANs. If the HIPERLAN identifier is assigned dynamically to take into account the potential HIPERLAN overlap situation, mingled HIPERLAN MAC communication from indistinguishable HIPERLANs is less likely to occur.

A special HIPERLAN identifier, Any_HIPERLAN, is reserved to allow communication with HM-entities belonging to any (non-specific) HIPERLAN and shall not be assigned as the HIPERLAN identifier of a specific HIPERLAN.

The HIPERLAN name may identify a HIPERLAN meaningfully and is used solely by HMS-users as the means to explore the available HIPERLANs. It would be valuable and practical for the HIPERLAN name to be assigned according to the purpose of HIPERLAN deployment. Although the HIPERLAN identification scheme is an integral part of the HIPERLAN specification, the methods of:

- HIPERLAN identifier assignment; and
- HIPERLAN name assignment;

are outside the scope of this ETS.

4.2.2 Communication confidentiality

As a radio channel is boundless and readily available, communication confidentiality is a concern in the case of a HIPERLAN deployment expecting the level of protection of a wired LAN. Therefore, the HIPERLAN MAC protocol uses an encryption-decryption scheme to provide the HIPERLAN MAC communication with a minimum measure against eavesdropping by HM-entities of other HIPERLANs. However, the HIPERLAN encryption-decryption scheme does not necessarily require data to be encrypted.

Although the HIPERLAN encryption-decryption scheme is an integral part of this ETS, its application by a HIPERLAN is optional and HIPERLAN-wide.

4.2.2.1 HIPERLAN encryption-decryption scheme

The HIPERLAN encryption-decryption scheme employs a single encryption-decryption algorithm which requires an identical key and an identical initialization vector for both the encryption and the corresponding decryption operations.

In this scheme, all the HM-entities of a HIPERLAN shall use a common set of zero or more keys, referred to as the HIPERLAN key-set, for the encryption-decryption operations. This scheme allows an encryption-decryption operation to be applied with any key independently selected from the HIPERLAN key-set, as well as no encryption-decryption operation to be applied by selecting no key. Each key in the HIPERLAN key-set is identified by a unique key identifier and a special key identifier is reserved to identify that no key applies. The relevant key identifier is conveyed with the encrypted data to the receiver so that the receiver can determine the exact key from the HIPERLAN key-set to be used in decryption.

Any initialization vector may be independently selected for use in an encryption-decryption operation. If the encryption-decryption operation is not applied, the initialization vector is not required. The relevant initialization vector is also conveyed with the encrypted data to the receiver for use in decryption.

Figure 3 illustrates the operations of the HIPERLAN encryption-decryption scheme.

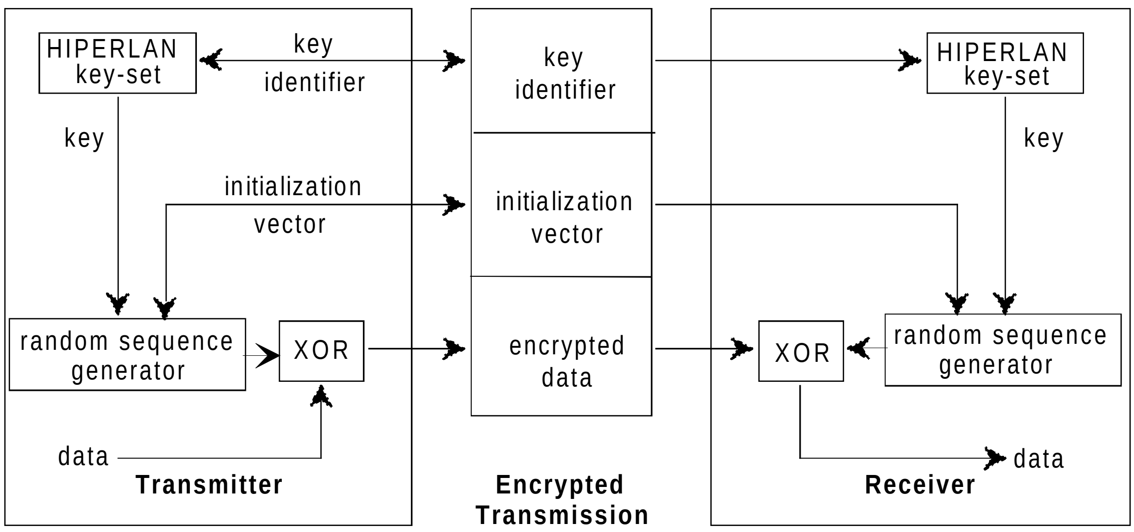


Figure 3: HIPERLAN encryption-decryption scheme

Although the HIPERLAN encryption-decryption scheme is an integral part of the HIPERLAN specification, the methods of:

- common HIPERLAN key-set maintenance by all the HM-entities of a HIPERLAN;
- key selection from the HIPERLAN key-set for use in an encryption-decryption operation; and
- initialization vector selection for use in an encryption-decryption operation;

are outside the scope of this ETS.

The degree of HIPERLAN communication confidentiality may be improved with the dynamic use of various keys and various initialization vectors in the encryption-decryption operations.

4.2.3 HIPERLAN relaying

The HIPERLAN MAC protocol employs multihop relaying to extend the HIPERLAN MAC communication beyond the radio range.

Each HM-entity shall be either a forwarder or a non-forwarder. A non-forwarder never forwards the HMPDU that it has received. On the other hand, a forwarder forwards, when appropriate, the HMPDU that it has received.

A multicast (including broadcast) MSDU transfer is supported by distributing the associated DT-HMPDU, in which the MSDU is carried, to all the HM-entities in the HIPERLAN.

A unicast MSDU transfer is more efficiently supported, if sufficient route information is available, by relaying the associated DT-HMPDU towards its destination along a route through specific forwarders. In the absence of sufficient route information, a unicast MSDU transfer may also be supported by distributing the associated DT-HMPDU to all the HM-entities in the HIPERLAN.

4.2.4 Power conservation in communication

The HIPERLAN MAC protocol specifies a power conservation function for the HIPERLAN MAC communication to take place in such a way that power conservation is possible.

The HIPERLAN power conservation function defines two roles:

- the p-saver, referring to a HM-entity which arranges when it will be able to receive HMPDUs; and

- the p-supporter, referring to a HM-entity which arranges when it will transfer HMPDUs to its neighbouring p-savers.

Since a p-saver knows when it needs the HIPERLAN CAC service to be available, it does not require its supporting HC-entity to be continuously active and thereby allows the relevant HIPERLAN node to conserve power. However, the actual power conservation method it is outside the scope of this ETS.

Although the HIPERLAN power conservation function is an integral part of the HIPERLAN MAC protocol, it is an optional function. If a HM-entity chooses to be engaged in power conservation in the HIPERLAN MAC communication, it may operate as a p-saver, a p-supporter or both.

4.3 HIPERLAN CAC sublayer features

Typical features of the HIPERLAN CAC sublayer are elaborated in the following subclauses.

4.3.1 HIPERLAN radio channel selection

Although a HIPERLAN CAC protocol is specified for a particular set of one or more shared radio channels, the selection of the exact shared radio channel to be used is outside the scope of this ETS.

4.3.2 Non-Pre-emptive priority Multiple Access (NPMA)

The HIPERLAN MAC protocol relies on the provision of a hierarchically independent CAM by the HIPERLAN CAC sublayer to support time-bounded communication.

Therefore, the CAM specified by a HIPERLAN CAC protocol shall adhere to the principle of Non-pre-emptive Priority Multiple Access (NPMA), which provides hierarchical independence of performance by means of channel access priority such that the performance of data transmission attempts with a given channel access priority is not degraded by those with lower channel access priorities.

NPMA defines three activity phases: the prioritization phase, the contention phase and the transmission phase. NPMA operates in channel access cycles on the channel. As illustrated in figure 4, there are two kinds of channel access cycles: the channel free channel access cycle and the synchronized channel access cycle.

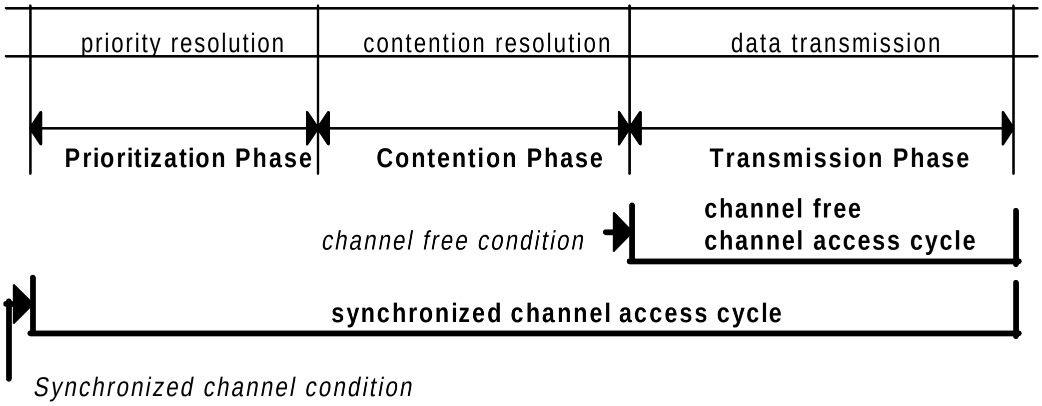


Figure 4: NPMA channel access cycles

The channel free channel access cycle, comprising only the transmission phase, takes places in the channel free condition when the medium is considered free.

The synchronized channel access cycle, comprising in series the prioritization, contention and transmission phases, takes places in the synchronized channel condition when synchronization to the end of the previous channel access cycle is achieved. In this case, each channel access attempt is associated with a channel access priority.

The NPMA channel access cycle is non-pre-emptive, so that only data transmission attempts ready at the start of a channel access cycle may contend for channel access in that channel access cycle and that no new data transmission attempts are allowed to interfere during that channel access cycle.

During the prioritization phase, priority resolution is performed according to a priority resolution scheme. The priority resolution scheme ensures that only those data transmission attempts with the highest channel access priority among them will survive the prioritization phase.

The prioritization phase is immediately followed by the contention phase, during which only the data transmission attempts which have survived the prioritization phase contend for the right of transmission according to a contention resolution scheme. The contention resolution scheme ensures that each surviving data transmission attempt has a statistically equal chance to gain the right of transmission.

Finally, if a data transmission attempt has obtained the right of transmission in the contention phase, it transmits its data in the transmission phase.

5 HIPERLAN MAC service definition

The HIPERLAN MAC service definition uses the descriptive conventions given in ISO TR 8 509 [5].

The service model, service primitives and time-sequence diagrams used are entirely abstract descriptions; they do not represent a specification for implementation.

The HIPERLAN MAC service definition is based on the ISO MAC service specification in ISO 15 802-1 [7].

The HIPERLAN MAC service model is illustrated in figure 5.

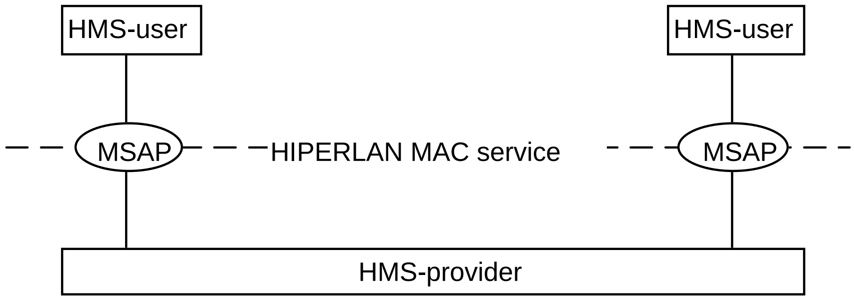


Figure 5: Model of the HIPERLAN MAC service

The HIPERLAN MAC service is provided by the HMS-provider to a HMS-user through a MSAP.

The MSDU transfer service is defined as a connectionless-mode data transfer service in which:

- the MSDU is delimited and transferred from a source MSAP to a single destination MSAP or a group of destination MSAPs in a single invocation of the connectionless-mode MSDU transfer service, without first establishing or later releasing a connection;
- each invocation of the MSDU transfer service is independent of any other;
- the HMS-user is relieved from all concerns, with the exception of HIPERLAN MAC Quality of Service (HMQoS) considerations, regarding the means used by the HMS-provider;
- the MSDU is transparently transferred with data integrity, without restricting its content, format or coding of its information, nor ever interpreting its structure or meaning;
- the HMS-user may request the MSDU transfer with a specified user priority and MSDU lifetime;
- the HMS-user can identify itself and specify the individual or group MSAP to which the MSDU is to be transferred; and
- the HMS-provider may perform any or all of the following actions:
    - discard MSDUs;
    - duplicate MSDUs; and
    - change the order of MSDUs.

The HMQoS failure report service is defined for the HMS-user to be notified when the HMS-provider has failed to support the agreed measures of HMQoS associated with one of its previous invocations of the MSDU transfer service.

The HIPERLAN look-up service is defined for the HMS-user to explore the HIPERLANs in its neighbourhood.

5.1 MAC Service Access Point address (MSAP-address)

There are two kinds of MSAP-addresses:

- the individual-MSAP-address, which identifies a single MSAP; and
- the group-MSAP-address, which identifies a group of MSAPs.

The 48-bit LAN MAC address is adopted, such that:

- an individual 48-bit LAN MAC address is used as an individual-MSAP-address; and
- a group 48-bit LAN MAC address is used as a group-MSAP-address.

Although an individual-MSAP-address may be used as both a source and a destination address, a group-MSAP-address shall be used only as a destination address.

5.2 HMQoS

The following HMQoS parameters are defined:

- user priority;
- MSDU lifetime; and
- residual MSDU lifetime.

5.2.1 User priority

The user priority specifies the relative importance of a MSDU with respect to gaining use of shared resources in the HMS-provider.

Table 1 provides a summary of the valid values of the user priority parameter.

Table 1: Valid user priority values

All values are integer

Parameter	Valid range of value	Default value
User priority	0 - 1 (see note)	1
NOTE: The numerically lower value indicates higher user priority.		

5.2.2 MSDU lifetime

The MSDU lifetime specifies the maximum elapsed time between a MSDU transfer request at the source MSAP and the corresponding delivery at the destination MSAP(s), beyond which the delivery becomes unnecessary.

Table 2 provides a summary of the valid values of the MSDU lifetime parameter.

Table 2: Valid MSDU lifetime values

All values are integer, in milliseconds

Parameter	Valid range of value	Default value
MSDU lifetime	0 - 16 000	500

5.2.3 Residual MSDU lifetime

The residual MSDU lifetime specifies the amount of time which remains from the MSDU lifetime after the experienced transit delay between a MSDU transfer request at the source MSAP and the corresponding delivery at the local MSAP.

Table 3 provides a summary of the valid values of the residual MSDU lifetime parameter.

Table 3: Valid residual MSDU lifetime values

All values are integer, in milliseconds

Parameter	Valid range of value
Residual MSDU lifetime	0 - 16 000

5.3 HIPERLAN information

The HIPERLAN information consists of the HIPERLAN names and HIPERLAN identifiers of zero or more HIPERLANs. The HIPERLAN name and HIPERLAN identifier are defined in the HIPERLAN MAC protocol specification.

5.4 HIPERLAN MAC service primitives

HIPERLAN MAC service primitives (HMS-primitives) are defined to represent the HMS-user/HMS-provider interactions. HMS-primitives convey parameters which indicate information available in the HMS-user/HMS-provider interactions and have a global significance.

Table 4 is a summary of the HMS-primitives and their parameters.

Table 4: HMS-primitives and their parameters

Facility	Service	Primitive	Parameters
Data transfer	MSDU transfer	HM-UNITDATA request	(Source address, destination address, MSDU, user priority, MSDU lifetime)
		HM-UNITDATA indication	(Source address, destination address, MSDU, user priority, MSDU lifetime, residual MSDU lifetime)
Control	HMQoS failure report	HM-QOSFAILURE indication	(Destination address, user priority, MSDU lifetime)
	HIPERLAN look-up	HM-LOOKUP request	-
		HM-LOOKUP confirm	(HIPERLAN information)

The parameters which apply to each group of HMS-primitives are set out in tables 5 to 7. Each "X" in the tables indicates that the primitive labelling the column in which it falls shall carry the parameter labelling the row in which it falls. Some entries are further qualified by "(=)" to indicate that the value supplied in an indication primitive is always identical to that supplied in the corresponding request primitive issued at the peer MSAP.

5.4.1 Sequence of primitives at one MSAP

The possible overall allowed sequences of HMS-primitives at a MSAP are defined in the state transition diagram in figure 6.

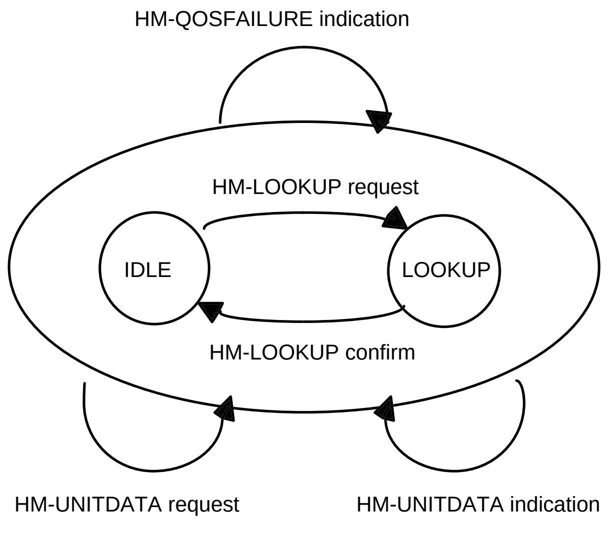


Figure 6: State transition diagram for sequences of HMS-primitives at one MSAP

5.5 MSDU transfer

Connectionless-mode MSDU transfer service primitives can be used to transfer an independent, self-contained MSDU from one MSAP to another MSAP or a group of MSAPs in a single service access. It is self-contained in that all of the information required to deliver the MSDU is presented to the HMS-provider in a single service access, provided that the HMS-users exist and are known to the HMS-provider. Thus no initial establishment or subsequent release of a connection is required.

A MSDU transmitted using the connectionless-mode MSDU transfer service is not considered by the HMS-provider to be related in any way to any previously transmitted MSDU. Although the HIPERLAN MAC service maintains the integrity of individual MSDUs, it does not necessarily deliver them to the receiving HMS-user in the order in which they are presented by the sending HMS-user.

No means are provided by which the receiving HMS-user may control the rate at which the sending HMS-user may send MSDUs (peer-to-peer flow control). The HMS-provider does not maintain any state information relative to any aspect of the flow control of information between any specific combination of MSAPs.

If the local MSAP is designated by the destination address parameter of a HM-UNITDATA request primitive, the indication primitive is also invoked by the HM-entity to the HMS-user. For example, a MSDU transferred to the broadcast address invokes HM-UNITDATA indication primitives at all MSAPs in the HIPERLAN including the MSAP at which the transfer request is generated.

5.5.1 Types of primitives and parameters

Table 5: HM-UNITDATA primitives and their parameters

Parameters/Primitives	HM-UNITDATA request	HM-UNITDATA indication
Source address	X	X(=)
Destination address	X	X(=)
MSDU	X	X(=)
User priority	X	X(=)
MSDU lifetime	X	X(=)
Residual MSDU lifetime	-	X

5.5.1.1 Source address parameter

The source address parameter specifies an individual-MSAP-address identifying the source MSAP.

5.5.1.2 Destination address parameter

The destination address parameter specifies an individual-MSAP-address identifying a single destination MSAP or a group-MSAP-address identifying a group of destination MSAPs.

5.5.1.3 MSDU parameter

The MSDU parameter allows the transfer of an MSDU between HMS-users, without modification by the HMS-provider. The HMS-user may transfer any integral number of octets greater than zero, up to a limit determined by the HMS-provider. The value of this limit is made available to the HMS-user by the use of management facilities or a priori knowledge.

5.5.1.4 User priority parameter

The user priority parameter specifies the user priority at which the MSDU is transferred.

5.5.1.5 MSDU lifetime parameter

The MSDU lifetime parameter specifies the MSDU lifetime for the MSDU transfer.

The HMS-provider shall attempt to deliver the MSDU at the destination MSAP(s) before its lifetime elapses. If its lifetime expires before it is delivered to the destination MSAP (or all the destination MSAPs), the MSDU shall be discarded by the HMS-provider.

5.5.1.6 Residual MSDU lifetime parameter

In the HM-UNITDATA indication primitive, the residual MSDU lifetime parameter is calculated by the HMS-provider and shall specify the amount of time given by the MSDU lifetime specified in the corresponding HM-UNITDATA request primitive minus the elapsed time incurred between the invocation of the two primitives.

5.5.2 Sequence of primitives

The sequence of primitives in a successful MSDU transfer is defined by the time sequence diagram in figure 7.

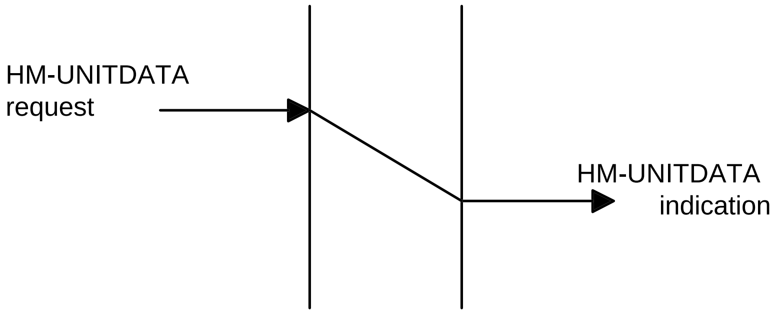


Figure 7: Sequence of primitives in a successful MSDU transfer

A MSDU transfer may fail because the associated MSDU is discarded by the HMS-provider. The sequence of primitives in an undetected MSDU transfer failure is defined by the time sequence diagram in figure 8.

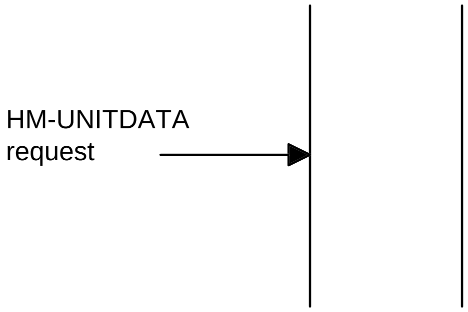


Figure 8: Sequence of primitives in an undetected MSDU transfer failure

5.6 HMQoS failure report

When a MSDU transfer request is not successfully supported by the HMS-provider, the HM-entity which serves the sending HMS-user may not be aware. However, if the HM-entity detects that the MSDU transfer request by its HMS-user has failed because of MSDU lifetime expiry, it shall invoke the HMQoS failure report service to inform its HMS-user of the failure.

The HMQoS failure report service may therefore help the HMS-user adjust the HMQoS measures in subsequent MSDU transfer requests.

5.6.1 Types of primitives and parameters

Table 6: HM-QOSFAILURE primitive and its parameters

Parameters/Primitives	HM-QOSFAILURE indication
Destination address	X
User priority	X
MSDU lifetime	X

5.6.1.1 Destination address parameter

The destination address parameter shall be the destination address of the discarded MSDU, which is specified in the failed HM-UNITDATA request primitive.

5.6.1.2 User priority parameter

The user priority parameter shall be the user priority of the discarded MSDU, which is specified in the failed HM-UNITDATA request primitive.

5.6.1.3 MSDU lifetime parameter

The MSDU lifetime parameter shall be the MSDU lifetime of the discarded MSDU, which is specified in the failed HM-UNITDATA request primitive.

5.6.2 Sequence of primitives

The sequence of primitives in a detected MSDU transfer failure due to MSDU lifetime expiry is defined by the time sequence diagram in figure 9.

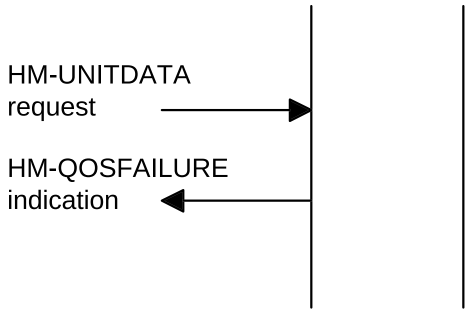


Figure 9: Sequence of primitives in a detected MSDU transfer failure

5.7 HIPERLAN look-up

The HIPERLAN look-up service provides the HMS-user a means to explore the HIPERLANs in its neighbourhood.

5.7.1 Types of primitives and parameters

Table 7: HM-LOOKUP primitives and their parameters

Parameters/Primitives	HM-LOOKUP request	HM-LOOKUP confirm
HIPERLAN information	-	X

5.7.1.1 HIPERLAN information parameter

The HIPERLAN information parameter is determined by the HMS-provider and specifies the HIPERLAN information of the HMS-user's neighbourhood.

5.7.2 Sequence of primitives

The sequence of primitives in a HIPERLAN look-up is defined by the time sequence diagram in figure 10.

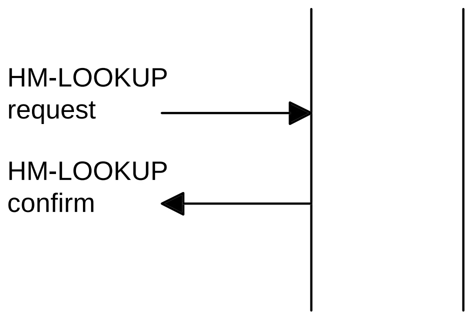


Figure 10: Sequence of primitives in a HIPERLAN look-up

6 HIPERLAN MAC protocol specification

The HIPERLAN MAC protocol provides the HIPERLAN MAC service to the HMS-user and assumes the HIPERLAN CAC service from the HCS-provider. It supports a maximum MSDU size of 2 383 octets. It specifies:

- the HIPERLAN look-up function;
- the power conservation function;
- the user data transfer function;
- the routeing information maintenance function; and
- the HMPDU transfer function.

This clause describes the functions performed as part of the MAC protocol. Implementations are not required to perform all of the functions: clause 11 specifies which functions are mandatory and which are optional.

6.1 Protocol operation elements

The following subclauses introduce the protocol operation elements.

6.1.1 HIPERLAN name

The HIPERLAN name identifies a HIPERLAN and is a fixed-length string of 32 16-bit characters encoded in UCS-2 with implementation level 3 according to ISO 10 646-1 [9].

6.1.2 HIPERLAN identifier

The HIPERLAN identifier identifies a HIPERLAN and its valid values are defined in table 8.

Table 8: Valid HIPERLAN identifier values

All values are integer

HIPERLAN identifier	Valid range of value or reserved value	Description
Any_HIPERLAN	0	It identifies any (non-specific) HIPERLAN and shall not be assigned as the HIPERLAN identifier of a specific HIPERLAN.
-	1 - (2^{31}-1)	It identifies a specific HIPERLAN, which does not apply the HIPERLAN encryption-decryption scheme and therefore never encrypts data.
-	2^{31} - (2^{32}-1)	It identifies a specific HIPERLAN, which applies the HIPERLAN encryption-decryption scheme and therefore may encrypt data.

6.1.3 Key length

The length of each key in the HIPERLAN key-set shall be 30 bits.

6.1.4 Key identifier

The key identifier identifies the key in HIPERLAN key-set which is used in encrypting and decrypting the user data. The assignment of a specific key to a key identifier value is outside the scope of this ETS. The valid key identifier values are defined in table 9.

Table 9: Valid key identifier values

All values are integer

Key identifier	Valid range of value or reserved value	Description
No_Key	0	It indicates that the user data is not encrypted.
-	1 - 3	It identifies the key which is used in encrypting the user data.

6.1.5 Reserved group-HCSAP-addresses

The values of the reserved group-HCSAP-addresses are defined in table 10. These reserved HIPERLAN CAC Service Access Point addresses (HCSAP-address) are totally transparent to the MAC service.

Table 10: Reserved group-HCSAP-addresses

All values are expressed in the hexadecimal representation of the 48-bit LAN MAC address

Reserved group-HCSAP-address	Binding	Description
All_Neighbours	19 02 65 03 01 50	It simultaneously identifies all neighbouring HM-entities within radio range.

6.1.6 Sequence number

Sequence numbers are used to differentiate and to specify the relative order of elements generated by the same HM-entity.

The valid range of value of the sequence number is defined in table 11. The sequence number assignment follows the following rules:

1) any valid value can be used as the initial value for the sequence number;

2) the next sequence number is:

((the previous sequence number + 1) Mod 65 536);

and,

3) for any two sequence numbers a and b which are not identical, a is considered to succeed b if:

(((65 536 + (a - b)) Mod 65 536) < 32 768);

otherwise b is considered to succeed a.

Table 11: Valid sequence number values

All values are integer

Parameter	Valid range of value
Sequence number	0 - 65 535

6.1.7 HMPDU priority

Each HMPDU awaiting transmission is assigned a HMPDU priority, which specifies the relative importance of its transmission among other local HMPDUs awaiting transmission. The valid HMPDU priority values are defined in table 12.

Table 12: Valid HMPDU priority values

All values are integer

Parameter	Valid range of value
HMPDU priority	0 - 1 (see note)
NOTE: The numerically lower value indicates higher HMPDU priority.	

6.1.8 HMPDU

The defined HMPDU types are shown in table 13.

Table 13: Valid HMPDU type values

HMPDU	Description	Defined HMPDU type value
DT-HMPDU	data HMPDU	1
LR-HMPDU	look-up request HMPDU	2
LC-HMPDU	look-up confirm HMPDU	3
IP-HMPDU	individual-attention pattern HMPDU	4
GP-HMPDU	group-attendance pattern HMPDU	5
TC-HMPDU	topology control HMPDU	6
HO-HMPDU	hello HMPDU	7

Each HMPDU awaiting transmission has an associated holding time, representing its residual HMPDU lifetime, upon expiry of which it is no longer subject to transmission and is removed.

Each HMPDU awaiting transmission is also assigned a transmit condition { C_{Pri}, C_{HId}, C_{Next}, C_{Dist} }, which specifies that the HMPDU has the HMPDU priority C_{Pri}, is to be transmitted to the HCSAP-address C_{Next} in the HIPERLAN identified by C_{HId} and is estimated to have C_{Dist} hops en route to its final destination from the local HM-entity. While a HMPDU awaits transmission, its transmit condition changes according to the updates made to the information about the relevant route.

6.1.9 P-saver information base

In order to support its unicast HCSDU transfer to its neighbouring p-savers, a p-supporter records the individual-attention pattern of neighbouring p-savers in its p-saver information base as an individual-attention pattern entry. Each individual-attention pattern entry has an associated holding time, upon expiry of which it is no longer applicable and is removed.

6.1.10 P-supporter information base

In order to support the multicast HCSDU transfer by its neighbouring p-supporters, a p-saver records the group-attendance pattern of neighbouring p-supporters in its p-supporter information base as a group-attendance pattern entry. Each group-attendance pattern entry has an associated holding time, upon expiry of which it is no longer applicable and is removed.

6.1.11 Duplicate detection information base

It is possible for a HM-entity to receive duplicate HMPDUs that it has previously transmitted or received. In order to avoid redundant processing, a HM-entity remembers such a HMPDU in its duplicate detection information base as a duplicate detection entry { D_{Src}, D_{Seq} }, which specifies that the remembered HMPDU has the HMPDU sequence number D_{Seq} and is originated from the HM-entity at the HCSAP-address D_{Src}. Each duplicate detection entry has an associated holding time, upon expiry of which it is no longer applicable and is removed.

6.1.12 Route information base

In order to allow possible use of unicast HCSDU transfer to support unicast MSDU transfer, a HM-entity records the information about a route in its route information base as a route entry { R_{Dest}, R_{Next}, R_{Dist} }, which specifies that the MSAP identified by the MSAP-address R_{Dest} is estimated to be R_{Dist} hops away from the local HM-entity and can be reached via the neighbouring HM-entity at the HCSAP-address R_{Next}.

6.1.13 Relay role

With respect to relaying, a HM-entity is either a non-forwarder or a forwarder. The defined relay types are shown in table 14.

Table 14: Valid relay type values

All values are integer

Relay type	Valid reserved value	Description
R_NonForwarder	1	It indicates that the relevant HM-entity is a non-forwarder.
R_Forwarder	2	It indicates that the relevant HM-entity is a forwarder.

6.1.14 Neighbour information base

A HM-entity records the information about each communication link with its neighbouring HM-entities in its neighbour information base as a neighbour entry { N_{Nbour}, N_{Status} }, which specifies that the neighbouring HM-entity at the HCSAP-address N_{Nbour} has a neighbour status N_{Status}. Each neighbour entry has an associated holding time, upon expiry of which it is no longer applicable and is removed.

The valid neighbour status values are defined in table 15.

Table 15: Valid neighbour status values

All values are integer

Neighbour status	Valid reserved value	Description
N_Asym	1	It indicates that the local HM-entity has an asymmetric link with the relevant neighbouring HM-entity.
N_Sym	2	It indicates that the local HM-entity has a symmetric link with the relevant neighbouring HM-entity.
N_MultiRelay	3	It indicates that the local HM-entity has a symmetric link with the relevant neighbouring HM-entity and has selected this neighbouring HM-entity as its multipoint relay.

The set of neighbouring forwarders selected by a HM-entity as its multipoint relays has a sequence number. Each time such multipoint relay set changes, the multipoint relay set sequence number is set to the next value.

6.1.15 Hello information base

A HM-entity records each piece of neighbour information provided by its neighbouring HM-entities in its hello information base as a hello entry { H_{Dest}, H_{Status}, H_{Next} }, which specifies that the HM-entity at the HCSAP-address H_{Dest} has a status H_{Status} and can be reached via the neighbouring HM-entity at the HCSAP-address H_{Next}.

H_{Status} can specify the following status:

- H_NeighbourNF, which indicates that H_{Dest} (and thus H_{Next}) identifies a neighbouring non-forwarder;
- H_NeighbourF, which indicates that H_{Dest} (and thus H_{Next}) identifies a neighbouring forwarder; and
- H_TwoHop, which indicates that H_{Dest} is two hops away from the local HM-entity and that H_{Next} identifies a mutual neighbouring forwarder.

6.1.16 Source multipoint relay information base

When a HM-entity selects a neighbouring forwarder as its multipoint relay, it becomes a source multipoint relay of that forwarder.

A forwarder records the information about each of its source multipoint relays in its source multipoint relay information base as a source multipoint relay entry { S_{SMR}, S_{Seq} }, which specifies that the HM-entity at the HCSAP-address S_{SMR} has selected the local HM-entity as a multipoint relay in the multipoint relay set with the sequence number S_{Seq}. Each source multipoint relay entry has an associated holding time, upon expiry of which it is no longer applicable and is removed.

6.1.17 Topology information base

A forwarder records the information about each of the source multipoint relays of other forwarders in its topology information base as a topology entry { T_{Dest}, T_{Last}, T_{Seq} }, which specifies that the HM-entity at the HCSAP-address T_{Dest} has selected the forwarder at the HCSAP-address T_{Last} as a multipoint relay in the multipoint relay set with the sequence number T_{Seq}. Therefore, the HM-entity at the HCSAP-address T_{Dest} can be reached in the last hop from the forwarder at the HCSAP-address T_{Last}. Each topology entry has an associated holding time, upon expiry of which it is no longer applicable and is removed.

6.1.18 Alias information base

When an MSDU is to be delivered to a destination MSAP which is outside of the HIPERLAN, such an MSAP can be associated with an alias MSAP which is a member of the HIPERLAN in order to allow the application of route information.

An HM-entity records the information about the alias MSAP for an MSAP outside of the HIPERLAN in its alias information base as an alias entry { A_{Ori}, A_{Alias} }, which specifies that the MSAP identified by the MSAP-address A_{Ori} is associated with an alias MSAP identified by the MSAP-address A_{Alias}. Each alias entry has an associated holding time, upon expiry of which it is no longer applicable and is removed.

6.2 HIPERLAN look-up function

With the HIPERLAN look-up function, an HM-entity may discover the HIPERLANs within its range by requesting its neighbouring HM-entities to declare their HIPERLAN information. However, the HIPERLAN look-up function does not guarantee that all the HIPERLANs within range will be discovered.

An HM-entity makes a HIPERLAN look-up request by using a LR-HMPDU and a neighbouring HM-entity responds with its HIPERLAN information by using a LC-HMPDU. It is only during the collection interval, which follows immediately after the LR-HMPDU generation, that the requesting HM-entity collects HIPERLAN information.

An HM-entity which has not been assigned to any specific HIPERLAN may invoke HIPERLAN look-up requests and collect HIPERLAN information, but it shall not respond to HIPERLAN look-up requests by other HM-entities.

6.2.1 HIPERLAN information query

This procedure is executed to determine the HIPERLAN names and the associated HIPERLAN identifiers of the HIPERLANs within range, when the attached HMS-user issues an HM-LOOKUP request primitive.

6.2.1.1 Procedure

An LR-HMPDU is generated (subclause 6.7.4), which has a holding time of l_{LR} and is assigned a transmit condition in which:

- C_{Pri} is set to p_{LR} (table 18);
- C_{HId} is set to Any_HIPERLAN;
- C_{Next} is set to All_Neighbours; and
- C_{Dist} is set to 1.

Immediately after the generation of the LR-HMPDU follows the collection interval lasting t_C, during which HIPERLAN information is collected from all the invocations of the HIPERLAN information collection procedure. Upon expiry of the collection interval, a HM-LOOKUP confirm primitive is issued to the attached HMS-user, where:

- the HIPERLAN information parameter is set to the HIPERLAN names and HIPERLAN identifiers of zero or more HIPERLANs within range, which are collected during the collection interval.

6.2.2 HIPERLAN information declaration

This procedure is executed to declare the HIPERLAN name and the HIPERLAN identifier of the local HM-entity's HIPERLAN, upon receipt of an LR-HMPDU.

6.2.2.1 Procedure

If there is no previously generated LC-HMPDU awaiting transmission, an LC-HMPDU is generated (subclause 6.7.4), where:

- its HID contains the HIPERLAN identifier of the local HM-entity's HIPERLAN; and
- its HN contains the HIPERLAN name of the local HM-entity's HIPERLAN.

The generated LC-HMPDU has a holding time of l_{LC} and is assigned a transmit condition in which:

- C_{Pri} is set to p_{LC} (table 18);
- C_{HId} is set to Any_HIPERLAN;
- C_{Next} is set to All_Neighbours; and
- C_{Dist} is set to 1.

6.2.3 HIPERLAN information collection

This procedure is executed to process a received LC-HMPDU.

6.2.3.1 Procedure

If the LC-HMPDU is received during the collection interval, the HIPERLAN name and the HIPERLAN identifier conveyed in the received LC-HMPDU are collected for the HIPERLAN information query procedure.

If the received LC-HMPDU conveys the same HIPERLAN information as does a previously generated LC-HMPDU which still awaits transmission, this previously generated LC-HMPDU no longer needs to be transmitted and is removed.

6.3 Power conservation function

The power conservation function allows an HM-entity to choose to conserve power by actively receiving only during pre-arranged intervals instead of continuously.

HIPERLAN power conservation is based on mutual respect between the p-saver and the p-supporter, of respectively the p-supporter's group-attendance pattern and the p-saver's individual-attention pattern. A p-saver is assigned one and only one recurring individual-attention pattern, of which it makes regular declaration in the IP-HMPDU. A p-supporter is assigned one and only one recurring group-attendance pattern, of which it makes regular declaration in the GP-HMPDU.

These recurring patterns are defined by the following timing elements, as shown in figure 11:

- the practice interval specifies the duration of the p-saver's individual-attention interval or that of the p-supporter's group-attendance interval;
- the pattern period specifies the amount of time between the start of successive practice intervals; and
- the pattern offset specifies the amount of time which has elapsed since the most recent start of the practice interval.

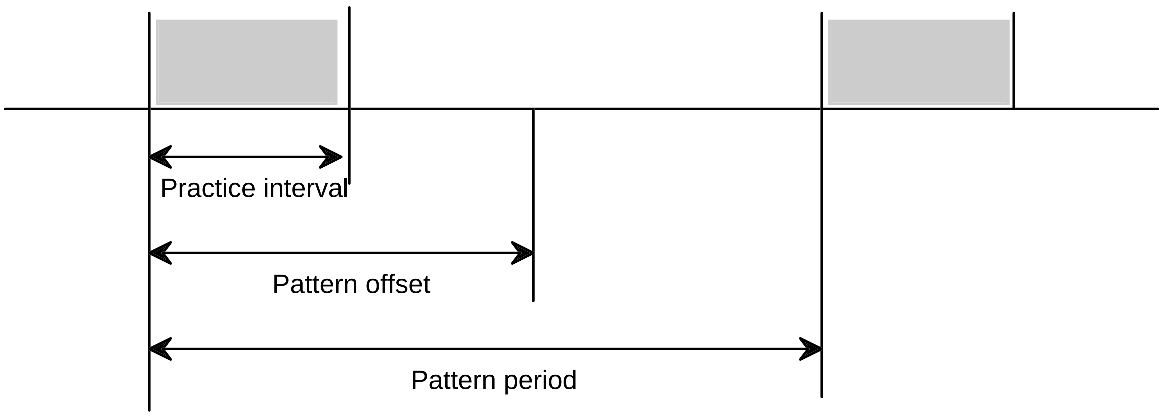


Figure 11: Timing elements of a recurring pattern

A pattern is defined such that:

- the values of the timing elements are assigned according to table 16;
- the practice interval is no greater than the pattern period; and
- the pattern offset is no greater than the pattern period.

Table 16: Valid values for the timing elements of a recurring pattern

All values are integer, in milliseconds

Timing elements	Valid range of value
pattern offset	0 - 65 535
pattern period	500 - 65 535
practice interval	500 - 65 535

While conserving power, a p-saver is ready to receive during its declared recurring individual-attention intervals, so that its neighbouring p-supporters can schedule their unicast HCSDU transfer to the p-saver. In supporting the neighbouring p-savers, a p-supporter tries to have all its multicast HCSDU transfer take place during its declared recurring group-attendance intervals, so that its neighbouring p-savers may choose to schedule their reception of the multicast HCSDU transfer from the p-supporter.

6.3.1 Individual-attention pattern declaration

This procedure is executed by a p-saver to declare its individual-attention pattern to its neighbouring HM-entities, at the start of its individual-attention interval of every n^{th} individual-attention pattern period, where n is recommended to be no greater than

$$\text{Max} \{ 1, \text{Int}(t_{IP} / (2 \times \text{individual-attention pattern period})) \}$$

6.3.1.1 Procedure

An IP-HMPDU is generated (subclause 6.7.5), where:

- its PP contains the time between the start of successive individual-attention intervals; and
- its PI contains the duration of the individual-attention interval.

The generated IP-HMPDU has a holding time of l_{IP} and is assigned a transmit condition in which:

- C_{Pri} is set to p_{IP};
- C_{HId} is set to the HIPERLAN identifier of the local HM-entity's HIPERLAN;
- C_{Next} is set to All_Neighbours; and
- C_{Dist} is set to 1.

6.3.2 Group-attendance pattern declaration

This procedure is executed by a p-supporter to declare its group-attendance pattern to its neighbouring HM-entities, at the start of its group-attendance interval of every n^{th} group-attendance pattern period, where n is recommended to be no greater than

$$\text{Max} \{ 1, (t_{GP} / (2 \times \text{group-attendance pattern period})) \}$$

6.3.2.1 Procedure

An GP-HMPDU is generated (subclause 6.7.5), where:

- its PP contains the time between the start of successive group-attendance intervals; and
- its PI contains the duration of the group-attendance interval.

The generated GP-HMPDU has a holding time of l_{GP} and is assigned a transmit condition in which:

- C_{Pri} is set to p_{GP};
- C_{HId} is set to the HIPERLAN identifier of the local HM-entity's HIPERLAN;
- C_{Next} is set to All_Neighbours; and
- C_{Dist} is set to 1.

6.3.3 Individual-attention pattern recording

This procedure is executed by a p-supporter to record a neighbouring p-saver's declared individual-attention pattern, upon receipt of an IP-HMPDU.

6.3.3.1 Procedure

The p-saver's individual-attention pattern conveyed in the received IP-HMPDU is recorded in the local p-saver information base for a holding time of t_{IP}.

Whenever a new individual-attention pattern entry is recorded, an earlier individual-attention pattern entry for the same p-saver, if it exists, is considered outdated and is replaced. If there is not sufficient space to record the new individual-attention pattern entry, the received IP-HMPDU is ignored.

6.3.4 Group-attendance pattern recording

This procedure is executed by a p-saver to record a neighbouring p-supporter's declared group-attendance pattern, upon receipt of an GP-HMPDU.

6.3.4.1 Procedure

The p-supporter's group-attendance pattern conveyed in the received GP-HMPDU is recorded in the local p-supporter information base for a holding time of t_{GP} (table 18).

Whenever a new group-attendance pattern entry is recorded, an earlier group-attendance pattern entry for the same p-supporter, if it exists, is considered outdated and is replaced. If there is not sufficient space to record the new group-attendance pattern entry, the received GP-HMPDU is ignored.

NOTE: If a p-saver wishes to receive multicast HCSDU transfers, it is recommended to schedule its reception of multicast HCSDU transfers according to only the group-attendance pattern(s) selected from its p-supporter information base.

6.3.5 Expired individual-attention pattern entry removal

This procedure is executed by a p-supporter to remove an individual-attention pattern entry from the local p-saver information base, upon expiry of its holding time.

6.3.5.1 Procedure

The individual-attention pattern entry whose holding time has expired is removed from the local p-saver information base.

6.3.6 Expired group-attendance pattern entry removal

This procedure is executed by a p-saver to remove a group-attendance pattern entry from the local p-supporter information base, upon expiry of its holding time.

6.3.6.1 Procedure

The group-attendance pattern entry whose holding time has expired is removed from the local p-supporter information base.

NOTE: It is recommended that a p-saver does not use the expired group-attendance pattern(s) to schedule its reception of the multicast HCSDU transfer.

6.4 User data transfer function

The user data transfer function is concerned with the support of MSDU transfer between HMS-users in accordance with the HIPERLAN MAC service definition.

When a MSDU is submitted by a HMS-user, it is transmitted by the attached HM-entity in the DT-HMPDU, which is relayed towards the destination(s) as long as the MSDU lifetime of the MSDU has not expired. When a DT-HMPDU arrives at a HM-entity whose attached HMS-user is the destination or one of the destinations of the conveyed MSDU, the MSDU is delivered to the HMS-user.

If the HIPERLAN encryption-decryption scheme is applied in the HIPERLAN, the MSDU may be encrypted at the HM-entity attached to the source MSAP and decrypted at the HM-entit(y/ies) attached to the destination MSAP(s).

6.4.1 Sanity check computation

This procedure is executed to compute the sanity check on the octet sequence in the DT-HMPDU from the KID to the SC inclusively.

6.4.1.1 Procedure

The value of the SC is determined such that it causes the following two formulae to be satisfied:

$$\sum_{i=1}^{L} a_i \ (\text{Mod } 255) = 0$$

$$\sum_{i=1}^{L} a_i \ (L - i + 1) a_i \quad (\text{Mod } 255) = 0$$

in which L is the number of octets in the octet sequence from the KID to the SC inclusively and a_i is the value of the octet at position i. The first octet in the octet sequence is considered to occupy position i = 1. The value of the SC applies only to the unencrypted contents of the UD; therefore, if the contents of the UD are encrypted, the decrypted contents of the UD are used instead.

When this procedure is used, neither octet of the SC shall be set to zero.

6.4.2 User data encryption-decryption

This procedure is executed to obtain the encrypted or decrypted contents of the UD of the DT-HMPDU.

6.4.2.1 Procedure

A pseudo random number generator is defined by the ETSI Security Algorithm Group of Experts (SAGE) for use in this procedure and it is made available via ETSI custodianship.

The encrypted or decrypted contents of the UD of the DT-HMPDU are obtained in the following steps:

1) the key is obtained from the HIPERLAN key-set according to the key identifier carried in the KID;

2) the initialization vector is the value of the IV;

3) the key and the initialization vector are used to initialize the pseudo random number generator;

4) a random bit sequence, of the same length as the bit sequence corresponding to the UD, is obtained from the pseudo random number generator. The first bit, bit 0, of the random bit sequence is the most significant bit of the first random number generated by the pseudo random number generator; whereas the last bit of the random bit sequence is the least significant bit of the last random number generated by the pseudo random number generator;

5) the encrypted or decrypted contents are the bit sequence produced by XORing, at identical bit positions, the bit sequence corresponding to the UD and the random bit sequence generated by the pseudo random number generator.

6.4.3 HMQoS failure reporting

This procedure is executed to inform the attached HMS-user that its previously issued HM-UNITDATA request primitive cannot be honoured because the associated HMQoS measures cannot be met.

6.4.3.1 Procedure

An HM-QOSFAILURE indication primitive (subclause 5.6.1) is issued to the attached HMS-user, where:

- the destination address parameter is set to the destination address parameter of the unhonoured HM-UNITDATA request primitive;

- the user priority parameter is set to the user priority parameter of the unhonoured HM-UNITDATA request primitive; and

- the MSDU lifetime parameter is set to the MSDU lifetime parameter of the unhonoured HM-UNITDATA request primitive.

6.4.4 User data acceptance

This procedure is executed to process the attached HMS-user's MSDU transfer request, when the attached HMS-user issues a HM-UNITDATA request primitive.

6.4.4.1 Procedure

If the destination address parameter of the HM-UNITDATA request primitive identifies (exclusively or inclusively) the attached HMS-user, a HM-UNITDATA indication primitive (subclause 5.5.1) is issued to the attached HMS-user, where:

- the source address parameter is set to the source address parameter of the HM-UNITDATA request primitive;

- the destination address parameter is set to the destination address parameter of the HM-UNITDATA request primitive;

- the MSDU parameter is set, in the same octet ordering, to the MSDU parameter of the HM-UNITDATA request primitive;

- the user priority parameter is set to the user priority parameter of the HM-UNITDATA request primitive;

- the MSDU lifetime parameter is set to the MSDU lifetime parameter of the HM-UNITDATA request primitive; and

- the residual MSDU lifetime parameter is set to the MSDU lifetime parameter of the HM-UNITDATA request primitive.

If the destination address parameter of the HM-UNITDATA request primitive is not an individual-MSAP-address identifying the attached HMS-user and it can be determined that the requested HMQoS measures is unattainable, the MSDU transfer request is refused by invoking the HMQoS failure reporting procedure.

NOTE: This ETS does not specify any refusal conditions, which may be, but are not limited to, the following situations:

- the estimated local transit delay for the MSDU transfer request is longer than the associated MSDU lifetime; and/or

- the acceptance of the MSDU transfer request would certainly cause the transmission attempt of any existing HMPDU awaiting transmission to be abandoned.

If the destination address parameter of the HM-UNITDATA request primitive is not an individual-MSAP-address identifying the attached HMS-user and the MSDU transfer request is accepted, a DT-HMPDU is generated (subclause 6.7.3), where:

- its DA contains the destination address parameter of the HM-UNITDATA request primitive;
- its SA contains the source address parameter of the HM-UNITDATA request primitive;
- its ASA contains the HCSAP-address of the local HM-entity if the source address parameter of the HM-UNITDATA request primitive does not identify the local HM-entity or FF FF FF FF FF FF otherwise;
- its UP contains the user priority parameter of the HM-UNITDATA request primitive;
- its ML contains the MSDU lifetime parameter of the HM-UNITDATA request primitive;
- the value of its KID is set to No_Key if the HIPERLAN encryption-decryption scheme is not applied in the HIPERLAN; otherwise it is set to the selected key identifier;
- the value of its IV is set to 0 if the value of its KID is set to No_Key; otherwise it is set to the selected initialization vector; and
- its UD contains, in the same octet ordering, the MSDU parameter of the HM-UNITDATA request primitive.

Then, the value of its SC is set to 0 if the value of its KID is set to No_Key; otherwise its is set to the value according to the sanity check computation procedure.

Afterwards, if the value of its KID is not set to No_Key, the original contents of its UD are then replaced by the encrypted contents obtained from the user data encryption-decryption procedure.

The generated DT-HMPDU has a holding time of the MSDU lifetime parameter of the HM-UNITDATA request primitive and is assigned a transmit condition in which:

- C_{Pri} is set to the user priority parameter of the HM-UNITDATA request primitive; and
- C_{HId} is set to the HIPERLAN identifier of the local HM-entity's HIPERLAN.

6.4.5 User data delivery

This procedure is executed to deliver the received MSDU to the attached HMS-user, upon receipt of a DT-HMPDU conveying a MSDU whose destination MSAP-address identifies (exclusively or inclusively) the attached HMS-user.

6.4.5.1 Procedure

If the value of the KID of the received DT-HMPDU is not No_Key, the decrypted contents of the UD are obtained from the user data encryption-decryption procedure and the value of the SC is then verified for the decrypted contents of the UD according to the sanity check computation procedure.

If the KID is not No_Key and the value of the SC is correct or if the KID is No_Key, a HM-UNITDATA indication primitive (subclause 5.5.1) is issued to the attached HMS-user, where:

- the source address parameter is set to the value of the SA of the received DT-HMPDU;
- the destination address parameter is set to the value of the DA of the received DT-HMPDU;
- the MSDU parameter is set, in the same octet ordering, to the, decrypted if applicable, contents of the UD of the received DT-HMPDU;
- the user priority parameter is set to the value of the UP of the received DT-HMPDU;
- the MSDU lifetime parameter is set to the value of the ML of the received DT-HMPDU; and
- the residual MSDU lifetime parameter is set to the value of the RL of the received DT-HMPDU.

If the KID is not No_Key and the value of the SC is incorrect, no HM-UNITDATA indication primitive is issued to the attached HMS-user for the UD of the received DT-HMPDU.

6.4.6 User data forwarding

This procedure is executed by a forwarder to forward the received DT-HMPDU towards its destination, upon receipt of a DT-HMPDU if:

- the destination MSAP-address of the conveyed MSDU is an individual-MSAP-address which does not identify the attached HMS-user; or
- the destination MSAP-address of the conveyed MSDU is a group-MSAP-address and the source address parameter of the HC-UNITDATA indication primitive delivering the DT-HMPDU corresponds to S_{SMR} of a source multipoint relay entry in the local source multipoint relay information base.

6.4.6.1 Procedure

The received DT-HMPDU is forwarded (awaiting transmission) with a holding time of the value of its RL and is assigned a transmit condition in which:

- C_{Pri} is set to the value of its UP; and
- C_{HId} is set to the HIPERLAN identifier of the local HM-entity's HIPERLAN.

6.5 Rooting information maintenance function

The routeing information maintenance function is concerned with the local HM-entity's exchange of routeing information with the other HM-entities and its maintenance of local routeing information.

6.5.1 Route determination

This procedure is executed to determine the route for a DT-HMPDU awaiting transmission.

6.5.1.1 Procedure

In the DT-HMPDU awaiting transmission, if the value of its DA corresponds to A_{Ori} of an alias entry in the local alias information base, the value of its ADA is set to A_{Alias} of the alias entry; otherwise its ADA is set to the value FF FF FF FF FF FF.

If the MSAP-address conveyed in, the ADA in case its value is not FF FF FF FF FF FF or the DA otherwise, corresponds to R_{Dest} of a route entry in the local route information base, the transmit condition of the DT-HMPDU is updated such that:

- C_{Next} is set to R_{Next} of the route entry; and
- C_{Dist} is set to R_{Dist} of the route entry.

Otherwise, the transmit condition of the DT-HMPDU is updated such that:

- C_{Next} is set to All_Neighbours if the local HM-entity is a forwarder, the DA conveys a group-MSAP-address or there is no hello entry in the local hello information base whose H_{Status} is H_NeighbourF; otherwise it is set to H_{Dest} of any hello entry whose H_{Status} is H_NeighbourF; and
- C_{Dist} is set to n_{MHD} if the DA conveys a group-MSAP-address or n_{UHD} otherwise.

6.5.2 Route information base establishment

This procedure is executed to (re-)establish the local route information base, upon modification of the local topology information base and/or the neighbour information base.

6.5.2.1 Procedure

All the route entries of the local route information base are removed. Then new route entries are recorded in the local route information base as long as there is sufficient space.

New route entries for HM-entities one hop away are recorded in the local route information base in the following manner:

- for each neighbour entry in the local neighbour information base whose N_{Status} is not N_Asym, a new route entry is recorded in the local route information base, where:
    - R_{Dest} and R_{Next} are set to N_{Nbour}; and
    - R_{Dist} is set to 1.

New route entries for HM-entities k+1 hops away, where k>0, are recorded in the local route information base in the following manner:

- for each topology entry in the local topology information base, if:
    - T_{Dest} does not correspond to R_{Dest} of any route entry in the local route information base whose R_{Dist} is less than k+1; and
    - T_{Last} corresponds to R_{Dest} of a route entry in the local route information base whose R_{Dist} is†k;

  a new route entry is recorded in the local route information base, where:

    - R_{Dest} is set to T_{Dest};
    - R_{Next} is set to R_{Next} of the route entry whose R_{Dest} is T_{Last}; and
    - R_{Dist} is set to k+1.

  After all route entries for HM-entities k+1 hops away are recorded, if there are more than one route entries with the same R_{Dest}, only one of them is kept and the rest are removed.

6.5.3 Multipoint relay selection

This procedure is executed to select a set of neighbouring forwarders as the multipoint relays for optimizing the distribution of HMPDUs from the local HM-entity to all HM-entities in the HIPERLAN.

6.5.3.1 Procedure

The multipoint relay set is selected from among all the neighbouring forwarders identified by N_{Nbour} of each neighbour entry in the local neighbour information base which is a forwarder and whose N_{Status} is either N_Sym or N_MultiRelay; so that for each HM-entity identified by H_{Dest} of one or more hello entries in the local hello information base whose H_{Status} is H_TwoHop, the multipoint relay set contains at least one of the forwarders identified by H_{Next} of each of these hello entries.

If the newly selected multipoint relay set is different from the previous one:

- N_{Status} of each neighbour entry in the local neighbour information base whose N_{Nbour} does not identify any forwarder in the multipoint relay set is set to N_Sym;
- N_{Status} of each neighbour entry in the local neighbour information base whose N_{Nbour} identifies a forwarder in the multipoint relay set is set to N_MultiRelay; and
- the multipoint relay set sequence number is set to the next value.

6.5.4 Neighbour information declaration

This procedure is executed to declare periodically the neighbour information to the neighbouring HM-entities, with a recommended period of no greater than half the t_{HO} (table 18).

6.5.4.1 Procedure

The multipoint relay selection procedure is invoked to select the multipoint relay set.

A HellO HIPERLAN MAC Protocol Data Unit (HO-HMPDU) (or more if one HO-HMPDU cannot convey all the neighbour information) is generated (subclause 6.7.7), where:

- the value of its RTI is set to R_NonForwarder if the local HM-entity is a non-forwarder or R_Forwarder if the local HM-entity is a forwarder;
- the value of its MSN is set to the multipoint relay set sequence number; and
- the values of zero of more { NA, NS } pairs are set respectively to N_{Nbour} and N_{Status} of each neighbour entry in the local neighbour information base.

The generated HO-HMPDU has a holding time of l_{HO} and is assigned a transmit condition in which:

- C_{Pri} is set to p_{HO} (table 18);
- C_{HId} is set to the HIPERLAN identifier of the local HM-entity's HIPERLAN;
- C_{Next} is set to All_Neighbours; and
- C_{Dist} is set to 1.

If the local neighbour information base is empty, a single HO-HMPDU with no { NA, NS } pair shall be generated. In other cases, more than one HO-HMPDU may be generated such that the information of each neighbour entry in the local neighbour information base is conveyed in at least one of the generated HO-HMPDUs.

6.5.5 Neighbour information recording

This procedure is executed to record the neighbour information of a neighbouring HM-entity in the local HM-entity's neighbour information base, hello information base and source multipoint relay information base, upon receipt of a HO-HMPDU.

6.5.5.1 Procedure

The HO-HMPDU is received from the neighbouring HM-entity which is identified by the source address parameter of the HC-UNITDATA indication primitive delivering the received HO-HMPDU.

If the HCSAP-address of the local HM-entity is specified in one of the NAs of the received HO-HMPDU, the local HM-entity is known by the neighbouring HM-entity. If, in addition, the value of the paired NS is N_MultiRelay, the local HM-entity is also selected as a multipoint relay of the neighbouring HM-entity.

If the neighbouring HM-entity is identified by N_{Nbour} of a neighbour entry in the local neighbour information base and the local HM-entity is known:

- N_{Status} of the neighbour entry is set to N_Sym if it is N_Asym; and
- the holding time of the neighbour entry is reset to t_{HO}.

If the neighbouring HM-entity is not identified by N_{Nbour} of any neighbour entry in the local neighbour information base, a new neighbour entry is recorded in the local neighbour information base for a holding time of t_{HO}, where:

- N_{Nbour} is set to the source address parameter of the HC-UNITDATA indication primitive; and
- N_{Status} is set to N_Sym if the local HM-entity is known or N_Asym otherwise.

If necessary, an earlier neighbour entry is removed to provide sufficient space to record the new neighbour entry.

In case the local HM-entity is a forwarder:

- if the neighbouring HM-entity is identified by S_{SMR} of a source multipoint relay entry in the local source multipoint relay information base whose S_{Seq} precedes or equals the value of the MSN of the received HO-HMPDU:
    - if the local HM-entity is not selected as a multipoint relay, the source multipoint relay entry is removed from the source multipoint relay information base; or
    - if the local HM-entity is selected as a multipoint relay, S_{Seq} is set to the value of the MSN and the holding time of the source multipoint relay entry is reset to t_{HO}.
- if the neighbouring HM-entity is not identified by S_{SMR} of any source multipoint relay entry in the local source multipoint relay information base and the local HM-entity is selected as a multipoint relay, a new source multipoint relay entry is recorded in the local source multipoint relay information base for a holding time of t_{HO}, where:
    - S_{SMR} is set to the source address parameter of the HC-UNITDATA indication primitive; and
    - S_{Seq} is set to the value of the MSN.

  If necessary, an earlier source multipoint relay entry is removed to provide sufficient space to record the new source multipoint relay entry.

A new hello entry is recorded in the local hello information base for a holding time of t_{HO}, where:

- H_{Dest} and H_{Next} are set to the source address parameter of the HC-UNITDATA indication primitive; and

- H_{Status} is set to H_NeighbourF if the value of the RTI of the received HO-HMPDU is R_Forwarder or H_NeighbourNF if the value of the RTI is R_NonForwarder.

While recording this new hello entry, an earlier hello entry with the same H_{Dest}, if it exists, is considered outdated and is replaced. If necessary, an earlier hello entry is removed to provide sufficient space to record the new hello entry.

For each { NA, NS } pair conveyed in the received HO-HMPDU, if:

- the value of the NA does not identify the local HM-entity;

- the value of the NA does not correspond to H_{Dest} of any hello entry in the local hello information base whose H_{Status} is H_NeighbourF or H_NeighbourNF;

- the value of the RTI of the HO-HMPDU is R_Forwarder; and

- the value of the NS is N_Sym or N_MultiRelay;

a new hello entry is recorded in the local hello information base for a holding time of t_{HO}, where:

- H_{Dest} is set to the value of the NA;

- H_{Status} is set to H_TwoHop; and

- H_{Next} is set to the source address parameter of the HC-UNITDATA indication primitive.

While recording such a new hello entry, an earlier hello entry with the same H_{Dest} and the same H_{Next}, if it exists, is considered outdated and is replaced. If necessary, an earlier hello entry is removed to provide sufficient space to record a new hello entry.

6.5.6 Source multipoint relay information declaration

This procedure is executed by a forwarder to declare periodically its source multipoint relay information to the forwarders in the HIPERLAN, with a recommended period of no greater than half the t_{TC} (table 18).

6.5.6.1 Procedure

A TC-HMPDU (or more if one TC-HMPDU cannot convey all the source multipoint relay information) is generated (subclause 6.7.6), where:

- the value of its OA is set to the HCSAP-address of the local HM-entity; and

- the values of zero of more { MSN, SMA } pairs are set respectively to S_{Seq} and S_{SMR} of each source multipoint relay entry in the local source multipoint relay information base.

The generated TC-HMPDU has a holding time of l_{TC} and is assigned a transmit condition in which:

- C_{Pri} is set to p_{TC} (table 18);

- C_{HId} is set to the HIPERLAN identifier of the local HM-entity's HIPERLAN;

- C_{Next} is set to All_Neighbours; and

- C_{Dist} is set to n_{MHD} (table 18);

If the local source multipoint relay information base is empty, a single TC-HMPDU with no { MSN, SMA } pair shall be generated. In other cases, more than one TC-HMPDU may be generated such that the information of each source multipoint relay entry in the local source multipoint relay information base is conveyed in at least one of the generated TC-HMPDUs.

6.5.7 Source multipoint relay information recording

This procedure is executed to record the source multipoint relay information of a forwarder in the local HM-entity's topology information base, upon receipt of a TC-HMPDU.

6.5.7.1 Procedure

For each { MSN, SMA } pair conveyed in the received TC-HMPDU, if the value of the SMA does not correspond to T_{Dest} of any topology entry in the local topology information base whose T_{Seq} succeeds the value of the MSN, a new topology entry is recorded in the local topology information base for a holding time of t_{TC}, where:

- T_{Dest} is set to the value of the SMA;
- T_{Last} is set to the value of the OA; and
- T_{Seq} is set to the value of the MSN.

While recording such a new topology entry:

- an earlier topology entry with the same T_{Dest} and the same T_{Last}, if it exists, is considered outdated and is replaced; and
- each earlier topology entry with the same T_{Dest} and T_{Seq} preceding the value of the MSN is removed.

If necessary, an earlier topology entry is removed to provide sufficient space to record a new topology entry.

6.5.8 TC-HMPDU forwarding

This procedure is executed by a forwarder to forward the received TC-HMPDU to other forwarders, upon receipt of a TC-HMPDU from one of the local HM-entity's source multipoint relays.

6.5.8.1 Procedure

If the source address parameter of the HC-UNITDATA indication primitive delivering the received TC-HMPDU corresponds to S_{SMR} of a source multipoint relay entry in the local source multipoint relay information base, the received TC-HMPDU is forwarded (awaiting transmission) with a holding time of the value of its RL and is assigned a transmit condition in which:

- C_{Pri} is set to p_{TC} (table 18);
- C_{HId} is set to the HIPERLAN identifier of the local HM-entity's HIPERLAN;
- C_{Next} is set to All_Neighbours; and
- C_{Dist} is set to n_{MHD} (table 18).

6.5.9 Alias address learning

This procedure is executed to learn an alias address for a MSAP outside of the HIPERLAN, upon receipt of a DT-HMPDU.

6.5.9.1 Procedure

If the value of the ASA of the received DT-HMPDU is FF FF FF FF FF FF and the value of the SA corresponds to A_{Ori} of an alias entry in the local alias information base, the alias entry is considered outdated and is removed.

Otherwise, if the value of the ASA of the received DT-HMPDU is not FF FF FF FF FF FF, a new alias entry is recorded in the local alias information base for a holding time of t_A, where:

- A_{Ori} is set to the value of the SA; and

- A_{Alias} is set to the value of the ASA.

While recording the new alias entry, an earlier alias entry with the same A_{Ori}, if it exists, is considered outdated and is replaced. If necessary, an earlier alias entry is removed to provide sufficient space to record the new alias entry.

6.5.10 Expired neighbour entry removal

This procedure is executed to remove a neighbour entry from the local neighbour information base, upon expiry of its holding time.

6.5.10.1 Procedure

The neighbour entry whose holding time has expired is removed from the local neighbour information base.

6.5.11 Expired source multipoint relay entry removal

This procedure is executed to remove a source multipoint relay entry from the local source multipoint relay information base, upon expiry of its holding time.

6.5.11.1 Procedure

The source multipoint relay entry whose holding time has expired is removed from the local source multipoint relay information base.

6.5.12 Expired topology entry removal

This procedure is executed to remove a topology entry from the local topology information base, upon expiry of its holding time.

6.5.12.1 Procedure

The topology entry whose holding time has expired is removed from the local topology information base.

6.5.13 Expired alias entry removal

This procedure is executed to remove an alias entry from the local alias information base, upon expiry of its holding time.

6.5.13.1 Procedure

The alias entry whose holding time has expired is removed from the local alias information base.

6.6 HMPDU transfer function

The HMPDU transfer function is concerned with the transmission and reception of a HMPDU using the CAC service.

Whenever the CAC service is ready to accept a HMPDU transmission attempt, the HM-entity selects for transmission the most important HMPDU awaiting transmission.

The DT-HMPDUs and the TC-HCPDUs which have previously been transmitted or received are remembered to avoid redundant processing when they are received later due to their relaying.

6.6.1 Expired HMPDU removal

This procedure is executed to remove a HMPDU awaiting transmission, upon expiry of its holding time.

6.6.1.1 Procedure

The HMPDU awaiting transmission whose holding time has expired is removed.

If the removed HMPDU concerns a DT-HMPDU generated (not forwarded) by the local HM-entity, the attached HMS-user is notified according to the HMQoS failure reporting procedure.

6.6.2 HMPDU selection

This procedure is executed to select the most important HMPDU awaiting transmission for transmission.

6.6.2.1 Procedure

The transmit condition of each DT-HMPDU awaiting transmission is updated according to the route determination procedure.

All HMPDUs awaiting transmission are candidates for the HMPDU selection, unless the local HM-entity is a p-supporter, in which case the following HMPDUs are not considered ready for transmission and are therefore not candidates for the HMPDU selection:

- any DT-HMPDU with C_{Next} of its transmit condition identifying a p-saver in the local p-saver information base which is currently not in its individual-attention interval; and

- any HMPDU subject to a second successful transmission with C_{Next} of its transmit condition set to All_Neighbours when the local HM-entity is not currently in its group-attendance interval.

For each HMPDU which is a candidate for the HMPDU selection:

- its normalized residual HMPDU lifetime is determined as its residual holding time divided by C_{Dist} of its transmit condition; and

- its channel access priority is determined according to table 17.

Table 17: HMQoS and channel access priority mapping

normalized residual HMPDU lifetime (NRL)	Channel access priority, if C_{Pri} is 0	Channel access priority, if C_{Pri} is 1
NRL < 10 ms	0	1
10 ms ≤ NRL < 20 ms	1	2
20 ms ≤ NRL < 40 ms	2	3
40 ms ≤ NRL < 80 ms	3	4
80 ms ≤ NRL	4	4

The selection of the most important HMPDU awaiting transmission is then performed in the following order:

1) select the HMPDUs with the highest channel access priority;
2) from which select the HMPDU with the shortest normalized residual HMPDU lifetime;
3) from which select any one.

6.6.3 HMPDU transmission

This procedure is executed to transmit the most important HMPDU awaiting transmission:

- when the attached HCS-provider issues a HC-SYNC indication primitive; or
- after the attached HCS-provider issues a HC-FREE indication primitive and before it issues a subsequent HC-STATUS indication primitive.

6.6.3.1 Procedure

The most important HMPDU awaiting transmission is selected according to the HMPDU selection procedure.

If the selected HMPDU is a TC-HMPDU or a DT-HMPDU which is generated (not forwarded) by the local HM-entity:

- the value of its PSN is set to the next HMPDU sequence number; and
- a new duplicate detection entry is recorded in the local duplicate detection information base for a holding time of the selected TC-HMPDU or DT-HMPDU's residual holding time, where:
  - D_{Src} is set to the HCSAP-address conveyed in the OA of the TC-HMPDU or the MSAP-address conveyed in the SA of the DT-HMPDU; and
  - D_{Seq} is set to the value of the PSN of the TC-HMPDU or the DT-HMPDU.

  If necessary, an earlier duplicate detection entry with the shortest residual holding time is removed to provide sufficient space to record the new duplicate detection entry.

If the selected HMPDU is a TC-HMPDU or a DT-HMPDU, the value of its RL is set to its residual holding time.

If the selected HMPDU is a IP-HMPDU or a GP-HMPDU, the value of its PO is set to the amount of time which has elapsed since the most recent start of the practice interval.

The value of the LI of the selected HMPDU is set to the number of octets in the selected HMPDU.

A HC-UNITDATA request primitive (subclause 7.5) is then issued for the selected HMPDU to the attached HCS-provider, where:

- the source address parameter is set to the local HM-entity's HCSAP-address;
- the destination address parameter is set to C_{Next} of the transmit condition of the HMPDU;
- the HCSDU parameter is set, in the same octet ordering, to the HMPDU;
- the HIPERLAN identifier parameter is set to C_{HId} of the transmit condition of the HMPDU; and
- the channel access priority parameter is set to the channel access priority of the HMPDU (previously determined in the HMPDU selection procedure).

The attached HCS-provider is expected to issue a HC-STATUS indication primitive. If the transfer status parameter of the HC-STATUS indication primitive is set to "transfer successful", the transmitted HMPDU is removed to avoid retransmission, unless the transmitted HMPDU is subject to a second successful transmission when:

- the local HM-entity is a p-supporter; and
- the transmitted HMPDU is a TC-HMPDU or a DT-HMPDU transmitted to All_Neighbours when the local HM-entity is outside its group-attendance interval.

If the transfer status parameter of the HC-STATUS indication primitive is set to "transfer unsuccessful", the transmission has failed and the transmitted HMPDU is subject to retransmission.

6.6.4 HMPDU reception

This procedure is executed to receive a HMPDU from the attached HCS-provider, when it issues a HC-UNITDATA indication primitive.

6.6.4.1 Procedure

The received HMPDU is retrieved, in the same octet ordering, from the HCSDU parameter of the HC-UNITDATA indication primitive.

The received HMPDU is rejected and is not considered received if:

- any of its fields contains an invalid value, where an incorrect sanity check value in a received DT-HMPDU whose KID is not No_Key is considered a valid value;
- the HIPERLAN identifier parameter of the relevant HC-UNITDATA indication primitive is not Any_HIPERLAN and is not the HIPERLAN identifier of the local HM-entity's HIPERLAN;
- the destination address parameter of the relevant HC-UNITDATA indication primitive does not identify the local HM-entity (exclusively or inclusively);
- it is a TC-HMPDU and the values of its OA and its PSN correspond respectively to D_{Src} and D_{Seq} of a duplicate detection entry in the local duplicate detection information base; or
- it is a DT-HMPDU and the values of its SA and its PSN correspond respectively to D_{Src} and D_{Seq} of a duplicate detection entry in the local duplicate detection information base.

If the received HMPDU is a TC-HMPDU or a DT-HMPDU which is not rejected:

- a new duplicate detection entry is recorded in the local duplicate detection information base for a holding time of the value of the RL of the received TC-HMPDU or DT-HMPDU, where:
  - D_{Src} is set to the HCSAP-address conveyed in the OA of the TC-HMPDU or the MSAP-address conveyed in the SA of the DT-HMPDU; and
  - D_{Seq} is set to the value of the PSN of the TC-HMPDU or the DT-HMPDU.

  If necessary, an earlier duplicate detection entry with the shortest residual holding time is removed to provide sufficient space to record the new duplicate detection entry.

If the received HMPDU is not rejected, it shall be processed according to the relevant procedures.

6.6.5 Expired duplicate detection entry removal

This procedure is executed to remove a duplicate detection entry from the local duplicate detection information base, upon expiry of its holding time.

6.6.5.1 Procedure

The duplicate detection entry whose holding time has expired is removed from the local duplicate detection information base.

6.7 Structure and encoding of HMPDUs

The following subclauses specify the structure and encoding of the HMPDUs exchanged between HM-entities.

6.7.1 Transmission and representation of information

All HM-entities respect the following bit and octet ordering conventions.

6.7.1.1 Octet sequence

An octet sequence shall contain an integral number of octets. The octets in an octet sequence are numbered starting from 1 and increasing in the order they are transmitted and received by peer HM-entities. The bits in an octet are numbered from 1 to 8, where bit 1 is the low order bit.

When the structure of an octet sequence is represented using a diagram, the following convention applies:

- octets are shown with the lower numbered octets to the left and higher numbered octets to the right; and

- within an octet, bits are shown with bit 8 to the left and bit 1 to the right.

6.7.1.1.1 Encoding of an unsigned binary number

When consecutive octets are used to represent an unsigned binary number, the lower numbered octet has the more significant value. Within an octet, the higher numbered bit of the octet represents the higher order bit.

6.7.1.1.2 Encoding of the 48-bit LAN MAC address

The 48-bit LAN MAC address is always encoded in a 6-octet sequence. The lowest numbered octet of the 6-octet sequence contains the first octet of the MAC address, the second lowest numbered octet of the 6-octet sequence contains the second octet of the MAC address and so on. Within each octet of the 6-octet sequence, the higher numbered bit represents the higher order bit of the hexadecimal representation of the corresponding MAC address octet.

6.7.1.2 Bit sequence

The bits in a bit sequence are numbered, starting from 0.

When the structure of a bit sequence is represented using a diagram, the following convention applies:

- bits are shown with the lower numbered bits to the left and higher numbered bits to the right.

6.7.1.2.1 Encoding of an unsigned binary number

When consecutive bits are used to represent an unsigned binary number, the lower numbered bit represents the higher order bit.

6.7.1.3 Mapping between an octet sequence and a bit sequence

If any part of an octet sequence needs to be treated as a bit sequence or vice versa, the following mapping rule shall apply:

- the highest numbered bit of the lowest numbered octet in the octet sequence corresponds to bit 0 in the corresponding bit sequence; and

- the lowest numbered bit of the highest numbered octet in the octet sequence corresponds to the highest numbered bit in the corresponding bit sequence.

6.7.2 General HMPDU structure and encoding

A HMPDU is represented by an octet sequence and has a general structure shown in figure 12.

	Octet
HMPDU length indicator field (LI) = n	1 - 2
HMPDU type indicator field (TI)	3
...	4 - n

Figure 12: The general structure of a HMPDU

6.7.2.1 HMPDU length indicator field (LI)

The LI, a 2-octet field, contains the number of octets in the whole HMPDU, which is encoded as an unsigned binary number.

6.7.2.2 HMPDU type indicator field (TI)

The TI, a 1-octet field, contains the HMPDU type, which is encoded as an unsigned binary number (table 13).

6.7.3 DT-HMPDU

The structure of a DT-HMPDU is shown in figure 13.

<table>
<tr><th colspan="2"></th><th>Octet</th></tr>
<tr><td colspan="2">HMPDU length indicator field
(LI) = n</td><td>1 - 2</td></tr>
<tr><td colspan="2">HMPDU type indicator field
(TI) = 1</td><td>3</td></tr>
<tr><td colspan="2">Residual HMPDU lifetime field
(RL)</td><td>4 - 5</td></tr>
<tr><td colspan="2">HMPDU sequence number field
(PSN)</td><td>6 - 7</td></tr>
<tr><td colspan="2">Destination MSAP-address field
(DA)</td><td>8 - 13</td></tr>
<tr><td colspan="2">Source MSAP-address field
(SA)</td><td>14 - 19</td></tr>
<tr><td colspan="2">Alias destination MSAP-address field
(ADA)</td><td>20 - 25</td></tr>
<tr><td colspan="2">Alias source MSAP-address field
(ASA)</td><td>26 - 31</td></tr>
<tr><td>User priority field
(UP) [bit 8]</td><td>MSDU lifetime field</td><td>32</td></tr>
<tr><td colspan="2">(ML)</td><td>33</td></tr>
<tr><td>Key identifier field
(KID) [bit 8-7]</td><td>Initialization vector field</td><td>34</td></tr>
<tr><td colspan="2">(IV)</td><td>35 -37</td></tr>
<tr><td colspan="2">User data field
(UD)</td><td>38 - (n-2)</td></tr>
<tr><td colspan="2">Sanity check field
(SC)</td><td>(n-1) - n</td></tr>
</table>

Figure 13: The structure of a DT-HMPDU

6.7.3.1 Residual HMPDU lifetime field (RL)

The RL, a 2-octet field, contains the residual HMPDU lifetime, which is encoded as an unsigned binary number.

6.7.3.2 HMPDU sequence number field (PSN)

The PSN, a 2-octet field, shall contain the HMPDU sequence number, which is encoded as an unsigned binary number.

6.7.3.3 Destination MSAP-address field (DA)

The DA, a 6-octet field, contains the destination MSAP-address, which is encoded as a 48-bit LAN MAC address.

6.7.3.4 Source MSAP-address field (SA)

The SA, a 6-octet field, contains the source MSAP-address, which is encoded as a 48-bit LAN MAC address.

6.7.3.5 Alias destination MSAP-address field (ADA)

The ADA, a 6-octet field, contains the alias destination MSAP-address, which is encoded as a 48-bit LAN MAC address.

6.7.3.6 Alias source MSAP-address field (ASA)

The ASA, a 6-octet field, contains the alias source MSAP-address, which is encoded as a 48-bit LAN MAC address.

6.7.3.7 User priority field (UP)

The UP, a 1-bit field, contains the user priority, which is encoded as an unsigned binary number.

6.7.3.8 MSDU lifetime field (ML)

The ML, a 15-bit field, contains the MSDU lifetime, which is encoded as an unsigned binary number.

6.7.3.9 Key identifier field (KID)

The KID, a 2-bit field, contains the key identifier, which is encoded as an unsigned binary number. If the HIPERLAN encryption-decryption scheme is not applied in the HIPERLAN, the value of the KID shall be No_Key.

6.7.3.10 Initialization vector field (IV)

The IV, a 30-bit field, contains the initialization vector, which is encoded as an unsigned number. If the HIPERLAN encryption-decryption scheme is not applied in the HIPERLAN, the value of the IV shall be 0.

6.7.3.11 User data field (UD)

The UD, a field of 1 to 2383 octets, contains the unencrypted MSDU in the same octet ordering of the MSDU if the value of the KID is 0; otherwise, it contains the encrypted MSDU in the same octet ordering of the encrypted MSDU.

6.7.3.12 Sanity check field (SC)

The SC, a 2-octet field, contains the sanity check for the unencrypted MSDU. If the value of the KID is No_Key; its value shall be 0.

6.7.4 LR-HMPDU and LC-HMPDU

The structure of a LR-HMPDU is shown in figure 14.

	Octet
HMPDU length indicator field (LI) = 3	1 - 2
HMPDU type indicator field (TI) = 2	3

Figure 14: The structure of a LR-HMPDU

The structure of a LC-HMPDU is shown in figure 15.

	Octet
HMPDU length indicator field (LI) = 71	1 - 2
HMPDU type indicator field (TI) = 3	3
HIPERLAN identifier field (HID)	4 - 7
HIPERLAN name field (HN)	8 - 71

Figure 15: The structure of a LC-HMPDU

6.7.4.1 HIPERLAN identifier field (HID)

The HID, a 4-octet field, contains the HIPERLAN identifier, which is encoded as an unsigned binary number.

6.7.4.2 HIPERLAN name field (HN)

The HN, a 64-octet field, contains the HIPERLAN name, which is a fixed-length string of 32 16-bit characters encoded in UCS-2 with implementation level 3 according to ISO 10646-1 [9]. The character string starts and ends respectively at the lowest and the highest numbered octets of the HN.

6.7.5 IP-HMPDU and GP-HMPDU

The structure of an IP-HMPDU is shown in figure 16.

	Octet
HMPDU length indicator field (LI) = 9	1 - 2
HMPDU type indicator field (TI) = 4	3
Pattern offset field (PO)	4 - 5
Pattern period field (PP)	6 - 7
Practice interval field (PI)	8 - 9

Figure 16: The structure of a IP-HMPDU

The structure of a GP-HMPDU is shown in figure 17.

	Octet
HMPDU length indicator field (LI) = 9	1 - 2
HMPDU type indicator field (TI) = 5	3
Pattern offset field (PO)	4 - 5
Pattern period field (PP)	6 - 7
Practice interval field (PI)	8 - 9

Figure 17: The structure of a GP-HMPDU

6.7.5.1 Pattern offset field (PO)

The PO, a 2-octet field, contains the pattern offset, which is encoded as an unsigned binary number.

6.7.5.2 Pattern period field (PP)

The PP, a 2-octet field, contains the pattern period, which is encoded as an unsigned binary number.

6.7.5.3 Practice interval field (PI)

The PI, a 2-octet field, contains the practice interval, which is encoded as an unsigned binary number.

6.7.6 TC-HMPDU

The structure of a TC-HMPDU is shown in figure 18.

	Octet
HMPDU length indicator field (LI) = n	1 - 2
HMPDU type indicator field (TI) = 6	3
Residual HMPDU lifetime field (RL)	4 - 5
HMPDU sequence number field (PSN)	6 - 7
Originator HCSAP-address field (OA)	8 - 13
Multipoint relay set sequence number field (MSN) (see note)	14 - 15
Source multipoint relay HCSAP-address field (SMA) (see note)	16 - 21
{ MSN, SMA } pairs	22 - (n-8)
Multipoint relay set sequence number field (MSN)	(n-7) - (n-6)
Source multipoint relay HCSAP-address field (SMA)	(n-5) - n
NOTE: The MSN and the SMA exist in pairs in a TC-HMPDU. There may be 0 up to any number of { MSN, SMA } pairs in a TC-HMPDU, subject to the maximum size of the TC-HMPDU.	

Figure 18: The structure of a TC-HMPDU

6.7.6.1 Originator HCSAP-address field (OA)

The OA, a 6-octet field, contains the HCSAP-address of the HM-entity which originates the TC-HMPDU, which is encoded as a 48-bit LAN MAC address.

6.7.6.2 Multipoint relay set sequence number field (MSN)

The MSN, a 2-octet field, shall contain the multipoint relay set sequence number, which is encoded as an unsigned binary number.

6.7.6.3 Source multipoint relay HCSAP-address field (SMA)

The SMA, a 6-octet field, contains the HCSAP-address of a source multipoint relay, which is encoded as a 48-bit LAN MAC address.

6.7.7 HO-HMPDU

The structure of an HO-HMPDU is shown in figure 19.

	Octet
HMPDU length indicator field (LI) = n	1 - 2
HMPDU type indicator field (TI) = 7	3
Relay type indicator field (RTI)	4
Multipoint relay set sequence number field (MSN)	5 - 6
Neighbour HCSAP-address field (NA) (see note)	7 - 12
Neighbour status field (NS) (see note)	13
{ NA, NS } pairs	14 - (n-7)
Neighbour HCSAP-address field (NA)	(n-6) - (n-1)
Neighbour status field (NS)	n
NOTE: The NA and the NS exist in pairs in a HO-HMPDU. There may be 0 up to any number of { NA, NS } pairs in a HO-HMPDU, subject to the maximum size of the HO-HMPDU.	

Figure 19: The structure of a HO-HMPDU

6.7.7.1 Relay type indicator field (RTI)

The RTI, a 1-octet field, contains the relay type, which is encoded as an unsigned binary number.

6.7.7.2 Neighbour HCSAP-address field (NA)

The NA, a 6-octet field, contains the HCSAP-address of a neighbouring HM-entity, which is encoded as a 48-bit LAN MAC address.

6.7.7.3 Neighbour status field (NS)

The NS, a 1-octet field, contains the neighbour status, which is encoded as an unsigned binary number.

6.8 HIPERLAN MAC protocol predefined values

The predefined values used by the HIPERLAN MAC protocol are shown in table 18.

Table 18: Predefined values

Symbol	Use	Predefined value
t_{IP}	holding time for the individual-attention pattern	30 s
t_{GP}	holding time for the group-attendance pattern	30 s
t_{TC}	holding time for the information from the received TC-HMPDU	40 s
t_{HO}	holding time for the information from the received HO-HMPDU	20 s
t_{A}	holding time for an alias entry	30 s
l_{LR}	HMPDU lifetime of the LR-HMPDU	500 ms
l_{LC}	HMPDU lifetime of the LC-HMPDU	500 ms
l_{IP}	HMPDU lifetime of the IP-HMPDU	500 ms
l_{GP}	HMPDU lifetime of the GP-HMPDU	500 ms
l_{TC}	HMPDU lifetime of the TC-HMPDU	500 ms
l_{HO}	HMPDU lifetime of the HO-HMPDU	500 ms
p_{IP}	HMPDU priority of the IP-HMPDU	1
p_{GP}	HMPDU priority of the GP-HMPDU	1
p_{LR}	HMPDU priority of the LR-HMPDU	1
p_{LC}	HMPDU priority of the LC-HMPDU	1
p_{TC}	HMPDU priority of the TC-HMPDU	0
p_{HO}	HMPDU priority of the HO-HMPDU	0
t_{C}	HIPERLAN information collection interval	1 s
n_{UHD}	default hop distance for unicast MSDU transfer	1
n_{MHD}	default hop distance for multicast MSDU transfer	5

7 HIPERLAN CAC service definition

The HIPERLAN CAC service definition uses the descriptive conventions given in ISO TR 8 509 [5].

The service model, service primitives and time-sequence diagrams used are entirely abstract descriptions. They do not represent a specification for implementation.

The HIPERLAN CAC service model is illustrated in figure 20.

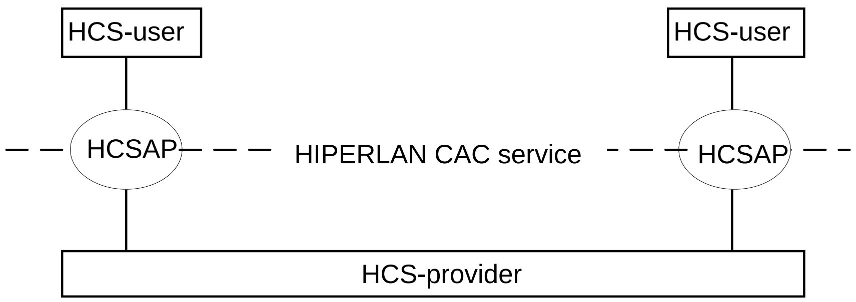


Figure 20: Model of the HIPERLAN CAC service

The HIPERLAN CAC service is provided by the HCS-provider to a HCS-user through a HCSAP.

The HCSDU transfer service is defined as a connectionless-mode data transfer service in which:

- the HCSDU is delimited and transferred from a source HCSAP to a single destination HCSAP or a group of destination HCSAPs in a single invocation of the connectionless-mode HCSDU transfer service, without first establishing or later releasing a connection;

- each invocation of the HCSDU transfer service is independent of any other;

- the invocation of the HCSDU transfer service is guided by the HCS-provider with respect to the NPMA channel access cycles;

- each invocation of the HCSDU transfer service is always acknowledged by the HCS-provider with an advice of whether the HCSDU transfer may be considered successful;

- the HCS-user is relieved from all concerns, with the exception of HIPERLAN CAC quality of service (HCQoS) considerations, regarding the means used by the HCS-provider;

- the HCSDU is transparently transferred with data integrity, without restricting its content, format or coding of its information, nor ever interpreting its structure or meaning;

- the HCS-user may request the HCSDU transfer with a specified channel access priority; and

- the HCS-user can identify itself and specify the individual or group HCSAP to which the HCSDU is to be transferred.

The transfer control service is defined for the HCS-provider to control when the HCS-user may invoke a HCSDU transfer and to inform the HCS-user of the status of its HCSDU transfer.

7.1 HCSAP-address

There are two kinds of HCSAP-addresses:

- the individual-HCSAP-address, which identifies a single HCSAP; and

- the group-HCSAP-address, which identifies a group of HCSAPs.

The 48-bit LAN MAC address is adopted, such that:

- an individual 48-bit LAN MAC address is used as an individual-HCSAP-address; and

- a group 48-bit LAN MAC address is used as a group-HCSAP-address.

Although an individual-HCSAP-address may be used as both a source and a destination address, a group-HCSAP-address shall be used only as a destination address.

7.2 HCQoS

The following HCQoS parameter is defined:

- channel access priority.

7.2.1 Channel access priority

The channel access priority, defined in NPMA, specifies the relative importance of a HCSDU with respect to gaining use of shared resources in the HCS-provider.

Table 19 provides a summary of the valid values of the channel access priority parameter.

Table 19: Valid channel access priority values

All values are integer

Parameter	Valid range of value	Default value
Channel access priority	0 - 4 (see note)	4
NOTE: The numerically lower value indicates higher channel access priority.		

7.3 HIPERLAN identifier

The HIPERLAN identifier is defined in the HIPERLAN MAC protocol specification.

7.4 Transfer status

The transfer status specifies the operating status of the HCSDU transfer service.

Table 20 provides a summary of the values of the transfer status parameter.

Table 20: Transfer status values

Parameter	Value	Meaning
Transfer status	"transfer successful"	This value specifies that the relevant HCSDU transfer may be considered successful.
	"transfer unsuccessful"	This value specifies that the relevant HCSDU transfer may be considered unsuccessful. This value is also used to indicate or remind that the HCS-provider is not ready to process a HCSDU transfer.

7.5 HIPERLAN CAC service primitives

HIPERLAN CAC service primitives (HCS-primitives) are defined to represent the HCS-user/HCS-provider interactions. HCS-primitives convey parameters which indicate information available in the HCS-user/HCS-provider interactions and have a global significance.

Table 21 is a summary of the HCS-primitives and their parameters.

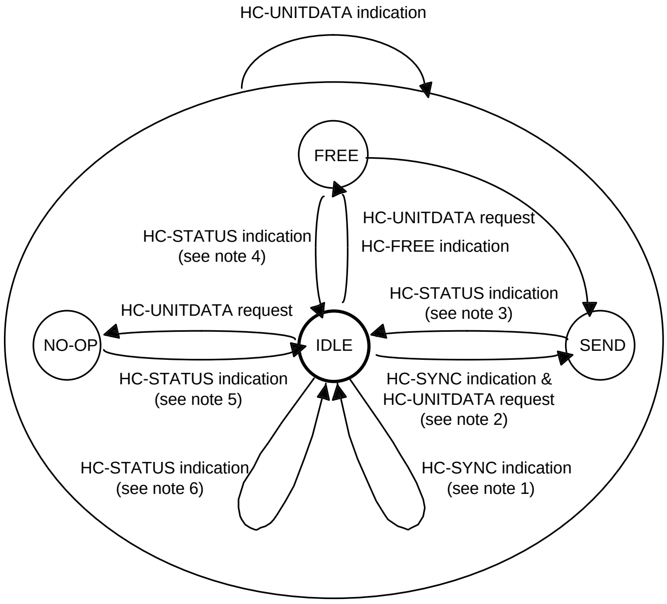
Table 21: HCS-primitives and their parameters

Facility	Service	Primitive	Parameters
Data transfer	HCSDU transfer	HC-UNITDATA request	(Source address, destination address, HCSDU, HIPERLAN identifier, channel access priority)
		HC-UNITDATA indication	(Source address, destination address, HCSDU, HIPERLAN identifier)
Control	Transfer control	HC-SYNC indication	-
		HC-FREE indication	-
		HC-STATUS indication	(Transfer status)

The parameters which apply to each group of HCS-primitives are set out in tables 22 and 23. Each "X" in the tables indicates that the primitive labelling the column in which it falls shall carry the parameter labelling the row in which it falls. Some entries are further qualified by "(=)" to indicate that the value supplied in an indication primitive is always identical to that supplied in the corresponding request primitive issued at the peer HCSAP.

7.5.1 Sequence of primitives at one HCSAP

The possible overall allowed sequences of HCS-primitives at a HCSAP are defined in the state transition diagram in figure 21.



NOTE 1: This transition represents the occurrence of a HC-SYNC indication primitive when the HCS-user has no outgoing HCSDU pending.

NOTE 2: This transition represents the occurrence of a HC-SYNC indication primitive when the HCS-user has outgoing HCSDU pending, provoking the HCS-user's generation of a HC-UNITDATA request primitive at the same moment as the HC-SYNC indication primitive is invoked.

NOTE 3: This transition represents the occurrence of a HC-STATUS indication primitive, with any transfer status value, acknowledging the previous invocation of a HC-UNITDATA request primitive.

NOTE 4: This transition represents the occurrence of a HC-STATUS indication primitive, with the "transfer unsuccessful" transfer status value, indicating that the HCS-provider is no longer ready to process a HCSDU transfer.

NOTE 5: This transition represents the occurrence of a HC-STATUS indication primitive, with the "transfer unsuccessful" transfer status value, indicating that the previous invocation of a HC-UNITDATA request primitive is ignored by the HCS-provider.

NOTE 6: This transition represents the occurrence of a HC-STATUS indication primitive, with the "transfer unsuccessful" transfer status value, reminding that the HCS-provider is not ready to process a HCSDU transfer.

Figure 21: State transition diagram for sequences of HCS-primitives at one HCSAP

7.6 Transfer control

The HCS-provider shall use the transfer control service to guide the HCS-user's HCSDU transfer activities. The HCS-provider uses the transfer control service to specify when it is ready to process an HCSDU transfer; that is, when it is allowed to attempt access to the channel for transmission according to the NPMA operations. With the transfer control service, the HCS-user can therefore assign the most updated channel access priority to its HCSDU transfers.

The HCS-provider may decide that only a synchronized HCSDU transfer is processed by means of the invocation of a HC-SYNC indication primitive. In this case, if the HCS-user has an outgoing HCSDU pending, it needs to invoke a HC-UNITDATA request primitive at the same moment as the HC-SYNC indication primitive is invoked for the HCSDU transfer to be processed. The HC-SYNC indication primitive shall be generated by the HCS-provider at the start of the channel access cycle. The moment of the start of a particular channel access cycle is denoted as t_{SYNC}.

In addition, the HCS-provider may specify an interval during which it is ready to process a free HCSDU transfer by means of the invocation of a HC-FREE indication primitive. In this case, the HCS-provider is ready to process a single invocation of a HC-UNITDATA request primitive at any moment until it invokes a HC-STATUS indication primitive.

The HCS-provider also uses the HC-STATUS indication primitive as a means to acknowledge each HCSDU transfer, advising the sending HCS-user of whether the HCSDU transfer may be considered successful. The HCS-user shall not invoke a new HC-UNITDATA request primitive before the previous one is acknowledged by the corresponding HC-STATUS indication primitive invocation. Only the HC-UNITDATA request primitive invocation which is associated with a HC-SYNC indication primitive invocation or preceded by a HC-FREE indication primitive invocation is processed by the HCS-provider. The HCS-provider always acknowledges an unprocessed HC-UNITDATA request primitive invocation as an unsuccessful HCSDU transfer.

7.6.1 Types of primitives and parameters

Table 22: Transfer control service primitives and their parameters

Parameters/Primitives	HC-SYNC indication	HC-FREE indication	HC-STATUS indication
Transfer status	-	-	X

7.6.1.1 Transfer status parameter

The transfer status parameter specifies whether the associated HCSDU transfer may be considered successful when the HC-STATUS indication primitive is invoked to acknowledge the previous invocation of a HC-UNITDATA request primitive. Although the transfer status does not necessarily imply that the HCSDU transfer is actually successful, it indicates the HCS-provider's recommendation on the need of retransmission of the relevant HCSDU by the HCS-user.

The transfer status parameter is always set to "transfer unsuccessful" if the HC-STATUS indication primitive is invoked to end the interval, initiated by the previous invocation of a HC-FREE indication primitive, during which the HCS-provider is ready to process a free HCSDU transfer.

7.6.2 Sequence of primitives

The sequence of primitives in an unfulfilled synchronized HCSDU transfer opportunity is defined by the time sequence diagram in figure 22.

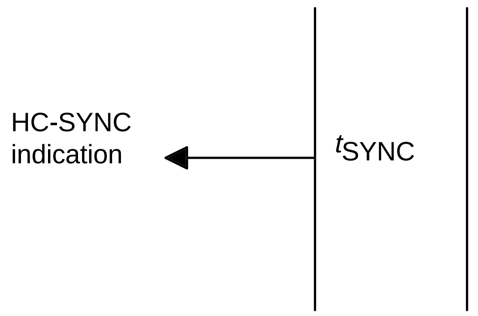


Figure 22: Sequence of primitives in an unfulfilled synchronized HCSDU transfer opportunity

The sequence of primitives in an unfulfilled free HCSDU transfer opportunity is defined by the time sequence diagram in figure 23.

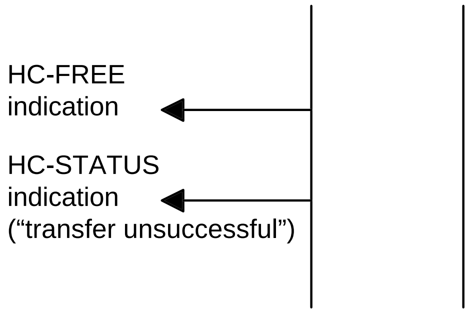


Figure 23: Sequence of primitives in an unfulfilled free HCSDU transfer opportunity

7.7 HCSDU transfer

Connectionless-mode HCSDU transfer service primitives can be used to transfer an independent, self-contained HCSDU from one HCSAP to another HCSAP or a group of HCSAPs in a single service access. It is self-contained in that all of the information required to deliver the HCSDU is presented to the HCS-provider in a single service access, provided that the HCS-users exist and are known to the HCS-provider. Thus no initial establishment or subsequent release of a connection is required.

A HCSDU transmitted using the connectionless-mode HCSDU transfer service is not considered by the HCS-provider to be related in any way to any previously transmitted HCSDU. In addition to maintaining the integrity of individual HCSDUs, the HIPERLAN CAC service delivers them to the receiving HCS-user in the order in which they are presented by the sending HCS-user.

No means are provided by which the receiving HCS-user may control the rate at which the sending HCS-user may send HCSDUs (peer-to-peer flow control). The HCS-provider does not maintain any state information relative to any aspect of the flow control of information between any specific combination of HCSAPs.

If the local HCSAP is designated by the destination address parameter of a HC-UNITDATA request primitive, the indication primitive is not invoked by the HC-entity to the HCS-user. For example, a HCSDU transferred to the broadcast address invokes HC-UNITDATA indication primitives at all HCSAPs within the medium range excluding the HCSAP at which the transfer request is generated.

The invocation of the HCSDU transfer service is controlled by the transfer control service.

7.7.1 Types of primitives and parameters

Table 23: HC-UNITDATA primitives and their parameters

Parameters/Primitives	HC-UNITDATA request	HC-UNITDATA indication
Source address	X	X(=)
Destination address	X	X(=)
HCSDU	X	X(=)
HIPERLAN identifier	X	X(=)
Channel access priority	X	-

7.7.1.1 Source address parameter

The source address parameter specifies an individual-HCSAP-address identifying the source HCSAP.

7.7.1.2 Destination address parameter

The destination address parameter specifies an individual-HCSAP-address identifying a single destination HCSAP or a group-HCSAP-address identifying a group of destination HCSAPs.

7.7.1.3 HCSDU parameter

The HCSDU parameter allows the transfer of a HCSDU between HCS-users, without modification by the HCS-provider. The HCS-user may transfer any integral number of octets greater than zero, up to a limit determined by the HCS-provider. The value of this limit is made available to the HCS-user by the use of management facilities or a priori knowledge.

7.7.1.4 HIPERLAN identifier parameter

The HIPERLAN identifier parameter specifies the HIPERLAN identifier applicable to the HCSDU transfer.

7.7.1.5 Channel access priority parameter

The channel access priority parameter specifies the channel access priority at which the HCSDU is transferred.

7.7.2 Sequence of primitives

The sequence of primitives in a successful synchronized HCSDU transfer is defined by the time sequence diagram in figure 24.

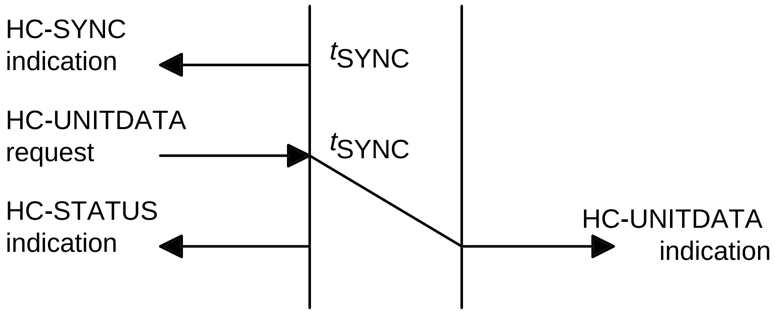


Figure 24: Sequence of primitives in a successful synchronized HCSDU transfer

However, a synchronized HCSDU transfer may fail. The sequence of primitives in an unsuccessful synchronized HCSDU transfer is defined by the time sequence diagram in figure 25.

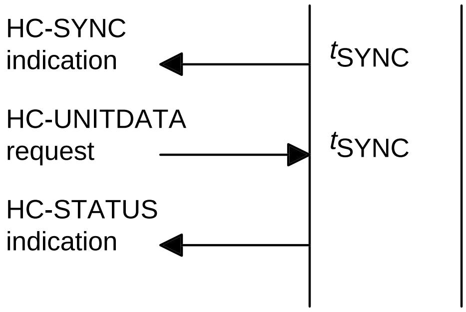


Figure 25: Sequence of primitives in an unsuccessful synchronized HCSDU transfer

The sequence of primitives in a successful free HCSDU transfer is defined by the time sequence diagram in figure 26.

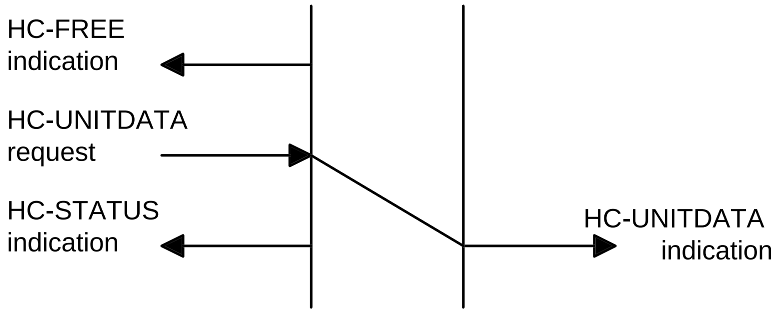


Figure 26: Sequence of primitives in a successful free HCSDU transfer

However, a free HCSDU transfer may fail. The sequence of primitives in an unsuccessful free HCSDU transfer is defined by the time sequence diagram in figure 27.

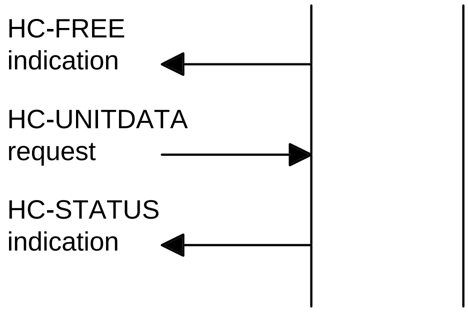


Figure 27: Sequence of primitives in an unsuccessful free HCSDU transfer

8 HIPERLAN CAC protocol specification

The HIPERLAN CAC protocol provides the HIPERLAN CAC service to the HCS-user and assumes the facilities from the physical layer. It supports a maximum HCSDU size of 2 422 octets. It specifies:

- the operations of EY-NPMA;
- the channel permission function;
- the user data transfer function; and
- the HCPDU transfer function.

This clause describes the functions performed as part of the CAC protocol. Implementations are not required to perform all of the functions: clause 11 specifies which functions are mandatory and which are optional.

8.1 Protocol operation elements

The following subclauses introduce the protocol operation elements.

8.1.1 HCPDU

Structurally, a HCPDU may have two parts: the low-bit-rate part (LBR-part) and the high-bit-rate part (HBR-part). There are two kinds of HCPDUs according to their structures:

- the LBR HCPDU, which contains only the LBR-part; and
- the LBR-HBR HCPDU, which contains both the LBR-part and the HBR-part.

There is only one type of LBR HCPDU: the acknowledgement HCPDU (AK-HCPDU).

The defined LBR-HBR HCPDU types are shown in table 24.

Table 24: Valid LBR-HBR HCPDU type values

LBR-HBR HCPDU	Description	Defined HMPDU type value
CP-HCPDU	channel permission HCPDU	0
DT-HCPDU	data HCPDU	1

8.1.2 HBR-part padding

The physical protocol requires the HBR-part of a LBR-HBR HCPDU to have 1 to 47 blocks of 52 octets. Therefore, if necessary, an appropriate number of padding octets are put in the HBR-part to satisfy this requirement.

The valid number of blocks in the HBR-part is shown in table 25.

Table 25: Valid number of blocks in the HBR-part

All values are integer

Parameter	Valid range of value
Number of blocks in the HBR-part	1 – 47

The valid number of padding octets in the HBR-part is shown in table 26.

Table 26: Valid number of padding octets in the HBR-part

All values are integer

Parameter	Valid range of value
Number of padding octets	0 – 51

8.2 Elimination-Yield Non-pre-emptive Priority Multiple Access (EY-NPMA)

The EY-NPMA is based on the principle of NPMA:

- it defines the prioritization, contention and transmission phases;
- in the channel free condition, it may operate in the channel free channel access cycle, comprising only the transmission phase; and
- in the synchronized channel condition, it operates in the synchronized channel access cycle, comprising in series the prioritization, contention and transmission phases.

In the contention phase, the EY-NPMA uses a combination of the elimination scheme and the yield scheme for contention resolution.

The objective of the elimination scheme is to eliminate as many as possible, but not all, contending nodes from competing for the right of transmission. It can be used to provide a low and quasi-constant collision rate independent of the number of simultaneous contending nodes, up to a presumed maximum number of simultaneous contending nodes.

The yield scheme's objective is to complement the elimination scheme. It is designed particularly to further resolve contention between any remaining contending nodes surviving from the elimination scheme.

The EY-NPMA activities are illustrated in figure 28.

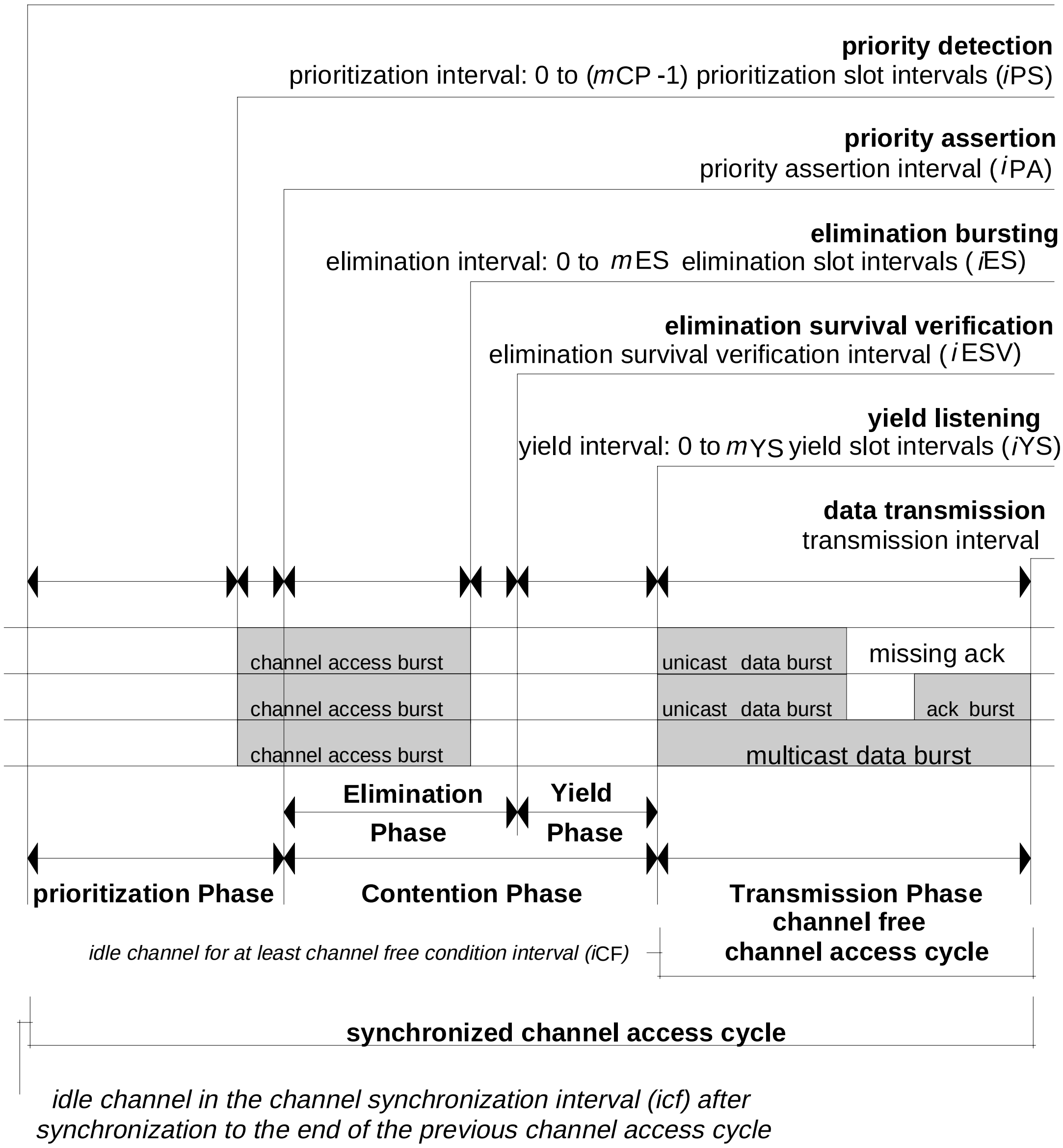


Figure 28: The EY-NPMA activities

8.2.1 Prioritization phase

The priority resolution scheme provides hierarchical independence of performance between loads at different channel access priorities. The operation of the priority resolution scheme is outlined below:

- there are a total of m_{CP} channel access priorities, which are numbered from 0 to (m_{CP}-1), with 0 denoting the highest channel access priority;
- prioritization slots are used for prioritization of different channel access priorities. The duration of the prioritization slot interval is denoted by i_{PS};
- priority resolution takes place by means of priority detection and priority assertion. A contending node, whose data transmission attempt has a channel access priority n, shall listen for n prioritization slot intervals. If the channel is sensed idle in the n prioritization slot intervals, the node asserts the channel access priority by transmitting immediately a channel access burst for the duration of the priority assertion interval, denoted by i_{PA}. Otherwise, the node stops its data transmission attempt in the current channel access cycle;
- if the prioritization phase ends with a priority assertion for channel access priority n, the duration of the prioritization interval is n prioritization slot intervals;

- at least one contending node will survive the prioritization phase.

8.2.2 Elimination phase

The operation of the elimination scheme is outlined below:

- elimination slots are used for elimination bursting. The duration of the elimination slot interval is denoted by i_{ES};

- the length of an individual elimination burst is 0 to m_{ES} elimination slot intervals long, with the probability of bursting in a elimination slot being p_E. Accordingly, the probability for an individual elimination burst to be n elimination slot intervals long, denoted by $P_E(n)$, is given by:

  $$P_E(n) = p_E^{\,n}(1 - p_E) \quad \text{for } 0 \le n < m_{ES}$$

  $$P_E(n) = p_E^{\,m_{ES}} \quad \text{for } n = m_{ES}$$

  The accuracy of $P_E(n)$ demonstrated by an implementation is subject to a tolerance of ± 5 %;

- the elimination scheme resolves contention by means of elimination bursting and elimination survival verification. A contending node transmits a channel access burst to eliminate other contending nodes and then listens to the channel in the elimination survival verification interval, denoted by i_{ESV}, to verify if it is eliminated by other contending nodes. A contending node survives the elimination phase if and only if the channel is sensed idle in its elimination survival verification interval; otherwise, the node is eliminated and withdraws from the competition for the right of transmission in the current channel access cycle;

- the duration of the elimination interval is the longest elimination burst among the contending nodes;

- at least one contending node will survive the elimination phase.

8.2.3 Yield phase

The operation of the yield scheme is outlined below:

- yield slots are used for yield listening. The duration of the yield slot interval is denoted by i_{YS};

- the length of an individual yield listening is 0 to m_{YS} yield slot intervals long, with equal likelihood. Accordingly, the probability for an individual yield listening to be n yield slot intervals long, denoted by $P_Y(n)$, is given by:

  $$P_Y(n) = 1 / (m_{YS} + 1) \quad \text{for } 0 \le n \le m_{YS}$$

  The accuracy of $P_Y(n)$ demonstrated by an implementation is subject to a tolerance of ± 5 %;

- the yield scheme resolves contention by means of yield listening. A contending node survives the yield phase if and only if the channel is sensed idle in its yield listening; otherwise, the node yields to the other contending nodes and withdraws from the competition for the right of transmission in the current channel access cycle;

- the duration of the yield interval is the shortest yield listening among the contending nodes;

- at least one contending node will survive the yield phase.

8.2.4 Transmission phase

During the transmission phase, the data transmission concerns either:

- a multicast LBR-HBR HCPDU transmission; or
- a unicast LBR-HBR HCPDU transmission, which is expected to be followed by a corresponding AK-HCPDU transmission from the destination HC-entity.

When a HC-entity transmits a AK-HCPDU to acknowledge a received unicast LBR-HBR HCPDU transmission, the acknowledgement time requirement, measured at its antenna, is imposed such that the start of its AK-HCPDU burst shall occur i_{AK}, with an accuracy of $\pm d_{AK}$, after the end of the received LBR-HBR HCPDU burst.

As far as the transmitter of a LBR-HBR HCPDU is concerned, its multicast LBR-HBR HCPDU transmission is always successful, whereas its unicast LBR-HBR HCPDU transmission is considered successful only if a corresponding AK-HCPDU is received.

8.2.5 Conditions for commencing channel access

There are three conditions under which an attempt may be made to access the channel and the method of access is different in each of the three cases.

8.2.5.1 Channel access in channel free condition

The channel free condition occurs when the channel remains idle for at least the channel free interval. In the channel free condition, the channel is considered free and a channel access attempt may take place using the channel free channel access cycle.

The methods of determining the channel free interval is outlined below:

- the channel free interval has a minimal duration of i_{MF}. Free extension slots are used for dynamic extension in the channel free interval. The duration of the free extension slot interval is denoted by i_{FS};
- the length of a dynamic extension in the channel free interval is 0 to m_{FS} free extension slot intervals long, with equal likelihood. Accordingly, the probability for the duration of an individual channel free interval to be ($i_{MF} + n\, i_{FS}$), denoted by $P_F(n)$, is given by:

  $$P_F(n) = 1 / (m_{FS} + 1) \qquad \text{for } 0 \le n \le m_{FS}$$

  The accuracy of $P_F(n)$ demonstrated by an implementation is subject to a tolerance of ± 5 %.

8.2.5.2 Channel access in synchronized channel condition

The synchronized channel condition occurs when the channel is idle in the channel synchronization interval, which starts immediately after the end of the previous channel access cycle determined at the local antenna. In the synchronized channel condition, a channel access attempt shall take place using the synchronized channel access cycle, which follows immediately the channel synchronization interval. The duration of the channel synchronization interval is denoted by i_{CS}.

The end of the previous channel access cycle at the local antenna shall be determined with an accuracy of $\pm d_{EC}$ and is defined to be:

- the end of the LBR-HBR HCPDU burst, transmitted for its transmitter and received for its receivers, in the case of a multicast LBR-HBR HCPDU transmission;
- the end of the AK-HCPDU burst, transmitted for its transmitter and received for its receivers, in the case of a unicast LBR-HBR HCPDU transmission followed by a corresponding AK-HCPDU transmission; or

- the end of the absent or missing AK-HCPDU burst which would have been received, in the case of a unicast LBR-HBR HCPDU transmission whose corresponding AK-HCPDU is either not transmitted or not received.

8.2.5.3 Channel access in hidden elimination condition

The hidden elimination condition occurs when, in a synchronized channel access cycle, the local HC-entity loses the right of transmission in the contention phase but detects no data transmission. It indicates that there may be a hidden node situation. The hidden elimination condition occurs at the start of the relevant time slot in which the right of transmission is lost and it lasts for the next 500 ms.

The next channel access attempt is suspended until the channel access suspension interval has elapsed:

- since every occurrence of the hidden elimination condition; or

- since the end of the LBR-HBR HCPDU burst for a unicast LBR-HBR HCPDU transmission which commences in the hidden elimination condition and whose corresponding AK-HCPDU is not received.

The methods of determining the channel access suspension interval is outlined below:

- the duration of the channel access suspension slot interval is denoted by i_{SS};

- the length of the channel access suspension interval is 1 to m_{SS} channel access suspension slot intervals long, with equal likelihood. Accordingly, the probability for an individual channel access suspension interval to be ($n\ i_{SS}$), denoted by $P_S(n)$, is given by:

  $$P_S\,(n) = 1 / m_{SS} \qquad \text{for } 1 \le n \le m_{SS}$$

  The accuracy of P_S (n) demonstrated by an implementation is subject to a tolerance of ± 5 %.

8.2.6 EY-NPMA operating parameter settings

The EY-NPMA operating parameter settings, which are shown in table 27, are specified to satisfy the following objectives:

- a target collision rate of about 3,5 % for a presumed maximum of 256 simultaneous contending nodes; and

- a presumed maximum radio range is 50 m.

Table 27: EY-NPMA operating parameter settings

EY-NPMA operating parameter	Value
m_{CP}	5 (see note)
p_E	0,5
m_{ES}	12
m_{YS}	9
i_{CS}	256 high rate bit-periods
i_{PS}	168 high rate bit-periods
i_{PA}	168 high rate bit-periods
i_{ES}	212 high rate bit-periods
i_{ESV}	256 high rate bit-periods
i_{YS}	168 high rate bit-periods
i_{MF}	2 000 high rate bit-periods
m_{FS}	3
i_{FS}	200 high rate bit-periods
m_{SS}	5
i_{SS}	1 ms
i_{AK}	512 high rate bit-periods
d_{AK}	5 high rate bit-periods
d_{EC}	10 high rate bit-periods
NOTE: m_{CP} shall be 5, according to the number of channel access priorities defined in the HIPERLAN CAC service definition.	

8.3 Channel permission function

There are 5 defined communication channels, which are numbered according to their carrier numbers. Channel 0, channel 1 and channel 2 are the mandatory default channels, in which transmission access is always permitted. However, channel 3 and channel 4 are non-default channels, whose availability is subject to national administrations.

HIPERLAN systems may be portable or mobile and consequently subject to different channel permissions at different times. Transmission access to non-default channels is communicated to HC-entities by means of CP-HCPDUs. The CP-HCPDU conveys the channel permission information indicating if the non-default channels are permitted to be used. If one of more non-default channels are permitted to be used, CP-HCPDUS conveying the channel permission information are transmitted on all the default channels as well as those non-default channels permitted to be used.

Before having obtained permission to use a non-default channel, an HC-entity shall not transmit and shall ignore all received HCPDUs except the CP-HCPDUs in that non-default channel.

8.3.1 Channel permission declaration

This procedure is executed by a HIPERLAN enhancement unit to declare the applied channel permission information.

8.3.1.1 Procedure

A CP-HCPDU is generated (subclause 8.6.4), where:

- the value of its BLI is set to 1;
- the value of its PLI is set to 29;
- the value of its HID is set to Any_HIPERLAN;
- the value of its DA is set to All_Neighbours;
- the value of its SA is set to the value FF FF FF FF FF FF, to indicate that this field is irrelevant;

- the value of its C3 is set to 1 if channel 3 may be used or 0 otherwise; and

- the value of its C4 is set to 1 if channel 4 may be used or 0 otherwise.

The generated CP-HCPDU is then transmitted by the LBR-HBR HCPDU transmission procedure, with the channel access priority 0.

8.3.2 Channel permission recording

This procedure is executed to record the channel permission information, upon receipt of a CP-HCPDU.

8.3.2.1 Procedure

In the received CP-HCPDU:

- the use of channel 3 is forbidden immediately if the value of the C3 is 0 or is permitted otherwise; and

- the use of channel 4 is forbidden immediately if the value of the C4 is 0 or is permitted otherwise.

If permitted, channel 3, channel 4 or both may be used for the next 60 seconds as the permission validity time.

8.3.3 Channel permission invalidation

This procedure is executed to invalidate the permission to use the non-default channels, upon expiry of the permission validity time.

8.3.3.1 Procedure

The use of channel 3 and channel 4 is forbidden immediately.

8.4 User data transfer function

The user data transfer function is concerned with the support of HCSDU transfer between HCS-users in accordance with the HIPERLAN CAC service definition.

Typically, a HCSDU is submitted by a HCS-user with a specified channel access priority for transmission to a specified destination, which may be either an individual HCS-user or a group of HCS-users. A HCS-user may initiate a HCSDU transfer request only after the previous one has been acknowledged by the HCS-provider with a HC-STATUS indication primitive.

The HCSDU is transmitted by the HC-entity in a DT-HCPDU. When a DT-HCPDU is received by a HC-entity whose attached HCS-user is the destination or one of the destinations of the conveyed HCSDU, the HCSDU is delivered to the HCS-user.

8.4.1 Synchronized transfer invitation

This procedure is executed to invite, but not mandate, the attached HCS-user to immediately initiate a HCSDU transfer, upon detection of the synchronized channel condition.

8.4.1.1 Procedure

A HC-SYNC indication primitive is issued to the attached HCS-user.

8.4.2 Free transfer inviation

This procedure is executed to invite the attached HCS-user to initiate a HCSDU transfer at any time, upon detection of the channel free condition.

8.4.2.1 Procedure

A HC-FREE indication primitive is issued to the attached HCS-user.

8.4.3 Free transfer cancellation

This procedure is executed to inform the attached HCS-user that the previous free transfer inviation is cancelled and the local HC-entity is no longer ready to accept any HCSDU transfer request, upon nullification of the channel free condition.

8.4.3.1 Procedure

A HC-STATUS indication primitive is issued to the attached HCS-user, where:

- the transfer status parameter is set to "transfer unsuccessful".

8.4.4 User data refusal

This procedure is executed to refuse a HCSDU transfer request from the attached HCS-user, when the attached HCS-user issues a HC-UNITDATA request primitive which does not take place in the synchronized channel condition or the channel free condition.

8.4.4.1 Procedure

A HC-STATUS indication primitive is issued to the attached HCS-user, where:

- the transfer status parameter is set to "transfer unsuccessful".

8.4.5 User data acceptance

This procedure is executed to process the attached HCS-user's HCSDU transfer request, when the attached HCS-user issues a HC-UNITDATA request primitive which takes place in the synchronized channel condition or the channel free condition.

8.4.5.1 Procedure

If the destination address parameter of the HC-UNITDATA request primitive is not an individual-HCSAP-address identifying the attached HCS-user, a DT-HCPDU is generated (subclause 8.6.5), where:

- the value of its BLI is set to the number of blocks in the HBR-part;
- the value of its PLI is set to the number of padding octets required in the PAD for the size of the entire HBR-part to be a minimum multiple of 52 octets;
- its HID contains the HIPERLAN identifier parameter of the HC-UNITDATA request primitive;
- its DA contains the destination address parameter of the HC-UNITDATA request primitive;
- its SA contains the source address parameter of the HC-UNITDATA request primitive; and
- its UD contains, in the same octet ordering, the HCSDU parameter of the HC-UNITDATA request primitive.

If a DT-HCPDU is generated, it is transmitted by the LBR-HBR HCPDU transmission procedure, with the channel access priority specified by the channel access priority parameter of the HC-UNITDATA request primitive.

A HC-STATUS indication primitive is issued to the attached HCS-user, where the transfer status parameter is set to:

- "transfer successful" if no DT-HCPDU is generated or the LBR-HBR HCPDU transmission procedure concludes successfully for the generated DT-HCPDU; or

- "transfer unsuccessful" if the LBR-HBR HCPDU transmission procedure concludes unsuccessfully for the generated DT-HCPDU.

8.4.6 User data delivery

This procedure is executed to deliver the received HCSDU to the attached HCS-user, upon receipt of a DT-HCPDU conveying a HCSDU whose destination HCSAP-address identifies (exclusively or inclusively) the attached HCS-user.

8.4.6.1 Procedure

A HC-UNITDATA indication primitive is issued to the attached HCS-user, where:

- the source address parameter is set to the value of the SA of the received DT-HCPDU;

- the destination address parameter is set to the value of the DA of the received DT-HCPDU;

- the HCSDU parameter is set, in the same octet ordering, to the contents of the UD of the received DT-HCPDU; and

- the HIPERLAN identifier parameter is set to the value of the HID of the received DT-HCPDU.

8.5 HCPDU transfer function

The HCPDU transfer function is concerned with the transmission and reception of a HCPDU.

A multicast LBR-HBR transmission is always considered successful; whereas a unicast LBR-HBR transmission is considered successful if and only if it is acknowledged by a corresponding AK-HCPDU.

8.5.1 LBR-part checksum computation

This procedure is executed to compute separate 4-bit checksums for the HDA, the BLIR and the AID of the LBR-part of a HCPDU.

8.5.1.1 Procedure

The HDACS, the BLIRCS and the AIDCS are the 4-bit checksum fields containing the 4-bit checksums computed respectively on the HDA, the BLIR and the AID.

The value of the 4-bit checksum is determined according to the following generating polynomial:

$$G(x) = x^4 + x + 1$$

The value of the 4-bit checksum is computed on the n-bit sequence corresponding to the relevant field in the following steps:

1) the lowest numbered 4 bits of the n-bit sequence are complemented;

2) the n bits of the n-bit sequence are used as the coefficients of a polynomial M(x) of degree n-1, with the bit 0 value corresponding to the x^{n-1} term and the highest numbered bit value corresponding to the x^0 term;

3) M(x) is multiplied by x^4 and divided by G(x), producing a remainder R(x) with a maximum degree of 3;

4) the coefficients of R(x) are used to produce a 4-bit sequence, whose bit 0 value corresponds to the x^3 term and bit 3 value corresponds to the x^0 term;

5) the 4-bit sequence is complemented to produce the 4-bit checksum and is assigned to the relevant checksum field as a bit sequence.

8.5.2 HBR-part checksum computation

This procedure is executed to compute the 32-bit checksum for the entire HBR-part of a LBR-HBR HCPDU except the CS.

8.5.2.1 Procedure

The value of the 32-bit checksum is determined according to the following generating polynomial:

$$G(x) = x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$$

The value of the 32-bit checksum is computed on the n-bit sequence corresponding to the entire HBR-part of a LBR-HBR HCPDU except the CS in the following steps:

1) the lowest numbered 32 bits of the n-bit sequence are complemented;

2) the n bits of the n-bit sequence are used as the coefficients of a polynomial M(x) of degree n-1, with the bit 0 value corresponding to the x^{n-1} term and the highest numbered bit value corresponding to the x^0 term;

3) M(x) is multiplied by x^{32} and divided by G(x), producing a remainder R(x) with a maximum degree of 31;

4) the coefficients of R(x) are used to produce a 32-bit sequence, whose bit 0 value corresponds to the x^{31} term and bit 31 value corresponds to the x^0 term;

5) the 32-bit sequence is complemented to produce the 32-bit checksum and is assigned to the CS as a bit sequence.

8.5.3 Hashed destination address computation

This procedure is executed to compute the hashed destination address for a given LBR-HBR HCPDU.

8.5.3.1 Procedure

For the given LBR-HBR HCPDU, the hashed destination address is computed so that in the HDA:

- the highest order bit is set to 1 if the DA contains a group-HCSAP-address or 0 otherwise; and

- the lower order 8 bits are derived, in the same bit ordering, from XORing the corresponding bits of the individual octets of the HID and the DA.

8.5.4 LBR-HBR HCPDU transmission

This procedure is executed to transmit a generated LBR-HBR HCPDU.

8.5.4.1 Procedure

The generated LBR-HBR HCPDU is set up such that:

- the value of its HDA is set to the hashed destination address according to the hashed destination address computation procedure;

- the value of its HDACS is set to the checksum computed on the HDA according to the LBR-part checksum computation procedure;

- the value of its BLIR is set to the number of blocks in the HBR-part of the LBR-HBR HCPDU, which is also contained in the BLI of the HBR-part of the LBR-HBR HCPDU;

- the value of its BLIRCS is set to the checksum computed on the BLIR according to the LBR-part checksum computation procedure;

- the PAD contains any value; and

- the value of the CS is set to the checksum according to the HBR-part checksum computation procedure.

The generated LBR-HBR HCPDU is then transmitted:

- after surviving the priority and contention resolution if it concerns a synchronized channel access cycle; or

- immediately if it concerns a channel free channel access cycle.

This procedure is considered to conclude successfully if:

- the value of the DA is a group-HCSAP-address and the transmission takes place; or

- the value of the DA is an individual-HCSAP-address and the transmission takes place, followed by the reception of a AK-HCPDU, within a time period allowing for the acknowledgement time requirement at the transmitter of the AK-HCPDU and the anticipated maximum round trip propagation delay, whose AID contains the least significant 8-bit value of the CS of the transmitted LBR-HBR HCPDU.

Otherwise, this procedure is considered to conclude unsuccessfully.

8.5.5 HCPDU reception

This procedure is executed to receive an HCPDU when received from the physical protocol.

8.5.5.1 Procedure

The contents of the following bits of the LBR-part of the received HCPDU shall not be verified:

- bits 0 to 9 if the HCPDU is an LBR HCPDU; and

- bits 0 to 9 and bit 34 if the HCPDU is an LBR-HBR HCPDU.

If the received HCPDU is an AK-HCPDU, it is rejected and is not considered received if:

- the checksum in its AIDCS is incorrect according to the LBR-part checksum computation procedure; or

- the local HC-entity is not currently awaiting an acknowledgement for the previous unicast LBR-HBR HCPDU transmission.

If the received HCPDU is an LBR-HBR HCPDU, it may optionally be rejected and considered not received if the checksum(s) in the HDACS or the BLIRCS of the LBR-part is(are) incorrect according to the LBR-part checksum computation procedure.

If the received HCPDU is an LBR-HBR HCPDU, it is rejected and is not considered received if:

- the correct value of its HDA does not identify the attached HC-entity according to the hashed destination address computation procedure;

- any of its fields of the HBR-part contain an invalid value;

  NOTE 1: An incorrect checksum in its CS of the HBR-part, according to the HBR-part checksum computation procedure, is considered an invalid value.

NOTE 2: The processing of a received LBR-HBR HCPDU of an unknown LBR-HBR HCPDU type is undefined.

- the value of its HID of the HBR-part is not Any_HIPERLAN and is not the HIPERLAN identifier of the attached HM-entity's HIPERLAN; or

- the value of its DA does not identify the attached HM-entity (exclusively or inclusively).

If the received LBR-HBR HCPDU is not rejected, the contents of its HBR-part overrides all the relevant information in its LBR-part.

If the received LBR-HBR HCPDU is not rejected and the value of the DA is the individual-HCSAP-address identifying the attached HM-entity, a AK-HCPDU is generated and transmitted according to the acknowledgement time requirement, where:

- the value of its AID is set to the acknowledgement identifier, which is the least significant 8-bit value of the CS of the HBR-part of the received LBR-HBR HCPDU; and

- the value of its AIDCS is set to the checksum computed on its AID according to the LBR-part checksum computation procedure.

If the received HCPDU is not rejected, it shall be processed according to the relevant procedures.

8.6 Structure and encoding of HCPDUs

The following subclauses specify the structure and encoding of the HCPDUs exchanged between HC-entities.

8.6.1 Transmission and representation of information

All HC-entities respect the following bit and octet ordering conventions.

8.6.1.1 Octet sequence

An octet sequence shall contain an integral number of octets. The octets in an octet sequence are numbered starting from 1 and increasing in the order they are transmitted and received by peer HC-entities. The bits in an octet are numbered from 1 to 8, where bit 1 is the low order bit.

When the structure of an octet sequence is represented using a diagram, the following convention applies:

- octets are shown with the lower numbered octets to the left and higher numbered octets to the right; and

- within an octet, bits are shown with bit 8 to the left and bit 1 to the right.

8.6.1.1.1 Encoding of an unsigned binary number

When consecutive octets are used to represent an unsigned binary number, the lower numbered octet has the more significant value. Within an octet, the higher numbered bit of the octet represents the higher order bit.

8.6.1.1.2 Encoding of the 48-bit LAN MAC address

The 48-bit LAN MAC address is always encoded in a 6-octet sequence. The lowest numbered octet of the 6-octet sequence contains the first octet of the MAC address, the second lowest numbered octet of the 6-octet sequence contains the second octet of the MAC address and so on. Within each octet of the 6-octet sequence, the higher numbered bit represents the higher order bit of the hexadecimal representation of the corresponding MAC address octet.

8.6.1.2 Bit sequence

The bits in a bit sequence are numbered, starting from 0.

When the structure of a bit sequence is represented using a diagram, the following convention applies:

- bits are shown with the lower numbered bits to the left and higher numbered bits to the right.

8.6.1.2.1 Encoding of an unsigned binary number

When consecutive bits are used to represent an unsigned binary number, the lower numbered bit represents the higher order bit.

8.6.1.3 Mapping between an octet sequence and a bit sequence

If any part of an octet sequence needs to be treated as a bit sequence or vice versa, the following mapping rule shall apply:

- the highest numbered bit of the lowest numbered octet in the octet sequence corresponds to bit 0 in the corresponding bit sequence; and

- the lowest numbered bit of the highest numbered octet in the octet sequence corresponds to the highest numbered bit in the corresponding bit sequence.

8.6.2 General HCPDU structure and encoding

The LBR-part of a HCPDU is represented by a bit sequence whereas the HBR-part of a HCPDU is represented by an octet sequence.

The general structure of a LBR HCPDU is shown in figure 29.

LBR-part										**Bit**
1	0	1	0	1	0	1	0	0	1	0 - 9
HBR-part indicator field (HI) = 0										10
...										11 - n

Figure 29: The general structure of a LBR HCPDU

The general structure of a LBR-HBR HCPDU is shown in figure 30.

LBR-part										Bit
1	0	1	0	1	0	1	0	0	1	0 - 9
HBR-part indicator field (HI) = 1										10
Hashed destination HCSAP-address field (HDA)										11 - 19
Hashed destination HCSAP-Address CheckSum field (HDACS)										20 - 23
Block length indicator replica field (BLIR)										24 - 29
Block length indicator replica checksum field (BLIRCS)										30 - 33
1										34

HBR-part		Octet
HCPDU type indicator field (TI) [bit 8-7]	Block length indicator field (BLI) [bit 6-1] = n	1
Padding length indicator field (PLI) = m		2
HIPERLAN identifier field (HID)		3 - 6
Destination HCSAP-address field (DA)		7 - 12
Source HCSAP-address field (SA)		13 - 18
...		19 - (52n-m-4)
Padding field (PAD)		(52n-m-3) - (52n-4)
Checksum field (CS)		(52n-3) - 52n

Figure 30: The general structure of a LBR-HBR HCPDU

8.6.2.1 HBR-part Indicator field (HI)

The HI, a 1-bit field, contains a value specifying if the HCPDU has the HBR-part, which is encoded as an unsigned binary number. It has a value 1 if the HCPDU is a LBR-HBR HCPDU or 0 otherwise.

8.6.2.2 Hashed Destination HCSAP Address field (HDA)

The HDA, a 9-bit field, contains the hashed destination HCSAP-address, which is encoded as an unsigned binary number.

8.6.2.3 Hashed destination HCSAP-Address CheckSum field (HDACS)

The HDACS, a 4-bit field, contains the checksum for the HDA.

8.6.2.4 Block Length Indicator Replica field (BLIR)

The BLIR, a 6-bit field, contains the number of blocks in the HBR-part (as replicated from the BLI), which is encoded as an unsigned binary number.

8.6.2.5 Block Length Indicator Replica CheckSum field (BLIRCS)

The BLIRCS, a 4-bit field, contains the checksum for the BLIR.

8.6.2.6 HCPDU Type Indicator field (TI)

The TI, a 2-bit field, contains the LBR-HBR HCPDU type, which is encoded as an unsigned binary number.

8.6.2.7 Block Length Indicator field (BLI)

The BLI, a 6-bit field, contains the number of blocks in the HBR-part, which is encoded as an unsigned binary number.

8.6.2.8 Padding Length Indicator field (PLI)

The PLI, a 1-octet field, contains the number of padding octets used in the PAD, which is encoded as an unsigned binary number.

8.6.2.9 HIPERLAN IDentifier field (HID)

The HID, a 4-octet field, contains the HIPERLAN identifier, which is encoded as an unsigned binary number.

8.6.2.10 Destination HCSAP-Address field (DA)

The DA, a 6-octet field, contains the destination HCSAP-address, which is encoded as a 48-bit LAN MAC address.

8.6.2.11 Source HCSAP-Address field (SA)

The SA, a 6-octet field, contains the source HCSAP-address, which is encoded as a 48-bit LAN MAC address.

8.6.2.12 PADding field (PAD)

The PAD, a field of 0 to 51 octets, contains the padding octets of any values. If the value of the PLI is 0, the PAD does not exist.

8.6.2.13 CheckSum field (CS)

The CS, a 4-octet field, contains the checksum for the entire HBR-part except the CS.

8.6.3 AK-HCPDU

The structure of a AK-HCPDU, which is a LBR HCPDU, is shown in figure 31.

LBR-part										**Bit**
1	0	1	0	1	0	1	0	0	1	0 - 9
HBR-part indicator field (HI) = 0										10
Acknowledgement identifier field (AID)										11 - 18
Acknowledgement identifier checksum field (AIDCS)										19 - 22

Figure 31: The structure of (the LBR-part of) a AK-HCPDU

8.6.3.1 Acknowledgement IDentifier field (AID)

The AID, an 8-bit field, contains the acknowledgement identifier, which is encoded as an unsigned binary number.

8.6.3.2 Acknowledgement IDentifier CheckSum field (AIDCS)

The AIDCS, a 4-bit field, contains the checksum for the AID.

8.6.4 CP-HCPDU

The structure of the HBR-part of a CP-HCPDU, which is a LBR-HBR HCPDU, is shown in figure 32.

HBR-part			Octet
HCPDU type indicator field (TI) [bit 8-7] = 0	Block length indicator field (BLI) [bit 6-1] = 1		1
Padding length indicator field (PLI) = 29			2
HIPERLAN identifier field (HID) = Any_HIPERLAN			3 - 6
Destination HCSAP-address field (DA) = All_Neighbours			7 - 12
Source HCSAP-address field (SA) = FF FF FF FF FF FF			13 - 18
Channel 3 field (C3) [bit 8]	Channel 4 field (C4) [bit 7]	Reserved field [bit 6-1] = 0	19
Padding field (PAD)			20 - 48
Checksum field (CS)			49 - 52

Figure 32: The structure of the HBR-part of a CP-HCPDU

8.6.4.1 Channel 3 field (C3)

The C3, a 1-bit field, contains a value specifying if channel 3 is permitted to be used, which is encoded as an unsigned binary number. It has a value 1 if channel 3 is permitted to be used or 0 otherwise.

8.6.4.2 Channel 4 field (C4)

The C4, a 1-bit field, contains a value specifying if channel 4 is permitted to be used, which is encoded as an unsigned binary number. It has a value 1 if channel 4 is permitted to be used or 0 otherwise.

8.6.4.3 Reserved field

The reserved field, a 6-bit field, is currently unused and shall contains the value 0.

8.6.5 DT-HCPDU

The structure of the HBR-part of a DT-HCPDU, which is a LBR-HBR HCPDU, is shown in figure 33.

HBR-part		Octet
HCPDU type indicator field (TI) [bit 8-7] = 1	Block length indicator field (BLI) [bit 6-1] = n	1
Padding length indicator field (PLI) = m		2
HIPERLAN identifier field (HID)		3 - 6
Destination HCSAP-address field (DA)		7 - 12
Source HCSAP-address field (SA)		13 - 18
User data field (UD)		19 - (52n-m-4)
Padding field (PAD)		(52n-m-3) - (52n-4)
Checksum field (CS)		(52n-3) - 52n

Figure 33: The structure of the HBR-part of a DT-HCPDU

8.6.5.1 User Data field (UD)

The UD, a field of 1 to 2 422 octets, contains the HCSDU in the same octet ordering of the HCSDU.

9 Physical layer

The tasks of the physical layer include the following:

- to modulate and demodulate radio carriers with a bit stream of a defined instantaneous rate to create an RF link;
- to acquire and maintain bit and burst synchronization between Transmitters (Txs) and Receivers (Rxs);
- to transmit or receive a defined number of bits at a requested time and on a particular carrier frequency;
- to add and remove the synchronization sequence;
- to encode and decode the Forward Error Correction scheme;
- to measure received signal strength;
- to decide whether a channel is idle or busy, for the purposes of deferral during channel access attempts; and
- to maintain a defer threshold.

9.1 Equipment classes

All transmitters shall be of class A, B or C. All receivers shall be of class A, B or C. Only the permissible combinations of receiver and transmitter classes shown in table 28 shall be used in a single HIPERLAN equipment.

Table 28: Permissible combinations of transmitter and receiver classes

	Transmitter class A (+ 10 dBm)	**Transmitter class B (+ 20 dBm)**	**Transmitter class C (+ 30 dBm)**
Receiver class A (- 50 dBm)	Permissible	Not permissible	Not permissible
Receiver class B (- 60 dBm)	Permissible	Permissible	Not permissible
Receiver class C (- 70 dBm)	Permissible	Permissible	Permissible
NOTE: The figures in parentheses indicate the nominal transmitted power (EIRPEP) or receiver sensitivity associated with each class.			

9.2 RF carriers

9.2.1 Nominal frequencies of RF carriers

The nominal radio frequency band allocated to HIPERLAN is 5 150 MHz to 5 300 MHz (see CEPT Recommendation T/R 22-06 [1]).

The nominal frequency of each carrier, corresponding to its carrier number, c, is shown in table 29.

All transmissions shall be centred on one of the nominal carrier frequencies F(0) to F(4), as shown in table 47.

All HIPERLAN equipments shall operate on all 5 channels.

Table 29: Nominal carrier centre frequencies

Carrier number, c	**Centre Frequency, F(c) MHz**
0	5 176,468 0
1	5 199,997 4
2	5 223,526 8
3	5 247,056 2
4	5 270,585 6

The carriers numbered 0, 1 and 2 are designated the "default" carriers.

NOTE: Making transmissions on the carriers numbered 3 and 4 can be illegal in some countries.

9.2.2 Accuracy and stability of RF carriers

The transmitted RF carrier frequency (f_c) shall be within 10 ppm of the nominal frequency shown above.

9.3 Antenna systems

Where an external antenna is used, the method of connection to the HIPERLAN equipment shall be specifically designed to avoid operation using unauthorized antennas.

9.4 Clear Channel Assessment (CCA)

The HIPERLAN clear channel assessment scheme is based on the measurement of the received signal strength only. A threshold is used for determining whether the channel is busy or idle. In order to raise the threshold to allow transmission in the presence of non-HIPERLAN interference on the radio channel, an optional adaptive defer threshold scheme is defined.

The time-domain variation of the received signal strength is used for the threshold adaptation. It is known that HIPERLAN signals are bursty in nature and it is assumed that any interference will be of relatively constant power level. The adaptation algorithm detailed below seeks to raise the threshold to just above the level of any continuous signals on the channel. In the presence of bursty signals, the threshold scheme is intended to allow transmission during "quiet" periods.

The parameters for the measurement of signal strength, expressed as Signal Level Number (SLN), are defined in subclause 9.9.2.

The channel shall be considered to be idle when the received SLN is less than the defer threshold value. In all other cases the channel shall be considered to be busy.

9.4.1 Default defer threshold

The default defer threshold shall be SLN 1.

A threshold higher than the default defer threshold may be used provided that is less than or equal to the Maximum Adaptive Defer Threshold (MADT).

9.4.2 Maximum adaptive defer threshold

The MADT shall not be greater than SLN 22.

NOTE: SLN 22 corresponds to a received signal level of approximately -40 dBm.

The MADT is 2 levels higher than the lowest SLN measured in any 5 ms window, as shown in figure 34.

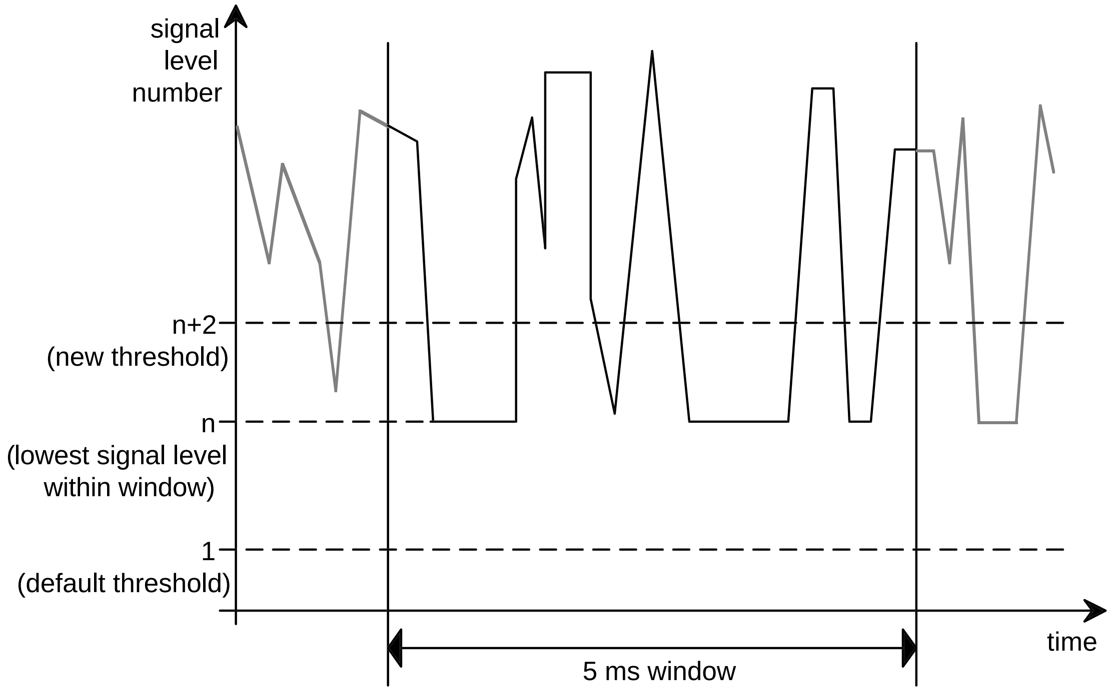


Figure 34: Operation of adaptive defer threshold

A 5 ms measurement window may occur at any time and may include time during which the HIPERLAN equipment is transmitting.

9.4.3 Ageing of defer threshold

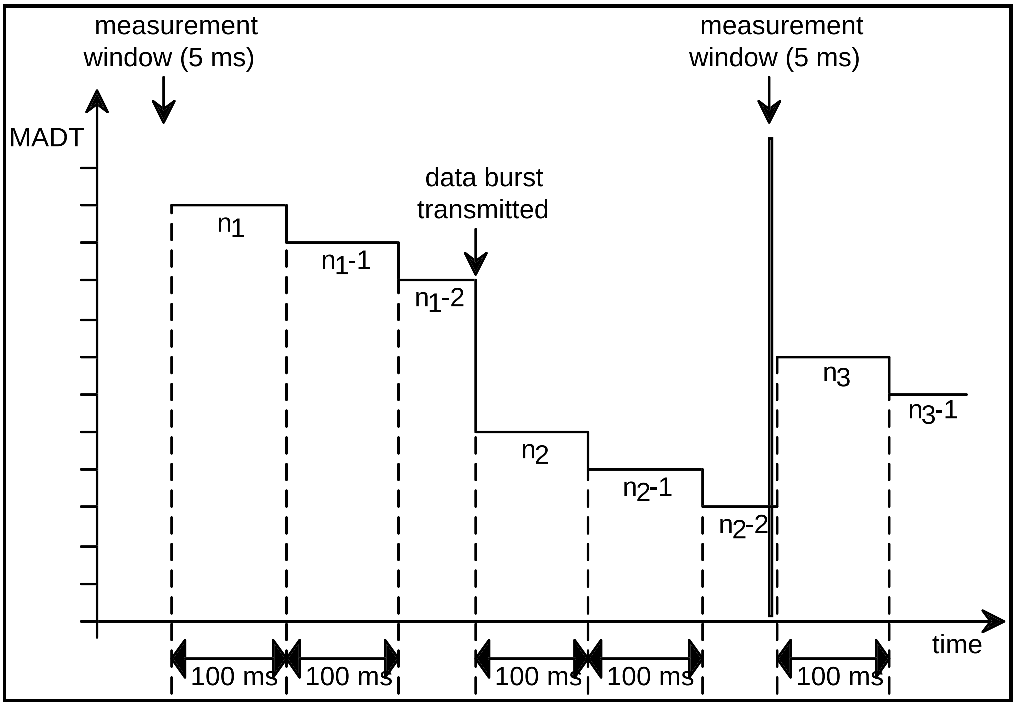


Figure 35: Example of ageing of defer threshold

The MADT shall only be valid for 100 ms after the end of the most recent 5 ms measurement window.

The MADT shall be decreased by one SLN level for every 100 ms in which no new measurement window occurs, until the MADT reaches SLN 1.

Whenever a data burst is successfully transmitted by a HIPERLAN equipment and a defer threshold higher than SLN 1 is being used, the equipment shall measure the signal strength during the 256 bit periods immediately following the end of the LBR-HBR data burst. If the measured signal strength is lower than (MADT - 2) then the MADT shall be reduced to two levels higher than that SLN.

9.5 Channel access burst

A channel access burst is used for priority assertion and elimination bursting defined in EY-NPMA. The channel access conveys a high rate bit stream formed by the necessary repetition of the bit sequence shown in table 30 for the duration of the burst, which shall be transmitted using the high bit rate modulation scheme.

Table 30: Bits sequence used in a access burst

Bits
11111010100010011100000110010110
NOTE: Bit transmission order is from left to right

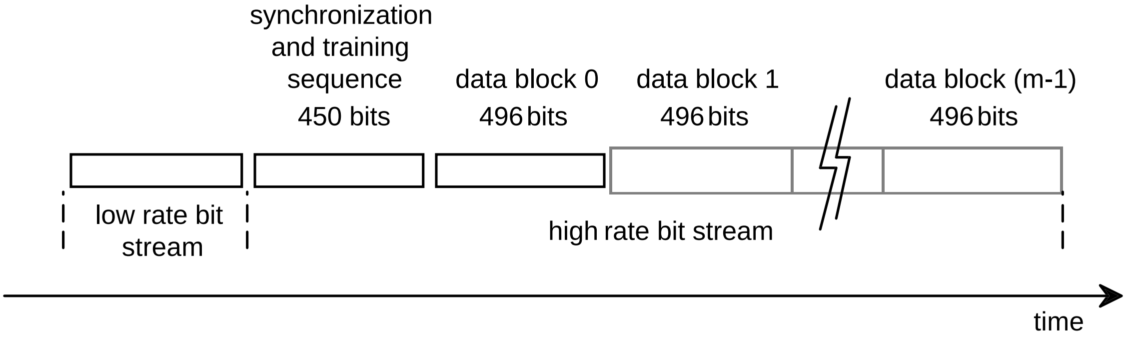
9.6 Data Bursts

9.6.1 Overview of data burst types

There are two types of data bursts:

- LBR-HBR data burst, which encodes a LBR-HBR HCPDU; and
- LBR data burst, which encodes a LBR HCPDU.

These two types data bursts are shown in figures 36 and 37:



NOTE: The number of bits shown refers to the number of high rate bits

Figure 36: LBR-HBR data burst

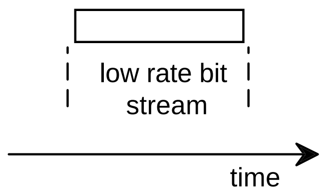


Figure 37: LBR data burst

9.6.2 LBR-HBR data burst

This subclause gives a general description of the structure of data bursts and describes the terminology used in defining the contents of the burst. The detailed specification of the contents of the burst is given in the following subclauses.

A data burst shall contain the following fields:

- a number of low rate bits;
- a synchronization/training sequence of 450 high rate bits; and
- a number (at least one) of blocks of 496 high rate bits of interleaved, coded data.

Each data block consists of 416 data high rate bits, divided into 16 segments of 26 bits and each coded with a BCH (31,26) code. The resulting 16 x 31 = 496 bits are block interleaved.

9.6.2.1 Derivation of LBR-HBR data burst

A LBR-HBR data burst conveys a low rate bit stream and a high rate bit stream.

The low rate bit stream, denoted as R(0) ... R(NL - 1), correspond exactly to the bit sequence in the LBR-part of the LBR-HBR HCPDU (according to subclause 8.6.2), which has NL integral number of bits.

The high rate bit stream, denoted as D(0) ... D(NH - 1), have NH integral number of bits which comprise:

- a synchronization/training sequence of 450 bits; and
- m data blocks of 496 bits, where m is an integer between 1 and 47 inclusively.

  NOTE: This maximum value (47) of m has been determined for mobile operation of the HIPERLAN equipment at speeds of up to 1,4 m/s. It is recommended that the maximum value of m be reduced for operation at higher speeds.

Accordingly, NH = 450 + 496 $\times$ m.

In a LBR-HBR data burst, R(0) ... R(NL - 1) is transmitted starting with R(0), using the low bit rate modulation scheme, followed by the transmission of D(0) ... D(NH - 1) starting with D(0), using the high bit rate modulation scheme. The centre of D(0) shall be 8,5 high rate bit periods after R(NL - 1).

The m data blocks encode the HBR-part of the LBR-HBR HCPDU, which is 416 $\times$ m bits. The HBR-part of the LBR-HBR HCPDU is mapped into a bit sequence P(0) ... P(416 $\times$ m - 1) according to subclause 9.7.1.3. A data block is constructed from every 416 bits of P(0) ... P(416 $\times$ m - 1). These 416 bits are divided into 16 segments of 26 bits, each coded with a BCH (31, 26) code. The resulting 16 31-bit codewords are interleaved into a 496-bit data block.

The whole process of generating a LBR-HBR data burst, i.e. the bit sequence delivered to the modulator, is described as a sequential series of operations, each corresponding to one of the blocks in the figure below. However, this description does not prescribe a particular implementation.

The procedures for generating the D(0) ... D(NH - 1) bit sequence is described in the following subclauses.

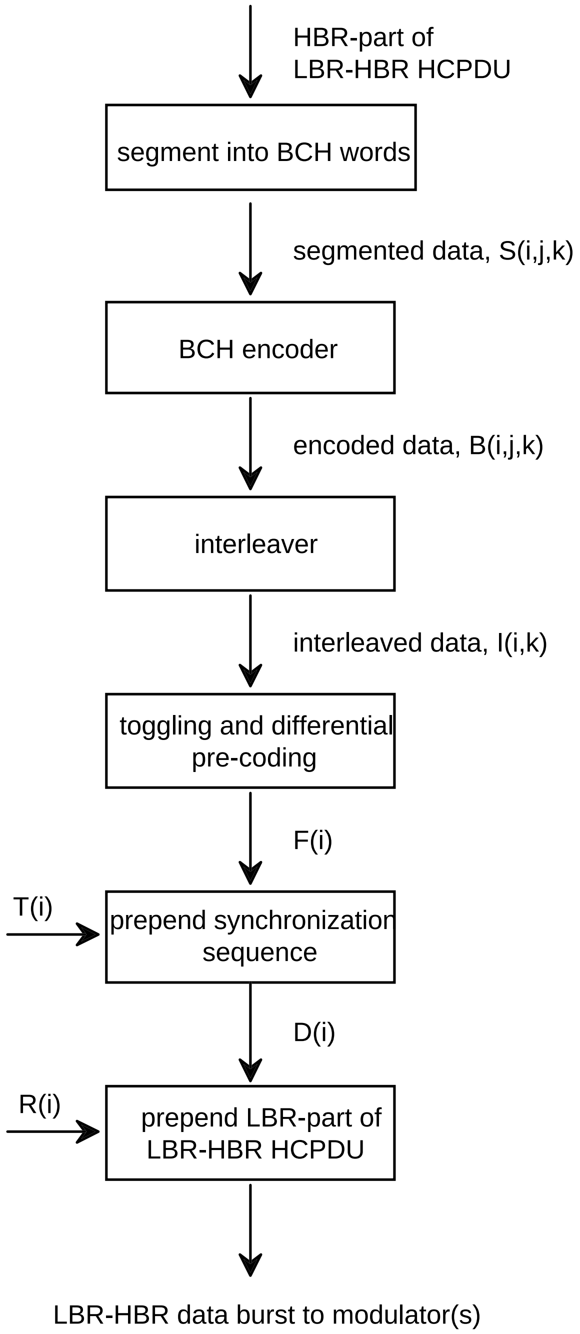


Figure 38: Data burst formatting procedure

9.6.2.2 Segmentation

The bit sequence P(0) ... P(416×m - 1) is segmented into 26 bit segments and 416 bit uncoded data blocks as follows:

$$S(i, j, k) = P(i + 26 \times j + 416 \times k)$$

where:

- $0 \le i \le 25$;
- $0 \le j \le 15$;
- $0 \le k \le (m - 1)$; and
- i, j, k are integers.

9.6.2.3 Bose-Chaudhuri-Hocquenghem (BCH) encoding

Each 26 bit segment S(0,j,k) ... S(25,j,k) is encoded according to the following relationship:

$$\left[B'(0,j,k)\ldots B'(30,j,k)\right] = \left[S(0,j,k)\ldots S(25,j,k)\right]\begin{bmatrix}
1000000000000000000000000010010\\
0100000000000000000000000001001\\
0010000000000000000000000010110\\
0001000000000000000000000001011\\
0000100000000000000000000010111\\
0000010000000000000000000011001\\
0000001000000000000000000011110\\
0000000100000000000000000001111\\
0000000010000000000000000010101\\
0000000001000000000000000011000\\
0000000000100000000000000001100\\
0000000000010000000000000000110\\
0000000000001000000000000000011\\
0000000000000100000000000010011\\
0000000000000010000000000011011\\
0000000000000001000000000011111\\
0000000000000000100000000011101\\
0000000000000000010000000011100\\
0000000000000000001000000001110\\
0000000000000000000100000000111\\
0000000000000000000010000010001\\
0000000000000000000001000011010\\
0000000000000000000000100001101\\
0000000000000000000000010010100\\
0000000000000000000000001001010\\
0000000000000000000000000100101
\end{bmatrix}$$

Where all arithmetic is to be performed modulo-2.

The first bit of each BCH codeword is then inverted according to the following relationship:

$B(i,j,k) = \text{not}\ (B'(i,j,k))$ for $i = 0$; and
$B(i,j,k) = B'(i,j,k)$ for $1 \le i \le 30$.

This encoding results in words of 31 coded bits B(0,j,k) ... B(30,j,k);

where:

- $0 \le j \le 15$;
- $0 \le k \le (m - 1)$; and
- j, k are integers.

9.6.2.4 Interleaving

Each encoded block of 496 bits is then interleaved according to the following relationship:

I(i, k) = B(Int (i / 16), i Mod 16, k)

where:

- $0 \leq i \leq 495$;
- $0 \leq k \leq (m - 1)$; and
- i, k are integers.

9.6.2.5 Bit toggling

The full data field of the transmitted burst is then given by:

W(i) = I(i Mod 496 , Int(i / 496));

where $0 \leq i \leq 496 \times m - 1$.

The vector W(i) is then toggled according to the following relationship:

G(i) = W(i) for (Int (i / 2)) Mod 2 = 0; and

G(i) = Not (W(i)) for (Int (i / 2)) Mod 2 = 1;

where $0 \leq i \leq 496 \times m - 1$.

9.6.2.6 Differential pre-coding

The vector of toggled data is then differentially encoded according to the following relationship:

F(i) = Not ((G(i) + 1) Mod 2) for i = 0; and

F(i) = Not ((G(i) + G(i - 1)) Mod 2) for i > 0;

where $0 \leq i \leq 496 \times m - 1$.

9.6.2.7 Synchronization and training sequence

The synchronization and training sequence is given in table 31.

Table 31: Values of synchronization and training sequence bits

Bits	Value (read left to right)
T(0) ... T(39)	0 0 0 0 1 0 1 0 1 1 1 0 1 1 0 0 0 1 1 1 1 1 0 0 1 1 0 1 0 0 1 0 0 0 0 1 0 1 0 1
T(40) ... T(79)	1 1 0 1 1 0 0 0 1 1 1 1 1 0 0 1 1 0 1 0 0 1 0 0 0 0 1 0 1 0 1 1 1 0 1 1 0 0 0 1
T(80) ... T(119)	1 1 1 1 0 0 1 1 0 1 0 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0
T(120) ... T(159)	1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0
T(160) ... T(199)	1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 1 0 0 1 1 1 0 0 0 0
T(200) ... T(239)	1 1 0 1 0 1 0 0 1 0 0 0 1 0 1 1 1 1 1 0 1 1 0 0 1 1 1 0 0 0 0 1 1 0 1 0 1 0 0 1
T(240) ... T(279)	0 0 0 1 0 1 1 1 1 1 0 1 1 0 0 1 1 1 0 0 0 0 1 1 0 1 0 1 0 0 1 0 0 0 1 0 1 1 1 1
T(280) ... T(319)	0 1 0 0 0 1 0 0 1 0 1 0 1 1 0 0 0 0 1 1 1 0 0 1 1 0 1 1 1 1 1 0 1 0 0 0 1 0 0 1
T(320) ... T(359)	0 1 0 1 1 0 0 0 0 1 1 1 0 0 1 1 0 1 1 1 1 1 0 1 0 0 0 1 0 0 1 0 1 0 1 1 0 0 0 0
T(360) ... T(399)	1 1 1 0 0 1 1 0 1 1 1 1 1 1 1 1 1 0 1 1 1 0 0 0 1 0 1 0 1 1 0 1 0 0 0 0 1 1 0 0
T(400) ... T(439)	1 0 0 1 1 1 1 1 0 1 1 1 0 0 0 1 0 1 0 1 1 0 1 0 0 0 0 1 1 0 0 1 0 0 1 1 1 1 1 0
T(440) ... T(449)	1 1 1 0 0 0 1 0 1 0

NOTE: The training sequence in table 31 is based on five different length 31 m-sequences with the generator polynomials:

$m_1(x) = x^5 + x^2 +1$
$m_2(x) = x^5 + x^4 + x^3 + x^2 + 1$
$m_3(x) = x^5 + x^4 + x^2 + x + 1$
$m_4(x) = x^5 + x^3 + 1$
$m_5(x) = x^5 + x^3 + x^2 + x + 1$

Each m-sequence is repeated three times, starting with three m_1 then three m_2 etc. The last repetition of m_5 is truncated after the 16^{th} bit.

9.6.2.8 Format HBR-part of LBR-HBR data burst

The high rate bit stream D(0) ... D(NH - 1) is given by the following expressions:

$D(i) = T(i)$ for $0 \leq i \leq 449$; and

$D(i) = F(i - 450)$ for $450 \leq i \leq NH - 1$.

9.6.3 LBR data burst

An LBR data burst conveys a low rate bit stream.

In an LBR data burst, the bit sequence in the AK- HCPDU is transmitted starting with bit 0 (according to subclause 9.7), using the low bit rate modulation scheme.

9.7 Modulation technique

Gaussian Minimum Shift Keying (GMSK) with BT=0,3 shall be used as the high bit rate modulation scheme to modulate a high rate transmission and Frequency Shift Keying (FSK) shall be used as the low bit rate modulation scheme to modulate a low rate transmission, as defined in the following subclauses.

9.7.1 Gaussian Minimum Shift Keying (GMSK)

GMSK is specified as follows:

For the purposes of defining the modulation scheme, the data to be modulated is considered to be a sequence of bits d_i where $d_i \in \{0,1\}$.

The modulating data value input to the modulator is:

$$a_i = 1 - d_i \qquad (a_i \in \{-1,+1\}).$$

The modulating data values, as represented by Dirac pulses, excite a linear filter with impulse response defined by:

$$g(t) = h(t) * \mathrm{rect}(t/T);$$

where the function rect is defined by:

$$\mathrm{rect}(t/T) = 1/T \quad \text{for} \quad |t| < T/2;$$

$$\mathrm{rect}(t/T) = 0 \quad \text{otherwise;}$$

and $*$ denotes convolution h(t) is defined by:

$$h(t) = \exp\left(-t^2 / \left(2s^2T^2\right)\right) / \left(\sqrt{(2\pi)}sT\right)$$

where:

$$s = \sqrt{\ln(2)} / 2\pi BT$$

and, in HIPERLAN:

$$BT = 0{,}3$$

where B is the 3 dB bandwidth of the filter with impulse response h(t) and T is the duration of one input data bit, equal to the reciprocal of the bit rate defined in subclause 9.7.3.1 and approximately equal to 42,5 ns.

The phase of the modulated signal is:

$$z(t') = \sum_i a_i \pi h \int_{-\infty}^{t'-iT} g(u)du$$

where the modulating index h is 1/2 (maximum phase change in radians is $\pi/2$ per data interval).

The time reference t'=0 is the start of the active part of the burst.

The modulated RF carrier, except during the start and end of the burst may therefore be expressed as:

$$x(t') = \sqrt{(2E_c/T)}\cos\left(2\pi f_c t' + z(t') + z_0\right);$$

where E_c is the energy per modulating bit, f_c is the centre frequency and z_o is a random phase and is constant during one burst.

9.7.2 Frequency Shift Keying (FSK)

FSK is specified as follows:

Each low rate bit shall be mapped to a transmitted frequency as shown in table 32.

Table 32: Nominal frequencies for FSK modulation

Bit value	Nominal frequency
0	f_c - 368 kHz
1	f_c + 368 kHz

where f_c is the centre frequency.

9.7.3 Modulation signalling rate

9.7.3.1 High rate transmission

The signalling rate for high-rate transmissions of a HIPERLAN node shall be nominally 23,529 4 Mbit/s and shall be accurate to within the range ± 235 bit/s.

9.7.3.2 Low rate transmission

The signalling rate for low rate transmissions of a HIPERLAN node shall be nominally 1,470 588 Mbit/s and shall be accurate to within the range ± 15 bit/s.

9.7.4 Modulation accuracy

When transmitting a burst, the accuracy of the signal, relative to the theoretical modulated waveform as specified above is defined as follows:

9.7.4.1 High rate transmission

This subclause applies to the part of a data burst from the centre of the first bit of high rate data to the centre of the last bit of high rate data.

The phase error trajectory shall be measured by computing the difference between the phase of the transmitted waveform and the phase of the expected one. The RMS phase error (difference between the phase error trajectory and its linear regression over any 1 000 bits) shall not be greater than 10° with a maximum peak deviation of less than 30°.

9.7.4.2 Low rate transmission

This subclause applies to a low rate bit stream.

The low rate bit stream shall have a maximum transition time from "1" to "0" or from "0" to "1" of 50 ns.

When the low rate bit stream is not followed by high bit rate data, the peak frequency deviation of the FSK modulation shall be within the limits shown in the table 33.

Table 33: Limits on peak deviation frequency of low rate bit stream which is not followed by high bit rate data

Bit position	Minimum peak deviation frequency (kHz)	Maximum peak deviation frequency (kHz)
0 and 1	0	700
2 to 9	190	550
10 to 14	250	500
15 until the last bit	330	460

However, when the low rate bit stream is followed by high bit rate data, the peak frequency deviation of the FSK modulation shall be within the limits shown in the table 34.

Table 34: Limits on peak deviation frequency of low rate bit stream which is followed by high bit rate data

Bit position	Minimum peak deviation frequency (kHz)	Maximum peak deviation frequency (kHz)
0 and 1	0	700
2 to 9	190	550
10 to 14	250	500
15 until the penultimate bit	330	460
the last bit	0	700

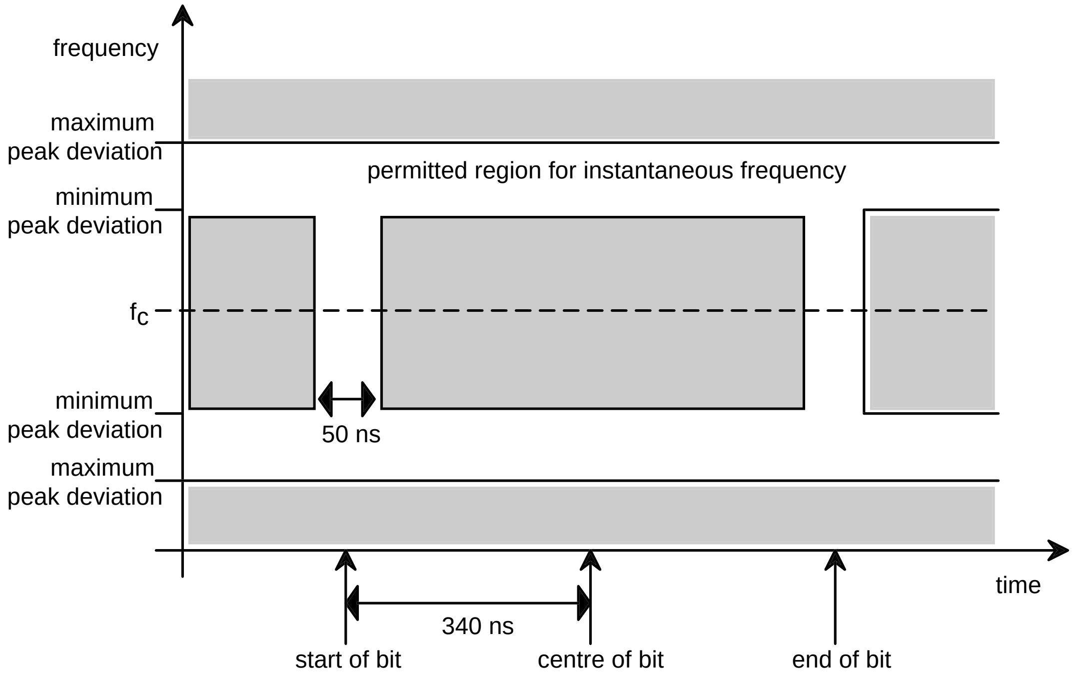


Figure 39: FSK modulation instantaneous frequency limits

9.8 Burst transmission

9.8.1 Transmitted power

9.8.1.1 Instantaneous transmitted power

The Effective Isotropic Radiated Peak Envelope Power (EIRPEP) shall not exceed 1 W.

9.8.1.2 Power profile during burst

The permitted transmitter power levels for the start, duration and end of transmitted bursts are shown in figure 40. The Normal Transmitter Power (NTP) shall be defined as the mean power between the start of the burst and end of the burst.

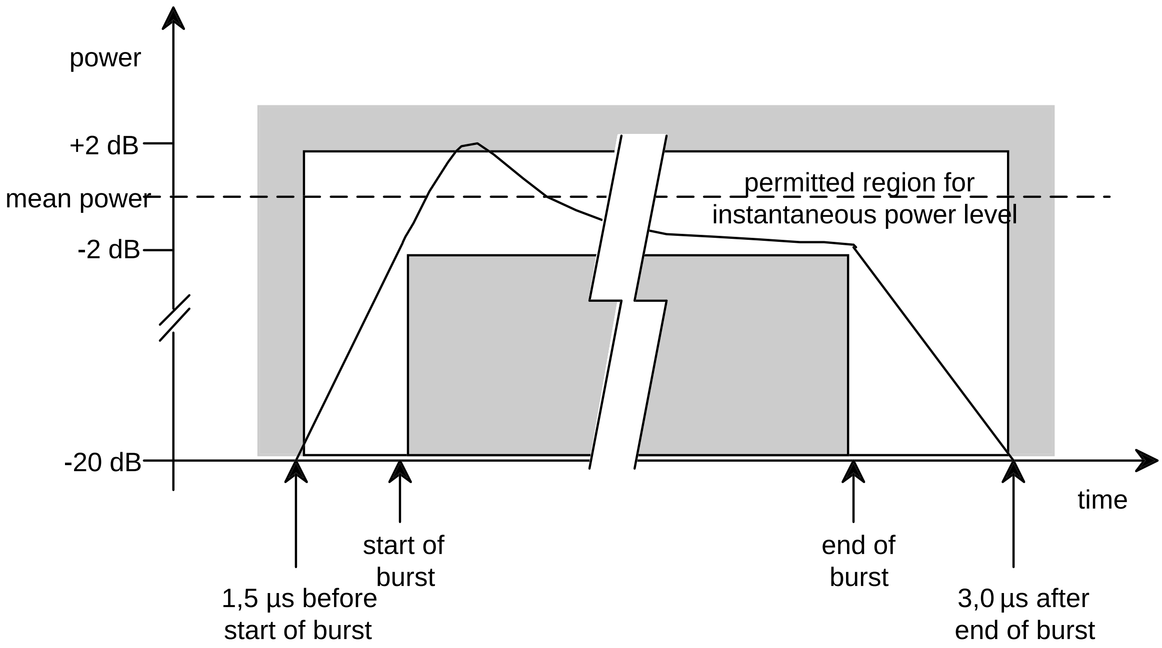


Figure 40: Power mask during transmission

In figure 40, the "start of burst" is:

- the centre of the first bit of the burst, if the burst commences with a high rate bit; or
- 8 high rate bit periods before the centre of the first bit, if the burst commences with a low rate bit.

In figure 40, the "end of burst" is:

- the centre of the last bit of the burst, if the burst ends with a high rate bit; or
- 8 high rate bit periods after the centre of the last bit, if the burst ends with a low rate bit.

Power outside the time mask shall be maintained below -60 dBc.

9.8.1.3 Transmitter rise time

This is the time from when the radiated power is 60 dB below NTP to the start of the burst.

The transmitter rise time shall be less than 2,5 µs.

The level shall not rise to more than -20 dB below the NTP until 1,5 µs from the start of the burst (see figure 40).

NOTE: No minimum rise time is specified explicitly. The minimum time will be determined implicitly by spectral requirements.

9.8.1.4 Transmitter fall time

This is the time from the end of the burst to when the radiated power is 60 dB below NTP.

The transmitter fall time shall be less than 4,0 µs.

The level shall fall to more than -20 dB below the NTP after 3,0 µs after the end of the burst (see figure 40).

NOTE: No minimum fall time is specified explicitly. The minimum time will be determined implicitly by spectral requirements.

9.8.1.5 Power variation during the burst

During the period from the start of the burst to the end of the burst, the instantaneous power shall be within ± 2 dB of the NTP.

9.8.1.6 Transmit power control

The transmitter shall implement up to three power levels as shown in the tables 35, 36 or 37, depending on the transmitter class.

Table 35: Power control levels for class A transmitters

Power level number	EIRPEP
0	+ 10 dBm

Table 36: Power control levels for class B transmitters

Power level number	EIRPEP
0	+ 10 dBm
1	+ 20 dBm

Table 37: Power control levels for class C transmitters

Power level number	EIRPEP
0	+ 10 dBm
1	+ 20 dBm
2	+ 30 dBm

The transmitted power shall be within 5 dB of that specified in the tables above, but subject to the overall limit of subclause 9.8.1.1.

9.8.2 Unwanted RF radiation

9.8.2.1 Unwanted emissions outside the HIPERLAN bands

The unwanted emissions of the transmitter shall not exceed the values in table 38 in the indicated bands. The limits are for average power over 50 maximum length and 50 minimum length bursts, plus associated contention resolution cycles and LBR data burst transmissions. Measurements shall be from 1,5 µs before the start of the burst to 3 µs after the end of the burst.

NOTE: The start and the end of the burst are defined in subclause 9.8.1.2.

Table 38: Transmitter unwanted radiated emission limits

Frequency range	Maximum power	Bandwidth
30 MHz to 1 GHz	- 36 dBm	100 kHz
1 GHz to 5 GHz	- 30 dBm	1 MHz
5 GHz to 5,15 GHz	- 33 dBm	100 kHz
5,30 to 5,45 GHz	- 33 dBm	100 kHz
5,45 to 26,5 GHz	- 30 dBm	1 MHz

When operating on channels 0,1 or 2 the limit in table 39 shall also be met.

Table 39: Additional limit

Frequency range	Maximum power	Bandwidth
5,25 to 5,30 GHz	- 33 dBm	100 kHz

The bandwidths are nominal -3 dB bandwidths.

9.8.2.2 Emissions due to modulation and switching

When a transmitter is operating on a carrier of frequency F(c), the emissions due to the modulation and switching should be lower than the limits in table 40.

Table 40: Limits for emissions due to modulation and switching

Frequency range	Peak power in 1 MHz relative to transmitter power	Average power in 1 MHz relative to total transmitted power
|F(c) - F|< 10 MHz		0 dB
10 MHz < |F(c) - F|< 12 MHz		- 5 dB
12 MHz < |F(c) - F|< 15 MHz		- 10 dB
15 MHz < |F(c) - F|< 25 MHz	- 12 dB	- 22 dB
25 MHz < |F(c) - F|< 35 MHz	- 30 dB	
35 MHz < |F(c) - F|< 45 MHz	- 40 dB	
45 MHz < |F(c) - F|	- 50 dB	

The averaging shall be over 50 maximum length and 50 minimum length bursts, plus associated contention resolution cycles and LBR data burst transmissions. Peak measurements shall be measured between 1,5 µs before the start of the burst to 3 µs after the end of the burst. Average measurements shall be measured between 1,5 µs after the start of the burst to 1,5 µs before the end of the burst.

NOTE: The start and the end of the burst are defined in subclause 9.8.1.2.

The power levels all refer to the power in a 1 MHz bandwidth centred on a frequency F. These limits take into account the total power of all emissions including modulation and switching transients.

There shall be no limit more stringent than -33 dBm in 1 MHz.

9.8.3 Diversity transmission

Transmissions shall only be made from an antenna which was used for reception during CCA and whose characteristics have not been changed since CCA was performed.

9.8.4 Switching times

9.8.4.1 Time to switch from transmit to receive

The maximum time between ceasing transmission and having a valid estimate of the received signal strength shall be 6 µs.

9.8.4.2 Time to change RF carrier

The time during which a HIPERLAN equipment is inoperable whilst changing RF carrier shall be less than 1 ms.

9.9 Receiver parameters

9.9.1 Spurious emissions

Emissions of the HIPERLAN equipment made outside the time of transmitted bursts shall not exceed the values in the table 41 in the indicated bands.

Table 41: Spurious radiated emission limits

Frequency range	Maximum power	Bandwidth
30 MHz to 1 GHz	- 57 dBm	100 kHz
1 GHz to 26,5 GHz	- 47 dBm	1 MHz

The bandwidths are nominal -3 dB bandwidths.

9.9.2 Measurement of signal strength

Where the receiver is required to measure the received signal level it shall be measured in the same bandwidth used for reception of high rate transmission. The level shall be measured in terms of Signal Level Number (SLN) as shown in table 42.

Table 42: Parameters for measurement of signal level

Signal Level Number (SLN)	Value dBm	Tolerance
0	lower than SLN 1	
1	-75,0	+3, -5 dB
2	-73,3	+4, -5 dB
3	-71,7	± 5 dB
4	-70,0	± 5 dB
5	-68,3	± 5 dB
6	-66,7	± 5 dB
7	-65,0	± 5 dB
8	-63,3	± 5 dB
9	-61,7	± 5 dB
10	-60,0	± 5 dB
11	-58,3	± 5 dB
12	-56,7	± 5 dB
13	-55,0	± 5 dB
14	-53,3	± 5 dB
15	-51,7	± 5 dB
16	-50,0	± 5 dB
17	-48,3	± 5 dB
18	-46,7	± 5 dB
19	-45,0	± 5 dB
20	-43,3	± 5 dB
21	-41,7	± 5 dB
22	-40,0	± 5 dB
23	-38,3	± 5 dB
24	-36,7	± 5 dB
25	-35,0	± 5 dB
26	-33,3	± 5 dB
27	-31,7	± 5 dB
28	-30,0	± 5 dB
29	-28,3	± 5 dB
30	-26,7	± 5 dB
31	-25,0	± 5 dB

In addition to the tolerance given in table 42, the SLN steps shall be monotonic.

These values for SLN are for receivers with nominally 0 dB gain (isotropic) antennas. For other antennas, the power levels may be changed by the number of decibels of peak antenna gain or loss relative to an isotropic radiator.

A received power level greater than the maximum signal level shown in table 42 shall be reported as SLN 31.

9.9.3 Radio receiver performance

The radio receiver sensitivity for high bit-rate data in LBR-HBR data bursts is the power level at the receiver RF input at which the proportion of received HBR-parts with uncorrected errors is 0,01. This shall apply for HBR-parts of LBR-HBR HCPDUs of 4 160 bits.

The radio receiver sensitivity for low bit-rate data in LBR-HBR data bursts is the power level at the receiver RF input at which the proportion of received LBR-parts (of LBR-HBR HCPDUs) with errors is 0,01.

The radio receiver sensitivity for low bit-rate data in LBR data bursts is the power level at the receiver RF input at which the proportion of received LBR HCPDUs with errors is 0,01.

These requirements shall apply when the signal input to the receiver is not distorted by multipath or additive noise or interference.

9.9.3.1 Minimum input level for operation

The minimum input level for operation is the highest value of the radio receiver sensitivity for high bit-rate data in LBR-HBR data bursts; the radio receiver sensitivity for low bit-rate data in LBR-HBR data bursts and the radio receiver sensitivity for low bit-rate data in LBR data bursts.

The minimum input level for operation shall be at least that shown in table 43, depending on the receiver class.

Table 43: Minimum input level

Receiver class	Minimum input level
A	- 50 dBm
B	- 60 dBm
C	- 70 dBm

These minimum input level figures are for receivers with nominally 0 dB gain (isotropic) antennas. For other antennas, the minimum input level may be changed by the number of decibels of peak antenna gain or loss relative to an isotropic radiator.

9.9.3.2 Maximum input level for operation

With an input signal level of up to -20 dBm, the proportion of HBR-parts (of LBR-HBR HCPDUs) and LBR HCPDUs received in error shall not exceed 0,01.

9.9.3.3 Maximum input level without damage

The receiver shall be able to withstand an input signal level of 0 dBm without damage.

9.9.3.4 Radio receiver adjacent channel performance

Under the following conditions, the proportion of received HBR-parts (of LBR-HBR HCPDUs) and LBR HCPDUs which contain uncorrected errors shall be less than 0,01. The test conditions shall be a wanted on-channel signal and an unwanted adjacent-channel signal, which is HIPERLAN modulated, both at power levels of 3 dB above the minimum specified sensitivity for the appropriate receiver class and both applied at the antenna port. This shall apply for HBR-parts of LBR-HBR HCPDUs of 4 160 bits.

9.9.3.5 Sensitivity to values in a bit stream

The performance of the receiver shall not be impaired by the presence of continuous streams of up to 128 consecutive ones or zeros presented to the receiver in the data stream as represented in a GMSK (BT=0,3) modulated RF signal at the high rate of transmission.

9.10 PHY Layer Management

9.10.1 RSSI Measurement

Where signal strength is required to be reported outside the PHY, received signal strength indication (RSSI) will be used. RSSI is measured in units of SLN (see table 42). The RSSI for a received burst is power averaged between the start of the burst and the end of the burst. Start and end of burst are defined in subclause 9.8.1.2.

There shall be no requirement on the PHY which mandates the RSSI to be available before 512 high rate bit-periods after the end of the burst or for the RSSI to be available after another priority pulse has been detected.

9.10.2 Procedure for changing channel

When a HIPERLAN PHY is commanded to change channel, the channel change shall not take place until the current channel access cycle finishes and the next transmission or reception attempt shall be suspended until the channel change has completed. The channel change is subject to the requirements of subclause 9.8.4.2.

9.10.3 Procedure for changing power

When a HIPERLAN PHY is requested to change power level, the power level change shall take place at the start of the next channel access cycle after an interval of 512 high rate bit-periods has elapsed and the new power level shall be used subsequently until the next power level change.

9.10.4 Procedure for measuring channel Load

The measurement of channel load is optional. Where provided it shall be measured as:

$$\text{Channel Load} = 100 \times [(N_{LBR} \times (T_{ACW} + T_{LBR} + T_{ACK} + T_{PH})) + (T_{DB} \times N_{TDB}) + (N_{LFE} \times T_{MPL})] / T_{MW} \%;$$

where:

- N_{LBR} is the number of received LBR-parts of LBR-HBR HCPDUs with correct length fields;
- T_{ACW} is the average length of contention window, 112 µs;
- T_{LBR} is the duration of LBR-part of LBR-HBR HCPDUs, 24 µs;
- T_{ACK} is the total duration of LBR data burst transmission, 42 µs;
- T_{PH} is the duration of burst header (equalizer training sequence), 19 µs;
- T_{DB} is the duration of one data block, 21,08 µs;
- N_{TDB} is the total number of data blocks transmitted (sum of length fields in all correctly received LBR-parts of LBR-HBR HCPDUs);
- T_{MW} is the measurement interval;
- N_{LFE} is the number of length fields received in erroneously;
- T_{MPL} is the maximum time for transmission of a burst (assuming maximum number of data block in the burst), 1 010 µs; and
- T_{MW} shall be at least the length of the individual-attention period for a HIPERLAN using power conservation.

NOTE 1: There is nothing to prevent continuous measurement of channel load statistics; however it will be quantized into measurement blocks. The limits on averaging time is designed to prevent artificially long measurement windows being used to distort the results.

NOTE 2: T_{ACW} is calculated based on 16 contenders present on the channel and is the sum of the synchronization interval and average lengths of prioritization, elimination and yield phases. (Average number of prioritization slots is 2, average number of elimination slots is 4,373, average number of yield slots is 3,993).

NOTE 3: The maximum burst length is used if a header length field is decoded in error (checksum fails) as this means the channel is unreliable, probably due to collisions and the channel usage statistics should reflect this.

10 HIPERLAN enhancement unit

A HIPERLAN enhancement unit shall obey the EY-NPMA operation and shall transmit the CP-HCPDU to provide the channel permission information.

11 Conformance

11.1 Static conformance requirements

In the tables in the following subclauses, the following notation is used:

- M indicates mandatory - if the role is supported then the procedure shall be supported;
- O indicates optional - if the role is supported the procedure may be supported;
- O.x indicates optional - if the role is supported then either all or none of the procedures with the same identifier x shall be supported; and
- X indicates prohibited - if the role is supported then the procedure shall not be supported.

11.1.1 MAC conformance requirements

In order to conform to this ETS a HM-entity shall be either a forwarder or a non-forwarder and in addition may be a p-saver and/or a p-supporter.

A HM-entity shall implement all the mandatory procedures for the role(s) supported and optionally support any combination of optional procedures for those roles specified in tables 44 and 45.

Table 44: Static conformance requirements for non-forwarder and forwarder roles

Protocol procedure		Roles	
Description	**Reference subclause**	**Non-forwarder**	**Forwarder**
HIPERLAN information query	6.2.1	M	O.3
HIPERLAN information declaration	6.2.2	M	M
HIPERLAN information collection	6.2.3	M	M
Sanity check computation	6.4.1	O.1	O.4 (note)
User data encryption-decryption	6.4.2	O.1	O.4 (note)
HMQoS failure reporting	6.4.3	M	O.3
User data acceptance	6.4.4	M	O.3
User data delivery	6.4.5	O	O (note)
User data forwarding	6.4.6	X	M
Route determination	6.5.1	M	M
Route information base establishment	6.5.2	M	M
Multipoint relay selection	6.5.3	M	M
Neighbour information declaration	6.5.4	M	M
Neighbour information recording	6.5.5	M	M
Source multipoint relay information declaration	6.5.6	X	M
Source multipoint relay information recording	6.5.7	O.2	M
TC-HMPDU forwarding	6.5.8	X	M
Alias address learning	6.5.9	M	M
Expired neighbour entry removal	6.5.10	M	M
Expired source multipoint relay entry removal	6.5.11	X	M
Expired topology entry removal	6.5.12	O.2	M
Expired alias entry removal	6.5.13	M	M
Expired HMPDU removal	6.6.1	M	M
HMPDU selection	6.6.2	M	M
HMPDU transmission	6.6.3	M	M
HMPDU reception	6.6.4	M	M
Expired duplicate detection entry removal	6.6.5	M	M
NOTE: These options are only relevant if the procedures indicated as O.3 are supported.			

Table 45: Static conformance requirements for p-saver and p-supporter roles

Protocol procedure		Roles	
Description	**Reference subclause**	**P-saver**	**P-supporter**
Individual-attention pattern declaration	6.3.1	M	
Group-attendance pattern declaration	6.3.2		M
Individual-attention pattern recording	6.3.3		M
Group-attendance pattern recording	6.3.4	M	
Expired individual-attention pattern entry removal	6.3.5		M
Expired group-attendance pattern entry removal	6.3.6	M	

11.1.2 CAC conformance requirements

In order to conform to this ETS a HC-entity shall be either a normal HIPERLAN device or a HEU.

A HC-entity shall implement all the mandatory procedures for the role(s) supported and optionally support any combination of optional procedures for those roles specified in table 46.

Table 46: Static conformance requirements for Normal HIPERLAN implementation and HEU roles

Protocol procedure		Roles	
Description	**Reference subclause**	**Normal HIPERLAN device**	**HEU**
EY-NPMA	8.2	M	M
Prioritization phase	8.2.1	O.5	M
Elimination phase	8.2.2	O.5	M
Yield phase	8.2.3	O.5	M
Transmission phase	8.2.4	M	M
Channel access in channel free condition	8.2.5.1	M	M
Channel access in synchronized channel condition	8.2.5.2	O.5	M
Channel access in hidden elimination condition	8.2.5.3	O.5	M
Channel permission declaration	8.3.1	X	M
Channel permission recording	8.3.2	M	X
Channel permission invalidation	8.3.3	M	X
synchronized transfer invitation	8.4.1	O.5	X
Free transfer inviation	8.4.2	M	X
Free transfer cancellation	8.4.3	M	X
User data refusal	8.4.4	M	X
User data acceptance	8.4.5	M	X
User data delivery	8.4.6	M	X
LBR-part checksum computation	8.5.1	M	M
HBR-part checksum computation	8.5.2	M	M
Hashed destination address computation	8.5.3	M	M
LBR-HBR HCPDU transmission	8.5.4	M	M
HCPDU reception	8.5.5	M	M

11.2 Dynamic conformance requirements

Any protocol procedure supported shall be implemented in accordance with the appropriate subclauses of clauses 6, 8 and 9.

Any protocol data unit transmitted shall be constructed in accordance with the appropriate subclauses of clauses 6, 8 and 9.

Annex A (informative): HIPERLAN MIB Example

This informative annex describes a set of Management Information Base (MIB) entries that should be supported by HIPERLAN devices.

Table A.1

Object	Mandatory or Optional	values	Read, Change
Source HMSAP Address	M	object	R,C
MAC-Enable	O	boolean	R
Manufacture ID	O	object	R
Product ID	O	object	R
HIPERLAN name	M	object	R,C
Hid	M	integer	R,C
Heard HIPERLAN names	O	object	R
Heard Hids	O	object	R
Group HMSAP address	O	object	
Topology ageing timer	O	counter	R,C
Frames transmitted correctly	O	counter	R
Frames not acknowledged	O	counter	R
Frames discarded due to lifetime expired	O	counter	R
Frames with deferred transmission	O	counter	R
Frames received correctly	O	counter	R
Frames received with CRC error	O	counter	R
Frames received with alignment error	O	counter	R
Frames received with length error	O	counter	R
Encryption Capability	M	boolean	R,C
Encryption key value #1	O	object	R,C
Encryption key value #2	O	object	R,C
Encryption key value #3	O	object	R,C
Encryption key value #4	O	object	R,C
Forwarding capability	M	boolean	R,C
forwarder state	O	boolean	R,C
forwarder neighbour table ageing period	O	integer	R
forwarder topology table ageing period	O	integer	R
hello ageing timer	M	counter	R
hello refresh period	M	integer	R,C
p-saver capability	M	Boolean	R,C
p-supporter	M	boolean	R,C
power conservation state	O	enumerated value list: none, p-saver, p-supporter, unknown	R,C
p-saver wake period	O	integer (ticks)	R,C
p-saver wake time	O	integer	R,C
p-support DMD period	O	integer	R,C
p-support DMD wake time	O	integer	R,C
Hidden note flag	M	boolean	R
Hidden node ageing timer	M	counter	R
Quality of service table	O	object	R

(continued)

Table A.1 (concluded)

Object	Mandatory or Optional	values	Read, Change
Current channel	M	0 - 4	R,C
Channel 3 flag	M	boolean	R
Channel 4 flag	M	boolean	R
CP-HCPDU Timer	M	integer	R
Current channel map	M	object	R,C
Average length of contention window (T_{ACW})	O	0-65355(us)	R,C
Number of received LBR parts of LBR-HBR HCPDUs with correct length fields (N_{LBR})	O	0-65355	R
Channel Load Measurement Interval (T_{MW})	O	minimum wake interval or greater	R,C
Number of LBR length fields received in erroneously (N_{LFE})	O	0-65355	R
Observed channel load	O	0 - 200	R
RSSI	O	SLN 0-31	R
Number of Antennas	O	0-65355	R
Current Antenna	O	0-65355	R
TX equipment class	M	A,B,C	R
RX equipment class	M	A,B,C	R
Current TX power level	M	1,2,3	R,C
MADT	O	SLN 0-31	R
MADT timer	O	integer	R
Support for other optional feature	O		R,C

Annex B (informative): HIPERLAN management

This informative annex is not based on specific HIPERLAN managed objects but rather is intended to be an informative guide to general OSI management principles and the use of HIPERLAN managed objects to influence the physical resources on which HIPERLAN communication is based.

ISO 10 164 specifies OSI Systems Management.

ISO 15 802-2 specifies LAN/MAN Management.

ISO 9 595 specifies Common Management Information Service.

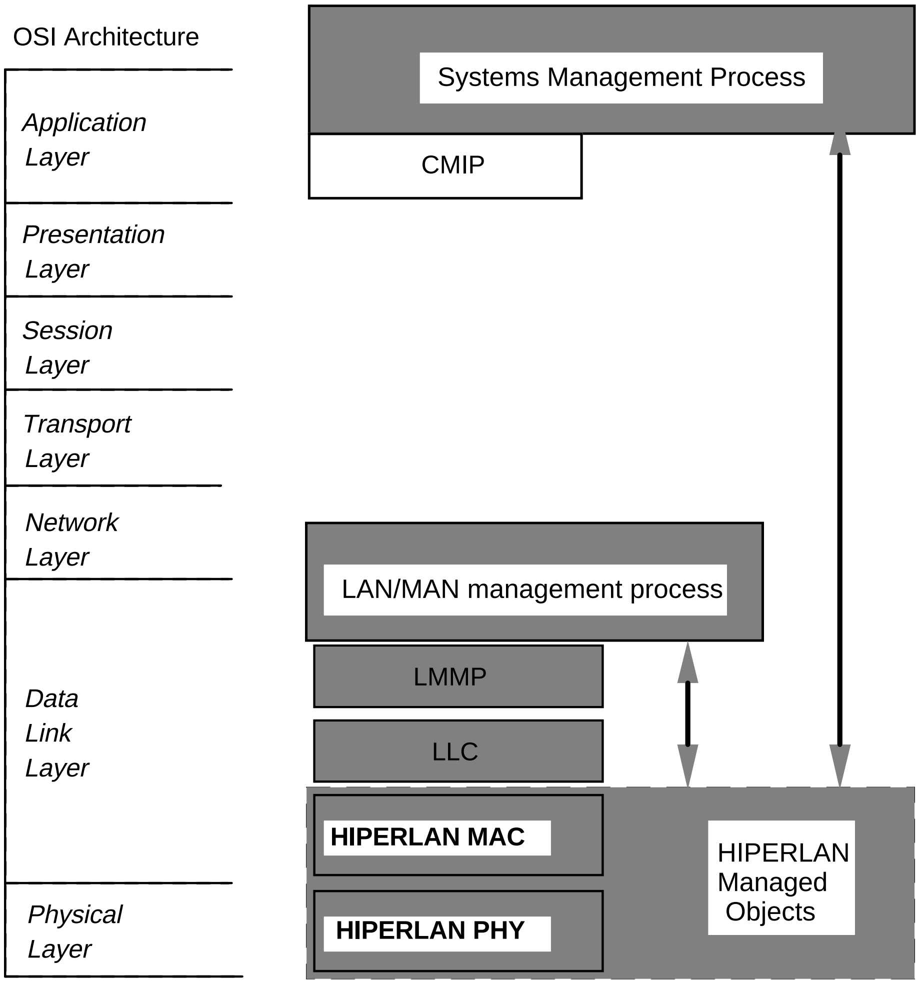
ISO 9 596 specifies Common Management Information Protocol.

The functionality of a managed object is made available via the managed object boundary, as expressed in the OSI Management Information Model (ISO/IEC 10 165). The Management Information Model defines the set of generic operation and notification types that a managed object may support: a given managed object may support a subset of these types.

ISO 15 802-2 defines the tables used to support event forwarding mechanisms. These mechanisms are employed by management agents to inform management managers of notifications emitted by managed objects.

B.1 HIPERLAN in the OSI management framework

The OSI Management Framework defines OSI systems management functions that support management applications to manipulate resources in the OSI environment. As HIPERLAN operates in the OSI context, it is subject to the OSI Management Framework. Two management standards are concerned: OSI Systems Management and LAN/MAN Management. Figure B.1 illustrates HIPERLAN in the OSI Management Framework.



non-standard, implementation-dependent interaction

application, process, object (implementation)

protocol

LMMP: LAN/MAN Management Protocol (ISO 15802)
CMIP: Common Management Information Protocol (ISO 9596)

Figure B.1: HIPERLAN in the OSI management framework

The OSI Management Framework defines OSI Systems Management as an Application layer activity, related to the management of the use of OSI resources and their status across all seven layers of the OSI architecture.

OSI Systems Management employs the Common Management Information Protocol (CMIP), which functions in the Application layer.

Architecturally compatible to the OSI Management Framework, LAN/MAN Management is defined as an (N)-layer management activity specific to the management of layer 1 and 2 in a IEEE 802 Local or Metropolitan Area subnetwork. LAN/MAN Management employs the LAN/MAN Management Protocol, which requires the connectionless services offered by the LLC Type 1 procedure as a means of conveying management information between stations in a LAN/MAN environment. The management information is conveyed using the protocol data unit (PDU) formats defined by CMIP, making it available both to the LAN/MAN Management protocol and to CMIP; hence this information may also be used to support OSI Systems Management.

OSI Systems Management defines functions to be used to create, delete and rename instances of managed objects, change attribute values and report on attribute change events for such instances.

Both OSI Systems Management and LAN/MAN management applications may communicate via reliable underlying services. OSI Systems Management operates over a connection oriented OSI stack and LAN/MAN Management operates over LLC Type 1 with either basic or enhanced reliability in the service invocation.

The HIPERLAN standard defines the Managed Objects upon which both the OSI Systems Management and the LAN/MAN Management applications can operate for the management of HIPERLAN resources which are represented by instances of the HIPERLAN Managed Objects.

B.1.1 Use of HIPERLAN channels

HIPERLANs operate on one of the HIPERLAN channels as specified in subclause 9.5. There are several considerations which may affect the choice of which channel to select for operation:

- a HIPERLAN system requires to communicate with some existing service or known application. The HIPERLAN access function LOOK-UP procedure is used to search for that service or application via a priori knowledge of the HIPERLAN name used by that service or application. The channel upon which the required service or application is located determines the choice of channel for the HIPERLAN system;

- a HIPERLAN system does not require to communicate with any existing services or applications and can freely choose which channel to use. Any legal HIPERLAN channel may therefore be selected using any decision criteria.

B.1.2 Use of HIPERLAN management

As an example function of HIPERLAN management application, consider use of the hiperlanChannel MO defined to have attribute currentChannel with legal range some set of integers n...m and get capability the necessary and sufficient capability to fulfil the requirements of the following example.

For the members of some HIPERLAN H to be able to communicate a common value shall be used for the currentChannel attribute of the hiperlanChannel MO. Therefore, before each member of H commenced communication in H, the value of currentChannel shall have been set to, say, m.

ISO 15 802-2 specifies how:

- management agent entities will report notification events emitted by managed objects to the local management manager entity or remote management manager entities or both according to entries in the notification type table;

- a event report destination table identifies the set of destination management manager entities for each notification type.

HIPERLAN management applications in H should insert an entry in their event report destination table for each member of H with destination Quality of Service (QoS) attribute set to enhanced and link these entries, via their table indexes, to the event report notification table entry for the notification type attributeChanged for attribute currentChannel of object class hiperlanChannel.

The hiperlanChannel MO at each member of H generates an attributeChanged notification event to its management agent on change of currentChannel from m to n. The management agent searches the notification type table for an entry of type attributeChanged for class hiperlanChannel. The agent forwards the notification, in the form of a event report, to each destination CPE address indicated by the set of pointers to event report destination table entries, i.e. each member of H. Enhanced QoS is used to provide reliable delivery of these reports.

By suitable local interpretation of these report events a co-ordinated change from channel m to channel n may be reliably achieved for the membership of HIPERLAN H. However, each local management application should determine its freedom to change channels based on the HMS-users communication context, i.e. if some HMS-user requires operation on channel m then the channel change notification should be ignored and subsequent communication with the relocated entities need be re-established via another path.

Verification or synchronization of the HIPERLAN H on channel n may be achieved by invocation of M-GET service for the attribute currentChannel for each member or by some other management exchange between the members of H.

Annex C (informative): Bibliography

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