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Foreword

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

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

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

Introduction

HIgh PErformance Radio Local Area Network (HIPERLAN) is a short range radio-communications sub-system intended for use with computer systems.

HIPERLAN will offer users at least 10 Mbit/s service data rate and support a range of services such as asynchronous LAN and time bounded services. The target size for the physical implementation of the standard is a Personal Computer Memory Card Interface Association (PCMCIA) card.

ETR 069 [1] provides a description of HIPERLAN, outlines why there is a need for the HIPERLAN standard and provides details of potential applications.

This ETR defines the architectural framework within which subsequent protocol definitions will be made and provides the reference description of HIPERLAN sub-system behaviour.

This ETR is structured in such a way as to lead the reader through a description of HIPERLAN, its logical components and their inter-relationships. Clause 5 describes HIPERLAN from a high level perspective, defines the boundaries of HIPERLAN responsibilities, and specifies the assumed external dependencies. The remaining Clauses detail specific aspects of HIPERLAN components and features as required to meet the objectives defined.

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1 Scope

This ETR describes the architecture of the HIPERLAN sub-system and is an expansion of the outline architecture provided in ETR 069 [1].

The HIPERLAN architecture described herein is confined to the lower two Open Systems Interconnection (OSI) layers. Functions of higher layers are required for operation and inter-working of a complete system and are outside the scope of HIPERLAN. Therefore they are not considered in this ETR.

The architecture described in this ETR serves as the basis and reference for the HIPERLAN standard to be defined in a future European Telecommunication Standard (ETS).

ETR 069 [1], outlines a number of applications of HIPERLAN based systems. They are not considered further in this ETS.

2 References

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

[1] ETR 069: "Radio Equipment and Systems (RES); HIPERLAN Services and facilities".

[2] ISO 7498: "Information processing systems - Basic reference model".

[3] ISO/IEC 10039 (1991): "Information technology - Open Systems Interconnection - Local Area Networks - Medium Access Control (MAC) service definition".

[4] ISO 8802-2 (IEEE Std 802.2) (1989): "Information processing systems - Local area networks - Part 2: Logical link control".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

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

Asynchronous service: a service provided by HIPERLAN to support asynchronous traffic between HIPERLAN nodes.

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

Attached sub-network: a sub-network to which a HIPERLAN sub-network is attached for the purpose of communication to either an end system or another sub-network.

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

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

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

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

Encryption: a means of obtaining data confidentiality, (see also: **Data confidentiality)**.

End system: a system which contains application processes, which from an OSI point of view are considered as sources and sinks of information. Communication protocols are expected to support the needs of these application processes.

Forwarding: a dynamic routing mechanism that enables a HIPERLAN node to provide connectivity within one single HIPERLAN.

NOTE: Forwarding operates independently of the underlying physical medium.

HIPERLAN: denotes a situation where nodes with the same HID form a network. A HIPERLAN is a set of HIPERLAN nodes that have the same HID, and which have the logical ability to interchange traffic.

HIPERLAN IDentifier (HID): a HIPERLAN sub-network identifier used to differentiate HIPERLANs from each other. All members of a given HIPERLAN use the same HID.

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

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

Inter-Working Function (IWF): the interactions referred to in the inter-working definition rely on IWFs and on the means to select these functions. These include the conversion of physical and electrical states and the mapping of protocols.

Inter-Working Unit (IWU): an intermediate system used to inter-connect sub-networks. The IWU will contain the inter-working functions necessary to support the required network inter-working between the sub-networks.

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

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

MAC Service Data Unit (MSDU): the unit of data delivery between MAC Users.

Medium Access Control (MAC): the sub-layer of the ISO 8802 reference model between the Physical Layer and the LLC.

Node identifier: an unambiguous identifier that differentiates entities within a single HIPERLAN.

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

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

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

3.2 Abbreviations

For the purposes of this ETR the following abbreviations apply.

CA	Channel Access
CAM	Channel Access Mechanism
DA	Destination Address
DLC	Data Link Control, layer 2 of the ISO/OSI reference model
DTS	Data Transfer Service
ETR	ETSI Technical Report
ETS	European Telecommunication Standard
ETSI	European Telecommunications Standards Institute
HID	HIPERLAN identifier
HIPERLAN	HIgh PErformance Radio Local Area Network
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Standards Organisation
IWF	Inter-Working Function
IWU	Inter-Working Unit
LAN	Local Area Network
LLC	Logical Link Control
MAC	Medium Access Control
MCRS	Multi-Channel Resource Sharing
MPDU	MAC Protocol Data Unit
MSDU	MAC Service Data Unit
NID	Node IDentifier
OSI	Open Systems Interconnection
PCMCIA	Personal Computer Memory Card Interface Association
PCM	Power Concervation Mode
PDU	Protocol Data Unit
PHY	PHYsical layer
QoS	Quality of Service
SA	Source Address
SCF	System Co-ordination Function
SDU	Service Data Unit
SB	Sleeping Broadcaster

4 HIPERLAN architecture overview

The following description of the HIPERLAN systems architecture assumes knowledge of the OSI Reference Model and HIPERLAN Services and Facilities.

NOTE: See ISO 7498 [2] for a description of the OSI Reference Model and the conceptual division of communications functions into their respective layers and ETR 069 [1] for details of HIPERLAN services and facilties and the general reference model for HIPERLAN. In addition, reference is made to support of the ISO MAC service (see ISO/IEC 10039 [3]). The implications of support of the ISO MAC service are assumed to be understood and are not repeated here unnecessarily.

4.1 General

As shown in figure 1, in terms of the OSI Reference Model, the HIPERLAN architecture addresses requirements at the Physical layer (PHY) and the MAC sub-layer of the Data Link (DL) layer.

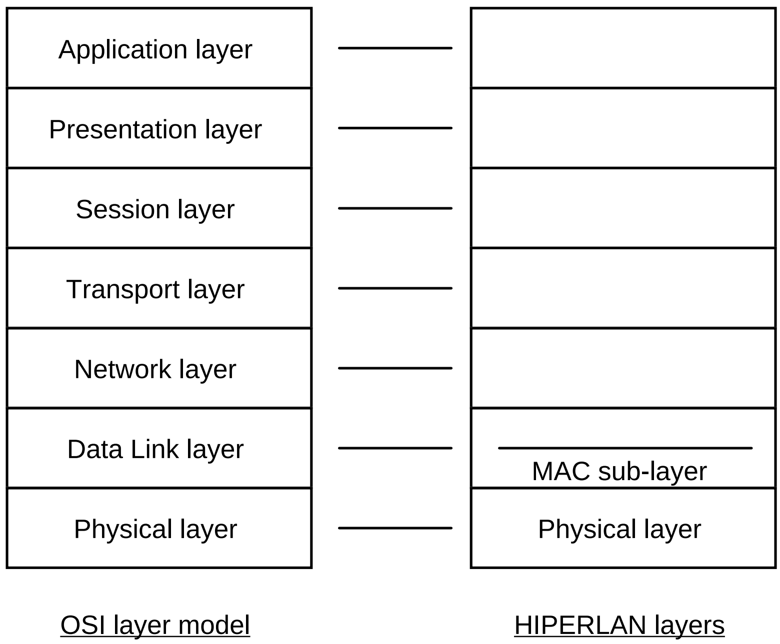

Figure 1: HIPERLAN architecture with respect to the OSI Reference Model

The HIPERLAN MAC sub-layer supports the OSI MAC service. The OSI MAC service defines the external interface at the upper boundary of the HIPERLAN architecture. This interface is expressed in terms of the service primitives in table 1.

Table 1: ISO/IEC 10039 [3] MAC connectionless mode service primitives and parameters

MA-UNITDATA.request (destination-address, source-address, msdu, priority, service-class); MA-UNITDATA.indication (source-address, destination-address, msdu, reception-status, priority, service-class).

HIPERLAN interprets the priority and service-class (and reception-status) parameters of the MA-UNITDATA primitives in the more general sense of Quality of Service (QoS). This QoS parameter is used to enable a range of data services to be described.

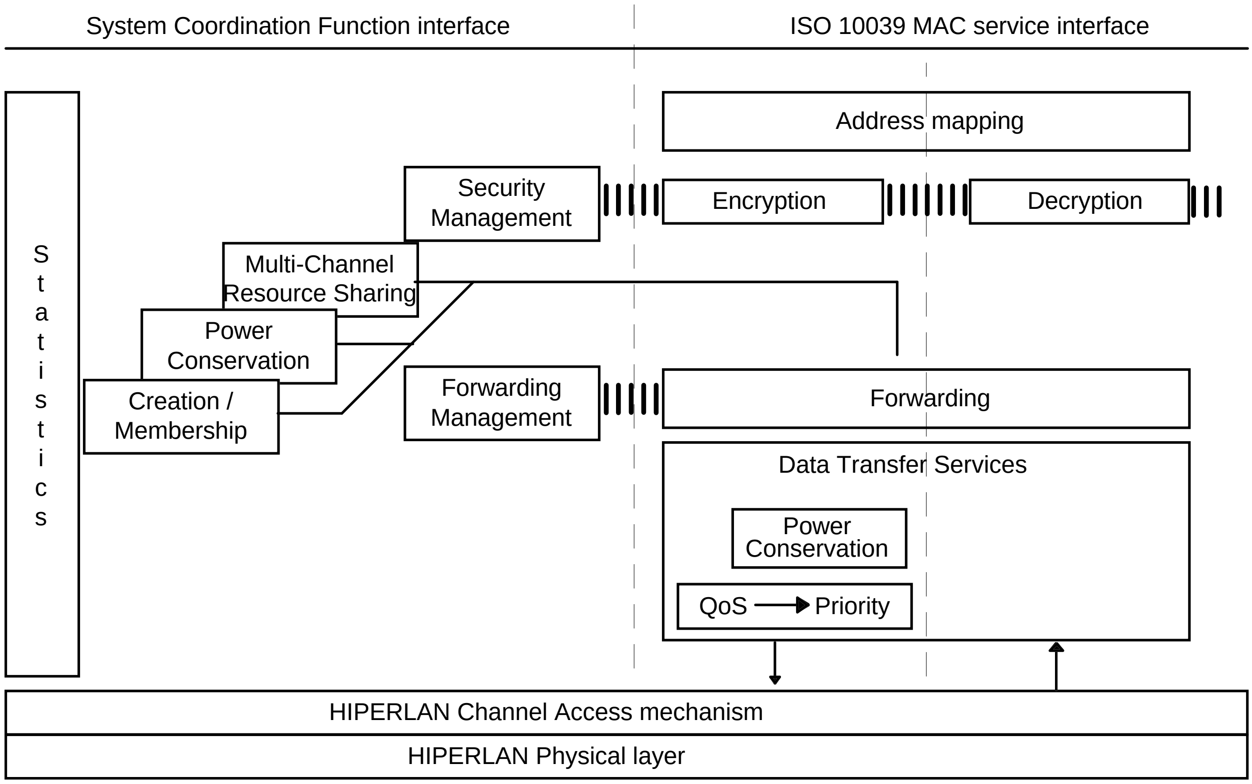

Figure 2: HIPERLAN MAC sub-layer block diagram

The HIPERLAN MAC sub-layer interfaces to the HIPERLAN PL. The specific details of the radio transmission mechanism and channel access mechanism are hidden from the HIPERLAN MAC sub-layer via an abstraction called the HIPERLAN Channel Access Mechanism (CAM).

Between these two service interfaces, the HIPERLAN architecture is called upon to deal with the specific differences between HIPERLAN's radio and other communications media. Under control of the functions embedded in the Systems Co-ordination Function (SCF) HIPERLAN MAC sub-layer functions accept MAC service requests, process MAC Destination Address (DA) information to determine transmission paths for the MSDU at a Channel Access (CA) priority derived from the QoS information.

Support is provided for encryption of MSDU data, communication with devices capable of entering and exiting power conservation states and traffic statistics to assist in making efficient use of multiple channels.

4.2 MAC sub-layer functions

The HIPERLAN MAC sub-layer supports the following functions:

a) SCF - including Multi-Channel Resource Sharing (MCRS) and Power Conservation Management (PCM) functions;

b) DTS function - including equitable access and power conservation transmission functions;

c) addressing functions;

d) forwarding functions.

4.2.1 System Co-ordination Function (SCF)

The SCF defines facitities that are used to:

a) create a HIPERLAN;

b) enable an individual node to join or leave a given HIPERLAN;

c) control encryption of MSDU data;

d) enable and disable HIPERLAN forwarding;

e) enable co-operating HIPERLAN devices using power conservation techniques to communicate in a satisfactory manner;

f) enable HIPERLAN operation in a multi-channel environment;

g) collect statistics.

MPDUs generated within the SCF are transmitted with pre-defined QoS.

The HIPERLAN SCF interface is expressed in terms of the service primitives in table 2.

Table 2: HIPERLAN SCF service primitives

SCF.request (scf-function-parameter-list); SCF.confirm (scf-function-parameter-list); SCF. indication (scf-function-parameter-list); SCF.response (scf-function-parameter-list).

4.2.2 Data Transfer Services (DTS) function

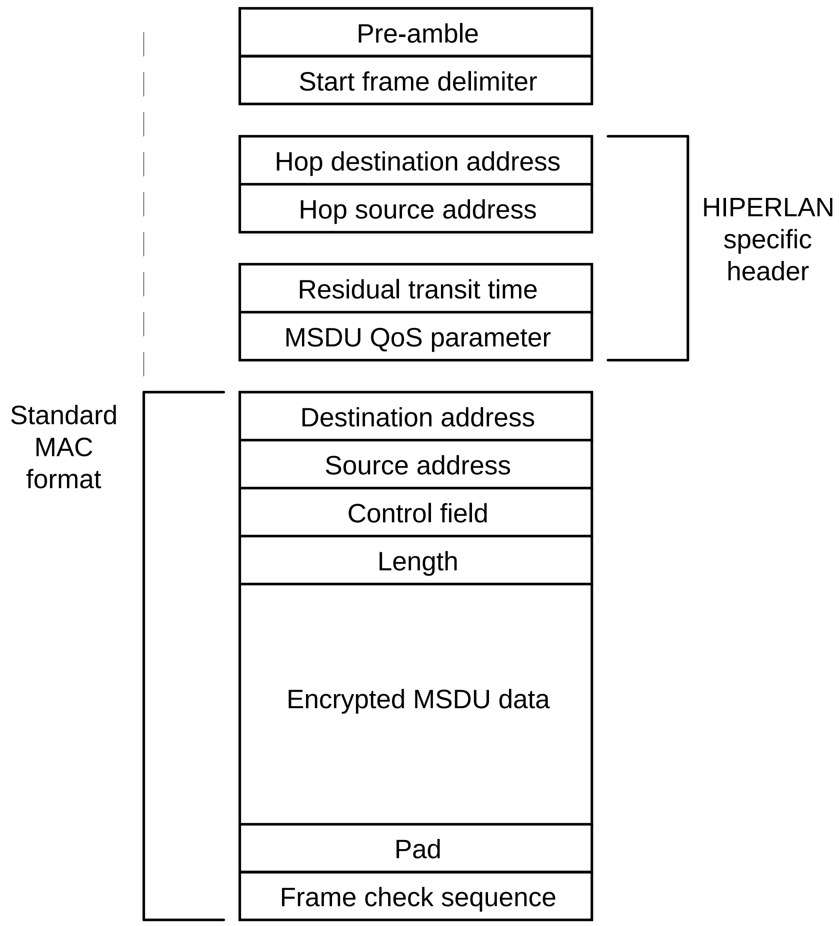

Figure 3: Example of a HIPERLAN MAC general format frame

HIPERLAN data frames are based on ISO MAC frame formats. Where required to support HIPERLAN functions, additional fields are added to the frame header. Figure 3 shows such additional fields used for QoS management during the delivery of a data frame from source to destination addresses via multiple hops. Figure 3 is not intended to be definitive but simply informative.

The service primitives and parameters provided by the MAC service are specified in ISO/IEC 10039 [3]. The primitives are shown in table 1. In order to honour a requested QoS, the HIPERLAN MAC sub-layer prioritises MPDUs for transmission. Within the QoS parameter, the combination of priority and transit delay allow the MAC service user to describe a range of data delivery requirements. The DTS function maps these QoS parameters into a single MPDU priority. MPDUs received for transmission where the requested QoS cannot be honoured are not transmitted.

The HIPERLAN standard will define the permissible QoS parameters and the corresponding MPDU priorities.

The HIPERLAN DTS function aims to achieve equitable channel usage among competing HIPERLAN nodes and MPDUs given multiple levels of transmission priority.

The HIPERLAN DTS function defines means for the delayed transmission of MPDUs destined for devices known to be applying power conservation techniques.

The HIPERLAN MAC layer encrypts MPDUs governed by the SCF. Encryption is applied only to the MSDU data parameter leaving the header fields clear for manipulation and interpretation by other HIPERLAN functions.

The HIPERLAN DTS function delivers to the MAC service user the MSDUs received. The original QoS parameters plus the residual transit delay is reported in the MA_UNITDATA.indication.

In order for the HIPERLAN data transmission and reception function to perform correctly, the HIPERLAN CAM provides the necessary hierarchically independent priority mechanisms.

4.2.3 HIPERLAN addressing

HIPERLAN addressing supports the SCF, DTS and forwarding functions. In particular, this implies support for broadcast, multicast and unicast transmission amongst HIPERLAN nodes within the same HIPERLAN. MAC service addressing and HIPERLAN addressing are independent. A mapping relates the MAC service addresses of the MSDU to the HIPERLAN addresses of the MPDU.

4.2.4 Forwarding function

Forwarding is the operation which establishes and maintains connectivity in a single HIPERLAN. Forwarding routes MPDUs between source and destination via one or more forwarder nodes.

Inter-working between HIPERLANs, or between a HIPERLAN and a non-HIPERLAN sub-network is performed above the MAC service boundary and is outside the scope of HIPERLAN.

4.3 Channel Access Mechanism (CAM)

The HIPERLAN CAM is expressed in terms of the service primitives in table 3.

Table 3: HIPERLAN CAM service primitives and parameters

CA-UNITDATA.request(HIPERLAN-da, HIPERLAN-sa, mpdu, priority, TxPower, valid-lifetime);
CA-UNITDATA.indication(HIPERLAN-da, HIPERLAN-sa, mpdu, RxPower/Quality).

The HIPERLAN CAM permits the exchange of radio power management information as well as received data quality indication for re-use optimization. Support for MSDU QoS requests is provided by the CAM in terms of channel access priority and valid lifetime parameters.

4.4 Physical layer (PHY)

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

4.5 Service interfaces

The HIPERLAN MAC sub-layer specifies the following service interfaces:

- the MAC service interface including HIPERLAN QoS parameter definitions;
- the SCF interface.

4.6 HIPERLAN management

The HIPERLAN systems architecture assumes a standard management environment to be provided in the systems in which the HIPERLAN sub-system is embedded. HIPERLAN management considerations are therefore limited to the definition of the HIPERLAN managed objects which may be manipulated by such a standard management environment.

5 System Co-ordination Function (SCF)

The SCF offers an interface to those HIPERLAN MAC sub-layer functions not directly concerned with MSDU delivery. Some SCF functions generate protocol specific data and some functions act locally only.

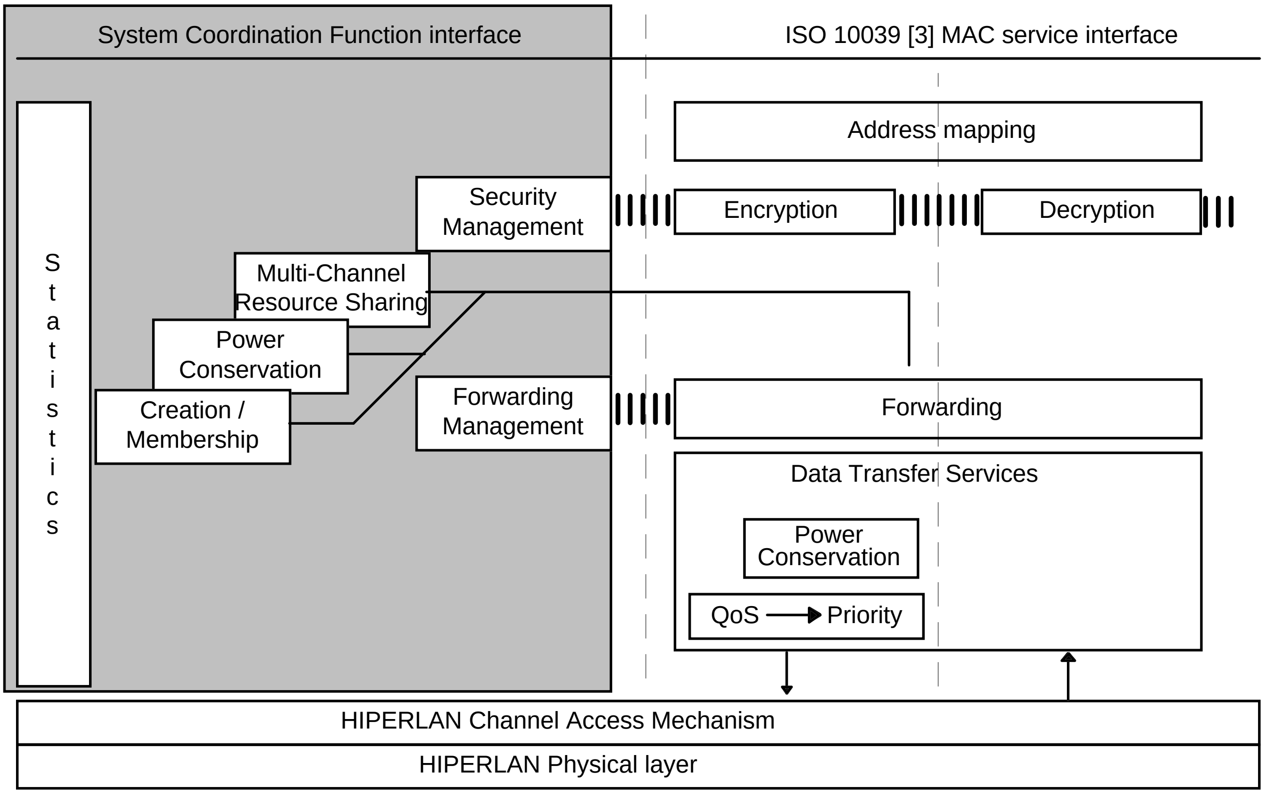

Figure 4: SCF block diagram

5.1 SCF summary

The SCF defines scf-function-parameters that are used to:

a) create a HIPERLAN;

b) enable an individual node to join or leave a given HIPERLAN;

c) control encryption of MSDU data;

d) enable and disable HIPERLAN forwarding;

e) enable co-operating HIPERLAN devices using power conservation techniques to communicate in a satisfactory manner;

f) enable HIPERLAN operation in a multi-channel environment;

g) collect statistics.

MPDUs generated within the SCF are transmitted with pre-defined QoS.

The HIPERLAN SCF interface is expressed in terms of the service primitives in table 4.

Table 4: HIPERLAN SCF service primitives and parameters

SCF.request (scf-function-parameter-list); SCF.confirm (scf-function-parameter-list); SCF.indication (scf-function-parameter-list); SCF.response (scf-function-parameter-list).

5.2 HIPERLAN creation and membership functions

The SCF interface enables requests to be processed for the creation of new HIPERLANs and to join existing HIPERLANs.

A HIPERLAN is created by generating a new HIPERLAN ID.

Creation parameters at the SCF interface are given in table 5.

Table 5: SCF interface creation parameters

Primitive	Parameters
Request	Create new HIPERLAN (HIPERLAN seed)
Confirm	HIPERLAN ID

A request for membership of an existing HIPERLAN results in a Join-HIPERLAN indication at the SCF interface. Response to this indication is a local matter.

Membership parameters at the SCF interface are given in table 6.

Table 6: SCF interface membership parameters

Primitive	Parameters
Request	Join HIPERLAN (HIPERLAN ID)
Confirm	Join Status (success / fail, Node ID, HIPERLAN seed)
Indication	Join HIPERLAN (HIPERLAN ID, Known Requestor Group ID)
Response	Join Status (HIPERLAN ID, Known Requestor ID, success / fail, Node ID)

HIPERLAN seed is used to further qualify a HIPERLAN ID as necessary.

The HIPERLAN leave operation causes the node to leave the HIPERLAN with the specified HID. The default HIPERLAN group can not be left.

Table 7: SCF interface leave parameters

Primitives	Parameters
Request	Leave HIPERLAN (HIPERLAN ID)
Confirm	Leave HIPERLAN (HIPERLAN ID)

The Remap HIPERLAN operation allows HIPERLANs that have identified an address conflict to change their HID's such that each HIPERLAN uses a different HID and hence is again unique. Remap PDUs are internally generated by the HIPERLAN MAC Layer.

Table 8: Internal remap parameters

Primitives	Parameters
Indication	Remap HIPERLAN (old HID, HIPERLAN seed, new HID)

5.3 Security management

The SCF security management function interfaces via the SCF interface to enable and disable the encryption of MSDU data by the DTS function. The encryption/decryption key is supplied through the SCF security management function and key change indications are generated by the SCF security function to be encoded by the DTS function.

The SCF security management function uses the interface parameters in table 9.

Table 9: SCF interface security management parameters

Primitives	Parameters
Request	Enable / Disable encryption
Confirm	Encryption Enabled / Disabled
Request	Set encryption key (key value)
Confirm	Key set / not set

5.4 Forwarding management

The SCF forwarding management function enables or disables the support for forwarding services. Forwarding services require the maintanence of HIPERLAN topology information and the generation of forwarding PDUs relating to topology management. Forwarding is an optional HIPERLAN facility.

The SCF forwarding management function uses the interface parameters in table 10.

Table 10: SCF interface forwarding management parameters

Primitives	Parameters
Request	Enable / Disable Forwarding
Confirm	Fowarding Enabled / Disabled

5.5 Statistics

The SCF may capture statistics information at a number of internal interface points within the HIPERLAN node. Statistics are made available at the SCF interface.

The SCF statistics function uses the interface parameters in table 11.

Table 11: SCF interface statistics parameters

Primitives	Parameters
Request	Statistics
Confirm	Statistics (data)

The format of statistics data is outside the scope of HIPERLAN.

5.6 Multi-Channel Resource Sharing (MCRS)

The SCF provides various facilities to enable HIPERLAN operation in a multi-channel environment. The two principle facilities are the provision or request of load information data for a given channel and the control of relocation of a HIPERLAN from one channel to another. These facilities are expressed via the interface parameters in table 12.

Table 12: SCF interface resource sharing parameters

Primitives	Parameters
Request	Get Channel Load Information (Channel ID)
Confirm	Channel Load Information (Channel ID, data)
Request	Relocate HIPERLAN (HIPERLAN ID, Channel ID)
Indication	Relocate (HIPERLAN ID, Channel ID)
Indication	Channel Load Information (Channel ID, data)

Channel IDs are HIPERLAN specified channel identifiers. The format of the data parameter in response to the Load Information requests depends on the CAM.

5.7 Power conservation functions

5.7.1 Power Conservation Mode (PCM) declaration

Power conservation operations consist of switching between sleep state and wake state according to a declared periodic time pattern. PCM functions in the SCF generate and manage the effects of reception of power conservation protocol elements.

Support for power conservation operation is optional. Any HIPERLAN node wanting to operate in PCM will broadcast, within its direct neighbourhood, a PDU indicating its intention to use periodic sleep states. The PDU indicates the respective lengths of sleep and wake periods in HIPERLAN defined time intervals and constitutes the declaration of starting time for these intervals. In addition, a wake-extension may be declared which is the delayed return to sleep time used by a node in PCM following receipt of an MPDU during its wake period. The wake-extension does not affect the declared periodic timing.

The effect of reception of such a PDU depends on the state of the SCF power conservation function. If activated, the SCF power conservation function will cause the DTS to build and maintain a table of sleep state neighbours and to manage transmission of MPDUs destined to these neighbours via a delayed transmission facility. The delayed transmission facility schedules MPDUs for transmission at time intervals which match the declared wake periods of destination nodes that are using power conservation.

5.7.2 Power Conservation Broadcasts (PCB)

Nodes operating in PCM require additional support for the efficient reception of broadcast transmissions. For this purpose a virtual source may be declared to which broadcast MPDUs may be aligned. This virtual source is called the Sleeping Broadcaster (SB).

The sleep/wake periods of the SB declare the time intervals at which multicast messages destined for nodes that are in PCM may be transmitted. The sleep/wake period of a SB may be queried by any node. Any node using the SB may respond on behalf of the virtual source.

Power conservation functions at the SCF interface are supported by the parameters in table 13.

Table 13: SCF interface power conservation parameters

Primitives	Parameters
Request	Enable / Disable Power Conservation Mode support
Confirm	Power Conservation Mode Enabled / Disabled
Request	Power Conservation Mode Declaration (Sleep, Wake and optional Wake-Extension)
Request	Get Sleeping Broadcast Period

In addition, internal generated power conservation PDUs processed by the power conservation SCF are given in table 14.

Table 14: Internal power conservation parameters

Primitives	Parameters
Indication	(HIPERLAN Address) Power Conservation Mode declaration (sleep, wake periods)
Indication	Sleeping Broadcaster declaration (sleep, wake periods)
Request	Sleeping Broadcaster declaration (sleep, wake periods)

6 HIPERLAN addressing

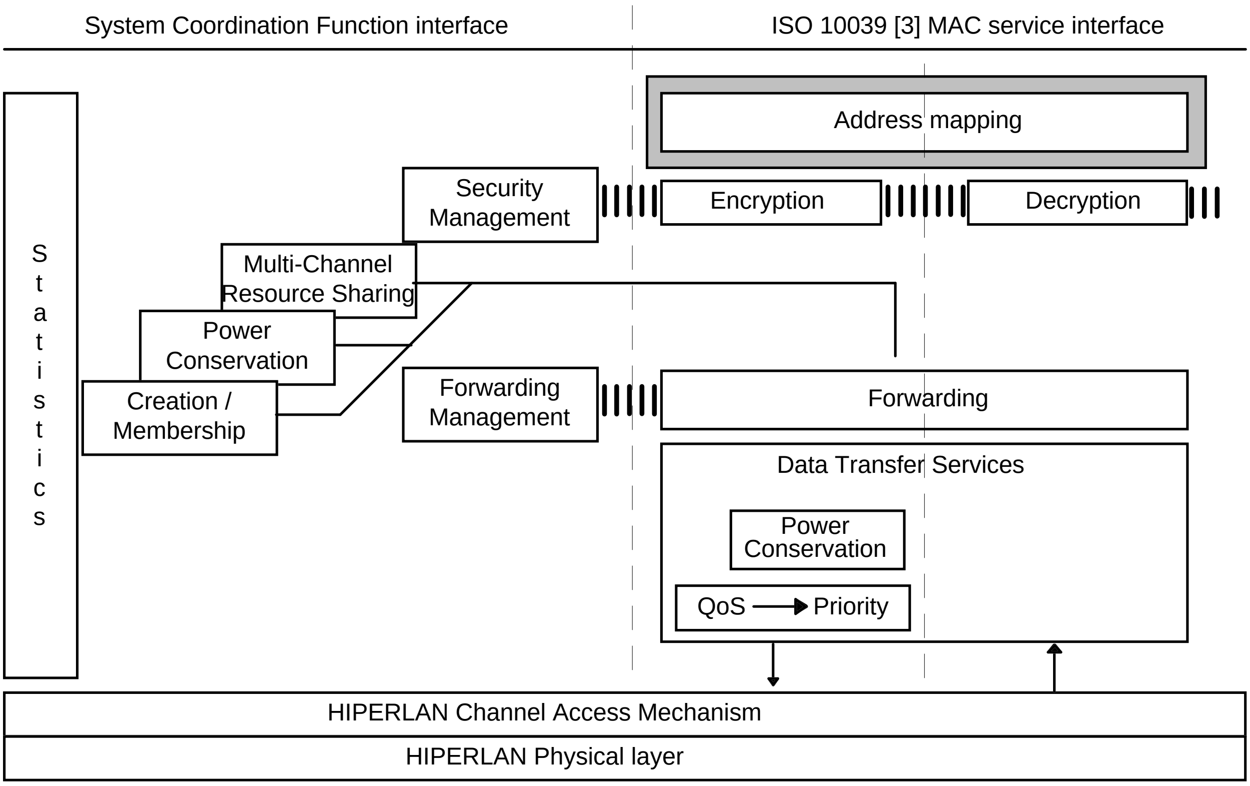

Figure 5: HIPERLAN Addressing Block Diagram

6.1 Addressing definitions:

6.1.1 HIPERLAN ID (HID)

The HID is used to identify a HIPERLAN. When a HIPERLAN is created, the HID is unique with respect to all other known HIPERLANs. The HID is a structured field that supports efficient forwarding and inter-working with other networks. A subset of the HID will be capable of separating HIPERLANs by organization.

A HID may conceptually be viewed as follows:

(Org ID, ForwardingInfo) where the ForwardingInfo may be further structured.

Each HIPERLAN node is a member by default of one HIPERLAN, known as the Default HIPERLAN Group (DHG). The HID for this group is well defined and globally unique.

One value of OrgID is reserved and is recognized by all nodes. The ForwardingInfo field is ignored in this case. All other values of OrgID are used to identify organizations. These values are globally defined.

One value of the ForwardingInfo is reserved and is recognized by all nodes that are a member of the HIPERLAN identified by the specified OrgID.

6.1.2 Node ID (NID)

A HIPERLAN NID identifies a HIPERLAN node unambiguously within the scope of a HIPERLAN. One value of NID is reserved and is recognized by all nodes within the HIPERLAN specified by the HID.

6.1.3 HIPERLAN address

A HIPERLAN address consists of the tuple (HID/NID).

6.1.4 Addressing structure

Each HIPERLAN MPDU will carry the following address information:

- (Hop DA, Hop SA) (Final DA, Original SA) (Final DA MAC, Original SA MAC);

where:

- Hop DA, Hop SA, Final DA, and Original DA are HIPERLAN addresses;
- Hop DA (Destination Address) identifies the immediate destination;
- Hop SA (Source Address) identifies the last node to transmit the frame;
- Final DA (Destination Address) identifies the final (HIPERLAN) destination;
- Original SA (Source Address) identifies the originating (HIPERLAN) node;
- Final DA MAC(Destination Address) identifies the final destinations ISO 8802 address;
- Original SA MAC(Source Address) identifies the originators ISO 8802 address.

The Final DA MAC and Original SA MAC have no meaning in HIPERLAN forwarding.

6.2 Frame reception

A node will recognize and process a MPDU received on the set of its HIPERLAN addresses including all the reserved values for HID and NID.

A node will respond to a broadcast MPDU containing its own ISO 8802 [4] address as FinalDA MAC with a MPDU containing one of its fully qualified HIPERLAN addresses. If possible the HID of this qualified HIPERLAN address should match that of the originator, but otherwise any valid HID may be used.

End nodes remember the source mapping of all broadcast MPDUs received which were recognised by their Final DA MAC address.

6.3 HIPERLAN HID conflict detection and resolution

HIPERLAN nodes detect ambiguous HIDs. This detection will result in a remap indication at each member of the HIPERLANs with the ambigous HID.

7 Data Transfer Services (DTS)

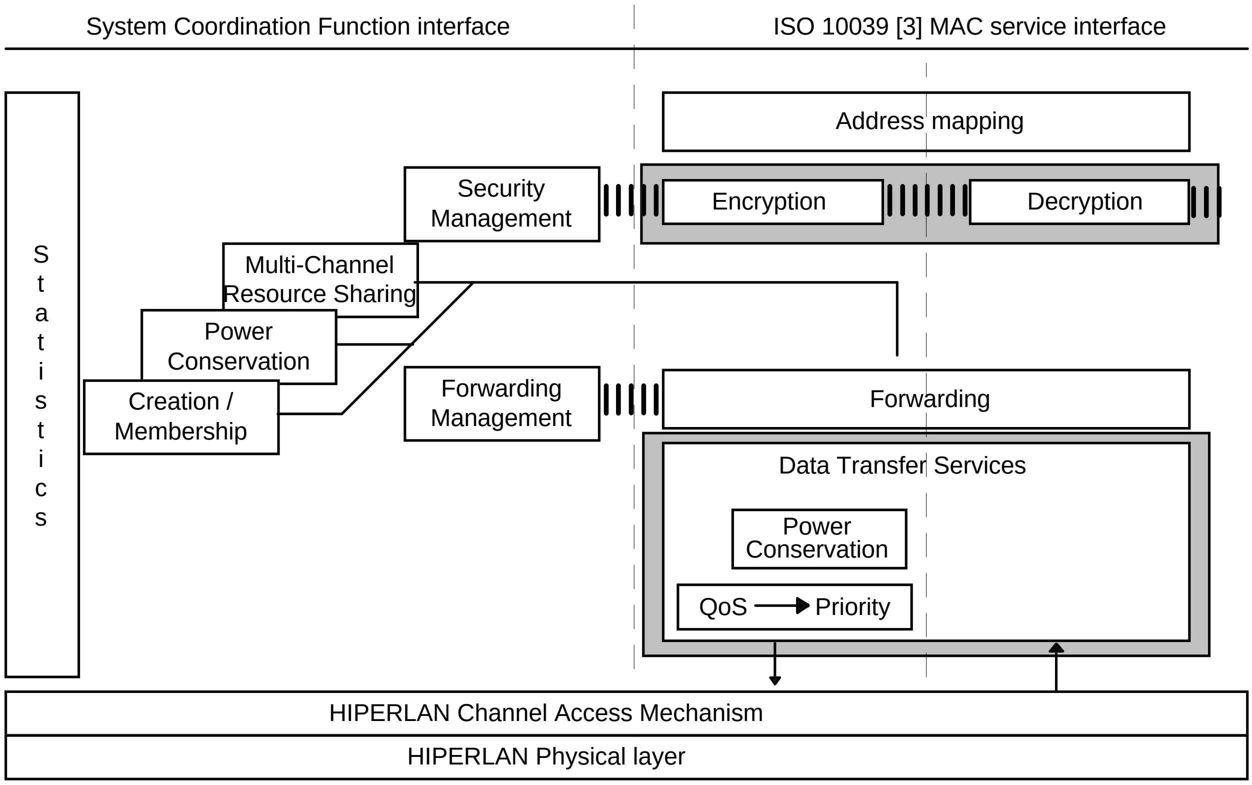

Figure 6: DTS block diagram

7.1 Overview

The HIPERLAN DTS provides the following:

a) local queuing and delivery of data MPDUs;

b) derivation of the CAM priority to provide a best attempt to meet the requested QoS;

c) delayed transmission to provide a way to communicate with devices that are known to be implementing power conservation;

d) encryption and decryption of MSDU data.

HIPERLAN defines the permissible QoS parameters and the corresponding MPDU priorities. MPDUs are discarded if the requested QoS cannot be satisfied.

The HIPERLAN DTS encrypts MPDUs governed by the SCF. Encryption is applied only to the MSDU data parameter leaving the header fields clear for manipulation and interpretation by other HIPERLAN functions.

The HIPERLAN DTS delivers to the MAC service user the MSDUs received. The original QoS parameters plus the residual transit delay are reported in the MA_UNITDATA.indication.

The MPDU will carry the residual time to live, which is updated at each hop.

7.2 Quality of Service (QoS) parameters

The MAC service interface uses ISO/IEC 10039 [3] MAC primitives with QoS parameters allowing the MAC user to specify the QoS on a per MSDU.

Table 15: Qos parameters in the MAC user primitives

MA-UNITDATA.request(source-address, destination-address, msdu, QoS); MA-UNITDATA.indication(destination-address, source-address, msdu, QoS).

The QoS parameters include maximum transfer delay, delay variance and a discard parameter.

The maximum transfer delay parameter can be used for data which is only valid for a limited time. The discard parameter indicates whether the MPDU is to be discarded if the maximum transfer delay is exceeded.

QoS parameters allow for a wide range of data delivery requirements to be described. A simple example of how different types of data service could be expressed though QoS parameters is given below.

Example:

MaxDelay = Max (or Value)	Discard = No	Asynchronous Service
MaxDelay = Value	Discard = No/Yes	Time Bounded Service
MaxDelay = small	Discard = No	Expedited Service

This example is not intended to be definitive, but simply informative.

7.3 Priority assignment

In order to satisfy the requested QoS, the following mechanisms are used within the DTS:

- queue order priority;
- channel access priority.

7.3.1 Queue order priority

MPDUs accepted for transmission are queued within the DTS. The MPDUs may be ordered in a best attempt to satisfy the requested QoS.

7.3.2 Channel access priority

The CAM provides at least two hierarchically independent levels of channel access priority and fair access between contending nodes at a given access priority.

The CAM priority is derived from the QoS parameters and the residual transit delay, according to specified rules.

7.4 Power conservation support

The power conservation function serves to enable cooperating HIPERLAN devices using power conservation techniques to communicate in a satisfactory manner. Support for HIPERLAN power conservation is optional.

PCM functions are provided in the SCF. If power conservation is activated, the DTS will build and maintain a table of sleep state neighbours and manage transmission of MPDUs destined to these neighbours via a delayed transmission facility. The delayed transmission facility schedules MPDUs for transmission at time intervals which match the declared wake periods of destination nodes that are using power conservation.

7.5 Data encryption

HIPERLAN data encryption provides protection against casual eavesdropping and data modification at a level that is comparable with that of wired LANs.

Only the MSDU data field is encrypted. A HIPERLAN encryption algorithm will be specified which uses keys for encryption and decryption. The security management function in the SCF is used to enable and disable encryption and to provide the key. Information will be provided in the MPDU to indicate whether encryption is enabled and to support key synchronisation.

8 Forwarding

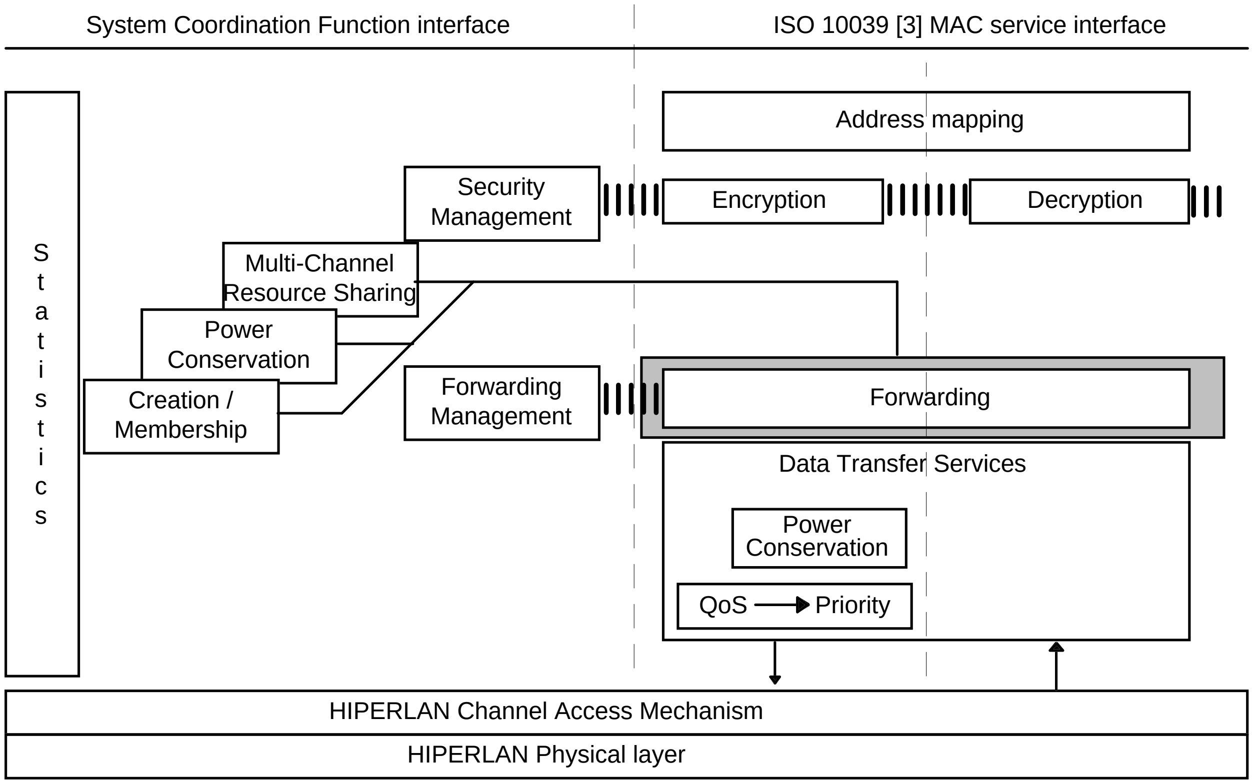

Figure 7: Forwarding block diagram

8.1 General

Unlike wired LANs, in which all nodes are connected directly to all other nodes, the nodes within a HIPERLAN may or may not be able to communicate directly with all other nodes. The connectivity between nodes depends on the prevailing radio conditions.

When full connectivity is not available, communication between nodes is achieved by means of forwarding. During forwarding, one or more intermediate nodes pass messages between a source node and a destination node which cannot communicate directly.

8.2 Forwarding requirements

The forwarding requirements of HIPERLAN are similar in many respects to routing, normally performed at OSI layer 3, and bridging, normally performed at OSI layer 2. One of the main differences is the greatly increased frequency with which topology changes within a HIPERLAN occur. This is due to mobility of nodes and changes in radio propagation conditions and membership of HIPERLANs. The forwarding information is therefore regularly updated and the information required to make these updates (details of topology changes) is distributed throughout the HIPERLAN.

The forwarding scheme provides a means of point-to-point, multicast and broadcast communications. This will be provided in such a way as to minimise the number of replicated messages so that efficient use of the radio resource is achieved.

Forwarders which are members of more than one HIPERLAN may forward MPDUs between them.

HIPERLAN forwarding uses hop-by-hop routing.

8.3 HIPERLAN forwarding methodology

For the purposes of describing the operation of MAC sub-layer forwarding, it is convenient to visualise the forwarding function as a sub-layer of the MAC sub-layer, and to consider the operation of this in conjunction with a Channel Access (CA) sub-layer (see figure 8).

NOTE: This division of the MAC into sub-layers is not subject to HIPERLAN standardisation and the interface between the forwarding sub-layer and the CA sub-layer is not part of the HIPERLAN standard. No specific implementation is implied by this approach.

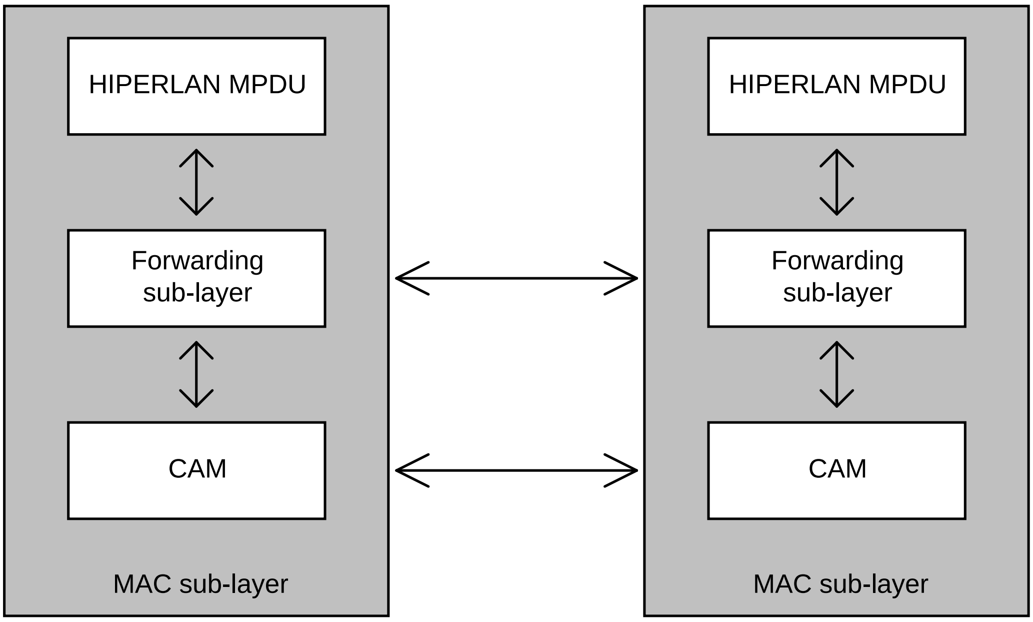

Figure 8: Exchange of PDUs within and between MAC sub-layers

The forwarding sub-layer decides the route for the MPDU based on the destination HIPERLAN address. If the destination HIPERLAN address is not a neighbour of the forwarding node, it forms a F_PDU which contains the MPDU and the hop addresses as shown in figure 9 below.

Figure 9: Encapsulation of MPDUs in F-PDUs

This process is repeated at the next forwarding sub-layer. When the destination HIPERLAN address is a neighbour of the forwarder, the MPDU is delivered. Clause 6 describes the general format of HIPERLAN addresses.

8.4 HIPERLAN forwarding services

HIPERLAN forwarding is an optional service the operation of which is governed by the SCF. The characteristics of forwarders are:

a) all forwarders in a given HIPERLAN have symmetric communication paths between them;

b) each forwarder maintains knowledge of its neighbours with which it has symmetric communication;

c) any change in a forwarder's neighbours results in the generation of sufficient topology information to enable all the forwarders within that HIPERLAN to update their forwarding tables.

The existence of forwarders can be detected from their generated management PDUs. Since all nodes, including non-forwarding nodes, will be in range of topology carrying PDUs the use of topology information is not limited to forwarders.

The minimum necessary behaviour of any node in a HIPERLAN with forwarders, to communicate with all members of that HIPERLAN, is to identify at least one neighbour who is a forwarder.

All nodes generate some PDUs at a rate which prevents them being lost from neighbour tables through aging.

8.5 Loop control

HIPERLAN forwarders have to implement suitable techniques to detect and prevent MPDUs from looping.

8.6 Broadcast forwarding

HIPERLAN forwarders have to implement suitable techniques to increase the efficiency of broadcast MPDU forwarding in environments with multiple neighbouring forwarders.

8.7 Transmit power control

Radio power management information is available at the CAM service interface. This information in conjunction with neighbour tables may be used to derive optimum transmitted power.

Annex A (informative): HIPERLAN management

A.1 Overview

HIPERLAN provides facilities that allow the HIPERLAN user to control the operation of, and to obtain information about, HIPERLAN. The facilities fall into three broad classes:

- operational control - controlling the membership of a HIPERLAN;
- configuration control - controlling the operating parameters of the HIPERLAN node;
- reporting - obtain information about this and other HIPERLANs.

These facilites may be modeled by managed objects and as such may be locally or remotely manipulated.

A.2 Operational control object

The following operations are defined:

a) create HIPERLAN, this operation creates a new HIPERLAN;

b) join a HIPERLAN, this operation allows a node to join a given existing HIPERLAN;

c) leave a HIPERLAN, this operation allows a node to leave a given HIPERLAN.

A.3 Configuration control

A.3.1 Forwarding object

The following operations are defined:

a) enable or disable forwarding within a given HIPERLAN;

b) enable or disable forwarding between two given HIPERLANs.

A.3.2 Encryption object

The following operations are defined:

a) enable and disable;

b) change the encryption key;

c) add encryption key;

d) remove encryption key.

A.3.3 Power conservation object

The following operations are defined:

a) enable/disable PCM;

b) set sleep/wake/wake extend periods.

A.4 Reporting object

The following operations are defined:

a) get RF channels, this operation returns the RF channels that are in use;

b) get HIPERLANs, this operation returns the known HIPERLANs (HIDs);

c) get statistics, this operation returns statistical information collected by the HIPERLAN node.

History

Document history	
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