ETSI TR 101 957 V1.1.1 (2001-08)

Technical Report

**Broadband Radio Access Networks (BRAN);
HIPERLAN Type 2;
Requirements and Architectures for Interworking between
HIPERLAN/2 and 3rd Generation Cellular systems**

Reference

DTR/BRAN-0020003-1

Keywords

3G, access, broadband, HIPERLAN, interworking, LAN, radio, UMTS

ETSI

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

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

Siret N° 348 623 562 00017 - NAF 742 C
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Foreword

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

Introduction

Recently, the mobile business professionals have been more and more looking for an efficient way to access corporate information systems and databases remotely through the Internet backbone. However, the high bandwidth demand of the typical office applications, such as large email attachment downloading, often calls for very fast transmission capacity. Further, certain hot spots, like airports and railway stations are a natural place to use the services. However, in these places the time available for information download is typically fairly limited.

In the light of above there clearly is a need for a public wireless access solution that could cover the demand for data intensive applications and enable smooth on-line access to corporate data services in hot spots and would allow a user to roam from a private, micro cell network (e.g. a HIPERLAN/2 Network) to a 3G cellular network.

Together with high data rate cellular access, HIPERLAN/2 has the potential to fulfil end user demands in hot spot environments. HIPERLAN/2 offers a possibility for cellular operators to offer additional capacity and higher bandwidths for end users without sacrificing the capacity of the cellular users, as HIPERLANs operate on unlicensed frequency bands. Also, HIPERLAN/2 has the QoS mechanisms that are capable to meet the mechanisms that are available in the UMTS systems. Furthermore, interworking solutions enable operators to utilize the existing cellular infrastructure investments and well established roaming agreements for HIPERLAN/2 network subscriber management and billing.

1 Scope

The scope of the present document is limited to Requirements and Architectures for interworking between HIPERLAN/2 and 3G systems (and specifically to UMTS Release 3).

The present document describes the requirements and architectures that are applicable to interworking between High Performance Radio Local Area Network HIPERLAN/2 and 3rd Generation Cellular Systems.

The requirements in the present document address subjects such as operational requirements, user requirements, mobility, QoS mapping, subscription information, equipment identity, security and standardization requirements.

The architectures address communications layer models as well as the reference models that identify interfaces and issues subject to standardization.

2 References

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

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3 Definitions symbols and abbreviations

3.1 Definitions

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

Access Point (AP): interface between the radio network part and the wired network part of a HIPERLAN/2 network, offering wireless connectivity to MTs

NOTE 1: The AP handles forwarding of traffic between MTs and the wired part of the HIPERLAN/2 network.

handover: to maintain a path between an MT and a correspondent node when the MT moves between cells of the same radio technology or between different radio technologies with a minimum of involvement from the user

HIPERLAN/2 network: consists of a number of Access Points with continuous radio coverage and of associated mobile terminals

NOTE 2: If, in addition, the Access Points can communicate with each other at the control plane, the user plane and the management plane via a fixed network, that fixed network with all of its protocols is also a part of a HIPERLAN/2 network.

Home AAA (AAAH): logical function within the loose coupling architecture that provides AAA functions to support subscribers who have a permanent relationship with that network

NOTE 3: Whether the subscriber is directly using a HIPERLAN/2 access network under the same administrative control as the AAAH, or is roaming on another operator's network, it is assumed that the AAA transactions are eventually handled by the AAAH, possibly via one or more intermediaries.

Home Location Register (HLR): centralized entity containing subscription data that is required for user authentication and encryption in a 2nd generation GSM network on a per user basis

Home Subscriber Server (HSS): centralized entity containing subscription data that is required for user authentication and encryption in a 3rd generation mobile network (UMTS) on a per user basis

Local AAA (AAAL): logical function within the loose coupling architecture that enforces the AAA policy within the local HIPERLAN/2 network

NOTE 4: Its distinguishing characteristics are that it is assumed to be part of the same administrative domain as the HIPERLAN/2 Access Points that make up the network, and indeed that security relationships between it and the access points may be manually configured.

Mobile Terminal (MT): end system equipment providing the interface towards human beings through a set of applications

NOTE 5: The MT includes, among other things, the functions and protocols necessary to provide and handle the communication to the HIPERLAN/2 network, as well as against other networks, services, and applications.

mobility: ability of an MT to be used in different network environments, within a single and in different administrative domains, with minimum user intervention

mobility between administrative domains: ability for a MT to function in a serving network different from the originating network

mobility between network environments: refers to the ability of an MT to be used in different network environments, such as home, corporate and public

roaming: mobility between administrative domains

3.2 Abbreviations

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

2G	2nd Generation (Cellular System)
3G	3rd Generation (Cellular System)
3GPP	3G Project Partnership
AAA	Authentication, Authorization and Accounting
AAAH	Home AAA
AAAL	Local AAA
AAL	ATM Adaptation Layer
AF	Assured Forwarding
AP	Access Point
ATM	Asynchronous Transfer Mode
BRAIN	Broadband Radio Access for IP based Networks (IST-1999-10050)
BRAN	Broadband Radio Access Networks
CDMA	Code Division Multiple Access
CHAP	Challenge Handshake Authentication Protocol
CL	Convergence Layer
CN	Core Network
COPS	Common Open Policy Service
CS	Circuit Switched
DFS	Dynamic Frequency Selection
DHCP	Dynamic Host Configuration Protocol
DLC	Data Link Control
DRNC	Drift Radio Network Controller
DSCP	Differentiated Services Code Point
EAP	Extensible Authentication Protocol
EAPOL	EAP Over LAN
EF	Expedited Forwarding
FA	Foreign Agent
GGSN	Gateway GPRS Support Node
GPRS	General Package Radio Service
GTP	GPRS Tunnelling Protocol
GTP-U	GPRS Tunnelling Protocol-User plane
HA	Home Agent
HIRAN	HIPERLAN/2 Radio Access Network
HLR	Home Location Register
HSS	Home Subscriber server
ID	IDentifier
IEEE	Institute of Electrical and Electronic Engineers
IETF	Internet Engineering Task Force
IKE	Internet Key Exchange
IMEI	International Mobile Equipment Identity
IMSI	International Mobile subscriber Identity
IMT-2000	International Mobile Telecommunications 2000
IP	Internet Protocol
ITU	International Telecommunications Union
IWU	InterWorking Unit
LAN	Local Area Network
MAC	Media Access Control
MAC	Message Authentication Code
MCC	Mobile Country Code
MIP	Mobile IP
MM	Mobility Management
MNC	Mobile Network Code
MS	Mobile Station
MT	Mobile Terminal
NAI	Network Access Identifier
NAS	Non Access Stratum
PDH	Plesiochronous Digital Hierarchy

PDP	Packet Data Protocol
PDU	Packet Data Unit
PHB	Per Hop Behaviour
PLMN	Public Land Mobile Network
PPP	Point to Point Protocol
PS	Packet Switched
QoS	Quality of Service
RAC	Routing Area Code
RAD	RADIUS (IETF AAA protocol)
RANAP	Radio Access Network Application Part
RLC	Radio Link Control
RNC	Radio Network Controller
RNSAP	Radio Network Subsystem Application Part
RNTI	Radio Network Temporary Identifier
RSVP	Resource reSerVation Protocol
SAC	Service Area Code
SAI	Service Area Identifier
SAP	Service Access Point
SDH	Synchronous Digital Hierarchy
SDU	Service Data Unit
SGSN	Serving GPRS Support Node
SIM	Subscriber Identity Module - see also (U)SIM
SIP	Session Initiation Protocol
SM	Session Management
SONET	Synchronous Optical NETwork
SRNC	Serving RNC
SSCS	Service Specific Convergence Sublayer
TCP	Transmission Control Protocol
TEID	Tunnel Endpoint Identifier
TLS	Transport Level Security
TMSI	Temporary Mobile Subscriber Identity
TOS	Type Of Service
UMTS	Universal Mobile Telecommunication System
URA	UTRAN Registration Area
(U)SIM	User Service Identity Module - see also SIM
UTRAN	Universal Terrestrial Radio Access Network
WCDMA	Wideband Code Division Multiple Access

4 Overview

The present document describes Requirements and Architectures for interworking between HIPERLAN/2 and certain 3G systems.

4.1 HIPERLAN Type 2

HIPERLAN Type 2 (HIPERLAN/2) is intended to provide local wireless access to IP, Ethernet, IEEE 1394, ATM and UMTS infrastructure by both stationary and moving terminals that interact with access points. The access points are connected to an IP, Ethernet, IEEE 1394, ATM or UMTS backbone network. A number of these access points are required to service all but the smallest networks of this kind and therefore the wireless network as a whole supports handovers of connections between access points.

4.2 Systems

UMTS is one of the major third generation mobile systems that is being developed and standardized by the 3rd Generation Partnership Project (3GPP) within the framework of International Mobile Telecommunications 2000 (IMT-2000), defined by the International Telecommunications Union (ITU). Other 3G systems include e.g. CDMA-2000. The present document primarily focuses on UMTS standards.

The current working UMTS standard, Release 3, of UMTS was finalized in spring 2000 with work continuing in Release 4. A further developed standard will be available by beginning of 2002 (Release 5), and finally service provision is expected between 2002 and 2005.

5 Requirements

Requirements in this clause shall apply to all 3G systems. However, in some cases the requirements are more specific and it has to be specified to which 3G system they shall be adapted.

Within the present document Packet Switched (PS) services are only considered.

5.1 General

It is foreseen that the HIPERLAN/2 network will be used in different network environments like:

- corporate, where the user obtains a wireless connection to the office legacy LAN (typically via the Ethernet CL);
- public, which are HIPERLAN/2 island networks in public places like airports, hotels, etc.;
- home, where the HIPERLAN/2 terminals will be used within domestic equipment (typically via IEEE 1394 CL or Ethernet CL).

These different network environments may belong to different administrative domains. Furthermore there could be an interworking between these network environments/administrative domains and 3G.

From these assumptions the following requirements are derived:

- the users' HIPERLAN/2 terminal shall be able to move between different administrative domains and network environments with as little intervention from the user as possible;
- users that have a subscription with a 3G mobile operator, who also provides HIPERLAN/2 network access, shall be able to use both access networks with as little intervention from the user as possible;
- partnership or roaming agreements between a 3G operator and a HIPERLAN/2 network operator shall give the user the same benefits as if the interworking was handled within one network operator.

5.2 Subscriber Data

The user can have a subscription to HIPERLAN/2 networks solely or to the combination of HIPERLAN/2 and 3G networks. For the interworking of HIPERLAN/2 networks with 3G, the networks could be owned by one single operator. Depending on the level of interworking, one scenario could also be that two different network operators could own the networks and consequently the subscriber's database. The interworking between the HIPERLAN/2 network and the 3G network will in this case take place through a partnership or a roaming agreement.

From this background the requirement on the subscriber data is given:

- the subscriber identification shall be in such a format that it can be used in just a HIPERLAN/2 environment or in HIPERLAN/2 network that is interworking with the 3G cellular system;
- the subscriber database for interworking between the HIPERLAN/2 network and the 3G network, could be just one that is shared or there could be one for each network that share the subscribers' security association. The subscriber database could be an HLR/HSS (3GPP terminology) or an AAA server (IETF terminology).

5.3 Mobility and Handover

Handover from HIPERLAN/2 to 3G and vice versa shall be supported. HIPERLAN/2 supported user services may not be supportable in 3G networks and/or may not be robust enough for the supported handover requirements. Services that will suffer from the latter are typically time stringent, as for the former these may be services/applications that require an amount of capacity that is not supported. In cases where the service/application cannot be supported, due to a change of access network, the user should be notified of the forthcoming termination.

In cases where the service/application may be supported, but with a degradation of the provided quality, the user may be controlled through a subscription. The subscription may define the level of mobility between HIPERLAN/2 and 3G that the user requests on certain services/applications with an agreed quality that is applicable to provide in the serving access network. In any circumstances the user should be notified of any possible degradation of the provided quality of service due to the change of access network.

5.4 End user device

The following points should be considered:

1) Usage and handling of the (U)SIM if applicable.

2) Communication between two mechanically different parts, within a single terminal;

3) The placement of common functions, like handover;

4) The different behaviour of a "terminal" comprising two parts, when connected or disconnected.

6 Level of Interworking

There are two fundamentally different ways of solving the interworking; entitled loose interworking and tight interworking in the present document. These two architectures are further discussed in the present document.

6.1 Loose Interworking

Loose coupling is defined as the utilization of HIPERLAN/2 as an access network complementary to current 3G access networks, utilizing the subscriber databases but without any user plane Iu type interface, i.e. avoiding the SGSN, GGSN nodes. The operator will still be able to utilize the same subscriber database for existing 3G clients and new HIPERLAN/2 clients, allowing centralized billing and maintenance for different access technologies.

More specifically only IP services are supported across the access network, whilst AAA functions directly access core network control functions, perhaps with new specifications where required.

At the level of BRAN, security, mobility, and QoS need to be addressed using IETF schemes. Upper layer issues such as interfaces to existing 3G subscriber databases are out of scope of standardization within BRAN.

The objective of the present document is to suggest possible solutions utilizing IETF protocols wherever possible, the remainder of the solution being defined within the present document.

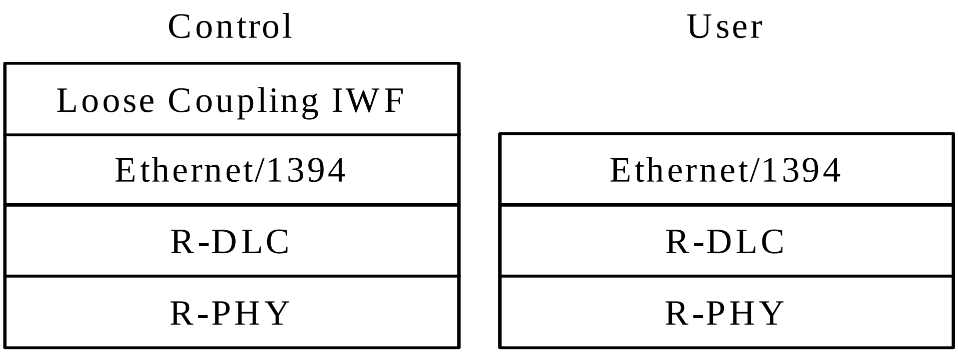


Figure 1: Loose Coupling interaction with Convergence sublayers

Figure 1 presents the loose coupling interaction with the HIPERLAN/2 convergence layers (CL). The convergence layer on the left is a 3G loose-coupling specific one, whereas the CL on the right is any CL defined by BRAN (e.g. ATM/Ethernet/IEEE 1394 CL, with others to follow in the future).

It is interesting to note that this solution is equally applicable for GSM (2G), GPRS (2.5G) and native IP networks.

Mobility and security are functions of the convergence layer used and the network user is attached to. These issues are further considered in clause 7 in the particular case of the Ethernet convergence layer and an IP access network. BRAIN material discusses another alternative of IP convegence layer and a native IP network

For interested readers, the BRAIN Deliverable D2.2 [27] contains further reading on the area.

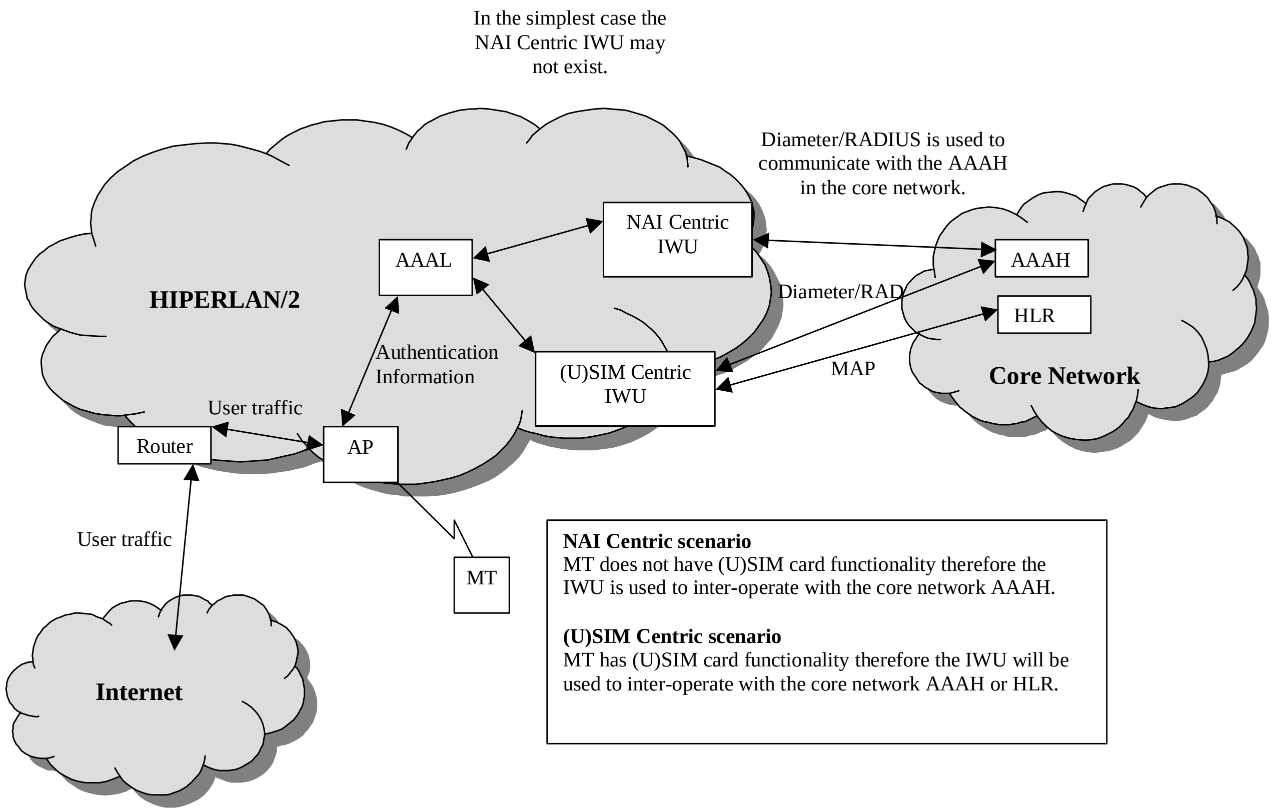


Figure 2: Loose Coupling Architecture

6.1.1 Security variants

There are two alternative approaches that can be supported by one common architecture as shown in figure 2, with only minor differences in the authentication server itself, referred to as NAI centric and (U)SIM centric. These are described in more detail in clause 7.2. The motivation for network operators to build up HIPERLAN/2 networks based on each security variant may be different for each operator. However, both variants offer a maximum of flexibility and allow coupling to existing and future cellular mobile networks.

6.2 Tight Interworking

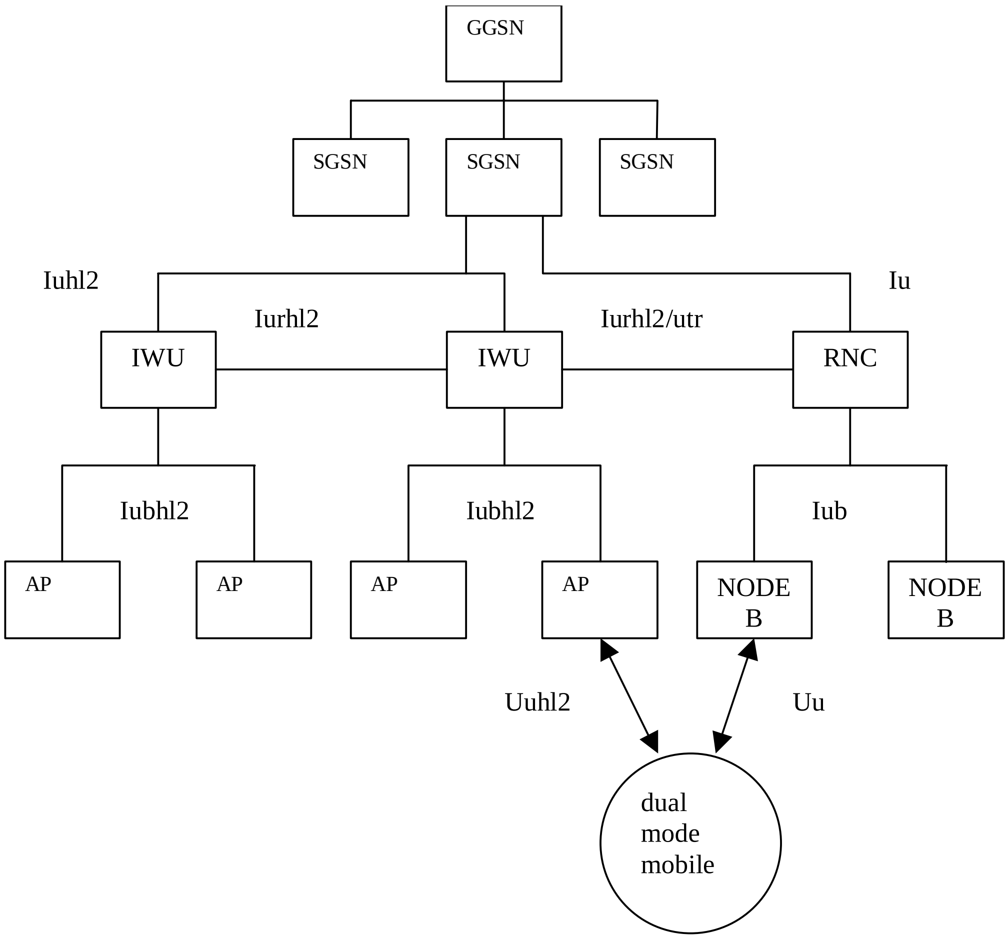


Figure 3: Tight Coupling Architecture

In the tight interworking as shown in figure 3, the HIPERLAN/2 network is connected to the rest of the UMTS network (the core network) in the same manner as other UMTS radio access technologies (UTRAN, GERAN), using the Iuhl2 interface. Iuhl2 is very similar to the Iu interface.

In this way, especially the mechanisms for mobility, QoS and security of the UMTS core network can be reused.

Other interfaces than Iu/Iuhl2 shown in figure 3can be HIPERLAN/2 network specific, like Iurhl2, and others are certainly HIPERLAN/2 specific, like Iubhl2 and Uuhl2.

The protocol standardization of the tight scheme can be done in steps to speed up standardization and product development.

The GGSN is the interface between the UMTS core network and the Internet.

Apart from the common interface Iu, also some addresses and identifiers of UMTS are used by the HIPERLAN/2 network.

7 Loose Interworking between HIPERLAN/2 and 3G Systems

7.1 Requirements

7.1.1 Mobility and handover

The requirements for mobility and handover differ depending upon the type of the networks involved. This clause considers several different mobility options.

7.1.1.1 Mobility within and between HIPERLAN/2 networks

- Mobility shall be supported between HIPERLAN/2 networks belonging to different administrative domains.
- Handover shall be provided within a HIPERLAN/2 network belonging to an administrative domain. Handover might be performed based on the link layer Network Handover procedure defined in [14] with the possible addition of higher layer mobility protocols, e.g. Mobile IP when necessary.
- Handover should be supported within a HIPERLAN/2 network belonging to different administrative domains.

NOTE: BRAIN project has studied another alternative based on IP micro mobility.

7.1.1.2 Mobility between HIPERLAN/2 and 3G networks

- Full association and authentication will be needed within the respective network.
- Terminals shall support mobility between different HIPERLAN/2 and 3G networks.
- Mobility between administrative domains shall be supported.

The specific requirements for loose coupling would be achieved by IETF inter-domain mobility mechanisms external to the HIPERLAN/2 and 3G networks such as SIP or Mobile IP, and therefore the requirement is that any loose coupling solution should not prevent the operation of such mechanisms.

7.1.2 Security

The security requirements can be divided into two parts:

- for the HIPERLAN/2 network;
- for the HIPERLAN/2 specific user equipment.

The HIPERLAN/2 specific user equipment includes the HIPERLAN/2 card as well as a storage unit for HIPERLAN/2 security parameters. The requirements have been derived from [10].

7.1.2.1 HIPERLAN/2 network requirements

As noted above, implementation of some of these requirements may require changes to the HIPERLAN/2 standards. Identifying which of them is not compatible with the current HIPERLAN/2 standards needs to be carried out.

A valid HIPERLAN/2 subscription shall be required to use the network.

- It shall be possible to prevent intruders from obtaining unauthorized access to the network by masquerading as authorized users.
- It shall be possible for network providers to authenticate users at any time, such as when the user first enters the network and while the user is using the network.

- It shall be possible to detect and prevent the fraudulent use of the network. Audit logs of security related events will need to be produced.
- It shall be possible to blacklist users.
- It shall be possible for an AP to cause an immediate termination of the access provided to a user.
- It shall be possible for the network to authenticate the origin of user traffic, signalling data and control data.
- It shall be possible to prevent intruders from restricting the availability of services by logical means.
- It shall be possible to protect against unauthorized modification of user traffic.
- It shall be possible to protect against unauthorized modification of certain signalling data and control data.
- It shall be possible to protect against unauthorized modification of user-related data that is stored or processed by a provider.
- It shall be possible to ensure the origin, integrity and freshness of authentication data, particularly of the cipher key.
- It shall be possible to protect the confidentiality of certain signalling data and control data.
- It shall be possible to protect the confidentiality of user traffic.
- It shall be possible to protect the confidentiality of user-related data that is stored or processed by a provider.
- It shall be possible to protect the confidentiality of user-related data stored by the user in the HIPERLAN/2 specific user equipment.

7.1.2.2 HIPERLAN/2 specific user equipment requirements

- It shall be possible to control access to HIPERLAN/2 specific data (protocol intervention).
- It shall not be possible to access HIPERLAN/2 specific data that is only intended to be used for security purposes, e.g. authentication keys and algorithms.
- It shall be difficult to change the identifier.

7.1.2.3 Comparison with HIPERLAN/2 capabilities

After looking at the current HIPERLAN/2 specification some issues have been identified as needing further attention in order to fulfil the requirements. These issues are:

1) There does not seem to be any replay protection. The challenge needs to be sequential to assure that the same challenge is not sent several times.
2) After a user leaves a multicast group (implementation using multicast MAC ID) the key needs to be changed in order to assure that the user, that is no longer part of the multicast group, can no longer gain access to multicast information.
3) Integrity protection is needed and a separate key should be used for this purpose.
4) The AP should be able to re-authenticate the user if desired.
5) The AP should be able to initiate a key refresh even if the lifetime of the session key has not yet expired.
6) Messages between an AP and the AAAL need to be well protected. This should be done with the standard facilities provided by the AAA protocol or other IP security mechanisms (e.g. IPSec security associations between the AP and AAAL).

7.1.3 Quality of Service

Note that one of these requirements below, would also apply to a non-3G interworking HIPERLAN/2 networks. Later more detailed system requirements on the provisioning of IP QoS in HIPERLAN/2 networks are provided. In the loose coupling case it is not the intention to replicate/use the UMTS QoS mechanisms.

Overall Requirements

- QoS provisioning in HIPERLAN/2 networks should be subject to user's subscription.
- It should be possible for a HIPERLAN/2 network operator to monitor the QoS provided to the users.
- It should be possible to charge a user based on the level of QoS provided and on the QoS subscribed.
- The provisioning of QoS in HIPERLAN/2 networks should have a minimum impact on the provisioning of QoS in 3G networks.
- It should be possible for applications to request QoS treatment for their communications through one mechanism independently of the access network used (i.e. UTRAN or HIPERLAN/2 network).
- It shall be possible to prevent unauthorized users to send (upstream) inadmissible data through the network.
- It should be possible to include HIPERLAN/2 related service/QoS subscription of a HIPERLAN/2-3G user in the HLR/HSS or an authentication and authorization entity such as an AAAH. This possibility requires further standardization.
- Within HIPERLAN/2 networks, QoS mechanisms towards external networks should be aligned with the IP mechanisms used on the 3G Gi interface [22] (in order to simplify interworking with the operator's ISP platform). Additionally it should be possible to easily integrate, in the future, the IP Multimedia Subsystem QoS requirements.
- QoS authorization should be performed locally. Once the service/QoS profile is downloaded to the local domain, the authorization is accomplished in the local domain to minimize signalling.

IP QoS requirements

By using existing or emerging IETF protocols (e.g. RSVP [16], COPS [17]), the HIPERLAN/2 and 3G domains can interwork without extensive additional work. From the QoS perspective, the focus in this clause will be from the end-user part through the HIPERLAN/2 network connected to an IP network. The requirements to fulfil the end-to-end quality of service are outside the scope of the present document.

It is a requirement to be able to differentiate between MTs connected to one and different APs, to fulfil this requirement "policy-based" server scan be used. It is recommended that functionalities like user profile, IP policy handling and traffic conditioning are also included in this node and could thereby act as a DiffServ boundary node. This differentiation is needed to ensure that resource (e.g. bandwidth) allocation and (re)-negotiation is properly performed. For example, when a user with higher priority entering the network using a real time application will not result in that another user with lower priority will be out of resources or logged out.

The provisioning of IP QoS should fulfil the following requirements partly taken from [1], [18] and [19]:

- The IETF's Differentiated Services should be supported via the priorities in Ethernet CL.
- The implementation of DiffServ classes EF (Expedited Forwarding) and AF (Assured Forwarding) shall comply with [18] and [19].
- The mapping between IEEE 802.1p priority levels (0-7 bits) and IP DiffServ (DSCP in the TOS byte should be supported.
- It should be possible for the operator to control/configure the mapping between IEEE 802.1p (priority bits) and DiffServ classes.
- QoS parameter mapping from the IP-application parameters to IEEE 802.1p priority levels (0-7 bits) in MT shall be supported.

- The policy-based server must be able to perform the traffic classification, shaping (re)-marking, QoS differentiation based on profile, SLA etc for both incoming and outgoing traffic.
- Support of IETF based protocol COPS (Common Open Policy Service) [17] intended for communication of policy request, decisions and policy provisioning.

7.2 System architecture

This clause introduces the system architecture that is required to support loose coupling. In order to provide HIPERLAN/2 access for this scenario the HIPERLAN/2 network as described for corporate access can be used [H2GF SFA]. However, it is useful to split up authentication into a server and a client part where the client part resides at the premises of the HIPERLAN/2 network and the server part may reside in the public operator's cellular network. Refer to figure 2 for NAI centric architecture.

Figure 4: Void

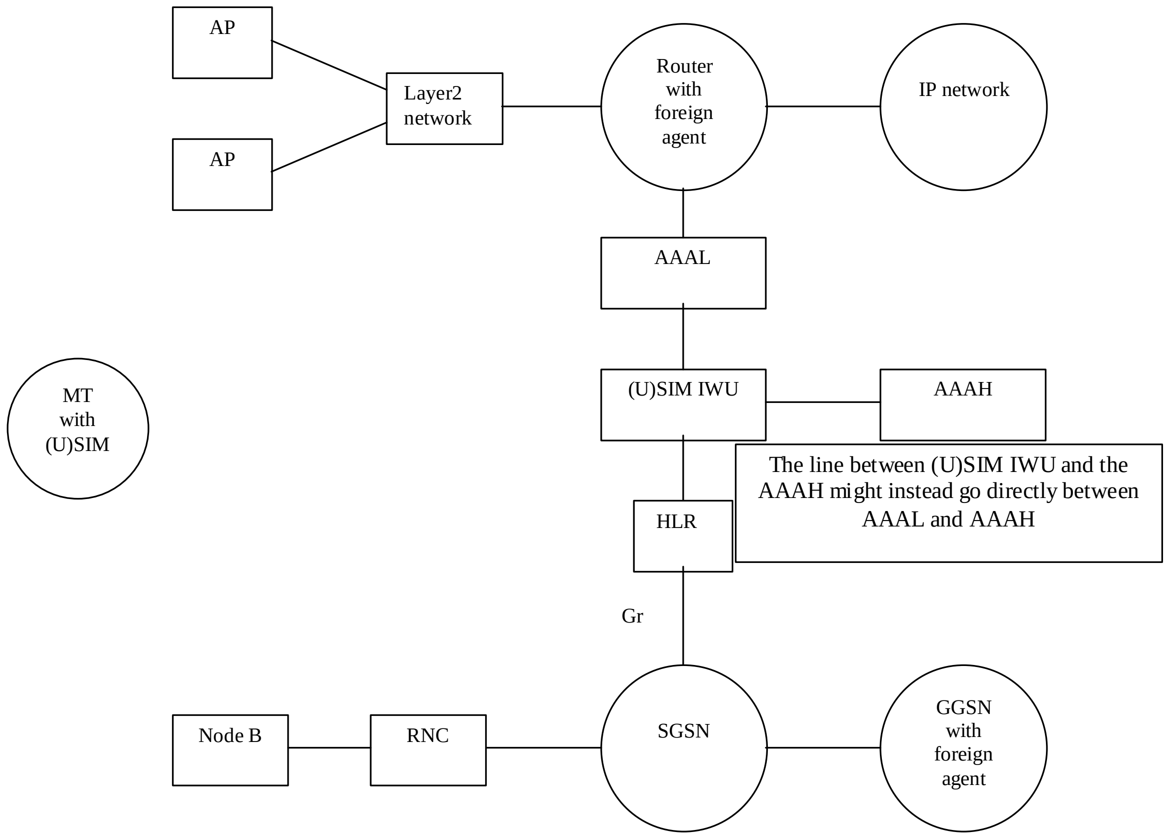


Figure 5: (U)SIM centric system architecture

Prerequisites and assumptions for figures 2 and 5:

1) The interworking between the HIPERLAN/2 access network and UMTS network uses (U)SIM centric authentication and accounting towards the HLR.

2) Initially MIPv4 will be used.

3) The HIPERLAN/2 access network communicates with HLR via an interworking unit (IWU) that has an interface with the local AAA server.

7.2.1 Protocol stacks

These protocol stacks have been created for the Ethernet CL as an example CL and reflect UMTS Release 3. Additionally it should be noted that TCP may also be used instead of SCTP to transport the Diameter [30] protocol.

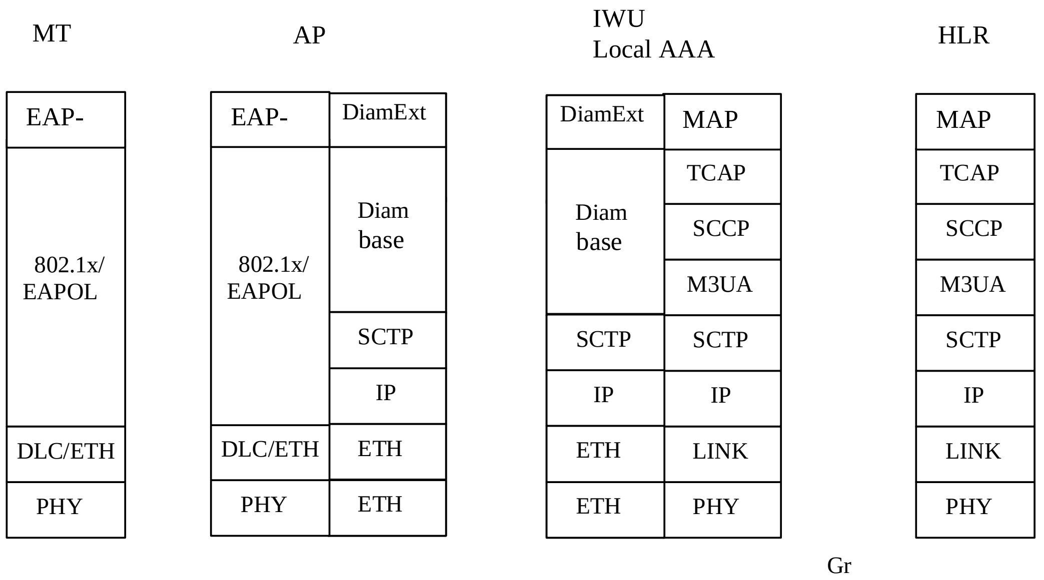


Figure 6: Control plane (using HIPERLAN/2 user plane), authentication part

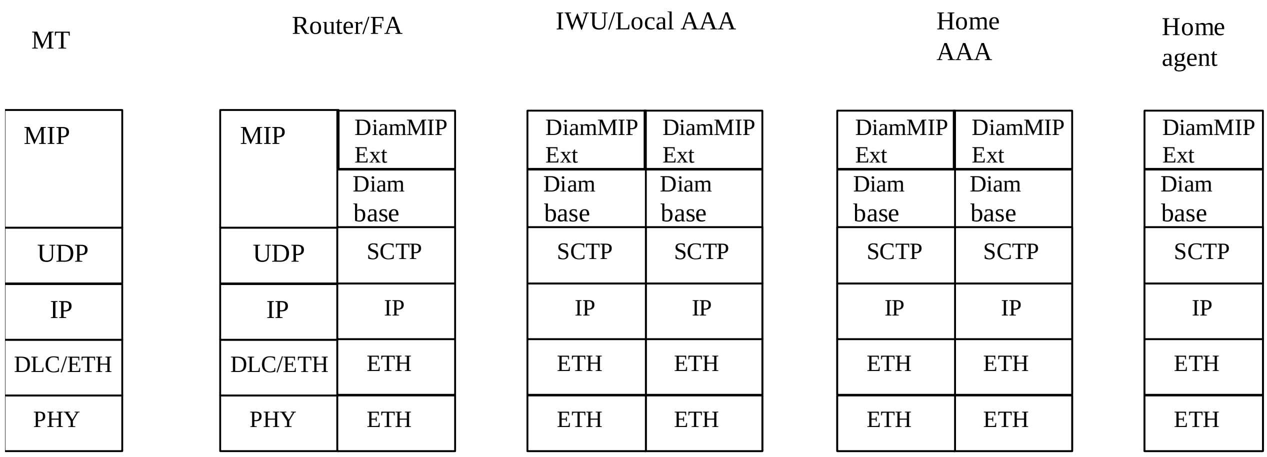


Figure 7: Control plane (using HIPERLAN/2 user plane), mobility part

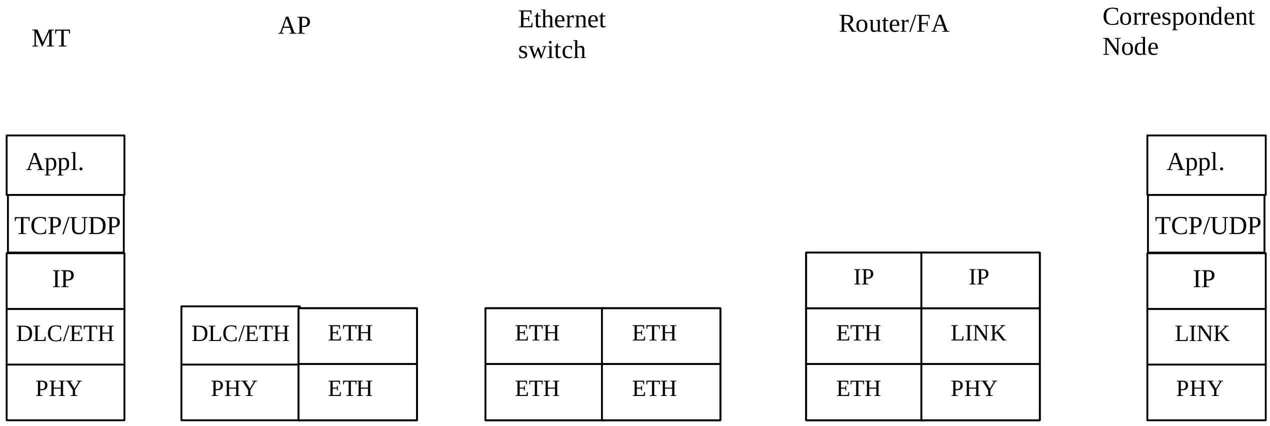


Figure 8: User Plane

7.2.2 Interworking with UMTS Releases

The roaming, including charging and security issues, can be handled by the AAA (Authentication, Authorization and Accounting). For Release 4, the Home Subscriber Server (HSS) in the UMTS Core Network is the master database holding the subscriber data for e.g. charging and identity. In future Releases it may be possible to terminate AAA protocols in the HSS.

Handover between the different networks can be provided through Mobile IP. The UMTS system (Release 3) optionally supports Mobile IP for access independent roaming at IP level. Integration of MIP with UMTS has been described in [20]. Mobile IP is further described in [2]. Generally speaking the direction of standardization within 3GPP is to have an AAA based HSS.

In UMTS it will be mandatory to support DiffServ at transport level and at user level in Release 4 there are several QoS mechanisms. For HIPERLAN/2 DiffServ can probably be supported via the priorities in Ethernet CL. QoS support is in Release 4 divided on several functional entities, as described above in clause 7.1.3.

7.2.3 Interface definitions

Figure 9 presents the interfaces that are covered by the scope of the present document. Interfaces W.1 and W.2 were introduced in reference [15]. The present document defines the sub-parts of W.2.

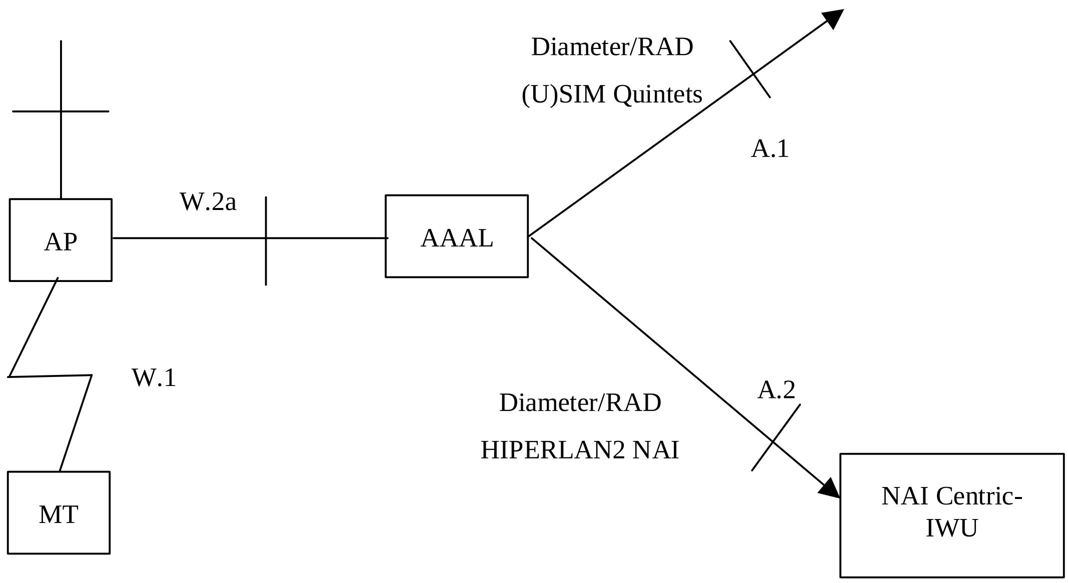


Figure 9: Loose Coupling Interface Definitions

W.1

HIPERLAN/2 air interface standard as defined by reference [29].

W.2

The interface between the AP and the relevant core network. This is dependent upon the chosen convergence layer, so that for example connection to a Corporate Intranet/Public Intranet would utilize the Ethernet CL.

W.2a

The name of this interface has already been defined by H2GF [24].

A.1

This interface is required for transmission of subscriber information from the (U)SIM card within the Mobile Terminal. It is transported using the IETF protocol Diameter or RADIUS.

A.2

This interface is required for transmission of user subscription data such as username and password and accounting data. It is transported using the IETF protocol Diameter or RADIUS.

7.2.4 Subscriber data

There are three basic ways in which the subscriber management for HIPERLAN/2 and 3G users can be co-ordinated.

1) Have the interworking between the HIPERLAN/2 subscriber database and HLR/HSS. This is for the case where the interworking is managed through a partnership or roaming agreement. The administrative domains' AAA servers share security association or use an AAA broker.

2) The HIPERLAN/2 authentication could be done on the basis of a (U)SIM token.

3) The 3G authentication and accounting capabilities could be extended to support access authentication based on IETF protocols. This means either integrating HLR and AAA functions within one unit (e.g. a HSS unit), or by merging native HLR functions of the 3G network with AAA functions required to support IP access.

Based on these different ways for subscriber management, the user authentication identifier can be on three different formats:

1) NAI.

2) International Mobile Subscriber Identity (IMSI), requires a (U)SIM card.

3) IMSI in NAI, requires a (U)SIM card.

The user authentication identifier is pointed out to be something that could affect the HIPERLAN/2 standardization work and is therefore further discussed in clauses 7.2.4.1, 7.2.4.2, 7.2.4.3.

7.2.4.1 NAI as the user authentication identifier

Internet AAA protocols identify users with the Network Access Identifier (NAI). The NAI that is the userID submitted by the client during authentication (PPP or AAA). The NAI format is: user@realm. In mobility between different administrative domains, the purpose of the NAI is to identify the user as well as to assist in the routing of the authentication request. Visited network can route an authentication request to the home domain (or forward it to a roaming broker) based on the realm.

A proposed possibility is to use NAI as the identification of a user in a HIPERLAN/2 IP network. This allows the user not to have an existing be GSM/GPRS/UMTS subscription (i.e. a user can then decide only to subscribe to HIPERLAN/2). The HIPERLAN/2 standard is already prepared for the NAI as an authentication identifier. According to existing standards [29], the NAI is mandatory in the BRAN Business Profile (i.e. corporate environment), this facilitate a future interworking between the corporate and public scenarios.

A consequence of using NAI is that for users with subscriptions to both GSM/GPRS/UMTS and HIPERLAN/2, there need to be a way to map the two.

7.2.4.2 IMSI as the user authentication identifier

The subscribers of the cellular systems GSM/GPRS and UMTS are identified by the International Mobile Subscriber Identity (IMSI), which is stored on a Subscriber Identity Module (U)SIM card, which is a smart card. The IMSI consists of three parts; the Mobile Country Code (3 digits), the Mobile Network Code (2 digits) and the Mobile Subscriber Identity Number (up to 10 digits). These digits together form a globally unique number. To be able to use the cellular system and its services the user need to be a native cellular subscriber. In order to establish an interworking between HIPERLAN/2 the user has to be authenticated in the HIPERLAN/2 network. The advantage of using the IMSI is that it is an international identifier that has been in use for some time. Another advantage of using IMSI would be that since IMSI is used for administrative purposes in mobile networks today, no mapping would be needed if it were used for HIPERLAN/2 as well. The drawbacks for using the IMSI as it is, as an authentication identifier for the HIPERLAN/2 network are:

- IMSI is strongly related to GSM/GPRS/UMTS subscribers. For users that only subscribe to a HIPERLAN/2 service no IMSI is available. It is foreseen that only some HIPERLAN/2 operators will offer an interworking with the cellular systems.

- It is also foreseen that the public HIPERLAN/2 network will be widely spread through partnership and roaming agreements. It is therefore important that the authentication identifier is consistent between different HIPERLAN/2 operators. Furthermore the IMSI as an authentication identifier requires standardization work for BRAN (because IMSI is not currently among the 6 identifiers within the BRAN standard).

7.2.4.3 IMSI in NAI as the user authentication identifier

The next feasible possibility is to use the IMSI in NAI [ref: MobileIP I-D]. This means that the IMSI is encoded as a NAI, where the username portion of the NAI contains the IMSI as a string of digits, and the realm portion identifies the AAA server. The IMSI itself contains enough information to identify the GSM operator and to route the authorization requests to the subscriber's home GSM operator. How this shall be solved requires further investigation and possibly standardization in 3GPP and IETF.

7.2.4.4 Pre paid SIM

As far as the HLR within the core network is concerned, it cannot distinguish the difference between a customer who is pre-paid or not. Hence, this prevents a non-subscriber to this specific 3G network from using the system, if the operator wishes to impose this restriction.

As an example, pre-paid calls within a 2G network are handled via an Intelligent Network (IN) probably co-located with the HLR. When a call is initiated, the switch can be programmed with a time limit, or if credit runs out the IN can signal termination of the call. This then requires that the core network knows the remaining time available for any given customer. Currently the only signals that originate from the IN are to terminate the call from the network side.

This may be undesirable in a HIPERLAN/2 - 3G network, so that a more graceful solution is required. A suitable solution is to add pre-paid SIM operation to the system together with hot billing (i.e. bill upon demand) or triggered session termination. This could be achieved either by the AAAL polling the core network utilizing RADIUS to determine whether the customer is still in credit, or by using a more complicated protocol such as Diameter which allows network signalling directly to the mobile terminal.

The benefit of this approach is to allow the operator to present the mobile user with a web page (for example), as the pre-paid time period is about to expire, allowing them to purchase more airtime.

All these solutions would require an increased integration effort with the core network subscriber management system (ABC). Further additional services such as CAMEL may also allow roaming with pre-paid SIM cards.

7.2.5 Mobility and handover

In line with the requirements as stated for mobility and handover (see clause 7.1.1), the system architecture supporting this is divided up into two parts: mobility within and between HIPERLAN/2 networks, and mobility between HIPERLAN/2 networks and any other network. (The 'other' network could be a different HIPERLAN/2 network or a 3G network).

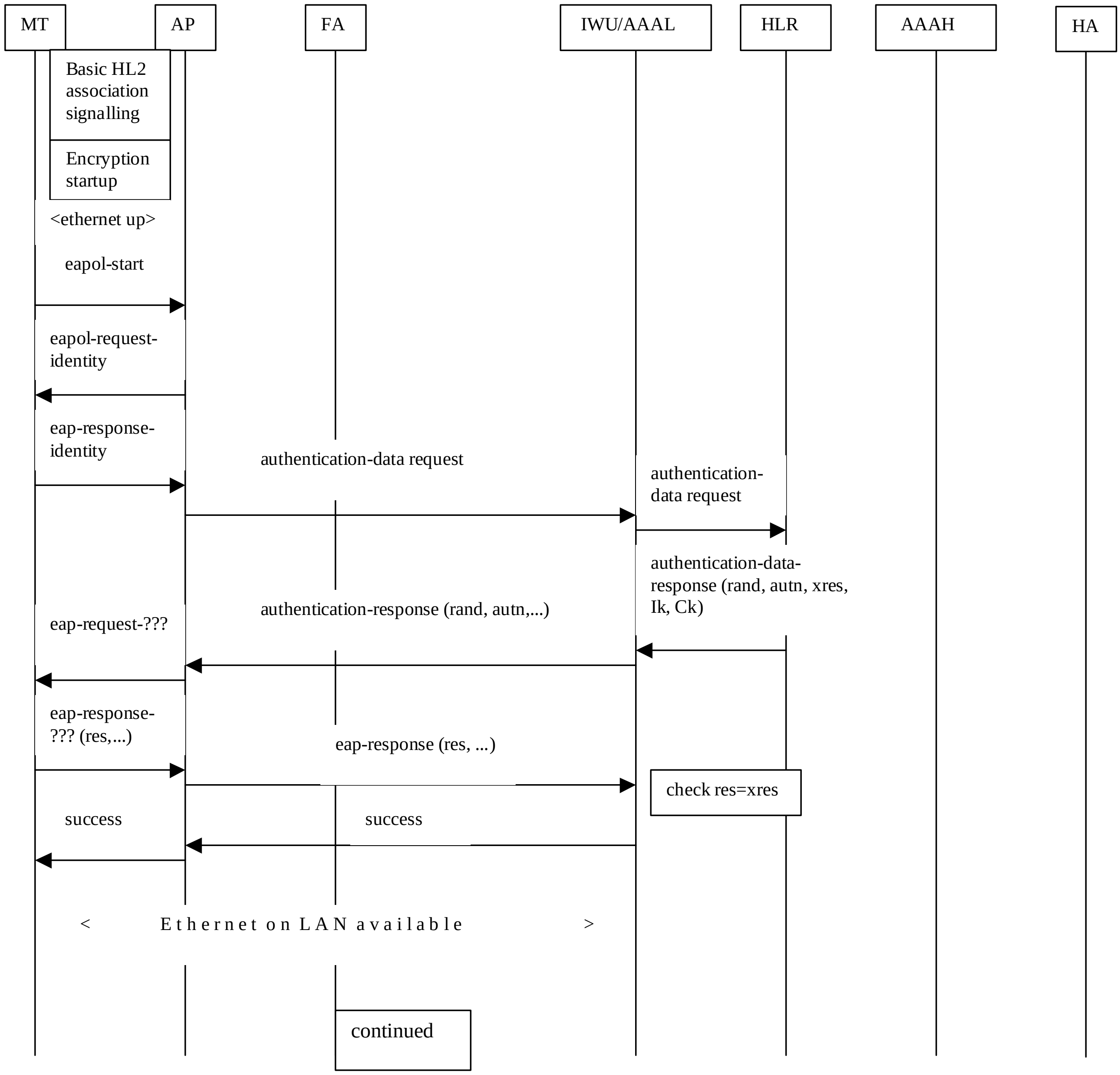
7.2.5.1 Mobility within and between HIPERLAN/2 Islands

In the loose coupling approach, the mobility within the HIPERLAN/2 network is provided by native HIPERLAN/2 (i.e. RLC layer) facilities, possibly extended by the convergence layer in use (e.g. the current Ethernet CL, or a future IP CL). This functionality should be taken unchanged in the loose coupling approach, i.e. handover between access points of the same HIPERLAN/2 network does not need to be considered especially here. This is justified by the following:

- the network handover capabilities of HIPERLAN/2 RLC are supported by both terminals and APs;
- given that HIPERLAN/2 network handover is supported, further details for completing the mobility between access points are provided by convergence layer dependent functionality;
- completion of this functionality to cover interactions between the APs and other parts of the network (excluding the terminal and therefore independent of the air interface) are currently under development outside BRAN. In the special case where the infrastructure of a single HIPERLAN/2 network spans more than one IP subnetwork, some of the above approaches assume an additional level of mobility support that may involve the terminal.

NOTE: The following message sequence diagrams utilize the HLR as an example of a subscriber database and do not imply a suggested architecture for loose interworking.

7.2.5.1.1 The MT registers to a foreign network



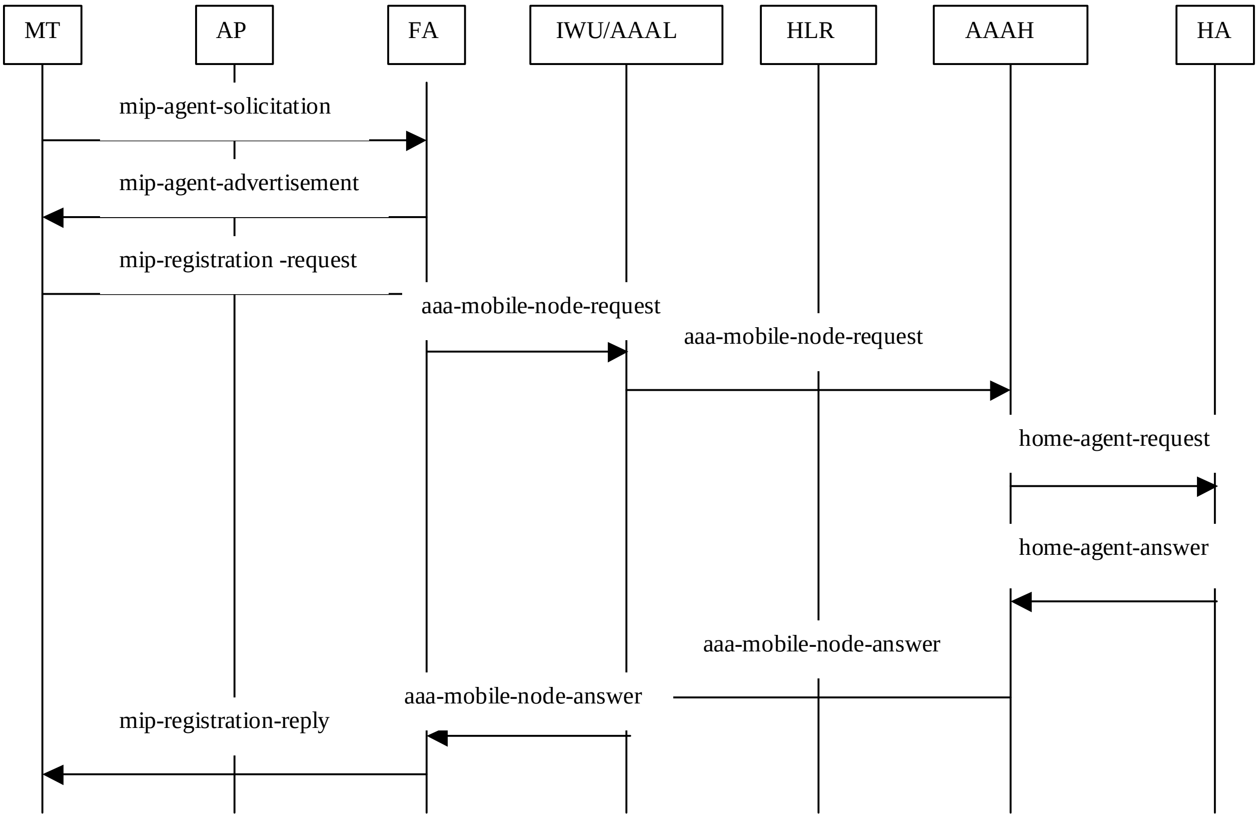
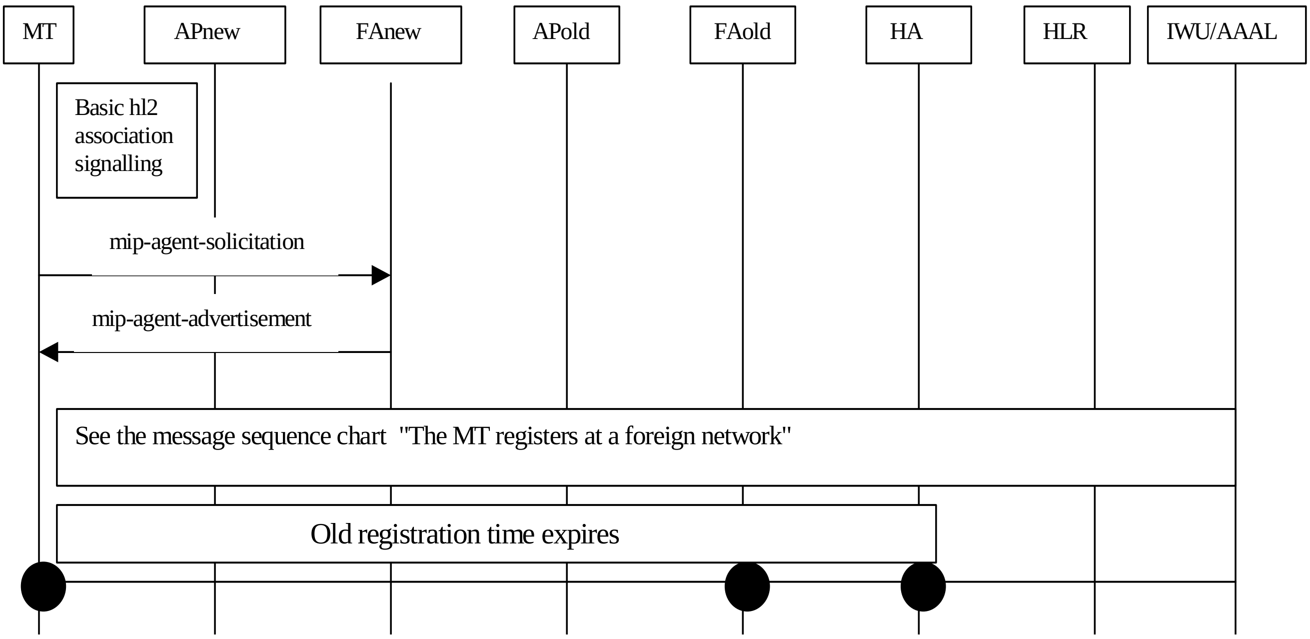


Figure 10: The MT registers at a foreign network

7.2.5.2 The MT moves to a new AP connected to a new foreign agent



NOTE: The black circles designate the nodes that are affected by the expiration.

Figure 11: Sequence diagram. The MT moves to a new AP connected to a new foreign agent

7.2.5.3 Mobility Between HIPERLAN/2 access networks and 3G access networks

For the case of mobility between HIPERLAN/2 and 3G access networks, recall that we have the following basic architecture:

- An MT attaches to a HIPERLAN/2 network, authenticates and acquires an IP address. At that stage, it can access IP services using that address while it remains within that HIPERLAN/2 network. If the MT moves to a network of a different technology (i.e. UMTS), it can re-authenticate and acquire an IP address in the packet domain of that network, and continue to use IP services there.

- This basic case has been referred to as AAA roaming. Note that while it provides mobility for the user between networks, any active sessions (e.g. multimedia calls or TCP connections) will be dropped on the handover between the networks because of the IP address change (e.g. use DHCP). However, this provides mobility in accordance with the requirements of clause 7.1.1.

It is possible to provide enhanced mobility support, including handover between HIPERLAN/2 access networks and 3G access networks in this scenario by using servers located outside the access network. Two such examples are:

- The MT can register the locally acquired IP address with a Mobile IP home agent (HA) as a co-located care-of address, in which case handover between networks is handled by Mobile IP. This applies to MIPv4 and MIPv6 (and is the only mode of operation allowed for MIPv6).

- The MT can register the locally acquired IP address with an application layer server such as a SIP proxy. Handover between two networks can then be handled using SIP (re-invite message).

Note that in both these cases, the fact that upper layer mobility is in use is visible only to the terminal and core network server, and in particular is invisible to the access network. Therefore, it is automatically possible, and can be implemented according to existing standards, without impact on the HIPERLAN/2 network itself. We therefore consider this as the basic case for the loose coupling approach.

Three options for further study are:

- The use of a Foreign Agent care-of address (MIPv4 only). This requires the integration of Foreign Agent functionality with the HIPERLAN/2 network, but has the advantage of decreasing the number of IPv4 addresses that have to be allocated. On the other hand, for MTs that do not wish to invoke global mobility support in this case, a locally assigned IP address is still required, and the access network therefore has to be able to operate in two modes.

- The option to integrate access authentication (the purpose of this loose coupling standard) with Mobile IP Home Agent registration (If Diameter is used, it is already present). This would allow faster attach to the network in the case of a MT using MIP, since it only requires one set of authentication exchanges; however, it also requires integration on the control plane between the home AAA server and the Mobile IP Home Agent itself. The current assumption that this integration should be carried out in a way that is independent of the particular access network being used, and is therefore out of scope of this activity.

- The implications of using services (e.g. SIP call control) from the UMTS IMS (Internet Multimedia Subsystem), which would provide some global mobility capability. This requires analysis of how the IMS would interface to the HIPERLAN/2 access network (if at all).

7.2.5.3.1 The MT moves from UMTS/UTRAN to HIPERLAN/2

It is assumed that the MT has both HIPERLAN/2 and UMTS/UTRAN coverage. It also assumed that the MT remains attached to the UMTS core network by sending routing area updates with a periodicity shorter than the mobile reachable timer in SGSN. The MT will then be in PMM-IDLE mode towards the core network. It also assumes that the HA can keep the registration without sending duplicate packets to both FAs. This is not possible in MIPv4 today.

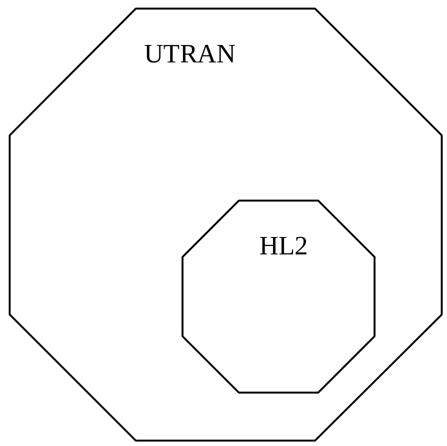
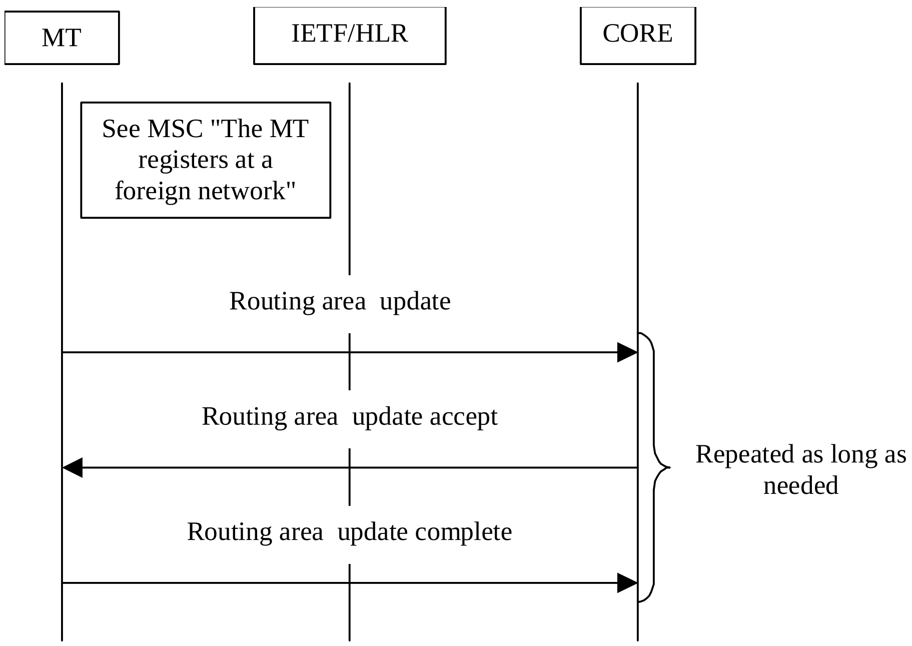


Figure 12: Logical encapsulation of HIPERLAN/2 within UTRAN



NOTE: "IETF/HLR" above designates all the IETF nodes and severs + the HLR.

Figure 13: Sequence diagram. The MT moves from UTRAN to HIPERLAN/2 while at the same time keeping the core network attachment and the MIP registration

7.2.5.3.2 The MT moves from HIPERLAN/2 to UMTS/UTRAN. MIP registration in UMTS still valid

It is assumed that the MT has both HIPERLAN/2 and UTRAN coverage. It also assumed that the MT is already attached to the core network and is in PMM-IDLE mode and that the MIP registration is still available.

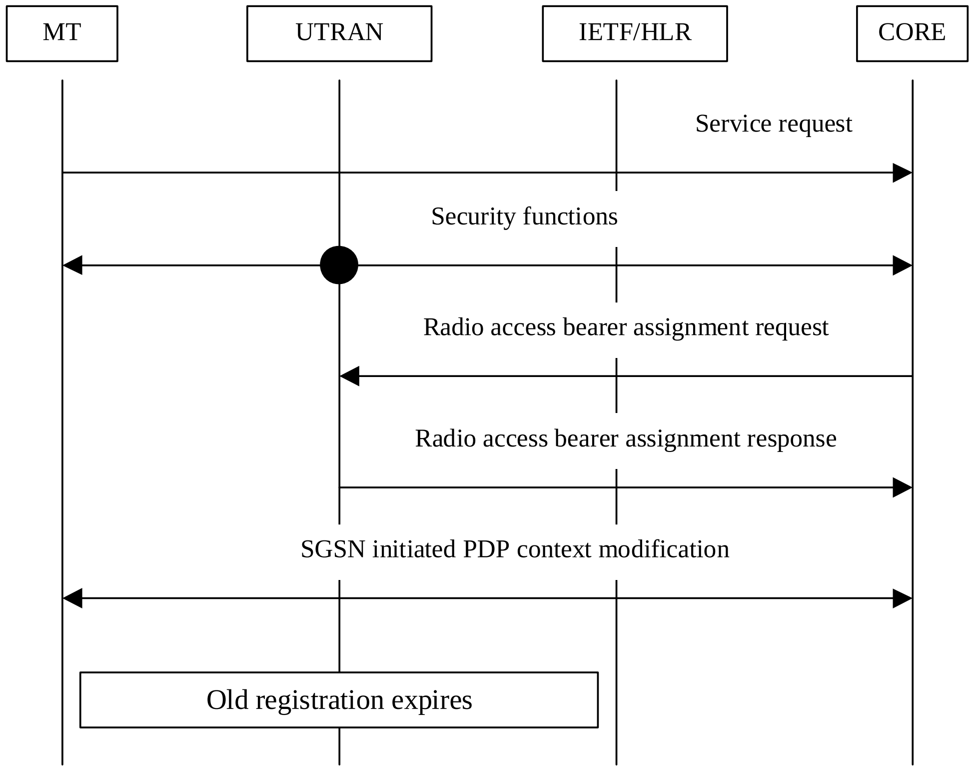


Figure 14: Sequence diagram. The MT moves from HIPERLAN/2 to UTRAN. It is still attached to UTRAN and the MIP registration is still there

7.2.5.3.3 MT moves from HIPERLAN/2 to UMTS/UTRAN. MIP registration in UTRAN not valid

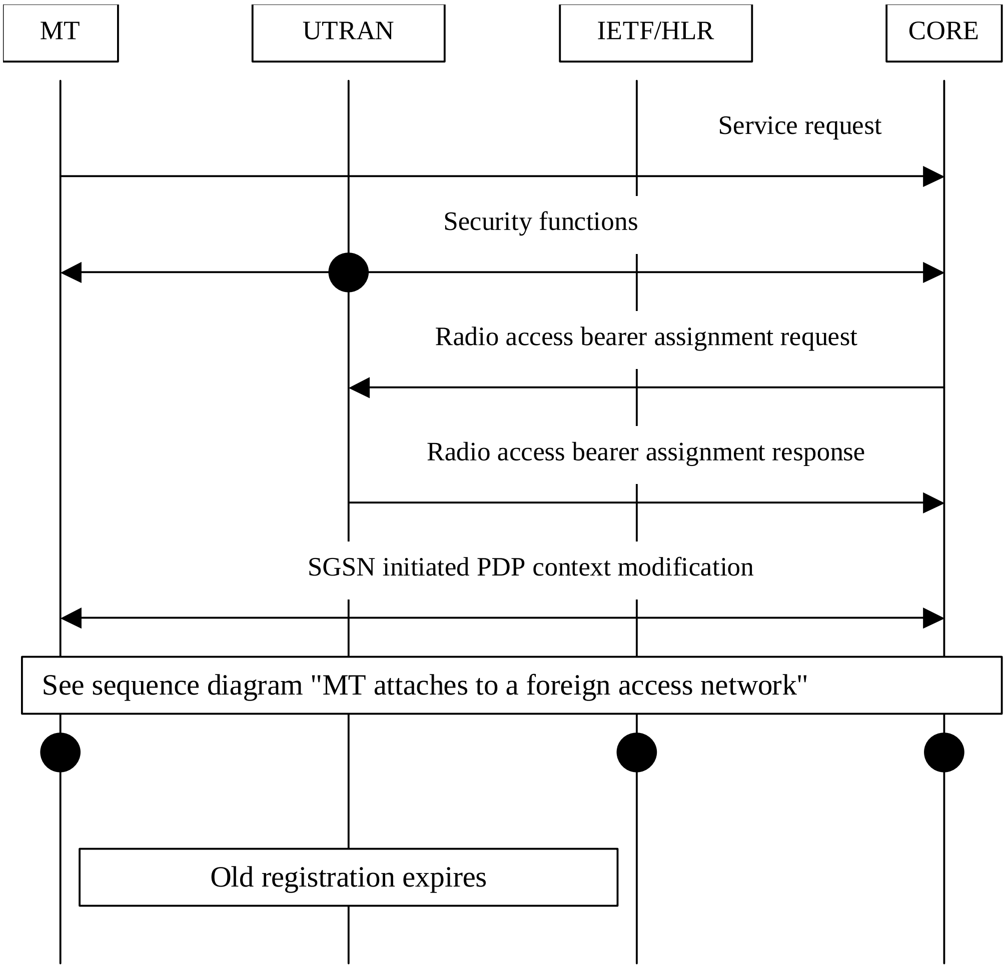


Figure 15: Sequence diagram. The MT moves from HIPERLAN/2 to UTRAN. The UMTS MIP registration is not valid

7.2.5.4 Handover Triggers

For handover, the terminal must have enough information to be able to make a handover decision for itself, or be able to react to a network decision to handover. Indeed these decision driven events are referred to as triggers, resulting in Network centric triggers or Terminal centric triggers.

Simple triggers include the following:

- Network Centric: Poor network resources or low bandwidth. Poor or changing QoS provided by the 3G network.
- Terminal Centric: Poor signal strength. Change of QoS.

The BRAIN project documentation addresses the different trigger mechanisms in further detail.

7.2.6 Security

For Loose Coupling it is possible to use the security features described in the current HIPERLAN/2 standard, with some additions. As mentioned in the introduction there are two variants of security that can be considered.

7.2.6.1 NAI centric

Within this approach HIPERLAN/2 users may be either existing 3G subscribers or just HIPERLAN/2 network subscribers.

These users want to make use of their existing data devices (e.g. Laptop, Palmtop) without additional hardware/software requirements. For both users and mobile operators it is beneficial to be able to base the user authentication and accounting on existing cellular accounts, as well as to be able to have HIPERLAN/2-only operators and users; in any case, for reasons of commonality in MT and AP development it is important to be able to have a single set of AAA protocols which supports all the cases.

This scenario is driven by the requirement to add only minimal software functionality to the terminals (e.g. by downloading java applets), so that the use of a HIPERLAN/2 mobile access network does not require other changes in the functionality (hardware or software) than those required by broadband wireless data access in the corporate, or home scenarios.

7.2.6.2 (U)SIM centric

The (U)SIM centric definitely requires that a user is a native cellular subscriber while - in addition and distinctly from the NAI centric approach - standard cellular procedures and parameters for authentication are used (e.g. (U)SIM quintets). In this way a mobile subscriber using a HIPERLAN/2 mobile access network for broadband wireless data access will appear as a normal cellular user employing standard procedures and interfaces for authentication purposes. It is important to notice that for this scenario (U)SIM card functionality is required in the user equipment. (U)SIM provides new and enhanced security features in addition to those provided by 2G SIM (e.g. mutual authentication) as defined by 3GPP. Note that to provide equivalent security functionality within HIPERLAN/2 as is required for 3G public operations (e.g. periodic re-authentication) it will be necessary to enhance the base HIPERLAN/2 standards specifically the authentication requirements of the RLC [29].

For the NAI centric approach there is no need to integrate the HIPERLAN/2 security architecture with the UMTS security architecture [23]. It might not even be necessary to implement all of the HIPERLAN/2 security features if security is applied at a higher level, such as using IPSec at the IP level. An additional situation that has to be considered is the use of pre-paid SIM cards. This scenario will introduce additional requirements for hot billing and associated functions.

7.2.6.3 Key exchange

Key agreement for confidentiality and integrity protection is an integral part of the UMTS authentication procedure, and hence the UTRAN confidentiality and integrity mechanisms should be reused within the HIPERLAN/2 when interworking with a 3G core network. This will also increase the applied level of security.

The Diffie-Hellman encryption key agreement procedure could be used to improve user identity confidentiality. By initiating encryption before UMTS AKA is performed, the user identity will not have to be transmitted in clear over the radio interface, as is the case in UMTS when the user enters a network for the first time. Thus, this constitutes an improvement compared to UMTS security.

It is also important to have a secure connection between APs within the same network if session keys or other sensitive information are to be transferred between them. A secure connection can either be that for some reason they trust each other and no one else can intercept the communication between them or that authentication is performed and integrity and confidentiality protection are present.

7.2.6.4 (U)SIM vs no (U)SIM

Another issue under discussion is whether a (U)SIM shall be used or not. Given the assumption that a (U)SIM is a smart card that needs to be inserted into the terminal the following two paragraphs can be used as input to the discussion. It should be noted that the way (U)SIM is discussed here is independent of authentication identifier and it is not necessary to use 3G procedures, it is simply a storage place as discussed below.

From a security perspective there are several advantages with using a (U)SIM, the main one being that certain security parameters, such as the authentication key, never leaves the (U)SIM. Another, not security related, advantage is that the calculations required for authentication are performed on the (U)SIM and no extra software is needed for this purpose. The user simply has to plug in the card to get it working. One downside is that there is a need for a card reader. If the (U)SIM card reader is not integrated with the HIPERLAN/2 network card, the terminal will need an extra device/slot for the (U)SIM.

If a (U)SIM is not used, the same information needs to be stored in some other way, such as in software on the terminal or on a disc. This solution does not require an extra device, but on the other hand, the security parameters can be accessed and copied quite easily.

7.2.6.5 Authentication, Authorization and Accounting architecture

Authentication, Authorization and Accounting functionality needs to be handled by the HIPERLAN/2 network. To support both scenarios outlined above; the AAA server is split into a client (AAAL) and a server (AAAH) part. The AAAH is likely to, but does not have to, be part of a mobile network (e.g. UMTS) or interwork with equivalent mobile network entities (e.g. 2G, 2.5G mobile networks).

The AAAL supports APs within the HIPERLAN/2 access network with AAA functionality. This device supports both the NAI and (U)SIM centric scenario, resulting in a single access network that can support both forms of terminals. (U)SIM quintets are directed over the A.1 interface, whilst AAA messages are routed to the AAAH via the A.2 interface as shown in figure 9.

The present document only considers the interaction between the AP and AAAL and the network architecture further towards the core is included for informative purposes. However, note also that the AAAL may simply be an AAA proxy server, in which case the W.2a protocol is most easily described as a combination of the A.1 and A.2 protocols.

There are two methods of achieving the link between the AAAH and the HLR, which interfaces the AAA messages received by the AAAH to the core network databases, as shown in figure 2:

- linking to the subscriber database using a proprietary protocol;
- linking to the 3G AuC (Authentication Centre) (MAP/SS7) using a standardized interface such as Z_B as defined by reference [12].

7.2.7 Quality of Service

This clause discusses the mechanisims that could be used to meet the requirements isted in clause 7.1.3. In UMTS it will be mandatory to support DiffServ at transport level and at user level in Release 4. For HIPERLAN/2 DiffServ can probably be supported via the priorities in the Ethernet CL (TS 101 493-2 [28]). Interoperability between HIPERLAN/2 and UMTS may therefore be implemented in two phases, first a best effort in Release 3 and then with QoS support for Release 4.

The Differentiated Services architecture is based on a simple model where traffic entering a network is classified and possibly conditioned at the boundaries of the network, and assigned to different behaviour aggregates. Each behaviour aggregate is identified by a single *Differentiated Services codepoint* (DSCP, the value of the TOS byte). Within the core of the network, packets are forwarded according to the *per-hop behaviour* or PHBs associated with the Differentiated Services codepoint. A PHB can result in different classes of traffic receiving different performance. There are two standardized PHB groups in IETF:

- expedited Forwarding (EF) PHB: The EF PHB can be used to build a low loss, low latency, low jitter and assured bandwidth;
- assured Forwarding (AF) PHB: AF PHB group provides delivery of IP packets in four independently forwarded AF classes. Within each AF class, an IP packet can be assigned one of three different levels of drop precedence.

In HIPERLAN/2 a CL has two main functions: adapting service request from higher layers to the service offered by the DLC and to convert the higher layer packets (SDUs) with variable or possibly fixed size into a fixed sized that is used within the DLC. The generic architecture of the CL makes HIPERLAN/2 suitable as a radio access network for diversity of networks, e.g. Ethernet, IP, UMTS, etc. There are currently two different types of common convergence sublayers defined: cell-based and packet-based. The structure of the packet-based CL (TS 101 493 [28]) with a common and several service-specific parts allows for easy adaptation to different configurations and fixed networks.

The Ethernet SSCS (Service Specific Convergence Sublayer) offers two QoS schemes:

- best effort: mandatory to support and treats all traffic equally, so that guarantees can be provided.
- IEEE 802.1p: priority schemes, optional and separates traffic in different priority queues as described in IEEE 802.1p (see below).

IEEE 802.1p [26] provides priority mechanism to enable QoS in LANs. These mechanisms have been incorporated into IEEE 802.1d (see [26]). Eight (numbered 0-7) different priority levels are defined. The user priorities are mapped one-to-one or many-to-one to queues, depending on the number of queues supported. In HIPERLAN/2 each queue corresponds to one DLC user connection.

Hence, the QoS mapping between the IP QoS (DiffServ) and IEEE 802.1p priority schemes should be supported and configurable by the operator.

In summary, there are several issues to consider here:

What type of QoS is required?

This is dependent upon the layers concerned:

- DLC User Control as defined by the HIPERLAN/2 standards (TS 101 761 [29]);
- convergence Layer QoS;
- Upper Layer signalling (e.g. IEEE 802.1p, RSVP).

For each network element, the AP will have knowledge of the CL used.

How is it engineered?

This is implementation dependent and should not be standardized.

How is it controlled?

It will be controlled by algorithms such as fair sharing and again these are implementation dependent.

7.2.8 User Traffic Management

User traffic will be carried by the CL as defined within the stack as shown in figure 1. Hence the management of this traffic is beyond the scope of the present document.

7.2.9 End user device (terminal)

For interworking with 3G, the terminal can be of different kinds, like:

- a multimode terminal, i.e. one terminal or one module such as a PC card with many different radio interfaces;
- separated modules with different radio interfaces. The modules are used in a single terminal. A driver selection function between active modes in a terminal can be used to handle modules with different radio interfaces. (How do then split the (U)SIM card).
- Separated modules with different radio interfaces. The modules can be used in separated terminals. These two terminals can communicate over a third interface, e.g. Bluetooth, which can enable the interworking between HIPERLAN/2 and 3G networks.

If the case is that the IMSI shall be used for subscriber identification in the HIPERLAN/2 environment, it requires that the terminal have a smart card reader. However, as more and more manufacturers (e.g. Laptops) are building in the WLAN module it can limit the users' choice of HIPERLAN/2 operator if the terminal has not got a smart card reader. (Hence can still use NAI approach or external SIM card reader).

8 Tight interworking HIPERLAN/2 and 3G

8.0 General

This clause only considers UMTS as a specific example of 3G technology. Its scope is to investigate some of the Control Plane issues. User plane issues are not considered.

8.1 Requirements

8.1.1 Mobility and handover

Two main types of mobility and handover should be handled: between HIPERLAN/2 cells and between HIPERLAN/2 and UTRAN.

The radio controller in UTRAN is called RNC and for HIRAN IWU, since the main function for HIRAN is interworking rather than controlling the radio network. Thus, an AP may be connected to an IWU while a "node B" is connected to an RNC.

The mobility and handover are "layered": change of APs/node Bs connected to the same IWU/RNC; change of APs/node Bs connected to different IWU/RNCs, thus change of IWU/RNC and change of APs/node Bs connected to different IWUs/RNCs and different SGSNs, thus change of IWU/RNC and SGSN.

For both of the main types, mobility and handover should be handled.

Seamless handover at the link layer should not be required. It means that higher layers looses packets or use retransmission mechanisms.

It is an important requirement at handover to keep the radio access bearers and the sessions. It is also an important requirement that the user of an end user service experiences the interruption as short, especially for the conversational and streaming service classes. It is mainly a matter of handover time. The maximum time for handover should be the following:

1) Low 100 ms for intra-IWU handover between HIPERLAN/2 IWUs.

2) Below 300 ms for inter-IWU handover between HIPERLAN/2 IWUs.

3) Below 5 s for inter-IWU/RNC handover between a HIPERLAN/2 IWU and a UTRAN RNC.

8.1.2 Security

The same security level as for other UMTS access network technologies should be required.

The requirements on security of 3GPP services described in [10] are used as a basis for the security requirements in this case. The important access network related functions that should be supported are:

1) A valid (U)SIM shall be used to access any 3G service;

2) Authentication of users and serving network;

3) Authentication of data origin;

4) Access control to limited access to intended users;

5) Protection against modification of signalling;

6) Confidentiality protection of user traffic, user related identities and signalling data;

7) Terminal barring;

8) Terminal related security requirements like protection against of user data stored in the (U)SIM should also be considered.

8.1.3 Quality of Service

Reference [1] lists a number of high level requirements for the QoS; end user, general and technical. All of these high level requirements are applicable to HIPERLAN/2 as well.

The UMTS bearer service is a part of the end-to-end service. The external bearer service cannot be controlled by UMTS, nor can the bearer service internal to the end user device be. Therefore, the present document treats only the UMTS part. The UMTS bearer service is further subdivided into Radio access bearer service and Core network bearer service. The radio access bearer part is subdivided into the Radio bearer and the Iu bearer. The QoS discussion in the present document concentrates on the Radio access bearer part since it is this one that affects HIPERLAN/2.

Reference [1] identifies four QoS classes:

1) Conversational;

2) Streaming;

3) Interactive;

4) Background.

A HIPERLAN/2 standard should support all of them. It should be optional to support them in a product implementation. It would probably be advantageous to start a standardization with the two lowest QoS classes; interactive and background. The main distinguishing factor between the traffic classes is how delay sensitive the traffic is, both delay and delay variation, but also the acceptable SDU error ratio.

Mapping the QoS between HIRAN and, for example UTRAN, needs further studies.

A full HIPERLAN/2 standard should support the QoS attributes listed below.

The following UMTS bearer service attributes are described in [1]:

- Traffic class.
- Maximum bit rate. Maximum number of bits delivered by UMTS and to UMTS at a SAP within a period of time, divided by the duration of the period.
- Guaranteed bit rate. Guaranteed number of bits delivered by UMTS at a SAP within a period of time, divided by the duration of the time.
- Delivery order. Whether the UMTS bearer shall provide in-sequence SDU delivery or not.
- Maximum SDU size. The size may vary. Only applicable if SDU format information is not specified.
- SDU format information. List of possible exact sizes of SDUs.
- SDU error ratio. The fraction of SDUs lost or detected as erroneous.
- Residual bit error ratio. The undetected bit error ratio in the delivered SDUs.
- Delivery of erroneous SDUs, yes or no.
- Transfer delay. Maximum delay for 95th percentile of the distribution of delay for all delivered SDUs during the lifetime for a bearer service.
- Traffic handling priority. The relative importance for handling of all SDUs belonging to the UMTS bearer compared to the SDUs of other bearers.

- Allocation/retention priority. Relative importance compared to other UMTS bearers for allocation and retention of the UMTS bearer. Subscription parameter.

The HIPERLAN/2 standard does not support the QoS attributes at present It would be advisable though, to develop the standard in two steps, where step one covers the lowest traffic class where HIPERLAN/2 probably can keep the ethernet mechanisms available now. Step 2 could then add at least the interactive and the streaming classes and perhaps also the conversational class.

8.2 System architecture

8.2.1 General

The discussions below have the following prerequisites:

1) Generally, the standard and design of a HIRAN should be independent of the standard and design of other UMTS access technologies like UTRAN.

2) The Iuhl2 interface (SGSN - IWU) should be used as it is specified by 3GPP, that is, Iu. Some small changes may be necessary.

3) The Iurhl2 and Iurhl2/utr interfaces (IWU - IWU and IWU - RNC) will be discussed later in the present document.

4) The Uuhl2 interface (AP - MT) should be modified in a way that reflects the signalling over the Iuhl2 interface.

A number of UMTS/UTRAN terms are used in clause 8.2. This does not mean that HIRAN should use the same solutions but rather serve as a guide to similarities and differences between the two access technologies.

8.2.2 Iu/Iuhl2

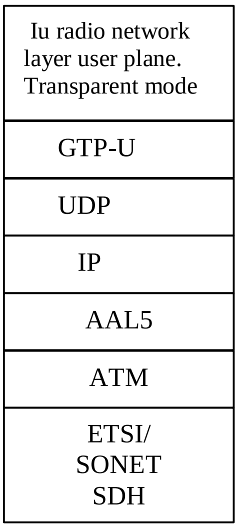
See reference [5].

It is assumed that the Iuhl2 interface, RANAP included, will be used as it is specified by 3GPP, with a minimum amount of changes.

RANAP
SCCP
M3UA
SCTP
IP
AAL5
ATM
SDH ETSI/ SONET

NOTE: RANAP is placed in the radio network layer control plane.

Figure 16: The control plane of Iu and Iuhl2



NOTE: Iu and Iuhl2 user planes are placed in the radio network layer user plane. GTP-U is the user plane of the GPRS Tunnelling Protocol.

Figure 17: The user plane of Iu and Iuhl2

There is no general support of broadcast and multicast at present in UMTS.

It is assumed that the transparent mode of the user plane of Iu will be used for HIPERLAN/2. Discussions within 3GPP are on going to standardize a special support mode for IP telephony, and in that case it should be adopted for HIPERLAN/2 as well. At present, the support mode is used only for AMR coded speech in the circuit switched network.

The RANAP signalling belongs to the radio network layer control plane and is placed on top of the transport network layer user plane. There are two main ways of using RANAP: one is mapped to the IWU signalling and the second one is to carry data between the core network and the UE transparently and there is no mapping to IWU signalling. In the latter case, signalling is carried by the RANAP signal DIRECT TRANSFER.

An important division is also whether relocation is used or not. Relocation is a substantial part of the RANAP signalling. Relocation means that the tunnel between SSGN and IWU/RNC is moved from one IWU/RNC to another one.

If relocation is used, most RANAP messages will also be used for HIPERLAN/2. The following signals are used for relocation:

- RELOCATION REQUIRED
- RELOCATION COMMAND
- RELOCATION PREPARATION FAILURE
- RELOCATION REQUEST
- RELOCATION REQUEST ACKNOWLEDGE
- RELOCATION FAILURE
- RELOCATION DETECT
- RELOCATION COMPLETE
- RELOCATION CANCEL
- RELOCATION CANCEL ACKNOWLEDGE

8.2.3 Iur, Iurhl2, Iurhl2/utr. The use of RNSAP signalling for HIPERLAN/2

See references [6] and [7].

RNSAP
SCCP
M3UA
SCTP
IP
AAL5
ATM

NOTE: This is not to imply that the solution should be used for HIRAN.

Figure 18: The protocol stack of the control plane of Iur for UTRAN

In order to offload the core network at handover between two IWU/RNCs, the Iur, Iurhl2, Iurhl2/utr interface can be used for signalling and user data. It could also be used for signalling only. The IWU/RNCs may be from different manufacturers and they may belong to different radio technologies, for example HIPERLAN/2 and UTRAN.

The radio network control plane for UTRAN is realized with RNSAP that is placed on top of the transport network layer. The radio network user plane is also placed on top of the transport network user plane, but with a much simpler protocol stack below it. RNSAP procedures are divided into four parts: Basic mobility, Dedicated Channel, Common transport channel, Global.

The main reason for using Iur is that it speeds up handover. The main reason for using a standardized interface is that it shall be possible to communicate between RNCs controlling different types of access networks. It is the signalling protocol, e.g. RNSAP for UTRAN, that will control what happens over the Iub and Uu interfaces.

The Iur interface as it is standardized at present is very UTRAN oriented and cannot be used as it is by HIPERLAN/2. There are three ways to proceed here:

1) Do not use Iur, Iurhl2, Iurhl2/utr at all.

2) Standardize an Iurhl2 that is defined for communication between HIPERLAN/2 IWUs only. Handover to and from UTRAN does not use Iurhl2. A HIPERLAN/2 only Iurhl2 could be relatively simple.

3) Use a subset of the Iur and make changes to that subset. This would allow some basic functionality between IWU/RNC of different types. The small subset would probably be basic mobility. The basic mobility consists of the messages uplink signalling transfer, downlink signalling transfer, paging and relocation commit.

4) Use a full Iurhl2/utr. Very complex as this requires the mixing of two radio interfaces within one protocol.

In order to simplify the standardization, at least for an initial phase, points 1 or 2 above could be a good way to start.

8.2.4 Iub/Iubhl2

Some reasoning about the functional distribution between the AP and an IWU can be made here.

It could be assumed that the AP handles all functions that can be isolated to its own cell. The IWU handles functions for interworking with the UMTS core network and with other IWUs. The IWU consists of a control plane unit and a user plane unit. The AP to AP communication does not require any repacketization, so this is a switch. The HIPERLAN/2/SGSN communication needs repacketization, so this is a user plane gateway.

8.2.5 Uu/Uuhl2

See references [8] and [9].

8.2.5.1 General

It is assumed that the PHY (TS 101 475 [32]), DLC (TS 101 761-1 [29]) and RLC (TS 101 761-2 [29]) layers of HIPERLAN/2 make up the basis for an UMTS interworking. It is assumed that PHY will not be affected, DLC to a relatively low extent (if any) and RLC to a relatively large extent for a full standard. The RLC part could be standardized in steps though.

The discussion below treats a Uuhl2 and is based on an effort to compare the signals used for Iu, Uu and HIPERLAN/2 RLC to see how the Uuhl2 could look like. There is no intention to use UTRAN signals in HIRAN just to keep the signals alike. The UTRAN signals are used for guidance here.

8.2.5.2 Uu/Uuhl2 signalling

8.2.5.2.1 General

Below, HIPERLAN/2 RLC is the same thing as Uuhl2 control plane.

The important property is what information needs HIPERLAN/2 RLC signalling and what information can be carried transparently over the air. Transparent here means information that goes directly between the MT and the core network (SGSN) and is not processed by the HIPERLAN/2 controlling function, whether this function is placed in the AP or in a Radio Network Controller. It is only processed in the sense that there is a low level protocol conversion, repacketization.

HIPERLAN/2 RLC signalling is used when the controlling function of HIPERLAN/2 is involved at all control plane layers.

In the next parts of this clause, signalling will be classified in the following way:

1) existing HIPERLAN/2 RLC signals that can be used as they are;
2) existing HIPERLAN/2 signals that can be used after changes of the contents;
3) possible new HIPERLAN/2 RLC signals.

The following classifications can also be made at a future point:

1) transparent signals, going between MT and core network (NAS, Non Access Stratum);
2) HIPERLAN/2 RLC signals, being processed by HL IWU. All of the signals in the classification list above belong to this category.

   And then also:

1) Signals that are caused by Iu/Iuhl2 signals;
2) Signals that are used by the HIPERLAN/2 radio network only.

Several bearers for signalling may be set up, depending on acknowledged or non-acknowledged, on transparent or non-transparent and on using a dedicated channel or a common channel.

8.2.5.2.2 Existing HIPERLAN/2 RLC signals that can be used as they are

1) RELEASE. RELEASE-ACK (RADIO BEARER handling). Iuhl2 related.
2) MAC-ID-ASSIGN. MAC-ID-ASSIGN-ACK. U-RNTI Iuhl2 related.
3) HANDOVER-REQUEST, HANDOVER-ASSOCIATION. See clause 8.2.5.2.4[], 3).
4) KEY-EXCHANGE-AP, KEY-EXCHANGE-MT. Probably not. If encryption and authentication are separated, there is a risk for a man-in-the-middle-attack.

5) UNICAST-KEY-REFRESH, UNICAST-KEY-REFRESH-ACK. Probably not. If encryption and authentication are separated, there is a risk for a man-in-the-middle-attack.

6) COMMON-KEY-REFRESH, COMMON-KEY-REFRESH-ACK. Probably not. If encryption and authentication are separated, there is a risk for a man-in-the-middle-attack.

7) GROUP-JOIN, GROUP-JOIN-ACK, GROUP-LEAVE, GROUP-LEAVE-ACK

8) BROADCAST-JOIN, BROADCAST-JOIN-ACK, BROADCAST-LEAVE, BROADCAST-LEAVE-ACK

9) MT-ALIVE-REQUEST, MT-ALIVE-REQUEST-ACK, MT-ALIVE, MT-ALIVE-ACK

10) MT-ABSENCE, MT-ABSENCE-ACK

11) SLEEP, SLEEP-ACK

12) CHANGE-FREQUENCY

13) AP-ABSENCE

14) FORCE-HANDOVER, FORCE-HANDOVER-ACK

15) SECTOR-HANDOVER-REQUEST, SECTOR-HANDOVER-REQUEST-ACK

16) HANDOVER-NOTIFY

17) FORCE-HANDOVER, FORCE-HANDOVER-ACK

18) RLC-UPLINK-PC-CALIBRATION

19) DISASSOCIATION, DISASSOCIATION-ACK

8.2.5.2.3 Existing HIPERLAN/2 signals that can be used after changes of the contents

1) SETUP. CONNECT. CONNECT-ACK (RADIO BEARER handling). Iuhl2 related.

2) MODIFY-REQ. MODIFY. MODIFY-ACK (RADIO BEARER handling). Iuhl2 related.

3) RBCH-ASSOCIATION. Can be used for paging and system information. Iu related.

4) LINK-CAPABILITY, LINK-CAPABILITY-ACK

5) INFO, INFO-ACK.

6) DFS-MEASUREMENT-SHORT-REQUEST, DFS-MEASUREMENT-PERCENTILES-REQUEST, DFS-MEASUREMENT-COMPLETE-REQUEST, DFS-REPORT-SHORT, DFS-REPORT-PERCENTILES, DFS-REPORT-COMPLETE. These signals might even be used without changes. The present names of these signals might not be very good since more types of measurements than DFS can be performed. See clause 8.2.5.2.4, 9).

8.2.5.2.4 Possible new HIPERLAN/2 RLC signals

1) PAGING type 1. See clause 8.2.5.2.3. Iuhl2 related.

2) PAGING type 2. See clause 8.2.5.2.3. Iuhl2 related.

3) CELL-UPDATE, CELL-UPDATE-CONFIRM. See clause 8.2.5.2.2, 2) and 3). New cell update signals are probably not needed.

4) MOBILITY-INFORMATION, MOBILITY-INFORMATION-CONFIRM. Probably needed.

5) REGISTRATION-AREA-UPDATE, REGISTRATION-AREA-UPDATE-CONFIRM

6) UE-CAPABILITY-ENQUIRY, UE-CAPABILITY-INFORMATION, UE-CAPABILITY-INFORMATION-CONFIRM. See clause 8.2.5.2.3, 4). Some mobile terminal information is already carried by the LINK-CAPABILITY signal.

Probably needed if handover between HIPERLAN/2 and UTRAN is required.

7) SYSTEM-INFORMATION. The RBCH-ASSOCIATION probably is a candidate, see clause 8.2.5.2.3, 3).

8) DOWNLINK-DIRECT-TRANSFER, UPLINK-DIRECT-TRANSFER. INFO and INFO-ACK could be candidates. See clause 8.2.5.2.3, 5). New signals are preferred instead of the INFO signals. Iu related.

9) MEASUREMENT-CONTROL, MEASUREMENT-REPORT. See clause 8.2.5.2.3, 6). Iu related. Probably not needed.

10) RRC-CONNECTION-REQUEST, RRC-CONNECTION-SETUP, RRC-CONNECTION-SETUP-COMPLETE, RRC-CONNECTION-REJECT, RRC-CONNECTION-RELEASE, RRC-CONNECTION-RELEASE-COMPLETE, RRC-CONNECTION-RE-ESTABLISHMENT-REQUEST, RRC-CONNECTION-RE-ESTABLISHMENT, RRC-CONNECTION-RE-ESTABLISHMENT-COMPLETE. Perhaps the present HIPERLAN/2 RLC connection signals could also be used for signalling connection handling.

Probably not needed.

11) SECURITY-MODE-COMMAND, SECURITY-MODE-COMPLETE, SECURITY-MODE-FAILURE. Iu related.

12) SIGNALLING-CONNECTION-RELEASE, SIGNALLING-CONNECTION-RELEASE-REQUEST.

13) INITIAL-DIRECT-TRANSFER. Iu related.

14) RRC_STATUS.

15) COUNTER-CHECK, COUNTER-CHECK-RESPONSE.

16) HANDOVER-TO-UTRAN-COMMAND, HANDOVER-TO-UTRAN-COMPLETE.

Possibly not to be used exactly as it is.

17) INTER-SYSTEM-HANDOVER-COMMAND (from UTRAN), INTER-SYSTEM-HANDOVER-FAILURE

Possibly not to be used exactly as it is.

18) SYSTEM-INFORMATION-CHANGE-INDICATION.

8.2.5.2.5 UTRAN signals probably not needed for HIPERLAN/2

Informational.

1) TRANSPORT-CHANNEL-RECONFIGURATION, TRANSPORT-CHANNEL-RECONFIGURATION-COMPLETE, TRANSPORT-CHANNEL-RECONFIGURATION-FAILURE. Probably not needed for HIPERLAN/2.

2) TRANSPORT-FORMAT-COMBINATION-CONTROL, TRANSPORT-FORMAT-COMBINATION-CONTROL-FAILURE. Probably not needed for HIPERLAN/2.

3) PHYSICAL-CHANNEL-RECONFIGURATION, PHYSICAL-CHANNEL-RECONFIGURATION-COMPLETE, PHYSICAL-CHANNEL-RECONFIGURATION-FAILURE. Probably not needed for HIPERLAN/2.

4) PHYSICAL-SHARED-CHANNEL-ALLOCATION. Not needed for HIPERLAN/2.

5) ACTIVE-SET-UPDATE, ACTIVE-SET-UPDATE-COMPLETE, ACTIVE-SET-UPDATE_FAILURE. Not needed.

8.2.5.2.6 Transparent signals (NAS)

See clause 8.2.7. It is not a complete list of transparent signals but only an example of those that are used for mobility functions. Over the air interface, transparent information is carried by the signals DOWNLINK-DIRECT-TRANSFER, UPLINK-DIRECT-TRANSFER and INITIAL-DIRECT-TRANSFER.

8.2.5.2.7 Summary of Uuhl2 signals

- up to 37 signals are used as they are;
- up to 16 signals are changed;
- up to 40 signals are added.

The figures are very uncertain and should be used for guidance only.

8.2.6 Subscriber data

The node handling the subscriber data for UMTS is HSS. It is an umbrella concept containing such parts as the HLR and AAA. The development of HSS will be done in steps. HLR and AAA will continue to be separated with different protocols as seen by an authenticating user for quite some time. Eventually, they will merge (under 3GPP standardization) so that an authenticating user will see one interface with one protocol.

The operator feeding subscriber data into the HSS will be using a common man-machine interface for the different parts relatively soon.

It means that the meaning of the requirement "sharing a subscriber data base" is not obvious.

8.2.7 Mobility and handover

8.2.7.1 General

In UMTS, the tracking of the location of the MS occurs on three levels; cell, UTRAN/HIRAN registration area and routing area. Change of cell and UTRAN/HIRAN registration area is not visible outside UTRAN/HIRAN.

Another way to classify the handover is intra-IWU/RNC, inter-IWU/RNC/intra-SGSN and inter SGSN.

Mobility and handover involve both Mobility Management procedures and Session Management procedures.

The mobility management consists of Attach, Detach and Routing Area Update.

Session Management consists of Packet Data Protocol (PDP) context handling (for the user plane).

Handover involves both session management and mobility management. At handover, the PDP context is always activated and the MT is always in PMM-CONNECTED state.

When Iur, Iurhl2, Iurhl2/utr is used and no relocation takes place, both intra-IWU/RNC and inter-IWU/RNC handover is done entirely inside UTRAN/HIRAN and is not seen by the SGSN.

For inter-IWU/RNC, it is mainly the MT and the SRNS that are responsible for the handover.

Mobility and handover can be done in different ways using a set of basic functions. Below some common basic functions are listed and after that some mobility and handover cases are given as examples. Sequence diagrams will also illustrate some typical mobility and handover cases.

This is not an exhaustive description of mobility and handover within an UMTS/UTRAN/HIRAN network.

8.2.7.2 UMTS/UTRAN/HIPERLAN/2 Identifiers

See reference [2].

A number of identifiers are used in UMTS. Some of them are partly handled by HIPERLAN/2 at present. In HIPERLAN/2 there is an AP-Id corresponding to the local cell-id. There is also a NOP-Id that perhaps can be used for the PLMN-Id. The fact that there is an AP field that is split between APT and APC can perhaps be used for the RNC identifier.

1) Public Land Mobile Network (PLMN–Id) = Mobile Country Code (MCC) + Mobile Network Code (MNC). Placed in RNC via O&M.
2) Core Network Packet Switched Domain-Id = PLMN-Id + LAC + RAC. RAC = Routing Area Code. LAC = Location Area Code. Placed in RNC via O&M.
3) Routing Area Identity = MCC+MNC+RAC.
4) Tunnel Endpoint Identifier (TEID).
5) RNC-Id. Global RNC-Id = PLMN-Id +Local RNC-Id. Placed in RNC via O&M.
6) Service Area-Id (SAI). Identifies one or more cells belonging to the same location area. SAI = PLMN-Id + LAC + SAC. SAC = Service Area Code.
7) UTRAN/HIPERLAN/2 Registration Area (URA) Id.
8) Cell-Id. Unique Cell-Id = RNC-Id + Local Cell-Id.
9) Serving RNC RNTI. RNTI=Radio Network Temporary Identifier. These identifiers are used as User Equipment identifiers within UTRAN and HIPERLAN/2 and also in signalling messages between UE and UTRAN.
10) Drift RNC RNTI.
11) Cell RNTI.
12) (UTRAN)/HIPERLAN/2 RNTI.
13) MT paging identity.

8.2.7.3 Numbering, addressing and identification

See reference [3].

1) International Mobile Subscriber Identity (IMSI).
2) Temporary Mobile Subscriber Identity (P-TMSI). The VLR and SGSN may allocate TMSI to visiting mobile subscribers in order to support subscriber identity confidentiality. It has only local significance.
3) International Mobile Station Equipment identity (IMEI).

8.2.7.4 Some mobility basic functions used to build mobile sequences

8.2.7.4.1 Basic function Attach

The following signals that are relevant for HIPERLAN/2 are exchanged:

1) Attach Request. From MT via IWU to SGSN.
2) Identity Request. From SGSN via IWU to MT.
3) Identity Response. From MT via IWU to SGSN.
4) Authentication. Between MT and SGSN via IWU.
5) IMEI check. Between MT and SGSN via IWU.

6) Attach Accept. From SGSN via IWU to MT.

7) Attach Complete. From MT via IWU to SGSN.

8.2.7.4.2 Basic function Detach

There are two types of detach, MT initiated and network initiated.

The following signals are relevant for HIPERLAN/2:

1) Detach Request. From/to MT via IWU to/from SGSN.

2) Detach Accept. To/from MT via IWU from/to SGSN.

3) PS signalling connection Release

8.2.7.4.3 Basic function Service Request, MS initiated

The service request is used by MT in PMM-IDLE state to establish the PS signalling connection for the upper layer signalling or for the resource reservation for active PDP contexts.

The following signals are relevant for HIPERLAN/2:

1) Service Request. From MT via IWU to SGSN.

2) Security signalling. MT-IWU-SGSN-HLR.

3) Radio Bearer setup. From IWU to MT.

4) Radio bearer setup complete. From MT to IWU.

8.2.7.4.4 Basic function Service Request, network initiated

When SGSN receives a downlink packet for an MT in PMM-IDLE mode, SGSN sends a paging request.

The following signals are relevant for HIPERLAN/2:

1) Paging. From IWU to MT.

2) Service Request. From MT via IWU to SGSN.

3) Security signalling between MT, IWU, SGSN and HLR.

4) Radio bearer setup. From IWU to MT.

5) Radio bearer setup complete. From MT to IWU.

8.2.7.4.5 Basic function PDP context activation, modification and deactivation

The following signals are relevant for HIPERLAN/2:

1) Activate PDP Context Request. From MT via IWU to SGSN.

2) Activate PDP Context Accept. From SGSN via IWU to MT.

3) Modify PDP Context Request. From/to MT via IWU to/from SGSN.

4) Radio Access Bearer Modification. MT - IWU - SGSN.

5) Modify PDP Context Accept. From/to SGSN via IWU to/from MT.

6) Deactivate PDP Context Request. From/ to MT via IWU to from SGSN.

7) Deactivate PDP Context Accept. From/to SGSN via IWU to/from MT.

8.2.7.4.6 Basic function SRNS Relocation Procedure. MT in PMM-CONNECTED state

Radio Network Subsystem relocation is the process where the Iu, Iurhl2, Iurhl2/utr connection is moved from one IWU/RNC to another. It is one ingredient of mobility and handover for optimization of routes, when there is no Iur, Iurhl2, Iurhl2/utr and when there is an Iur, but it is only used for the control plane.

For the serving RNS relocation procedure, it can either be "stand alone" or combined with hard handover or with cell/URA update.

The following signals are relevant for UTRAN/HIPERLAN/2, MT in PMM-CONNECTED state:

- Relocation Required. Source IWU to SGSN.
- Relocation Request. SGSN to target IWU.
- Relocation Request Acknowledge. Target IWU to SGSN.
- Relocation Command. SGSN to source IWU.
- Relocation Commit. Source RNC to target IWU.
- Forwarding of data, if used. Source IWU to target IWU.
- Relocation Detect. Target IWU to SGSN.
- Radio Network Temporary Identifier Reallocation. Target IWU to MT.
- Radio Network Temporary Identifier Reallocation Complete. MT to target IWU.
- Reallocation Complete. Target IWU to SGSN.
- Iu Release Command. SGSN to source IWU.
- Iu Release Complete. Source IWU to SGSN.

8.2.7.5 Mobility within the same IWU/RNC

If the MT is in MM-IDLE state, Routing Area Update is performed.

If the MT in PMM-CONNECTED and the PDP context is activated for user data, the mobility can be handled by the same type of mechanisms that exist for HIPERLAN/2 now, at least over the air.

8.2.7.6 Mobility within the same SGSN. Change of RNCs

8.2.7.6.1 General

See reference [4].

The RNCs can be either HIPERLAN/2 IWUs or UTRAN RNCs.

There are some main cases depending on the following factors:

1) MT in PMM-IDLE state or PMM-CONNECTED state. In PMM-IDLE state, the MT location is known in the SGSN with an accuracy of the routing area. In PMM-CONNECTED state the MT location is known in the SGSN with an accuracy of the serving IWU/RNC area.
2) To use the Iurhl2, Iurhl2/utr interface or not.
3) If dedicated channels are used or if the common channel is used. This has to do with QoS, handover time and use of radio resources. Relevant for the PMM-CONNECTED case. The two lowest QoS classes use common channels and the two highest QoS classes use dedicated channels.
4) How to map the UTRAN terminology "dedicated channel" and "common channel" to HIPERLAN/2 terminology has to be further studied. An example of a dedicated channel in HIPERLAN/2 is fixed slot allocation.

5) MS initiated mobility or network initiated mobility. At present, only the common channel is used for MT initiated mobility. The common channel cannot be used for, at least, the conversational and streaming QoS classes. At network initiated handover, the MT must send radio channel measuring data to the network.

In order to satisfy the requirements for fast handovers also between APs belonging to different RNCs and at the same time support all four of the QoS classes; Iurhl2, Iurhl2/utr, MT initiated handover and network initiated handover may all be needed.

Again, the corresponding channel types of HIRAN have to be identified.

When the MT is in PMM-IDLE state, it performs routing area update procedures. Paging is needed in order to reach the MT. It gets system information via control plane broadcasting.

When the MT is in PMM-CONNECTED state, it performs either UTRAN/HIRAN registration area update procedures or handover or cell update procedures.

The MT enters the PMM-CONNECTED state when the packet switched signalling connection is established between MT and SGSN. In this state, the location of the MS is tracked by the serving RNC.

Each one of these cases will be discussed with a HIPERLAN/2 perspective below.

It is assumed that the MT is attached to the network and hence it is either in one of the two states described above, PMM-IDLE or PMM-CONNECTED.

8.2.7.6.2 Routing Area Update. MT in PMM-IDLE state. Mobile initiated

For the routing area update procedure, the following four signals/signal types are relevant for HIPERLAN/2/UTRAN:

1) Routing Area Update Request. MT via SIWU to SSGN.
2) Security signals. Conditionally exchanged. MT to SIWU to SSGN.
3) Routing Area Update Accept. SGSN via SIWU to MT.
4) Routing Area Update Complete. MT via SIWU to SGSN.
5) Broadcasting of information relevant for RA update.
6) Initial UE. From IWU to SGSN.
7) Direct Transfer. IWU - SGSN.

8.2.7.6.3 SRNS relocation combined with hard handover. PMM-CONNECTED. PDP context activated. Network initiated

1) Physical Channel Reconfiguration. Source IWU to MT.
2) Physical Channel Reconfiguration Complete. Source IWU to MT to target IWU.
3) Forward SRNS Context. Source IWU to SGSN.
4) Forward SRNS Context. SGSN to target IWU.

8.2.7.6.4 Within the same SGSN. Change of IWU. Cell/URA update. Relocation. Iurhl2 used for the control plane. Mobile controlled handover. PMM-CONNECTED

Signals exchanged that influence HIPERLAN/2:

1) Cell/URA update. From MT to target IWU.
2) Uplink signalling Transfer Indication. From target IWU to source IWU.
3) Cell/URA update Confirm. From target IWU to MT.
4) RNTI reallocation Complete. From MT to target IWU.

Apart from the listed signals, there are quite many signals exchanged between source and target RNCs, RNCs to/from SGSN, etc.

8.2.7.6.5 Signals relevant for UTRAN/HIPERLAN/2 when the MT is in the PMM-CONNECTED state

Paging type 1. From RNC to MT.

8.2.7.6.6 Within the same SGSN. Change of IWU. Iurhl2 used with control plane and user plane. Network controlled handover. PMM-CONNECTED

The only control signals that go via a standardized interface relevant to HIPERLAN/2, Uu, are:

1) Physical Channel Reconfiguration from serving IWU to MT.

2) Physical Channel Reconfiguration Complete from MT to SIWU.

The other signals go via Iubhl2 and Iurhl2.

User plane signals are added.

8.2.7.6.7 Within the same SGSN. Change of IWU. Cell update. No relocation. Iur not used. Mobile controlled handover. PMM-CONNECTED, partly

Signals exchanged that influence HIPERLAN/2:

1) Cell update, as above. From MT to Drift IWU target.

2) Uplink signalling Transfer Indication, as above. From target Drift IWU to Serving IWU.

3) Common Transport Channel Resource Initialization Request. From SIWU to target DIWU.

4) Common Transport Channel Resource Initialization Response. From SIWU to targIWU.

5) Cell Update Confirm, as above. From SIWU to target DIWU to MT. Here the MT enters the PMM-IDLE state.

6) RNTI reallocation Complete, as above. From MT to target DIWU to SIWU.

7) Common Transport Channel Resources Release. From SIWU to source DIWU.

8) Routing area update.

9) Service request.

8.2.7.7 Mobility within the same GGSN. Change of RNC and SGSN

This is not covered in the present document.

8.2.8 Some simplified signalling diagrams for mobility/handover. Signals inside the core network not shown

8.2.8.1 General

The following cases should be considered.

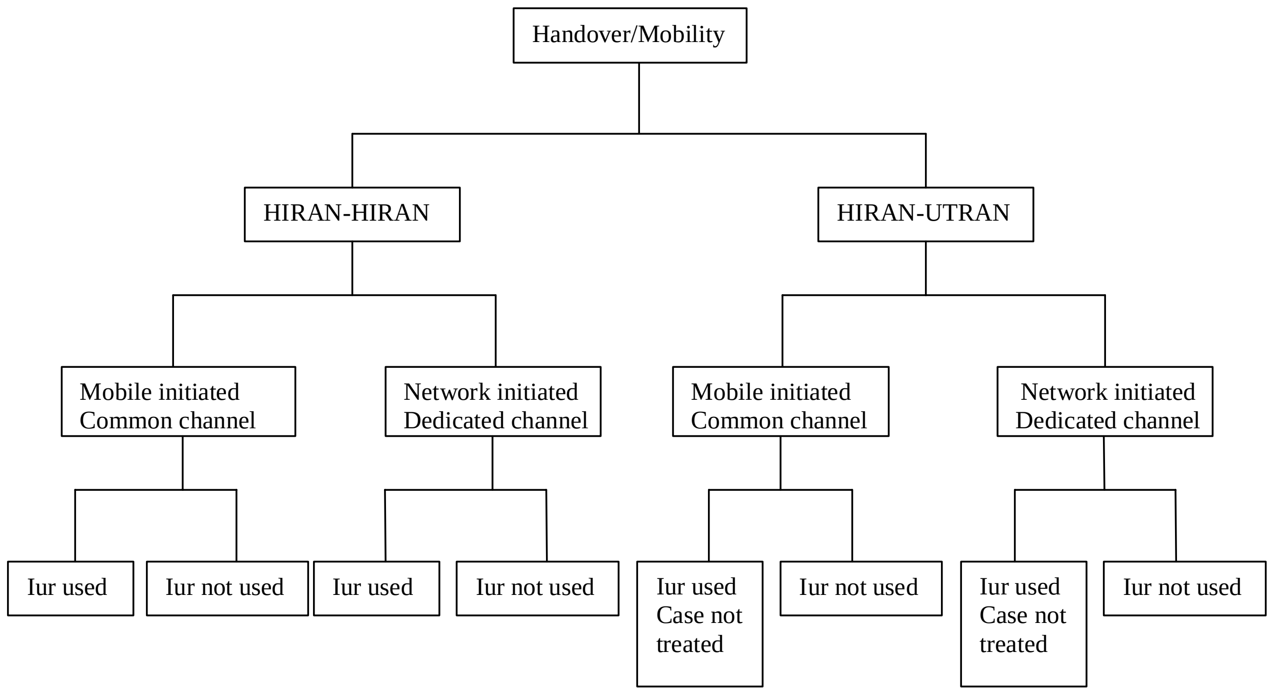


Figure 19: Handover/Mobility Triggers

8.2.8.2 ATTACH. An MT attaches (associates) to an UMTS network

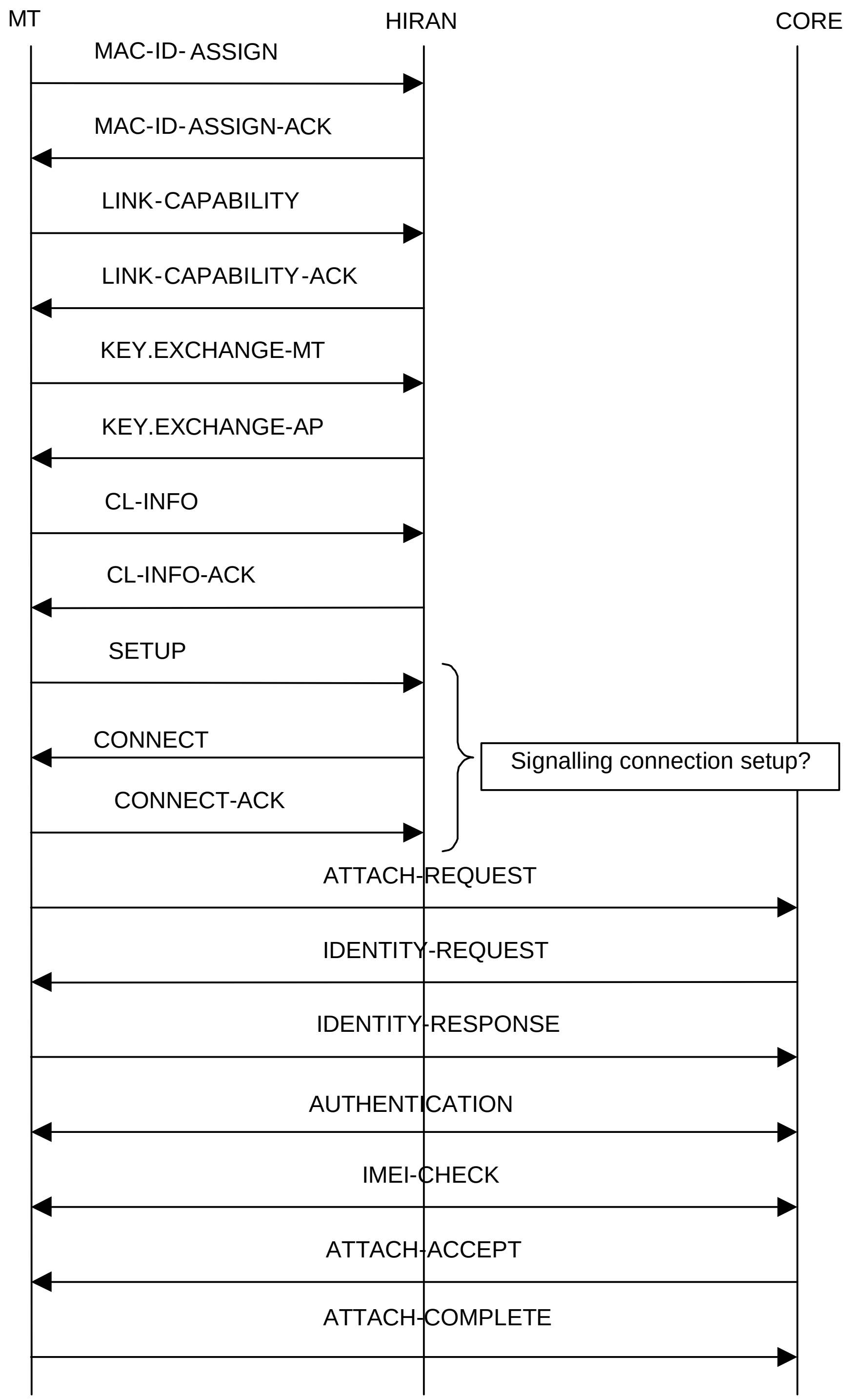


Figure 20: An MT attaches (associates) to an UMTS network

8.2.8.3 Network initiated handover without Iur. Handover with SRNS relocation. HIRAN-HIRAN and HIRAN-UTRAN

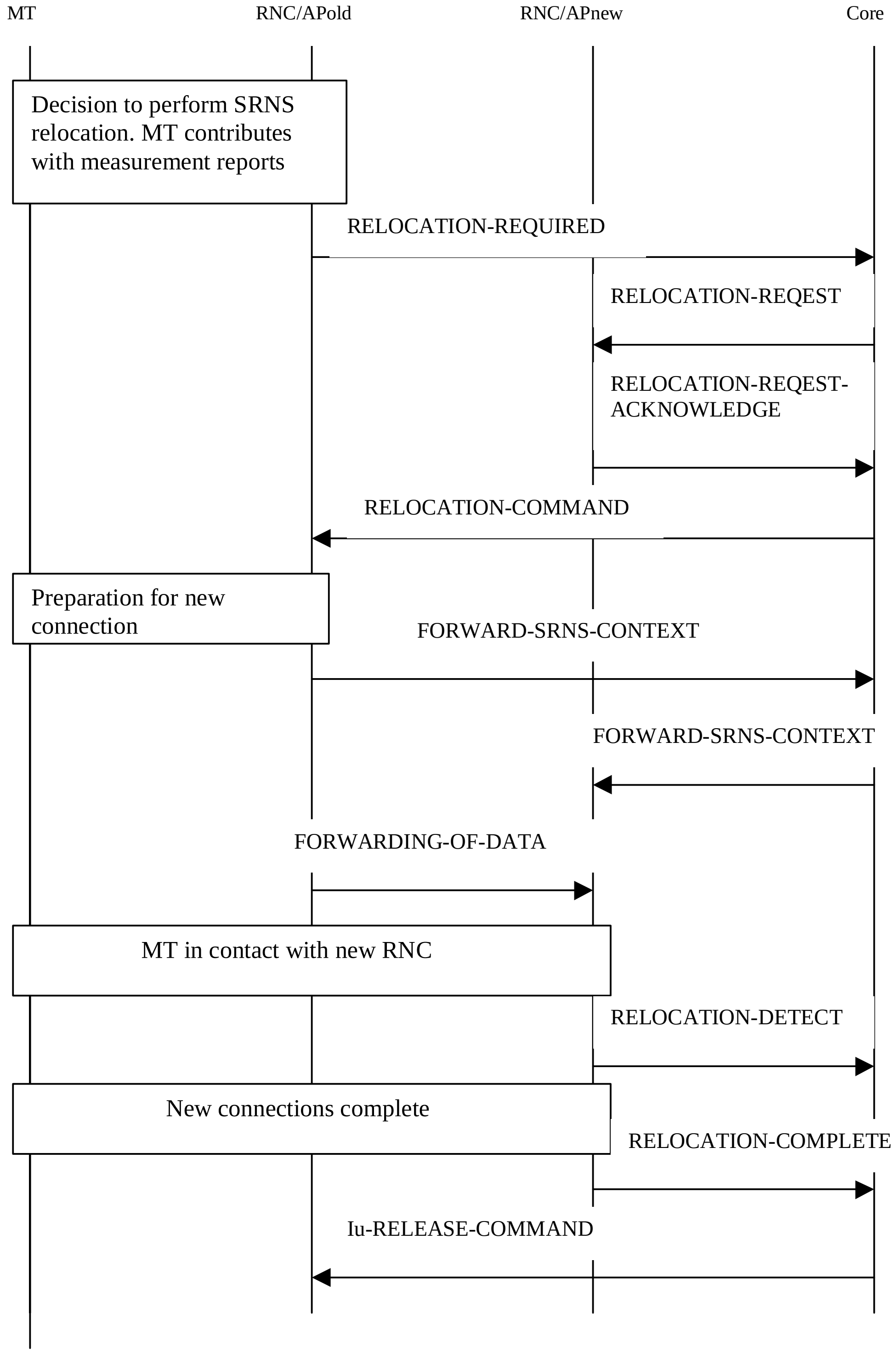


Figure 21: Network initiated handover without Iur. Handover with SRNS relocation. HIRAN-HIRAN and HIRAN-UTRAN

8.2.8.4 Network initiated handover with Iurhl2. HIRAN-HIRAN

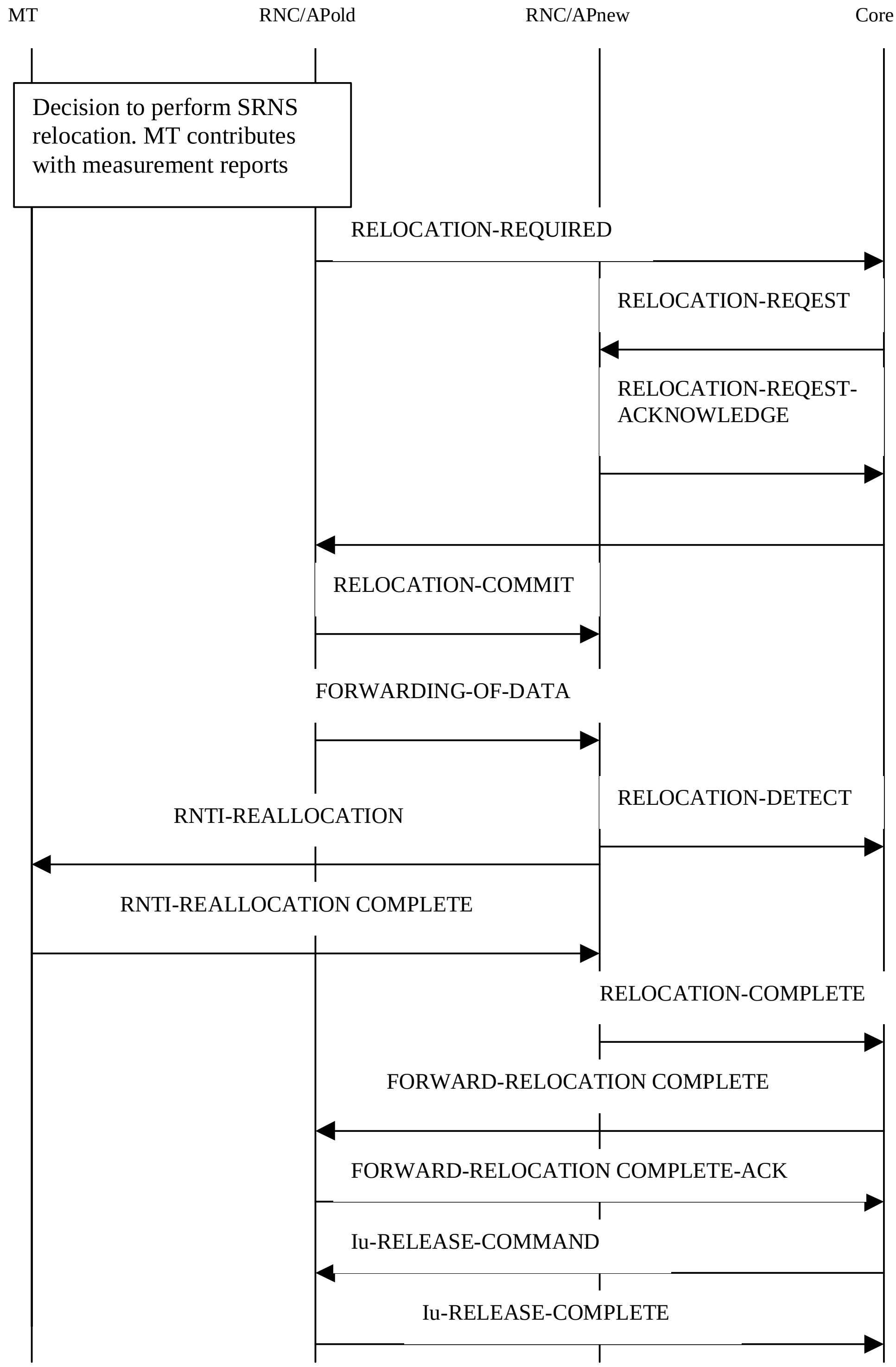


Figure 22: Network initiated handover with Iurhl2. HIRAN-HIRAN

8.2.8.5 Mobile initiated handover without Iur. HIRAN-HIRAN and HIRAN-UTRAN

It is not solved for UMTS yet. It will be done so in the near future.

8.2.8.6 Mobile initiated handover with Iur used. Combined cell/URA update and SRNS relocation. HIRAN-HIRAN

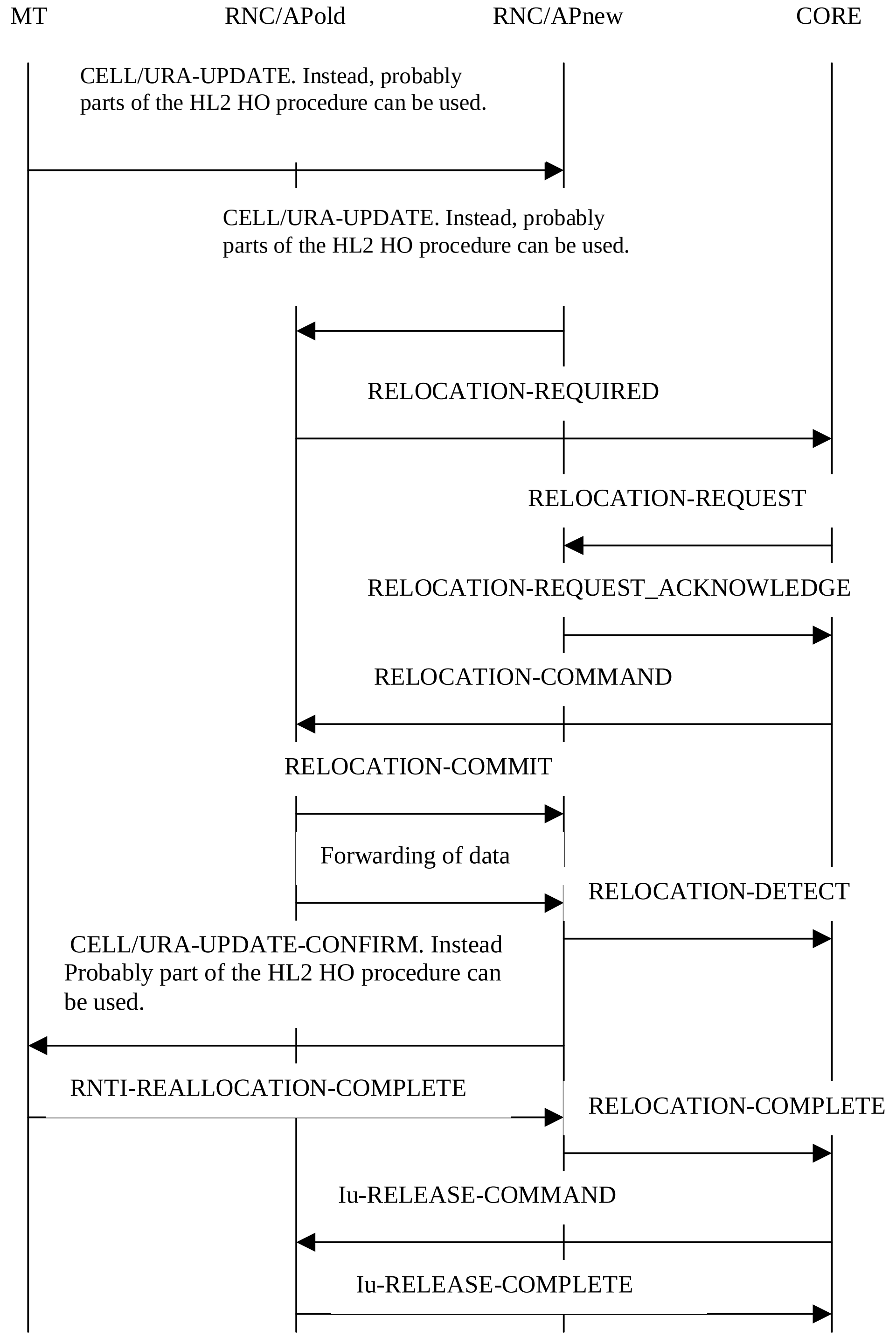


Figure 23: Mobile initiated handover with Iur used. Combined cell/URA update and SRNS relocation. HIRAN-HIRAN

8.2.9 Security

The security functions reside in the terminal, the access network and in the core network. The distribution of the functions differs and is described below.

(U)SIM based mutual authentication is used between the MT and the serving network. This requires that a physical device, UICC(UMTS IC Card), is available in the terminal. The UMTS authentication method supports requirements 1, 2 and 4 in clause 8.1.2.

Confidentiality of user traffic (requirement 6 in clause 8.1.2 is provided by the use of HIPERLAN/2 DES or TripleDES encryption. Encryption key management needs further study by BRAN. UMTS supports encryption between ME - RNC as there might be unprotected microwave links between Node B and RNC. It is assumed that HIPERLAN/2 access points will have wired connections to an RNC/IWU. This means that the already included encryption in HIPERLAN/2 could be sufficient. A threat analysis when having APs and the distribution network in a public environment should be carried out to verify the assumption about the encryption endpoint in the AP.

Authentication of data origin is required in requirement 3 in clause 8.1.2. This is supported in the same way as in UMTS. This means that the ability to encrypt PDU in a proper way is regarded as sufficient to assure the data origin.

Protection against modification of signalling, requirement 5 in clause 8.1.2 in UMTS requires the ME to support data integrity in the UMTS specified way. The UMTS data integrity protection method is also used for the signalling between the ME and the access network.

IMEI (International Mobile Equipment Identifier) is used to support terminal barring (requirement 7 in clause 8.1.2).

Quality of Service

The connection handling of HIPERLAN/2 RLC will be mapped with the Radio Access Bearer handling of the RANAP part of Iuhl2. Additions have to be made to HIPERLAN/2 RLC and perhaps DLC to handle the parameters that is a part of, for example RAB assignment request. How to use the concepts "common channel" and "dedicated channel" for HIRAN need to be decided at some later stage.

9 Conclusion

The present document shows that HIPERLAN/2 - 3G Interworking can be achieved by changes, discussed within the main body of the document, to existing HIPERLAN/2 standards. It is therefore recommended that the findings of the present document are acted on and taken further.

Annex A: List of figures

History

Document history		
V1.1.1	August 2001	Publication