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Mapping of IEEE 802.21 MIH primitives to EPS/LTE protocols

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Abstract

Building and operating multimode devices in heterogeneous networks can become very complex if each access technology has to be addressed directly and separately by the networking entities. To solve this issue, the IEEE, through its 802.21 work group, has developed a standard that allows a mobile terminal to seamlessly roam across different types of 802 network access technologies. Named Media Independent Handover Services, this standard enables in addition the mobility to and from of cellular systems based on 3GPP and 3GPP2 specifications. The Evolved Packet System (EPS) is the next step of the 3GPP network system following the Universal Mobile Telecommunications System (UMTS) which brings strong enhancement and improved performance to mobile communications. This document provides an update on the media dependent mapping of the IEEE 802.21 to LTE.

Index Terms

Heterogeneous networks, Handover, MIH, IEEE 802.21, LTE, EPS.

Contents

1 Introduction

Building and operating multimode devices in heterogeneous networks can become very complex if each access technology has to be addressed directly and separately by the networking entities. To solve this issue, the IEEE, through its 802.21 work group, has developed a standard [1] that allows a mobile terminal to seamlessly roam across different types of 802 network access technologies. Named Media Independent Handover Services, this standard enables in addition the mobility to and from of cellular systems based on 3GPP and 3GPP2 specifications.

The Evolved Packet System (EPS) is the next step of network system following the Universal Mobile Telecommunications System (UMTS, commonly known as 3G) which brings strong enhancement and improved performance to mobile communications. In the EPS, the control part of the system is simpler and more efficient. The figure below shows the control plane protocol stacks linking the Mobile Terminal (MT, or User Equipment, UE), to its eNodeB acting as the Point of Attachment (PoA) and the associated Mobility Management Entity (MME), acting as an Access Router or Point of Service (PoS). This control plane provides functions for the network access connection, disconnection, address activation, mobility and user plane resource allocation.

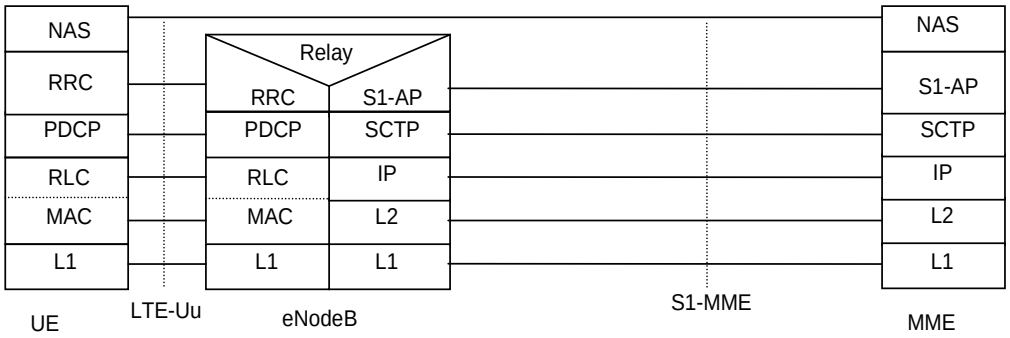

Figure 1: EPS Control Plane for Access Network interfaces (from [2])

Since the 3GPP system is not easily accessible, the exchange of 802.21 primitives should be performed at Layer 3 level, e.g. mapping on the Non-Access Stratum (NAS) protocol. This is what is proposed in the section 2.1. However, since there are some implementation allowing the direct interaction through the Radio Resource Control (RRC) Protocol (operating at L2), a direct mapping is also provided in section 2.2.

Figure 2 illustrates how the Media Independent Handover (MIH) reference model described on the IEEE 802.21 standard [1] could be applied to the EPS system.

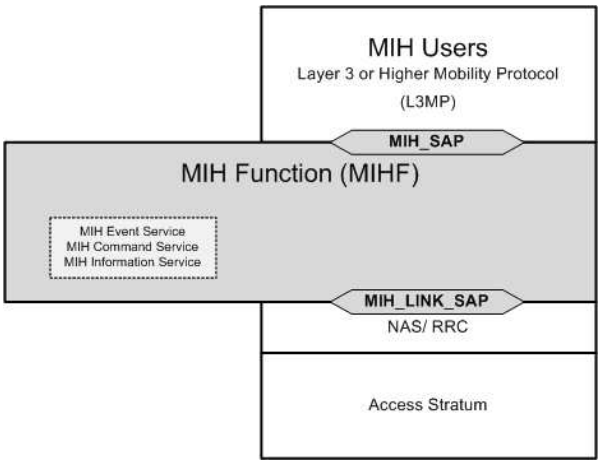

Figure 2: MIH reference model for EPS systems

This report has been submitted as a contribution to the IEEE 802.21 standard committee under reference "21-12-0027-00-0000-update-on-lte-mapping-for-ieee-802-21.docx".

2 Mapping

2.1 Mapping with the NAS protocol

Table 1 shows the proposed mapping and its rationales. It is followed by a very short summary of each of the 3GPP procedures and primitives used.

Table 1: Proposed mappings with the NAS protocol

Primitives	**3GPP**	**NAS protocol**
Link_Detected	N/A	Attach MT Signal Quality*
Link_Up	~~SMSM-ACTIVE~~ RABMSM-ACTIVATE	Attach Activate Default EPS bearer context Modify EPS bearer context
Link_Down	~~SMSM-DEACTIVEATE~~ ~~SMSM-STATUS~~ RABMSM-DEACTIVATE RABMSM-STATUS RABMAS-RAB-RELEASE	Detach Deactivate EPS bearer context ESM Status
Link_Parameters_Report	~~SMSM-MODIFY~~ RABMSM-MODIFY	Tracking Area Update
Link_Going_Down	N/A	N/A
Link_Handover_Imminent	N/A	N/A
Link_Handover_Complete	RABMAS-RAB-ESTABLISH RABMSM-MODIFY	Tracking Area Update Activate Default EPS bearer context Activate Dedicated EPS bearer context
Link_PDU_Transmit_Status	N/A	N/A
Link_Capability_Discover	N/A	N/A
Link_Event_Subscribe	N/A	Packet Domain Event reporting*
Link_Event_Unsubscribe	N/A	Packet Domain Event reporting*

Link_Get_Parameters	N/A	EPS QoS Dynamic parameters* MT Signal Quality*
Link_Configure_Thresholds	SMREG-PDP-MODIFY	Modify EPS bearer context
Link_Action / Disconnect	N/A	Detach Deactivate EPS bearer context
Link_Action / Low Power	N/A	MT Set Functionality*
Link_Action / Power Down	N/A	Detach
Link_Action / Power Up	N/A	Attach

Rationales

This mapping is based on 3GPP service procedures and commands.

When the 802.21 primitive involves some interaction between the mobile terminal (MT) and the network, this mapping refers to NAS procedures. The NAS protocol [3] has been selected because it is the EPS equivalent of the UMTS Layer 3 protocols (SMREG, RABMSM, RABMAS) that were used for the MIH_3GLINK_SAP mapping in the standard. The NAS procedures are used by the protocols for mobility management and session management between the User Equipment (UE, or MT) and the MME in the EPS. When relevant, an equivalent signalling is defined between the eNodeB or Point of Access and the MME, as part of the S1-AP protocol [4].

The mapping table lists NAS procedures rather than primitives to remain generic and compatible with both sides: MT and network nodes. From a general point of view, the end of the NAS procedure should trigger MIH events, and NAS procedures should be triggered by the reception of MIH commands.

When the 802.21 primitive implies a local action only, the corresponding local AT command defined for the operations inside the MT, as specified in [5], is used (AT means ATtention; this two character abbreviation is always used to start a command). These commands are marked with a (*) in the mapping table. This mapping would have to be extrapolated for network nodes, since equivalent commands are usually implementation dependant in the network equipment, and thus not specified.

Same as in the 3GPP mapping proposed by the 802.21 specification, a NAS procedure or AT command can be mapped to more than MIH primitive.

Summary of the NAS procedures used (from [3])

Attach: The attach procedure is used to attach to an Evolved Packet Core Network (EPC) for packet services in EPS.

Detach: The detach procedure is used by the UE to detach from EPS services, by the network to inform the UE that it is detached or by the network to inform the UE to re-attach to the network and re-establish all connections.

Activate Default EPS bearer context: The purpose of the default bearer context activation procedure is to establish a default EPS bearer context between the UE and the EPC. The default bearer context activation procedure can be part of the attach procedure. The default EPS bearer context does not have any Traffic Flow Template (TFT) assigned during the activation procedure. This corresponds to using a match-all packet filter. The network may at any time after the establishment of this bearer assign a TFT to the default EPS bearer and may subsequently modify the TFT or the packet filters of this default bearer.

Activate Dedicated EPS bearer context: The purpose of the dedicated EPS bearer context activation procedure is to establish an EPS bearer context with specific QoS and TFT between the UE and the EPC.

Modify EPS bearer context: The purpose of the EPS bearer context modification procedure is to modify an EPS bearer context with a specific QoS and TFT.

Deactivate EPS bearer context: The purpose of the EPS bearer context deactivation procedure is to deactivate an EPS bearer context or disconnect from a Packet Data Network (PDN) by deactivating all EPS bearer contexts to the PDN.

ESM Status: The purpose of the sending of the EMM STATUS message is to report at any time certain error conditions detected upon receipt of EMM protocol data. The EMM STATUS message can be sent by both the MME and the UE.

Tracking Area Update: The MME knows the location of the UE with the granularity of a few cells, called the Tracking Area (TA). The tracking area update procedure is always initiated by the UE and is used for purposes such as updating the registration of the actual tracking area of a UE in the network, updating certain UE specific parameters in the network, recovering from certain error cases.

Summary of the AT commands used (from [5])

Packet Domain Event reporting: This command enables or disables sending of unsolicited result codes, such as network detach, context activation, modification or deactivation.

EPS QoS Dynamic parameters: The execution of this command returns the Quality of Service parameters (QCI, DL_GBR, UL_GBR, DL_MBR, UL_MBR) of an established PDP Context.

MT Signal Quality: The execution of this command returns the received signal quality parameters: RSSI, BER (channel bit error rate), RSCP, Ec/No (energy per chip divided by the noise power), RSRQ, RSRP

MT Set Functionality: This command allows to select the level of functionality in the MT. Level "full functionality" is where the highest level of power is drawn. "Minimum functionality" is where minimum power is drawn.

2.2 Mapping with the RRC protocol

When RRC [6] is reachable (e.g. in the OpenAirInterface platform [7]), it is also interesting to establish a direct mapping between the 802.21 primitives and the RRC protocol.

Table 2: Proposed mappings with the RRC protocol

Primitives	**LTE/RRC procedure**
Link_Detected	System Information
Link_Up	RRC Connection establishment RRC Connection re-establishment RRC Connection reconfiguration
Link_Down	RRC Connection reconfiguration RRC Connection Release
Link_Parameters_Report	Measurement report
Link_Going_Down	N/A
Link_Handover_Imminent	N/A
Link_Handover_Complete	RRC Connection reconfiguration
Link_PDU_Transmit_Status	N/A
Link_Capability_Discover	N/A
Link_Event_Subscribe	Measurement configuration
Link_Event_Unsubscribe	Measurement configuration
Link_Get_Parameters	Measurement configuration
Link_Configure_Thresholds	Measurement configuration
Link_Action / Disconnect	RRC Connection Release
Link_Action / Low Power	N/A
Link_Action / Power Down	RRC Connection Release
Link_Action / Power Up	RRC Connection establishment

Summary of the RRC procedures used (from [6])

System Information: Broadcast at the cell level of system information, including NAS common information, cell parameters, neighbouring cell information or common channel configuration, ...

RRC Connection establishment: The purpose of this procedure is to set-up the connection of the radio interface. This procedure is also used to transfer the initial NAS dedicated information/ message from the UE to the eNodeB.

RRC Connection re-establishment: The purpose of this procedure is to re-establish the RRC connection when a valid UE context is known in the network.

RRC Connection reconfiguration: The purpose of this procedure is to modify an RRC connection, e.g. to establish/ modify/ release radio channels, to perform handover, to setup/ modify/ release measurements.

RRC Connection Release: The purpose of this procedure is to release the RRC connection, which includes the release of the established radio bearers as well as all radio resources.

Measurement configuration: In the RRC procedures, measurements performed by the UE are reported to the network. The UE reports the measurement information in accordance with the measurement configuration as provided by the eNodeB. The eNodeB provides this configuration, applicable for a connected UE, using the RRCConnectionReconfiguration message. In the OpenAirInterface platform, some measurements can also be configured for local reporting to the upper layers.

Measurement report: The purpose of this RRC procedure is to transfer measurement results from the UE to E-UTRAN. In the OpenAirInterface platform, the reporting can also be performed locally towards the upper layers.

Acknowledgements

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References

[1] IEEE Std 802.21-2008, IEEE Standard for Local and Metropolitan Area Networks, Part 21: Media Independent Handover Services, IEEE, January 2009.

[2] 3GPP TS 23.401; "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access"

[3] 3GPP TS 24.301; Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3"

[4] 3GPP TS 36.300; "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2"

[5] 3GPP TS 27.007; "AT command set for User Equipment (UE)"

[6] 3GPP TS 36.331; "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification"

[7] OpenAir Interface platform website, http://www.openairinterface.org/