

[0001] METHOD AND APPARATUS FOR MAPPING 3GPP SERVICE
PRIMITIVES TO MEDIA INDEPENDENT HANDOVER EVENT SERVICES

[0002] FIELD OF INVENTION

[0003] The present invention relates to wireless communication systems. More particularly, the present invention relates to mapping of Third Generation Partnership Project (3GPP) service primitives to media independent handover (MIH) event services as defined within the IEEE 802.21 standard.

[0004] BACKGROUND

[0005] The IEEE 802.21 standard relates to mechanisms and procedures that aid in the execution and management of inter-system handovers. Under the IEEE 802.21 standard, three main services can be accessed by mobility management (MM) applications in order to aid in the management of handover operations and system discovery and system selection. These three services include an event service, an information service and a command service, which are delivered to prospective users using a common uniform interface, regardless of the underlying access technologies supporting the communication towards the core network.

[0006] A method which supports the delivery of event services is needed to determine when an event is to be triggered based on the prevailing characteristics of the underlying technology. The underlying technology could be supported by the 3GPP specification, 3GPP2 and wireless local area networks (WLANs), (e.g., IEEE 802.11 or IEEE 802.16), and the like.

[0007] Currently, there are no procedures or functionality to generate triggers toward upper layers, based on information provided by the 3GPP underlying layers. The IEEE 802.21 specification outlines triggers that should be sent to upper layers. However, the IEEE 802.21 specification does not describe how events are triggered when the underlying physical resources are based on

3GPP technology. Therefore a method capable generating these triggers is required.

[0008]

SUMMARY

[0009] The present invention is related to a 3GPP-MIH service access point (SAP) which is configured to provide MIH event services, (e.g., IEEE 802.21 event services), by mapping service primitives to the MIH event services. The service primitives may be 3GPP service primitives which originate from at least one of a radio resources (RR) layer, a logical link control (LLC) layer, a general packet radio service (GPRS) mobility management (GMM) layer, a session management (SM) layer, a non-access stratum (NAS), an access stratum (AS) and an evolved universal terrestrial radio access (E-UTRA)/evolved core network (E-CORE) system. The event services may include a link parameter change event service, a link up event service, a link going down event service, a link down event service, a handover complete event service and a link detected event service.

[0010] The present invention uses existing service primitives already defined within 3GPP in order to trigger events that can be used for the determination of handover operations. These service primitives are mapped onto concrete IEEE 802.21 events as defined in IEEE 802.21, as a means to optimize inter-system handover operations.

[0011] The present invention provides a method to trigger MIH events, using existing 3GPP radio resource management (RRM), MM and session management (SM) service primitives. The concept of service primitives mapping is extended using mobility management procedures and concepts introduced within both long term evolution (LTE) and system architecture evolution (SAE) within the 3GPP specifications.

[0012] The present invention may be applicable to IEEE 802 standards including WLAN baseline air interface standards such as IEEE 802.11 baseline, IEEE 802.11a orthogonal frequency division multiplex (OFDM) 5GHz WLAN, IEEE 802.11b high rate direct sequence spread spectrum (HR-DSSS) 2.4GHz WLAN, IEEE 802.11g OFDM 2.4GHz WLAN, IEEE 802.11j OFDM 10 MHz

option WLAN, IEEE 802.11n high-throughput WLAN, and IEEE 802.16 broadband wireless access systems. The WLAN standards supplement to extend operation for particular scenarios such as IEEE 802.21 MIH.

[0013] The present invention is also applicable to cellular standards, such as 3GPP or 3GPP2, and other standardized or proprietary wireless technologies similar to IEEE 802 WLANs, examples notably include 802.15 Bluetooth, and HIPERLAN/2.

[0014] BRIEF DESCRIPTION OF THE DRAWINGS

[0015] A more detailed understanding of the invention may be had from the following description of a preferred embodiment, given by way of example and to be understood in conjunction with the accompanying drawings wherein:

[0016] Figure 1 shows an 3GPP-MIH SAP which maps 3GPP service primitives, received from various 3GPP entities, to MIH event services in accordance with the present invention;

[0017] Figure 2 is an exemplary block diagram of the MIH-GPP SAP of Figure 1;

[0018] Figure 3 is an example of mapping a 3GPP service primitive to an MIH event service when a page is received by an RR layer;

[0019] Figure 4 is an example of mapping a 3GPP service primitive to an MIH event service when data supporting a specific quality of service (QoS) is received by the RR layer;

[0020] Figure 5 is an example of mapping a 3GPP service primitive to an MIH event service when a peer LLC layer is established;

[0021] Figure 6 is an example of mapping a 3GPP service primitive to an MIH event service when a peer LLC layer is released;

[0022] Figure 7 is an example of mapping a 3GPP service primitive to an MIH event service when an LLC layer unrecoverable error occurs;

[0023] Figure 8 is an example of mapping a 3GPP service primitive to an MIH event service when a GMM layer indicates that a station is attached;

[0024] Figure 9 is an example of mapping a 3GPP service primitive to an MIH event service when a GMM layer indicates that a station is detached;

[0025] Figure 10 is an example of mapping a 3GPP service primitive to an MIH event service when an SM layer indicates that a data session is active;

[0026] Figure 11 is an example of mapping a 3GPP service primitive to an MIH event service when an SM layer indicates that a data session is deactivated;

[0027] Figure 12 is an example of mapping a 3GPP service primitive to an MIH event service when an SM layer indicates that a data session is modified;

[0028] Figure 13 is an example of mapping a 3GPP service primitive to an MIH event service when an SM layer indicates that a data session is terminated due to an unrecoverable error;

[0029] Figure 14 is an example of mapping a 3GPP service primitive to an MIH event service when an SM layer indicates that a packet data protocol (PDP) context is active;

[0030] Figure 15 is an example of mapping a 3GPP service primitive to an MIH event service when an SM layer indicates that a PDP context is modified;

[0031] Figure 16 is an example of mapping a 3GPP service primitive to an MIH event service when an SM layer indicates that a PDP context is deactivated;

[0032] Figure 17 is an example of mapping a 3GPP service primitive to an MIH event service when an NAS indicates that a station is attached;

[0033] Figure 18 is an example of mapping a 3GPP service primitive to an MIH event service when an NAS indicates that a station is detached;

[0034] Figure 19 is an example of mapping a 3GPP service primitive to an MIH event service when an NAS indicates that a PDP context is active;

[0035] Figure 20 is an example of mapping a 3GPP service primitive to an MIH event service when an NAS indicates that a PDP context is modified;

[0036] Figure 21 is an example of mapping a 3GPP service primitive to an MIH event service when an NAS indicates that a PDP context is deactivated;

[0037] Figure 22 is an example of mapping a 3GPP service primitive to an MIH event service when an NAS indicates that a radio access bearer (RAB) is activated for data transfer;

[0038] Figure 23 is an example of mapping a 3GPP service primitive to an MIH event service when an NAS indicates that a RAB is deactivated for data transfer;

[0039] Figure 24 is an example of mapping a 3GPP service primitive to an MIH event service when an NAS indicates that a RAB is modified for data transfer;

[0040] Figure 25 is an example of mapping a 3GPP service primitive to an MIH event service when an NAS indicates that a RAB data transfer error has occurred;

[0041] Figure 26 is an example of mapping a 3GPP service primitive to an MIH event service when an AS indicates that a RAB has been activated;

[0042] Figure 27 is an example of mapping a 3GPP service primitive to an MIH event service when an AS indicates that a RAB has been released;

[0043] Figure 28 is an example of mapping a 3GPP service primitive to an MIH event service when an AS failure occurs;

[0044] Figure 29 is an example of mapping a 3GPP service primitive to an MIH event service when an AS broadcasts information regarding a geographic area;

[0045] Figure 30 is an example of mapping a 3GPP service primitive to an MIH event service when an AS provides notification of paging for a particular user or terminal;

[0046] Figure 31 is an example of mapping a 3GPP service primitive to an MIH event service when an AS provides a notification for all users;

[0047] Figure 32 is an example of mapping a 3GPP service primitive to an MIH event service when an AS provides notification information for one or more users;

[0048] Figure 33 is an example of mapping a 3GPP service primitive to an MIH event service when an AS indicates a user equipment (UE) initiated connection establishment;

[0049] Figure 34 is an example of mapping a 3GPP service primitive to an MIH event service when an AS indicates a network initiated connection release;

[0050] Figure 35 is an example of mapping a 3GPP service primitive to an MIH event service when an AS indicates a network initiated RAB establishment;

[0051] Figure 36 is an example of mapping a 3GPP service primitive to an MIH event service when an AS indicates a network initiated RAB release;

[0052] Figure 37 is an example of mapping a 3GPP service primitive to an MIH event service when an AS indicates the potential for an aborted connection unless streamlining is performed;

[0053] Figure 38 is an example of mapping a 3GPP service primitive to an MIH event service when an AS indicates location information provided by a network for a specific UE;

[0054] Figure 39 is an example of mapping a 3GPP service primitive to an MIH event service when an AS indicates a connection loss;

[0055] Figure 40 is an example of mapping a 3GPP service primitive to an MIH event service when an E-UTRA/E-CORE system indicates that the location of a UE is now known by a network;

[0056] Figure 41 is an example of mapping a 3GPP service primitive to an MIH event service when an E-UTRA/E-CORE system indicates that the location of a UE is known to a network but no transport channel is established; and

[0057] Figure 42 is an example of mapping a 3GPP service primitive to an MIH event service when an E-UTRA/E-CORE system indicates that radio resources have been established and that a UE is able to perform uplink (UL) and downlink (DL) transport of a protocol data unit (PDU).

[0058] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0059] The present invention is based on the use existing and new, (e.g., LTE and SAE), primitives within 3GPP that can be mapped onto IEEE 802.21 events as defined by the IEEE 802.21 specification.

[0060] A primitive is an abstract representation of functions such as an information function, an event or a command.

[0061] An MIH event service classifies, filters and reports changes within the link layer characteristics, (i.e., maximum offered throughput, supported

bandwidth, or the like), the link status, (i.e., an indicator of whether the link is operational or not), and the link quality, (e.g., low signal strength). Event services may also indicate changes in the state and transmission behavior of the physical, data link and logical link layers. Furthermore, event services are used to indicate an operation state as a result of a management action.

[0062] Figure 1 is a mapping model for 3GPP layer primitives, where a 3GPP-MIH service access point (SAP) 100 maps 3GPP service primitives to MIH event services according to IEEE 802.xx standards.

[0063] As shown in Figure 1, a radio resources (RR) layer 105, an LLC layer 110, a general packet radio service (GPRS) mobility management (GMM) layer 115, and a session management (SM) layer 120 associated with a global system for mobile communications (GSM)/enhanced data rates for GSM evolution (EDGE) radio access network (GERAN) 125 send 3GPP service primitives 160 to the 3GPP-MIH SAP 100. Furthermore, the non-access stratum (NAS) 130 and the access stratum (AS) 135 of a universal mobile telecommunications system (UMTS) services 140 send 3GPP service primitives 160 to the SAP 100. An LTE system 145 sends 3GPP service primitives 160 via an evolved universal terrestrial radio access (E-UTRA) and evolved core network (E-CORE) layers 155 to the SAP 100. The SAP outputs MIH event services 170 in response to receiving the 3GPP service primitives 160.

[0064] Figure 2 is an exemplary block diagram of the 3GPP-MIH SAP 100 of Figure 1. The 3GPP-MIH SAP 100 includes a processor 205 and a 3GPP to MIH mapping database 210. When the SAP 100 receives a 3GPP service primitive 160, the processor 205 in the SAP 100 interprets, (i.e., identifies), the 3GPP service primitive 160 in terms of functional capabilities and potential parameters. The processor 205 then queries the mapping database 210 based on such functional capabilities and parameters to obtain and output the MIH event services 170.

[0065] Table 1 identifies specific 3GPP service primitives for each of the layers of the GERAN 125 shown in Figure 1. According to the present invention, the 3GPP service primitives generated by the GERAN 125 via the RR layer 105,

the LLC layer 110, the GMM layer 115 and the SM layer 120 are mapped to MIH event services, (e.g., IEEE 802.21 events), as shown in Table 1 below.

3GPP Layer	3GPP Service Primitive Descriptions	3GPP Service Primitive	MIH Event Service (e.g., IEEE 802.21 Event)
RR	Page received by RR layer	GMRR-PAGE	Link Parameter Change
	Successful reception of data supporting specific QoS	GRR-DATA	Link Parameter Change
LLC	Peer LLC layer is established	LL-ESTABLISH	Link Up/Link Parameter Change
	Peer LLC layer is released	LL-RELEASE	Link Going Down/Link Parameter Change
	LLC Layer unrecoverable error	LL-STATUS	Link Down
GMM	Station is attached	GMMREG-ATTACH	Link Parameter Change
	Station is detached	GMMREG-DETACH	Link Parameter Change
SM	Data session active	SMSM-ACTIVE	Link Up/Link Parameter Change
	Data session is deactivated	SMSM-DEACTIVATE	Link Down/Link Parameter Change
	Data session modified	SMSM-MODIFY	Link Parameter Change
	Data session terminated due to unrecoverable error	SMSM-STATUS	Link Down
	PDP Context is active	SMREG-PDP-ACTIVATE	Link Up/ Link Parameter Change/ Handover Complete
	PDP Context is modified	SMREG-PDP-MODIFY	Link up/Link Parameter Change/ Handover Complete

3GPP Layer	3GPP Service Primitive Descriptions	3GPP Service Primitive	MIH Event Service (e.g., IEEE 802.21 Event)
	PDP Context is deactivated	SMREG-PDP-DEACTIVATE	Link Going Down/Link Down

Table 1

[0066] Figure 3 is an example of mapping a 3GPP service primitive to an MIH event service when a page is received by the RR layer 105. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the RR layer 105 that indicates that a page was received by the RR layer 105. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 or the like.

[0067] Figure 4 is an example of mapping a 3GPP service primitive to an MIH event service when data supporting a specific QoS is received by the RR layer 105. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the RR layer 105 that indicates that data supporting a specific QoS is received by the RR layer 105. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 or the like.

[0068] Figure 5 is an example of mapping a 3GPP service primitive to an MIH event service when a peer LLC layer is established, as indicated by the LLC layer 110. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link up event service or a link parameter change event service in response to receiving a 3GPP service primitive from the LLC layer 110 that indicates that a peer LLC layer has been established. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0069] Figure 6 is an example of mapping a 3GPP service primitive to an MIH event service when a peer LLC layer 110 is released, as indicated by the

LLC layer 110. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link going down event service or a link parameter change event service in response to receiving a 3GPP service primitive from the LLC layer 110 that indicates that a peer LLC layer has been released. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0070] Figure 7 is an example of mapping a 3GPP service primitive to an MIH event service when an LLC layer unrecoverable error occurs, as indicated by the LLC layer 110. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link down event service in response to receiving a 3GPP service primitive from the LLC layer 110 that indicates that an LLC layer unrecoverable error has occurred. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0071] Figure 8 is an example of mapping a 3GPP service primitive to an MIH event service when the GMM layer 115 indicates that a station is attached. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the GMM layer 115 that indicates that a station is attached. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0072] Figure 9 is an example of mapping a 3GPP service primitive to an MIH event service when the GMM layer 115 indicates that a station is detached. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the GMM layer 115 that indicates that a station is detached. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0073] Figure 10 is an example of mapping a 3GPP service primitive to an MIH event service when the SM layer 120 indicates that a data session is active. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link up event service or a link parameter change event service

in response to receiving a 3GPP service primitive from the SM layer 120 that indicates that a data session is active. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0074] Figure 11 is an example of mapping a 3GPP service primitive to an MIH event service when the SM layer 120 indicates that a data session is deactivated. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link down event service or a link parameter change event service in response to receiving a 3GPP service primitive from the SM layer 120 that indicates that a data session is deactivated. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0075] Figure 12 is an example of mapping a 3GPP service primitive to an MIH event service when the SM layer 120 indicates that a data session is modified. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the SM layer 120 that indicates that a data session has been modified. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0076] Figure 13 is an example of mapping a 3GPP service primitive to an MIH event service when the SM layer 120 indicates that a data session is terminated due to an unrecoverable error. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link down event service in response to receiving a 3GPP service primitive from the SM layer 120 that indicates that a data session has been terminated due to an unrecoverable error. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0077] Figure 14 is an example of mapping a 3GPP service primitive to an MIH event service when the SM layer 120 indicates that a PDP context is active. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link up event service, a link parameter change event service or a handover complete event service in response to receiving a 3GPP service

primitive from the SM layer 120 that indicates that a PDP context is active. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0078] Figure 15 is an example of mapping a 3GPP service primitive to an MIH event service when the SM layer 120 indicates that a PDP context is modified. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link up event service, a link parameter change event service or a handover complete event service in response to receiving a 3GPP service primitive from the SM layer 120 that indicates that a PDP context has been modified. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0079] Figure 16 is an example of mapping a 3GPP service primitive to an MIH event service when the SM layer 120 indicates that a PDP context is deactivated. As indicated by Table 1 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link going down event service or a link down event service in response to receiving a 3GPP service primitive from the SM layer 120 that indicates that a PDP context has been deactivated. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0080] Table 2 identifies specific 3GPP service primitives for each of the layers of the UMTS 140 and the LTE system 145 shown in Figure 1. According to the present invention, the 3GPP service primitives generated by the UMTS 140 via the NAS 130 and the AS 135, as well as the 3GPP service primitives generated by the LTE via the E-UTRA/E-CORE system 150, are mapped to MIH event services, (e.g., IEEE 802.21 events), as shown in Table 2 below.

3GPP Layer	3GPP Service Primitive Descriptions	3GPP Service Primitive	MIH Event Service (e.g., IEEE 802.21 Event)
NAS	Station is attached	GMMREG-ATTACH	Link Parameter Change
	Station is detached	GMMREG-	Link Parameter

3GPP Layer	3GPP Service Primitive Descriptions	3GPP Service Primitive	MIH Event Service (e.g., IEEE 802.21 Event)
		DETACH	Change
	PDP Context is active	SMREG-PDP-ACTIVATE	Link Up/Handover Complete/Link Parameter Change
	PDP Context is modified	SMREG-PDP-MODIFY	Link Parameter Change/ Link Up
	PDP Context is deactivated	SMREG-PDP-DEACTIVATE	Link Down/Link Parameter Change
	Radio Access Bearer is activated for data transfer	RABMSM-ACTIVATE	Link Up/Link Parameter Change/ Handover Complete
	Radio Access Bearer is deactivated for data transfer	RABMSM-DEACTIVATE	Link Down/Link Link Parameter Change
	Radio Access Bearer is modified for data transfer	RABMSM-MODIFY	Link Parameter Change/Link Up/ Handover Complete
	Radio Access Bearer data transfer error	RABMSM-STATUS	Link Down
AS	Radio Access Bearer has been activated	RABMAS-RAB-ESTABLISH	Link Up/ Handover Complete
	Radio Access Bearer has been released	RABMAS-RAB-RELEASE	Link Down
	AS failure Indication	RABMAS-STATUS	Link Down
	Information regarding geographical area.	Information Broadcast	Link Parameter Change
	Notification of paging for particular user or terminal	Paging Request	Link Parameter Change
	Notification information for all users	Notification Broadcast	Link Parameter Change

3GPP Layer	3GPP Service Primitive Descriptions	3GPP Service Primitive	MIH Event Service (e.g., IEEE 802.21 Event)
	Notification information for a specific or for many user	Notification Indication	Link Parameter Change
	UE initiated connection establishment	Connection Establishment	Link Up
	Network initiated connection release	Infrastructure Side Initiated Connection Release	Link Down
	Network initiated Radio Access Bearer Establishment	Infrastructure Side Initiated Radio Access Bearer Establishment	Link Up/Link Detected
	Network initiated Radio Access Bearer Release	Infrastructure Side Initiated Radio Access Bearer Release	Link Down
	Indication that the connection may be aborted unless streamlining is done	Streamlining Required Indication	Link Going Down
	Location information provided by the network for a specific UE	UE location information	Link Parameter Change
	Connection loss indications	Connection loss indication	Link Down
E-UTRAN/ E-CORE	The location of the UE is now known by the network	LTE-detached	Link Parameter Change
	The UE is known to the network but no transport channel is established	LTE-idle	Link Parameter Change/Link Down
	Radio resources have been established and the UE is able to	LTE-Active	Link Up/Link Handover Complete

3GPP Layer	3GPP Service Primitive Descriptions	3GPP Service Primitive	MIH Event Service (e.g., IEEE 802.21 Event)
	perform UL and DL transport of PDU		

Table 2

[0081] Figure 17 is an example of mapping a 3GPP service primitive to an MIH event service when the NAS 130 indicates that a station is attached. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the NAS 130 that indicates that a station is attached. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0082] Figure 18 is an example of mapping a 3GPP service primitive to an MIH event service when the NAS 130 indicates that a station is detached. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the NAS 130 that indicates that a station is detached. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0083] Figure 19 is an example of mapping a 3GPP service primitive to an MIH event service when the NAS 130 indicates that a PDP context is active. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link up event service, a handover complete event service or a link parameter change event service in response to receiving a 3GPP service primitive from the NAS 130 that indicates that a PDP context is active. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0084] Figure 20 is an example of mapping a 3GPP service primitive to an MIH event service when the NAS 130 indicates that a PDP context is modified. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service or a link up event service

in response to receiving a 3GPP service primitive from the NAS 130 that indicates that a PDP context is modified. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0085] Figure 21 is an example of mapping a 3GPP service primitive to an MIH event service when the NAS 130 indicates that a PDP context is deactivated. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link down event service or a link parameter change event service in response to receiving a 3GPP service primitive from the NAS 130 that indicates that a PDP context is deactivated. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0086] Figure 22 is an example of mapping a 3GPP service primitive to an MIH event service when the NAS 130 indicates that a RAB is activated for data transfer. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link up event service, a link parameter change event service or a handover complete event service in response to receiving a 3GPP service primitive from the NAS 130 that indicates that a RAB is activated for data transfer. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0087] Figure 23 is an example of mapping a 3GPP service primitive to an MIH event service when the NAS 130 indicates that a RAB is deactivated for data transfer. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link down event service or a link parameter change event service in response to receiving a 3GPP service primitive from the NAS 130 that indicates that a RAB is deactivated for data transfer. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0088] Figure 24 is an example of mapping a 3GPP service primitive to an MIH event service when the NAS 130 indicates that a RAB is modified for data transfer. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service, a link up

event service or a handover complete event service in response to receiving a 3GPP service primitive from the NAS 130 that indicates that a RAB is modified for data transfer. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0089] Figure 25 is an example of mapping a 3GPP service primitive to an MIH event service when the NAS 130 indicates that a RAB data transfer error has occurred. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link down event service in response to receiving a 3GPP service primitive from the NAS 130 that indicates that a RAB data transfer error has occurred. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0090] Figure 26 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 indicates that a RAB has been activated. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link up event service or a handover complete event service in response to receiving a 3GPP service primitive from the NAS 130 that indicates that a RAB has been activated. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0091] Figure 27 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 indicates that a RAB has been released. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link down event service in response to receiving a 3GPP service primitive from the AS 135 that indicates that a RAB has been released. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0092] Figure 28 is an example of mapping a 3GPP service primitive to an MIH event service when a failure of the AS 135 occurs. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link down event service in response to receiving a 3GPP service primitive from the AS 135 that indicates that AS 135 has failed. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0093] Figure 29 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 broadcasts information regarding a geographic area. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the AS 135 that includes information regarding a geographic area. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0094] Figure 30 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 provides notification of paging for a particular user or terminal. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the AS 135 that provides notification of paging for a particular user or terminal. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0095] Figure 31 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 provides a notification for all users. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the AS 135 that provides notification information for all users. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0096] Figure 32 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 provides notification information for one or more users. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the AS 135 that provides a notification for one or more users. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0097] Figure 33 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 indicates a UE initiated connection

establishment. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link up event service in response to receiving a 3GPP service primitive from the AS 135 that indicates a UE initiated connection establishment. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0098] Figure 34 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 indicates a network initiated connection release. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link down event service in response to receiving a 3GPP service primitive from the AS 135 that indicates an infrastructure side, (i.e., network), initiated connection release. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0099] Figure 35 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 indicates a network initiated RAB establishment. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link up event service or a link detected event service in response to receiving a 3GPP service primitive from the AS 135 that indicates an infrastructure side, (i.e., network), initiated RAB establishment. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0100] Figure 36 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 indicates a network initiated RAB release. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link down event service in response to receiving a 3GPP service primitive from the AS 135 that indicates an infrastructure side, (i.e., network), initiated RAB release. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0101] Figure 37 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 indicates the potential for an aborted connection unless streamlining is performed. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link going down

event service in response to receiving a 3GPP service primitive from the AS 135 that indicates the potential for an aborted connection unless streamlining is performed. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0102] Figure 38 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 indicates location information provided by a network for a specific UE. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the AS 135 that indicates location information provided by a network for a specific UE. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0103] Figure 39 is an example of mapping a 3GPP service primitive to an MIH event service when the AS 135 indicates a connection loss. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link down event service in response to receiving a 3GPP service primitive from the AS 135 that indicates a connection loss. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0104] Figure 40 is an example of mapping a 3GPP service primitive to an MIH event service when the E-UTRA/E-CORE system 150 indicates that the location of a UE is now known by a network. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service in response to receiving a 3GPP service primitive from the E-UTRA/E-CORE system 150 that indicates that the location of a UE is now known by a network. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0105] Figure 41 is an example of mapping a 3GPP service primitive to an MIH event service when the E-UTRA/E-CORE system 150 indicates that the location of a UE is known to a network but no transport channel is established. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link parameter change event service or a link down event

service in response to receiving a 3GPP service primitive from the E-UTRA/E-CORE system 150 that indicates that the location of a UE is known to a network but no transport channel is established. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0106] Figure 42 is an example of mapping a 3GPP service primitive to an MIH event service when the E-UTRA/E-CORE system 150 indicates that radio resources have been established and that a UE is able to perform UL and DL transport of a PDU. As indicated by Table 2 above, the processor 205 in the SAP 100 illustrated in Figure 2 outputs a link up event service or a link handover complete event service in response to receiving a 3GPP service primitive from the E-UTRA/E-CORE system 150 that indicates that radio resources have been established and that a UE is able to perform UL and DL transport of a PDU. This MIH event service may be applicable to any type of standard, such as IEEE 802.21 and the like.

[0107] It should be noted that the specific mapping of a 3GPP service primitive to an MIH event service, (e.g., an IEEE 802.21 event), may change. In particular, primitives for SAE and LTE currently remain undefined. However, the present invention demonstrates how mapping service primitives to event services may easily be adapted or used to provide triggers.

[0108] Embodiments

1. A method for mapping service primitives to event services, the method comprising:

receiving at least one service primitive;
sending a query to a database based on the received service primitive;
obtaining information from the database in response to the query; and
providing an event service that corresponds to the received service primitive based on the information obtained from the database.

2. The method of embodiment 1 wherein the event service is a link parameter change event service.

3. The method of embodiment 1 wherein the event service is a link up event service.

4. The method of embodiment 1 wherein the event service is a link down event service.
5. The method of embodiment 1 wherein the event service is a handover complete event service.
6. The method of embodiment 1 wherein the event service is a link going down event service.
7. The method of embodiment 1 wherein the event service is a link detected event service.
8. The method as in any one of embodiments 1-7 wherein the event service is provided in accordance with the IEEE 802.21 standard.
9. The method as in any one of embodiments 1-8 wherein the received service primitive is a third generation partnership project (3GPP) service primitive.
10. The method as in any one of embodiments 1-9 wherein the service primitive is received from a radio resources (RR) layer.
11. The method as in any one of embodiments 1-9 wherein the service primitive is received from a logical link control (LLC) layer.
12. The method as in any one of embodiments 1-9 wherein the service primitive is received from a general packet radio service (GPRS) mobility management (GMM) layer.
13. The method as in any one of embodiments 1-9 wherein the service primitive is received from a session management (SM) layer.
14. The method as in any one of embodiments 1-9 wherein the service primitive is received from a non-access stratum (NAS).
15. The method as in any one of embodiments 1-9 wherein the service primitive is received from an access stratum (AS).
16. The method as in any one of embodiments 1-9 wherein the service primitive is received from an evolved universal terrestrial radio access (E-UTRA)/evolved core network (E-CORE) system.
17. The method as in any one of embodiments 1-16 wherein the event service is a media independent handover (MIH) event service.

18. Apparatus for mapping service primitives to event services, the apparatus comprising:

a mapping database; and

a processor coupled to the database, the processor being configured to receive at least one service primitive, send a query to the mapping database based on the received service primitive, obtain information from the mapping database in response to the query, and output an event service that corresponds to the received service primitive based on the information obtained from the mapping database.

19. The apparatus of embodiment 18 wherein the apparatus is a service access point (SAP).

20. The apparatus of embodiment 18 wherein the event service is a link parameter change event service.

21. The apparatus of embodiment 18 wherein the event service is a link up event service.

22. The apparatus of embodiment 18 wherein the event service is a link down event service.

23. The apparatus of embodiment 18 wherein the event service is a handover complete event service.

24. The apparatus of embodiment 18 wherein the event service is a link going down event service.

25. The apparatus of embodiment 18 wherein the event service is a link detected event service.

26. The apparatus as in any one of embodiments 18-25 wherein the event service is provided in accordance with the IEEE 802.21 standard.

27. The apparatus as in any one of embodiments 18-26 wherein the received service primitive is a third generation partnership project (3GPP) service primitive.

28. The apparatus as in any one of embodiments 18-27 wherein the service primitive is received from a radio resources (RR) layer.

29. The apparatus as in any one of embodiments 18-27 wherein the service primitive is received from a logical link control (LLC) layer.

30. The apparatus as in any one of embodiments 18-27 wherein the service primitive is received from a general packet radio service (GPRS) mobility management (GMM) layer.

31. The apparatus as in any one of embodiments 18-27 wherein the service primitive is received from a session management (SM) layer.

32. The apparatus as in any one of embodiments 18-27 wherein the service primitive is received from a non-access stratum (NAS).

33. The apparatus as in any one of embodiments 18-27 wherein the service primitive is received from an access stratum (AS).

34. The apparatus as in any one of embodiments 18-27 wherein the service primitive is received from an evolved universal terrestrial radio access (E-UTRA)/evolved core network (E-CORE) system.

35. The apparatus as in any one of embodiments 18-34 wherein the event service is a media independent handover (MIH) event service.

[0109] Although the features and elements of the present invention are described in the preferred embodiments in particular combinations, each feature or element can be used alone (without the other features and elements of the preferred embodiments) or in various combinations with or without other features and elements of the present invention.

CLAIMS

1. A method for use in a Media Independent Handover (MIH)-capable wireless transmit/receive unit (WTRU), the method comprising:
receiving a Third Generation Partnership Project (3GPP) data session active (SMSM-ACTIVE) primitive; and
providing an MIH link up event to an upper layer in response to the SMS-ACTIVE primitive.
2. The method of claim 1, further comprising:
receiving a 3GPP data session deactivate (SMSM-DEACTIVATE) primitive; and
providing an MIH link down event to an upper layer in response to the SMSM-DEACTIVATE primitive.
3. The method of claim 1, further comprising:
receiving a 3GPP data session modified (SMSM-MODIFY) primitive;
and
providing an MIH link parameter change event to an upper layer in response to the SMSM-MODIFY primitive.
4. The method of claim 1, further comprising:
receiving a 3GPP data session terminated due to unrecoverable error (SMSM-STATUS) primitive; and
providing an MIH link down event to an upper layer in response to the SMSM-STATUS primitive.
5. A wireless transmit/receive unit (WTRU), the WTRU

comprising:

- a circuit configured to receive a Third Generation Partnership Project (3GPP) data session active (SMSM-ACTIVE) primitive; and

- a circuit configured to provide a Media Independent Handover (MIH) link up event to an upper layer in response to the SMSM-ACTIVE primitive.

6. The WTRU of claim 5, further comprising:

- a circuit configured to receive a 3GPP data session deactivate (SMSM-DEACTIVATE) primitive; and

- a circuit configured to provide an MIH link down event to an upper layer in response to the SMSM-DEACTIVATE primitive.

7. The WTRU of claim 5, further comprising:

- a circuit configured to receive a 3GPP data session modified (SMSM-MODIFY) primitive; and

- a circuit configured to provide an MIH link parameter change event to an upper layer in response to the SMSM-MODIFY primitive.

8. The WTRU of claim 5, further comprising:

- a circuit configured to receive a 3GPP data session terminated due to unrecoverable error (SMSM-STATUS) primitive; and

- a circuit configured to provide an MIH link down event to an upper layer in response to the SMSM-STATUS primitive.

9. A method for use in a Media Independent Handover (MIH)-capable wireless transmit/receive unit (WTRU), the method comprising:

- receiving a Third Generation Partnership Project (3GPP) radio access bearer is activated for data transfer (RABMSM-ACTIVATE) primitive; and
- providing an MIH link up event to an upper layer in response to the

RABMSM-ACTIVATE primitive.

10. The method of claim 9, further comprising:
receiving a 3GPP radio access bearer is deactivated for data transfer (RABMSM-DEACTIVATE) primitive; and
providing an MIH link down event to an upper layer in response to the RABMSM-DEACTIVATE primitive MIH Event Service.

11. The method of claim 9, further comprising:
receiving a 3GPP radio access bearer is modified for data transfer (RABMSM-MODIFY) primitive; and
providing an MIH link parameter change event to an upper layer in response to the RABMSM-MODIFY primitive.

12. The method of claim 9, further comprising:
receiving a 3GPP radio access bearer data transfer error (RABMSM-STATUS) primitive; and
providing an MIH link down event to an upper layer in response to the RABMSM-STATUS primitive.

13. The method of claim 9, further comprising:
receiving a 3GPP radio access bearer has been activated (RABMAS-RAB-ESTABLISH) primitive; and
providing an MIH handover complete event to an upper layer in response to the RABMAS-RAB-ESTABLISH primitive.

14. The method of claim 9, further comprising:
receiving a 3GPP radio access bearer has been released (RABMAS-

RAB-RELEASE) primitive; and

providing an MIH link down event to an upper layer in response to the RABMAS-RAB-RELEASE primitive.

15. The method of claim 9, further comprising:

receiving a 3GPP packet data protocol (PDP) context is modified (SMREG-PDP-MODIFY) primitive; and

providing an MIH link parameter change event to an upper layer in response to the SMREG-PDP-MODIFY primitive.

16. A wireless transmit/receive unit (WTRU), the WTRU comprising:

a circuit configured to receive a Third Generation Partnership Project (3GPP) radio access bearer is activated for data transfer (RABMSM-ACTIVATE) primitive; and

a circuit configured to provide a Media Independent Handover (MIH) link up event to an upper layer in response to the RABMSM-ACTIVATE primitive.

17. The WTRU of claim 16, further comprising:

a circuit configured to receive a 3GPP radio access bearer is deactivated for data transfer (RABMSM-DEACTIVATE) primitive; and

a circuit configured to provide an MIH link down event to an upper layer in response to the RABMSM-DEACTIVATE primitive.

18. The WTRU of claim 16, further comprising:

a circuit configured to receive a 3GPP radio access bearer is modified for data transfer (RABMSM-MODIFY) primitive; and

a circuit configured to provide an MIH link parameter change event to an upper layer in response to the RABMSM-MODIFY primitive.

19. The WTRU of claim 16, further comprising:
a circuit configured to receive a 3GPP radio access bearer data transfer error (RABMSM-STATUS) primitive; and
a circuit configured to provide an MIH link down event to an upper layer in response to the RABMSM-STATUS primitive.

20. The WTRU of claim 16, further comprising:
a circuit configured to receive a 3GPP radio access bearer has been activated (RABMAS-RAB-ESTABLISH) primitive; and
a circuit configured to provide an MIH handover complete event to an upper layer in response to the RABMAS-RAB-ESTABLISH primitive.

21. The WTRU of claim 16, further comprising:
a circuit configured to receive a 3GPP radio access bearer has been released (RABMAS-RAB-RELEASE) primitive; and
a circuit configured to provide an MIH link down event to an upper layer in response to the RABMAS-RAB-RELEASE primitive.

22. The WTRU of claim 16, further comprising:
a circuit configured to receive a 3GPP packet data protocol (PDP) context is modified (SMREG-PDP-MODIFY) primitive; and
a circuit configured to provide an MIH link parameter change event to an upper layer in response to the SMREG-PDP-MODIFY primitive.

23. A method for use in a Media Independent Handover (MIH)-capable wireless transmit/receive unit (WTRU), the method comprising:

receiving a Third Generation Partnership Project (3GPP) user equipment (UE) location is now known to the network (LTE-detached) primitive; and

providing an MIH link parameter change event to an upper layer in response to the LTE-detached primitive.

24. The method of claim 23, further comprising:

receiving a 3GPP user equipment (UE) is known to the network but no transport channel is established (LTE-idle) primitive; and

providing an MIH link parameter change event or an MIH link down event to an upper layer in response to the LTE-idle primitive.

25. The method of claim 23, further comprising:

receiving a 3GPP radio resources have been established and a user equipment (UE) is able to uplink and downlink transport of a packet data unit (PDU) (LTE-active) primitive; and

providing an MIH link up event or an MIH link handover complete event to a upper layer in response to the LTE-active primitive.

26. A wireless transmit/receive unit (WTRU), the WTRU comprising:

a circuit configured to receive a Third Generation Partnership Project (3GPP) user equipment (UE) location is now known to the network (LTE-detached) primitive; and

a circuit configured to provide a Media Independent Handover (MIH) link parameter change event to an upper layer in response to the LTE-detached primitive.

27. The WTRU of claim 26, further comprising:

a circuit configured to receive a 3GPP user equipment (UE) is known to the network but no transport channel is established (LTE-idle) primitive; and

a circuit configured to provide an MIH link parameter change event or an MIH link down event to an upper layer in response to the LTE-idle primitive.

28. The WTRU of claim 26, further comprising:

a circuit configured to receive a 3GPP radio resources have been established and a user equipment (UE) is able to uplink and downlink transport of a packet data unit (PDU) (LTE-active) primitive; and

a circuit configured to provide an MIH link up event or an MIH link handover complete event to an upper layer in response to the LTE-active primitive.