Integration of Media Point System with the 3GPP IMS

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Abstract - **In this paper we propose an integration of the Media Point [1-6] and 3GPP/UMTS systems, which aims to allow subscribers to access Media Point specific personalised services by using both WLAN and UMTS interfaces, while focusing on a fast session re-establishment during system transition from UMTS to WLAN. Based on the interworking scenarios identified 3GPP, a loose-coupling solution for the WLAN/UMTS integration is presented. The solution arranges a connection at the application level between the service nodes of Media Point system and 3GPP IP Multimedia Subsystem (IMS) as it makes use of the fact that both systems are employing the Session Initiation Protocol (SIP) for their mobility and session management. We show that the integration can benefit from the Location Services (LCS) feature of the 3GPP system in order to minimise the session interruption time on one hand, and to help the user terminal save its battery on the other hand. The efficiency of the solution as well as the expected reduction of session resume time cannot be estimated yet as it strongly depends on the performance of the selected positioning method provided by the access network (UTRAN).**

1. Introduction

Our so-called Media Point service concept, which aims at enhancing the capabilities of WLAN-based access networks to provide personalised services to users in accordance with their mobility behaviour and device capabilities, is described in detail in [1-6]. As Media Points we refer to regular broadband radio access points installed on easily reachable places in public areas, e.g., traffic signs, street lamps, walls of buildings (inside and outside), etc., that are controlled in such a way to strive for service session continuity in spite of discontinuous radio coverage. As our previous works only dealt with the provisioning of Media Point specific services using a single Radio Access Technology (RAT), i.e., WLAN, in this work, we investigate the use of different RATs, i.e., WLAN and 3GPP/UMTS, and the issues on their interoperability. We focus on the scenario that a user with a dual-mode terminal wants to get access to his personalised services anytime, anywhere and by using either UMTS or WLAN interface – whatever is more beneficial. Due to the expected higher data throughput of WLAN, it is assumed that a system transition from UMTS to WLAN is preferred by the user for many data services and the actual service session should be resumed with the WLAN access as soon as possible.

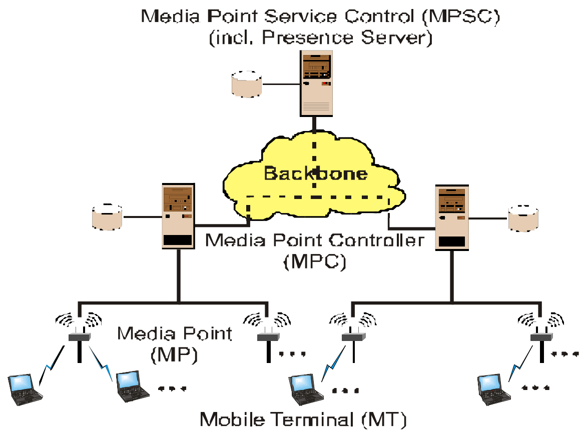

Fig. 1. Media Point network architecture

This paper is organised as follows. Section 2 provides a brief introduction into the Media Point network and its possible integration with the UMTS system. Section 3 gives a short introduction into the 3GPP IP Multimedia Core Network Subsystem (IMS), to which the Media Point service infrastructure is proposed to be connected. Furthermore we will address that the Media Point integration can benefit from the 3GPP Location Services (LCS) feature in order to achieve a minimal session resume time. An overview of LCS and the role of Mobile Location Protocol (MLP) are given in Section 4, while in Section 5 the LCS-supported integration approach is presented and discussed. Finally, Section 6 presents the conclusions of the work.

2. The Media Point Network

2.1. Network Architecture

As shown in Fig. 1 four types of components form together a Media Point network: the *Media Point Service Control (MPSC)*, the *Media Point Controllers (MPCs)*, the *Access Points* or *Media Points (MPs)*, and the *Mobile Terminals (MTs)*. MPSC is the central logical entity of a Media Point network and provides the interface to cellular network and Internet. It usually functions as a Presence Server (PS) as well to monitor the presence status and location of each active mobile user. MPSC supervises all MPCs belonging to that particular network. Each of the MPCs controls a group of MPs which are usually located in close geographical proximity. A group of MTs is finally associated to each of the MPs.

2.2. Signalling Mechanism using SIP

The mobility and session management within the Media Point network is handled by the *Session Initiation Protocol (SIP)* [7] (Fig. 2). As already

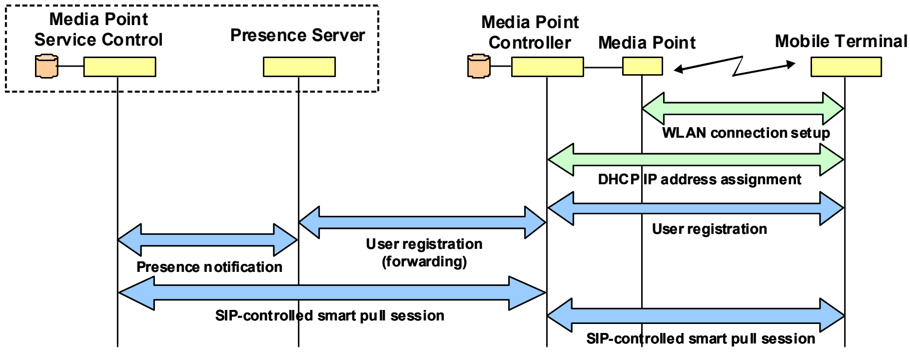

Fig. 2. SIP-based mobility and session management in Media Point network

mentioned the presence status of each user is stored in the *SIP Presence Server (PS)*, which is co-located in MPSC. The MPSC is notified when the user's presence status has changed (using SIP NOTIFY method). The change is detected by PS in the way that the MT registers itself at an MPC (using SIP REGISTER method) after it is associated with an MP and assigned an IP address via DHCP. The MPC forwards the registration to PS. Whenever new personalised data is available at MPSC and the addressed user is online, a new push session is initiated (using SIP INVITE). The data is transferred completely first to MPC before it is passed to MT. A "smart pull" approach is applied, which pushes a list of content available for download to the MT and MPC. This allows MPC or MT to decide by itself how and when the data should be downloaded depending on its capability, e.g., cache size, computational power, link quality, etc. Some services may be configured such that they are only provided when the terminal is connected to broadband hot spots.

2.3. Interworking with the UMTS System

In its technical report [8] the 3GPP group presents the results of its feasibility study on 3GPP system to WLAN interworking. In total 6 different interworking scenarios are identified with the goal to avoid modifications to WLAN standards and to minimise changes in existing 3GPP specifications. Each scenario realises an additional step in integrating WLAN in the 3GPP service offering and naturally includes the previous level of integration of the previous scenario. One of the scenarios, i.e., the interworking scenario 4, is highly relevant for the integration of Media Point and UMTS systems. This scenario allows WLAN users to access 3GPP Packet Switched services, e.g., IMS based services, location based services, etc. The scenario specifies that services can survive the process of change of access network technology (i.e., system transition) between WLAN and 3GPP system. The end user needs not to re-establish the service (i.e., manually) due to the change. As a consequence a change in service quality may happen. Noticeable interruptions during system transitions are tolerated.

Typical personalised data services to be offered by a Media Point network such as mailbox update or download of subscribed multimedia contents, do not absolutely need seamless service continuity. Service continuity should be provided in the way that minimal interruption time due to system transitions can be achieved as to allow fast (automated) session re-establishment. Data loss can be tolerated due to the caching and re-transmission capability of the Media Point network. Change of the terminal's local IP address can be handled by the corresponding SIP-based mobility management. The data services benefit from the potentially high data rate expected in WLAN. Some loss in data rates due to a change of access technology from WLAN to UMTS system is to be expected. Furthermore for UMTS wide area coverage is assumed. Therefore the switch from WLAN to UMTS is considered as less critical and thus we do not focus on optimisation of interruption times for this case. On the contrary the transition and session re-establishment procedure from UMTS to WLAN system should be completed as soon as possible concerning the possibly short user's dwell time due to limited Media Point coverage and user's mobility. As SIP is used in both 3GPP IMS and Media Point system, in the next sections we deal with issues on primarily realising the interworking scenario 4 for continuation of service offering due to change from 3GPP IMS to WLAN-based Media Point network.

3. The 3GPP IP Multimedia Subsystem (IMS)

The IP multimedia subsystem enables PLMN operators to offer their subscribers multimedia services based on Internet applications, services and protocols. The IMS shall support interworking with existing fixed and mobile voice and IP data networks, including PSTN, ISDN, and Mobile Internet. The complete solution consists of terminals, GSM and UMTS access networks, GPRS evolved core network, and the specific functional elements of IMS described in the following Section 3.1 [9]. SIP is used for call signalling and service session management. The packet switched domain is utilised by IMS to transport multimedia signalling and bearer traffic. The packet switched domain maintains the service while the terminal moves and hides these moves from the IMS.

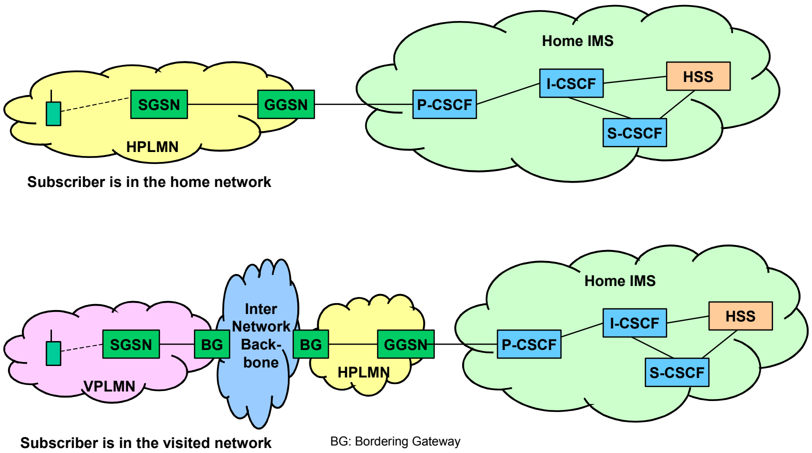

Fig. 3. Accessing IMS services via home or visited network

3.1. IMS Architecture

In order to access IMS services a mobile terminal (MT) connects to its home GGSN (Gateway GPRS Support Node) via SGSN (Serving GPRS Support Node) when the subscriber is in the home network (HPLMN) or via SGSN and BGs (Bordering Gateways) when the subscriber is in the visited network (VPLMN), as illustrated in Fig. 3. It is also possible to contact the GGSN and P-CSCF of the visited network, e.g., for the sake of routing optimisation. Further the terminal requires an IP address that is logically part of the IMS IP addressing domain, which can be established using an appropriate PDP (Packet Data Protocol) context. An IMS consists of a number of *Call/Session Control Functions (CSCFs)* with the following three roles:

- **Proxy CSCF (P-CSCF):** It is the first contact point within the IMS. Its address is discovered by mobile terminals following PDP context activation. P-CSCF forwards the SIP messages between the mobile terminal and its home network. The mobile terminal may contact the P-CSCF of its home network or a visited network.
- **Interrogating CSCF (I-CSCF):** It is the first contact point of an operator's network (for other operators). I-CSCF is responsible to assign an S-CSCF to a user performing SIP registration and to forward incoming requests or responses to the S-CSCF.
- **Serving CSCF (S-CSCF):** It performs session control and service triggering for the mobile users. Located in the user's home network, it accepts the SIP registration of the user and authenticates the user during registration. S-CSCF interacts with service platforms for the support of services. The service platforms may be located inside or outside the home network, i.e., external service platform.

The Home Subscriber Server (HSS), which evolves from the well-known Home Location Register (HLR), maintains a centralised database of the network's subscribers. It is interfaced with I-CSCF and S-CSCF to provide information about the location of the subscriber and the subscriber's subscription information.

3.2. Media Point Integration with IMS

The IMS can be connected to an *external service platform* via its S-CSCF entity. The Media Point infrastructure can be considered as such external service platform whereby the MPSC serves as the inter-system connection point to the IMS, as illustrated in Fig. 4. The MPSC's IP address is assumed to be fixed and known to its subscribers. Through the IMS/MPSC connection, a subscriber, who is currently connected to a 3GPP network/IMS, may contact the MPSC and thus its SIP Presence Server entity to pass on information related to his current location or service needs. Such information may be included in a SIP REGISTER message used for registering the user in the IMS. The

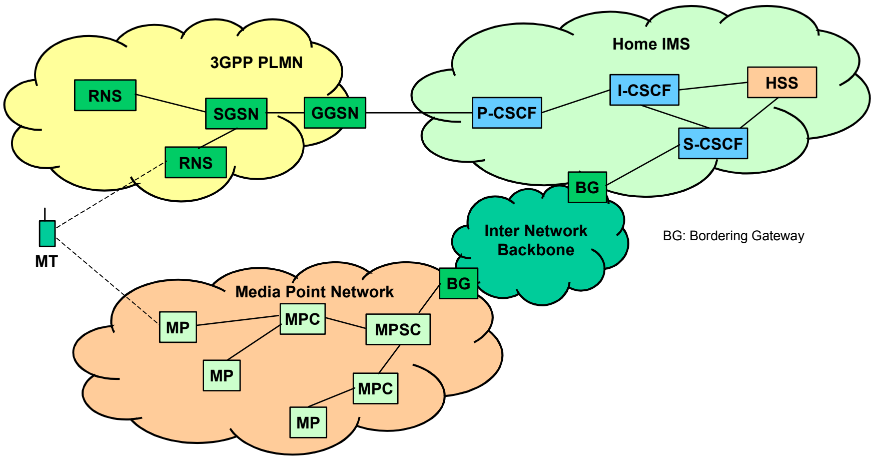

Fig. 4. Proposed architecture for the integration of Media Point infrastructure with 3GPP IMS

SIP MESSAGE method might be used for pushing this information as well.

Our main idea is to allow the MPSC get as much information about the current location and need of its subscriber as possible while his terminal is currently not physically connected with the Media Point network via one of its Media Points. The MPSC may thus prepare and cache the personalised user data such that faster session setup and re-establishment can be ensured when the subscriber connects with a Media Point in a foreseeable time. It is of high importance that the accurate position information of the user terminal can be passed on to the MPSC via the UMTS network/IMS. As MPSC can also send an instant message, i.e., using SIP MESSAGE method, to the subscriber through IMS, MPSC can trigger the user terminal to activate (or deactivate) its WLAN transceiver module based on the fact whether or not the terminal is currently moving within or in the proximity of a Media Point coverage area. This requires that the MPSC has a coverage map of the hotspot locations. This feature can help to save the terminal's battery as it prevents the terminal from scanning for a Media Point outside coverage. 3GPP has specified a number of methods to provide Location Services (LCS) in UMTS systems. In the next sections we describe the LCS capability of 3GPP system and its employment for supporting service offering via Media Points.

4. Location Services (LCS) in 3GPP System

A general description of 3GPP location services and service requirements are given in [10]. The position information of a mobile terminal is provided by the access network, e.g., by UTRAN [11], and to be made available to the user, network operator, service providers, and for PLMN internal operations, e.g., for location assisted handover. The position information is reported in standard geographical co-ordinates, together with the velocity, time of day and the estimated errors (uncertainty/accuracy) of the terminal's location [12].

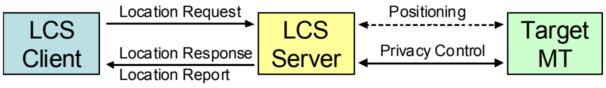

Fig 5. LCS logical reference model

4.1. Reference Model

The LCS reference model (Fig. 5) consists of the logical functional entities *LCS client*, *LCS server* and *Target MT*. An LCS client sends a *Location Request* to the LCS server to get the position information of one or several target MTs. The target MT may be identified by its MSISDN, IMSI, IP address, SIP URL, or other unique identification. The LCS server may provide a *Location Response* to a client's request if considerations of target MT privacy are satisfied. A response is either of type "immediate" or "deferred" depending on the request. Upon receipt of an *Immediate Location Request* the LCS server replies immediately with the current MT location estimate if this could be obtained. In case of a *Deferred Location Request* the LCS server may respond some time after the request was sent based on the following events:

- **MT Available:** Any event in which the SGSN has established a contact with the MT, e.g., after *GPRS Attach*. The event only requires one response and after the response, the event is concluded.
- **Change of Area:** An event where the MT enters, leaves or is currently within a geographical area pre-defined by the LCS client. The event may be reported once only, or several times depending on the LCS client's request. For this purpose the LCS server sends a *Location Report* to the LCS client.

LCS is logically implemented on the network structure through the addition of one network node, the *Mobile Location Centre (MLC)*. Each LCS client and server consists of a number of LCS functional entities which are distributed over, and allocated to different, PLMN elements like SGSN, GMLC, or HSS [13]. The *GMLC (Gateway MLC)* is the first node an external LCS client accesses in a PLMN.

The attributes for the information exchange between the LCS client and the LCS server have been standardised by the Open Mobile Alliance (OMA) within the scope of its Mobile Location Protocol (MLP) specification. External LCS client applications may communicate with LCS server applications (in GMLC) by using the messages defined in MLP.

4.2. LCS with Mobile Location Protocol (MLP)

MLP is an application-level protocol that can be used to request MT location information from an LCS server (e.g., GMLC). The MLP specification [14] provides a simple and secure application interface to LCS server. Well-known Internet protocols like HTTP or SSL/TLS can be used for the information exchange. The messages are formatted in eXtensible Markup Language (XML), which can be customised for operator or vendor specific features.

A number of different possible types of location services are defined in MLP. In the context of LCS-supported Media Point integration with IMS, the following two services are of high importance:

- **Standard Location Immediate Service:** This service is used when a (single) location response is required immediately or the request may be served by several asynchronous location responses/reports.
- **Triggered Location Reporting Service:** This is a service used when the MT location should be reported at a specific time interval or on the occurrence of a specific event. While currently only the triggering event "MT Available" is supported, future releases plan to support entering or leaving an area, as defined in [12]. Fig. 6 shows an example of triggered location reporting service of MLP.

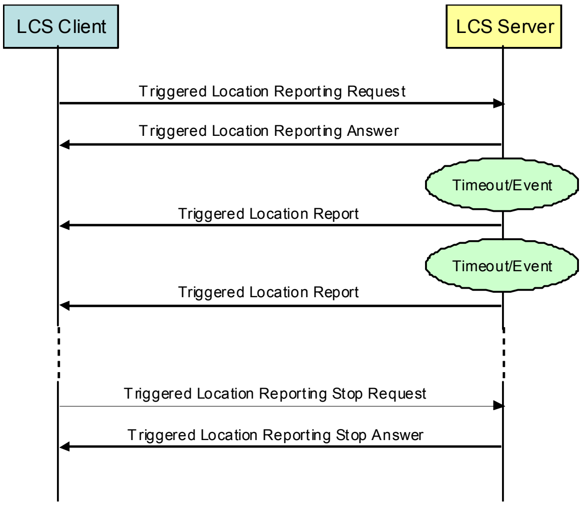

Fig. 6. Triggered location reporting service of MLP

5. Media Point System Integration with 3GPP IMS with LCS Support

LCS may support the Media Point system in estimating the location of its subscribers with the objective to prepare for the service provisioning as early as possible and to trigger the activation of WLAN transceiver module of the subscriber's terminal. The triggering should be based on the event that the terminal is currently within or moving towards one of the pre-defined Media Point coverage areas.

5.1. Protocol Description

The MPSC takes the role of an external LCS client which can exchange LCS information with an LCS server in the UMTS core network (GMLC as the first node) by means of MLP at application level. As both MPSC and GMLC can be identified and contacted by their IP addresses, both entities can exchange MLP messages over any IP-based backbone network, not necessarily over the IMS infrastructure. The *Standard Location Immediate Service* and *Triggered Location Reporting Service* of MLP are used for this purpose. In addition appropriate security measures, e.g., by applying IPsec, should be taken to protect the confidentiality and integrity of the exchanged messages. The security issue is not further considered in this paper.

The message flow for the LCS-supported Media Point integration with IMS is depicted in Fig. 7 and described as follows:

1. We assume that a dual-mode mobile terminal (MT) has established a UTRAN signalling channel, performed GPRS attach, activated the PDP context and discovered the P-CSCF address as preparation for SIP registration in the IMS. The terminal's WLAN transceiver module is deactivated.
2. MT initiates SIP registration in the IMS and indicates the MPSC as its external service platform. We assume that the MPSC's IP address is fixed and known to the subscriber.
3. After completing the registration procedure and, assumed that the IP address of the corresponding GMLC is known (e.g., based on user's subscription information and/or his terminal's current IP address), the MPSC requests the geographical information of the coverage area of the serving Node B (i.e., UTRAN cell) by sending the *Standard Location Immediate Request* to the GMLC.
4. After verifying the MPSC's identity, the core network (CN) sends the *Immediate Location Request* to the RNS to request the serving UTRAN cell location information.
5. The geographical information of the UTRAN cell is then provided to the CN within the *Location Report*. The CN includes this information in the *Standard Location Immediate Answer* and sends it to the MPSC.
6. By examining the location information of the serving UTRAN cell the MPSC can estimate the particular Media Point coverage areas inside the UTRAN cell.
7. The MPSC sends the location information of the determined Media Point coverage areas by means of the *Triggered Location Reporting Request* to the CN in order to request the event-based location report of the target MT once it is within one of the coverage areas. Note that this event is currently not yet supported by MLP.
8. The CN in turn creates the *Deferred Location Request* and sends it to the RNS.
9. The RNS acknowledges with a *Location Report* and applies the pre-configured method to localise the target MT.
10. The CN acknowledges the MPSC's request with the *Triggered Location Reporting Answer* .
11. As long as the MT does not enter one of the pre-defined areas the user may access the IMS-based services over the established UTRAN connection. The MPSC is used as an external service platform to provide personalised services to the user in accordance with the available service quality.
12. Once the RNS detects that the target MT has entered one of the pre-defined Media Point areas, it includes the estimate MT position in a *Location Report* and sends it to the CN.
13. The CN forwards the MT position to the MPSC within the *Triggered Location Report*.
14. By knowing now that the target MT is within the coverage of a Media Point (with certain accuracy), the MPSC sends a SIP MESSAGE to MT via the IMS interface. This instant SIP message includes information for triggering the activation of MT's WLAN transceiver module. In addition the MPSC carries out appropriate procedures to speed up the forthcoming session establishment between the MT and the Media Point network, e.g., by pre-caching the user data in the serving MPC.
15. After receiving the SIP MESSAGE the MT activates its WLAN transceiver module and scans for WLAN *Beacon Frames* to get associated with a Media Point in proximity. And after completing the association procedure the regular SIP-based session setup procedure (Fig. 2) is carried out and personalised data can be downloaded via the WLAN interface.

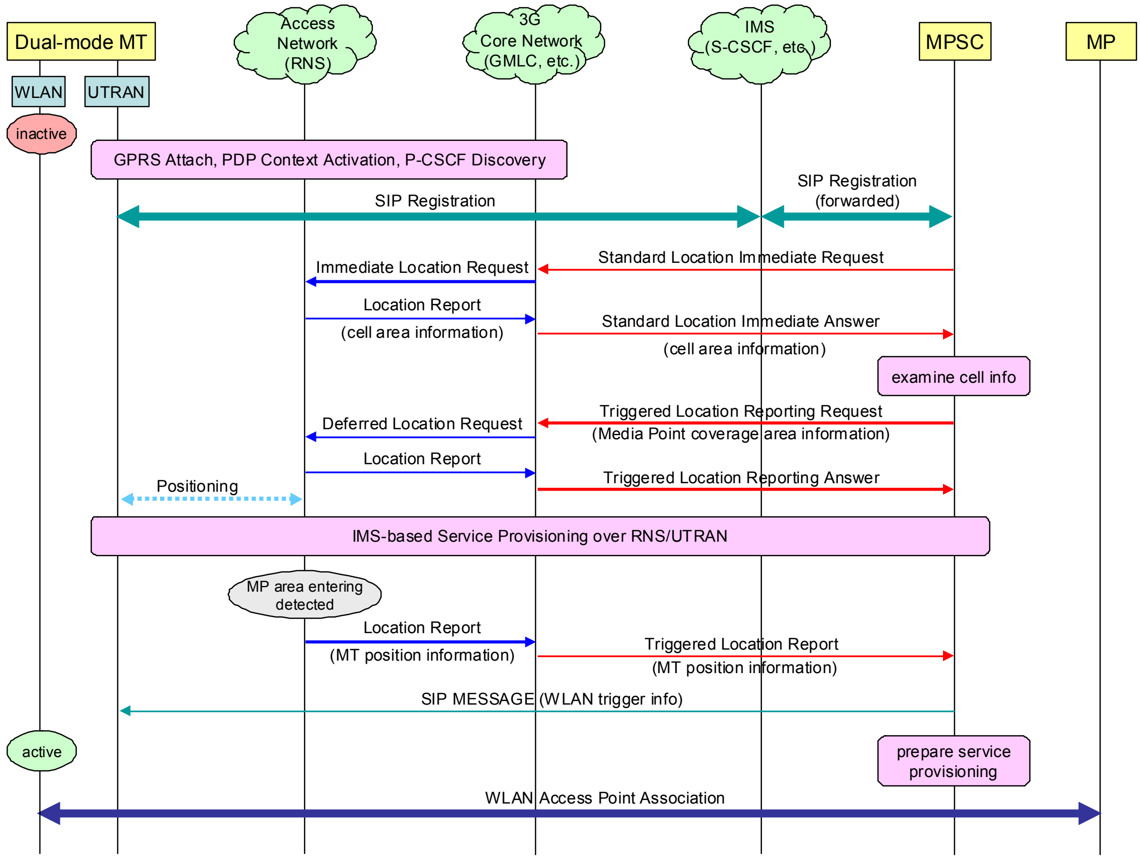

Fig. 7. Message flow for LCS-supported Media Point system integration with 3GPP IMS

5.2. System Behaviour after Change of Access Technology

It is implementation-dependent whether or not the connection with the IMS via UTRAN should be further maintained once the session over WLAN interface is (re-)established. One advantage to keep the connection alive is that the UMTS infrastructure may further be used for location services during the Media Point service sessions or during session interruptions (for supporting session re-establishment). The location report containing the geographical area information of the serving UTRAN cell may be provided periodically or based on "cell changing" event to the CN and forwarded to the MPSC using the *Standard Location Reporting Service* of MLP. The MPSC can thus react when the target MT has changed the cell; a new *Triggered Location Reporting Request* containing geographical information of other Media Point coverage areas should then be triggered.

Provided that the terminal's UTRAN access is not released during the WLAN service provisioning, the user terminal is further able to communicate with the MPSC through the IMS interface and vice versa. When the user leaves the Media Point coverage area and the AP association is lost consequently, the service provisioning will be interrupted and, depending on the pre-configured user's subscription profile and service characteristics, may be resumed via the UTRAN/IMS interface. A *Triggered Location Report* indicating the "leaving area" event will be sent from the CN to the MPSC. Since this report contains the current estimate MT position, which may include its velocity and heading, the MPSC can determine – based on its WLAN coverage area database – whether or not it makes any sense to let the terminal deactivate its WLAN module to save its battery. In order to avoid the "ping pong" effect, the terminal's WLAN module should remain active if the MPSC locates a Media Point coverage in terminal's proximity. When within a certain time period the terminal has entered the Media Point coverage area as expected, the AP association procedure will be carried out and the interrupted session will be re-established via the new AP. Otherwise the MPSC sends a SIP message (over the UTRAN/IMS interface) to the terminal to deactivate its WLAN module. As long as the terminal has not changed its UMTS cell, the MPSC needs not to update its *Triggered Location Reporting Request* to keep itself being notified about the "entering area" event.

Note that the integration approach presented above only applies to the data services that are provided by the MPSC as an external service platform via the S-CSCF. Other IMS-based services, e.g., Voice over IP, video conferences, that are provided by any other service platforms (internal or external), may apply another approach which is tailored to their service characteristics. The services may use separate (parallel) PDP contexts with different QoS for their data transfer and signalling. For example, the services might be redirected by means of Mobile IP in case of a system transition.

6. Conclusions

In this paper we deal with issues on the integration of 3GPP/UMTS network and the WLAN-based Media Point network, which aims at providing the session continuity of personalised services to dual-mode user terminals during vertical handover from UMTS to WLAN in particular. Though session interruptions can be tolerated by Media Point specific services (e.g., mailbox update) the interruption time caused by the system transition must be kept minimal due to the limited WLAN coverage. The session must be automatically re-established via WLAN as soon as possible.

In accordance with a WLAN/UMTS interworking scenario specified by 3GPP and the nature of Media Point personalised services we propose a loose-coupling integration [8] of the Media Point infrastructure with the 3GPP IP Multimedia Subsystem (IMS) to allow services survive the process of change of access network technology. A change in service quality as well as noticeable interruptions during system transitions can be tolerated. The integration approach seems reasonable as both the IMS and Media Point system employs SIP (Session Initiation Protocol) for their session and mobility management.

In order to minimise the service interruption times, we make use of the 3GPP Location Services (LCS) capability. We propose an LCS-based solution to allow the operator's network get notified once a user terminal with a deactivated WLAN transceiver module has entered a Media Point coverage area. By means of SIP-based communication the network can trigger the user terminal to activate its WLAN interface and thus start scanning for Media Points in proximity. This approach may help to save the terminal's battery. Due to such location prediction capability the network may pre-cache the personalised user data in the expected Media Point service node, from which the user terminal can download the data immediately after it is associated with the corresponding access point. The efficiency of this solution certainly strongly depends on the accuracy of the terminal's position information provided by the cellular access network (e.g., UTRAN).

Our further study deals with the tighter integration of the Media Point system with the cellular UMTS system. This may imply the integration of Media Point service nodes inside the UMTS core network. While a better improvement of the system performance regarding session setup and resume time could be achieved, higher implementation effort and technical complexity will be expected.

ACKNOWLEDGMENT

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