Impacts of SUPL Capabilities on Location Based Services in Next Generation Mobile Networks

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***Abstract* —While control plane depends on using network signaling channels, positioning information is exchanged over data bearers, such as IP, during location determination over user plane. Due to this infrastructure independence, user plane is a practical choice for location determination in next generation mobile networks, which are planned to be ALL-IP architectures with legacy interworking. In this paper Secure User Plane Location protocol is evaluated in the aspects of supported mobile networks and location services capabilities.**

***Keywords* — Location based services, next generation mobile networks, SUPL.**

I. Introduction

Detecting the location of a person has been an interest topic of mobile domain in the context of services like emergency assistance, lawful interception, corporate employee tracking, social applications (friend finder, child finder) and navigation.

In order to specify and standardize the architecture and mechanism of Location Services (LCS), 3GPP has been studying the subject since R99 from operator, subscriber and third party service providers perspective. The point reached by these studies considers GSM, UMTS and EPS (for E-UTRAN) together with WLAN interworking [1] in Rel9 where Gateway Mobile Location Server stands in heart of the architecture and implements most of the mechanisms stated in the standard.

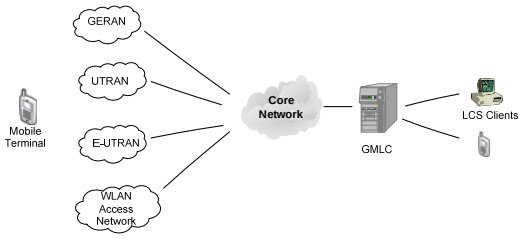

Fig. 1. General LCS Architecture in 3GPP Rel 9

Apart from standardization aspects, there have also been studies on location detection methodologies over wireless LAN[2] and Wimax[3] networks.

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Support of location determination have also been taken into consideration of next generation mobile networks where coexistence of various mobile technologies and interworking between them is targeted [5], [6].

Considering the growth of public WLANs and the opportunities for the appropriately equipped UEs to access to GSM/UMTS networks, studies in 3GPP domain where location services were also taken into consideration[4] in the past.

After a high level explanation of positioning methodologies in section II, SUPL protocol and how the positioning methodologies are applied by it are explained in section III.

II. Location Detection Methodologies

Location determination on mobile networks mainly depends on taking the coordinates of the served based stations as reference points. The location of the terminal can be estimated by utilizing, Time of Arrival (TOA), Time Difference of Arrival (TDOA), Angle of Arrival (AOA) and Signal Strength of Arrival (SSOA) of radio signals wireless network.

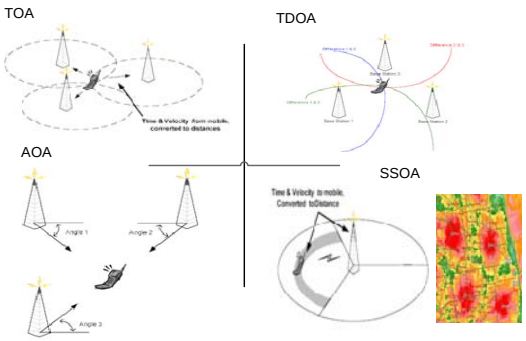

Fig. 2. Mobile Network Based Positioning Methodologies

On the other hand, satellite based positioning is based on the measurement of signal strengths of several global navigation satellite systems (e.g. GPS and Galileo) by the terminal that has the specified capability. The general name for these systems are Global Navigation Satellite Systems (GNSS) [7].

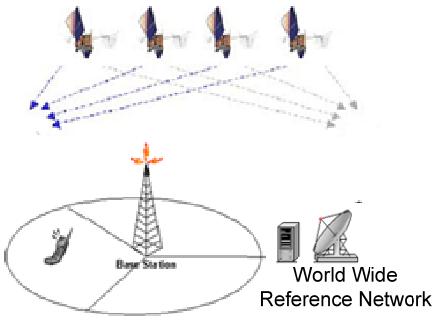

Fig. 3. A-GNSS Based Positioning

World Wide Reference Networks are ground based monitoring stations, which have the satellite orbit and system data. These information are called assistance data and is mainly retrieved by the mobile operators to be delivered to the terminals during satellite based location determination.

TABLE 1: 3GPP 23.271 REL 9 POSITIONING METHODS

GERAN	***UTRAN***	***E-UTRAN****
1-Cell Coverage Based 2-Enhanced Observed Time Difference (E-OTD) 3-AGNSS 4-Uplink Time Difference of Arrival (U-TDOA)	1-Cell Coverage Based 2-Observed Time Difference of Arrival (OTDOA) 3-A-GNSS 4- Uplink Time Difference of Arrival (U-TDOA)	1-Cell Coverage Based 2-Observed Time Difference of Arrival (OTDOA) 3-A-GNSS 4- Uplink Time Difference of Arrival (U-TDOA)

* For E-UTRAN above methods are being evaluated for Rel 9.

- Cell coverage based positioning: The position of a terminal is estimated by utilizing the serving base station or Node B coordinates and received signal strengths. For GERAN, Timing Advance(TA); for UTRAN signal RTT (Round Trip Time) in FDD mode and Rx Timing deviation in TDD mode parameters which represent the distance between the terminal are utilized to determine the location of the terminal.
- Enhanced Observed Time difference of arrival(E-OTD) : Observed time difference of arrivals of nearby base station and Node B pairs' signals are measured by the terminal to determine its position in GERAN and UTRAN respectively.
- A-GNSS based positioning methods: Satellite based positioning methods may operate both in an autonomous mode or in an assisted mode. In autonomous mode the terminal determines its position based on signals received from GNSS without assistance from network. In assisted mode, the terminal receives some of the data from network instead of satellite systems and utilizes them in its calculations. The receipt of assistance data both speeds up the position calculation procedure and decreases the battery usage on the terminal.
- Uplink Time Difference of Arrival (U-TDOA): Time Of Arrival (TOA) of a known signals sent from the terminal. are measured by three or more Location Measurement Units (LMU) devices on base stations to estimate the position.

For positioning over WLAN networks, 3GPP addresses OMA SUPL specification as well.

III. SUPL

The main idea of Secure User Plane Location Protocol (SUPL) of OMA depends on exchanging positioning specific information between the terminal and location server over data bearers such as IP. Therefore in it eliminates the need for any modification on core and radio network of an operator needed for location determination over control plane.

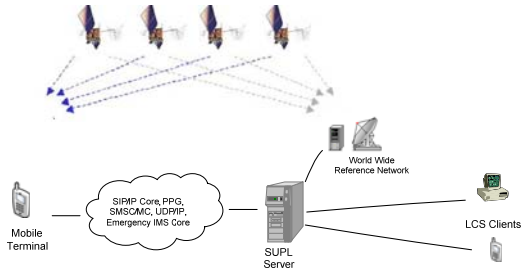

Fig. 4. SUPL Architecture

The first applications of SUPL have aimed to address the satellite based location method requirements such as heavy satellite assistance data to be supplied to terminal by the location server over user plane, in order to decrease the time to first fix and the battery usage of the terminal.

The first version of the protocol consisted terminal based and Assisted GPS, Autonomous GPS, E-OTD, OTDOA and enhanced Cell Id methods of GSM/UMTS networks and roaming support[8]. Support of LTE, UMB, I-WLAN, WiMAX. networks, both periodic and area event triggered positioning procedures, emergency positioning procedures, support of A-GNSS, delivery of location to third party and retrieval of another SUPL enabled terminal's (SET) location features were introduced in the second version[9].

SUPL Server may be considered as s GMLC with only user plane positioning capability. Both network and terminal based positioning procedures are covered in the context of SUPL.

A network based SUPL session may be initiated by a request towards the terminal using OMA Push, SMS, UDP/IP(in version 2) and SIP Push (in version 2) that consists the requested positioning method. After receiving that request the SET establishes a secure data connection to SUPL server using the URL in the terminal settings. The position related signal measurement data is exchanged over this channel till the location of the terminal is calculated.

In case of terminal based session, the SUPL Agent on terminal establishes a secure data connection to SUPL Server in order to exchange position related measurement data to be used during location determination.

IV. Conclusion

In this paper the state of art and future requirements for the location determination on the mobile networks are presented. Our aim was also to emphasize the SUPL capabilities, which fulfill the requirements of location determination over next generation mobile networks in a practical way, as it is not mentioned in the NGMN studies yet.

References

[1] 3GPP 'Functional stage 2 description of Location Services and System Aspects,' 3GPP TS 23.271 V9.1.0 September 2009

[2] M. Robinson and I. Psaromiligkos, 'Received Signal Strength Based Location Estimation of a Wireless LAN Client,' presented at the 2005 IEEE Wireless Communications and Networking Conference, New Orleans, LA, March 13-17.

[3] W. Jiao, P. Jiang, R. Liu, W. Wang and Y. Ma, 'Providing Location Service for Mobile WiMAX,' presented at the 2008 IEEE International Conference on Communications, Beijing, China 19-23 May

[4] 3GPP 'Feasibility study on Location Services (LCS) for Wireless Local Area Network (WLAN) interworking,' 3GPP TR 22.935 V8.0.0 December 2008.

[5] http://www.ngmn.org

[6] V. Kafedziski, 'Next Generation Mobile Networks,' presented at the Telecommunication Forum TELFOR 2008 Serbia, Belgrade, November 25-27 2008.

[7] A. Küpper (2005). *Location-Based Services Fundamentals and Operation* (1).

[8] Open Mobile Alliance, 'Secure User Plane Architecture,' Version 1.0, OMA-AD-SUPL-v1_0-20070615-A, 15June 2007.

[9] Open Mobile Alliance, 'Secure User Plane Architecture,' Version 2.0, OMA-AD-SUPL-V2_0-20080627-C, 27 June 2008.