Improving the LBS QoS through Implementation of QoS Negotiation Algorithm

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Abstract - Location-based Services (LBS) utilise location awareness for delivery of useful information/content to the user. When considering the Quality of Service (QoS) for LBS, few parameters defined in standards can offer the basic insight into the actual quality of provided service. Usually, the pattern is to strive to the best values for each defined parameter. It is however unnecessary, both from technological and economical point of view, to demand an excellent QoS performance for every LBS. It is much more efficient to use the service and user preferences and construct the appropriate level of QoS for LBS in question. This paper introduces the negotiation algorithm for improving the LBS QoS. Proposed algorithm makes it possible to determine the most suitable level of QoS for particular LBS. Practical validation of the algorithm is also presented, based on the developed prototype.

I. INTRODUCTION

Location-based services have finally emerged as a very prosperous group of telecommunication services [1]. Aimed to provide content and services based on user's location (knowledge of the user's place in a physical space enhanced by information about geospatial relations with the other neighbouring objects), it is the appropriate establishment of Quality of Service (QoS) for LBS that drives the business success [2].

Industrial standards [3] have determined the LBS QoS parameters and current common practice has aimed for obtaining as best QoS as possible, regardless of the actual and common needs of particular LBS. Such an approach usually overloads network resources without benefit for either service provider, content provider, network operator or end-user.

Here the improvement in the LBS QoS is presented, achieved through a special LBS QoS Negotiation Algorithm (NA) implementation. The introduction of the LBS QoS NA reduces usually overstretched requirements on positioning performance as the foundation of the LBS QoS, thus providing the most suitable QoS level in accordance with requirements of invoked LBS and the user personal profile.

Overall, proposed LBS QoS NA provides efficient utilisation of all resources involved in LBS provision with firm guarantees on the quality of the LBS provided.

II. LBS QUALITY OF SERVICE

As any other group of telecommunication services, LBS provide services with a certain level of quality [2]. International industrial standards [3] define the fundamental parameters of LBS QoS, as presented in Table 1. Although these parameters do not cover all aspects of LBS QoS and thus do not provide the complete LBS description, their international acceptance allows for at least provisional distinction between various location-based services based on their quality.

TABLE I

LBS QoS PARAMETERS

LBS QoS PARAMETERS
Horizontal position determination accuracy
Vertical position determination accuracy
Response time

In practice, achieving the requested level of LBS QoS [3] means the implementation of a particular position estimation method.

Existing position determination methods can be outlined in two essential groups:

- (telecom) network-based position determination methods
- terminal-based position determination methods.

Network-based position determination methods [3] are based on utilisation of signals and hardware installations of public mobile communication networks. The network is responsible for performing the appropriate measurements and calculation of the user's position estimate. User's equipment (mobile phones) serve in position determination process as auxiliary and assistance devices, supplying common control signals to the network. Common network-based position determination methods are [3]: Cell Global Identity (CGI) method and Extended Observed Time Difference (E-OTD) method. In principle, network-based position determination methods are robust and widely available (availability is determined by network coverage), but not accurate (~150 m, at their best) [3].

Terminal-based position determination methods are based on intelligent user equipment capable of conducting their own measurements (at least) and performing the appropriate position determination procedure (optional, the position determination can be performed within the network elements as well). In terminal-based position determination, the necessary measurements are conducted by mobile equipment, with optional assistance given either by public mobile communication network, or by some third party [1, 3]. A widely acclaimed example of terminal-based position determination method is one utilising a satellite navigation receiver embedded in user equipment.

Satellite-based determination of user's position [1] is based on satellite-to-user radio propagation time measurements, and is entirely terminal-based. At the moment, only one satellite navigation system is fully operational with global coverage: the US Global Positioning System (GPS) [1]. Russian system Glonass is to become operational in a couple of years, with a reduced satellite constellation already existing. The European Union prepares its own Galileo satellite positioning system [1, 3]. Several other countries are in process of establishing their own satellite positioning systems, either of global (China), or of regional (Japan, India) nature and coverage.

In addition to standard positioning service offered by satellite navigation systems, the augmentation and assistance systems can be established, some of them relying upon the mobile communication system [1, 3]. For instance, the information needed for position determination (navigation message) can be delivered through mobile communication network instead of satellite navigation satellite. This method is called Assisted GPS (A-GPS) [1, 3]. Furthermore, the correction of known position determination measurement errors can be supplied to users in order to improve the position determination performance. Such an enhancement is called differential GPS [1] and asks for additional equipment to be installed both on the network's and the user's side.

In general, satellite navigation provides unbeatable positioning performance globally. The achieved accuracy is in range of 5 m – 15 m with common commercially available equipment [4]. However, satellite navigation procedures for position determination are very vulnerable. Any action reducing the visibility of the sky can make the system completely unavailable: utilisation in urban canyons, forests, mountainous terrain etc [1, 4]. Satellite-based position determination is generally assumed not available in indoor areas. Furthermore, user equipment (mobile phones) with embedded GPS receivers suffer from the huge energy drainage, thus reducing considerably the life time of battery charge.

Common approach in designing the LBS is to get as better QoS as possible, although in majority of cases this is not needed. This asks for utilisation of GPS, when available.

III. ALGORITHM FOR LBS QoS NEGOTIATION

In an attempt to utilise the network resources in an optimal way, a sensible tailoring of the actual LBS QoS level is proposed. It definitely means lowering the LBS QoS levels in accordance with requirements of the invoked service and the user's willingness to pay for and ability to utilise in the whole the provided QoS. This does not imply degradation of the LBS QoS, but provision of the QoS level appropriate for the service in question.

Tailoring the LBS QoS is accomplished through the introduction of the LBS QoS Negotiation Algorithm (NA), presented on Fig 1. The LBS QoS NA targets the positioning performance (quality of position determination) as the major contributor to the LBS QoS. It uses three essential inputs:

- requirements for QoS for the specific service (service profile)
- service request
- user personal profile.

Parameters of all input groups are presented in Tables 2, 3 and 4, respectively. The choice of the most suitable position determination method for the LBS service in question is set as the goal of the LBS QoS NA.

The most common single position determination methods (satellite positioning using GPS, WLAN/WiFi-based positioning method and network-based positioning method) [1] are considered for possible utilisation. It is presumed that satellite positioning (GPS) method will yield the best positioning performance (smallest position estimation error) [4], followed by WLAN/WiFI (better by network positioning, but worse than GPS) and network positioning (the worst positioning performance, i. e. largest position estimation errors).

TABLE 2

SERVICE PROFILE PARAMETERS

Requested horizontal position determination accuracy
Requested vertical position determination accuracy
Requested response time

TABLE 3

SERVICE REQUEST PARAMETERS

User ID (MSISDN, SIP URL, IMSI)
Code of invoked service
Available position determination methods

TABLE 4
USER PERSONAL PROFILE PARAMETERS

Mobile Station International Subscriber Directory Number – MSISDN
SIP URL
International Mobile Subscriber Identity – IMEI
Status of Emergency Call
Allowed position determination methods

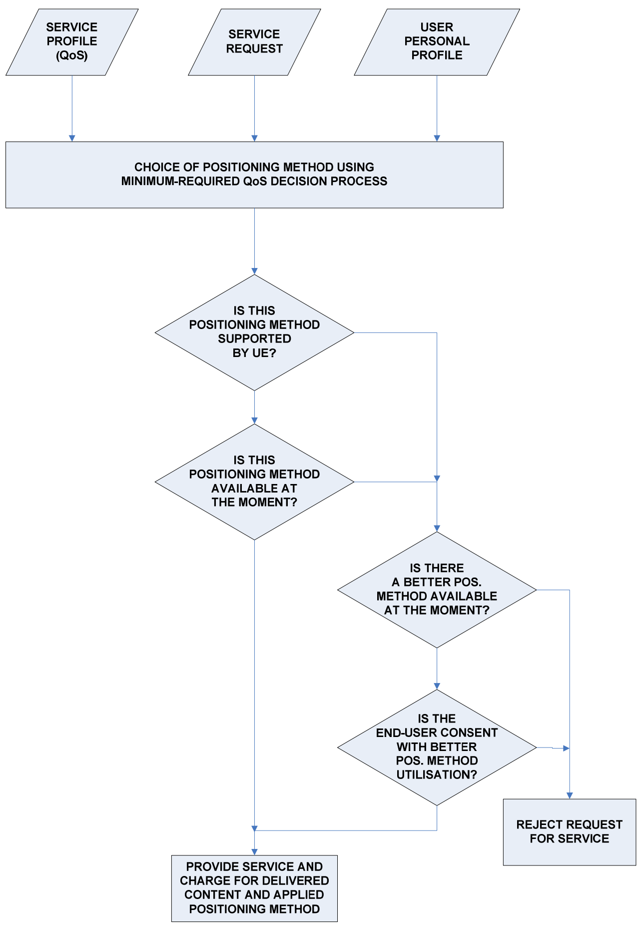

Fig. 1. LBS QoS Negotiation Algorithm

LBS QoS NA targets the minimum (not the best!) LBS QoS level for the service in question. In due course it firstly examines which of listed methods satisfies the minimum requirements for service in question. If this method exists, and if it is supported by user equipment and available at the moment, then this method is to be applied in position determination process and the end-user will be charged accordingly. In case of chosen position determination method being either unavailable or not supported by the user equipment, the first position determination method providing better-than-minimum LBS QoS is examined. If this method is available and the user is willing to pay for it, then it is to be utilised for the invoked service, and the end-user will be charged accordingly. Otherwise, the service request will be dropped, and user informed about it.

Evidently, the LBS QoS Negotiation Algorithm successes in provision of the appropriate LBS QoS for the service in question, preventing network resources of un-necessary over-stretching.

IV. PRACTICAL VALIDATION

The proposed LBS QoS NA is validated through a simple prototype delivering location-related content (points of interests presented on the ©Google Map taken as the geospatial background). Prototype distinguishes LBS QoS levels according to the choice of position determination method, providing maps on different scales and number of points of interest. For instance, the user utilising GPS position determination will be given the most detailed map with various sorts of points of interests (matched with the user personal profile). Naturally, provision of the highest level of LBS QoS will be appropriately charged. For user making different choice of position determination method, a map of different scale and less details will be provided, and at lower expense.

The architecture of the prototype and a snapshot of user's Graphical User Interface (GUI) are presented on figs 2 and 3, respectively.

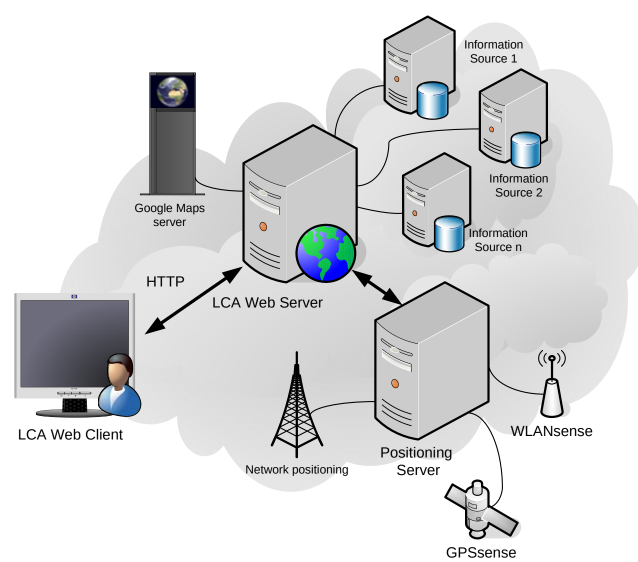

Fig. 2. Architecture of prototype demonstration of the LBS QoS NA

Prototype confirms improvement in efficiency of network resources utilisation.

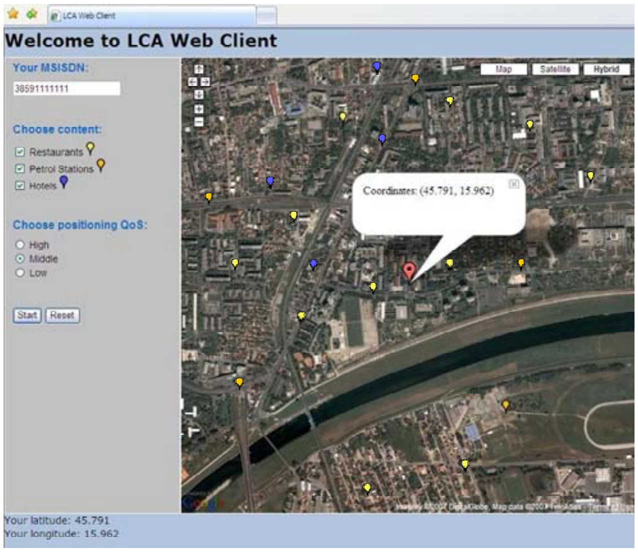

Fig. 3. A snapshot of prototype's GUI

V. CONCLUSION

Proposed concept of the appropriate LBS QoS provision instead of attempting to provide the best LBS QoS is proved to be correct.

Utilisation of the LBS QoS NA eased the stress on network resources, enabling at the same time provision of levelled LBS QoS hierarchy. The end-users get the guaranteed and transparent LBS QoS levels for which they are appropriately charged.

Presented work will be continued with the focus given on negotiating other LBS QoS parameters in order to allow provision of the most appropriate LBS QoS level for the invoked service.

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