# LoL@: a UMTS location based service

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### ABSTRACT

UMTS is expected to offer a powerful environment for location based multimedia services. We have specified such a service, using the packet switched domain of UMTS and overlaying standards like SIP and OSA/ Parlay. LoL@ (Local Location Assistant) is a showcase for future UMTS services and their requirements. It proposes an architecture for location based multimedia services, including advanced user interface concepts with speech recognition and central user preference management. It explores the potential of the standards and shows were improvements are necessary.

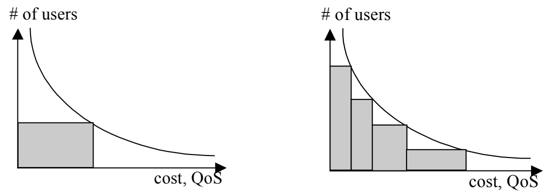
Key words: OSA, Parlay, SIP, LCS, UMTS, location based services, mobile multimedia.

## I. INTRODUCTION

The user is the key to success. In UMTS this paradigm is taken seriously, resulting in an architecture that goes far beyond the capabilities of 2G systems, i.e. GSM. Attractive, intuitive and easy-to-use services, personalised applications and ubiquitous access to location-based services are the driving user expectations [1]. The user will only use services that add value to his/her life, and thus help the service provider to increase his ARPU (Annual Revenue per User). Concepts for service management, e.g. customisable portals, complete the scene.

Mobile communications today is truly a mass market. In Europe, penetrations of 70% and more, as in Scandinavia and Austria, are already reality. In such advanced markets quality-of-service (QoS), in addition to attractive services, is an ideal tool for market segmentation, hence to penetrate the market even further (Fig. 1).

Consequently, a 3G system like UMTS must offer well defined QoS classes that can be guaranteed to the customer. Usually QoS is understood at the bearer level only (bearer data rate, delay constraints, etc.), but what is essential is the perceived end-user QoS.




(a) No segmentation by QoS possible

(b) Segmentation by QoS to increase penetration

Fig. 1: Market segmentation by QoS

In contrast to 2G systems, 3G standardisation is not focusing on services, but on a service network architecture. This allows to meet the user demands while still offering enough freedom to differentiate between user segments (e.g. business people, tourists, children) and competitors. Current mobile communications systems offer no standardised service platform, which would decrease service time-to-market and development costs. Access to network elements, like call state control function (CSCF) or home location register (HLR), is only possible within the network operator domain, by using mobile network specific concepts (CAMEL [2], MAP [3]). Consequently, there is no standardised way for third party applications to use these functionalities.

To realise rich UMTS services, a standardised frame-work for interaction between service provider and network operator is the essential part of UMTS. The fundamentals are open service access (OSA)/Parlay [4],[5] and virtual home environment (VHE) [6].

3GPP standards describe some necessary parts of such a service architecture. However, an implementation of several new features is still missing. A collaborative research project between industry and university at ftw (Forschungszentrum Telekommunikation Wien) aims to fill these gaps with the LoL@ prototype. The goal is to critically consider the process of UMTS service develop-ment (see also http://www.ftw.at/projektC1_en.html). We develop a location based multimedia UMTS service, and subsequently prove it with a demonstrator in a field trial. The ultimate objective is to improve the UMTS service network architecture under near-real-world circumstances.

Section 2 provides an overview of the location based service called LoL@. Section 3 describes the service network architecture, followed by a discussion of architecture concepts in Sec. 4. The paper ends with a summary and conclusions in Sec. 5.

## II. LOL@

Our starting point was to "add value" to the customer's life. We decided to go for a guided tour service named LoL@, Local Location @ssistant. From a UMTS service network point of view it is based on three essential functionalities: *positioning* combined with *multimedia* communication and *speech control*.

A service prototype shows the user experience of LoL@ (Fig. 2).

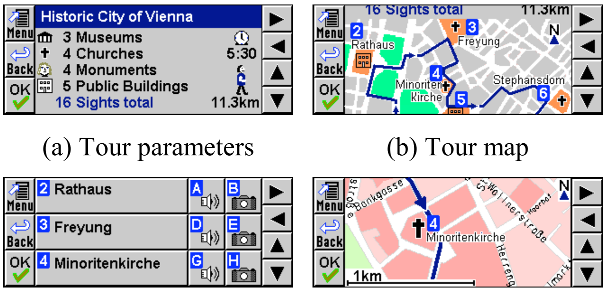



Fig. 2: LoL@ prototype

LoL@ realises a city navigation for tourists along a pre-defined route including points and areas of interest (churches, museums, etc.). We implement the following key concepts:

- location dependent audio/video information,
- single login,
- customisation (user and device profiles),
- voice control;

We need an elaborate user data management, including a standardised access to user profiles, authorisation and authentication. All this has to fit into the framework of UMTS standardisation. This means that the demonstrator architecture will be aligned with UMTS Release 5 architecture [7] and implemented in packet switched domain only.

## III. SERVICE NETWORK ARCHITECTURE

### *A. Domains*

According to the service concept described above, we use three domains within our architecture: *terminal*, *mobile network*, and *server domain* (see Fig. 3) [8].

The *terminal domain* consists of the *mobile termination* including SIM/USIM, and an *execution environment* for local or network based applications, e.g. a web browser or media player. The interfaces within the execution environment are standardised protocol stacks, e.g. TCP/IP, Bluetooth, and proprietary interfaces, like browser plug-ins or dynamic data exchange (DDE).

The *mobile network* is a transport network which acts as a "bit pipe". It connects the user equipment and server domain. This architecture is quite generic, since various transport networks may be used. Lo@ uses a packet switched network infrastructure, i.e. GSM/GPRS and UMTS packet domain.

All mobile network specific infrastructure components which extend the "bit pipe" functionality belong to the mobile network operator part of the *server domain*. These components, e.g. user- and network management databases (HLR/HSS, VLR, etc.) or localisation equipment, are standardised by 3GPP and use protocols like MAP [3]. The server domain includes also 3rd party enterprises, e.g. content provider or Internet application service providers (ASPs). These components are based on internet recommendations and standards. The interfaces between mobile network operator and 3rd party enterprises are built on CORBA and OSA/Parlay.

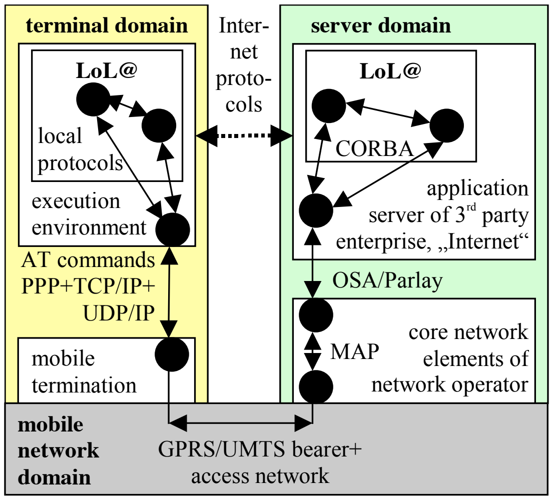



Fig. 3: Service network architecture domains

### *B. What is an application, what is a service ?*

There is some confusion about the terms *service* and *application*, caused by different definitions used in the telecommunications and internet world. Recently, the telecommunications standardisation is touching the internet community, therefore aligned definitions are needed in addition to standardised interfaces. In Fig. 4 we try to clarify the nomenclature, based on 3GPP phrases.

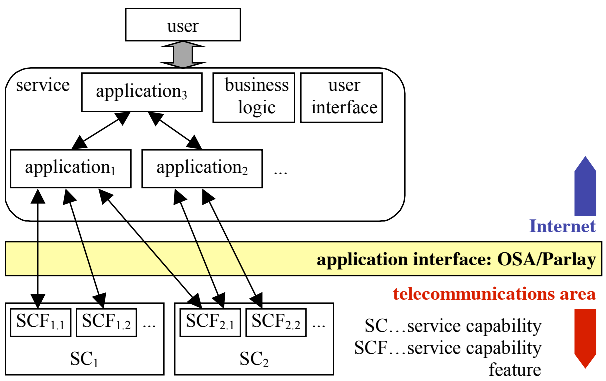



Fig. 4: 3G service network hierarchy

In the internet community, a service is usually the network connectivity provided by an Internet service provider (ISP). It may be extended by additional basic features (sometimes also called basic services), like mail routing or web-hosting. On top of this connection, various internet applications may be used, usually in a client-server communication pattern.

This paper uses the definitions of the telecommunications world: The basic connectivity to the network is called *bearer service*. It uses an access network which provides a bearer with specified QoS. Additionally, several *teleservices*, e.g. voice, facsimile, are defined.

The basic features of the UMTS service architecture are called *service capabilities* (SC), e.g. home location register (HLR) or CAMEL service environment (CSE). Their interfaces are *service capability features* (SCF) which may be accessed by application programmers using a standardised application interface (OSA/Parlay) [5].

The highest layer of the service network hierarchy are *services, providing a valuable functionality to the user*. Services include a business logic and a user interface. They are realised by means of several building blocks, the applications. An *application* is a software component that realises the functionality a service offers (Fig. 4) [4]. The interface between all components is typically based on CORBA.

*C. Concepts*

Using LoL@ as a typical 3rd generation service, we have identified the following important concepts. They may be mapped to applications and are described in the next section.

- OSA/Parlay: A standardised interface between network operator and service/application platform. The interface provides 3rd party *access to infrastructure* of the mobile network operator, like CSCF or location service (LCS). It includes a *framework* for service capability discovery and authentication.
- User profile management: A rich set of services need a well defined concept of preferences to avoid duplicate entries, inconsistencies, and to provide the best user experience on all possible terminals and networks.
- User interface: The key factor for a positive user experience is a comfortable user interface. Therefore advanced concepts like speech control, personal profiles, and device profiles are needed.
- Localisation and navigation: A unified localisation architecture for 2.5G and 3G networks is needed. It has to provide an accuracy in the order of 50m for location based services and navigation.
- Multimedia: UMTS will offer a multimedia framework. Additionally, bandwidth-efficient multimedia-codecs are necessary to provide useful and affordable services. The codecs need to consider wireless link characteristics.
- Integrated QoS management is also a central issue, especially for interactive multimedia services. It is necessary to distinguish between bearer level QoS, application level QoS, end-to-end QoS, and a QoS management concept including all user-related data streams.

## IV. ARCHITECTURE CONCEPTS

*A. OSA/Parlay*

The OSA implementation is based on the Parlay specification [5], containing the concept and several CORBA IDLs[1]. The following standardised parts will be included in LoL@:

- *Framework*: providing discovery and authorisation functionality.
- *Call Processing Package* for SIP[2] call control: A SIP [9] standard compliant implementation of a Proxy Server (see Fig. 5) provides session control features.

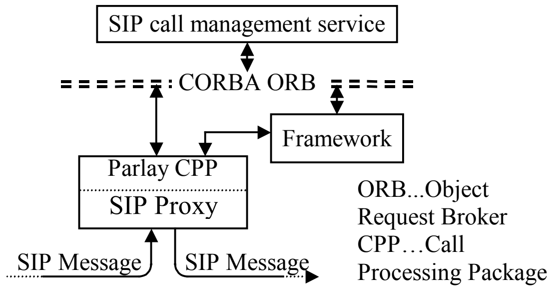



Fig. 5: Call control with SIP and Parlay

- *Mobility* application programming interface: Provides access to capabilities for the localisation of a UE as described in Subsection *D*.

Additionally the functionality of Parlay is extended by a *user profile management API* (see subsection *B*) and a *QoS management system*, which we believe will be *essential for mobile multimedia services*. The QoS management will extend the standardised concept of packet data profile (PDP) contexts [10]. Its purpose is to keep applications informed about the current QoS conditions, e.g. link quality, bit rate, bit error ratio. In analogy to a task scheduler of an operating system[3], the QoS manager is responsible for a harmonised access to the limited radio bearer capacity.

*B. User Profile Management*

To make the use of the service easy, user preferences settings have to be consistent in all services available to the user. A service capability for user profile management provides a single access point to user profile data for the network operator and 3rd party service providers. This automatically avoids database synchronisation problems. It gives the user a powerful instrument of manipulating general preferences at once rather than changing the same setting for all services

[1] IDL = Interface Definition Language
[2] SIP = Session Initiation Protocol
[3] A task scheduler manages access of programs (or tasks) to limited computer resources, like CPU or memory. Several access concepts and priority schemes are known in literature.

sequentially. However, service specific user preferences may be stored within a database owned by the service provider.

The implementation of this service capability is the home subscriber server (HSS) [11]. In our concept, the HSS is used as the central database, retaining network relevant and commonly used user preferences. We have defined a CORBA interface (see below), which provides the necessary user profile access functions independent of the actual data structures. We propose to add appropriate extensions to OSA/Parlay.

The Corba interface defines three functions:

1. void HSS_get_fieldidentifiers(in HssUserID user, out TpSting fields)
2. void HSS_read_entry(in HssUserID user, in HssFieldID field, out TpString data)
3. void HSS_write_entry(in HssUserID user, in HssFieldID field, in TpString data)

The first function is used for discovering the available HSS data fields (e.g. fields= "User IP Address", "User SIP Address"). In the second step, one of these fields is accessed with the functions for reading and writing. The specifications for the requested data field are passed to the HSS via the parameter HssFieldID; the syntax is: "key1&key2&key3:fieldname". This format grants independence of the interface of the stored data. Modifications of database data fields do therefore not influence the interface and connected network entities or services.

### C. User Interface

Mobile devices are critical in three ways: *small form factor* (limiting size of display and keyboard), *hostile environment* (background noise, varying light conditions), and *urgent information needs*. These limitations create a need for different user interaction mechanisms like menu selections (instead of typing), simple key strokes (instead of drag-and-drop), and voice recognition.

Our way to cope with these limitations is EIKON [12] in combination with voice recognition. EIKON is the user interface concept of EPOC (the operating system of Psion organisers and many smart phones) [13]. It uses pop-up menus instead of permanent menu bars and full screen program views instead of multiple windows.

When applying voice recognition, we face two problems: the limited resources of mobile devices and the data transmission. Because of the limited processing capabilities, a *distributed voice recognition* is necessary. In this case, the start of a voice command is detected at the mobile device. The device initiates a connection (or uses an existing one) to a speech server that performs the actual command processing.

Currently the combination of voice and data transfers is difficult, because they use different channels (circuit switched voice channels and circuit switched data bearers or GPRS packet switched bearers). In the future this problem will be eliminated because voice will also use the packet switched domain (with SIP and VoIP). However, SIP/VoIP has to be extended with bandwidth efficient codecs, like the GSM voice codecs. Currently used PCM codecs need too much bandwidth (64kbps).

Our packet switched demonstrator will include a SIP-based distributed voice recognition with a GSM voice codec. This enables us to study response time and simultaneous usage of data and voice packets over a single link. Advanced speech recognition technologies and multi-modal dialogues will be studied and implemented in cooperation with another project at ftw, called Speech & More (http://www.ftw.at/projektB2_en).

### D. Localisation and Navigation

Localisation and navigation is implemented in a layered structure. Basic localisation functionality is provided by a service capability with a standardised interface (OSA/Parlay), enabling location based services (Fig. 6).

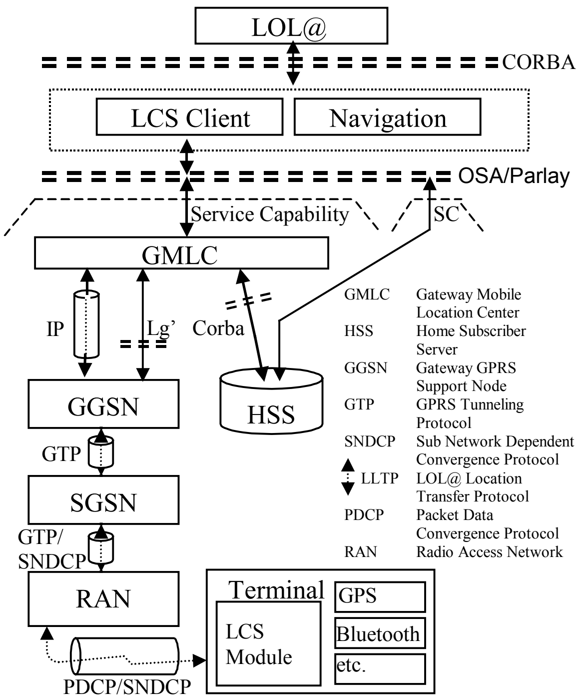
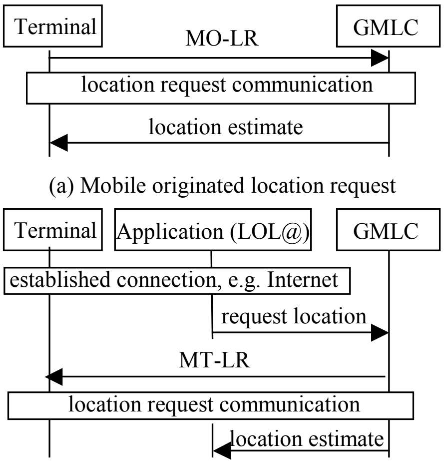



Fig. 6: LoL@ localisation architecture

We focus on value added services rather than on local regulatory requirements (e.g. E.911). The concept has to be applicable to most currently available networks including GPRS. Hence, networks with internal LCS support and legacy networks can be used. LCS enabled networks provide location information in the SGSN, which is accessed by the GMLC via the standardised Lg'-interface [Fig. 6]. Legacy networks are covered with an end-to-end LCS concept, extending 3GPP standardisation. It uses the network only as bit pipe. A terminal LCS module communicates with the GMLC, using the IP-based LoL@ Location Transfer Protocol (LLTP). The terminal LCS module can be seen as remote part of the GMLC.

A location based service requests (if authorised) the location information of a terminal. Location information may be requested directly by the terminal via the GMLC

(MO-LR: mobile originated location request, Fig. 7a) or by the application kernel residing in the server domain. In the latter case, the terminal has a connection established to this application (e.g. via internet protocols, TCP/IP or UDP/IP). The application acts as LCS client and requests the location (MT-LR: mobile terminated location request), see Fig. 7b.




(a) Mobile originated location request

(b) Mobile terminated location request

Fig. 7: Location request possibilities

In LoL@ we will implement several alternative methods, e.g. GPS and different cell-based algorithms [14]. This guarantees high location *accuracy* and *availability*. If one method is temporarily not available (e.g. GPS failure due to blocked satellite view) or cannot meet the accuracy requirements given by the LCS client, the GMLC automatically selects an alternative method.

On top of this basic localisation functionality, a more advanced localisation and navigation concept is implemented. It uses *tracking* and *interactive positioning* to improve location estimates.

*Tracking* uses a history of user locations to predict the next location or to eliminate ambiguities of location algorithms. It may also be used to estimate the user's speed. Estimation accuracy can be improved by using LoL@'s multi-layer *navigation feature* (Fig. 2b,d) with *interactive positioning*, i.e. the user confirms arrival at specific locations manually.

### *E. Multimedia*

UMTS will offer basic multimedia features that are suitable for mobile terminals. Consequently, there will not be full-screen high-resolution videos, but short video clips (cinema trailers), audio clips (CD intros), and video postcards. LoL@ will also offer the possibility for such multimedia information, including a wavelet-based video codec, designed for small screens, interrupted links, varying bandwidth, and low processing power.

## V. SUMMARY

A standardised service architecture is necessary for rapid and easy service development in 3G networks. We have specified the LoL@ application prototype that lead us to an extended UMTS service architecture. Our extensions include:

- A new CORBA/Parlay interface between the HSS and application server to support advanced user profile capabilities, like unified service preferences.
- An LCS architecture that also supports legacy networks by an end-to-end positioning method.
- Speech-control for the user interface based on SIP and VoIP.

Currently we are implementing the architecture components, including LCS, map preparation software, and speech recognition, as well as a QoS manager. Field-trials to access real world performance of LoL@ will conclude our work in the future.

## ACKNOWLEDGEMENTS

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