

Galileo: Benefits for Location Based Services

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Abstract. Location Based Services (LBS) will play a key role in the future development of the Galileo market, as they represent the ultimate synergy between communications and positioning technologies in order to deliver to the mass market a wide variety of new services. Examples of such services range from in-car guidance through to targeted advertising. This paper analyses the various requirements and restrictions imposed by different LBS applications, with particular emphasis being placed on the benefits that Galileo can bring in order to meet such user requirements.

From a Technical perspective, the work undertaken has focused on a sub-set of typical applications for LBS services; namely “car navigation” and “emergency call” in both rural and urban environments. With respect to these applications, the paper begins by identifying and subsequently quantifying key driving elements, such as availability and accuracy of service.

Having captured the key requirements and associated restrictions, an optimum architecture is described. In defining such an architecture, the current situation with respect to the technologies available and the relative merits of their use in various combinations is examined. This is a necessary step to take, as the future role of Galileo in providing such services will be built upon existing techniques and infrastructure. Following on from this, the benefits that Galileo will bring through improved accuracy and availability are examined. In order to validate the architecture defined, the results of the performance analysis undertaken will also be presented. From an economic perspective, future market opportunities offered by LBS, in terms of both terminal sales and value added service provision, are also touched upon.

The benefit of any technical solution involving Galileo for a great many applications only exists if relevant standards exist that allow for its inclusion. This is particularly true for LBS, as it is a technology that already exists and will develop at a rapid rate prior to the

launch of Galileo. The EC has thus initiated a substantial effort to introduce Galileo positioning in location-based standards for the 3rd generation of mobile communication, and the results of this activity to date shall be outlined.

Key words: Galileo, LBS, Performance Enhancements, Market Potential.

1 Introduction

The term LBS encompasses an ever-expanding set of applications that use as a basis the combination of positioning information with mobile communications to deliver a variety of value added services to the user. Examples of such value added services include navigation assistance, emergency assistance and tracking services, and such services are increasingly being integrated in various combinations, and to various extents, to meet both user and regulatory requirements in a variety of operational environments.

Market forecasts undertaken for Galileo by the EC all indicate that LBS will be the prime application with respect to both the number of users of Galileo and the revenue potentials offered to value added service providers, and as such the Galileo Program has and will continue to pay specific attention to this sector, in order to ensure that every possible step is taken to facilitate its development. With this objective in mind, activities related to the incorporation of Galileo in LBS in the technical, standardisation and market domains were undertaken as part of the recently completed ‘Galilei’ project which was funded by the EC, and it is upon the results of this work that this paper is based. However, it should be pointed out that the views and opinions

expressed throughout are those of the authors, and as such do not necessarily represent those of the EC.

2 KEY REQUIREMENTS FOR LBS

Before examining any benefit that Galileo can bring to LBS, it is first necessary to encapsulate the requirements of the application. However, as outlined in the introduction, the broad ranging and ever expanding nature of LBS make it neither practically desirable nor indeed possible to capture all LBS requirements, and subsequently define a single technological solution to meet them. It is however possible to select a specific application scenario and comprehensively define an associated set of requirements, from which an appropriate solution can be developed. This was the approach adopted for the technological work undertaken within ‘Galilei’, which after consideration of various potential application scenarios, chose to focus upon the integration of ‘In car Route Guidance’ and ‘Emergency Call’ in both urban and rural environments, and it is the key requirements pertinent to this which are focused upon in this section.

Tab 1: Performance Requirements for Route Guidance & Emergency Call.

Performance Requirements	
Coverage environment	The LBS System shall be able to provide route guidance/information service in outdoor environment (both urban and rural).
Bi-directional communication	The LBS system shall provide bi-directional wireless communication to the user using GSM and UMTS.
Availability	The LBS system shall be available in 95% of the user calls.
Route guidance Horizontal accuracy	In case of route guidance, the system shall provide a horizontal positioning accuracy $\leq 5m$ in 90% of the time.
Emergency call Horizontal accuracy	In case of emergency call, the system shall provide a horizontal positioning accuracy $\leq 50m$ in 67% of calls, and $\leq 150m$ for 95% of the calls (FCC 99-245).
LEUT Dynamics	The performance of the LBS service shall be ensured up to a speed of 130 km/h.
Latency Route Guidance	The latency period beginning with a warm start of the User Terminal, including the user request for route guidance information, the sending of aided data for quick acquisition of the handset and the provision of value added data from the service provider, shall be less than 1 min.
Latency Emergency Call	The LBS System shall guarantee that the call and position of a user reach a PSAP in less equal 30s.

In total over 100 requirements were identified for this application covering aspects including Performance, Constraints, Implementation, Operation, Safety, Security and Interface, and these are comprehensively defined in [GALJ2.1 2003]. Clearly it is impossible to list all requirements in such a paper, so Table 1 focuses only on those related to performance, as it is to these that the potential benefits to be gained through the incorporation of Galileo can be subsequently developed. This is especially true with respect to both accuracy and availability, and as such special attention is drawn to these.

3 TECHNOLOGICAL SOLUTION

Having identified the key performance requirements for the specific scenario described previously, it is possible to develop a technological implementation that meets these needs. However, before doing this it is first important to examine the potential applicability of solutions in existence today, before subsequently addressing the benefits brought by Galileo.

3.1 Current Techniques

Table 2 presents a summary of the main characteristics of the four existing technologies that can today be used to provide positioning information to mobile communication devices.

Table 2 : Comparison of different positioning methods.

Req.	Cell-ID	E-OTD	OTDOA	A-GPS
Accuracy	Poor 200m-20km 2D only	Average 100m-500m 2D only	Average 40m-150m 3D	Very Good 5m-10m 3D
TTF	Excellent 1s	Very Good 5s	Very Good 5s	Very Good 5s
Roaming	Excellent	Poor	Poor	Excellent
Expansion	Excellent	Poor	Poor	Excellent
Comp	Excellent	Poor	Poor	Excellent
Terminal cost	Negligible	Medium	Medium	High
Overall cost	Excellent	Poor	Average	Good
Summary	Average	Average	Average	Good

With respect to the requirements for the chosen application, the following statements on the characteristics of each technique can be made:

- Cell-ID meets cost objectives, supports roaming, but provides generally poor performance.
- E-OTD / OTDOA provide medium performance, but has severe roaming limitations and is expensive (set-up of LMU’s).
- A-GPS provides very good performance, is relatively inexpensive, supports roaming, can be used on all networks and provides good Return On Investment. It does have the problem of limited availability in Urban Environments, due to the obscuring by buildings of the satellite signals.

Having examined briefly each existing technique individually, one must also examine the potential of a hybrid ‘GPS/Network Based’ solution in meeting the application requirements.

- A-GPS + E-OTD/OTDOA: This combination has certain advantages in that, even if the accuracy provided is limited in some instances, it delivers almost continuous availability in urban

environments. In rural areas such benefits become more limited due to the reduced number of base stations and the increased number of satellites visible.

In summary, the accuracy requirements of the application chosen are best met by a GNSS based solution, but questions as to the ability of this technique to meet the associated availability requirements exist, particularly in operationally demanding environments such as city centers. This problem can be alleviated to some extent through the complementary use of network based positioning techniques, but at the expense of accuracy. It is with respect to this issue that the following section examines how the arrival of Galileo will contribute to the improvement of this situation.

3.2 Benefits Brought By Galileo

As described below, the Galileo system shall facilitate enhancements to LBS, which uses as a basis GNSS, by the following means:

3.2.1 Improved Signal Characteristics

The Galileo Signal In Space has been designed to improve acquisition and tracking performances, and offer a location service wherever required by costumers. In particular, the Galileo signals will be transmitted with significantly more power than the current GPS signal (5 dB improvement), thus improving the signal reception in challenging environment.

In addition, Galileo will broadcast, over each frequency band, a pilot signal, which is a ranging code without any data modulation. Using this pilot signal will allow users to track signals in extremely noisy environments, or in the presence of interfering RF sources likely to affect the processing of a traditional GPS receiver.

Finally, reflection phenomenon (called multipath) affect the propagation of the signals broadcast from the satellite and disturb the measurements made by the user equipment. The effects of multipath can range from a total loss of a satellite signal, through to the introduction of errors in the computed user position, and are especially prevalent in high-density urban environments where multiple reflectors exist. The fact that the future Galileo signals will be broadcast over wide bands will provide significantly improved robustness to multipath.

All these features will contribute to improved availability and accuracy for Location Based Services using as a basis

Galileo, especially in urban areas or indeed even in indoor environments.

3.2.2 Improved Performance

The Galileo space segment shall consist of a 27-satellite constellation (+3 active in-orbit spare satellites) with extremely good performance characteristics, delivering in the order of a two-fold improvement in accuracy over GPS. However, in practical terms, Galileo will not be used to replace GPS, but rather shall be combined with it in order to deliver further benefits to users.

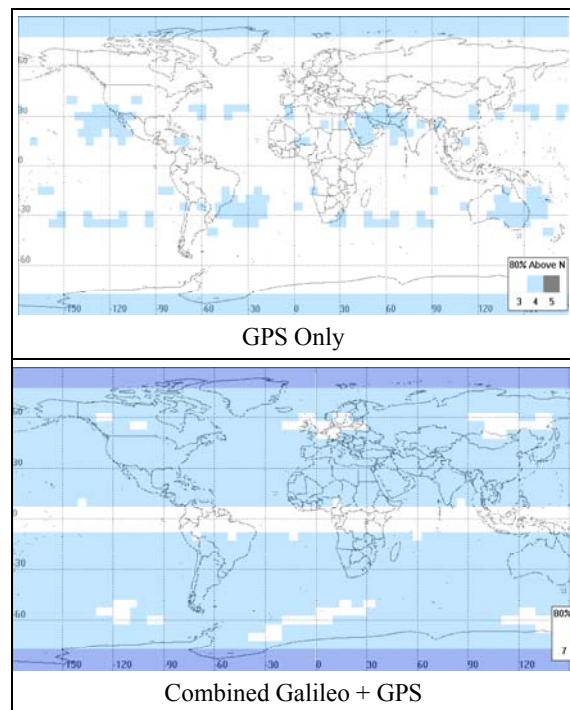


Fig 1: Number of Satellites In View for 30° Masking Angle.

Figure 1 shows the impact of the masking angle on the number of satellites in view, for both a GPS Only solution and for a combined Galileo + GPS solution. With a masking angle of 30°, which is representative of a typical urban environment. It can be seen that for GPS alone, only 3 satellites remain visible 80% of the time. This means that a 3D position solution is not available in such scenarios, and even when a position solution is possible, the satellite geometry remains poor, thus degrading significantly the positioning accuracy. In comparison, when the constellations of Galileo and GPS are combined, there remains visible at least 7 satellites in all instances, bringing associated benefits in terms of both accuracy and availability of position.

The level of this benefit is quantified in Table 3 which summarises some “Worst Site 95% Errors Statistics” calculated upon the basis of selected constellation and the masking angle combinations.

Table 3: Comparison of End-User Performance.

GPS SPS	Galileo L1	Mask Angle	Worst Site 95% Horiz Errors	Worst Site 95% Vert Errors
✓		5°	11.0 m	20.0 m
	✓		5.0 m	8.0 m
✓	✓		2.8 ms	5.0 m
✓	✓	30°	12.0 m	30.0 m

From the analysis presented above, it is clear that the use of Galileo in combination with GPS will bring to LBS applications, significant improvements in the performance in terms of both the accuracy and availability of the positioning solution available.

3.3 Galileo Enabled Architecture for LBS

3.3.1 Operational Concept

Having defined the key performance requirements for the chosen application, the first step in developing an architecture to meet these, is to develop a suitable operational concept. An overview of the typical operational flow between the different entities in the context of ‘Route Guidance’ is presented in Figure 2.

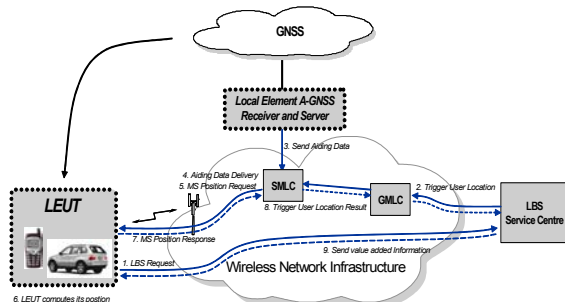


Fig 2: Overview of the operational concept for Route Guidance.

Figure 2 shows the LBS Local Element as being composed of the Local Element User Terminal (LEUT), the Local Element A-GNSS Receiver and Server

(LEAGRS), plus the LBS Service Centre (LBS SC). Within the wireless network infrastructure, the main module to be considered, and with which the LEUT and the LEAGRS will interact, is the Service Mobile Location Center (SMLC). The SMLC, as defined by the Third Generation Partnership Project (3GPP), facilitates the querying of user terminals for their position. The SMLC may receive some Trigger User Location requests from the LBS Service Centre via a Gate Mobile Location Center (GMLC). The GMLC is the entry point for 3rd Parties in the wireless network to request a mobile’s position.

The interactions between the SMLC and the LEUT have been specified in the 3GPP within the RRLP (Radio Resource LCS Protocol) [3GPP 04.31]. This mainly defines the *MeasurePositionRequest*, from the SMLC to the LEUT and the *MeasurePositionResponse*, from the LEUT to the SMLC. It is worth noting that the RRLP protocol is currently specified for GPS only and thus will require future adaptation to facilitate the use of Galileo.

Wireless networks already provide standardised positioning information to the Service Provider. So the interface between the GMLC and the Service Centre would typically be an existing one, namely Open Service Architecture (OSA) [3GPP 29.198] or Location Interoperability Forum (LIF) [LIFTS 101].

With respect to the Operational concept associated with ‘Emergency Calls’, the typical operational flow differs slightly and is thus presented in Figure 3.

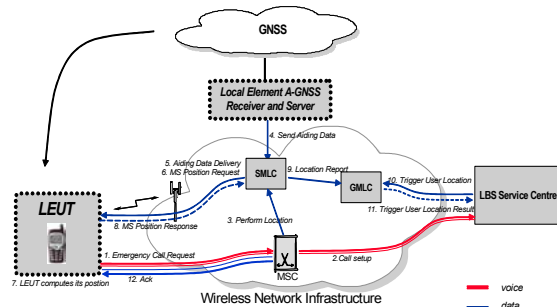


Fig 3: Operational concept for emergency calls.

In an emergency call, the Mobile service Switching Center (MSC) is involved. In the “basic” operational concept explained previously, the MSC has a minor role, and has therefore not been introduced in Figure 2 for reasons of clarity. The MSC tackles the reception of an emergency call raised by a mobile, switches the emergency call to the relevant emergency service, and initiates the request to the SMLC for a mobile’s position.

3.3.2 Functional Analysis

With the Operational Concept defined, the next stage in developing the final architecture is to perform a functional analysis in order to identify and group the various steps needed to meet the operational procedures already outlined.

Figure 4 presents a graphical representation of the functional analysis undertaken for both the 'Route Guidance' and 'Emergency Call' scenarios, superimposed upon the physical architecture as defined in the next section.

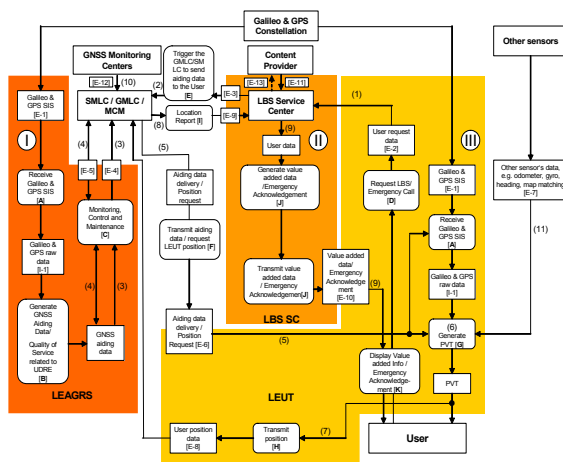


Fig 4: Functional Analysis

The order of functional steps for each scenario is detailed as follows:

Route Guidance: (1) LBS Service Request to the LBS SC, (2) The LBS SC triggers the SMLC via the GMLC to provide the user location, (3) The LEAGRS sends aiding data to the SMLC, (4) The MCM monitors and controls the LEAGRS, (5) The SMLC sends aiding data to the LEUT and asks for the LEUT position. (6) The LEUT generates PVT and (7) sends its position to the SMLC. (8) Location Report from the SMLC to the LBS SC. (9) Value added data is sent from the LBS SC to the user. (10) Any Information about the status of the Galileo+GPS constellation can be send from the GNSS Monitoring Centers to the LEUT. (11) The LEUT can calculate its position with and without In-car sensors.

Emergency Call: (1) Emergency Call Request to the LBS SC, (10) The LBS SC sends an Emergency Acknowledgement to the user. (2) The LBS SC triggers the GMLC to provide the user location. The SMLC provides the location to the GMLC. (3) The LEAGRS

sends aiding data to the SMLC. (4) The MCM monitors and controls the LEAGRS. (5) The SMLC sends aiding data to the LEUT and asks for the LEUT position. (6) The LEUT generates PVT and (7) sends its position to the SMLC. (8) Location Report from the SMLC to the LBS SC. Then further activities (ambulance, police, fire brigade etc) have to be started to help the user in distress (these are not part of the study). Data Links (10) and (11) are also valid for Emergency Call. Instead of the Content Provider box in case of Emergency Call this is a PSAP box, to which the LBS has an external interface E[13] (indicated by a dotted arrow).

3.3.3 Architectural Design

Having captured the key requirements, developed an operational concept, and performed a functional analysis, the final stage in the development process is to design a Physical Architecture. This architecture is depicted in Figure 5, and shows at the most general level both the components and the interfaces that exist between them.

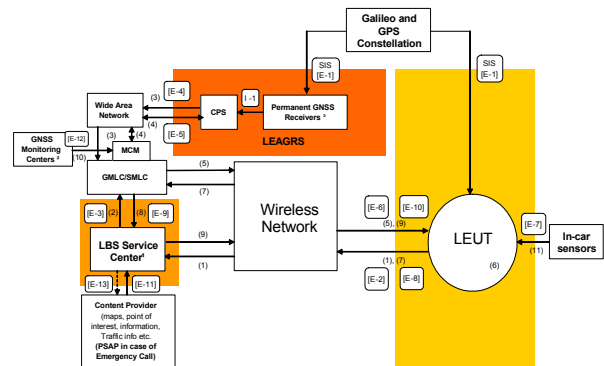


Fig 5: Physical Architecture.

It can be seen in Figure 5 that the architecture developed can be viewed as consisting of 3 main components; namely the LEUT, LEAGRS and the LBS SC, and a brief outline of each detailed below:

1. Local Element User Terminal – (LEUT)

The User Terminal is a hardware and software device, which incorporates mainly communication, navigation and man-machine-interface functions. In this case it contains a GNSS receiver for reception of the SIS, one or more communication parts and certain hardware features to communicate with the user. The main functionality of the LEUT can be described as: to initiate

requests for LBS data via the communication link (GSM,UMTS), to receive aiding data from the SLMC, to calculate its position and in turn send this to the SMLC, to receive permanently updated value added information from the LBS SC and display this to the user, and finally to receive acknowledgements of outgoing emergency calls.

2. Local Element A-GNSS Receiver and Server – (LEAGRS)

The LEAGRS consists of three GNSS reference receivers, which permanently receive Galileo and GPS SIS, a back-up receiver for redundancy reasons, a third receiver for quality monitoring via DGNSS corrections and a Central Processing Station CPS to extract and compute all necessary data. The main functionality of the LEAGRS can be described as: to receive raw Galileo and GPS data, to generate aiding data and differential corrections from this data, to provide quality of service monitoring checks via UDRE parameters (3GPP TS 04.35), route the afore mentioned data to the SMLC.

3. LBS Service Center – (LBS SC)

The LBS SC is responsible for receiving user requests and subsequently providing them with the value-added data requested. As the LBS SC does not generate such value added data its-self, it interfaces to content providers offering information that could include; mapping data, voice and video information of points of interest or traffic information. Additionally the LBS SC provides access control and billing functions. In the case that an incoming emergency call is not a voice call, but rather has been initiated by pushing a button or automatically, the SC shall also send an acknowledgement to the user in distress. In all Emergency Call instances, the SC on arrival of the user position the SC sends this information to the nearest PSAP for further rescue actions.

3.3.4 Facilitation of Architectural Components in Galileo’s Design

Having identified the major architectural components for this application, it is useful to indicate the specific design features of Galileo, which shall facilitate its future incorporation.

Dealing first with the User Terminals and Reference receivers, Figure 6 shows that the Galileo Signals shall share the same frequencies bands as both current and future GPS signals (L1 and L5 respectively), reduces both the complexity and cost of the hardware needed to receive signals from both systems. This is a specific design characteristic of the Galileo System, to facilitate

the maximum uptake of combined Galileo and GPS user terminals in all application domains.

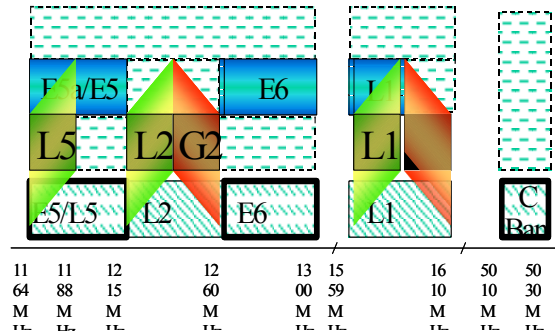


Fig 6: Frequency Band Sharing between Galileo/GPS.

With respect to the LBS SC, the Galileo System, through its Ground Segment, is also being designed to accommodate and supply many types of ‘Service Centre’ with any information they may require about Galileo. It is also the intention that this interface shall remain sufficiently flexible to incorporate future functionalities that as yet have not been foreseen.

3.3.5 Performance Evaluation

An important aspect of any architectural definition is an associated performance analysis, as it is only through this that the validity or otherwise of the solution proposed in meeting the requirements of the application can be proven. As such, extensive simulations were undertaken to quantify the performance levels achievable and the main results of these are summarised in the following section.

Dealing firstly with navigation, simulations were undertaken whereby a 3 dimensional model of Stuttgart (Germany), as depicted in Figure 7, acted as a ‘real-world’ reference terrain for an availability analysis of a network-assisted GNSS based positioning solution.

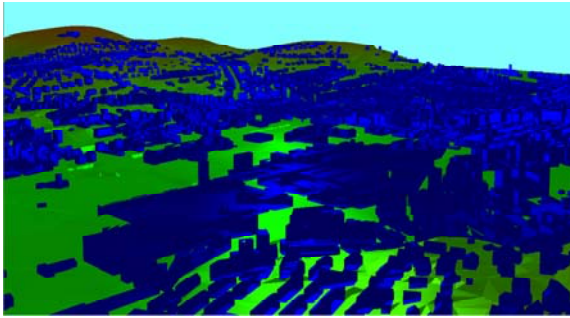


Fig 7: 3-Dimensional View of Stuttgart.

Using as a basis this terrain model, a reference track was defined around the city for a GNSS equipped vehicle to follow. This scenario was then run three times, once using Galileo only, once using GPS only and once using combined Galileo and GPS, generating the following results:

- For Galileo use alone the availability achieved was **78.3%**.
- For GPS use alone the availability achieved was **56.3%**.
- For the combined use of Galileo and GPS the availability increased to **99.7%**.

These figures clearly highlight the added benefit that Galileo will in the future deliver to GNSS based LBS applications. It also highlights that, whilst the performance of Galileo alone will represent a significant improvement over the situation as currently experienced with GPS, it is only through the integrated use of both systems that the maximum benefit of Galileo can be realised, and the requirements of the most demanding applications fulfilled.

With respect to communication performance, both the 'Route Guidance' and 'Emergency Call' scenarios were analysed, using as a basis typical assumptions on both the cellular network configuration and on the propagation conditions experienced in an urban environment. Dealing firstly with the 'Emergency Call' scenario, the requirement that the LBS System should guarantee that the call and position of a user in distress reach an emergency call center in less than 30 seconds was verified for both the GPRS and UMTS, if the Position Acquisition Time (PAT) remains inferior to 14.5 seconds.

For the 'Route Guidance' scenario, in the GPRS case, a greater number of active users result in an increased transmission delay. For a cell radius of 1 km, the delay requirement of 1 minute to access the service is satisfied when the density of active users remains inferior to 5

active GPRS users per km². The achievable added-value update rate can vary from 35 seconds to more than 2 minutes for a high density of active users. In the UMTS case, the higher the used channel throughput, the lower the transmission delays, and the lower the achievable density of active user is. The time requirement of 1 minute to access the service was always verified using this system, and the achievable added-value update rate was in the range of 25-45 seconds.

4 MARKET ASPECTS

The work performed within the 'Galilei' study also produced some interesting information about the LBS market, and it is the results of this work that are largely drawn upon in this section. If we first address the market predictions for GNSS enabled mobile phones we can see from Figure 8, that it is predicted that this market will grow from a present level of some 10 million units today, to a figure approaching 2 billion units by the year 2020 – representing 70% penetration of the global mobile phone market.

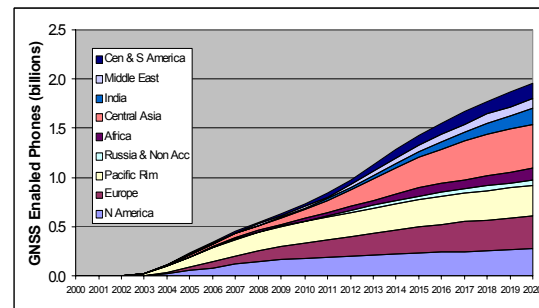


Fig 8: GNSS Enabled Mobile Phone Market.

The shape of the figure is also important as it reflects the difference in the timing of uptake of LBS services in the regions of the world indicated. The importance of this market is further emphasized when one considers such devices have an annual replacement rate approaching 50%, which if one considers the projected level of units in 2020, will equate to an annual production level approaching 1 billion units at this time.

Building upon this information related to the uptake of GNSS enabled mobile phones, Figure 9 quantifies the expected revenue potential that LBS will deliver to service providers in 2015. It shows that the vehicle guidance and personal mobility applications will together combine to make up some 75% of revenues of 'downstream' service provision at this time. This equates to a figure of just over 100 billion Euros, which is in the region of 10 times the Global revenues for all GNSS services today. These figures confirm the importance of LBS for Galileo, and in turn are justification of the

efforts, which the program has and will continue to make in facilitating to the maximum extent possible LBS.

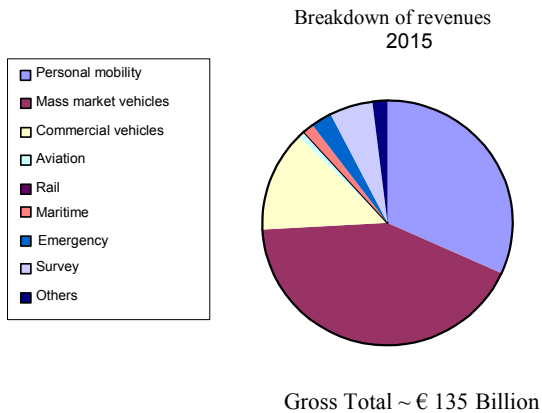


Fig 9: GNSS Service Provision Market Revenues (2015).

As well as concentrating solely on figures, it is important to also briefly consider the ‘Regulatory and Commercial’ drivers that to date have influenced the LBS market. With respect to the US, regulation has been the dominant force in driving the market to date. The E-911 (Enhanced 911) ruling as issued by the Federal Communications Commission (FCC) stipulates that wireless operators must provide a capability to automatically pass the location of a user making an emergency call to a Public Safety Answering Point (PSAP) with a certain level of accuracy and reliability. The situation in Europe remains slightly different to this, in that whilst the European Council has issued a directive related to emergency calls – referred to as E-112 calls, it stipulates that public telephone network operators make location information available to authorities ‘where technically feasible’. This much softer approach means that the market in Europe is subject to be Regulatory and Commercial influences. Finally if one wants to find a market driven almost entirely by commercial influences then the Pacific Rim (mainly Japan and Korea) provides such an example.

With respect to the future it is certain that both ‘Regulatory and Commercial’ factors shall continue to influence the size and shape of LBS evolution, but due to the wide variety of influential factors it is impossible to make any firm predictions on the respective influences of each, even at a national scale. For example ‘Privacy Issues’ which are gaining in influence in Europe could shape the LBS market in a different way than in regions where this is less of an issue. As such, all figures presented in this section represent only a best estimation of the future as seen today, and this will unquestionably be subject to change as the market develops and becomes more mature. What cannot be questioned however is the

massive market influence that LBS will command, both in terms of GNSS terminal sales and value added service provision. For a more detailed description of GNSS Market trends the reader is referred to [GALI 4.1 2003].

5 ON-GOING STANDARDISATION ACTIVITIES

The initial activities undertaken to date in this domain have focused on the 3GPP, which is in charge of producing standards for mobile communication systems. The scope of 3GPP is to produce globally applicable technical specifications for a 2nd and 3rd generation of mobile system.

The 3GPP is composed of 5 main technical bodies dealing with specific parts of the mobile network architecture. The initial effort was focused on the “Service and System Aspect” working group that is responsible for the overall architecture and service capabilities of systems based on 3GPP specifications. In particular, ‘SA 2’ is a sub working group that identifies, for each new service, the main functions and entities of the network impacted, the way these entities are linked to each other and the information they exchange.

Currently, the Location Services (LCS) standards developed by 3GPP standardise assisted GPS solutions for mobile positioning. The 3GPP standard supports the current GPS system that provides a single frequency signal that has some vulnerability to interference and shadowing.

The effort initiated a few months ago to introduce Galileo in the mobile phone standards has been given added impetus through the approval of a dedicated activity on Galileo with the following objectives:

- To identify the changes that might be needed to 3GPP standards to support “assisted Galileo” in addition or in combination with the currently specified assisted GPS.
- To assess the potential benefits of using Galileo (alone or combined with GPS) on service performance: in particular the availability improvement for in urban/indoor environment will be investigated.
- To study the likely complexity differential between 3GPP mobiles utilising A-GPS and those which might utilise a combination of A-GPS plus “Assisted Galileo”.

- And primarily to collect feedback from the 3GPP community on the desirable characteristics of Galileo that would minimize the impact to 3GPP mobiles when introducing the extension of A-GPS techniques to Galileo. This would be used to orientate final Galileo signal designs.

This work item will result in a Technical Report by the end of 2003, demonstrating the benefits of extending the existing LCS standards to include Galileo.

6 CONCLUSIONS

It is certain that LBS will in the coming years encompass an every increasing share of an ever-increasing market for both GNSS enabled receivers and value added service provision. These attributes therefore make LBS an important aspect for Galileo, and this has been recognised from the outset of the program, which has in turn been specifically designed in a number of instances to take into consideration the characteristics of GNSS that are of benefit to LBS. Galileo will include many new features that will improve significantly the performance of the positioning services available to LBS, especially when used in combination with GPS. This could well provide new impetus to LBS and open up many new opportunities, ensuring that, much as LBS will be important for the development Galileo, Galileo will in turn be important for the future development of LBS.

Finally, it is important to stress that the Galileo program is committed to continue its efforts in this domain, in coordination with the mobile communication actors. This is indicated by both ongoing standardisation work within 3GPP, and new efforts within the 6th framework program,

which shall encompass various LBS related activities, including mass-market receiver developments, continued technical activities on Galileo local services, and support to application development.

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Biography

John Swann graduated from the University of Glasgow (U.K.) in 1994 with a degree in 'Topographic Science', and from the University of Nottingham (U.K.) in 2000 with a PhD in 'Space Geodesy'. He has been working on Galileo since August 2000, initially developing software for the European Space Agencies 'Galileo Satellite Simulation Facility', before joining the Galileo Interim Support Structure in the capacity of 'Galileo Local Component Expert'. John is now a member of the Galileo Joint Undertaking, where he remains responsible for the development of Galileo's Local Services.