Author(s) de Reuver, Mark; Skournetou, Danai; Lohan, Elena-Simona

Title Impact of Galileo commercial service on location-based service providers: business model analysis and policy implications

Citation de Reuver, Mark; Skournetou, Danai; Lohan, Elena-Simona 2013. Impact of Galileo commercial service on location-based service providers: business model analysis and policy implications. Journal of Location Based Services vol. 7, num. 2, 67-78.

Year 2013

DOI http://dx.doi.org/10.1080/17489725.2012.750018

Version Post-print

URN http://URN.fi/URN:NBN:fi:tty-201406261323

Impact of Galileo Commercial Service on Location Based Service Providers: Business Model Analysis and Policy Implications

Mark de Reuver[1], Danai Skournetou[2] and Elena-Simona Lohan[3]

[1] Technology University of Delft, Faculty of Technology, Policy and Management, Delft, The Netherlands, G.A.deReuver@tudelft.nl

[2] bgator Ltd., Tampere, Finland, Email: Danai.Skournetou@bgator.com

[3] Dept. of Communications Engineering, Tampere University of Technology, P.O. Box 553, FIN-33101, Finland, Email: Elena-Simona.Lohan@tut.fi

Abstract

Today's mobile location-based services largely depend on a free-of-charge, best effort positioning technology, called Global Positioning System (GPS) which is controlled by the US military. The European alternative Galileo will not only offer a similar best-effort system by 2020, but also a premium-rate service known as Galileo Commercial Service (CS). Galileo CS is planned to provide higher positioning accuracy, improved security due to signal authentication, and service guarantee. While the technology behind Galileo is often studied, the impact of Galileo CS on the location-based service marketplace is rarely discussed. In this paper, we fill this gap by analyzing how improved accuracy, authentication and service guarantee may impact the business models of location-based service (LBS) providers. We do so by interviewing service providers, policy makers and industry experts on what new services would be enabled; technological alternatives that may emerge in the coming years; and organizational and financial issues that service providers face when adopting such a premium-priced positioning signal. We find that a more accurate, secure and reliable Global Navigation Satellite System (GNSS) signal enables a range of new LBSs, although several alternative technologies are emerging that may make Galileo CS obsolete before it is even launched. To convince LBS providers to adopt Galileo

CS, the institution operating Galileo should get governments on board early-on for building trust and should consider progressive pricing schemes. Still, service providers are skeptical about adopting Galileo CS, and the hope to recoup any investments in Galileo may thus be in vain.

Keywords: Galileo; Location-based services; Business models; Satellite technologies; GPS

Introduction

Location Based Services (LBSs) are omnipresent, both in the consumer (e.g., navigation services like TomTom) and business market (e.g., fleet management, tracking of dangerous goods). The business of LBS providers largely depends on the Global Positioning System (GPS), which employs two signals; one free-of-charge signal meant for civilian use and one used by the US military and its allies. Not only is GPS operated under the discretion of the US military, but also it also only gives best-effort guarantees on the accuracy and the availability of the civil signal. The European Union is preparing the launch of its own Global Navigation Satellite System (GNSS) platform, Galileo, which is expected to be fully operational around 2020 (European GNSS Agency, 2011).

Galileo will provide basic, free-access signals called Open Service (OS), which is expected to provide at least comparable performance to the civil GPS signal. In addition, the European Union plans to offer a premium-rate service based on Galileo called Galileo Commercial Service (CS) (European GNSS Agency, 2011). The CS signal will occupy the E6 band (1260-1300 MHz) of the Radio Navigation Satellite Services (RNSS) frequency band and it consists of two channels: the data channel E6B and the pilot channel E6C. The carrier frequency of E6 signal is at 1278.75 MHz and the receiver reference bandwidth is 40.920 MHz (the corresponding bandwidth of the free GPS signal is 2 MHz). The modulation used is the Binary Phase Shift Keying (BPSK) scheme, while the symbol and data rates are 1000 symbols per second (sps) and 500 bits per second (bps), respectively. CS will provide several advantages compared to Galileo OS and GPS. First, CS will enable higher positioning accuracy and second, the use of CS will involve an authentication mechanism with which the signal's origin will be authenticated in order to avoid spoofing (i.e., generation of a GNSS like signal with the help of a signal generator to "confuse" the GNSS receivers and cause erroneous positioning calculation). It is expected that a range code encryption type of authentication (similar to the one used in the military GPS signal) will be used (Barreca, 2010). Third, CS will offer service guarantee in order to enhance safety. From a legal point of view, the notion of service guarantee is relying on mechanisms to prevent, inform (off-line), alert (on-line) or compensate failure, disruption, or low performance (Feng, 2003).

While the technical implementation of these three advantages of Galileo CS are still under discussion, it does raise the question as to what the added value would be of a GNSS offering better accuracy, authentication and service guarantee than the free GPS signal. While the technological details of Galileo are often discussed in academic work, the business implications for the (mobile) telecommunications sector have not been studied by academics or popular press. We argue that the business impact of Galileo CS is highly relevant, given the sheer size of the location-based services market in the (mobile) telecommunications sector as well as the increased dependence of consumers and business on location-based services for their everyday activities. As far as we are aware, there is only a handful of reports, mainly from consultancies, that give a prediction on the business viability of Galileo CS; for example, a recent study from Helios emphasized that achieving all four objectives (i.e., stimulate the wider GNSS market, deliver a public service, generate commercial revenues and ensure fairness to all) set by EC for CS, equally, in an existing market with competing service providers and products is an extremely difficult task. Moreover, only in the context of a new emerging market and innovative service concept the CS will be able to deliver substantial revenues and user benefits without being overly constrained by issues of fairness (Sage & Mitchell, 2010). Motivated by the lack of research in this area, this paper analyzes how Galileo CS may impact the business models of typical location based service providers. We will structure the discussion along different business model domains (Bouwman et al 2008), including the Service domain (i.e., what new services would be enabled by Galileo CS?); Technology domain (i.e., what are the merits of Galileo CS compared to emerging technology alternatives); and Organization / Finance domain (i.e., what are organizational issues and financial risks that LBS providers face when adopting Galileo CS). We focus explicitly on Galileo CS, and treat the free-of-charge, best-effort version of Galileo as one of the alternative technologies. To do so, we conducted 14 semi-structured, in-depth interviews with policy makers, service providers and industry experts in 2011.

The main contribution of the paper is to raise awareness on and bring insight in how a new technology like Galileo CS may impact the business models of location based service providers. As a secondary contribution, we reflect on whether it is realistic to expect that service providers would be willing to pay for Galileo CS. The latter is crucial for policy makers but also the general public given that large investments are being made in Galileo hoping that they would partly be recouped using the premium-priced signal (European GNSS Agency, 2011). While the paper focuses on Galileo CS, its results are relevant for any type of GNSS service that offers premium-priced traits like accuracy, security and reliability improvements.

The remainder of this manuscript is organized as follows: Section 2 provides a concise overview of related work on business models for Information and Communication

Technology (ICT) enabled services, focusing on mobile context-aware services. Section 3 describes the method and Section 4 provides the results. Section 5 discusses the results and draws conclusions.

Related work on business models for location-based services

The concept of business models has been established as a means to explicate how companies can create and capture value from implementing technological innovations (Chesbrough & Rosenbloom, 2002). While business models were initially often used in a loose and narrative manner (Magretta, 2002), in the recent years several detailed frameworks have appeared in the literature that provide the key components and variables that comprise business models (Ballon, 2009; Bouwman, Haaker, & De Vos, 2008; Gordijn & Akkermans, 2001; Osterwalder & Pigneur, 2002).

Business models have especially gained attention in the domain of mobile telecommunications and mobile Internet services, which is not surprising given the evolving industry structure and technological landscape. Li & Whalley (2002) were very early to discuss the changing role of operators due to vertical disintegration and the subsequent impact on business models in the sector. Recently, the increasing role of device manufacturers and application stores has steered debate on how business models are changing (M De Reuver, Bouwman, Prieto, & Visser, 2011; Holzer & Ondrus, 2011). Another reason why business models are often discussed in the mobile services domain is due to the struggle of service providers to come up with value-adding and viable mobile services.

With regard to business models for context-aware services, Hegering et al. (2004) argue that a nontrivial context-aware service can only be realized by moving beyond the boundaries of single organizations. They advance several management challenges that are specifically relevant when providing context-aware services, such as configuration of the context value chain, error management, accounting, performance (quality of context) and security. Killstrom et al. (2007) suggest four generic business models for context-aware mobile services, i.e., an advertising-based model built around contextual advertising, a mobile extension model that extends the existing business of a company towards the mobile domain, a technology-based model that leverages new context-aware applications, and a contextualized content delivery model that delivers content based on user context. All these generic business models are generally complex, as they require the participation of partners providing context as well as content and/or partners from advertising. Bormann et al. (2007) discuss business models for local mobile services that enable SMEs in different segments (e.g., health, tourism, publishing, maintenance) to offer their local mobile services via a mobile network infrastructure, while Pawar et al. (2008) discuss a business model for context-aware services for mobile virtual communities that exploit the potential of social interaction and context-related information to offer personalized services.

Compared to other business model frameworks (e.g., Ballon, 2009; Gordijn & Akkermans, 2001; Osterwalder & Pigneur, 2002), the framework from Bouwman et al (2008) explicitly includes technology issues that enable a service offering as well as the organizational relationships between multiple actors in the ecosystem. As these elements are core for the present research question, we adopt their framework and define a business model as the way a company intends to create and capture value (Bouwman et al, 2008). In their conceptualization, business models cover four domains:

Service domain: a description of the value proposition (added value of a service offering) and the market segment at which the offering is aimed; Technological domain: a description of the technical functionality required to realize the service offering; Organizational domain: a description of the structure of the multi-actor value network required to create and distribute the service offering and to describe the focal firm's position within the value network; Financial domain: a description of the way a value network intends to generate revenues from a particular service offering and of the way risks, investments and revenues are divided among the various actors in a value network. In the context of mobile context-aware services, De Reuver and Haaker (2009) have illustrated the relevance of the above four business model domains for analyzing the impact of context-aware technologies in the marketplace. We will therefore structure the discussion on the impact of Galileo CS on business models along these four business model domains.

Research method

Interviews are particularly useful for getting the story behind a participant's experiences as the interviewer can pursue in-depth information around the topic. To determine the number of interviewees, we used the saturation principle (Miles & Hubermann 1994), i.e. we stopped interviewing additional persons if no additional insight was gained. Based thereon, we conducted 14 semi-structured, in-depth interviews with people in the GNSS and location-based services domain, during the spring of 2011. More precisely, we interviewed two representatives from EU Commission, four from European space agencies, six from location based service providers and two from research organizations. Typical job descriptions of interviewees include Chief Executive Officer, market monitoring officer, business consultant, project manager or academics.

In the beginning of each interview, we briefly described the Galileo system. Then, we explained that Galileo CS would be offered at a premium-rate to location-based service providers in exchange for improved accuracy, signal authentication and service guarantee. Regarding the Service domain of the business model, we asked the interviewees how accuracy, signal authentication and service guarantee would impact their services, and how this would differ across service categories and target groups. Regarding the Technology domain, we asked the interviewees whether they are aware of any alternatives to CS features and if yes, which ones. Regarding the Organization and Finance domain, we asked the interviewees to identify organizational and financial risks associated with the adoption of CS platform, if any.

The interviewees were allowed to make sidesteps and elaborations and their responses were taped in order to facilitate the transcription process. After the transcriptions were made, we submitted them to the interviewees in order reduce errors and clarify possible misunderstandings. We analyzed the transcripts using Atlas.ti (version 6.2) which is one of the most frequently used software for structuring the qualitative analysis of interview material. The use of a software tool in analyzing qualitative data can reduce analysis time, make procedures more systematic and explicit, and permit flexibility and revision in analysis procedure (Tesch, 1989).

An important step in the process of data analysis is the identification and annotation of the various concepts, known as coding. While analyzing the interview transcripts, we focused on the key concepts such as positioning accuracy, signal authentication and service guarantee. However, to prevent premature closure we kept an open mind to explanatory factors beyond the conceptual model and coded them as well (Miles & Huberman, 1994). After completion of the coding stage, we merged codes referring to similar concepts and removed others that were not considered essential. In order to ensure the applicability of the merging actions, we looked at the quotations attached to each of the codes and checked whether the merged code does indeed describe all the quotations. When the final code list was formed, we identified logical connections between codes and the nature of their relationship. Using one of the Atlas functions, we generated a network of codes, which is a visual illustration of the various concepts encountered during the interviews and their interconnections. In order to facilitate the data analysis, we identified categories of codes with common characteristics and grouped them into code families. This structuring not only improves the visual quality of the network by reducing the complexity but also introduces a hierarchy, which can serve as a guidance model.

Results

This section describes the results of the interview analysis by focusing on impact on services, value propositions and target groups; alternative technologies for Galileo CS; and organizational and financial issues that location based service providers face when adopting Galileo CS. The description of the results is based on the code network, from which views were created to focus on specific business model domains. Where relevant, we provide such views on the code network to illustrate the discussion.

Service domain: New services, target groups and value propositions

First, we explore how higher positioning accuracy, signal authentication and service guarantee would change the services and value proposition that location-based service providers can offer to their users.

Higher positioning accuracy

The improvements regarding positioning accuracy were mentioned the most in all interviews (37 times in total). Positioning accuracy is especially an issue in urban areas due to line-of-sight constraints and attenuation. Regarding higher positioning accuracy, interviewees propose that this is especially imperative for Business-to-Business (B2B) applications that are safety- or security-critical, and less important for Business-to-Customer (B2C) applications that are non-critical. Some of the interviewees considered positioning accuracy 'addictive' and thus the higher the better. Others emphasized that for certain applications, positioning accuracy is not the bottleneck, while real-time positioning is, as illustrated by this quote: "*It is a matter of instant satisfaction*".

Signal authentication

Signal authentication was regarded as a necessary feature for B2B applications and particularly for safety- and business-critical applications in which business and even lives depend on GNSS signals. For such niche markets, signal authentication was perceived as the most distinguishing key value driver. On the other hand, for mass-market (consumer) applications, the possibility to authenticate the signal would bring little if no benefits at all.

Service guarantee

Interviewees were most skeptical about key value driver service guarantee. While most of them were attracted to the concept of someone being liable for the service offered, some interviewees from the business world were concerned about the scope and the cost of such guarantees. They feared that in conditions where positioning performance is heavily degraded, such as in extreme weather conditions, during solar storms or in densely built areas, guarantees would not protect anyone against such cases, unless they would pay a very high price. A core issue here is the high level of trust that location based service providers we interviewed have in the continuous operation of GPS, which makes them skeptical as to whether the service guarantee would provide added value for the end-users.

New services enabled by Galileo CS

The availability of CS was regarded as an enabler for new services and applications or as a way to improve existing service offerings. Road tolling was an example of enabled services that was quoted the most. The main principle is that road users are charged based on how much they drive and this information is obtained by employing GNSS receivers that are built into the vehicles. An interviewee coming from a space agency emphasized that using GNSS for collecting road usage fees is especially advantageous over terrestrial-only or terrestrially supported solutions because it is easier to maintain, update and upgrade. Especially the proposed reliability and fraud prevention due to signal authentication would make CS more suitable than other GNSS based services.

Other services that could benefit from CS platform are tracking of valuable/dangerous goods, land/offshore construction, car parking and sharing, rail track and road lane sensitivity, inland and harbor shipping, maintenance of road infrastructure, fleet management, underground cable positioning, machine control, security services, financial transactions, logistics, agricultural activities, etc. Again, especially reliability and security were most mentioned regarding these services. Security was found necessary in safety-critical applications, such as in transportation of people or dangerous goods. Reliability was found extremely necessary in financially or security sensitive applications such as bank transactions. Interviewees also expected the CS service to suffer from less outage due to better management of the system, which is partly driven by the service guarantees.

Technological alternatives to Galileo CS

Almost all interviewees pointed to various (emerging) alternative technologies for Galileo CS. As Figure 1 shows, alternatives include not only inferior technologies (indicated with the code *Risk acceptance* in Figure 1) but also alternative technologies that could provide similar benefits as CS does (*Technological alternatives*).

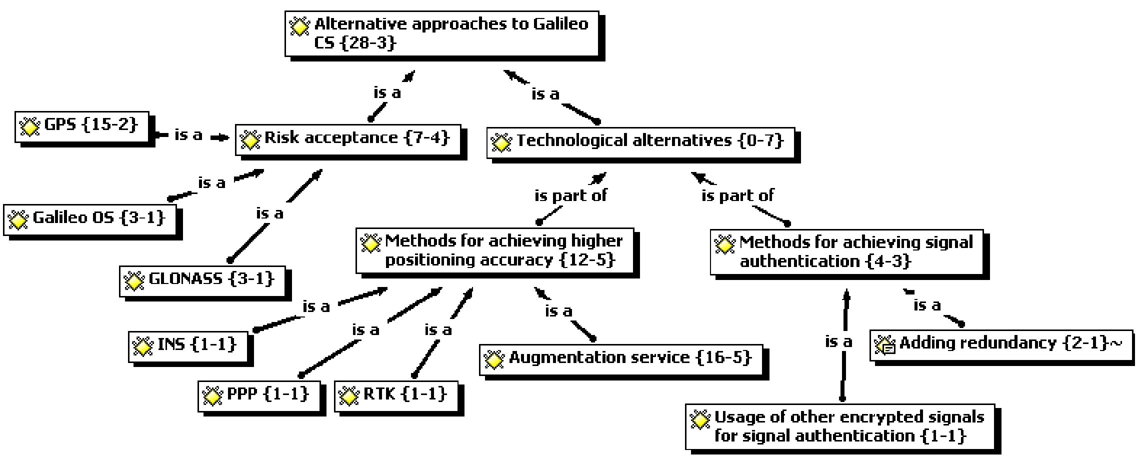

Figure 1. Alternative approaches to Galileo CS platform (number in brackets indicate the number of times mentioned in the interviewees and the number of interrelated codes, respectively)

The most commonly quoted alternative technology was GPS since this has been the default GNSS in use for the last two decades and its widespread adoption has turned it into a utility. The Russian GLObal NAvigation Satellite System (GLONASS) was also mentioned as an alternative satellite-based platform. GLONASS was fully operational by 1995 but the collapse of Soviet Union significantly delayed the system's continuous operation. Nowadays, the system is operational and GLONASS signals are being used for positioning. Besides the existing GPS and GLONASS system, the future Galileo OS was also regarded as a strong competitor to CS. OS is intended for mass-market applications and is accessible to any user equipped with a receiver, with no authorization required. OS does not offer integrity information and the determination of the quality of the signals will be left entirely to the users, as in the case of the GPS and GLONASS standard positioning service. The main reason why interviewees are in favor of these alternatives is because they are all offered free-of-charge and even if their offerings are much less than CS, they are willing to compromise and accept the risks.

Besides inferior positioning technologies, interviewees also pointed out various specialized solutions that have already been developed to assure higher positioning accuracy and signal authentication. Among the technologies designed to provide higher positioning accuracy, space-based or ground-based augmentation systems are the most commonly mentioned. An augmentation system consists of a network of earth stations whose exact location is known with great precision. These stations compute their location based on GPS signals and transmit the difference between the computed position and the true one to the users. Then, the user receiver incorporates this difference in the position calculation procedure in order to remove certain error. In that way, higher positioning accuracy is achieved. This method, known also as differential service, was the one quoted the most by the interviewees. Examples of such systems are the U.S. Wide Area Augmentation System (WAAS) and the European Geostationary

Navigation Overlay Service (EGNOS). Other methods for achieving higher positioning accuracy are

- Inertial Navigation System (INS) – a technique in which measurements provided by accelerometers and gyroscopes are used to track the position and orientation of an object relative to a known starting point, orientation and velocity. INSs are used for the navigation of aircrafts, tactical and strategic missiles, ships, etc. (Woodman, 2007)

- Real Time Kinematic (RTK) – a differential GNSS technique which provides high positioning performance in the vicinity of a base station. RTK utilizes carrier measurements and the transmission of corrections from the base station, whose location is known to the rover receiver, thus the main errors that drive the stand-alone positioning cancel out.

- Precise Point Positioning (PPP) - it requires the availability of precise reference satellite orbit and clock products in real-time using a network of GNSS reference stations distributed worldwide. Combining the precise satellite positions and clocks with a dual-frequency GNSS receiver, PPP is able to provide position solutions at centimetre to decimetre level (Laínez Samper, 2011).

- Receiver Autonomous Integrity Monitoring (RAIM) - a technique that provides integrity using redundant satellites (i.e. beyond the minimum required to estimate the user position) to protect the user against large navigation errors. .

Regarding alternative technologies for authenticating signals, two alternative methods were mentioned. The first one utilizes existing encrypted signals, such as the GPS military signal or the future Galileo Public Regulated Service (PRS) signals, in order to authenticate unencrypted signals transmitted from the same satellites. The second method is to introduce as much redundancy of reference signals as possible in order to minimize the possibility of intentional misguidance. The latter method is not a direct alternative since it cannot solve the problems related to simulated GNSS signals; instead, it is a way to mitigate the risks associated with unencrypted signals. Apart from the individual methods for increasing positioning accuracy and authenticating the signal, there were no other methods or services mentioned that would offer all three distinguishing features of CS.

All in all, for services where higher positioning accuracy is the main or only requirement, Galileo CS can be replaced by various technologies that are possibly more cost efficient. In applications where security is very crucial, there are very few alternatives to Galileo CS. In applications, where liability is necessary, the service guarantee from Galileo CS would be the only option. Besides the alternatives to individual value drivers, the combined offering of higher positioning accuracy, signal authentication and service guarantee has a vantage point.

Organizational and financial issues

Galileo CS will introduce a number of organizational and financial issues that limit the benefits of the technology for the business model, according to our interviewees. We provide an overview here, see Figure 2.

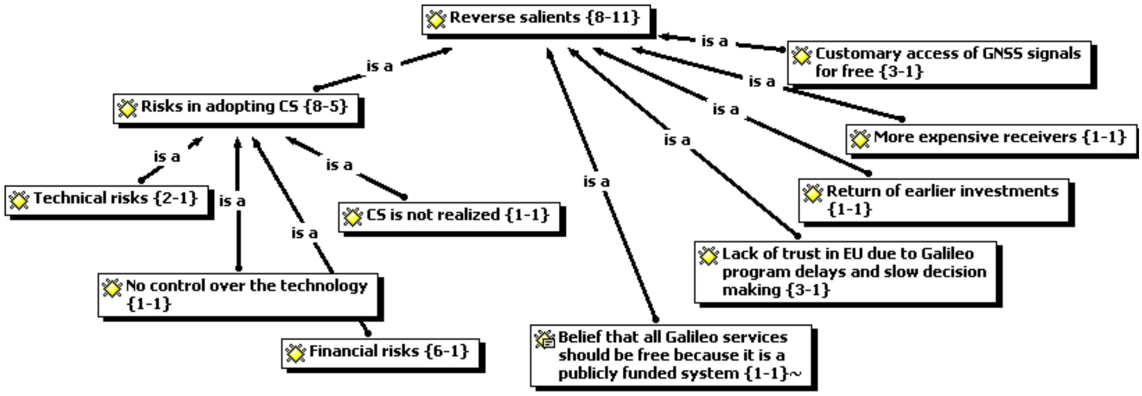

Figure 2: Organizational and financial issues that lead to reverse salients

Interviewees were asked whether they foresee any risks associated with the adoption of CS. The risks mentioned were the possibility CS is not realized or it does not to work as promised or expected. Some interviewees also emphasized their lack of trust in the EU decision-making process, due to the continuous delays of the Galileo program. This may impel service providers to choose an alternative solution from which it would be hard to switch to CS, when it will be available. Finally, being accustomed to using GNSS signals for free was also found as a reverse salient in the willingness to adopt CS.

Financial risks are also inherently present. The higher cost of CS receivers and the existence of earlier investments would make the business model of location based service providers less attractive. As one interviewee from a space agency said, "*Users employing existing systems won't switch to a new system before they get the return of their investment in the system they use. They will be conservative*". One interviewee also expressed his belief that Galileo services should be offered for free since Galileo has been a publicly funded program.

Discussion and Conclusions

Based on the interview analysis, it is evident that Galileo CS will impact the business models of location based service providers for specific target groups and services only: Galileo CS will mainly add value for business users (e.g., fleet managers, logistics providers) and governments (e.g., road pricing). Still, if CS is meant to serve professional markets, various technological alternatives are available such as differential services, with straightforward advantages: they are already available to the market, businesses have customized them to their needs and users are familiar with them. Based on the interviewees, it is clear that in order to ensure a competitive positive influence, CS design has to address at least the disadvantages of the existing solutions, such as higher cost (for example, due to the use of proprietary technology), inflexibility and lack of reliability and security. Service guarantee is an admittedly unique differentiator according to the interviewees; however, the concept of service guarantee is still ill defined, especially regarding governance, legal and accountability aspects.

If CS was to serve the consumer market, higher positioning accuracy would be a clear differentiator since there are no alternative technologies to address this particular market. Signal authentication seems an unnecessary feature for mass-market applications, although increased dependency on location based services will increase the consequences of a malicious attack.

Overall, we find that LBS providers are reluctant to make any serious preparations for adopting the technology, as they indicate there are too many uncertainties. As Galileo CS will only be available by 2020, various yet unknown technological alternatives may emerge in the meantime. The legal, financial and technical conditions that the EU will impose on using the CS signal as well as the liability chain to support the service guarantee are yet to be defined. LBS providers may adopt a wait-and-see strategy, but on the other hand they could also be more assertive to get a (perhaps temporary) competitive advantage over other LBS providers. A core issue is whether and when to make end-users aware of the existing and future issues about the security, accuracy and reliability issues that pertain best-effort GPS signal.

As a message for policy makers on Galileo, we point out that the viability of Galileo CS and the possibility to create revenues for its operators should not at all be taken for granted. This is in line with the recent observations made by the officials in the EU itself (Simon, 2011). Instead, our findings show that it is highly uncertain whether LBS providers will benefit from Galileo CS. To convince LBS providers to adopt Galileo CS, building up trust will crucial, as interviewed LBS providers were skeptical on the reliability of the offering and EU decision-making processes in general. Providing clarity regarding conditions, contract terms and liability models is crucial to create trust among LBS providers. Another approach to build up trust and reputation may be to get government institutions to adopt the Galileo CS system early on, for example for road tolling applications. One suggestion would be to intensify attempts to involve a broad range of LBS providers and users more intensively in Galileo related R&D programs of the European Commission and the European Space Agency. LBS providers may find themselves forced to adopt Galileo CS once their competitors start to adopt it. In other words, once a critical mass of LBS providers has adopted Galileo CS, others will have no choice but to adopt it simply to remain competitive. The institution operating Galileo CS may thus try to achieve a critical mass quickly, for example by applying progressive pricing schemes, in which early adopters get discounts just to get them on board early-on.

As in any paper that analyzes the business impact of a future technology, the results should be interpreted with care. As Galileo CS will be launched in about ten years from now, various alternative technologies may emerge that might achieve similar positioning accuracy, signal authentication and reliability. But also future events like issues with GPS concerning outages, hacking, spoofing, wars and other unforeseen problems may change the rationale for adopting Galileo CS. Although the technical specifications of Galileo CS still have to be worked out in detail, our results do pave the way for discussion on the merits of going beyond best-effort GNSS signals by increasing accuracy, security and reliability.

References

Ballon, P. (2009). Control and Value in Mobile Communications: A Political Economy of the Reconfiguration of Business Models in the European Mobile Industry. Dissertation, IBBT-SMIT, VUB, Brussels, Belgium.

Barreca, E. (2010). Future thinking on the Galileo Authentication Application. Retrieved from http://www.iisc.im/documents/Future_Thinking_on_the_Galileo_authentication_service_final_EB[1]_2.pdf

Bormann, F., Flake, S., & Tacken, J. (2007). Business Models for Local Mobile Services enabled by Convergent Online Charging. In I. Frigyes, J. Bito & P. Bakki (Eds.), Advances in Mobile and Wireless Communications – Views of the 16th IST Mobile and Wireless Communications Summit: Springer.

Bouwman, H., Haaker, T., & De Vos, H. (2008). Mobile service innovation and business models: Springer.

Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. Industrial and Corporate Change, 11(3), 529-555.

De Reuver, M., Bouwman, H., Prieto, G., & Visser, A. (2011). Governance of flexible mobile service platforms. Futures, 43(9), 979-985.

De Reuver, M., & Haaker, T. (2009). Designing viable business models for context-aware mobile services. Telematics and Informatics, 26, 240-248.

European GNSS Agency. (2011), from http://www.gsa.europa.eu/go/home/galileo/services

Feng, Y. (2003). Combined Galileo and GPS: A Technical Perspective. Journal of Global Positioning Systems, 2(1), 67-72.

Gordijn, J., & Akkermans, H. (2001). Designing and Evaluating E-Business Models. Intelligent Systems 4.

Hegering, G.-G., Küpper, A., Linnhoff-Popien, C., & Reiser, H. (2004). Management Challenges of Context-Aware Services in Ubiquitous Environments. Paper presented at the 14th IFIP/IEEE Workshop on Distributed Systems: Operations and Management, Heidelberg, Germany.

Hofmann-Wellenhof, B., Legat, K., & Wieser, M. (2003). Navigation: principles of positioning and guidance. New York: Springer.

Holzer, A., & Ondrus, J. (2011). Mobile application market: A developer's perspective. Telematics and Informatics, 28(1), 22-31.

Killström, U. (2007). Marketplace Dynamics and Business Models Framework. In M. Klemettinen (Ed.), Enabling Technologies for Mobile Services: The MobiLife Book. Chichester, England: John Wiley & Sons Ltd.

Laínez Samper M. D. et al. (2011). Multisystem real time precise-point-positioning, Coordinates, Volume VII, Issue 2.

Li, F., & Whalley, J. (2002). Deconstruction of the telecommunications industry: from value chains to value networks. Telecommunications Policy, 26, 451-472.

Magretta, J. (2002). Why Business Models Matter. Harvard Business Review, 80(5), 86-92.

Miles, M. B., & Huberman, A. M. (1994). Qualitative Data Analysis: Sage.

Osterwalder, A., & Pigneur, Y. (2002, June 17-19). An e-Business Model Ontology for Modeling e-Business. Paper presented at the 15th Bled Electronic Commerce Conference, Bled, Slovenia.

Pawar, P., Subercaze, J., Maret, P., Van Beijnum, B.-J., & Konstantas, D. (2008). Towards Business Model and Technical Platform for the Service Oriented Context-Aware Mobile Virtual Communities. Paper presented at the IEEE Symposium on Computers and Communications.

Sage, A., & Mitchell, S. (2010). Galileo Commercial Service Definition Study.

Simon, C. (2011). Galileo, business model evolution. Retrieved from http://www.business-meets-research.lu/fileadmin/user_upload/presentations_2011/ICT-SPACE-Simon.pdf

Tesch, R. (1989). Computer software and qualitative analysis: A reassessment. New Brunswick, NJ: Transaction Books.

Woodman, O. J. (2007). An introduction to inertial navigation. University of Cambridge Computer Laboratory, ISSN 1476-2986, 696, 1-37. Retrieved from http://www.cl.cam.ac.uk/techreports/UCAM-CL-TR-696.pdf