4-1-2010

Exploration of Adoption of Service Innovations Through Technology Road-Mapping: Case of Location Based Services

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ABSTRACT

This paper utilizes a technology roadmapping approach to demonstrate how a traditional technology management process can be applied to improve planning practices for technology-driven service innovations. With location based services (LBS) as the focus, the paper explores business, market, product and services drivers in developing the technology roadmap. Thus, the study demonstrates that technology management theory and processes from the product domain may be usefully applied to the management of technology-driven service innovations. The case study analysis identified service drivers including security, privacy and mobility as important factors for LBS success. Potentially disruptive service innovations resulting from the convergence of the computer and wireless industries are explored.

Keywords: Service science, management, engineering, technology, location based services, mobile services, technology management, technology roadmapping

Acknowledgements: We wish to thank Kenny Phan, Vijay Bhusari and Youngkoo Yoon for assistance with the data collection. We thank the anonymous reviewers as their input led to significant improvements in the paper. We also thank Editor-in-chief Dr. Miguel-Angel Sicilia for his support.

INTRODUCTION

The world economy is transitioning from a production-based economy to one that is more dependent on services for employment and wealth creation (Chesbrough and Spohrer, 2006; Demirkan et al., 2009; Spohrer and Maglio, 2008). This transformation has driven rapid research growth in service science and service innovation. Researchers have debated whether or not to differentiate between product and service innovations (Daim et al., 2008, Daim et al., 2009; Lin and Daim, 2008). Some argue that the same fundamentals are valid in either case, while others argue otherwise (Lusch and Vargo, 2006; Vargo and Lusch, 2004). It is our contention in the case of technology-driven service innovations, that tools and techniques that have been successfully applied in the product domain can be adapted to services research. We selected the case of location-based services (LBS) to demonstrate how technology road mapping can support innovation and the adoption of LBS processes. The rapid growth of mobile devices such as cellular phones (especially smart phones), personal digital assistants, and pagers have provided significant opportunities for service innovation.

An increasing number of mobile devices allow people to access the Internet wherever and whenever they want. The emergence of smart phones with GPS capability that operate on fast digital networks has become the key to the development of mobile location services. For some time, researchers have predicted that LBS will be the most common form of context-aware computing (Ljungstrand, 2001). LBS provide spatial and location-dependent information that is targeted to each user's specific location-relevant needs (Benson, 2001; Unni and Harmon, 2006). LBS users can enjoy various types of services such as mobile yellow pages (to find the nearest point of interests), mobile buddy lists (to find friends nearby the current location), traffic navigation (to find the shortest distance to the destination), emergency support services (to find nearest police stations or restaurants) and equipment tracking (Jose and Davies, 1999, Schiller and Voisard, 2004).

Although LBS are considered to be a primary technology service in the wireless space, the adoption process has been very slow. Consider that LBS have great potential for enhancing safety, security, navigation, collaboration, and productivity that is not possible on desktop computers, the slow adoption rate is disappointing (Barnes 2003a; Harmon and Daim 2009; Oracle Technical White Paper 2001). The reasons have become clear. Potential customers, both business and consumer, perceive LBS to be complex, costly, and offering insufficient value to warrant adoption (The Economist, 2006). However, with the advent of the GPS-enabled smart phone and 3G networks, the LBS trajectory is about to change. Recent projections indicate that worldwide subscribers of GPS-enabled LBS will grow from 12 million in 2007 to reach 315 million in 2011 (Morse, 2006), and the location-based advertising (LBA) market will be a $2 billion market opportunity by 2011 (Boulton, 2007).

Technology roadmapping, initially used in the 1970's (Probert and Radnor, 2003; Willyard and McClees, 1987), has many applications such as national-technology roadmaps (Diebold, 1995; Prem and Raghavan, 2005; Spencer and Seidel, 1995), industry-technology roadmaps (Ning, 1995), and international-technology roadmaps (Schaller, 2002). Early versions as applied by EIRMA (1997); Koen (1997) and Probert and Radnor (2003) defined technology roadmaps with practical tools for easy implementation. Phall et al. (2003, 2004) provided a method called T-Plan and demonstrated very efficient use of the process. Kostoff and Schaller (2001), Kostoff et al. (2004), Lee and Park (2005) and Rinne (2004) provided additional tools and perspective. Lee and Park (2005), Lopez-Ortega et al. (2006), Newman and Leyerhantz (2001), Kappel (2001), Albright and Kappel (2003), and Groenveld (2007) have applied roadmaps in diverse situations.

However, it is Kameoka et al. (2006) and Nakamura et al. (2006) that first provided the framework for integrating service innovation into a roadmap implementation. Following their work, we proceed with the exploratory application of technology roadmapping to service innovation in the case of LBS. Our major thesis is that the technology roadmapping methodology currently used in the product-innovation domain can also be effectively used to roadmap service innovations. In the next section, we provide an overview of location based services. Then, LBS technology roadmaps with business and market drivers are discussed. Next, we discuss products, services and technology roadmap applications. Finally, we will conclude with a discussion of applications of how technology management processes can help to further simplify the evaluating and planning processes for technology driven services.

OVERVIEW OF LOCATION BASED SERVICES

Location-based services enable consumers to receive mobile services based on their geographic location. For example, businesses can provide information about traffic, restaurants, retail stores, travel arrangements, or automatic teller machines based on the consumers' location at a particular moment in time. Such services are typically provided in response to a consumer's input of location information into the handset or by using "auto-location" technology (Federal Trade Commission, 2002). It is important to take into account that LBS applications are different from general Internet applications in two respects (Fritsch and Goethe, 2005). First, the mobility of the user and the device enables a user to access services from a variety of networks, and even without cellular connectivity. Second, location sensitivity enables applications to process location information to add contextual value based on user behavior, time, and location. LBS offer a broad range of application categories, such as:

- Emergency Services: Provides the ability to locate an individual who is either unaware or not able to reveal his /her location because of an emergency situation.
- Navigation Services: Offers direction assistance to users within their current geographical location. It has ability to locate and exact position of mobile devices in a series of navigation-based services.
- Information Services: Provides the ability to find the nearest service, access traffic news, get help with navigating in an unfamiliar city, obtain a local street map, search for travel services, etc.
- Tracking and Management Services: Tracking is applicable both to consumer and corporate markets. Examples are tracking packages, equipment, vehicles, and children.
- Billing Services: Provides the ability of a mobile location service provider to dynamically charge users of a particular service depending on their location when using or accessing the service.
- Outlook–Augmented Reality: Provides the ability to integrate graphics on the handset display and with inputs from the real-world environment. For example, a user can see the real world with computer graphics augmentation and labels integrated into the display.

Figure 1 below depicts the LBS components and the information flows among the various elements. The information flow is described below:

1. If the device and application are activated, the actual position of the mobile device will be tracked by the positioning service.
2. The mobile device users request location-specific information via the communication network gateway.
3. The gateway will exchange messages between the mobile network and Internet. It will locate the web addresses from several application servers and routes the request to a specific server. The gateway will store the information about mobile device which has asked for the information.
4. The application server will read the request and deliver the appropriate service (spatial search service).
5. The system will analyze the message and decide which additional information is needed to answer the request.
6. The service will find the information for a specific region, such as yellow page listings, and ask the data provider for such data.

7. The service will check if the requested information is available.
8. After calculating a list of the requests the result is sent back to the user via Internet, gateway and mobile network.

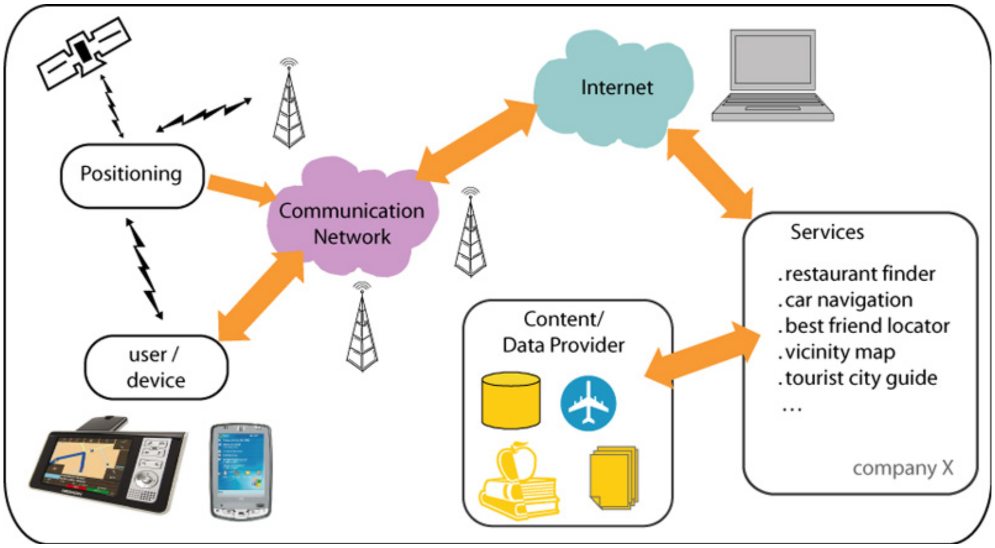

Figure 1. Location-Based Services Components and Information Flow (Adapted from GSM Association, 2002)

LBS consist of several main components (GSM Association, 2002):

- Mobile Devices: Tools (e.g. mobile phones, PDA, laptops, navigation devices) to send and receive needed information. The information could be texts, pictures, voices, location co-ordinates, etc.
- Communication Network: The mobile network transfers the user data and service requests from the customers to service provider and sends the information back to the user.
- Positioning Component: The exact location of users can be determined by using the Global Positioning System (GPS), WLAN stations, active badges or radio beacons. Usually, those positioning devices can determine the user's position automatically. If not, users can specify their location manually.
- LBS Application Providers: The LBS application providers are responsible for the service request processing. The activities include calculating the position, finding a route, searching sources with respect to position or searching specific information on objects of user interests and so forth.
- Data and Content Provider: The service provider will usually not store or maintain the information of the users. The information is usually requested from the maintaining authority such as the mapping service, mobile operator, and other industry partners.

Three types of information delivery services characterize LBS (Virrantaus et al., 2001):

- Pull Services: The information is directly requested by the end-users. Pull services are often associated with functional services (e.g. ordering taxi or ambulance by just pressing button on the device), and information services (e.g. searching for retailers, hotels or restaurants).

- Push Services: The information is pushed to the user by the service provider. Examples include news, travel information, and advertising messages for a specific city on an opt-in or subscription basis.
- Tracking Services: Users are able to track the location of the mobile handset or terminal. This type of service raises privacy and security issues and the assumption that the user has agreed to be tracked.

Reichenbacher (2004) states that locating, navigating, searching, identifying, and checking as the five elementary mobile actions associated with LBS. These five elements are described in Table 1. Each of these actions is should be considered in the development of LBS applications.

Table 1. Five Elements Mobile Actions in Location-Based Services (Reichenbacher, 2004)

Action	**Questions**	**Operations**
Locating	Where am I? Where is (person/object)?	Positioning, Geocoding, Geodecoding
Navigating	How do I get to (place/address)?	Positioning, Geocoding, Geodecoding Routing
Searching	Where is the nearest (point of interests)?	Positioning, Geocoding, Calculating Distance and Area, Finding Relationships
Identifying	What – Who – How Much is Here - There	Directory, Selection, Thematic/Spatial, Search
Checking	What Happens (here/there)?	Positioning, Geocoding, Geodecoding, Search

LBS are unique in that they are aware of the use context and can adapt content and presentation accordingly (Schilit et al., 1994). Context is any information that can be used to characterize the specific situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between user and application. This can include the user and the applications (Dey, 2001). Schilit et al. (1994) emphasizes three important aspect of context: where you are (spatial context), who you are with (social context), and what resources are nearby (information context). They also added that context information is influenced by technological factors such as bandwidth, connectivity, and speed and should also be taken into account.

Nivala and Sarjakoski (2003) identified nine types of context with specific reference to mobile services.

- Mobile Map User: The identity of the user and her demographics (age, gender, income, etc.) are linked with preferences, behavior, and social networks to provide location-relevant information.

- Location: The most commonly used context element. It allows information and services to be localized.
- Time: Defining the precise time such as morning, evening, day, week, month, season, and year is important since mobile services are time dependent. For example, time is a critical element in the selection of entertainment events.
- Orientation: Information about the physical orientation of the user determines direction being traveled and thus what is in front, behind or on either side.
- Navigation History: Allows users to see where they have been, what they have seen, and what they have done. This is useful in navigation to orientate a user while they are moving and allow them to backtrack if they get lost.
- Use Purpose: Defined by activities, goals, tasks, and roles of users. Different types of usage require different types of information, presentation, and interactions.
- Social and Cultural Situation: The social situation of the user is characterized by their proximity to others, social relationships, and collaborative tasks.
- Physical Surroundings: Includes the physical setting the user is in and such things as the lighting level, how much ambient noise there is, the type of event the user is attending, and the behavior being performed.
- System Properties: This relates to the computer infrastructure the user is employing. It includes type of device, its capabilities, and the type of network access (cellular, WiFi, etc.)

Context-awareness capability enables LBS to adapt in real time. The system dynamically responds according to the context. It is reactive, responsive, situated, context-sensitive, and environment directed (Abowd, et al., 1999). According to Reichenbacher (2003), the adaptive capability takes place at four different levels:

- Information Level: Information content is adapted. For instance, information may be filtered by the proximity to user or by changing the detail of information according to task requests and user behavior (Timpf and Kuhn, 2003).
- Technology Level: LBS information is provided based on the device and network technological profiles such as display size, resolution, memory capacity, processor speed, and network bandwidth.
- User Interface Level: The displayed information is updated as the user moves and performs specific tasks such as the automatic re-mapping of the user's route based on direction taken.
- Presentation Level: The visualization of the information is adapted based on contextual parameters. For example, the application is tasked to find restaurants that are more relevant to the user's preferences such as price, amenities, menu, and time of day.

The ability of LBS to adapt to content according to the context is a primary distinguishing characteristic when compared to other information technologies. The examples of adaption to the context that are relevant for LBS are detailed below:

- Adaption to User Preferences: Information content is adapted according to the context of the users' personal preferences for different types of information and their current location.

- Adaption to Season and User Age: Information content is adapted according to the context of the user's demographics and time-of- year.
- Adaption to Location and Social Context: Persson et al. (2002) and Burrell et al. (2002) looked at the impact of location and social context for guiding new students on a university campus. The systems adapted the information content according to location, time-of-day and social relationship between students and student groups.
- Adaption to System Context: Chalmers et al. (2004) used the system context to adapt the content and presentation of information to match system capabilities.

This section provided an overview of LBS, its components, and core functions that are useful for technology roadmapping. The next section addresses the implementation of the technology roadmapping process to map the LBS business and market drivers, products and services, and technologies.

LBS TECHNOLOGY ROADMAPS

Technology roadmapping has been applied in many industries for planning purposes (Phall et al., 2003, 2004). Although many variations are reported in the literature, many agree on the following three steps:

- Identifying Business and Market Drivers: This process identifies and lists all internal and external drivers that may impact an organization's plan for delivering products or services. For the LBS case a total-industry perspective is taken.
- Identifying Products and Services: This stage entails identifying the feasible set of products and services that a company is planning and maps them to the drivers identified in the prior stage. Gap analysis is indicated for comparison with competitive products and services in the industry.
- Identifying Supporting Technologies: This stage focuses on identifying both existing and required technologies necessary to enable the products and services identified in the previous stage. Currently available and emerging LBS technologies are reviewed.

BUSINESS DRIVERS

Stakeholders

LBS require the involvement of several different stakeholders working together to provide the complete service. All are involved in the LBS service innovation process. Two major group classifications are end-users and LBS enabling parties. End-users may be sub-divided into two categories: targets and requestors. Targets are end-users whose position is queried by the service. Requestors are end-users that are querying the position-available services. End-users can simultaneously have both roles.

LBS enabling parties may be categorized into four groups:

- Location technology providers manufacture the GPS enabled handsets, develop software applications, and manufacture location infrastructure.
- Network operators are the cellular carriers that maintain and operate the cellular networks and infrastructure. In most instances they are the keystone players that dominate the cellular ecosystem.
- Regulators are governmental organizations that specify how LBS can be legally implemented.
- Service providers are companies that provide the LBS on the mobile networks. They may provide LBS in partnership with the network operator or on an independent basis. Service providers may also develop their own applications.

Technological Convergence

The convergence of Internet and mobile technologies has finally created the opportunity for LBS to gain traction. Technologies such as Wi-Fi, VoIP-capable smartphones, and WiMAX, which recently became a 3G standard, are challenging the operators' closed-network business models (Allison, 2007). Government regulations that mandated cellular operators to provide accurate cell phone location data for emergency calls were the driving force that enabled the deployment of the technological infrastructure that provided the basis for the development of LBS (Rao and Minakakis, 2004; Unni and Harmon, 2006). But it is the recent advent of GPS handset technology coupled with the roll out of 3G data networks that holds the biggest promise for LBS adoption (Baig, 2006).

Real Time Access to the Customer

LBS enable marketers to reach customers at the right location with the right solution at the precise time they are ready to buy. They integrate the user's past behavior and preferences with the options provided by location and time (Kenny and Marshall, 2000). This enables smart mobile location-enabled services to sense and respond in real time based on who the customer is, where they are, what they are doing, and what information they likely require (The Economist, 2006). This provides a unique opportunity for real-time targeting of customers in virtual space (Luo and Seyedian, 2003).

Social Networks

Social networks are another potentially disruptive factor for the LBS industry (Waters and Allison, 2007). Mobile Web 2.0 applications use cellular technologies to enable access to Internet technologies for the creation of high-value services (Jaokar and Fish, 2006). The combination of social networks and the mobile web, known as mobile social networking, is considered to be a potential killer application (Norton, 2007). Social networking portals are proprietary by nature (Stross, 2007). However, Google has recently promoted a new open standard called "OpenSocial" for social networking. They are betting the large audience will draw the best software application developers (Waters and Allison, 2007).

Privacy is considered to be the major barrier for LBS adoption and for monetizing social networks (Schoenbachler and Gordon, 2002; Harmon and Daim, 2009). A recent study found that the telecoms industry in general was the worst for consumer privacy (Telecoms.com, 2007a). Security may be even more critical since the location information provided by LBS can compromise a user's physical safety (Willams, 2006). Perusco and Michael (2007) found that the use of LBS technology affected user perceptions of control, trust, and privacy, and security. Increased control reduces trust, but increased trust reduces concerns about privacy. If privacy is comprised users can worry that unauthorized knowledge of their location that can threaten their safety. Therefore, LBS with its highly interactive social capabilities have both benefits and drawbacks. Successful service development with be mindful of both.

MARKET DRIVERS

New Players

As Internet-based innovations diffuse to the mobile industry (Malykhina and Martin, 2007; Martin, 2007) customer expectations have increased, new competitors and technologies from the Internet and computer industries have entered the market, and the mobile operators' value chain members have sought ways to gain a greater share of industry revenues by directly targeting end-users. Perhaps the biggest threats to the operators are the new players from computing and Internet industries such as Apple and Google. The wireless network operators tend to have less LBS-relevant capabilities than the new entrants as the mobile phone morphs into a mobile computer (Kharif, 2007). While the market is changing, the new entrants are challenging the network operators who have been preoccupied with the roll out of their 3G network data-services infrastructure (Porter, 2001; Fry, 2006). As Apple and Google bring their business models to the wireless industry, it will be very difficult for the operators to maintain their walled gardens and do business as usual (Sharma, 2007; Harmon and Daim 2009).

Increased Customer Expectations

On top of this, operators have major issues with customer satisfaction. It is reported that over 80 per cent of mobile customers were not pleased with their mobile operator's service (Caplan, 2007). GPS-based personal navigation systems, Internet mapping sites such as Google maps, and family monitoring applications for child and elderly tracking have been the major drivers for LBS (Baig, 2006; Martin, 2007). As reported by Harmon and Daim (2009), Apple, Nokia, and Google have challenged the role of the network operators and have become the leading drivers of innovation in the mobile space. Consumers have taken notice. Apple's iPhone features Wi-Fi access which enables its users to side load content from iTunes, The App Store, and access the open Internet independent of AT&T's network (Kharif, 2007). The iPhone has been tremendously successful. The Apple brand is more powerful than that of AT&T (Harmon and Daim 2009).

Similarly, Nokia is directly targeting location services directly to consumers. It acquired Navteq, a U.S. mapping and LBS firm (Telecoms.com, 2007b) and launched the Ovi Internet and multimedia portal (Hesseldahl, 2007b). Users of Nokia's Navigator phone can view their current location on a map, search for destinations, plot specific routes, and locate services such shops, hotels, gas stations, and restaurants independent of the cellular network (Reardon, 2007). Nokia, like Apple and Google, has opened its services platform to third-party developers (Kharif, 2007) with an intention to develop closer relationships to end-users and capture a higher share of mobile services market (Schenker and Edwards, 2007).

Google, which has dominated Internet search-based advertising on the desktop, has the potential to be the biggest market disruptor. Its vision is to organize the world's information and to make it available to all. It intends its software and services to be as accessible on mobile networks as they are on the Internet (Sharma, 2007). Google's ultimate strategy is to target real-time location-based ads to individual behavior (Crockett et al., 2007). Google is also working with the US government so that any handset could be used on any mobile network with any application (Jenkins, 2007) which will stimulate software developers to create new features and applications (Babcock, 2007).

The new players, new smart phones, access to the open Internet, VoIP capability, and access to countless applications many of which are free, is starting to change the mobile location services game. No longer will be it the exclusive province of the network providers. Consumers can expect to have more choice at lower prices.

PRODUCTS AND SERVICES

LBS applications such as asset tracking, logistics planning, and workforce management which are used by enterprises have experienced relatively successful adoption (Cox, 2007). Use of similar applications for telemedicine has been increasing (Maglogiannis and Hadjiefthymiades, 2007). Location-based advertising has also been on the rise (Bruner Ii and Kumar, 2007). Other applications include insurance (Financetech.com, 2007; Reed, 2007); and family tracking (Telecoms.com, 2007c, Hesseldahl, 2007a). Other emerging applications include location-relevant features such as friends and events finding, user-generated content such as videos (Norton, 2007), and location-assisted collaborative mobile gaming (Kapko, 2007). A recent survey indicates that over 60% of consumers would be willing to accept a free ad-based usage model for local search (Telecoms.com, 2007d).

Figure 2 summarizes the key takeaways from our review of business, market, and products and services factors. Technological change is creating opportunities for new entrants and increasing customers' service expectations concerning LBS capabilities and price. These dynamic circumstances are creating challenges for the current service providers who have traditionally dominated the industry and been slow to innovate. As mentioned above, players such as those coming from the computer industry can leverage their experience and deliver the cutting-edge products and services to address the identified drivers. However, this may take a while and certainly will necessitate significant investments. The new members of the mobile ecosystem may choose to continue to form alliances such as AT&T and Apple and Google and T-Mobile have done.

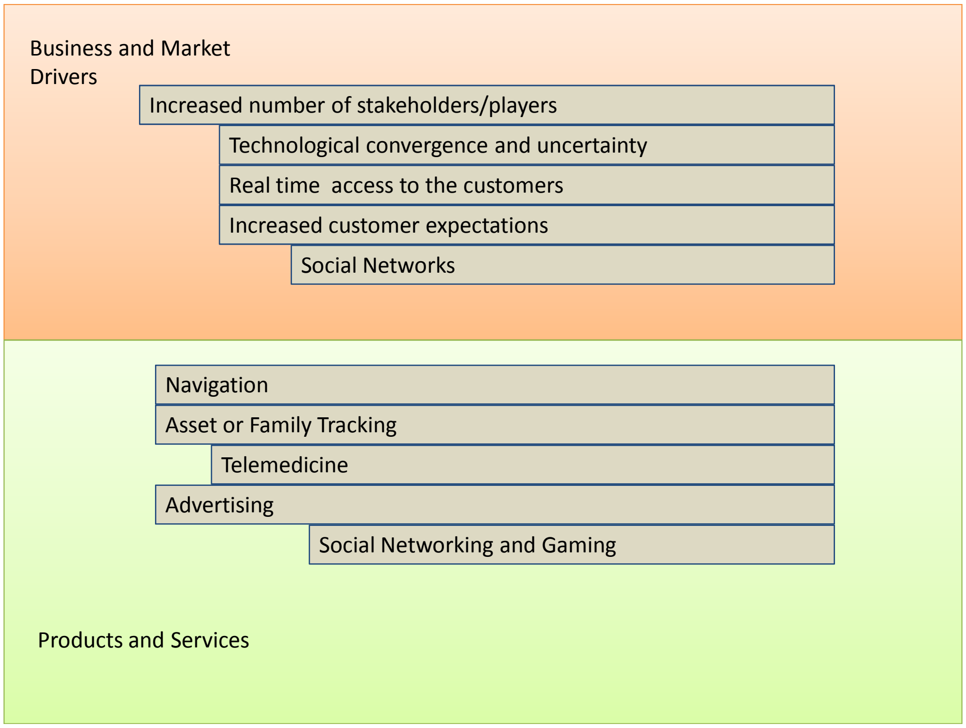

Figure 2. Business/Market Drivers and Products/Services for LBS

As depicted in Figure 2, business and market drivers will shape the features of products and services in their development phases. Firms need to keep technological convergence and uncertainty in their minds and target flexible products and services that can be upgraded with new technologies. Advertising firms will be able to leverage direct access to customers; however this may backfire as customers require more privacy. This represents two conflicting drivers that the firms in this business need to pay attention and weigh accordingly.

AVAILABLE TECHNOLOGIES

The convergence of Internet, computing, and wireless technologies are disrupting the mobile industry by reducing barriers to entry. This requires that all members of the wireless services ecosystem to be sensitive to these technologies and roadmap their feasibility. There are several technical features for classifying technologies. These classifications include the way the signals are transmitted (Rappaport, 2001; Gruber, 2005), the "access mechanism" (Gruber, 2005), and the technology generation such as 3G (Rappaport, 2001; Gruber, 2005). According to Burnham

(2002), a wireless communication system consists of three main components: the mobile switching centers (MSC) or central processing equipment, the base stations, and the user handsets.

The mobile handsets which may be cell phones, smart phones, or PDAs consist of a control/interface unit, transceiver, and antenna system (Dao et al., 2002). Location-enablement technologies can be either network-based, handset-based, or hybrid in nature (Burnham 2002). Network-based technologies make use of the cellular network to determine the location of the mobile device. Handset-based technologies utilize the radio navigation system provided by the satellites of the global positioning system (GPS). Many network operators are now implementing hybrid technologies that use both the network and the GPS system for location mapping. Table 2 below summarizes the location technologies that support LBS. The details of the technologies are reported by Barnes (2003b), Nokia (2003), Rao and Minakakis (2004), Lavrof (2000), Carayannis (2001), Tsalgatidou et al. (2003), and Harmon and Daim (2009).

Table 2: Location Technologies (Adapted from Harmon and Daim, 2009)

<table>
<tr><th></th><th colspan="2">Technology</th><th>Description</th><th>Advantages</th><th>Disadvantages</th></tr>
<tr><td>Network-Based</td><td colspan="2">Uplink Time Difference of Arrival (U-TDOA)</td><td>Compares the times at which a cell signal reaches multiple location measurement units installed at the operator's base stations. Accuracy is determined by the network layout and deployment density of base stations</td><td>RF technology
Promoted as a position solution for indoors and urban canyons. Network-based, supports legacy handsets. Accuracy is 50m-150m. May be used with A-GPS for hybrid location solution</td><td>Significant upgrades to network base stations.</td></tr>
<tr><td rowspan="3">Handset-Based</td><td rowspan="3">Global Navigation Satellite System (GNSS)</td><td>Global Positioning System (GPS)</td><td>Radio-navigation system w/ 24 low-orbit satellites, triangulates with three satellites</td><td>RF technology
Outdoor precision within 5m range
Not dependent on network.</td><td>Line-of-sight issues
Does not work well in urban canyons or indoors.</td></tr>
<tr><td>Galileo</td><td>Radio-navigation system w/ 30 satellites in three orbits</td><td>RF technology
Not dependent on network</td><td>Line-of-sight issues
Does not work well in urban canyons or indoors.</td></tr>
<tr><td>GPS
+
Galileo</td><td>Combined GPS and Galileo system.</td><td>Better number of visual satellites, Dilution of Precision (DOP) values, and internal and external reliabilities</td><td>Line-of-sight issues
Does not work well in urban canyons or indoors.</td></tr>
</table>

Hybrid Technology	**Assisted Global Navigation Satellite System (A-GNSS)**	**Base on Control-Plane**	Satellite location with explicit, pre-defined cellular network (GSM/WCDMA) assist. Enables location to be precisely determined over a global range. Facilitates location positioning inside buildings or in forests.	RF technology Most precise method for determining location over wide range of situations. Method of the future, accuracy falls in the range of 10m–50m.	Significant changes to network. Power consumption Does not work well for indoor positioning or in urban canyons. Expensive
		Base on User –Plane Or Enable SUPL	Satellite location with IP data connection assist. Enables location to be precisely determined over a global range. Facilitates location positioning inside buildings or in forests.	RF technology Don't need any wireless standard Most precise method for determining location over wide range of situations. Method of the future, accuracy falls in the range of 10m–50m.	
Local Position	**W-LAN: Wi-Fi, Blue tooth, RFID**		Short range technologies	Highly accurate, 5m-50m. Most portable computing devices and many wireless handsets have, or will have some of these capabilities.	Limited geographical coverage.

Galileo is a GNSS (Global Navigation Satellite System) built by the EU. Other GNSS include GPS (Global Positioning System, US), Beidou (China), GLONASS (GLObal NAvigation Satellite System, Russia), and QNZZ (Quasi-Zenith Satellite System, Japan). Although GPS is the only fully operational GNSS, Galileo has been in testing stage since 2004, and it will provide services to end users in 2012 (Hahn, 2007; Bellavista, 2008). GPS and Galileo are similar systems, with a significant difference. GPS is improved for military performance, so it has limitation in civil performance; but Galileo is improved only for civil applications. A GPS and Galileo combined system can improve the number of visual satellites, improve dilution of precision (DOP) values, and increase internal and external reliabilities beyond a GPS-only system. In the case of Busan, Korea, the GPS and Galileo combined system provides an increase of 205% in the number of visual satellites, improves the DOP value by 60%, while increasing internal reliabilities by 62%, and external reliabilities by 13% (Lee, 2005). In addition to the technological developments mentioned above, network operators are augmenting their network-based location system based on a control plane technology with an IP based one. The roll out of A-GPS enabled handsets and the secure user plane location architecture (SUPL) provides location services that are less dependent on the core network and reduces the load on the control plane (Park et al., 2009; Bayrak et al. 2008). SUPL is device centric and enables operators to increase positioning coverage on mixed 2G/3G networks and on multi-vendor networks. SUPL enables a faster first fix of GPS satellites, better location coverage, and longer device battery life.

Just as 3G technology is entering the early stages of its adoption cycle, the industry is making plans for 4G technologies. Long Term Evolution (LTE) and WiMAX technologies will provide the upgrade paths for the transition to 4G technologies. Verizon wireless, AT&T, and T-Mobile have reportedly adopted LTE. The EU will adopt LTE and Japan and Korea will adopt either WiMAX or LTE (Yoon et al., 2008).

Figure 3 maps out the critical technologies discussed in this section. The roadmap clearly indicates further technological changes that the service providers should pay attention to. In the area of network technology there are multiple alternatives emerging. It may be a wise idea to develop strategies for multiple scenarios. In many cases industry wide collaboration is necessary to make one technology standard. It would be a productive strategy to build such an alliance. The same transition is also valid for mobile data network as we see a transition towards 4G.

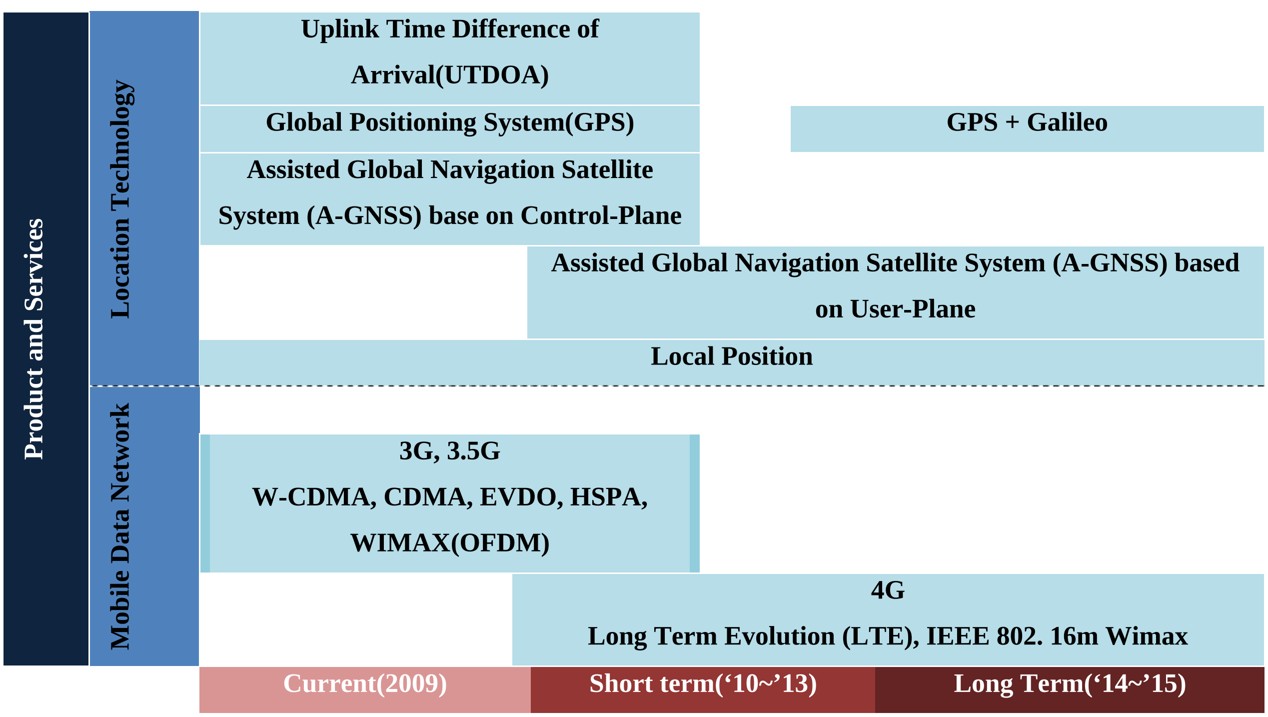

Figure 3: LBS Technology Roadmap

LBS are still in the early stages of development. However, with the advent of 3G mobile Internet networks, smart phone handsets, GPS technology, and new entrants from the computer industry, service innovation is accelerating and consumer the adoption of the services is beginning to take off. Accordingly, this paper has identified the key business and market drivers for LBS. Although the technology-based drivers are impacting the adoption of LBS positively, other factors such as security and privacy issues have the potential to impact the adoption negatively. All need to be considered for successful LBS innovation. The LBS technologies are also identified to be in a dynamic state. There are several new technologies being introduced at every layer of the technology stack. In addition there is a dual convergence underway between mobile, Internet, and location technologies; and between the land-line computing and wireless industries. Dominant players from the computer hardware and software industries are challenging the dominant wireless network operators. It is a true clash of the titans where the real winners will likely be the businesses and consumers that will be using the next generation of LBS applications.

CONCLUSIONS AND FUTURE RESEARCH

This paper makes two critical contributions. The first contribution is the demonstration of the application of technology roadmapping, a methodology from the product-innovation domain, to the service innovation domain in the case of location-based services. The case is developed with the traditional approach that maps the technology to the drivers of the service innovation. The second contribution is the paper opens the discussion on how processes and theories from technology management could be applied to the planning and evaluation of technology driven services.

Issues and Remedies for Adoption of Location Based Services

While people get much benefit from the useful and convenient information provided by LBSs, the privacy threat of revealing a mobile user's personal information (including the user's location) has become a severe issue (Barkhuss, et al., 2003, Beresford, et al., 2003). Location-based services raise privacy concern because provider of a location-based service could learn the current location of mobile device user, which might reveal information about the users' activities and interest. Bisdikian et al. (2001) and Snekkenes (2001) also agree that privacy is the essential issue for the successful adoption of LBS. This might be resolved by addressing the issues of how sensitive information is kept secured and who has access to it under what conditions. The flow of information helps business applications arrive create a high-value customer service model, but it can raise user fears.

Possible threats from the usage of LBS:

- Control over personal data: A subject might find himself/herself in the situation where their location and other personal information is made available to third parties without the user's knowledge (Fritsch, et al. 2005). At present the mobile operators own the data.
- Compromised anonymity: An anonymous subject's identity can be learned by observing frequently used locations such as where they work and live and vehicles driven (Fritsch, et al., 2005).
- Compromised location: A subject's location context can be guessed by observing location information combined with geographic metadata such as office location, business district, etc. (Fritsch, et al., 2005). The subject's personal security may be compromised.
- Revealed relationships: The proximity to other subjects can reveal personal relationships (Fritsch, et al., 2005).
- Misuse of data: Misuse of collected location data can cause serious privacy issues especially by data matching with other privacy data (Natsui, 2002).
- Privacy intrusion: Real time privacy intrusion that can cause a real-time privacy disturbance by other parties such as tracking an ex "significant other" (Natsui, 2002).
- Intercepted communications: Specific location data and messages for an identified user may be intercepted in real time. This event can compromise the security of that person (Natsui, 2002).
- Breach of confidentiality. Possible breach of confidentiality of consumer information by service providers and merchants (Beinat, 2001, Wallace et al., 2002).

Natsui (2002) proposed resolutions for these problems:

- Legal Method: Create adequate and effective legislation and its enforcement with reasonable dispute resolution measures.
- Technological Method: Develop a better technology for privacy protection or removal of unnecessary privacy collection functions.
- Self-Regulation Method: Develop better guidelines for relevant parties to agree on a common privacy goal on the basis of the international privacy protection standards.
- Education. Educate consumers about the risk of using the service and their rights under the user license agreement for the service.

The proposition from Natsui is more generic and broad. There are several ways proposed by other researchers regarding the issues in Location-based services. One traditional solution to protect privacy is the use of pseudonymity (Pfitzmann, et al., 2005). Pseudonymity means that a trusted middleware is employed to replace the real identifier of the user with a pseudonym before forwarding the request to a service provider (Gruteser, et al., 2003, Gedik, et al., 2005).

Kido et al. (2005) also proposed a dummy-based approach in which a user sends the actual-location with several fake locations (dummies) to a service provider. The service provider processes and returns an answer for each received location. The user finally refines the results based on the actual location. To reduce user fears the user should also be always informed about the information which is collected and the security of data transfer.

Management Tools for Technology Driven Service Innovations

While we have synthesized much of the current understanding of mobile location-based services, it is clear that there are still many knowledge gaps in this space. We need more refined technology acceptance models for LBS applications. Such models should incorporate a fuller understanding of the impacts of privacy and security and the conceptualization of space and time in different cultural settings for LBS. There is also a need to elaborate models that better characterize interdependencies between work-organization, mobility and different coordination mechanisms.

One approach is to have the LBS products, services and technologies by industry experts through the use of an analytical hierarchical process (Saaty, 1986). Figure 4 suggests a hypothetical set of LBS components and interrelationships that could be generated by the AHP methodology.

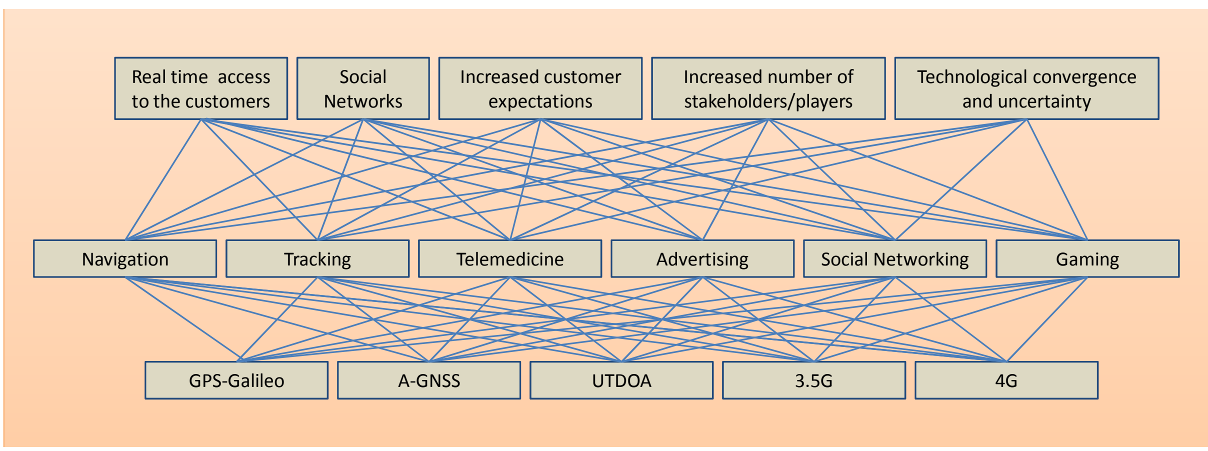

Figure 4: Recommended AHP hierarchies for future study

Furthermore, these drivers can be tested through the Technology Acceptance Model (Davis, 1986) with a survey of the consumers. Business and market drivers are expected to impact perceived usefulness and ease of use which then impact the actual use of the products and services in a manner suggested by Figure 5.

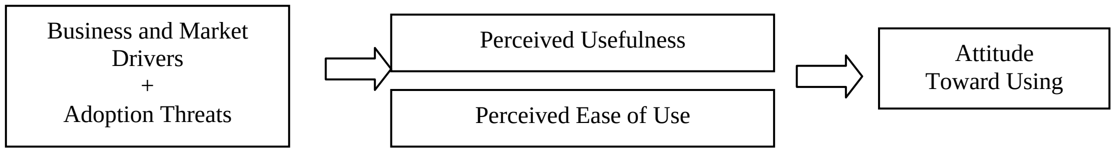

Figure 5: Recommended TAM framework for future study

Our case analysis demonstrated an interesting phenomenon which we have not experienced with physical products. The phenomenon is related to the technological disruptions in the service sector. LBS case demonstrated that companies are leveraging events like technological convergence very rapidly and entering into markets that they never played before. Similarly companies operating in those markets are disrupted with these entrances very rapidly without having time to get ready or respond. This observation makes technology management even more critical in the service sector. However service sector has too many variations as well. For example historically health care industry has been very slow to adopt technologies especially on the administration side. This may be explained by the health care industry acting more or less in a monopolistic way. However their behavior may change as technologies such as telemedicine may make providers in less expensive regions of the world become attractive to patients in US.

As a final note, we conclude that LBS innovation needs close attention by all the stakeholders, as the changing business and market drivers, as well as technological changes, are undoubtedly going to greatly impact the industry's competitive dynamics. Applying the suggested research models would provide additional insight on the evolution of LBS innovation and demonstrate the application of additional technology management theories and processes for the planning of technology driven service innovations.

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