



Location-Based Services: An End-to-End Perspective

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Abbreviations and Acronyms

1xRTT	One Times Radio Transmission Technology (CDMA 2000)	MPC	Mobile Positioning Center
3GPP	3rd Generation Partnership Project	MSC	Mobile Switching Center
4G	4th Generation cellular wireless system	MVNO	Mobile Virtual Network Operator
A-GPS	Assisted Global Positioning System	NMR	Network Management Report
API	Application Programming Interface	OMA	Open Mobile Alliance
ARPU	Average Revenue Per User	OEM	Original Equipment Manufacturer
BREW	Binary Run-time Environment for Wireless (Qualcomm)	PC	Personal Computer
CDMA	Code Division Multiple Access	PDE	Position Determining Entity
E9-1-1	Enhanced 911 (emergency service)	PSAP	Public Safety Answering Point
EDGE	Enhanced Data Rates for Global Evolution	RF	Radio Frequency
EVDO	Evolution Data Only (optimized version of CDMA 2000)	SAS	Stand Alone SMLC
E-SMLC	Evolved-SMLC	SIGTRAN	Signaling Transport
GIS	Geographical Information System	SMLC	Serving Mobile Location Center
GMLC	Gateway Mobile Location Center	SMS	Short Message Service
GPRS	General Packet Radio Service	SS7	Signaling System 7
GPS	Global Positioning Services	SUPL	Secure User Plan Location
GSM	Global System for Mobile Communications	TA	Timing Advance
HLR	Home Location Center	TCS	TeleCommunication Systems, Inc.
HSPA	High Speed Packet Access	TDOA	Time Difference of Arrival
IP	Internet Protocol	TOA	Time of Arrival
J2ME	Java 2 Micro Edition (Sun)	UMTS	Universal Mobile Telecommunications System
LAS	Location Assistance Services	VoIP	Voice over Internet Protocol
LBS	Location-Based Services	WAP	Wireless Application Protocol
LMU	Location Measurement Unit	Wi-Fi	Wireless Fidelity (IEEE 802.11 wireless networking)
LTE	Long Term Evolution (3GPP 4G technology)	WiMAX	Worldwide Interoperability for Microwave Access, Inc.
MID	Mobile Internet Device	XADS	Xypoint® Assistance Data Server
MPC	Mobile Positioning Center	XDDS	Xypoint® Dynamic Data Server
MSO	Multiple Service Operator	XLSA	Xypoint® Location Services Agent
MRL	Measured Results List	XLSG	Xypoint® Location Services Gateway
MRM	Mobile Resource Management	XMS	Xypoint® Mapping Server
		XRN	Xypoint® Reference Network

Introduction

Location changes everything

After years of promise and promotion, location-based services (LBS) has finally caught up to the hype. Over the past several years, remarkable advances in LBS has raised consumer and enterprise awareness and fueled increased demand. As a result, companies are rushing to provide LBS to this hotly expanding market.

Defined by Frost & Sullivan as “a growing range of services that combine handset geographic location with other data to provide a value-added experience to the mobile phone user,” LBS is a richly featured and high-revenue addition to wireless service providers’ core consumer and enterprise offerings.¹ Analysts and industry watchers view LBS as a paradigm-changer for mobile service providers (operators, MVNOs, OEMs, etc.), who can count on it as a means of attracting new users, increasing value-added-service revenue, enhancing competitive differentiation, increasing customer loyalty, and reducing customer churn. The entire mobile services value chain stands to gain from the LBS revolution as well—handset vendors, application software providers, global positioning services (GPS) chip set vendors, wireless network equipment providers, and the automotive industry are all becoming major beneficiaries of LBS growth.

This whitepaper provides a high-level overview of the evolving LBS landscape as it pertains to mobile services in North American and international markets. In particular, this paper will (1) present the business case for LBS, (2) outline the LBS value chain and describe its segments, and (3) examine the emerging end-to-end approach to LBS being taken by TeleCommunication Systems, Inc. (TCS), a company that has been providing location-based services since 1995.

¹ Frost & Sullivan. 2008 North America Consumer Location-based Services (LBS) Market—The Wireless Carrier Opportunity (N486-65). 2009.

The LBS Business Case for Operators

Strong, predictable growth

Location-enabled devices (e.g., handsets, laptops, MIDs) and portable navigation devices have become everyday tools for a growing segment of consumers and enterprises. It's no surprise, then, that operators are seeking ways to implement LBS on a scale that was not possible a few years ago. The value of LBS is now obvious as wireless operators begin to reap financial benefits directly from LBS offerings across multiple networks, handsets, and geographies.

Global Trends

The market for LBS is forecasted to grow rapidly over the next five years. Driven by an increasing number of location-enabled applications and services, the number of location-enabled subscribers will expand through 2014 at a compound annual growth rate of 71.9 percent.² Analysts expect worldwide LBS services revenue to increase 460 percent from a base of \$2.6 billion USD in 2009 to \$14.7 billion USD in 2014 (**Figure 1**).³

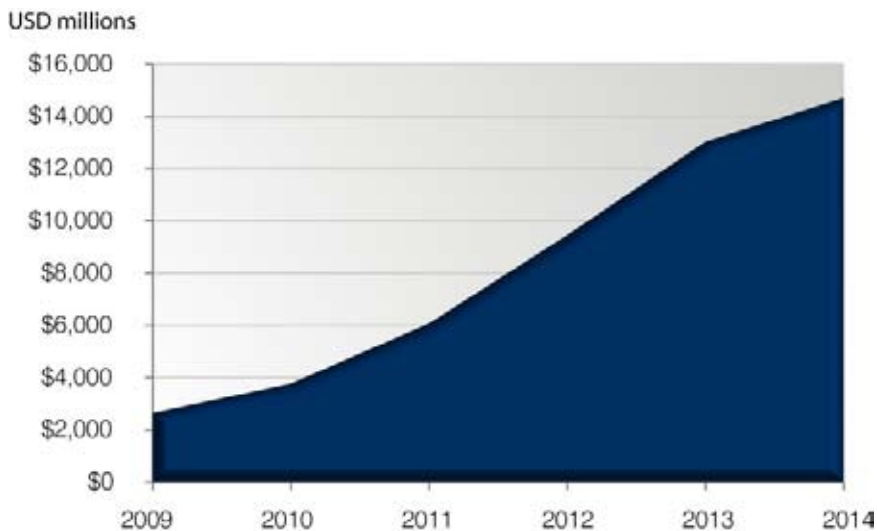


Figure 1: Projected LBS services revenue for all world markets (2009-2014)

Regional Trends

Among North American wireless subscribers, only 21.5 million used LBS solutions in 2009. Industry experts expect that by 2014 the number will increase by 837 percent—to a total of 201.2 million North American LBS

² ABI Research. Location Based Services Data. 2009.

³ Ibid.

subscribers.⁴ LBS services revenues in North America are expected to total \$1.2 billion USD by the end of 2010 and \$3.4 billion USD in 2014.^{5,6}

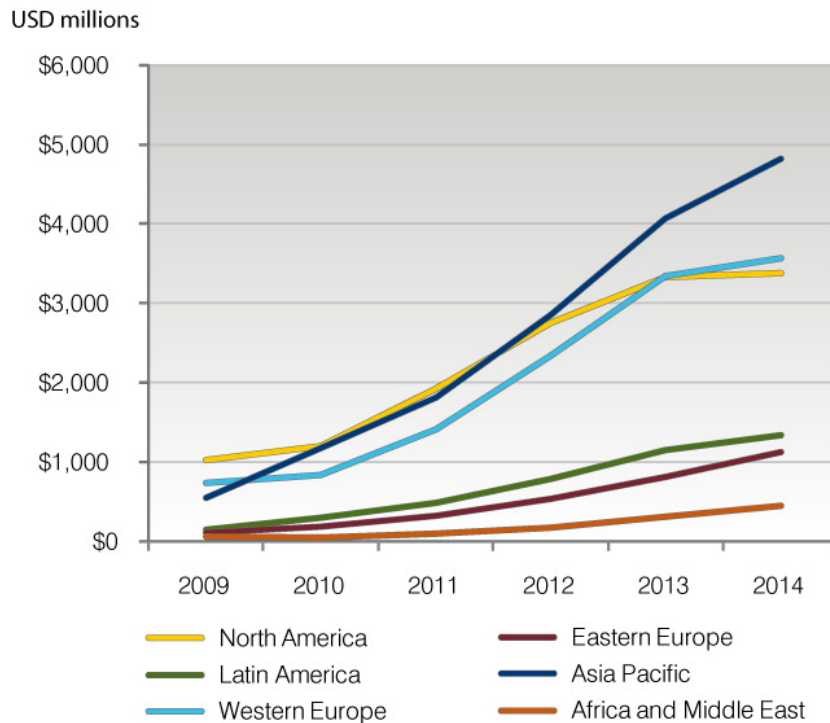


Figure 2: Projected LBS services revenue by region (2009-2014)⁷

The main drive for international growth will come from countries in the Asia Pacific region, notably India and China. Indeed, as the region’s subscriber numbers grow from 2009 levels of 1.4 billion to 2 billion in 2013, the Asia Pacific region will contribute half of the world’s wireless subscribers.⁸ LBS services revenues for this region, in third place behind North America and Western Europe in 2009, is expected to surpass both by mid-2012 (**Figure 2**).⁹

Analysts expect Western Europe to approach North America in LBS services revenues by 2014, when it is anticipated to achieve \$3.6 billion USD in revenues.¹⁰ Latin America, Eastern Europe, and Africa and Middle East also can anticipate seeing healthy growth in LBS; however, growth for these regions is expected to be at a lower rate than that of North America, Western Europe, and Asia Pacific.

4 Ibid.

5 “LBS services revenues” in this whitepaper and the resources it draws on refers generally to the revenues derived from service pricing.

6 Ibid.

7 Ibid.

8 Informa Telecoms and Media. Mobile Content and Services, 7th Edition. 2009.

9 ABI Research

10 Ibid.

Trends by Segment

The LBS market consists of two main segments—consumer and enterprise. Consumer and enterprise demand for location-based products are already expanding from personal navigation to enterprise mobility. Mobile users are increasingly expecting personalized, localized, and timely access to information and services from their mobile devices. Continued growth is forecasted in navigation, social location networking, family finder, local search/local advertising, fleet and asset management, and field-force automation, among other markets. **Figure 3** represents the anticipated growth of consumer and business LBS services revenue relative to one another. **Figure 4** shows the expected breakdown of LBS services revenue by application for the year 2014.

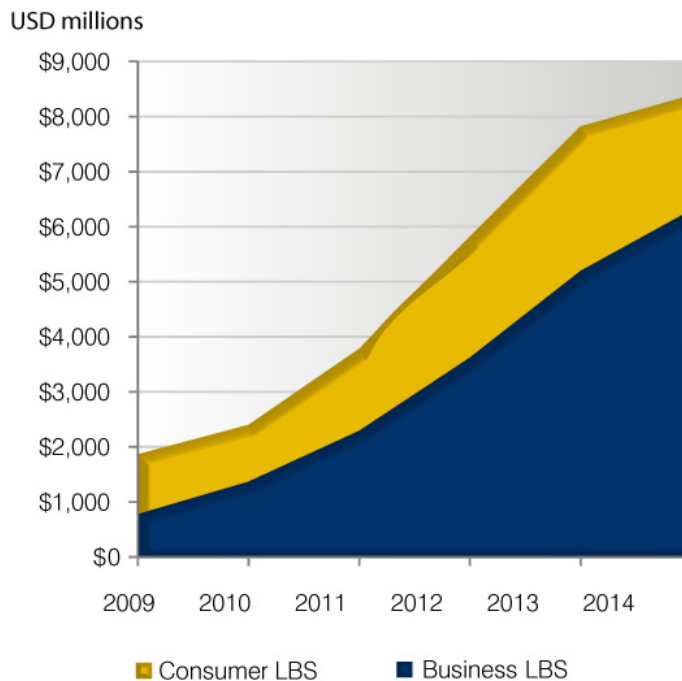


Figure 3: Projected LBS services revenue by LBS market segment

Business Benefits to Operators

LBS provides mobile service providers an additional revenue stream option in a highly competitive marketplace. Trends indicate that many consumers who use LBS sign up for more than one location application. Offering dynamic LBS content to these higher-ARPU (average revenue per user) consumers improves customer retention, increasing ARPU and customer satisfaction.

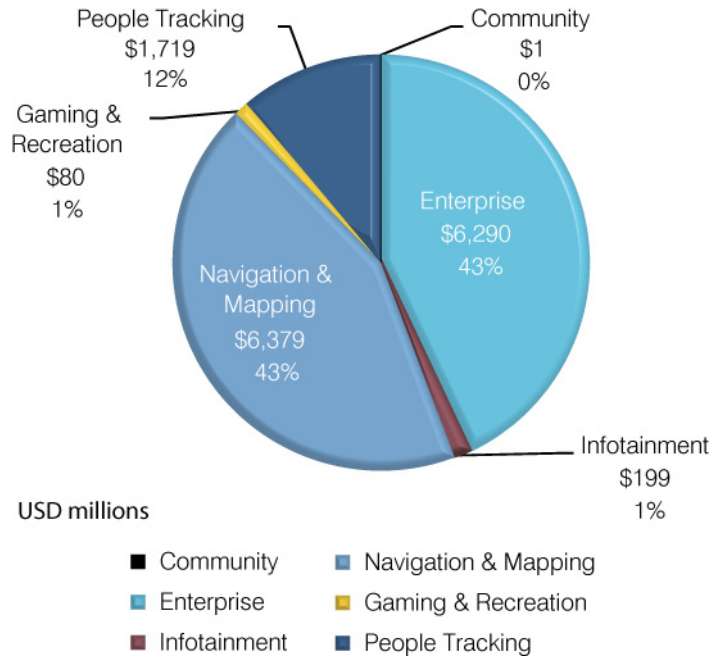


Figure 4: Projected 2014 LBS services revenue by application (USD millions)¹¹

The LBS Value Chain

Today's enabling technologies

Today's LBS value chain includes five major elements: LBS applications and devices, mapping and data servers, middleware, location servers and location assistance services (Figure 5).

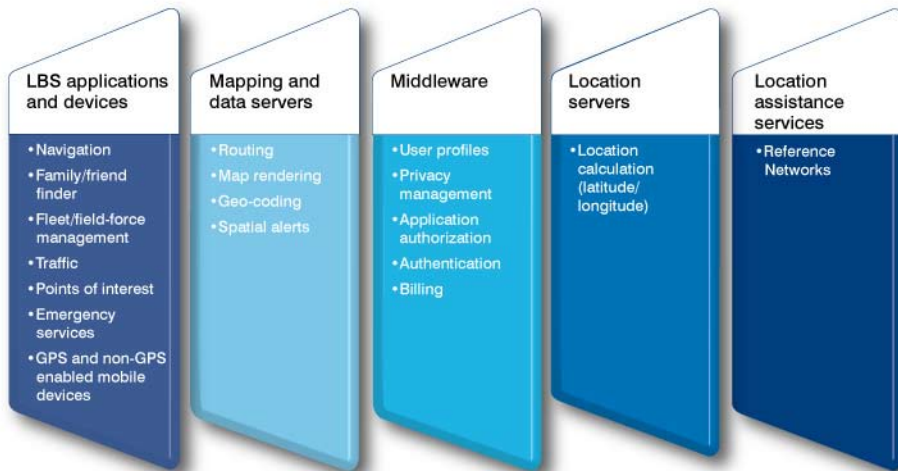


Figure 5: LBS value chain¹²

¹¹ Ibid.

¹² Adapted from Frost & Sullivan.

LBS Applications and Content

Location-based services draw in consumers, drive revenue, increase customer loyalty, and decrease churn. Application types range from simple push services, such as weather and traffic alerts, to more complex or interactive services, such as personal safety, people locator, and mobile resource management applications. Many business sectors, from entertainment to tourism, are beginning to incorporate location awareness in their applications and services to attract and retain consumers.

The Consumer Market

The top consumer applications in the U.S. market today are navigation, family finder, weather, fitness, social networking, and gaming.¹³

Navigation. Navigation is considered the “killer app” in consumer applications space. At its core, it provides continuous, real-time tracking and turn-by-turn directions from the current location to desired location. However, navigation applications frequently combine these personal navigation services with directory assistance, real-time traffic information, gas prices, weather, movie times, user reviews, and public transportation content to deliver a single portal for accessing LBS content. Common interface features include rich graphics (2D and 3D moving maps), voice recognition, and rerouting capabilities. Noteworthy deployments in North America include Verizon’s Navigator (provided by TCS) and AT&T’s Navigator. In Europe, Vodafone and T-Mobile Europe have deployed a number of mobile navigation applications. TATA Indicom has also launched personal navigation.

Family/Friend Finder. Family finder is targeted to families looking to securely and safely share their location. The applications’ features provide safety, security, and peace of mind for family members, particularly with regard to children. Family finder applications allow subscribers to securely locate eligible family members in real time from a subscriber’s PC or phone, and they enable members to share their location and communicate with each other securely. This application is growing in popularity as a result of subscribers’ desire to share more information via their mobile handsets. U.S. leaders in this category are Verizon’s Family Locator (provided by TCS) and AT&T Wireless’ FamilyMap.

¹³ Frost & Sullivan.

Friend finder provides on-demand information to end users about the position of others relative to themselves. For privacy reasons, these services require pre-authorization from the friends before the user can locate them. The privacy settings are dynamic, and users are able to control when, where, and by whom they are locatable. In the current business model, the person doing the locating pays the bill; however, advertisement support is emerging as a possible way of offsetting cost.

A source of growing interest in this application is the role it can play vis-à-vis social networking. Social networking is the grouping of individuals into specific internet-based groups that form around shared interests, activities, and so forth—typically through web-based social media (e.g., Facebook, LinkedIn, MySpace, Twitter). When social media converges with mobile location-enabled devices, users can experience mobile social networking. This feature enables users to know what friends are within their physical vicinity at any given time. The primary obstacle blocking full mobile social networking is the current lack of true interoperability between operator networks. Advertisers are keen to take advantage of the financial opportunities that mobile social networking presents—namely, highly-targeted advertising based on users psychographic, demographic, and behavioral information. Non-operator solution providers (e.g., Loopt and Google) envision building a free social networking service that is funded entirely by ad revenue.

Advertisers are keen to take advantage of the financial opportunities that mobile social networking—using friend and family finders—presents.

The applications within the family/friend finder group are emerging as the next killer apps.

Weather. Weather applications provide up-to-the-minute location-based weather updates for local weather, weather forecasts, and severe weather alerts. Subscribers receive updates automatically or on demand. The Weather Scout service is also being marketed to outdoors enthusiasts. Some navigation providers have begun to incorporate basic weather capabilities in their offerings as well.

Local Search/Points of Interest. Point-of-interest applications provide content relative to the end user's location. Such locations may include restaurants, gas stations, banks, ATMs, and hospitals, as well as user-defined locations (e.g., home and school).

Real Estate. Location-based real estate applications obtain user's location and return information on nearby properties for sale or rent. Information returned can include standard real estate data and can encompass floor plans, photographs, prices, community amenities, maps, and directions to the properties.

Fitness. Current fitness-oriented applications turn the mobile device (typically a phone), into a GPS trainer for sports and exercise activities.

These applications record data such as real-time distance, speed/pace, location, elevation, distance traveled, and calories burned for outdoor activities. Speed and elevation charts are provided. Some applications can give audible feedback for motivational purposes.

Emergency Services. Location-based emergency services provide location information about an end user to a third party for the purpose of providing emergency services, such as police, fire, and rescue. Location-based emergency services enable wireless operators to handle wireless emergency calls (e.g., 9-1-1 in the U.S. and 1-1-2 in the EU) by delivering the callback number and originating location information to the appropriate public safety answering point (PSAP). TCS, one of E9-1-1's pioneers, remains the leading provider of personal safety LBS technology to North American wireless operators, cable MSOs, and VoIP providers.

Gaming. There is a growing interest in LBS-based phone games, which provide interactive gaming based on the user's location. Interest in LBS-based games is particularly strong in Asia but shows signs of success in other markets as well. LBS-based games can be used via SMS, WAP, or an application residing on the handset. One advantage of gaming applications is that the community using a particular application creates its own content, thus eliminating the need on the part of the application provider to keep data fresh and reliable. Nevertheless, these applications are technically challenging in that they require managing the location of two mobile devices and the proximity between them.

The Enterprise Market

Mobile resource management (MRM) applications are the dominant LBS application for enterprise subscribers. These applications provide location information for one or more vehicles, mobile workers, or any other mobile asset. The primary benefit of asset trackers is that they enable the coordination and optimal deployment of fleet and personnel, thereby improving overall business productivity for their subscribers.

Operator-based MRM applications utilize network location services to provide location services at start-up and also to ping the device to determine its location. If a real-time fix is not possible, the network will return last known location from the location cache along with a date stamp to indicate the staleness of the user's location. Companies providing MRM solutions include TCS, Xora/Gearworks, and @Road. TCS is the technology-provider for Sprint Mobile Locator and Vodafone Spain's Mensa Red.

The applications within the family/friend finder group are emerging as the next killer apps.

Applications Spanning Enterprise and Consumer Categories

Applications and content that both consumers and enterprises demand include navigation, map data, traffic, and emergency services—the first three playing significant roles within or related to asset locator applications.

Location Clients

Some location applications can operate entirely through the network (see forthcoming TCS whitepaper on location technologies). Others, such as those that feature geo-fencing and notification for a family or friend finder application, require software on the wireless device. For example, TCS provides client software for its TCS People Locator product to enable handset resident geofencing (e.g., a parent is notified when a child arrives at and leaves a geographic boundary such as their school). Client porting is often required to support the device's unique hardware and operating system (e.g., Symbian, Windows Mobile, RIM, Apple OS).

Mapping and Data Servers

Mapping and data servers are responsible for the two key services provided by the next segment of the LBS value chain: mapping services and content services.

Mapping services include routing, map rendering, geo-coding, reverse geo-coding, and spatial alerts. Routing is the generation of routes between given points entered into an LBS application on a location-enabled device. These routes include turn-by-turn directions, optimization for shortest and fastest routes, alternative routes, and traffic integration, including dynamic re-routing based on real-time traffic conditions. Rendering refers to the dynamic process whereby map images are assembled and displayed on enabled LBS applications. Geo-coding converts real-world geographic locations (latitude/longitude coordinates) into physical addresses and vice versa. Geo-coding software frequently supports ambiguous, incomplete, or misspelled addresses that users enter into enabled LBS devices. Users may set spatial queries on LBS devices to alert the user via email or SMS when a tracked object exits or enters a geographic area.

Content services provide location-specific information on geographically relevant content such as traffic, weather, points of interest, parking, and other content.

Providers of mapping and data servers include TCS and ESRI.

Asset trackers enable the coordination and optimal deployment of fleet and personnel, thereby improving overall business productivity for their subscribers.

Middleware

One of the primary concerns since the advent of LBS has been personal privacy and security around user location data. Indeed, privacy controls are critical to ensuring consumer and enterprise adoption of LBS.

Middleware addresses these issues by performing a number of critical privacy and security functions:

1. Managing subscriber profile information.
2. Managing subscriber privacy—access controls allow subscribers to identify who can access their personal location information.
3. Managing application authorization, thus providing end-users control of their location information.
4. Managing authentication, confirming that the person trying to access subscriber information is who they say they are.
5. Integrating billing and operations systems securely.

In addition to these customer benefits, LBS middleware provides revenue and service assurance. Revenue assurance entails tracking and reporting on different location request types in order to manage and effectively bill against location-based services requests. Service assurance allow providers to differentiate between different network location services requests in order to provide different levels of location services based on application and subscriber profiles.

LBS middleware providers include TCS, Redknee, and ReachU.

Location Servers

The location server calculates position and routes location information from the operators' networks to mobile devices and applications. Location servers typically provide location determination, application programming interfaces (APIs), and geo-fencing capabilities. TCS, Openwave, Intrado, and Nokia are among the infrastructure vendors of precise location gateways. Of these, TCS is the only provider of precise location for both GSM and CDMA networks.

GSM/UMTS/LTE Servers

There are two kinds of location solutions—control plane and user plane. Control plane solutions are defined by the 3GPP standards body. They have the advantage on working on all legacy handsets and are therefore used for emergency services. Their disadvantage is that they are more costly to deploy and operate, typically requiring network upgrades. User plane solutions are defined by the Open Mobile Alliance (OMA) standards body. They are easier and less expensive to deploy and operate (e.g., they

Middleware performs critical privacy and security functions and affords LBS providers revenue assurance and service assurance abilities.

require no network upgrades) and are therefore preferred for commercial services. The disadvantage of user plane solutions is that the handset typically requires GPS technology.

For a GSM control plane solution, the base functionality needed is a Gateway Mobile Location Center (GMLC). The GMLC receives the network-initiated location request from an application and coordinates the activities to ensure that a location is obtained and returned to the requesting application. Like other control plane nodes, the GMLC uses Signaling System 7 (SS7) or IP based Signaling Transport (SIGTRAN) to communicate with the wireless network.

In GSM (2G) networks, a Serving Mobile Location Server (SMLC) is used for positioning the handset. The SMLC uses various positioning techniques at different cost and accuracy levels (see forthcoming TCS whitepaper on location technologies). In UMTS (3G) networks, Stand Alone SMLC (SAS) is used for positioning. In LTE (4G) networks, Evolved-SMLC (E-SMLC) is used for positioning. Both the SAS and the E-SMLC can perform A-GPS precise positioning.

The user plane solution for GSM-based systems (GSM/UMTS/LTE) is Secure User Plane Location (SUPL). SUPL enables A-GPS precise location in a cost-effective way. SUPL supports both network-initiated and mobile-originated positioning, enabling commercial services for applications that require precise positioning (e.g., navigation and family/friend finder). Newer versions of SUPL (e.g., v. 2.0) enables further cost-effective periodic and geo-fencing location services that are needed for family/friend finder type applications.

CDMA Servers

Similar to the GSM networks, CDMA networks also use control plane and user plane technologies.

The control plane solution utilizes a Mobile Positioning Center (MPC). The MPC leverages network-controlled means of making location requests to a handset for its location data that typically does not require end-user activation (e.g., emergency services). The MPC uses SS7 or SIGTRAN to communicate with the wireless network. A control plane solution typically works with all deployed handsets, whether they are A-GPS enabled or not. However, operators need to ensure that their networks (typically MSCs and HLRs) have location services functions enabled.

With user plane technology, mobile devices communicate directly with the location server to calculate their location coordinates. User plane location requests use IP-based technology. With user plane technology, the mobile device communicates directly with the Position

The location server calculates position and routes location information from the operators' networks to mobile devices and applications.

Determining Engine (PDE) to calculate its location coordinates. Once the location engine has calculated the device location, it gathers and routes the location information from the operator's wireless network to applications, thus bridging the position determination infrastructure and the applications. The PDE also manages, monitors, and measures location usage.

User plane location services provide data to A-GPS phones to quickly acquire the location of satellites and calculate location. This accelerates the time to calculate initial fix and reduce battery power requirements (a limited resource in mobile devices). Precise location servers support multiple positioning technologies, including A-GPS, hybrid, advanced forward link triangulation, and cell ID (for more information, see the forthcoming TCS whitepaper on location technologies). Location gateways that provide precise location can support both network-initiated and mobile-initiated location requests.

With user plane solutions, network impacts are minimized; the handset communicates directly with the PDE, requiring only an IP-based data connection. However, the devices used need to be A-GPS enabled. User plane services lend themselves to providing precise location services cost effectively, such as navigation, family/friend finders, and fleet/field-force management.

Location Assistance Services

Location assistance services (LAS) provide access to multiple networks of satellite receivers for A-GPS. LAS provides the current location of GPS satellites to wireless operators to speed the calculation of location coordinates (time to first fix). TCS is the leading provider satellite reference data for A-GPS services worldwide.

In the case of GPS-enabled devices, the LBS device and location platform interact with each other to determine location at any given moment using the satellite location assistance data. For non-GPS-enabled devices, the location platform interacts with the wireless network infrastructure to collect location data on the device and then calculate the device location.

LBS Deployment Options

Today's market provides three options for LBS deployment: in-network, hosted, and hybrid. For the in-network deployment option, operators host LBS applications on their own network. This option requires substantial capital expenditure for hardware and software as well as operating costs associated with round-the-clock operation, upkeep, and monitoring. The major benefit associated with the in-network deployment option is the control it affords the operator.

Location assistance services (LAS) provide access to multiple networks of satellite receivers for assisted global positioning (A-GPS).

The hosted option enables mobile service providers to leverage the expertise of the location services provider to manage, maintain, and enhance the LBS offerings while focusing on core competencies of subscriber acquisition and retention. It has the additional advantage of removing much of the capital acquisition costs as well as the operational and logistical burdens associated with hardware and software purchase, installation, scalability, maintenance, and around-the-clock operations.

In a hybrid deployment, the LBS hardware and software are set up in the operator's data center but are managed by the LBS application provider on behalf of the operator.

LBS Roaming and Inter-operator Operability

The ability to have inter-operator access to location information is crucial to the long-term success of location-based services to support subscribers across multiple networks.

Roaming is a challenge uniquely solved by a fully integrated LBS solutions provider. To enable roaming across multiple operators, the location services provider must have access to the full solution in order to provide network-based location services as well as geo-content and multiple location services (e.g., IP, WiMax, Cell ID).

While standards-based roaming is in the process of being implemented by operators, TCS offers a solution today to support LBS roaming.

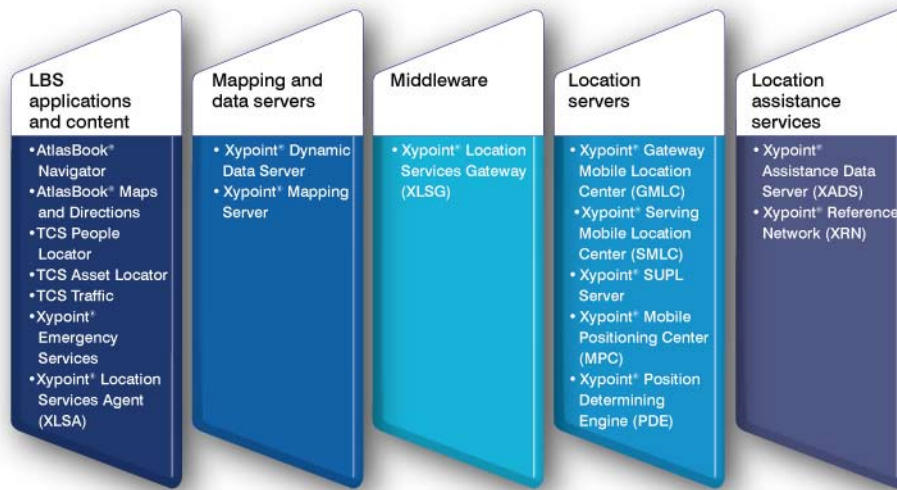
A True End-to-End LBS Solution

Provided by Telecommunication Systems, Inc.

TCS provides a complete end-to-end LBS solution that includes applications, infrastructure, mapping, and content. Recognized by Frost & Sullivan as the only single provider of every element in the LBS value chain, TCS pioneered the world's first wireless location platform in 1996. Since that time, the company has led the industry in innovating and providing enhanced emergency wireless connections (e.g., E9-1-1) in the U.S. Today, TCS provides time-tested location solutions to over 45 operators worldwide. TCS' unique approach and 12 years of LBS experience can speed time to market, eliminate integration problems associated with launching new location services, and minimize implementation and ongoing maintenance costs.

Figure 6 presents TCS' LBS products, services, and solutions according to their position in the above-outlined LBS value chain. Descriptions for these items are described immediately below.

The hosted option enables mobile service providers to leverage the expertise of the location services provider to manage, maintain, and enhance the LBS offerings while focusing on core competencies of subscriber acquisition and retention.



Frost & Sullivan recognizes TCS as the only single provider of every element in the LBS value chain.

Figure 6: TCS' offerings: providing a complete end-to-end LBS solution

TCS LBS Applications, Content, and Clients

AtlasBook™ Navigation is the next generation in personal navigation for wireless handsets. Featuring intuitive speech recognition, it provides for fast address entry, real-time traffic-based routing, best-in-class points of interest maps, custom content and branding, and a comprehensive set of core navigation capabilities.

AtlasBook™ Maps and Directions is an embeddable, white-label consumer maps and directions mobile application available for websites and wireless mobile devices. AtlasBook Maps and Directions lets content and application providers deliver content and data to consumers within the context of a user's location and preferences, enabling them to interact with the brand in ways not possible with traditional media outlets.

TCS People Locator provides family subscribers with the option to securely share their location with family and friends as well as to access other location-based information, such as points of interest.

TCS Asset Locator is a MRM that enables enterprises to locate their field force and resource in near real time, communicate with them using text messaging, and redirect employees and resources as necessary.

TCS Traffic is a white-label application that provides subscribers with up-to-the-minute traffic maps, complete with real-time speed and incident information, so they can avoid traffic delays. TCS Traffic is available on web-sites and WAP, J2ME, and BREW mobile devices.

Xypoint® Emergency Services enable wireless carriers to provide the enhanced emergency services that wireless customers demand while providing the security that they expect. This hosted solution utilizes TCS' Xypoint® Location Platform to enable wireless carriers to handle E9-1-1 calls.

The **Xypoint® Location Services Agent (XLSA)** is software that is resident on the mobile device at the operating system level and enables network and handset-based location requests. The XLSA responds to authenticated requests for location updates and location tracking sessions. It also provides handset resident geo-fencing for enhanced user experience and more effective network utilization. The XLSA currently works on BREW devices that support Java Mobile Edition; RIM and Windows Mobile support are currently in the design phase.

Figure 7 lists TCS' 25 commercial application deployments.

TCS' Commercial LBS Deployments*	
AT&T (U.S.)	Telus (Canada)
Boost (U.S.)	U.S. Cellular (U.S.)
Centennial (Puerto Rico)	Verizon/AllTel (U.S.)
Ntelos (U.S.)	Virgin Mobile (U.S.)
Sprint (U.S.)	Vodafone (Spain)
Tata (India)	

Figure 7: TCS' commercial application LBS deployments

* Includes multiple deployments in the case of some operators; numbers include commercial deployments of Networks In Motion, which TCS acquired in December of 2009.

TCS Mapping and Data servers

The **Xypoint® Mapping Server** enables service providers to develop and deploy location services with mapping and routing capability. Supporting web, mobile, and on-board clients, Xypoint Mapping Server provides a technology platform for client applications to request and receive location, routing, and point-of-interest information as well as to generate maps.

The **Xypoint® Dynamic Data Server** gives users invaluable real-time, route-specific traffic information, where and when they need it. The Xypoint Dynamic Data Server integrates seamlessly with the Xypoint Mapping Server to deliver traffic incidents, travel times, speed flow maps, points of interest, and more. Features include flexible data support, traffic incident searches, enhanced driving directions, and map display.

TCS' unique approach and 12 years of LBS experience can speed time to market, eliminate integration problems associated with launching new location services, and minimize implementation and ongoing maintenance costs.

TCS Middleware Platform

The **Xypoint® Location Services Gateway (XLSG)** is middleware that serves as the interface between the LBS platform components and the LBS applications using standard communication protocols (MLP). The XLSG provides authentication, authorization, privacy, and revenue assurance related to location applications and transactions. It brokers location transactions between third parties and carriers. Further, it enforces carrier location privacy policies and business rules. The XLSG exposes location capabilities to third party developers via standard APIs and toolkits.

TCS Location Servers

GSM, UMTS/HSPA, LTE Networks

The **Xypoint® Gateway Mobile Location Center (GMLC)** is a control plane system that interfaces, via XLSG, with emergency and commercial LBS applications and the operator's network to provide a mobile station's location. Supporting OMA-MLP and GSM MAP standard data interfaces, the GMLC has been commercially in operation with customers since 2002.

The **Xypoint Serving Mobile Location Server (SMLC)** uses Cell ID and Timing Advance location technologies for more accurate network-based positioning for 2G GSM networks.

The **Xypoint® SUPL Server** is the most accurate SUPL server in the industry. Xypoint SUPL Server is a state-of-the-art SUPL 1.0 standards-compliant A-GPS server that enables precise and sophisticated location-based services for mobile operators with GSM, GPRS, UMTS, and/or LTE networks.

CDMA Networks

The **Xypoint® Mobile Positioning Center (MPC)** is a standards-based solution that routes location information from the wireless operator's CDMA network to applications.

The **Xypoint® Position Determining Engine** provides the precise location of devices to applications in an operator's CDMA network.

TCS LBS Assistance Data Services

The **Xypoint® Reference Network** provides data on any satellite, for any location, at any given moment by accessing multiple networks of satellite receivers and constantly downloading data from strategically positioned receivers around the world. The data is then used by location servers and A-GPS devices to speed the time to first fix and conserve handset battery power.

The **Xypoint® Assistance Data Server (XADS)** converts satellite assistance data from Xypoint Reference Network or data sources into any specific format required by the operator's A-GPS servers.

TCS Deployment Options

TCS provides in-network, hosted, and hybrid LBS deployment. While the in-network option allows greater control, it demands a significant capital expenditure for requisite hardware and software as well as for the operating costs associated with non-stop operation, upkeep, and monitoring. By opting for TCS to host, operators remove the capital acquisition costs as well as the operational and logistical burdens associated with hardware and software purchase, installation, scalability, maintenance, and around-the-clock operations.

Summary and Conclusion

LBS today and tomorrow

This paper has covered the current state of the LBS landscape and has begun to draw back the curtain on what LBS holds for the future. First, the paper addressed the compelling business case for LBS, one that is predicated on strong and predictable growth well into the foreseeable future. Next, it outlined the LBS value chain with a discussion of its key elements. Finally, it presented how TCS technology provides LBS applications and content; mapping and data servers; middleware; location servers; and location assistance service—and how in doing so, it provides operators with a true end-to-end solution and a distinct competitive advantage.

And the future is even more promising. Recent development in LBS, broadband mobile internet access, powerful new smart phones, and application-specific devices are changing the way that people interact. The convergence of LBS-enabled search and messaging, mobile advertising, social networking, and next-generation location-based emergency services are enabling unique and differentiated services that will drive mobile operators' growth and value in the years ahead.

By opting for a TCS-hosted LBS deployment, operators remove the capital acquisition costs as well as the operational and logistical burdens associated with hardware and software purchase, installation, scalability, maintenance, and around-the-clock operations.

Wireless operators benefit from the knowledge of an industry insider with a proven track-record of innovation. They need flexible, scalable, and secure solutions that allow them to rapidly deliver products to market while achieving greater revenue. Operators need a trusted partner with a reputation for innovation, reliability, first-class support—and one who is going to lead and thrive in the years ahead.

TCS offers a complete LBS solution today, and by partnering with wireless operators worldwide, it is at the forefront of developing the future of location technology. Together with its customers and business partners, TCS will help chart the direction of location technology so that the emerging technologies of today become the location-based services of tomorrow.

As the leader in LBS, TCS will provide a cost-effective solution that is proven, precise, and above all, profitable.

Together with our customers and business partners, TCS will help chart the direction of location technology so that the emerging technologies of today become the location-based services of tomorrow.

Citations

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Frost & Sullivan. 2008 North America Consumer Location-based Services (LBS) Market—The Wireless Carrier Opportunity. N486-65. 2009.

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Contact TCS today for more information about TCS' individual LBS offerings and its end-to-end LBS solution.

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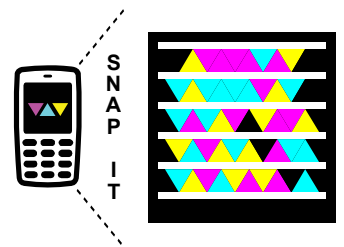
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Related reading:

TCS's forthcoming whitepaper on location technologies, to be posted at www.telecomsys.com/location-based-services.



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