

What are Location Services? – From a GIS Perspective

The convergence of multiple technologies including geographic information systems (GIS), Internet, wireless communications, location determination, and portable devices has given rise to exciting new types of information utilities that may be referred to simply as location services. Also called mobile location services, wireless location services, or location-based services, these systems are making a major impact on how we navigate our world and how business is done.

Knowing where a person or object is at any time presents a powerful new dimension to the kinds of information services that can be offered. Location services deliver geographic information between mobile and/or static users via the Internet and/or wireless network.

Why Is Location So Useful?

Location is central to how people organize and relate to their world. As an information-based society, we value systems and services that can tell us about the location of people, objects, and phenomena. Our existing information systems reflect this, as most of the contents in databases today are linked to location or geographic components. Location services leveraging communications and computing technologies can provide ready access to this information in a broad array of applications for the business, consumer and government market sectors.

For example, customer relationship management (CRM) systems integrated with GIS can enable organizations to close the information gap between service providers and their customers or constituencies. By tying ubiquitous geographic location information with all aspects of business activity, service agents, marketers, planners, analysts, and managers can detect patterns and trends in the data that may otherwise have been missed. Think of personnel in the field, away from their office desks, utilizing wireless devices to access their corporate database, and linking to information relevant to their current location. This scenario can deliver extremely powerful results. Instant access to remote databases, coupled with the power to manipulate and query that data with a GIS will not only make mobile workers more efficient, it enables service providers to interact with their customers in ways that were never possible before.

How Does GIS Provide Value?

Simply knowing where you are, or how far you are from someone or something, is typically not valuable by itself. Relating location to other pertinent information gives it meaning and value. For example, knowing that you are one mile from a particular facility may give some small comfort that you are getting closer, but obtaining a travel path to that point adds value. Obtaining a valid or reliable route adds even more value. Access to information about other features, such as stores or customers located along that route, may enhance the value even further. Having the power to modify the route to avoid delays due to construction or traffic incident adds yet another level of value.

To derive this type of value, two types of elements are required: spatial data and tools to manipulate spatial data. GIS is central to both of these elements. GIS has for many years provided the tools to generate, manipulate, and manage spatial data. Government agencies and commercial data vendors use GIS extensively to create and maintain the map data used by

location services. Vendors such as Geographic Data Technology, Inc. (GDT), Tele Atlas, and NavTech provide street centerline data sets that include address and street name, which are essential to geocoding and routing applications.

Location services that incorporate GIS tools enable a wide range of spatial transactions that can be delivered in meaningful ways. Data base management systems (DBMSs) now have some spatial data management capabilities providing limited support to location services, but they are not competitive in terms of performance, flexibility, and scalability without direct access to a robust GIS at their foundation.

These issues have been central to the Open GIS Consortium, Inc. (OGC), which, in its call for sponsors of the Open Location Services Initiative, www.opens.org/ states

Spatial connectivity is a primary, universal construct for business planning and modeling, service development and deployment, network provisioning and operation and customer satisfaction. Location application services are of universal industry service significance and depend upon the availability of relevant spatial information infrastructures in forms useful for small devices.

To better understand this, a more complete definition of location services is required. These services address so many different types of industries and applications that it is useful to consider a range of definitions.

The Broadest Definition

A location service, in the broadest sense, is any service or application that extends spatial information processing, or GIS capabilities, to end users via the Internet and/or wireless network. Applications accessible via desktop computer linked to the Internet, such as provided by Realtor.com (www.realtor.com) and the United States Environmental Protection Agency's EnviroMapper (<http://maps.epa.gov/enviromapper/>) are location services. Call centers where telephone operators manually enter or automatically access a customer's location could also be considered location services. Examples include emergency response services such as E-911 centers or American Automobile Association's (AAA) roadside assistance service. Self-service applications offered by public agencies such as Planning Departments empower citizens to view government records via geographic search. Hundreds of local government agencies in the United States have deployed Internet servers allowing anyone with a browser to view and query wide arrays of data and to make maps. This is leading to electronic government (e-gov) initiatives that enable on line transactions. These also are considered to be location services.

With the convergence of wireless communications and the Internet, the term location services has taken on a new meaning and has captured our attention as the next big technology advancement that will impact our lives, even more than the wired Internet has. This emerging industry will bring wireless location services to market. Whether wired or wireless, all types of location services require spatial data handling capabilities, and GIS is the technology that provides the foundation to these systems.

The E-911 Definition

By mandate of the United States Federal Communications Commission (FCC), the geographic position of all cellular phone devices must be detected so that emergency services can be dispatched to the caller's location. It is estimated that more than 100,000 calls per day to 911 come from wireless phones. Most of these wireless calls are from highways where it is difficult for callers to identify their precise location. Phase 1 of the E911 mandate required carriers to identify what cell site the caller was connected to. Phase 2 of the FCC mandate requires that by October 1, 2001, carriers provide a location within a 125-meter radius (410 feet) in at least 67 percent of the cases. Beyond the FCC mandate, Phase 3 emergency services will include location service authentication methods providing more control to the user to protect privacy and allow them to select which services they want to receive. It will support a wider array of information content such as a caller's emergency medical profile, and will be operable on a broader range of devices.

Many services such as roadside assistance, stolen vehicle recovery, traffic alerts, driving directions, and vehicle tracking are available now. The E-911 mandate is an important driver in the United States for the investment that will make these applications work for large volumes of users in wide geographic areas of coverage on wireless platforms.

The wireless phone carriers are committing enormous resources to building the communications infrastructure to make wireless services reliable and widely accessible. Wireless carriers have consistently cited location services as one of the top applications that will enable them to recoup these investments. Growing competition, commoditization, and the spread of prepaid wireless services have reduced the average revenue per user (ARPU) from traditional cellular communications services. Wireless carriers are scrambling to package location services in their offerings to increase air-time usage, improve customer satisfaction, achieve differentiation from competitors, and to develop strong new revenue sources.

The mobile operators are aggressively partnering with providers of technology and data content to quickly enable location services applications. ESRI is uniquely positioned as a provider of GIS tools to the enablers of location services including application service providers (ASPs) and systems integrators. SignalSoft Corporation, Xypoint Corporation and SCC Communications Corporation are just a few of the major players using ESRI products to deliver E-911 services. These companies operate the service centers that relate a wireless caller's location to a public safety access point (PSAP), which dispatches emergency response vehicles to the location of a reported emergency.

GIS plays a key role in E-911 services. The transportation and infrastructure databases must be carefully maintained for maximum accuracy and completeness. Lives are at stake if an address cannot be accurately geocoded, or if errors in the street network are not corrected. Professional-level GIS tools such as ESRI's ArcInfo are typically utilized to support demanding data reconciliation and preparation tasks such as conflation, generalization, and update.

The Pull Definition

Services that utilize the geographic position of a wireless device to derive information related to that location enable users to “pull” information to them wherever and whenever it is needed.

Types of pull services include

- Travel Directions — *I am here, how do I get there?* — Services offering on-line driving directions have gained broad acceptance. These are some of the first location services to be offered via the wired Web, and more recently for access by wireless devices.
- Taxi Hailing — *I need a taxi now* — A holder of a mobile device signals that a taxi is needed. Taxi services operating in that territory can automatically pass on the caller’s location and phone number either to a dispatcher or directly to the nearest taxi. Callers are contacted by a respondent informing them that a taxi is nearby and will soon arrive.
- Mobile Yellow Pages — *Where is the nearest x?* — Users indicate the business categories they are interested in and pull up a set of listings in order of proximity to the user’s location. Many types of specialized directories are coming to market. They will include the ability to locate places such as medical facilities, entertainment venues, or any other type of facility or event.
- Buying Services — *Notify me when I am near a supplier that carries the specific item I have been looking for* — This type of service, referred to as mobile commerce (m-commerce), connects buyers to sellers. Users entering a shopping area with an electronic list including the brands, features, or model numbers of the products they wish to purchase can receive information from nearby stores that carry the products corresponding to these shopping lists. Naturally, buyers could also obtain directions to the store. These applications greatly reduce the time people need to spend searching for items while, for vendors, it represents a highly focused means to communicate to their prospective buyers.
- Instant Information — These services enable users to point their wireless device at a landmark or facility and obtain information about it, either from a central database, or from the facility itself via infrared, or other type of wireless data transfer. This is useful not just for sightseeing tourists, but also for mobile workers that need details about the facilities they encounter. This could also be implemented as a kind of “push” service. For example, a facility could be outfitted to signal that it is in need of attention (see telemetry definition below).

The Push Definition

“Push” refers to location services that utilize the position of the wireless device to qualify the holder as a potential customer or recipient of a service. Applications and services include target marketing with advertisements to wireless devices, friend finders, traffic alerts, and zone alerts. Concerns about privacy and user authentication make these types of services rather controversial, but these issues are likely to be resolved with the anticipated growth of mobile commerce.

Mobile Advertisements — Studies done by electronic yellow page service providers indicate that users may be receptive to advertisements on their wireless devices in exchange for electronic coupons or other types of discounts or awards. Privacy issues aside, consumers may benefit from allowing suppliers to know they are nearby. The key to success will be allowing the consumer to opt into such services. The potential buyer/seller relationship could benefit if mobile advertising is handled properly. GIS tools used extensively in target marketing can be useful for profiling consumer's spatial behavior so that promotions may be tailored to derive maximum value.

Friend Finders — Services are now available that allow users to find the locations of their friends or family. Short message services (SMS), operating in Europe and Southeast Asia has become extremely popular. The service automatically notifies a user when a selected person (who also has a wireless device) is nearby or has entered into a specified area. Such a service could be designed to notify a parent when a child has arrived at home, school, or other specified location.

Zone Alerts — Similar in functionality to friend finder services, zone alerts can indicate when a person or vehicle has entered into or exited out of a specified region. Early implementations were used to track the movements of Alzheimer patients. If that person strays a certain distance from home, a caregiver can be notified, and the person could be easily located. The same type of service could be used to detect when an unwanted person enters within proximity of another person or place. This would be useful, for example, to track people under court restraining orders.

Traffic Alerts — Real-time traffic service providers such as TrafficStation notify users of the status of predefined travel routes. This service is especially useful to commuters who want to know in advance of committing to a particular route what the level of traffic congestion is. For people who tend to leave little extra time for delays, this service could make a big difference in helping to get them to their destination on time.

The Telemetry Definition

Machine-to-machine communication enables distributed assets to automatically notify service providers of their location and status. This applies to fixed assets such as vending machines; heating, ventilation and air conditioner (HVAC) systems; copiers; utility meters; alarm systems; or mobile assets such as trucks, rail cars, or packages. Aeris.net and Cellemetry LLC are the leading providers of telemetry communication services that enable a wide range of location service applications.

GIS adds value to these applications by pinpointing the location of the asset in relation to the service provider. For example, a company that provides commercial air conditioner maintenance can receive wireless short burst messages from a specific unit that the freon level is becoming critically low and the unit is about to shut down. The origin of the message can be located and a nearby service technician can be dispatched.

Compound services such as telematics systems like General Motor's OnStar span multiple categories of service. Telematics offerings may incorporate a wide range of services in addition to E-911 response such as in-vehicle navigation, electronic yellow page directories, access to a human operator for concierge services, remote door unlocking, and advertising in the form of e-coupons, etc. The open, integrative nature of GIS will help to develop new types of compound services yet to emerge.

The Evolution of Location Services

A white paper by Gravitte, Inc. (2000), identifies three generations of location services (www.grvt8.com/docs/whitepaper.pdf). First generation services require the user to manually input location in the form of a street address or postal code and are typically available to stationary desktop computers or mobile units. Examples of this include MapQuest, MapsOnUs, or other local information services.

Second generation location services, which are available today, have the ability to determine rough locations typically at the postal code level. Using a device such as the PalmVII to access the PalmNet data network, a mobile user can find restaurants or gas stations in order of proximity or travel directions.

Third generation location services are more location aware, taking advantage of more precise positional information and have the capability to initiate services proactively based on location. These trigger mode services can notify the user of relevant events or conditions without the active participation of the user such as traffic alerts that meet the user's preset preferences.

Gravitte identifies three types of triggers: Object triggers notify the user of the mobile device when entering within a predefined distance of a facility. For example, a chocoholic might want to know when a Godiva chocolate shop is nearby (<http://godiva.geoserve.com/forms/GodivaSep2000.htm>).

Object-temporal triggers add the dimension of time. Affinity triggers allow one mobile device to know of the location of another mobile device. This is of particular value to friend finder applications on the consumer side and to field force automation systems on the business side. For example, a construction foreman might use this type of service to locate a piece of heavy equipment or a specialized tool.

Location Service Applications

Given the ubiquity of location information, the increasing mobility of modern society, and the anticipated availability of broadband communications and mobile interfaces, the potential applications of location services are extremely diverse. There will be no single "killer application", but each industry sector will embrace services that significantly change the way information is gathered, maintained, and distributed. The integration of GIS with systems such as customer relationship management (CRM) and field force automation will produce some very promising location service applications.

Today the market focus is on location service applications that are consumer-oriented and involve just a few primary functions, which form the basis for many other types of applications:

- Locators (locate persons, objects, or places)
- Proximity Search (where is the nearest...?)
- Travel Directions (how do I get to...?)
- Traffic Conditions (is the route clear?)

Locators

From these key functions, a broad range of applications have emerged. Locating a vehicle, for example, provides the basis for tracking, dispatch, and fleet management systems. These applications are very important to public safety, transportation, logistics and many other industries as well as government. For many years, trucks and emergency vehicles have been tracked manually by having the driver “radio in” their location. Comparing the vehicle’s position in relation to an origin or destination provides dispatchers with information about the status of a fleet of vehicles.

Now, with automated location systems it is feasible to track any type of vehicle or mobile object. Emergency response personnel can find victims of accidents, contractors can track construction equipment, delivery companies can trace packages, service companies can locate field personnel, and police can find stolen property.

One of the first consumer services to employ tracking solutions was offered to caregivers that need to monitor the movement of Alzheimer patients. It remains to be seen if services enabling the tracking of pets, teenagers, and other family members will become commonplace. Early implementations of location services based on short message services (SMS) deployed in markets such as Japan and Finland have experienced surprising popularity of friend finder services where, for a small fee, people (mainly teens) can locate each other at any time.

Early consumer-oriented locator services were implemented by Visa for finding Automated Teller Machines (ATMs) anywhere in the world (www.visa.com/pd/atm/main.html). Many Web-based locator services developed initially for desktop access are moving to the wireless world. In the United States, where Web access via desktop has been readily available, there has been resistance to adopting mobile locators partially because of the limitations of the user interface. In other countries, where desktop access to the Web is less readily available, user interface expectations are much different and people are more tolerant of the limitations such as the size and quality of the keypad and display screen.

Proximity Search

Once geographic location is established, the next logical question to ask is, “where are the nearest facilities to my position?”. Electronic yellow pages and other directory services utilize proximity search algorithms to find the nearest business listings or other facilities within a specified radius of a location. Electronic yellow pages and direction services have attracted large

audiences on the desktop. Many of these consumer-oriented services are now available via wireless devices such as cell phones, personal digital assistants (PDAs), and pagers.

Business-oriented services can apply proximity search to any organization's database of facilities, assets, or customers. Many of these services are based on ESRI's *RouteMap* IMS software. In many cases the search is not limited to assets along a street network, but can also be applied to facility networks in the case of public utilities, pipelines, or telecommunications networks.

Proximity search can take many forms. Simple and sophisticated searches are supported by GIS software, which can be resident on a handheld client device or be accessed remotely. The common example cited for a basic offering is a consumer-oriented service that enables users to find the nearest restaurant by type of cuisine. The same set of functions could be employed in the business world to find all types of facilities or assets that are geographically dispersed. As more of the work force goes mobile, they will need help in finding the location of people, objects and phenomena, and to relate those locations to the organization's data resources.

Travel Directions

Services such as MapQuest utilize ArcInfo to develop seamless, high-quality geographic databases. ArcInfo is a professional-level GIS package that provides a robust set of cartographic functionality enabling map data users to combine the best features offered by multiple data vendors in a set of processes known as conflation. MapQuest, Etak, and many other direction service providers use ESRI's ArcInfo software to perform tasks such as edge matching, which combines multiple map area files into a seamless map coverage that enables routing across multiple geographic data files.

Real-Time Traffic Conditions

Traffic information has traditionally been reported via radio and television. Audio text delivery via telephone allowed users to obtain reports for selected roads. Now, companies such as TrafficStation are providing a unique service — live traffic data, picked up from sensors that monitor vehicle speed, combined with incident reports (www.trafficstation.com/). This service is provided to subscribers over the Internet. TrafficStation subscribers can download this information using their desktop browser, but more importantly, they can get live access through mobile devices. This means people are able to dynamically evaluate a planned itinerary and, if needed, select an alternative route to avoid problems.

Conclusion

Location services take many forms and provide value in a diversity of ways, but the common denominator is the spatial data handling capability that links location to other types of data. ESRI's strategy is to provide tools to location service enablers. Location services require technology that can manage extremely large volumes of spatial data and can integrate directly with all the rapidly evolving Internet and IT standards. ESRI's technology uniquely supports these requirements for both simple and more complex spatial data processing tasks. By

providing a GIS technology platform as a foundation for location services, ESRI is empowering not only the service providers, but also its worldwide GIS user base. Providing the best tools and support possible enables partners and customers to develop applications to solve problems that are unique to each industry.