

Location-Aware Access Control

► Security Models, Geospatial

Location-Aware Technologies

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Synonyms

Position-aware technologies; Global positioning system; GPS; Location based systems LBS

Definition

Location-aware technologies are devices that can report their precise geographic location at high temporal resolutions.

Main Text

Location-aware technologies (LATs) are devices that can report their geographic location in near-real time using methods such as *radiolocation* that exploit wireless communication systems, the *global positioning system* (GPS) that utilize time differences of signals from satellites in Earth orbit and *dead-reckoning* that use distances and directions along a route from a known location to determine the current location.

An emerging LAT is *radiofrequency identification* (RFID) tags. Mobile RFID tags transmit data to fixed readers using either passive (powerless) or active (powered) methods. Active tags are heavier and more expensive, but have a longer range and cheaper readers than can track multiple tags simultaneously. Unlike GPS, RFID tags must self-identify to the reader since the reader (not the client) conducts the location calculations. This means that RFID systems have a greater potential for surveillance. LAT enable *location-based services* (LBS). LBS provide targeted information to individuals based on their geographic location through wireless communication networks and devices such as portable computers, personal digital assistants (PDAs), mobile phones and in-vehicle navigation systems.

Cross References

- Geographic Knowledge Discovery
- Time Geography

Recommended Reading

1. Benson, J.: LBS technology delivers information where and when its needed, *Bus. Geogr.* 9(2), 20–22 (2001)

2. Grejner-Brzezinska, D.: Positioning and tracking approaches and technologies. In: Karimi, H.A., Hammad, A. (eds.) *Telegeoinformatics: Location-based Computing and Services*, pp. 69–110. CRC Press, Boca-Raton, FL (2004)
3. Morville, P.: *Ambient Findability: What We Find Changes Who We Become*. O'Reilly Media, Sebastopol, CA (2005)

Location Based Services

- Indoor Positioning with WirelessLocal Area Networks (WLAN)
- Nearest Neighbor Queries in Network Databases
- Privacy Threats in Location-Based Services

Location-Based Services

- Cloaking Algorithms for Location Privacy
- Indoor Positioning
- Information Services, Geography
- Moving Object Uncertainty

Location-Based Services: Practices and Products

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Directions Media, Huntsville, AL, USA

Synonyms

Services, web; Service, location; Positioning

Definition

Location Services or Location-based services (LBS) are terms that have been used to describe wireless, mobile, and mostly handheld devices that use wireless communications to deliver information that conveys a geographical reference. As such, information delivered to users of cellular phones, for example, depends on the use of a device that is capable of utilizing location-determination technology such as Global Positioning Systems or Wi-Fi to calculate a specific latitude and longitude of the device. This is a fundamental premise of LBS technology. Location becomes a supporting attribute to ancillary information related to that location such as a street address or other point of interest. Typical applications include automatic location identification (ALI) for emergency response phone calls made to a 9-1-1 dispatch operator.

However, an expanded use of the term is offered to include enterprise computing solutions of which location determination is an essential part. For example, corporations that

utilize wireless, location-aware devices to track its fleet of trucks or cars and to mobilize this fleet more efficiently are using a location-based service. Likewise, cellular phone users who subscribe to an “in-network” plan that allows them to determine the location of friends and family are utilizing a form of location-based social networking.

Terms & Types

LOCATION SERVICE: A location service, in the broadest sense, is any service or application that extends spatial information processing ... to end users via the Internet and/or wireless network [1].

Adapted from Niedzwiadek [2], here are definitions (List 1) of information types and a list of examples of location services (Table 1), in the form of user requirement statements (or questions), organized by information type (row) and market segment (column).

List 1: Types of Information in Time or Space [2]:

Positions. Fixed locations. Expressed in terms of coordinates, positions on a map, named places, and so forth.

Events. Time-dependent incidents (past, present, or future) at one or more locations.

Distributions (e. g. demographics). The densities, frequencies, patterns, and trends of people, objects or events within a given area(s).

Assets. Fixed and/or mobile assets. Asset management. Inventories. Condition/status.

Service Points. Points of service delivery. May also pertain to prospects or targets of interest. Further characterized by levels of service and quality of service.

Routes. Navigational information expressed in terms of coordinates, directions (angles), named streets and distances, landmarks, and/or other navigation aids. Navigational logs.

Context/ Overview. Maps, charts, three-dimensional scenes (virtual reality) or other means for representing the context and relationships between people, objects and events over a given area(s).

Directories. Catalogs. Listings. Directories.

Transactions. Transactions for the exchange of goods, services, securities, etc. Trading services. Financial services.

Sites. Characteristics of a given site (e. g. suitability).

Historical Background

One of the key drivers of location-based service was the 1996 mandate of the Federal Communications Commission of the United States to have all cellular carriers identify the location of a 9-1-1 caller. This mandate is being

fulfilled in stages but over a longer period of time than first anticipated as the cellular companies did not have the infrastructure or business plan to facilitate the service. The Phase I plan required cellular carriers to locate callers within the vicinity of the cellular antenna. Phase II requires that operators locate cellular calls to 9-1-1 to within 50 to 300 meters. (See FCC <http://www.fcc.gov/911/enhanced/>). Users of location services have been hindered by the lack of devices that are capable of recognizing the position of a user. Early location-based services depended on the user to input their location to a wireless device. The user would typically manually identify their location by typing a street address or intersection to their wireless device and the service would search for certain services within that vicinity. It is expected that as more wireless devices are able to automatically determine the user's position by incorporating GPS chips or using 802.11 protocols (W-Fi) by triangulation that the value proposition to users will become more evident.

Scientific Fundamentals

The basic technology infrastructure to support location-based services is supported by:

1. Location positioning infrastructure – This would include the navigational satellite constellations of the United States Global Positioning System (GPS), the European Galileo system, and the Russian Global Navigation Satellite System (GLONASS). Other positioning infrastructure is now being tested and deploying using the 802.11 Wi-Fi protocols.
2. Location determination – Mobile devices need to include technology that utilizes the location positioning infrastructure. These devices will most often include a receiver that will seek signals from three or more global positioning satellites to determine a location. The receivers interpret the time difference of arrival (TDOA) of the signal from each satellite and calculate the device position, often referred to as multilateration. Certain technology providers such as Skyhook Wireless utilize a database of the location of known Wi-Fi access points to establish position. Skyhook and GPS chip manufacturer SiRF Technology are partnering to provide both GPS and Wi-Fi positioning on a single chip. In areas where it is difficult to obtain a satellite fix, such as in an urban canyon or indoors where GPS will not function, Wi-Fi can be used as an alternative location determination technology.
3. Application Servers – Once the geographic position of the receiver is established, the location of the device is passed to a computer or geographic server that utilizes the location information for application development.

Location-Based Services: Practices and Products, Table 1 Types of Location Services [2]

Types of Location Information	Location Services		
	Consumer	Business	Government
Positions	Where am I? (map, address, place) Where is? (Person, business, place ...)	Contact nearest field service personnel. Where is this business located?	Location-sensitive reporting. What's your 20?
Events	Car broken down ... need help. Medical alert!	Local training announcements. Traffic alert!	Local public announcements. Accident alert!
Distributions	House hunting in low density area. Vacationing near highest concentration of ...	High growth trend? Sales patterns?	Growth patterns? Per capita greenspace?
Assets	Where is my car? Lowest insurance rates?	Where are my dispatched repair trucks? Status of my holdings?	Where are the snowplows? Road maintenance
Service Points	Tell me when I'm near where I'm going. Where are the sales?	Where are my customers, given target profile? Targeted advertising	Economic development areas? New zoning
Routes	How do I get there? (address, place) Fastest route (given traffic situation)?	Best delivery route given shipping manifest, traffic and weather? Taxi dispatch	Traffic patterns? Emergency dispatch
Context (Overview)	Nearest visible landmark? Show me the nearest____ (business, place ...)	What's near the hotel? Show me car rentals near the airport	Collaborative economic planning. Local commerce
Directories	Looking for nearest____ (specialist ...) Where can I buy? (product, service)	Best supplier within next two hours? Nearest repair services?	Public services. Outsourcing?
Transactions	Lowest shipping rates? Must purchase in specific location	Low cost distribution services? Location-sensitive quick-dial	Tax revenues. Location-sensitive tolls
Sites	Candidate properties to build my house. Places to visit?	Candidate store sites? Optimum cell tower locations?	New schools? Environmental monitoring stations?

Geographic information systems (GIS) or specialized location servers are tasked with geocoding the information to reveal additional information such as an address, for example.

Key Applications

Emergency 911/Automatic Location Identification

Calls to a police or fire agency, often referred to as a public service answering point or PSAP, via the Emergency 911 number must respond to an incident at a specific location. Emergency service dispatchers have had the ability to “look-up” the street address of a fixed, wire-line service for many years. This is often called Automatic Number Identification/Automatic location identification (ANI/ALI). This service as applied to wireless communication devices relies on location determination technology. This technology may be found at either the cellular tower base station or on the client side device such as a cell phone. At the tower base station, technology is employed

to support location determination by triangulating the position of a call based on the location of three or more cell towers and the time delay of arrival (TDOA) of the signal from the mobile handset. On the client device, GPS is often used to accurately determine the position of the device which is then broadcast to the dispatcher.

Logistics and Transportation: This application applies to a variety of services that require vehicles and cargo to be managed efficiently. Often this application requires both a wireless device for drivers and a server-based or web-based solution for call center operators and dispatchers to monitor the location of personnel and products. The two applications below describe examples of LBS:

Field Service Management (FSM): Government agencies and corporations that deploy mobile field personnel who provide maintenance, repair or delivery services will utilize wireless devices in conjunction with a desktop software or web service for dispatching, routing, and tracking. Forecasting service demand is a key element of FSM. It

is necessary for cutting excess idle time in the field workforce. Another element of FSM helps to determine the best deployment strategy to maximize the coverage of personnel workload in a service area, and to minimize the cost to do so. As a result of understanding these elements, managers will better understand and evaluate the actual effectiveness of the optimization routines and re-evaluate further forecasting improvements.

Mobile Asset Management: Certain parcels, cargo, or vehicles have a need to be tracked. The locations of these assets that are in transit provide managers the ability to alter routes and monitor deliver progress. These items will utilize location-determination technology such as GPS receivers or RFID tags to identify position.

Personal Navigation and Concierge Services: Many GPS manufacturers, cellular telecommunications companies, and web-service providers are offering portable devices with GPS to request driving directions and local search information on nearby services (e.g. gas stations, movie theaters, restaurants, car dealerships, repair services, etc.). One of the more popular services that helped spawn this industry was OnStar (offered by General Motors), which allowed the driver of a vehicle to push a button to have direct communication with a call center that offered immediate assistance with driving directions as well as emergency roadside assistance. In addition, should the vehicle be engaged in an accident where the driver is unable to communicate with the OnStar call center, OnStar is connected to some of the vehicle's electronics and will be notified if air bags are deployed. The OnStar call center will then notify emergency responders via a 911 call to dispatch roadside assistance.

Telematics: This term is a blend of two words: telecommunication and informatics: the linking of mobile things (vehicles, people, cell phones, PDAs, etc.) to remote sources of information and entertainment [3].

Social Networking: This service allows cellular phone subscribers the ability to locate friends or family. Some services will alert the subscriber when a member of their network enters a certain geographic proximity.

Location-based Gaming: Using a wireless device, subscribers will be issued instructions to locate caches of prizes or other instructions to pursue further information.

Inventory Tracking & RFID: Tracking inventory carried by truck often only allows product manufacturers to know only basic information about the gross cargo load.

Radio Frequency Identification (RFID) tags applied to palettes or single items is a technology that allows for more comprehensive information to be stored on the tag about the product in which it is attached. RFID readers, generally a stationary device, will emit a radio signal that will "illuminate" the RFID tag and scan information contained on the tag for information about the item or palette as it passes the reader. Readers may be positioned at various locations. Those locations are known to the manufacturer and a time stamp can be applied to the information at the RFID-tagged item passes each reader thus allowing logistic managers to keep a more accurate inventory.

Fitness and Exercise: Increasingly, more devices and Mobile Virtual Network Operators (MVNO) are providing services specifically for the exercise and fitness market. Devices released by Trimble Outdoors and services for monitoring biking, hiking and running activities offered by Boost Mobile, an MVNO and subsidiary of Sprint Nextel, are gaining popularity in a niche market.

Future Directions

Berg Insights, a noted market research firm, has the following analysis of the LBS market:

"Penetration for fleet management technology in the European Union road transportation industry will exceed 70 percent by 2010. The report urges the industry to look beyond transportation for additional growth opportunities. Until very recently most vendors have focused exclusively on road transport enterprises, even though these only represent 11 percent of the total potential market. There are twice as many commercial vehicles in the construction industry, but no one seems yet to have figured out how to reach that segment. Because most other segments will remain relatively undeveloped the total market penetration for fleet management technology in Western Europe will be significantly lower at about 15 percent in 2010."

Berg Insight also forecasts that the major truck manufacturers – starting with Volvo and Mercedes-Benz – will make satellite tracking and mobile data communication standard issue on high-end models from as early as 2008. Berg Insight pointed out that remote monitoring is already a standard feature for a certain Volvo truck engine model in the US and said he believes this is the start of a very significant development in the commercial vehicle industry [3].

Another market research firm estimates the global potential revenue of the LBS market to be \$750 Billion by 2019 [5].

Cross References

- Indoor Positioning
- Positional Accuracy Improvement (PAI)
- Radio Frequency Identification (RFID)
- Road Maps, Digital
- Routing Vehicles, Algorithms

Recommended Reading

1. Koppell, I.: What are Location Services? – From a GIS Perspective, LBS360.NET (<http://www.lbs360.net/LBSArticles/ESRI.What%20are%20LS%20Whitepaper.pdf>)
2. Niedzwiadek, H.: Where is the Value in Location Services, LBS360.NET. (<http://www.lbs360.net/LBSArticles/HN.Where%27s%20the%20Value%20in%20Location%20Services.pdf>), July 1 (2002)
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7. Williams, D.: The Definitive Guide To GPS, RFID, Wi-Fi, and Other Wireless Location-Based Services – What Applications Will Succeed in What Markets, and How To Design and Market Them (2005)

Location Based Systems

- Location-Aware Technologies

Location Blurring

- Cloaking Algorithms for Location Privacy

Location Estimation

- Indoor Positioning, Bayesian Methods

Location Intelligence

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Synonyms

Locational data analysis

Definition

Location intelligence is defined as the use of locationally-referenced information as a key input in business decision

making. Location intelligence uses geographic information systems (GIS) tools and techniques to transform and analyze data that becomes valuable information to make more informed and rational business decisions. Thus, location intelligence is neither simply an analytical technique nor business process; but a discipline that encompasses both.

Historical Background

Location intelligence is a term that has only recently come into wide usage in the business world. The term is derived from the concept of business intelligence, which seeks to leverage a corporation's data to make business decisions. Location intelligence expands this concept by adding a spatial perspective to business data analysis and decision making.

Examples of locationally-referenced business data include such items as property locations, customer locations, or supplier locations. These data may be found in the form of addresses, geographic coordinates, region designations (postal code, political boundary).

These data can be combined with other types of geographic data such as population, road networks, climate information, or topography to analyze various spatially-referenced phenomena.

Scientific Fundamentals

To develop a location-intelligent solution, there are generally four recognized processes: identification of locational elements, transformation of those elements into a form suitable for analysis, development of research plans for how these data can be queried and analyzed, and use of statistics and other methods to draw conclusions from the data.

Identification of Locational Elements

First, databases (or data sources) must be reviewed for data that could contain a locational element. As locational elements are identified, the database analyst must determine what type of locational element the data represents. Most locational data used for analysis can be classified as either point, linear, or polygon types. Polygons are often referenced for the business community as regions.

In many cases locational elements are added to a database or referenced from the database for use in location intelligence. Often valuable insights result from using complementary data that extend what an organization typically captures. In the case of retail for example, the geodemographic or 'lifestyle' characteristics of a customer significantly enhances the understanding of retail perfor-