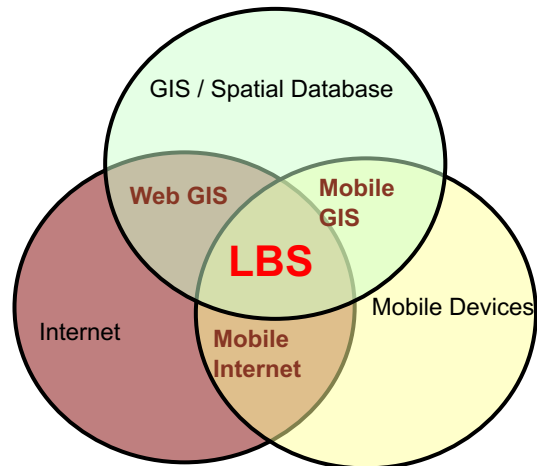# MOBILE COMPUTING

CSE 40814/60814
Spring 2021

Location-based Services: Definition

LBS: A certain *service* that is offered to the users *based* on their *locations*.

Convergence of Technologies

History

- The main origin of Location-Based Services (LBS) was the **E911** (Enhanced 911) mandate, which the U.S. government passed in 1996.

- The mandate was for mobile-network operators to locate **emergency callers** with prescribed accuracy, so that the operators could deliver a caller's location to **Public Safety Answering Points (PSAPs)**.

- Cellular technology couldn't fulfill these accuracy demands back then, so operators started enormous efforts to introduce advanced positioning methods.

History

- **E911 Phase 1:** Wireless network operators must identify the phone number and cell phone tower used by callers, within six minutes of a request by a PSAP.

- **E911 Phase 2:**
  - 95% of a network operator's in-service phones must be E911 compliant ("location capable") by December 31, 2005.
  - Wireless network operators must provide the latitude and longitude of callers within 300 meters, within six minutes of a request by a PSAP.

History

- To gain returns on the E911 investments, operators launched a series of commercial LBSs.

- In most cases, these consisted of **finder services** that, on request, delivered to users a list of nearby **points of interest** (**PoIs**), such as restaurants or gas stations.

- However, most users weren't interested in this kind of LBS, so many operators quickly phased out their LBS offerings and stopped related development efforts.

History

- The emergence of **GPS**-capable mobile devices, the advent of the Web 2.0 paradigm, and the introduction of 3G broadband wireless services were among the enabling developments.

- A timeline of the most significant developments and landmark events in the short history of LBS is depicted in the next figure.
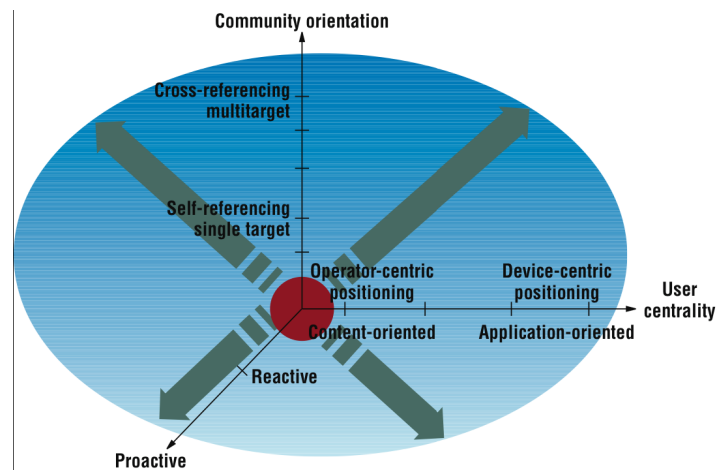
History

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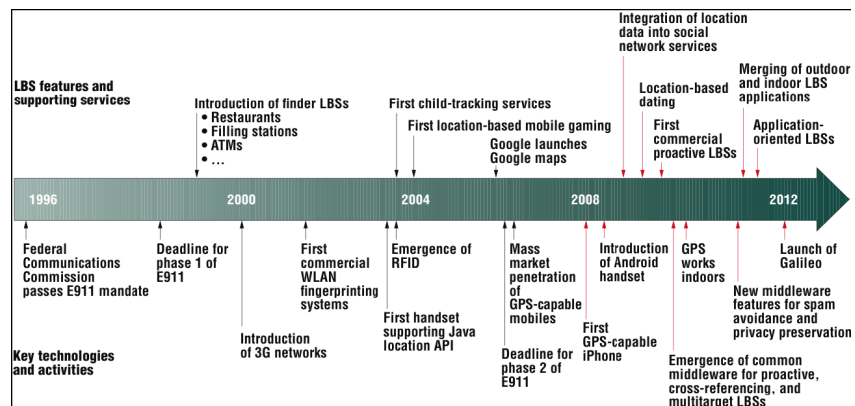
Evolution

- Early LBSs were **reactive**, requiring user initiation of service requests.

- They were also **self-referencing and single-targeted**, meaning concerned only with one mobile user location.

- They were mainly **content-oriented**, providing only information based on current location.

- Early LBSs were "operator" centered and owned.

Evolution

Evolution

- In 2004, operators and other providers started offering services for **fleet management** and for **tracking children and pets**— these were the first examples of **cross-referencing LBSs**.

- Initial versions of these services were based on **cell-ID positioning** using triangulation techniques, which suffered from low accuracy and were soon replaced by **GPS**.

- An **overlay of geo-location technologies** consisting of cellular and Wi-Fi triangulations, in addition to low-power GPS receivers (e.g., assisted GPS), made it possible for location information to be available most of the time and with variable accuracies.

Maps

- **Interactive digital** maps; used in many applications, with many map features (location, navigation, nearby sites, traffic overlay, …)
- The world of digital navigable maps can be traced back to **NAVTEQ**, the most dominant company in geographic information systems and electronic maps in early 2000s.
  - The majority of portable GPS navigation devices , many web based map applications (Yahoo! Maps, MapQuest and Bing Maps), as well as mobile maps (Nokia Maps, Bing Mobile Maps for Windows Phone and Maps for iOS) used NAVTEQ.
  - Even Google started off using NAVTEQ maps in 2004 (a service then called Google Local) before it switched, and later on generated its own map assets.

Maps

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- The world of digital navigable maps can be traced back to **NAVTEQ**, the most dominant company in geographic information systems and electronic maps.
- **Indoor** maps, e.g., major airports, shopping malls, stadiums, resorts and other complex architectural spaces; seamlessly embedded and laid over outdoor maps, which requires no switching actions by the users - only zooming is required to see the details of an indoor map.

LBS in iOS

- LBS on the iOS platform consists of

1. **Core Location framework** for accessing user location and getting notifications of location changes,

2. **Map Kit framework** for accessing and manipulating maps,

3. "Maps" application for map viewing and browsing.

LBS in iOS

iOS Core Location Framework

- The CoreLocation.framework must be linked to the application if location services are to be used. The framework empowers LBS applications with the following capabilities:

1. **Verifying device capability** for location services: This allows LBS applications to make sure they can run successfully, as they start up. App stores can use the same verification capability to ensure the app is downloaded to an appropriate device.

LBS in iOS

iOS Core Location Framework

2. Obtaining **current location**: The framework provides a configurable standard location service often used with most applications.

3. Obtaining **significant-change location**: A configurable, low-power, service for devices with cellular radios which provides location and location change events with accuracy acceptable by many applications. The service does not use GPS, and instead utilizes the cellular network IDs.

4. **Region Monitoring:** In iOS 4.0 and later, applications can use region monitoring to be notified when the user crosses geographic boundaries. Classes are provided for defining region boundaries and for starting and receiving region boundaries crossing events (in or out).

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LBS in iOS

iOS Map Kit Framework

• Map Kit is an iOS 3.0 and later framework used to embed maps into applications through a fully functional map interface.

• The framework supports displaying street view and satellite view maps, search for addresses and POIs, and zooming and panning through multi-touch display interactions.

• To use the features of the Map Kit framework, the MapKit.framework must be linked to the application in the Xcode project .

• It provides geocoding and reverse geocoding capabilities.

LBS in Android

• Support for LBS on the Android platform consists of

1. Location Manager Service

2. A Geocoding service

3. Google Map View—a Google MAP library for accessing and manipulating Google Maps through the GoogleAPI

4. Several powerful LBS applications (e.g., Google Maps for Android, Places, Navigation, etc.).

LBS in Android

Location Manager Service

- Android utilizes an overlay of location providers, currently including the GPS system, WiFi network, and cellular network.

- This overlay provides alternative location sources to be used in different contexts (e.g., WiFi indoors and GPS outdoors).

- It also provides for a more reliable positioning when all sources are used combined, and gives the developer choices of positioning accuracy and power savings.

- Obtaining the user location reliably is the key service Android provides for LBS development.

LBS in Android

Android GeoCoding Service

- Geocoding and reverse geocoding are key services provided by Android to enable LBS applications.

- For geocoding, an address is provided to obtain its longitude and latitude.

- For reverse geocoding, an array of addresses is returned for an area that surrounds a given latitude and longitude.

LBS in Android

Google MapView

- The Google Maps library is used to create map activities in the application.

- It is not part of the standard Android library and must be included by updating the AndroidManifest.xml file.

- The first step to using a Google map view is to create a "MapView" layout for the application. This is done by creating or editing the layout XML file to include as the root node com.google.android.maps.MapView.

- Main.xml requires an API Key that must be obtained from Google prior to developing the map activity.

LBS in Android

Google MapView

- The second step is to construct the application by extending MapActivity.

- The latter is a sub-class of Activity provided by the Maps library, which includes all the capabilities needed to view and interact with the Google maps.

- Once constructed, the layout should be overridden by the layout of main.xml, which is the MapView layout.