Mobile Services (ST 2010)
Chapter 8: Location-based Services

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8 Location-based Services

8.1 What are Location-based Services?
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8.1 What are Location-based Services?

Definitions

Location-based Services

- IT services that generate, compile, select, or filter information or perform other actions by taking into consideration the locations of one or several target persons or mobile objects, which are commonly referred to as targets.
- Usually process a target’s current location, her or his last known location, or locations the target has visited in the past, and present the result to the user, either on demand, automatically, or in a continuous fashion.
- In most cases, the location is derived from a process known as positioning, which automatically determines the geographic position of the target in real-time.

Location services ...

- ... deal with the localization of target persons or objects
- ... make location data (e.g., WGS-84 coordinates obtained by GPS) available to external actors
- ... do not imply the processing of location data for composing information or performing high-level functions
- ... are not end-user services
- ... are important sub-services of LBSs
8.1 What are Location-based Services? LBSs and Context-aware Services

- LBSs as a special appearance of context-aware services

Context-aware services
- Services that automatically adapt to one or several parameters (context information) reflecting the context of a target

Primary context
- Any kind of raw data derived from sensors
- Sensors: light sensors, bio sensors, microphones, accelerometers, location sensors

Secondary context
- High-level context derived from raw data by combination, selection, filtering....
- Example: state of a person (sleeping, working, eating,...)
8.1 What are Location-based Services?

LBS History

- **Active Badge**
  - Pre-LBS-area

- **First telematic services in luxury class vehicles**
  - 1st LBS generation

- **Network-centric finder LBSs (restaurants, filling stations, ATMs, ...)**

- **First location-based gaming**

- **First child tracking services**

- **Appearance of geotagging applications**

- **Emergence of telematic LBSs on PNDs**

- **Advanced telematic services**

**LBS features and supporting services**

- **1990**: Mark Weiser establishes the area of Ubiquitous Computing
  - **Introduction of 2G networks**

- **1995**: GPS declared ready for full operation
  - **Federal Communications Commission passes Wireless E911 mandate**

- **2000**: Deadline of Wireless E911 Phase I
  - **Introduction of 3G networks**

- **2005**: First commercial WLAN fingerprinting systems
  - **Emergence of RFID**

- **2010**: Mass market penetration of GPS-capable handsets
  - **First GPS-capable phone**

- **Launch of eCall**

**Key technologies and driving forces**

- **Google maps launched**

- **Location-based Web 2.0 and community services**

- **First GPS-capable handsets**

- **Introduction of Android handsets**

- **Introduction of 4G networks**
8.2 Application Scenarios

Pol Services

- Provide the mobile user with nearby *points of interest*
- Examples
  - Restaurants
  - Automated Teller Machines
  - Sightseeings,....

- User specifies type of points of interest he wishes to obtain
- Upon request, the user is automatically located by the mobile network
- Service provider assembles a list of points of interest according to the user's position
8.2 Application Scenarios

Community Services

- Support interaction between users that share common interests (cooking, traveling, family, computer, eroticism, ...)

- Example
  - Instant Messaging
  - Buddy lists: show which of a user's buddies are online (presence feature)

- Idea: Location-based Community Services
  - Show a user the current locations of his buddies
  - Alert user if one of his buddies stays close by
  - Alert user if one of his buddies enter or leaves a pre-defined location

- Challenges
  - Permanent tracking of buddies required
  - Privacy issues
8.2 Application Scenarios
Mobile Advertising and Sales Promotion

Mobile Advertising and Sales Promotion

- Promotion of products and services by interacting with consumers through their mobile devices
- Contact is established by using "media channels" like SMS, MMS or WAP

Advantages

- Accurate selection of target groups by evaluating user profiles that reflect a customer's interests in products and services and his buying patterns in the past
- High degree of interactivity between consumers and agencies carrying out a campaign

Location-based mobile marketing

- Consumer is provided with information about products and services of local relevance
- Risk: consumers might feel harassed by incoming advertisement messages
8.2 Application Scenarios
Mobile Gaming

Location-based mobile gaming

- Interactive games allow remote users to share the same session and to enter into a real-time competition via their mobile devices.
- Virtual and real worlds merge and the current location of users become an essential aspect of the play.
- Examples
  - *Can you see me now?*
    - On-line players catch professional players who run through real city streets.
    - On-line players are equipped with mobile-devices for tracking and communication with the game server.
  - *Mogi*
    - Players have to cruise the streets of a city to collect virtually hidden treasures.
    - Mobile device indicates hiding places of treasures on a map.
8.2 Application Scenarios
Traffic Telematics and Fleet Management

Traffic Telematics
- Navigation,
- Automatic configuration of appliances and features inside the vehicle,
- Diagnostics of malfunctions,
- Dissemination of warning messages, ...

Fleet Management & Logistics
- Deals with the control and coordination of fleets of vehicles by a central office (freight services, public transportation, emergency services, ...)
- Request the position of vehicles
- Display their positions on a map
- Determine the distance between different vehicles of a fleet as well as between a vehicle and its destination, ...
8.2 Application Scenarios
Collecting Tolls (I)

The German system *Toll Collect*

- System for charging trucks on highways
- Should have been launched in August 2003
- Went into operation with a reduced functional range in January 2005 after profound defects
- Features: combination of positioning via GPS and fixed control stations

Based on obtained position, OBU detects toll roads and transfers toll charges to the toll center via GSM/GPRS

Trucks without OBUs are detected and controlled by fixed stations along the road

OBUs with GPS receiver and GSM/GPRS unit

GPS receiver of the OBU determines the truck's position

Source of images: [http://www.daserste.de/wwiewissen/](http://www.daserste.de/wwiewissen/)
8.2 Application Scenarios
Collecting Tolls (II)

Source: Toll Collect GmbH
http://www.toll-collect.de/
8.2 Application Scenarios
Enhanced Emergency Services (I)

Background

- Persons calling an emergency response agency (e.g., police, fire) are unable to communicate their current location (dt.: Röchelrufe) or they simply do not know it
- Address of a caller can be easily determined when made over the fixed telephone network
- But: rescue workers have serious problems locating emergency callers from mobile networks
- 50% of all emergency calls increasingly originate from mobile networks
- Administrations in many countries oblige mobile operators to extend their networks for offering enhanced emergency services

Features of Enhanced Emergency Services

- Selective routing: routing of an emergency call to the Public Safety Answering Point (PSAP) that serves the geographical area the call originates from
- Automatic Number Identification (ANI): delivery and display of the emergency caller's telephone number
- Automatic Location Identification (ALI): determines the location (in terms of a street address) of an emergency caller
8.2 Application Scenarios
Enhanced Emergency Services (II)

E-911
- Phase 1
  - Derive a mobile caller's location from the coordinates of the serving cell site from where the emergency call has been made
  - Automatic Number Identification
  - Scheduled to be completed in April 1998
- Phase 2
  - Locate a caller accurately within 50 to 100m in 67% and 150 to 300m in 95% of all emergency calls
  - Required the operators to begin network enhancements not later than October 2001 and to finish them by December 2005
  - Operators were and still are faced with serious problems with the realization of Phase 2
8.3 LBS Roles and Actors

Overview

- Provisioning of LBSs is an interorganizational matter

Actor
- Autonomous entity like a person, a company, or an organization
- Adopts one or several roles

Role
- Characterizes the functions an actor fulfills from a technical point of view or the impacts it exerts on LBS from an economical or regulatory point of view

Operational actors
- Actors cooperating during execution of an LBS and request and provide subservices of an LBS
- Maintain technical infrastructures like mobile devices, server farms, networks
- Examples: user, target, service provider, content provider, operator

Non-operational actors
- Dictate the economical or regulatory circumstances of LBS operation
- Examples: government, trade & commerce, vendors, standardization groups, ...
8.3 LBS Roles and Actors

Generic Role Model

- **Target**: mobile individual that is to be located, tracked, or sighted
- **Positioning Enabler**: maintains a positioning network and controls and coordinates the positioning process
- **Location Aggregator**: proxy that collects, stores, and manages location data on behalf of a target
- **LBS Provider**: central role that coordinates the entire LBS supply chain
- **Content provider**: may supply an LBS provider or user with geographic content such as maps, routing data for navigation, or lists of PoIs
- **User**: requests and consumes an LBS
8.3 LBS Roles and Actors

Scenarios for a Restaurant Finder

Scenario 1

Scenario 2

Scenario 3

Relationship:
Supplier ➞ Consumer
8.3 LBS Roles and Actors

Scenarios for Multiple Positioning Sources

Scenario 4

CONNECT [Positioning Enabler]

LOCASSIST [Positioning Enabler]

ALICE [Target User]

G-MAPS [LBS Provider]

Scenario 5

CONNECT [Positioning Enabler]

ALICE [Target User]

G-MAPS [LBS Provider]

Relationship:
Supplier ——— Consumer
8.3 LBS Roles and Actors

Scenarios for Location-based Mashups

Scenario 4

Scenario 5

Relationship:
Supplier — Consumer
8.3 LBS Roles and Actors

Scenario for Multiple Aggregators
8.4 LBS Classification
 Reactive versus Proactive LBSs

Reactive LBSs
- Explicitly invoked by the user by establishing a service session between the client application and the LBS server
- User or another person is located only during the service session (either one or several times)

Proactive LBSs
- Automatically initialized as soon as a predefined location event occurs
- Not explicitly requested by the user
- Examples
  - User approaches, enters, or leaves a certain point of interest
  - User approaches, enters, or leaves another person
  - Require continuous tracking in order to detect location events
8.4 LBS Classification
Selfdirectional, Unidirectional, and Bidirectional LBSs

- LBS user: person that requests and consumes the LBS
- Target: individual to be located

Self-directional LBSs
- User and target are the same individual
- User’s location is processed for his own purposes

Unidirectional LBSs
- Roles of user and target are adopted by different individuals
- User requests the location of a target or permanently tracks the location where a target stays
- Example: child tracking

Bidirectional LBSs
- Mutual exchange of location data between different participants
- Example: community services
8.4 LBS Classification

Outdoor versus Indoor LBSs

Outdoor LBSs
- Cover large geographical areas and make use of satellite or cellular positioning technologies
- Positioning is usually based on lateration or proximity sensing and delivers position fixes with accuracies between 10 m and several hundreds of meters
- Geographic location data based on a spatial reference system

Indoor LBSs
- Assist the user inside buildings, for example, shopping malls or large administration buildings
- Positioning is based on proximity sensing or fingerprinting and position fixes have typical accuracies in the range of some meters or even centimeters
- Symbolic location data (e.g., room numbers) or location data based on a local reference system
8.4 LBS Classification

Network-centric versus Terminal-centric LBSs

Network-centric LBSs

- Serving mobile network operator entirely (or at least essentially) control the LBS value chain
- Positioning process is managed and coordinated by the control plane of the serving network
- Position data is made accessible to external actors via an GMLC

Terminal-centric LBSs

- Positioning is entirely decoupled from the infrastructure of the serving mobile network operator
- Autonomous self-positioning of a terminal (e.g., by using GPS or RFID)
- Control and dissemination of location data via the user plane
8.4 LBS Classification

Client/Server versus P2P Operation

Client/Server Operation
- Clients are given by terminals carried by the targets or users respectively
- Clients send requests and location data for processing to a central server
- Server processes location data and returns results to the clients

P2P Operation
- Location data is directly shared between the peers without passing the domains of intermediate players
- Different strategies for organizing P2P network (unstructured, structured, DHT, ...)

Client/server operation

P2P operation