LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Praktikum Mobile und Verteilte Systeme

Context-Awareness and Location-based Services

Prof. Dr. Claudia Linnhoff-Popien
Florian Dorfmeister, Chadly Marouane, Kevin Wiesner
http://www.mobile.ifi.lmu.de

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Context-Awareness and Location-based Services

Today:

- Context-Awareness
  - What is Context / Context-Awareness?
  - How to sense context?

- LBS
  - What are LBS?
  - Origin and evolution of LBS
  - Classification and role model
  - Position Management in LBS

Defining Context

- **Schilit (1994)**:
  - *Computing context*: connectivity, communication cost, bandwidth, nearby resources (printers, displays, PCs)…
  - *User context*: user profile, location, nearby people, social situation, activity, mood …
  - *Physical context*: temperature, lighting, noise, traffic conditions
  - **Chen/Kotz (2000)** added:
    - *Time context* (time of day, week, month, year…)

- **Dey and Abowd (2000)**: "Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and the application themselves."

Sensing Context

- Sensing location: e.g. GPS (cf. outdoor / indoor positioning)
- Media capturing: e.g. camera, microphone
- Connectivity: mobile network, bluetooth, WLAN, NFC
- Time: e.g. day of week, calendar
- Motion and environmental sensors:
- `TYPE_ACCELEROMETER, TYPE_AMBIENT_TEMPERATURE, TYPE_GRAVITY, TYPE_GYROSCOPE, TYPE_LIGHT, TYPE_LINEAR_ACCELERATION, TYPE_MAGNETIC_FIELD, TYPE_ORIENTATION, TYPE_PRESSURE, TYPE_PROXIMITY, TYPE_RELATIVE_HUMIDITY, TYPE_ROTATION_VECTOR, TYPE_TEMPERATURE`

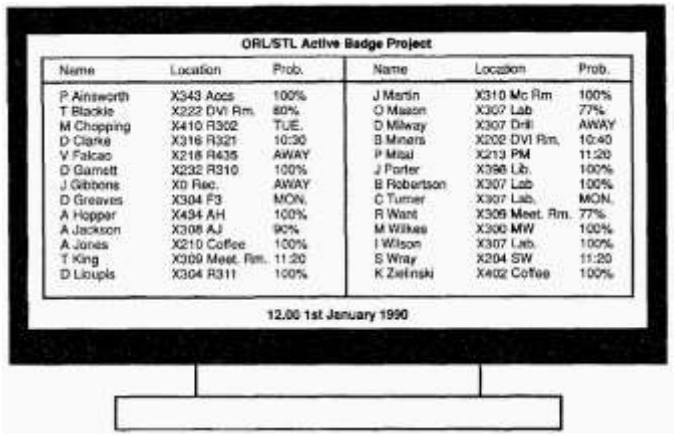
Further: active/running apps on device,
remaining energy level,

- …

Example: Active Badge / ParcTab

Active Badge

- From Olivetti Research Lab in 90's
- One of the first context-aware systems
- Office personnel wear badges (IR signal)
- Applications
  - Call Forwarding



ParcTab

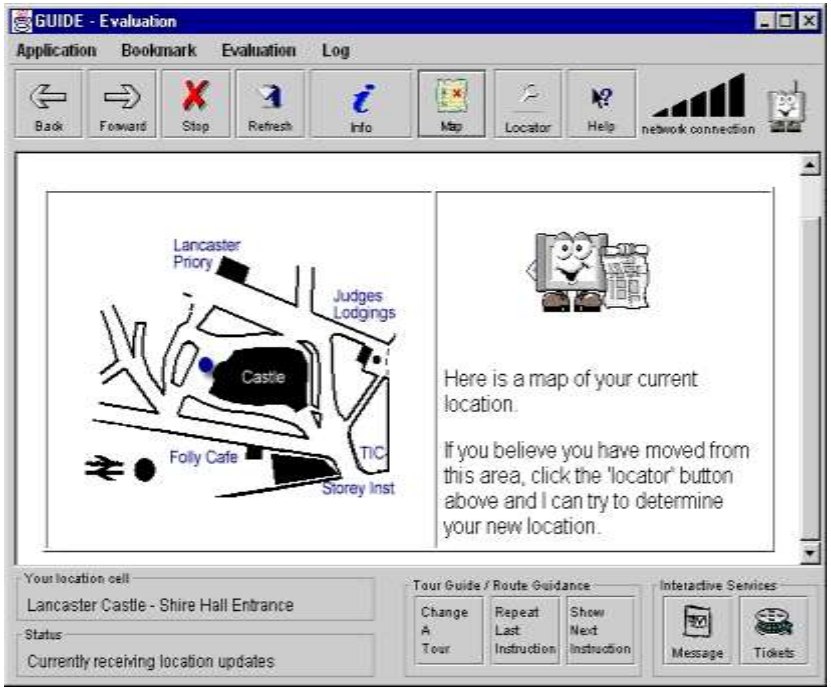
- From Xerox Palo Alto Research Center
- Room-sized IR cells
- Applications
  - Active Map
  - Location information (Room number)
  - Others: Find local resources
    (e.g. nearest printer), Remote control

Example: GUIDE

- Developed in Lancaster University
  - For Lancaster City visitors

Using WaveLAN as communication
- infrastructure
- A tourist comes to a region(cell),
- then he receives information of
  - the region.

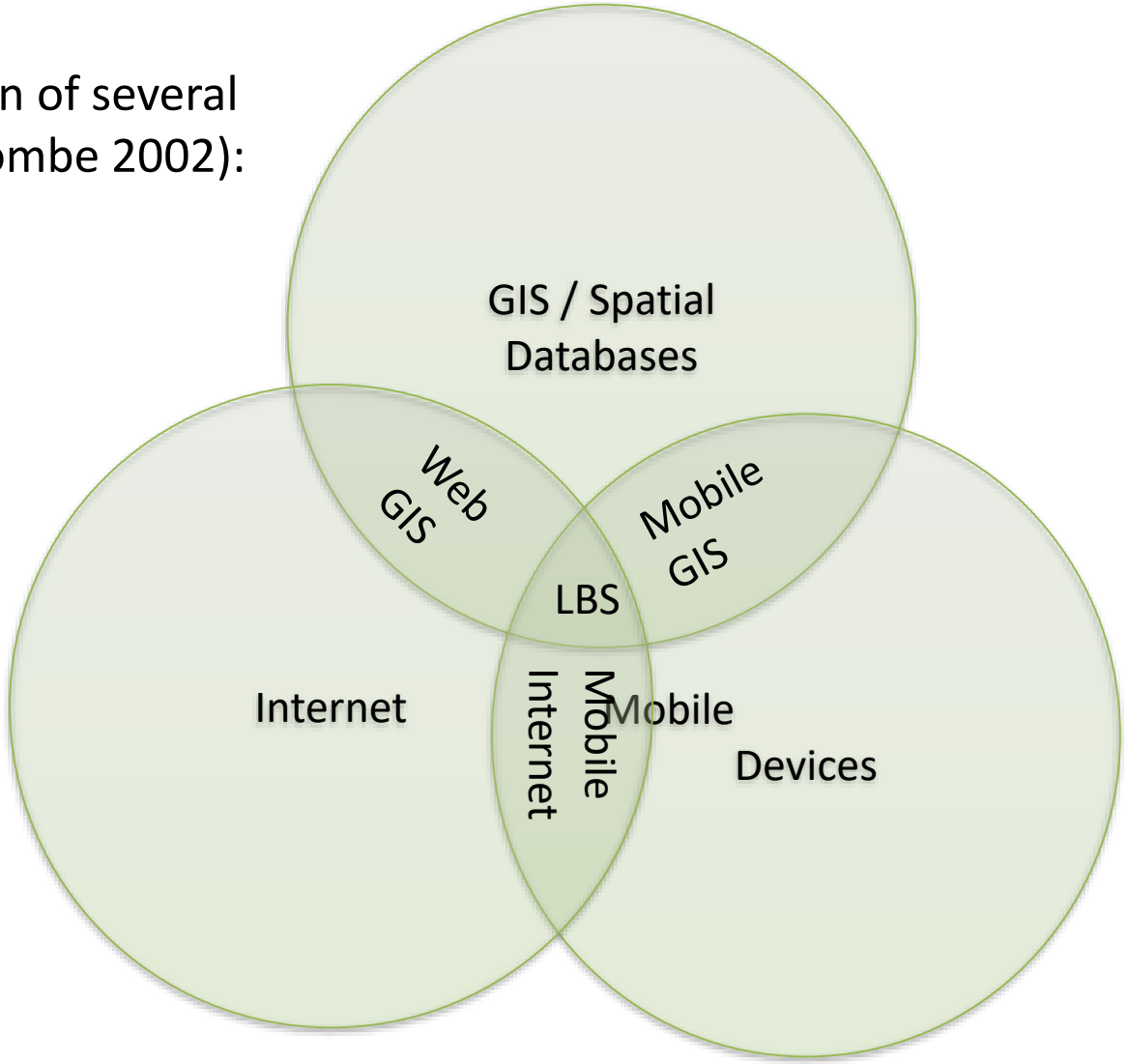
- Information provided using
  - Fujitsu TeamPad 7600 portable PC
  - Java based http browser



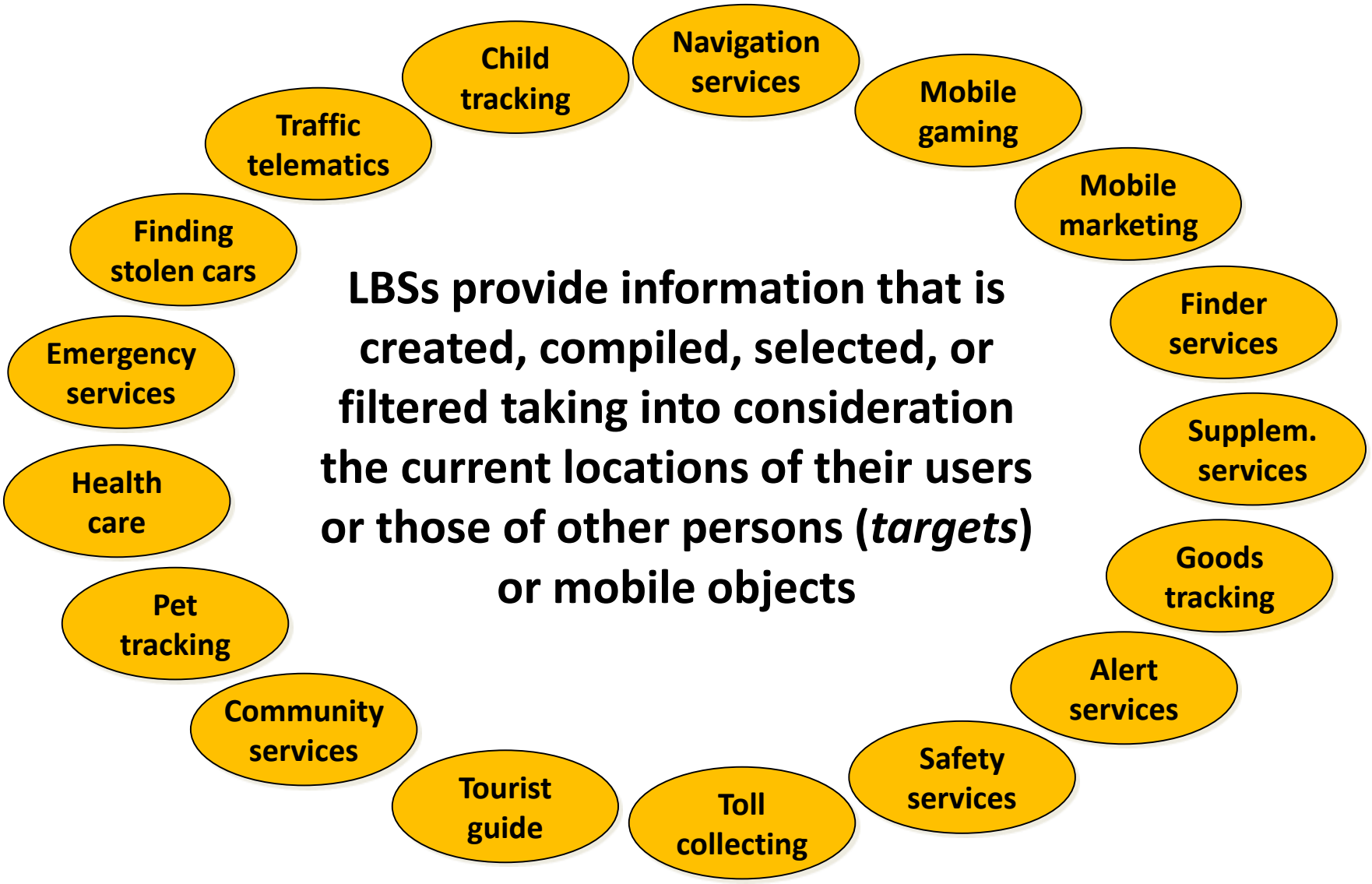
LBS – Relation to Other Areas

LBS as the intersection of several technologies (Brimicombe 2002):

- Internet
- Mobile Devices
- GIS



LBS – Application domains



Background: emergency services

- Persons calling an emergency response agency (e.g., police, fire) are unable to communicate their current location 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
- 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

Examples

- Enhanced 911 (E-911) in the United States
- Enhanced 112 (E-112) in Europe
- Similar activities in Japan and Korea

E-911

- Passed by U.S. *Federal Communications Commission* (FCC) in 1996
- 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

http://www.fcc.gov/911/enhanced/

E-112

- Coordinated by the European *Coordination Group on Access to Location Information for Emergency Services* (CGALIES)
- CGALIES investigates and prepares for the introduction of enhanced emergency services in all countries of the EU
- Commitments for operators are less restrictive than in the U.S.
- No mandate, just recommendations defining several features of E-112
- No time schedule
- Operators are urged to locate emergency callers as accurately as possible


http://europa.eu/

Position Management – Low-level functions (1)

Low-level functions are strategies to transmit position updates to the location server…

Basic position queries are provide by this layer:

- **Polling:** The location server *polls* the current location from the mobile device. Can be performed periodically, on behalf of the application or on the location server.

- **Periodic position update:** The device triggers the updates after a certain time interval elapsed after the last position update.

- **Distance-based position update:** The mobile devices sends a position update if it has moved further away than a given threshold.

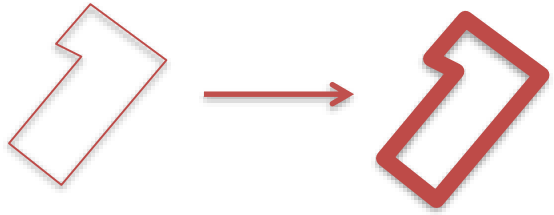
- **Zone-based position update:** Mobile devices sends a position update if it enters or leaves a predefined *update zone* (Polygon, Circle…)

Zone-based Update Jobs

- Objective:
- Alert user when MTs enter or
  - leave pre-defined zones

- Applications:
  - e.g. child tracking

Efficiently monitor position on
- mobile terminal
- Definition of bounding polygon
- depends on used positioning
- technology (borderline tolerance)



Position Management – High-level functions

High-level functions are strategies on how to use the low-level functions...

→ Number of required position updates (*low-level* function calls) should be **minimized** (transmission costs energy and bandwidth)

Possible *high-level* functions are:

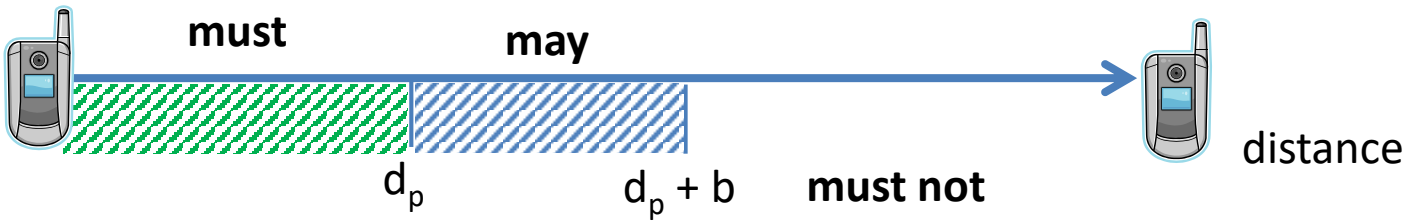
- **Proximity detection:** Detect if a pair of mobile devices in a group approaches each other closer than a predefined *proximity distance.* Thus each mobile devices has a set proximate mobile devices.

- **Separation detection:** Detect automatically if two mobile devices in a given set have a larger distance than a predefined *separation distance*.

- **k-nearest neighbors:** Retrieve the *k* nearest other mobile devices
-

High-level functions – Proximity Detection (2)

- Let *dist*(t_i,t_j) denote the geographic distance between t_i and t_j
- Proximity detection is implemented using the predefined constants:
  - Proximity distance d_p: Proximity for devices closer than d_p *must* be detected
  - borderline distance b: Proximity for devices closer than d_p+b *may* be detected



- Requirements for proximity detection:
  - If *dist*(t_i,t_j) < d_p: Proximity **must** be detected
  - If d_p · *dist*(t_i,t_j) · d_p + b: Proximity **may** be detected
  - If d_p + b < *dist*(t_i,t_j): Proximity **must not** be detected