



Fine-Grained Mobility Monitoring Tool

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Mobility Experiment

Ordinary People

- Running LifeMap* as background service in smartphone



Live with
 **LifeMap**
 enabled smartphone

- **Personalized Scheme**
 - All mobility data is stored in individual phone
- **Sensing Levels**
 - High level sensing is activated only if low level sensing increases uncertainty
 - Level 1 (Cell-ID), Level 2 (Wi-Fi), Level 3 (GPS)
- **Point-of-Interest Recognition with Room-Level**
 - Room level-based Wi-Fi fingerprint
 - Aggregate identical places
- **Adaptive sensing schedule of GSM, Wi-Fi, GPS**
- **Two participants use LifeMap during the MobiSys conference (2~3 days)**

Small Contributor

- Running SmartSLAM* and walk interested indoor-space one time



Walk with
 **SmartSLAM**
 enabled smartphone
 one time

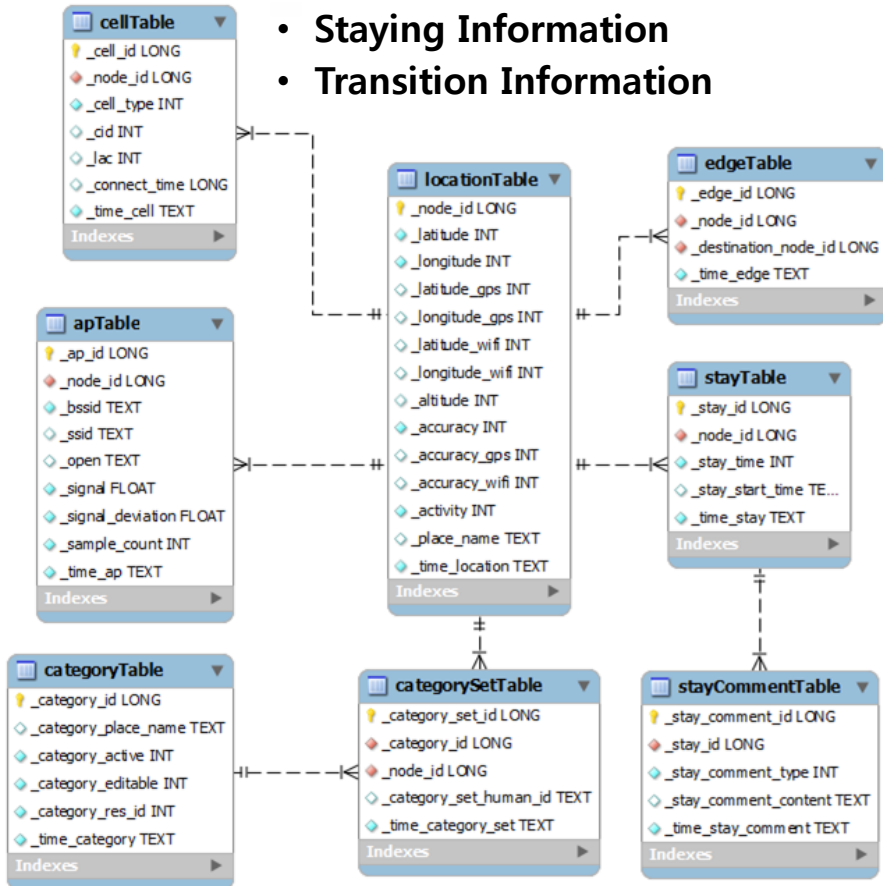
- **Smartphone-based SLAM Technique**
 - No prior map information
 - Inertial sensor-based pedestrian tracking
 - Use Wi-Fi fingerprints as observations
 - Use Kalman filter and Particle filter
- **Radio Map Interpolation**
 - Estimating a radio pattern for unvisited places
 - Log-distance path loss model
- **Continuous Sensing of Accelerometer, Magnetometer, Wi-Fi**
- **One participant uses SmartSLAM in DoubleTree hotel one time (5 minutes)**

* See more on [1] Y. Chon, H. Cha, "LifeMap: A Smartphone-based Context Provider for Location-based Service," IEEE Pervasive Computing, and [2] H. Shin, Y. Chon, K. Park, H. Cha, "FindingMiMo: Tracing a Missing Mobile Phone using Daily Observations," ACM MobiSys 2011.

Data Description

LifeMap provides Everyday Mobility Data* with Room-Level

- Location (latitude, longitude, accuracy, activity)
 - Scanned Wi-Fi APs, Cell-Towers
 - Staying Information
 - Transition Information



SmartSLAM provides Radio Map in Indoor Environments

- Location (Building ID, local x, local y)
- Scanned Wi-Fi APs



Manual Building ID



Estimated AP Location

Walked Path

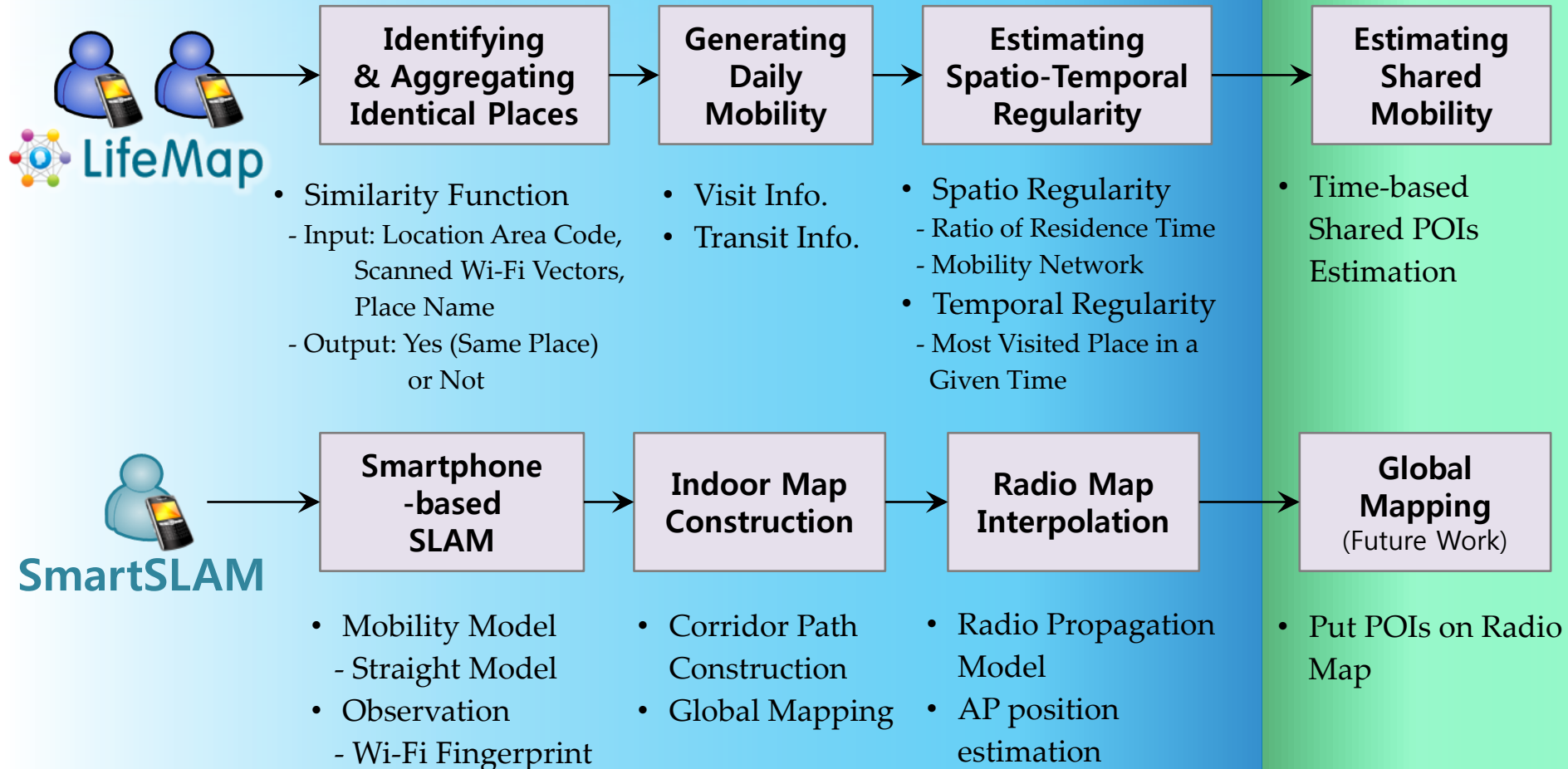
- **Grid** = (id, x, y, A)
- **AP Set** $A = \{ ap_1, ap_2, \dots, ap_n \}$
- **AP** $ap = \{ BSSID, SSID, signal \}$

* See more on our homepage [3] <http://lifemap.yonsei.ac.kr>

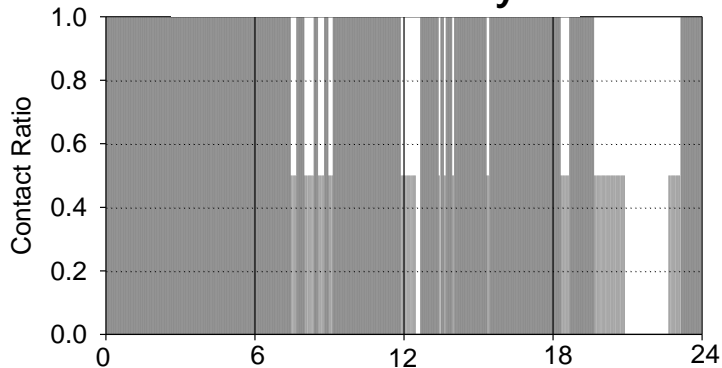
Data Processing

Personalized Phase (in Individual Smartphone)

Sharing (in Server)



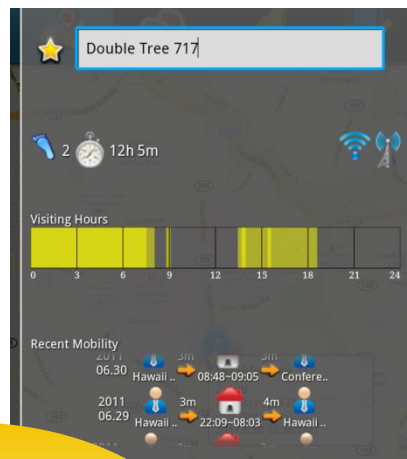
Shared Mobility



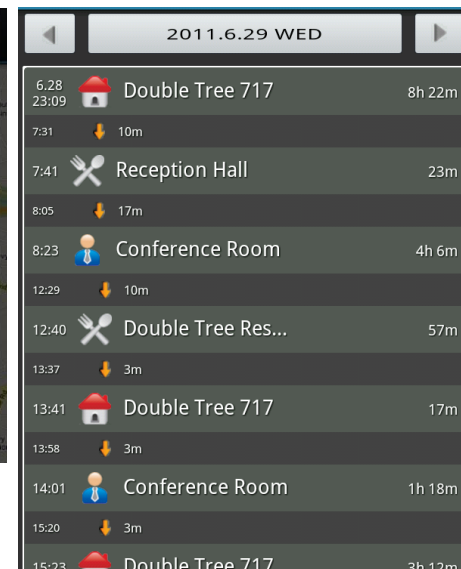
The probability that two users are located in same place. 0.5 at 12pm means that two users were located in same place with 50% of their time at 12pm during collection period.

Shared Mobility

POI Information



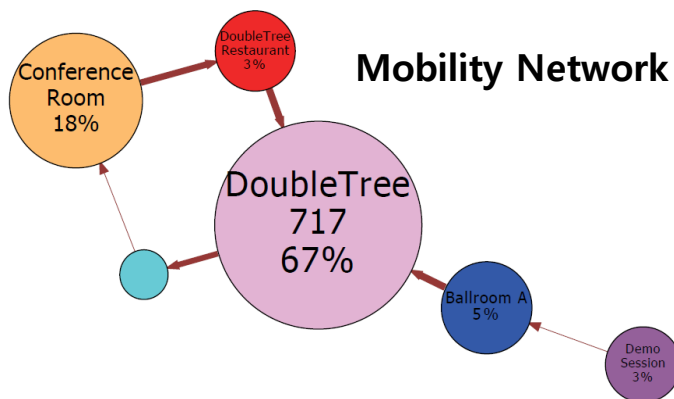
Daily Mobility



Stay & Transit Information



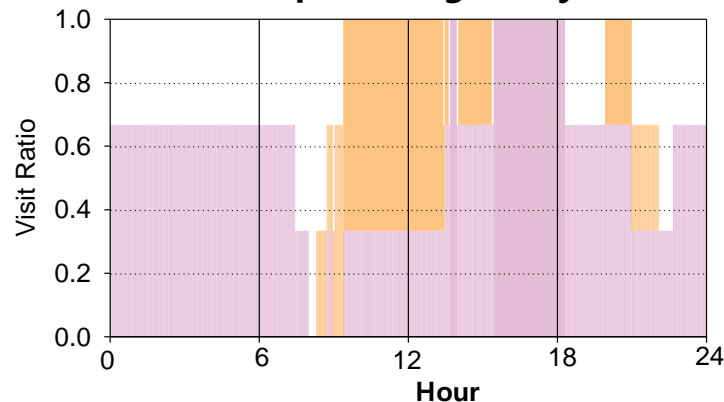
Individual Regularity



The size of node presents the ratio of residence-time. The width of edge indicates frequency of transition. A user spends most of his time at a few selected places.

* Visualization Tool: LifeMap v1.1 in Android Market, Graphviz 2.26.3, SigmaPlot 11

Temporal Regularity



The probability of top 2 visited location during the corresponding minute-long period. 0.67 at 6am means that a user are located 67% of their time in his most visited location at 6am.

Ready to Sense Human Mobility in the World

✓ Take a Message

- ❖ **Wi-Fi fingerprint scheme is acceptable to monitor everyday mobility with room-level accuracy**
- ❖ **Our approach will improve the granularity of location-based mobile services**
 - Ordinary people stores Wi-Fi fingerprint of individual POIs
 - Small contributor makes high-granularity indoor map
- ❖ **Useful tools for mobility-related research (web: lifemap.yonsei.ac.kr)**
 - Personalized mobility monitoring tool
 - Light-weight construction tool for indoor floor plan with radio map

✓ Future Work

- ❖ **Practical Application**
 - Prevent Children Kidnap
 - Find Missing Child