Sensing Multi-modal Mobility Patterns: A Case Study of Helsinki using Bluetooth Beacons and a Mobile Application

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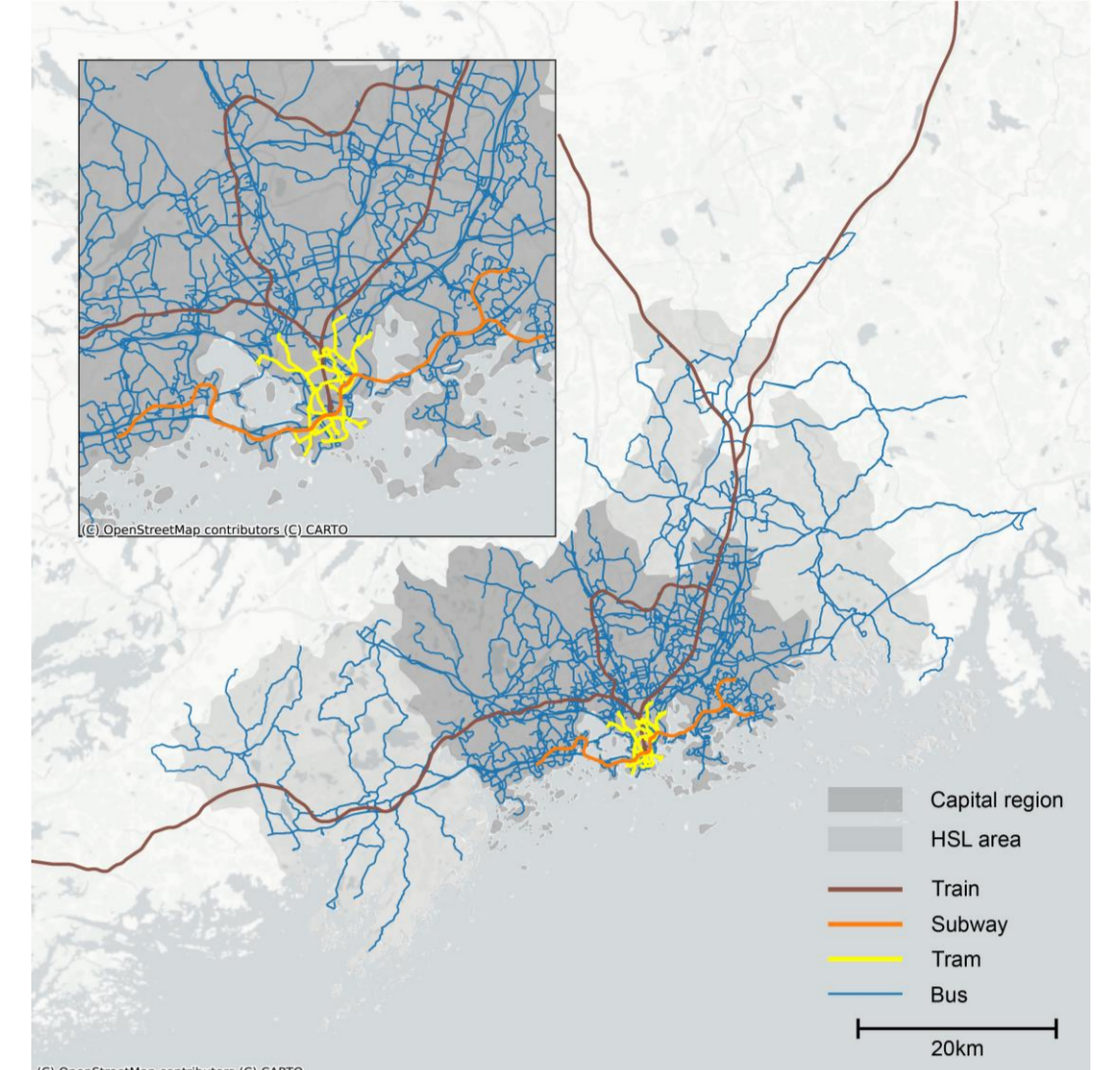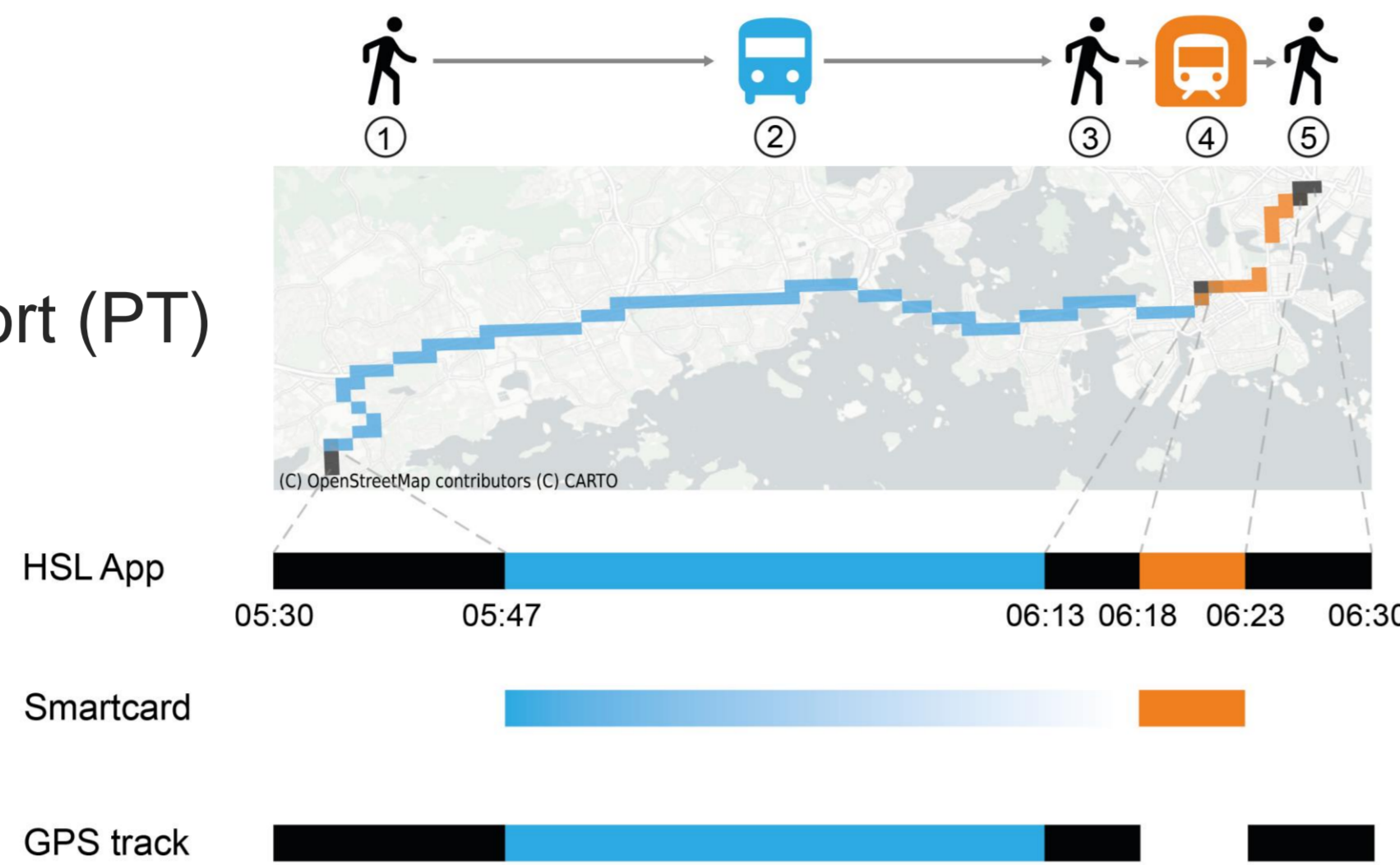**A!** Aalto University School of Science

HSL HRT

Current challenges

Smartcard:
- Without info. outside public transport (PT)
- Uncertain PT destination
- Honor-based fare collection

Mobile phone GPS:
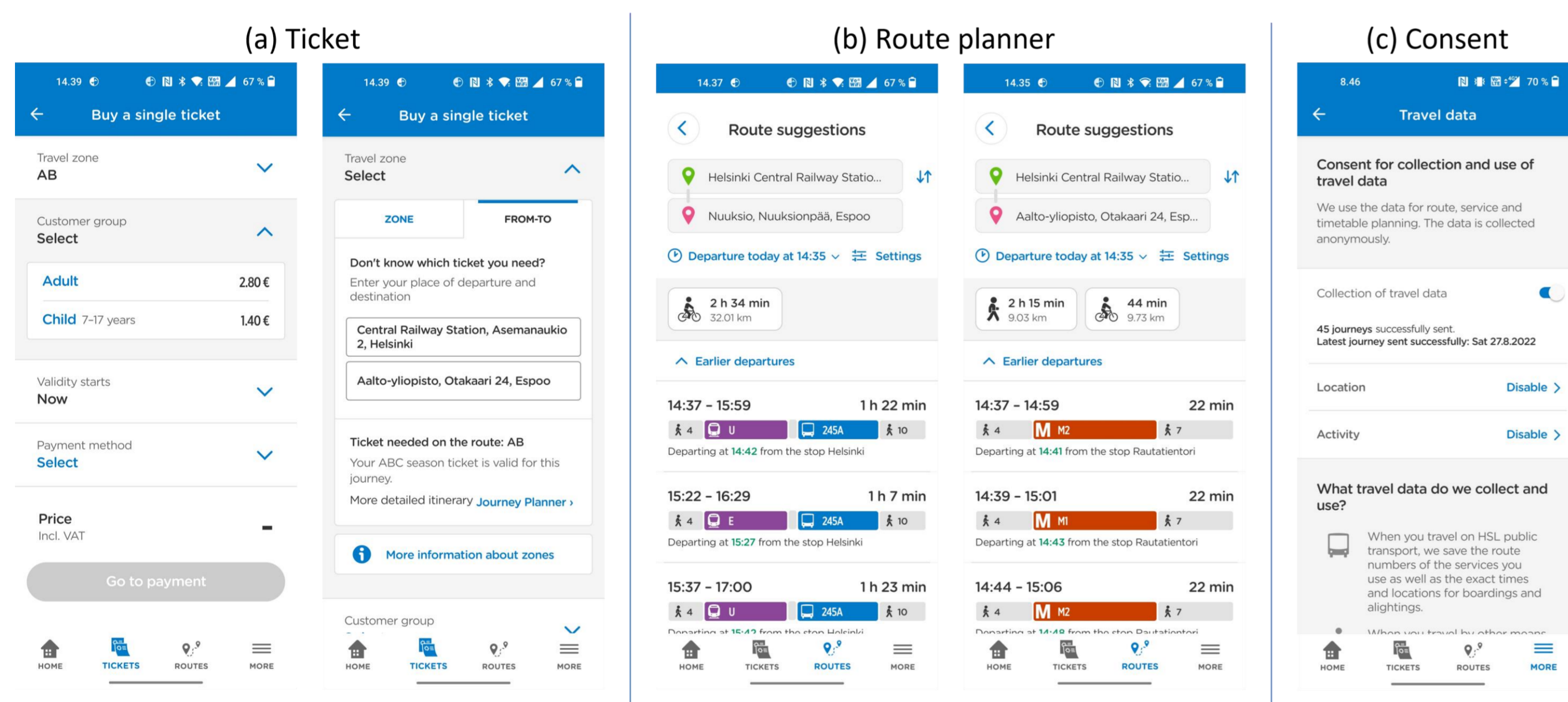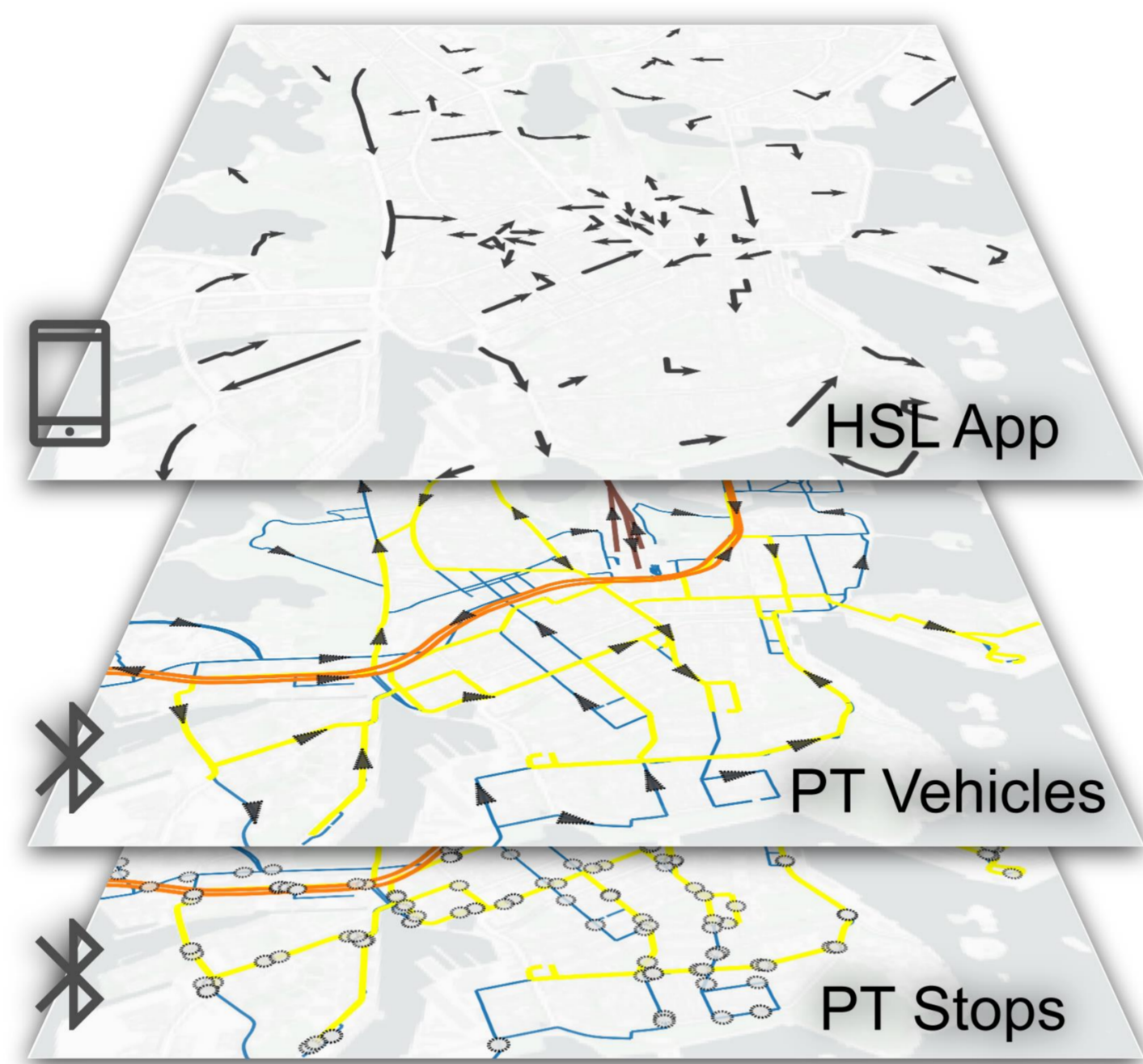- Signal issues
- Without PT info.

Method

Physical Infrastructure:
- Mobile phone: GPS + Activity
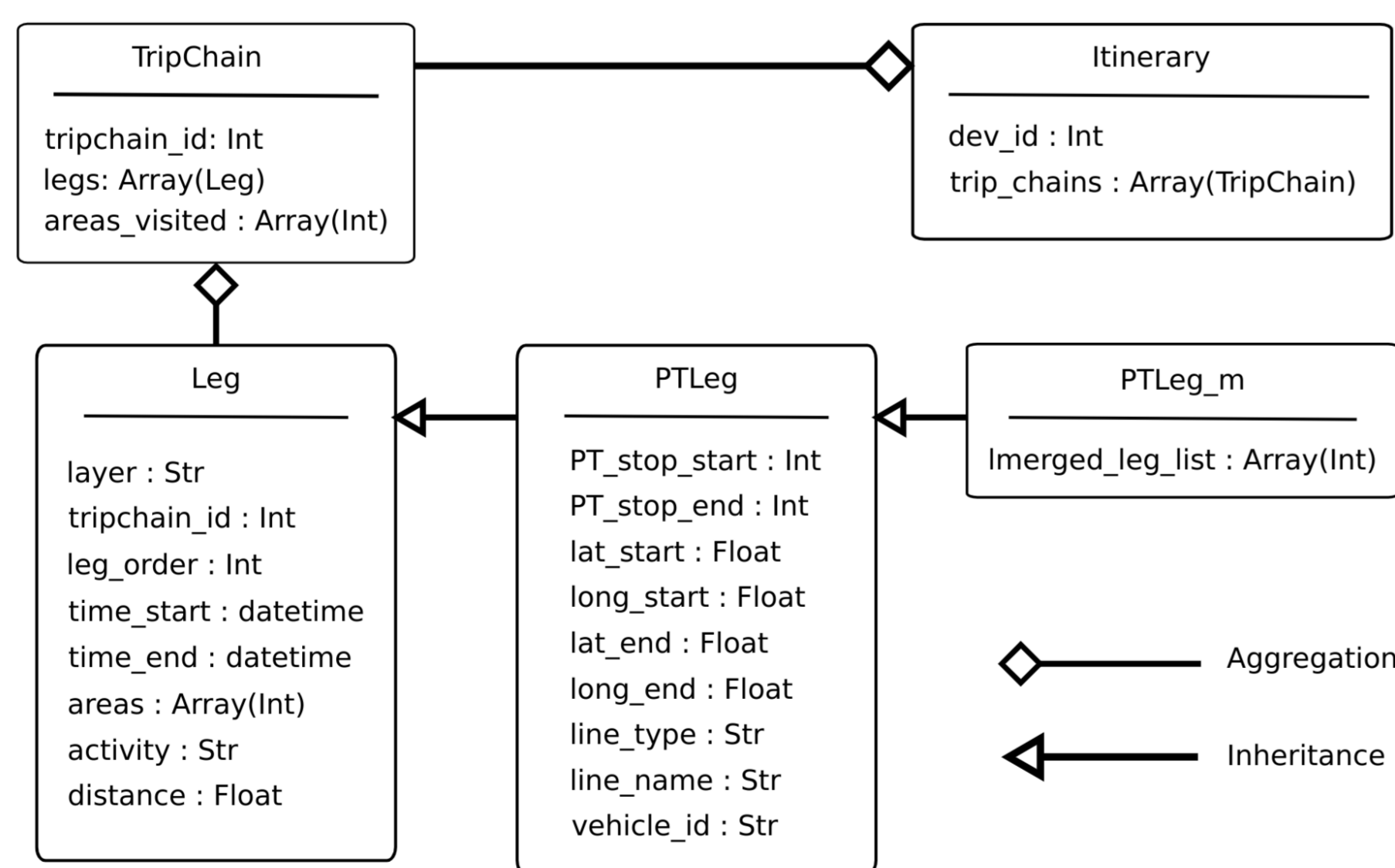- Moving Bluetooth beacons
- Stationary Bluetooth beacons

User side:
- Ticket purchase
- Route planner
- Data consent

(a) Ticket (b) Route planner (c) Consent

Data structure:
- Leg
  - PTLeg
- Tripchain
- Itinerary

Privacy protect:
- Location details are restricted to 250m x 250m grid cells.
- Times for locations outside the PT network are rounded to the nearest 15 minutes.
- Devices are anonymized daily with random IDs to prevent long-term tracking.

Results

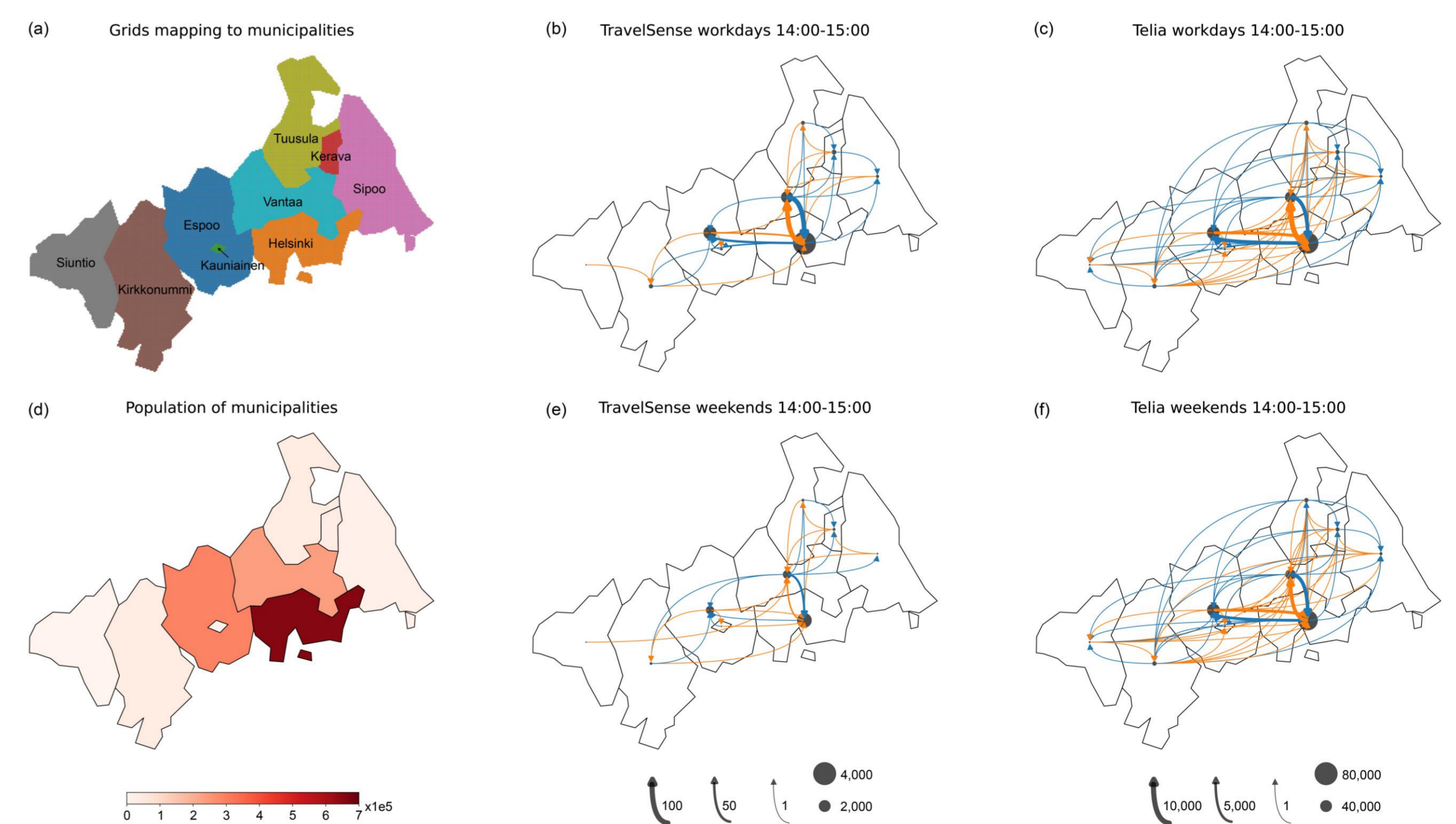**Spatio-temporal distribution of multi-modal mobility patterns**:

Walking | Cycling | Private vehicle
Bus | Urban rail | Train
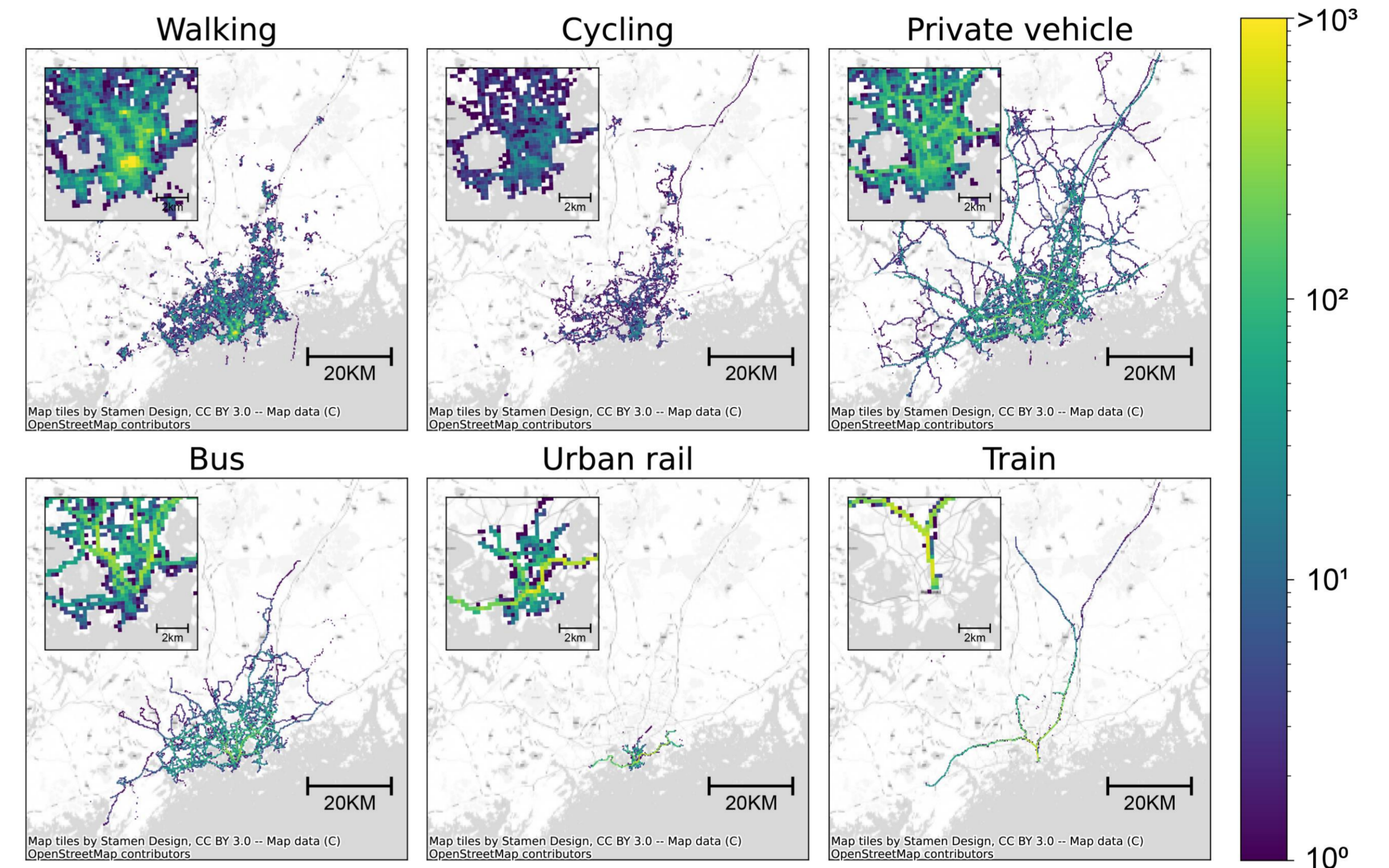
Comparing with travel surveys:

MODE SHARE COMPARISON OF THE TRAVELSENSE DATA WITH HSL TRAVEL SURVEYS OF 2012 AND 2018

Percentage(%)	Car	PT	Cycling	Walking	Other
TravelSense legs	26	19	4	38	13
TravelSense trip chains	19	41	4	19	17
Travel surveys (2018)	39	22	9	29	1
Travel surveys (2012)	40	24	8	25	3

Comparing with mobile phone trip data:

(a) Grids mapping to municipalities (b) TravelSense workdays 14:00-15:00 (c) Telia workdays 14:00-15:00
(d) Population of municipalities (e) TravelSense weekends 14:00-15:00 (f) Telia weekends 14:00-15:00

Conclusion

1. Collecting anonymized traveler's door-to-door trajectories.
2. Understanding the representativeness and bias of this approach.
3. Using this data for public transportation practice.
   - Transfer analysis
   - Traffic analysis for network structure changes