

Spring Semester 2017 CDS Seminar

Swiss-Sense-Synergy Status Updates

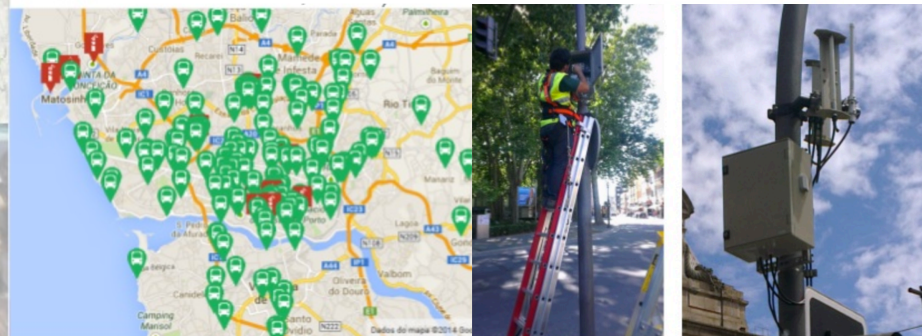
Zhongliang Zhao
Universität Bern
24.07.2017

- Swiss-Sense-Synergy status
 - Mobility prediction for VANETs
 - 1 order/2 order/hybrid Markov chain solutions
 - Collaborations with Uni Aveiro/Instituto de Telecomunicações
 - Indoor localization
 - Machine learning-enhanced room level landmark detections
 - Kidnapped robot problem recovery
- Future works
 - Mobility prediction
 - Joint publications with Uni Aveiro
 - Traffic estimation
 - Indoor localization
 - iBeacon integration
 - Edge implementation

Porto Dataset



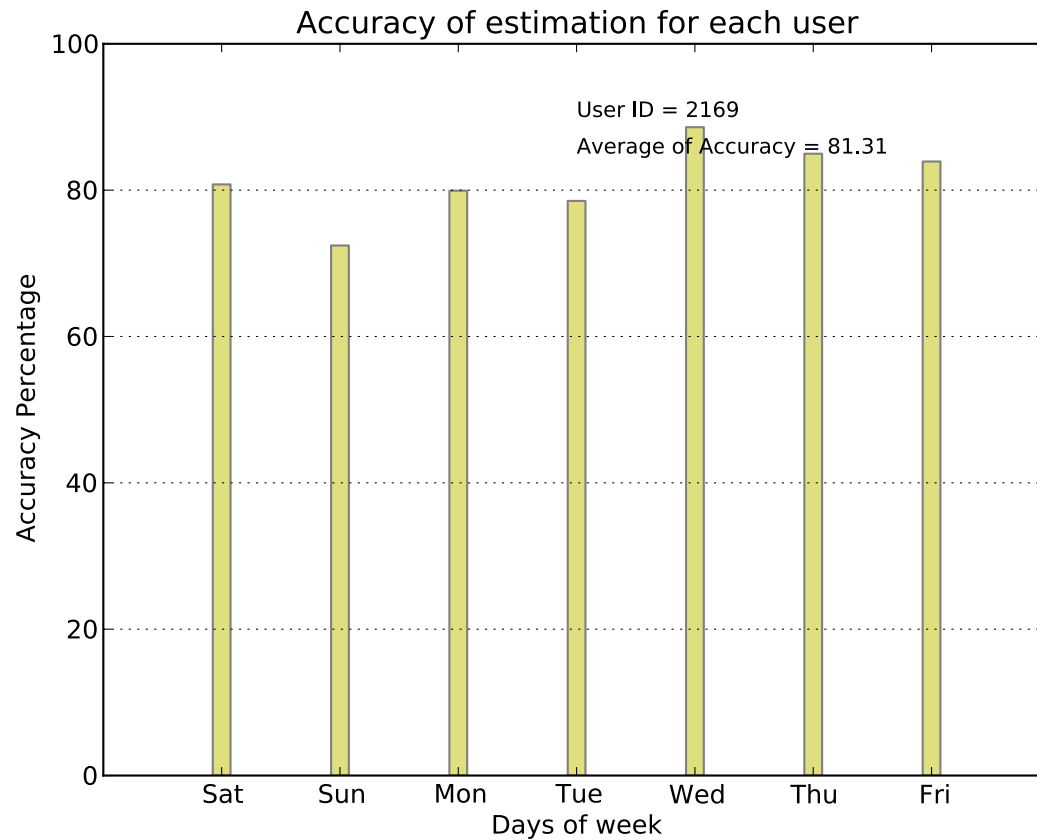
- Largest VANETs testbed in the world
- Services
 - Offer free Wi-Fi on public transportation
 - Acquire real-time city-scale data
- Infrastructures
 - Testbed deployed in Porto, Portugal
 - 460+ cabs with GPS and 3/4G & 600+ bus/garbage trucks as On Board Units (OBUs)
 - 70+ Road Side Units (RSUs)
 - IEEE 802.11p between vehicles



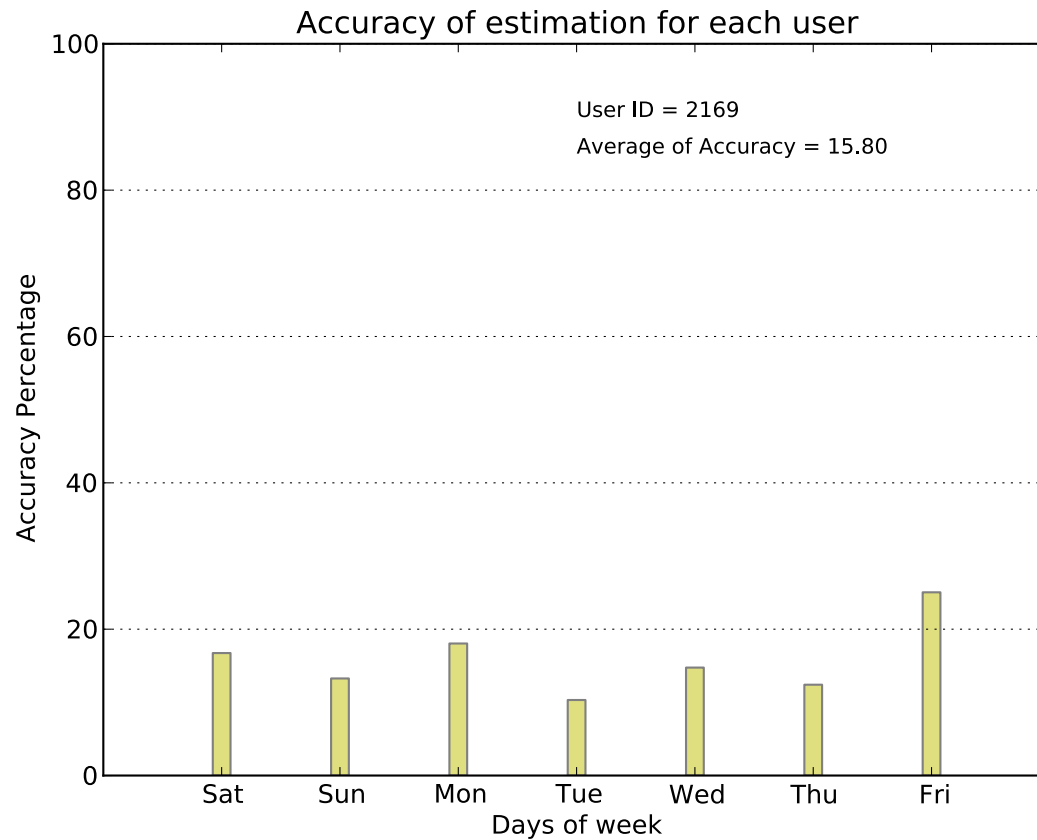
VANETs Mobility Prediction

- Goal:
 - Predict OBU's next connected RSU
- Approach:
 - First order Markov chain from MCN
 - Second order Markov chain
 - Consider current connected RSU, and previous connected RSU
 - Linear/exponential interpolation to estimate missing values
 - Hybrid solution
 - 1st order + 2nd order M.C. adaptively

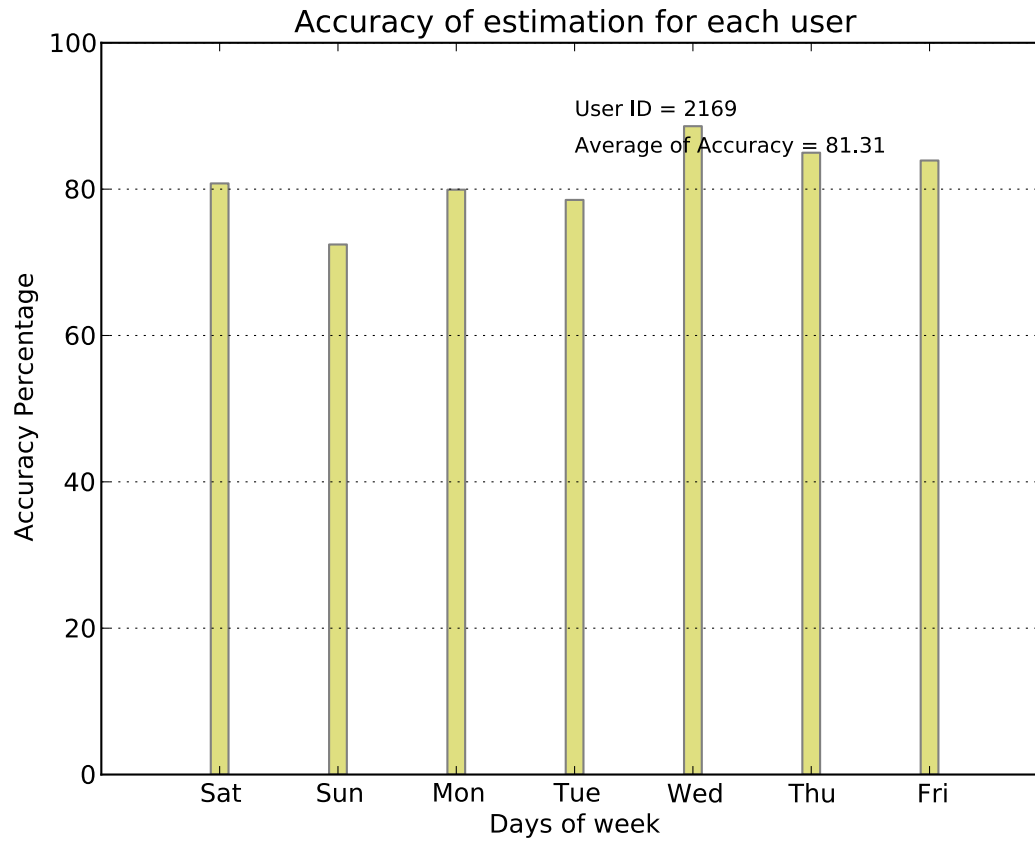
Results (1st order M.C.)



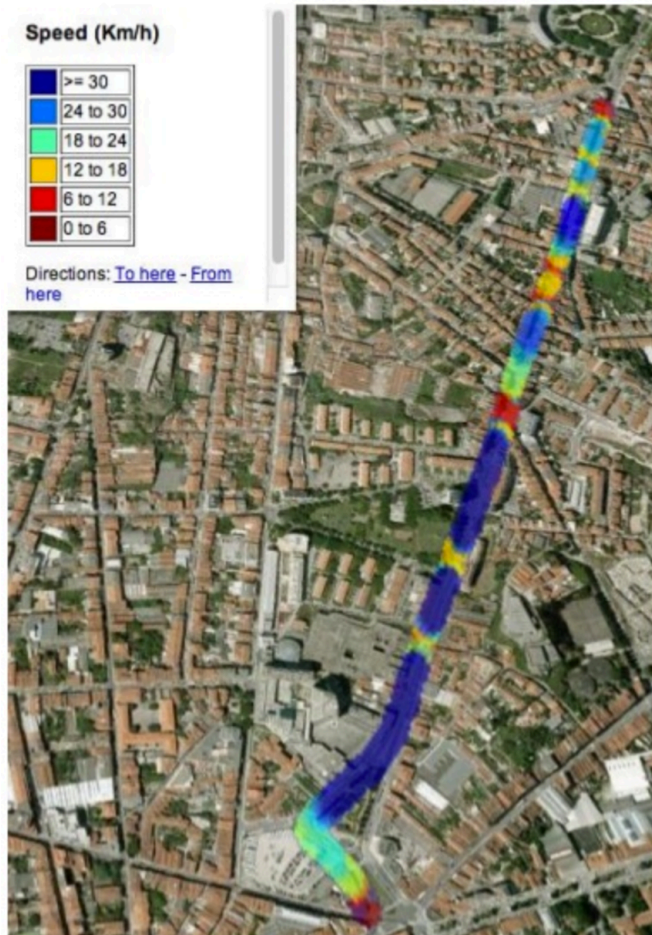
Results (2nd order M.C.)



Results (Hybrid M.C.)



Mobility Analysis for Traffic Estimation



- Traffic jam estimation considering:
 - Intersections on the road segment
 - Average speed in road sub-segment
 - Events
 - Weather
 - Etc.

Mobility Prediction for OTT Content Pre-fetching

- Goals:
 - Predict OBU's next connected RSU
 - Pre-fetch the OTT content before connected to next RSU (emulated by Raspberry pi)

Content-Aware Prefetching in Over-The-Top Wireless Networks

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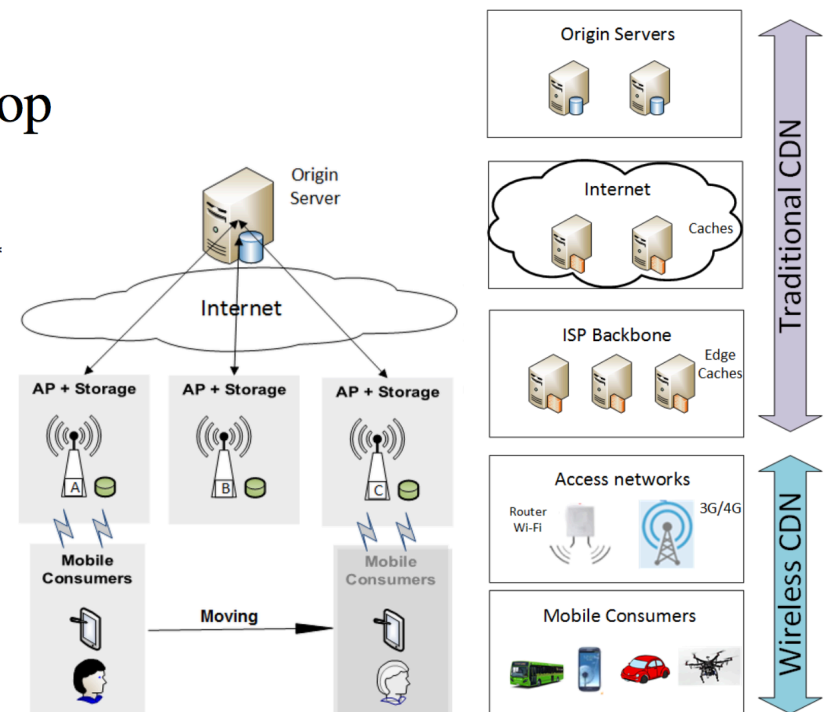
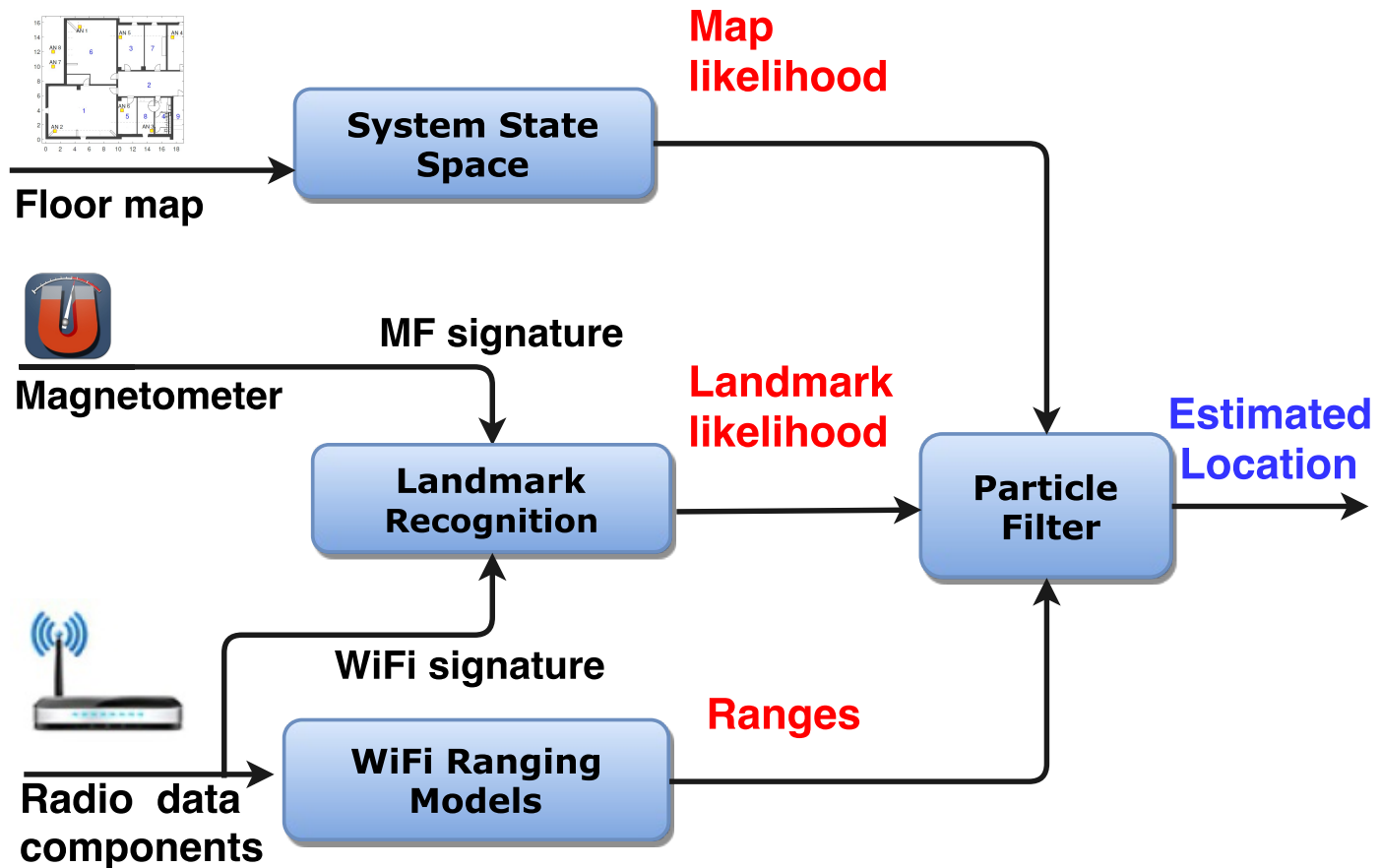


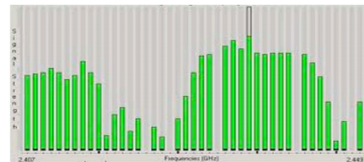
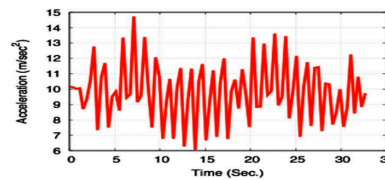
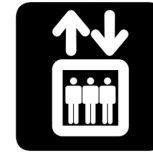
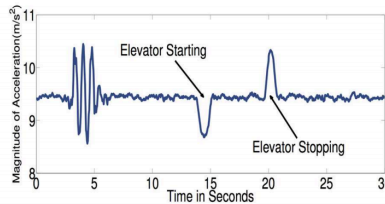
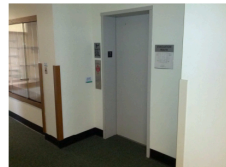
Fig. 1: Typical Wireless CDN infrastructure.

Indoor Localization



Landmark-based Indoor Localization

- Certain locations in an indoor environment present identifiable key signatures multiple sensing dimensions.
- These signatures naturally exist and can be envisioned as internal Landmarks of a building.



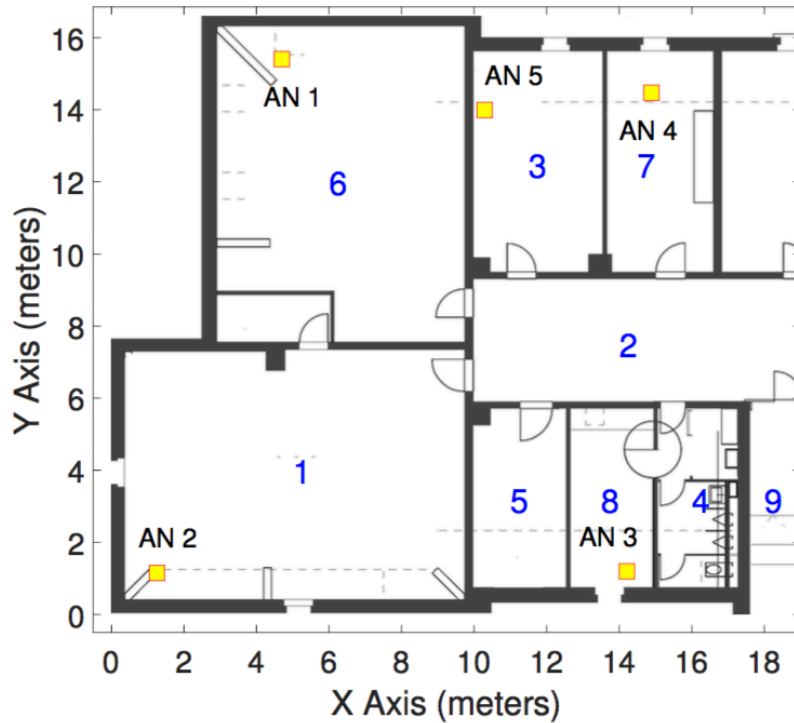
Wi-Fi + Magnetic Field as Landmarks

- Landmark
 - Indoor location point where at least one sensor shows a stable and discriminative pattern in the measurements
- Fingerprinting approach to provide landmark recognition with room level accuracy
 - Wi-Fi RSSI + Magnetic field
- Room-level localization
 - Classification problem
 - Machine learning approaches
 - K-Star
 - Multi-Layer Perceptron (MLP)
 - J48
 - Support Vector Machine (SVM)

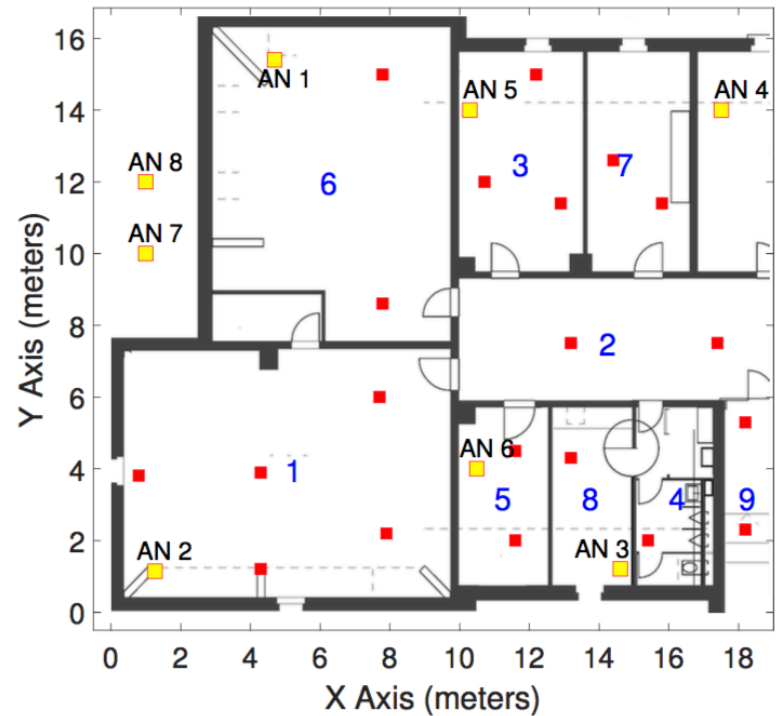
Localization Failures Recovery

- Localization failures
 - Kidnapped-robot problem: a situation where an indoor object is carried to *an arbitrary location* during the localization procedure
 - Reasons:
 - Wi-Fi instability
 - Low Wi-Fi sampling rates
 - PDR estimation accumulated errors
- Kidnapped-robot problem solution
 1. Failure recognition
 - ML-based room recognition to detect the correct room
 2. Failure recovering
 - Equally distributed particle resampling

Experiments



(a) Scenario 1 (5 ANs)



(b) Scenario 2 (8 ANs)

Results

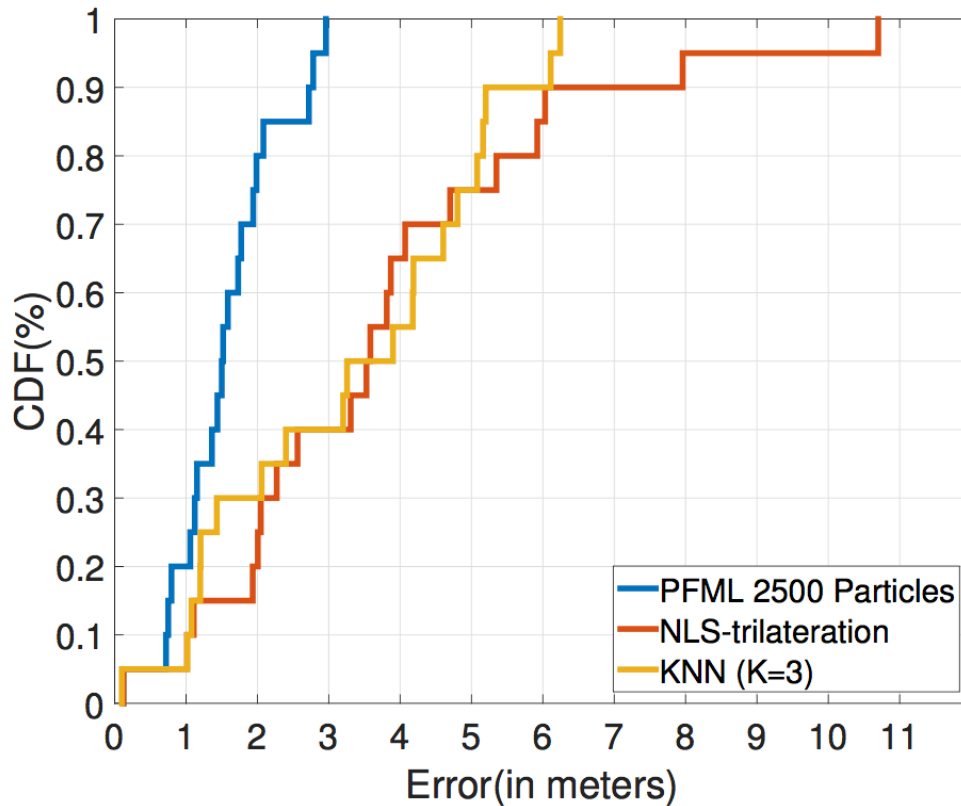


Figure 7: Localization error CDF PFML, NLST, KNN

Table I: Wi-Fi(5 ANs) and MF Scenario 1.

Classifier	Wi-Fi	Wi-Fi and MF
KStar	80.1%	86%
MLP	76.9%	79.4%
J48	76.5%	79%
SVM	68.4%	74.4%

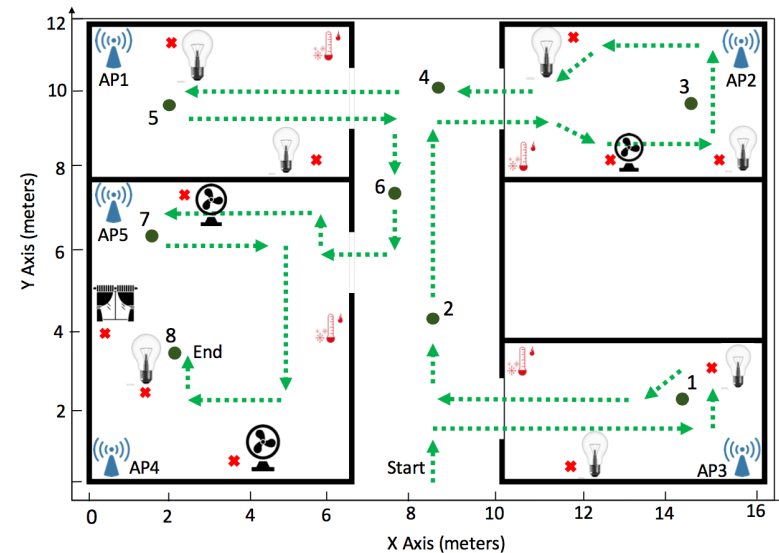
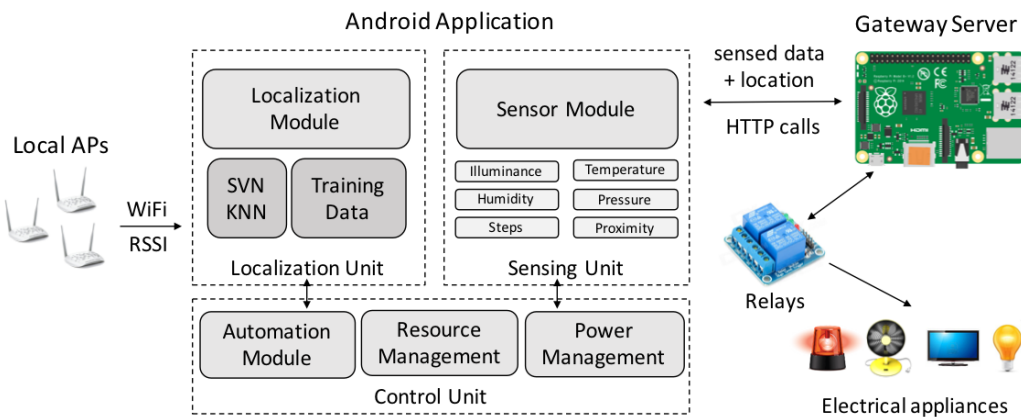
Table II: Wi-Fi(5 ANs) and MF Scenario 2.

Classifier	Wi-Fi and MF
KStar	94.5%
MLP	91.9%
J48	90.7%
SVM	85.8%

Average error of 1.55 meter.

Collaborations with Other Partners

- Indoor location-aware WSNs sensor actuation
 - Indoor localization module (Uni Bern)
 - WSN management module (Uni Geneva)



- Achievements
 - Working prototype
 - IEEE LCN'17 paper accepted & demo submission preparation

Future Works

- Mobility prediction
 - 1st/2nd/Hybrid Markov chain solution validations
 - Porto dataset/Uni Aveiro collaborations
 - OTT prefetching (by September, NOMS'18 or VTC'18)
 - Traffic estimation
- Indoor localization
 - More landmark information
 - iBeacon integration for iOS
 - Edge implementation

Conclusions

- SSS current status
 - Mobility prediction
 - New use cases of traffic estimation and content pre-fetching
 - Indoor localization
 - Machine learning-based landmark (Wi-Fi + Magnetic) detection
 - Integration with other project partners
 - Indoor location-aware IoT sensor actuation (Bern & Geneva)
- Future works
 - Mobility prediction
 - Further experiments with VANETs dataset
 - Indoor localization
 - More landmarks measurements (e.g., iBeacon), more experiments

Thanks for your attentions.

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