Indoor Positioning Using the OpenHPS Framework

Maxim Van de Wynckel, Beat Signer

Web & Information Systems Engineering Lab Vrije Universiteit Brussel



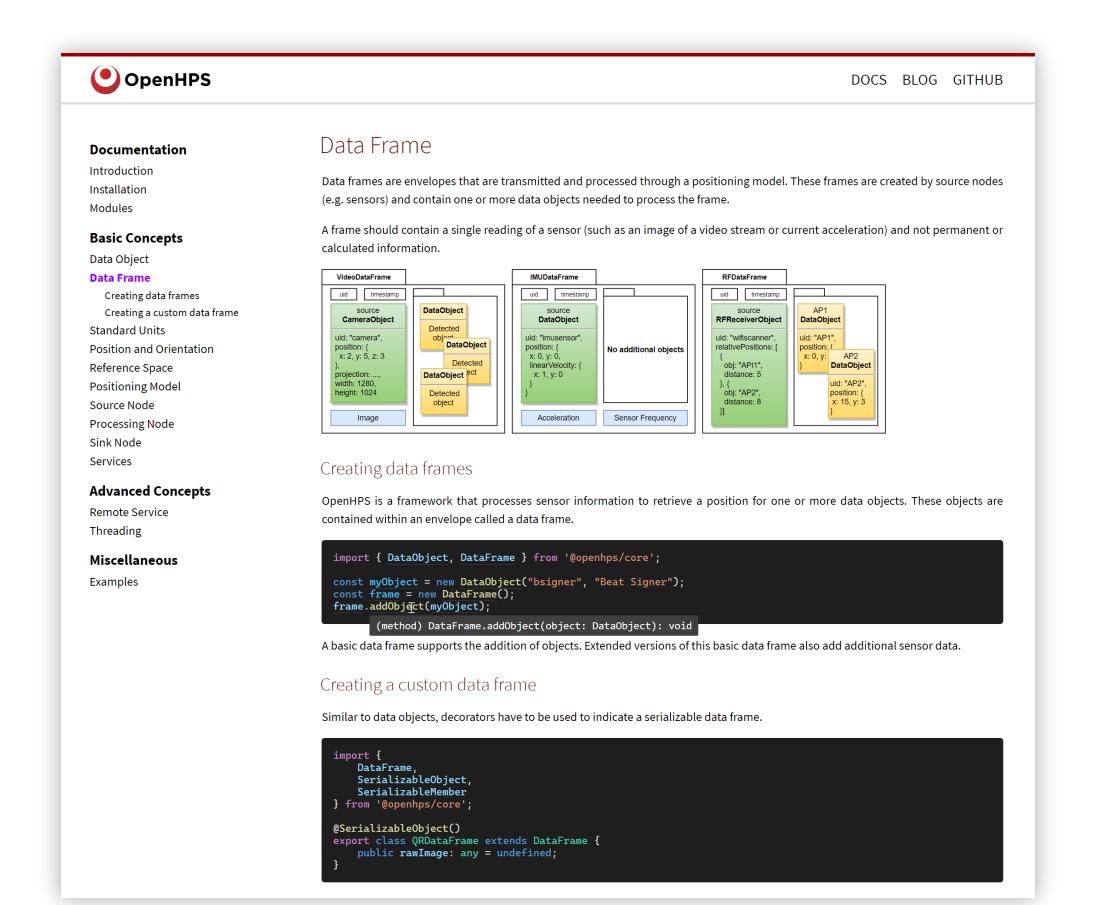




What is OpenHPS?



An Open Source Hybrid Positioning System



What is OpenHPS?

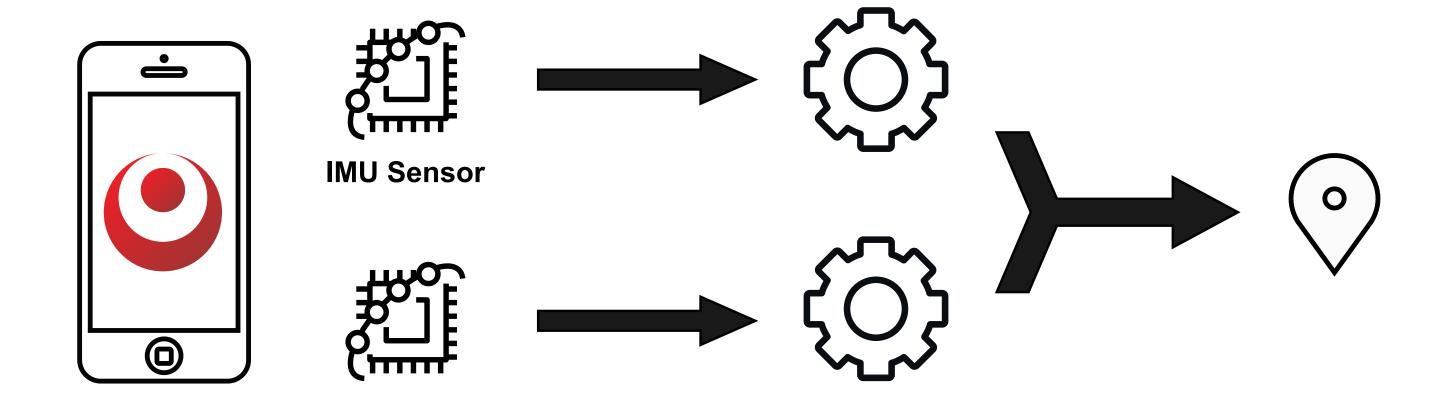


An Open Source Hybrid Positioning System

- Any technology
- Any algorithm
- ► Various use cases
- ► Flexibile processing and output
 - Accuracy over battery consumption, reliability, ...
- ► Aimed towards
 - Developers
 - Researchers

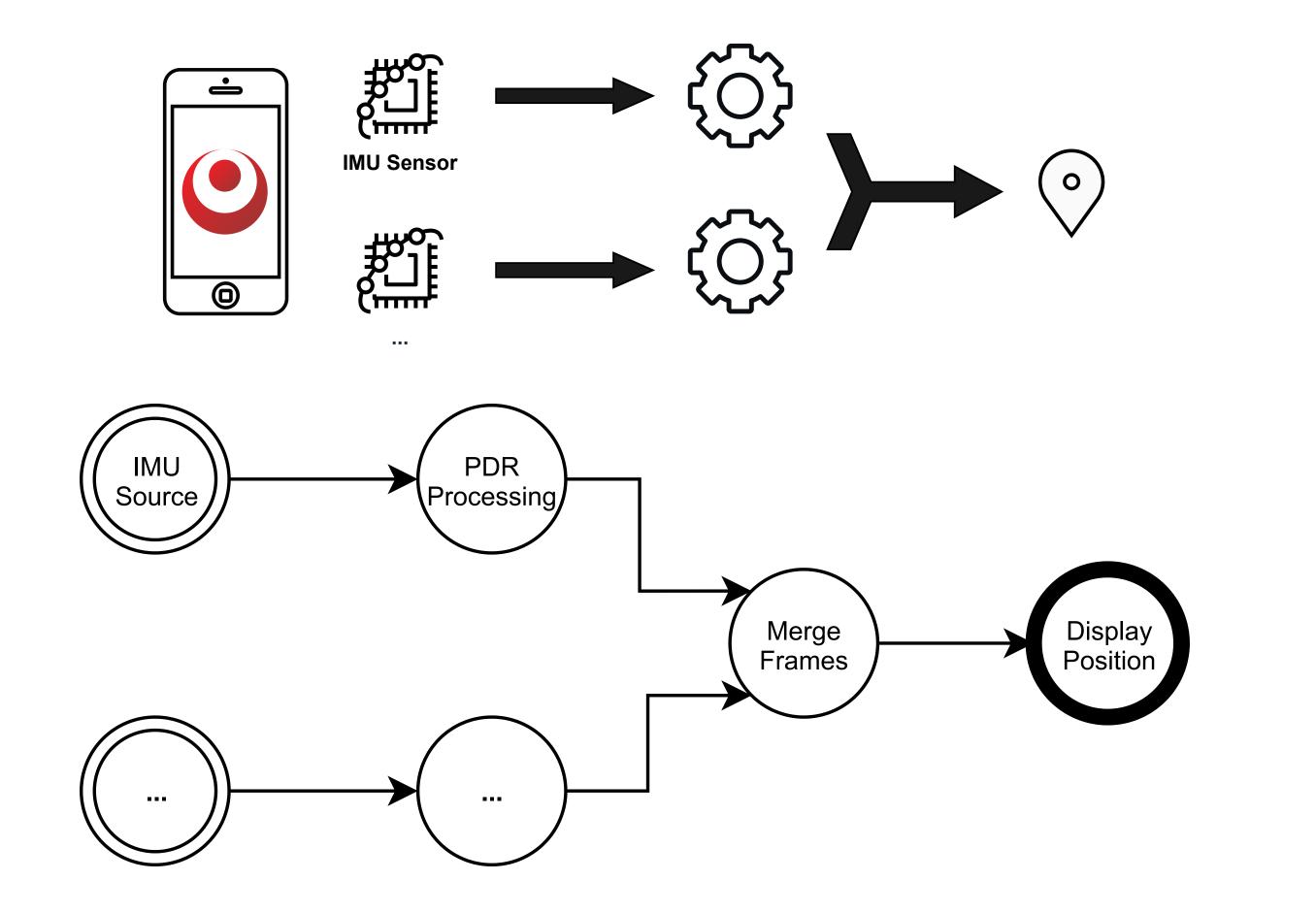
Process Network Design





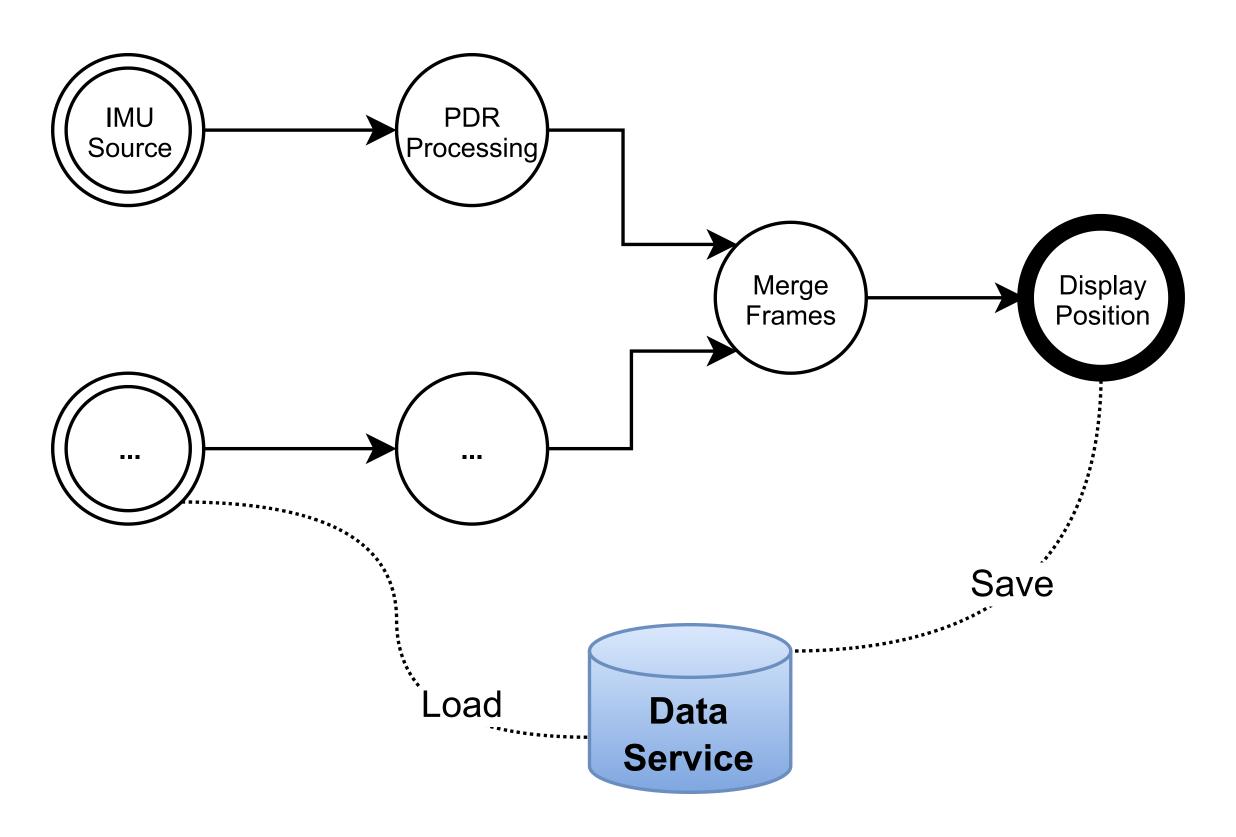
Process Network Design ...





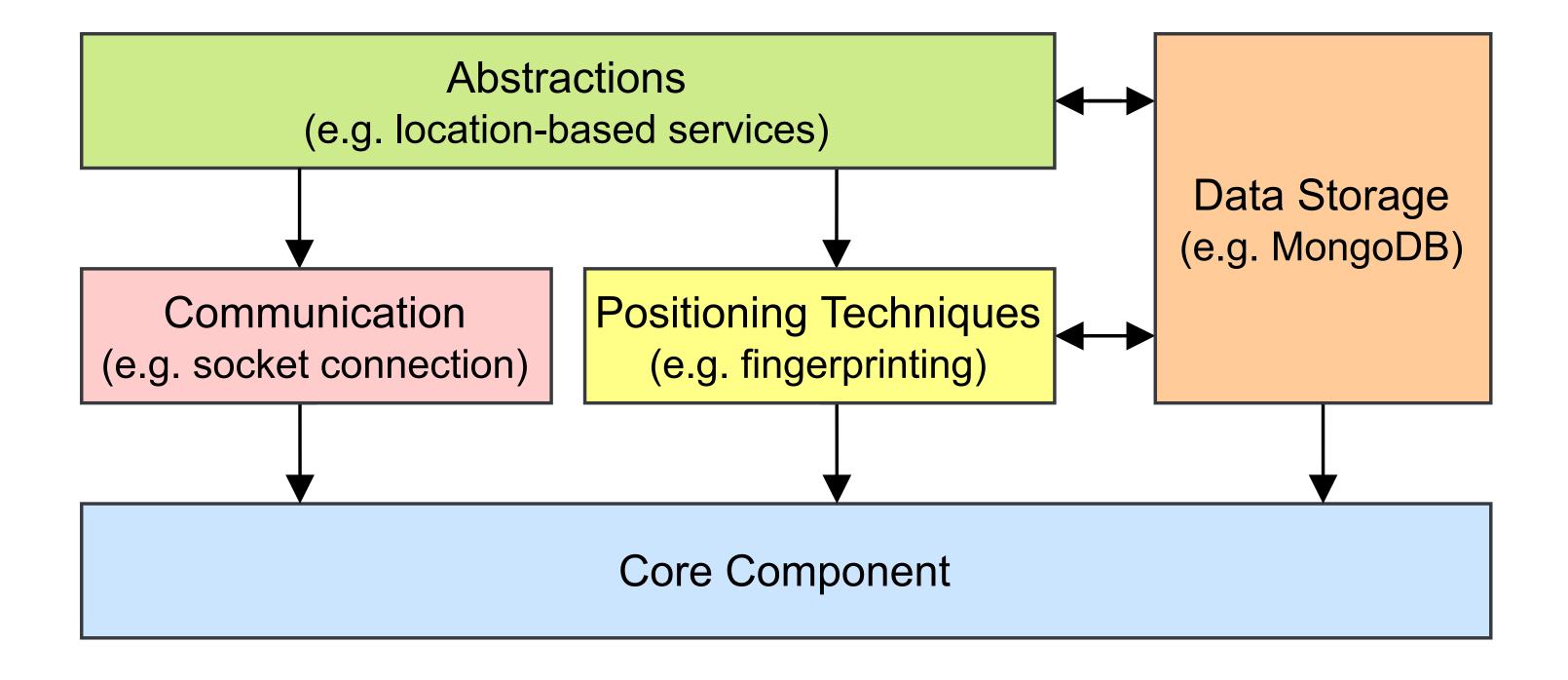
Process Network Design ...





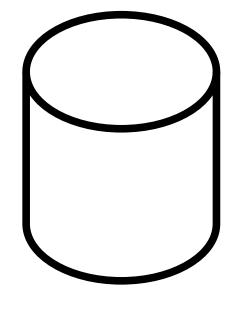
Modularity



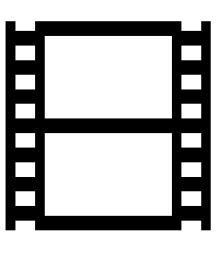


Data Processing

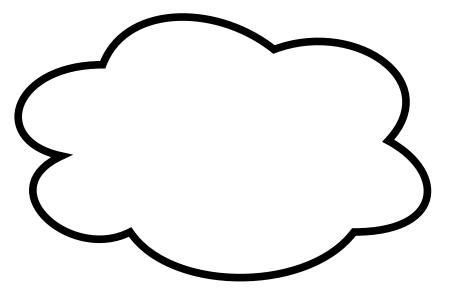








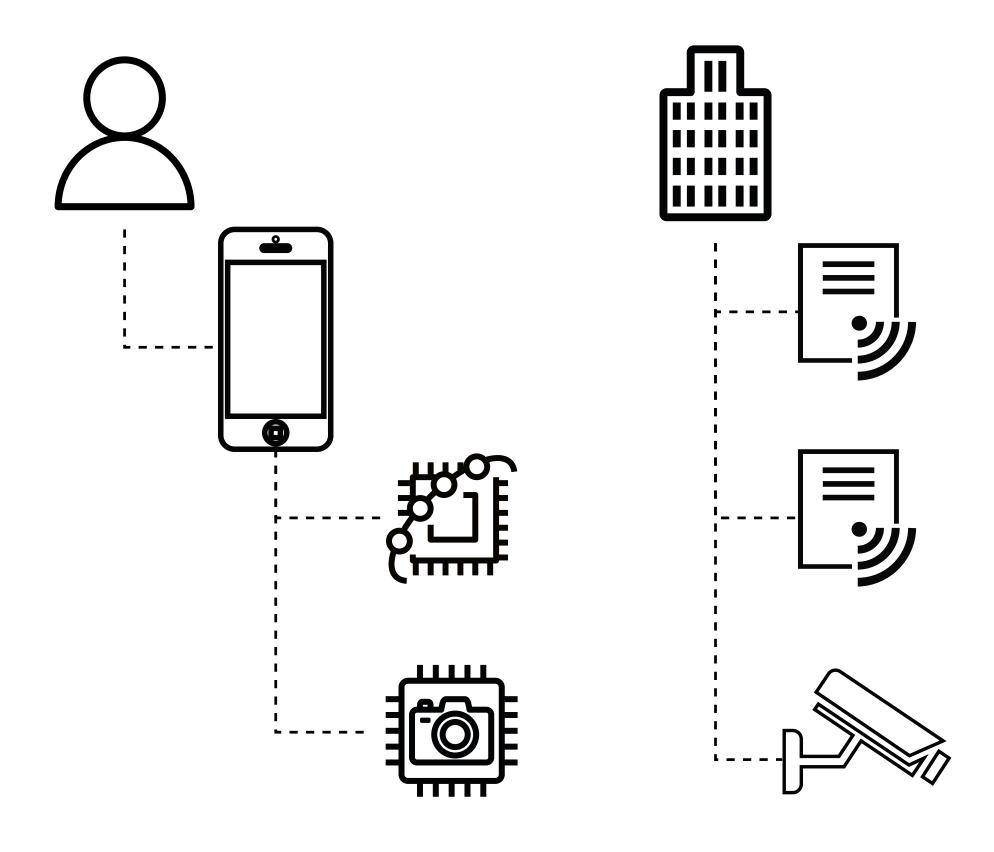
Raw Data



Processed Data

DataObject





Absolute and Relative Positions



Absolute

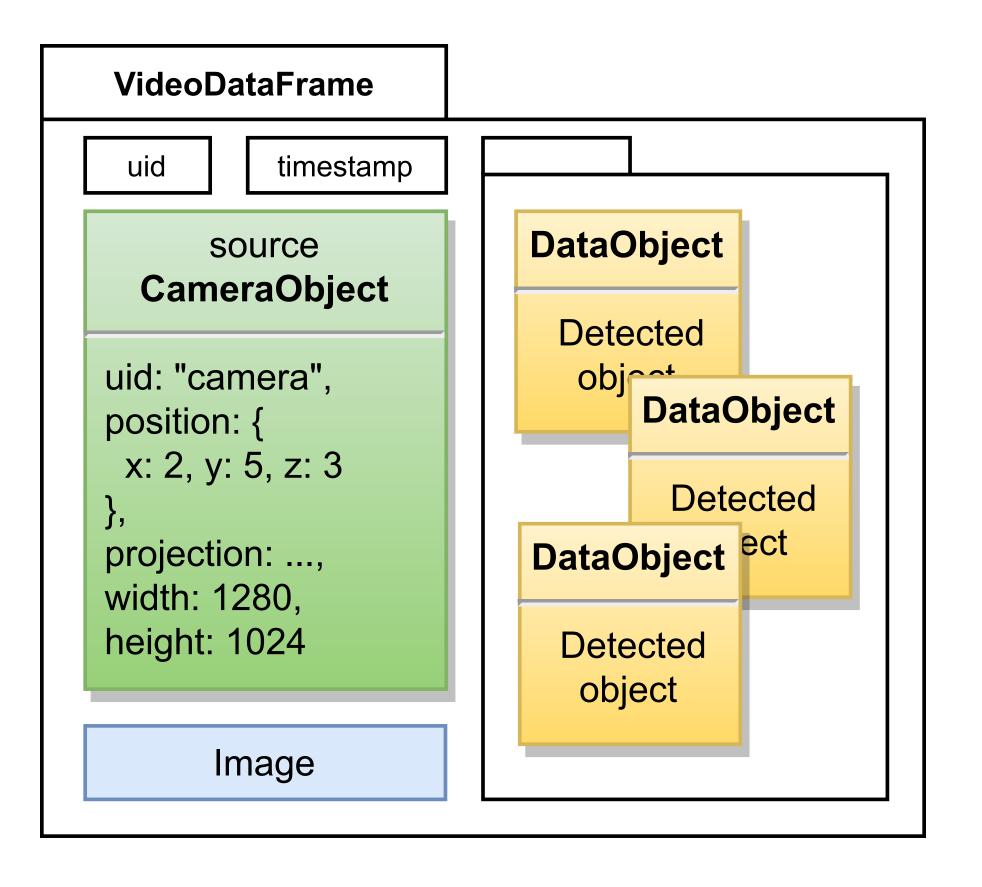
► 2D, 3D, Geographical, ...

Relative

- ► Distance, angle, velocity, ...
- ► Relative to another *object*

DataFrame





SymbolicSpace



An object that semantically defines a space

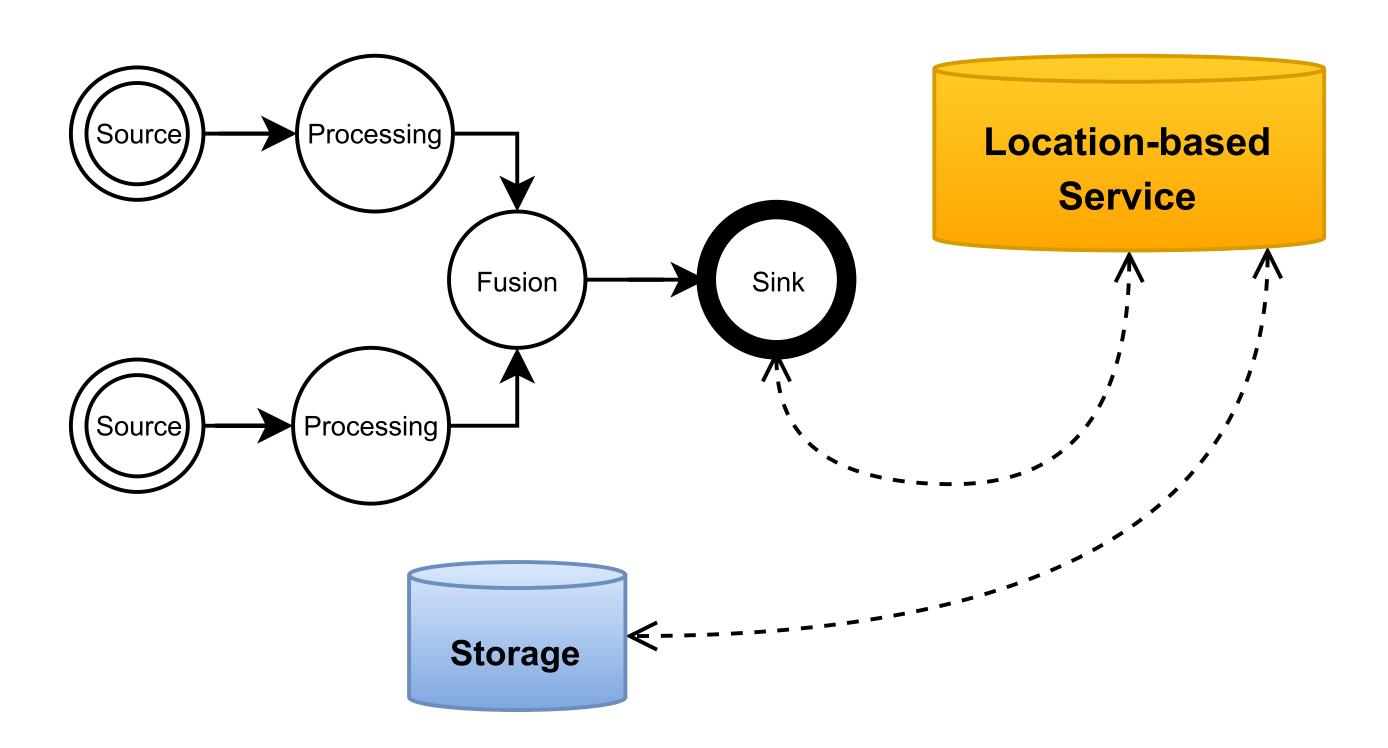
- Spatial hierarchy
- ► Graph connectivity with other spaces
- ► Geocoding
- ► GeoJSON compatibility
- ► Can be used as a location
- ► Can be extended ...



Location-based Service



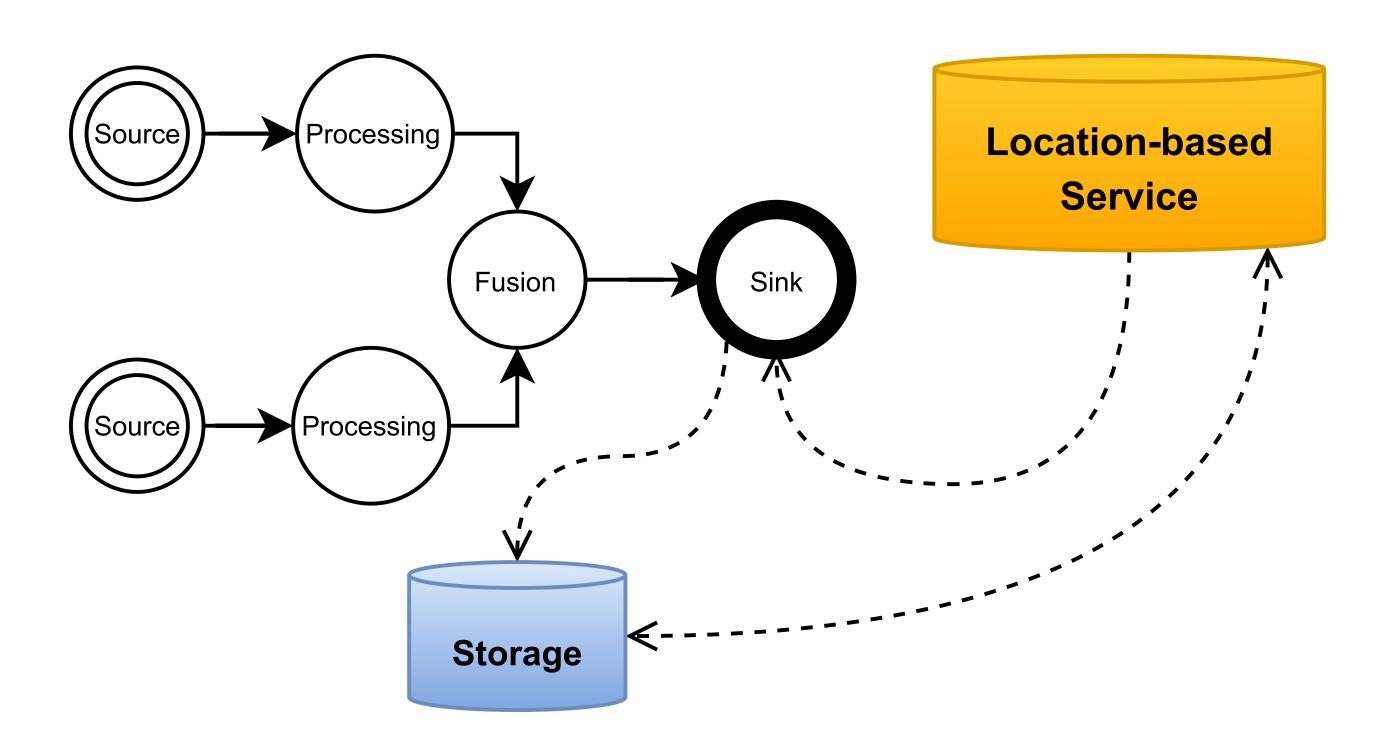
getCurrentPosition("me", ...)



Location-based Service ...



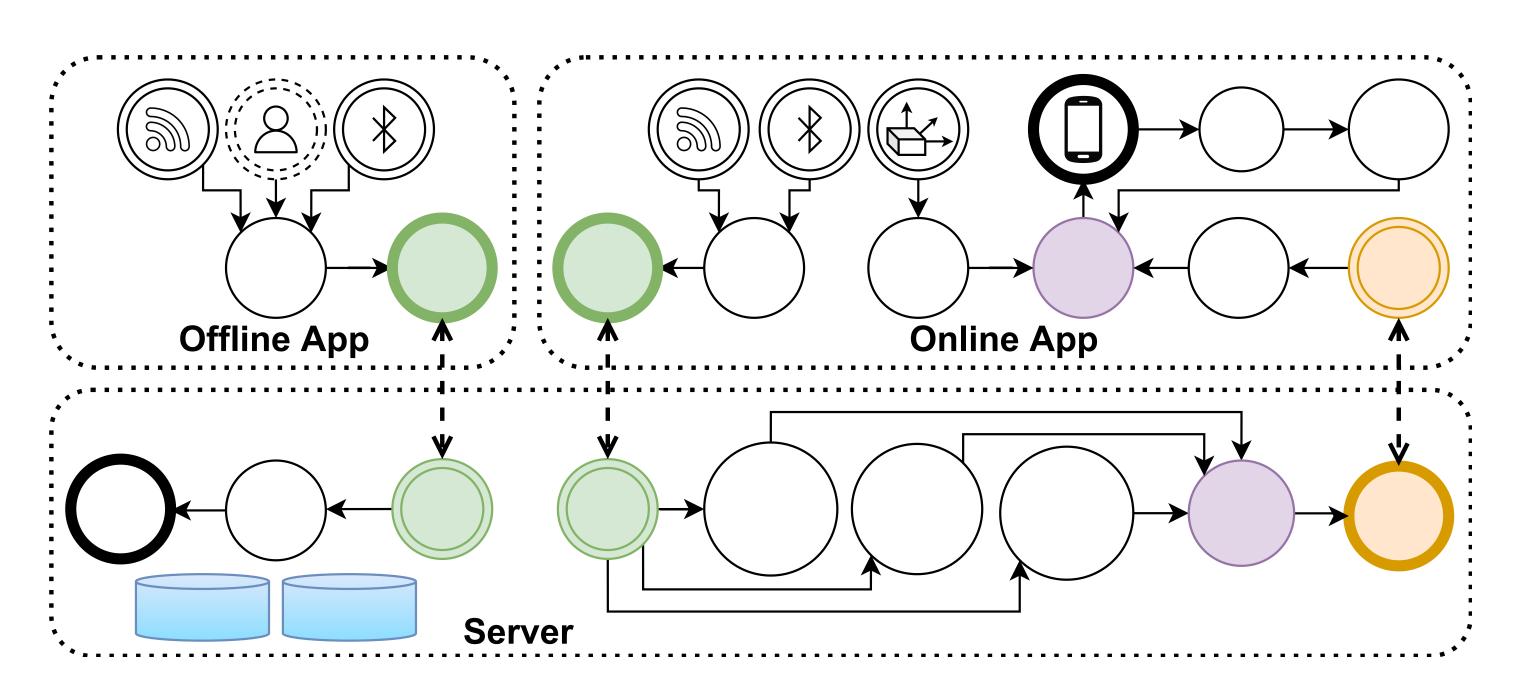
watchPosition("me", ...)



Demonstration

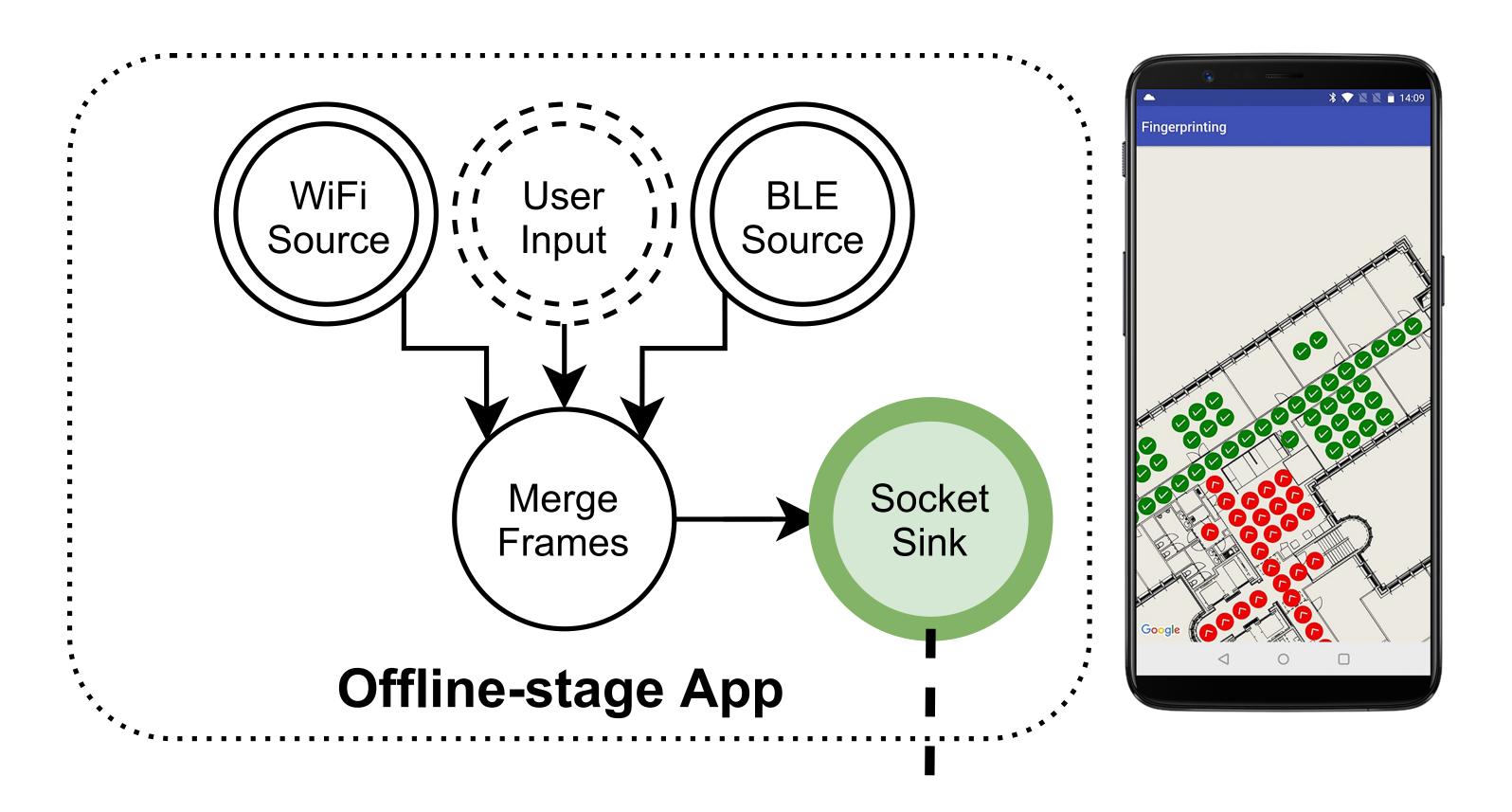


- ► Indoor positioning use case
- ▶ Use existing techniques
- ► Validation of **flexibility** and modularity

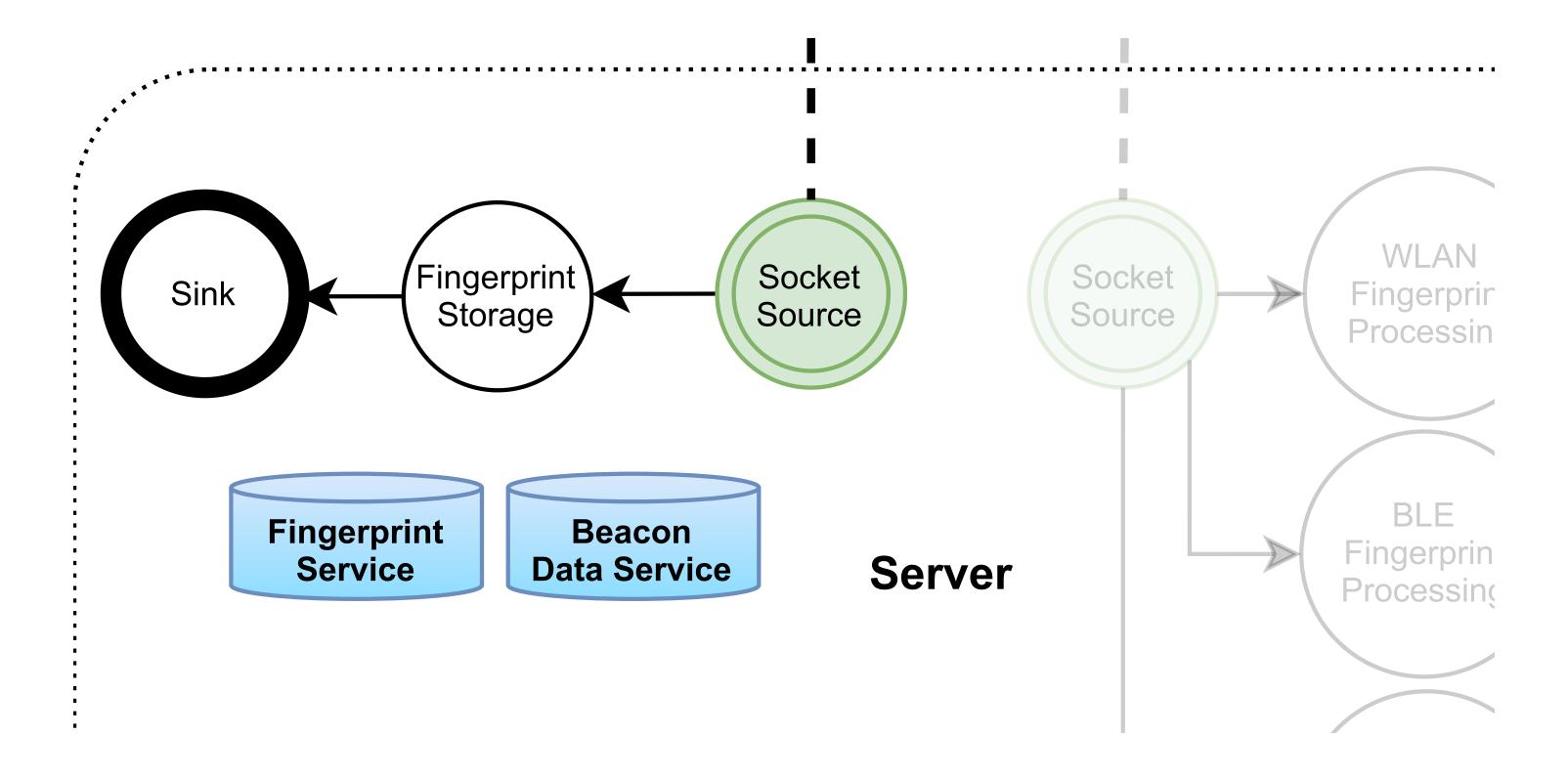


Positioning Model

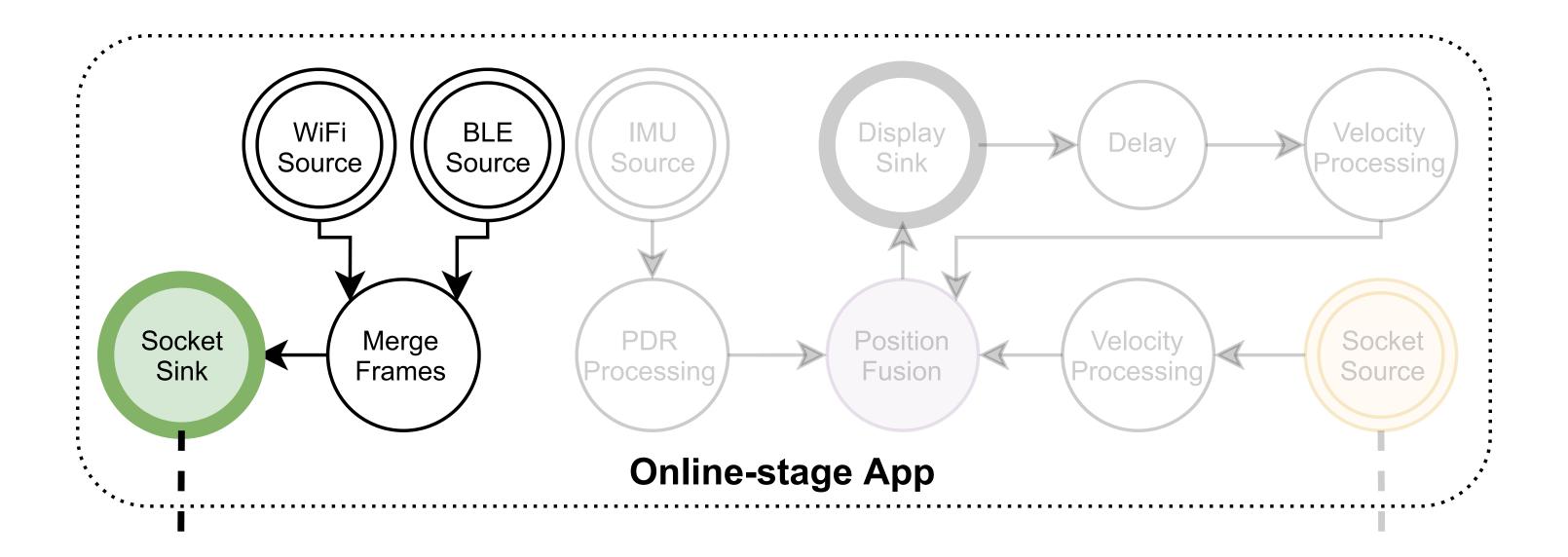




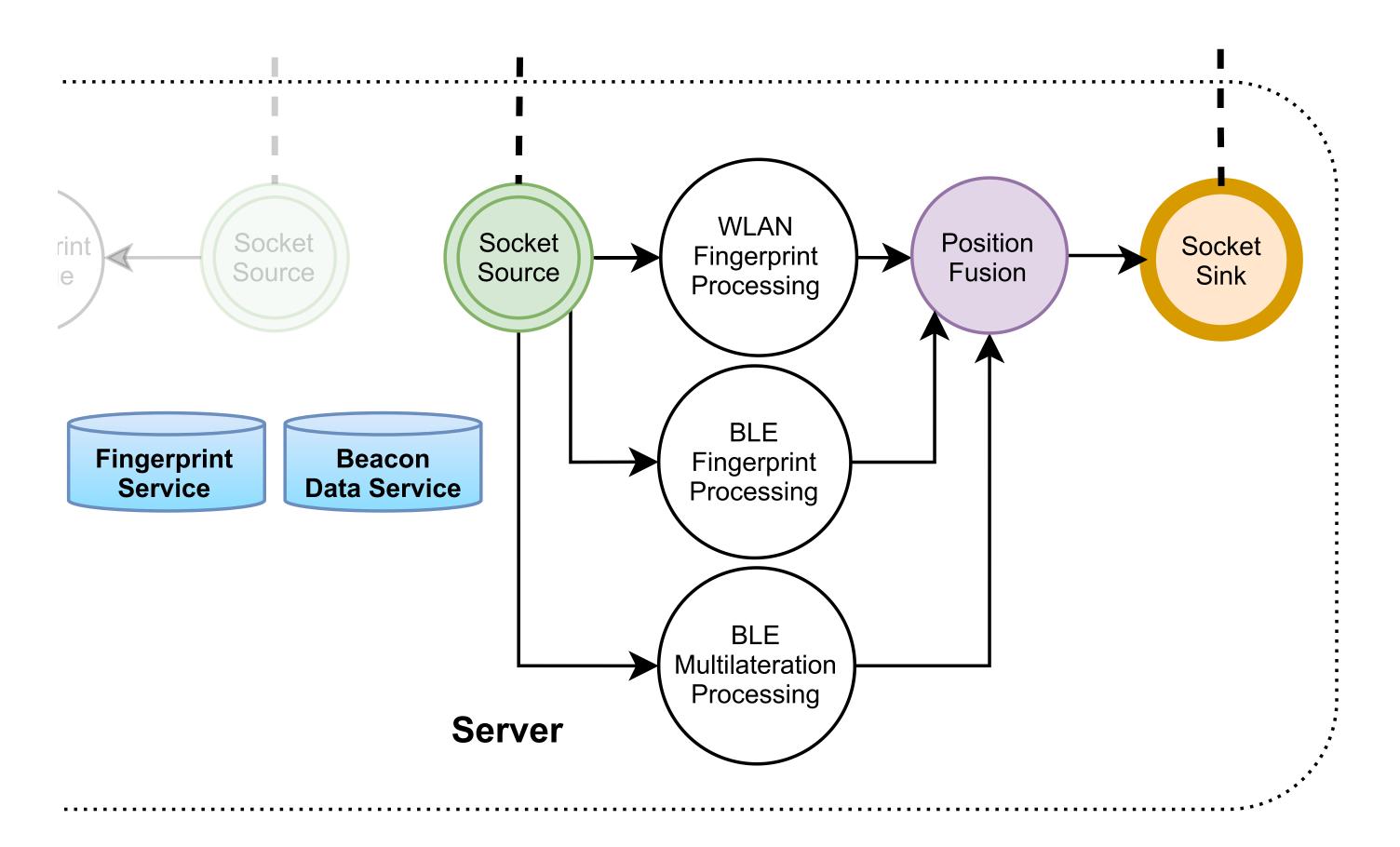




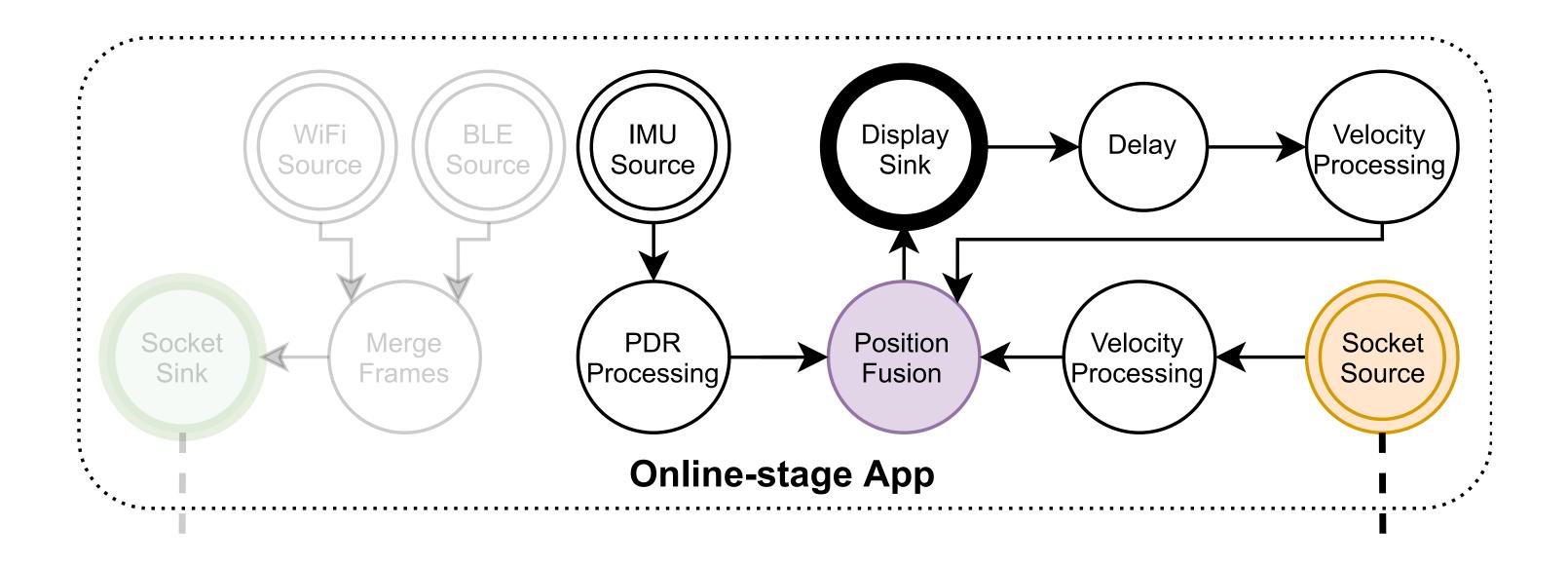






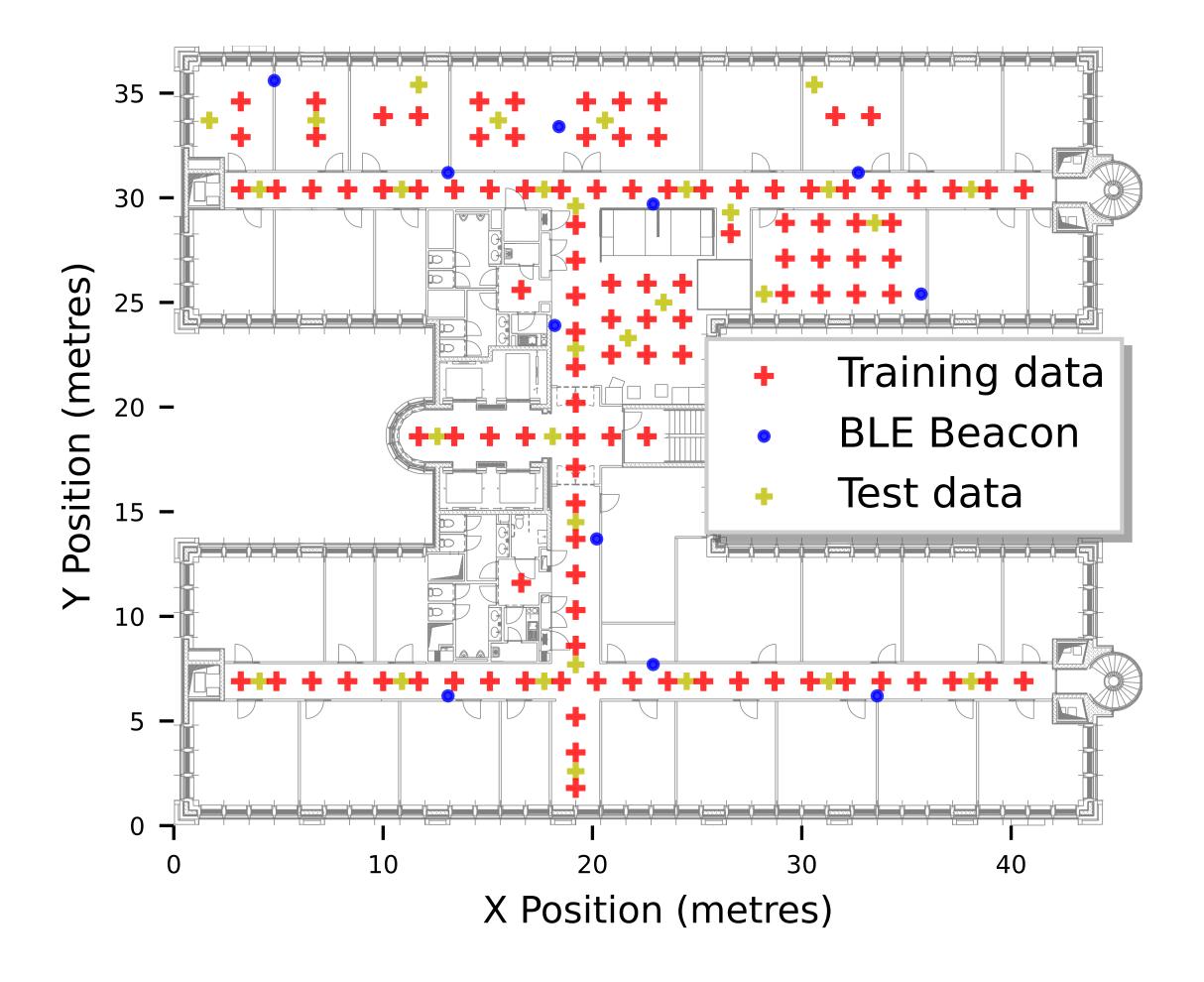






Dataset





Validation Results



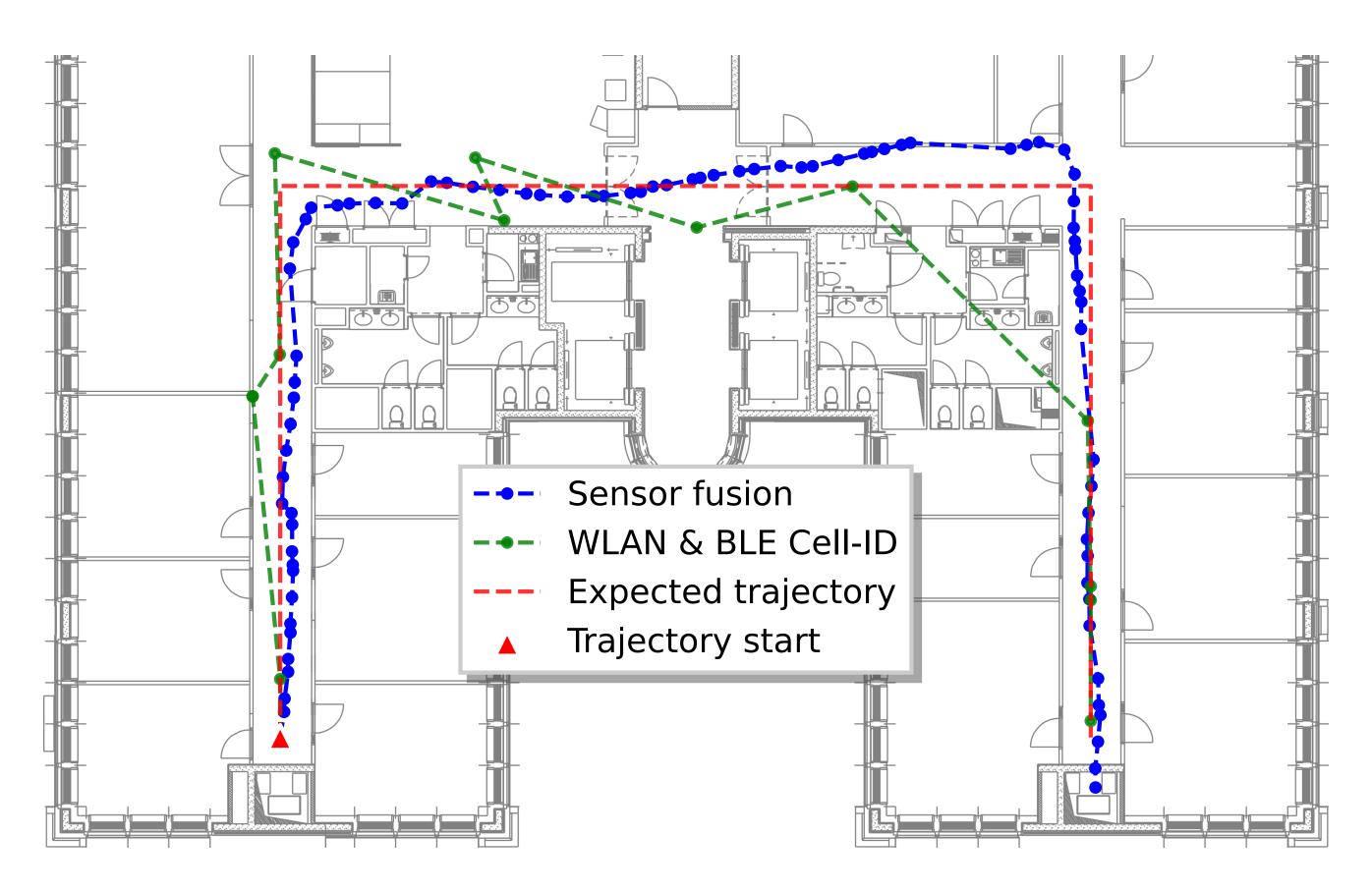
Static Positioning

	WLAN fingerprinting	BLE fingerprinting	BLE multilateration	Fusion
failed points	0	6	12	0
average error	1.23 m	3.23 m	4.92 m	1.37 m
minimum error	0.01 m	0.17 m	0.74 m	0.01 m
maximum error	4.77 m	15.39 m	19.26 m	9.75 m
hit rate	95.82 %	80.83 %	52.50 %	96.67 %

Validation Results ...



Trajectories



Validation Results ...



Trajectories

	WLAN + BLE	WLAN + BLE + IMU
average error	3.28 m	1.26 m
maximum error	9.60 m	3.10 m
average update frequency	3.04 s	0.52 s

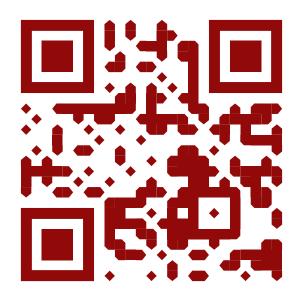


Sensor fusion
WLAN & BLE Cell-ID
Expected trajectory
Trajectory start

Contributions and Conclusions



- OpenHPS: open source framework for hybrid positioning
 - Aimed towards developers and researchers
- ► **Abstractions** such as location-based services and spaces
- ► Validation of an indoor positioning use case
- ► Configurable and interchangeable **nodes** and **services**
- ► Public dataset with multiple orientations



Visit https://openhps.org for additional resources, documentation, source code and more!