Indoor Positioning Using the OpenHPS Framework

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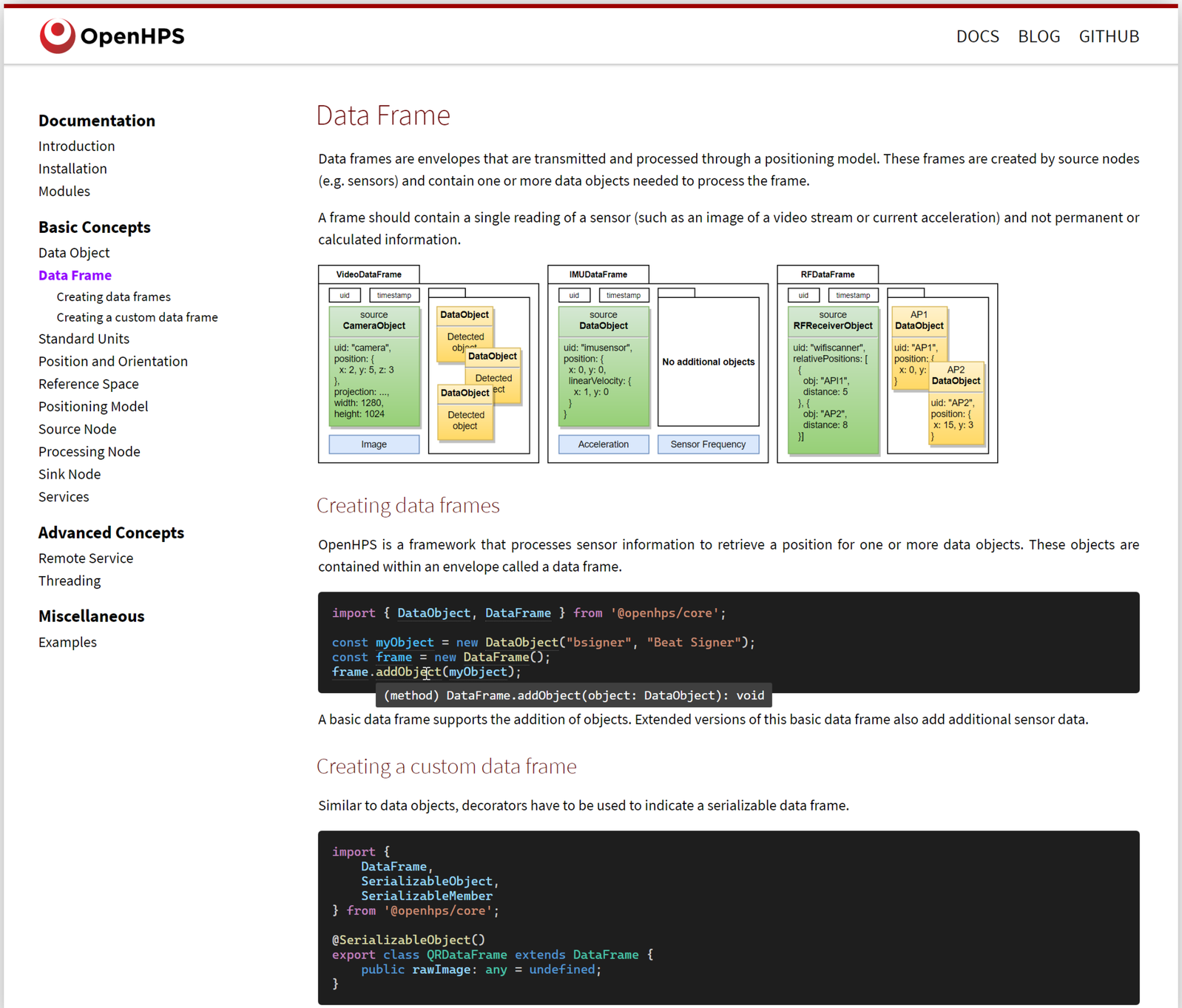
What is OpenHPS?

An Open Source Hybrid Positioning System



What is OpenHPS?

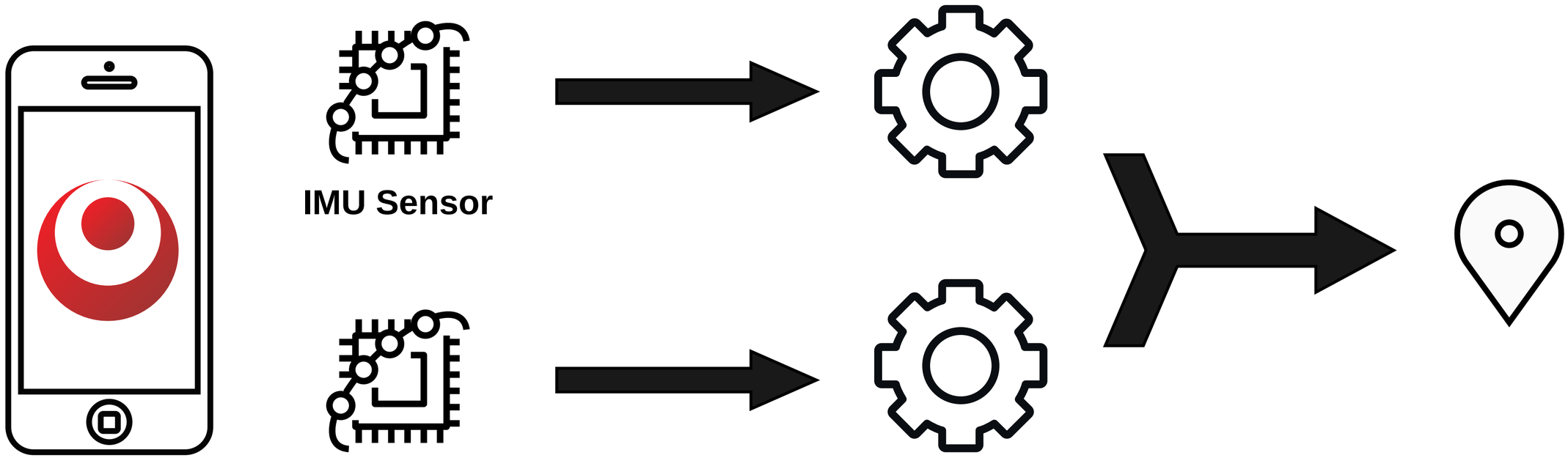
OpenHPS

An Open Source Hybrid Positioning System

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

Process Network Design

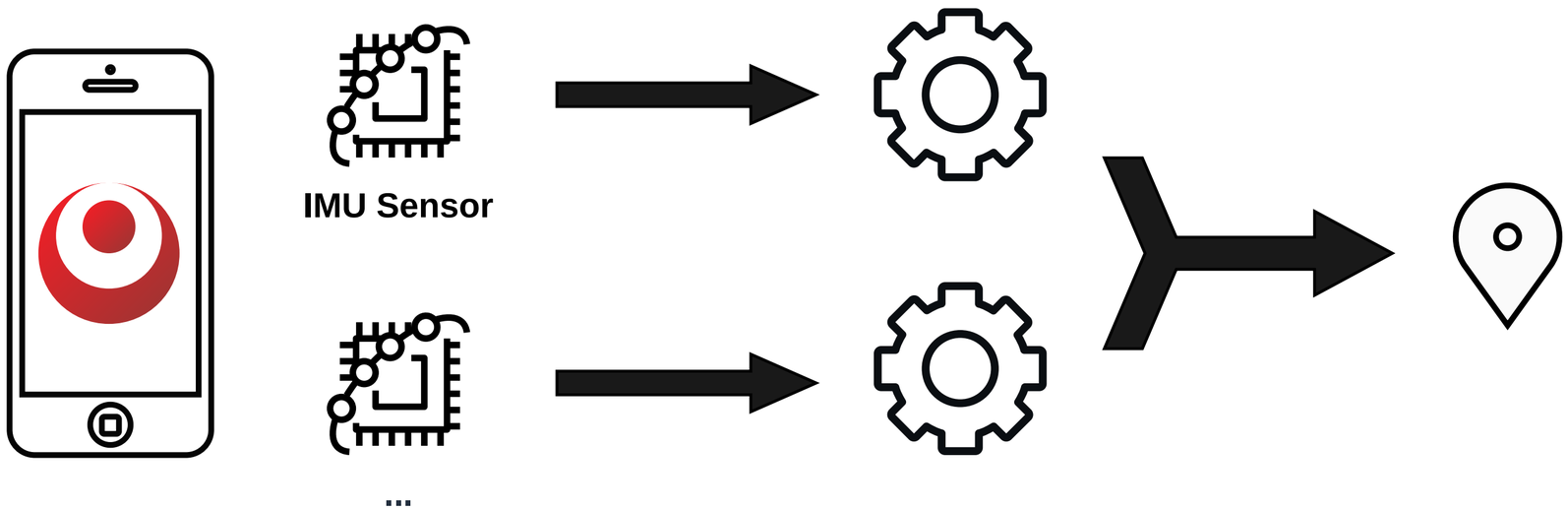
OpenHPS

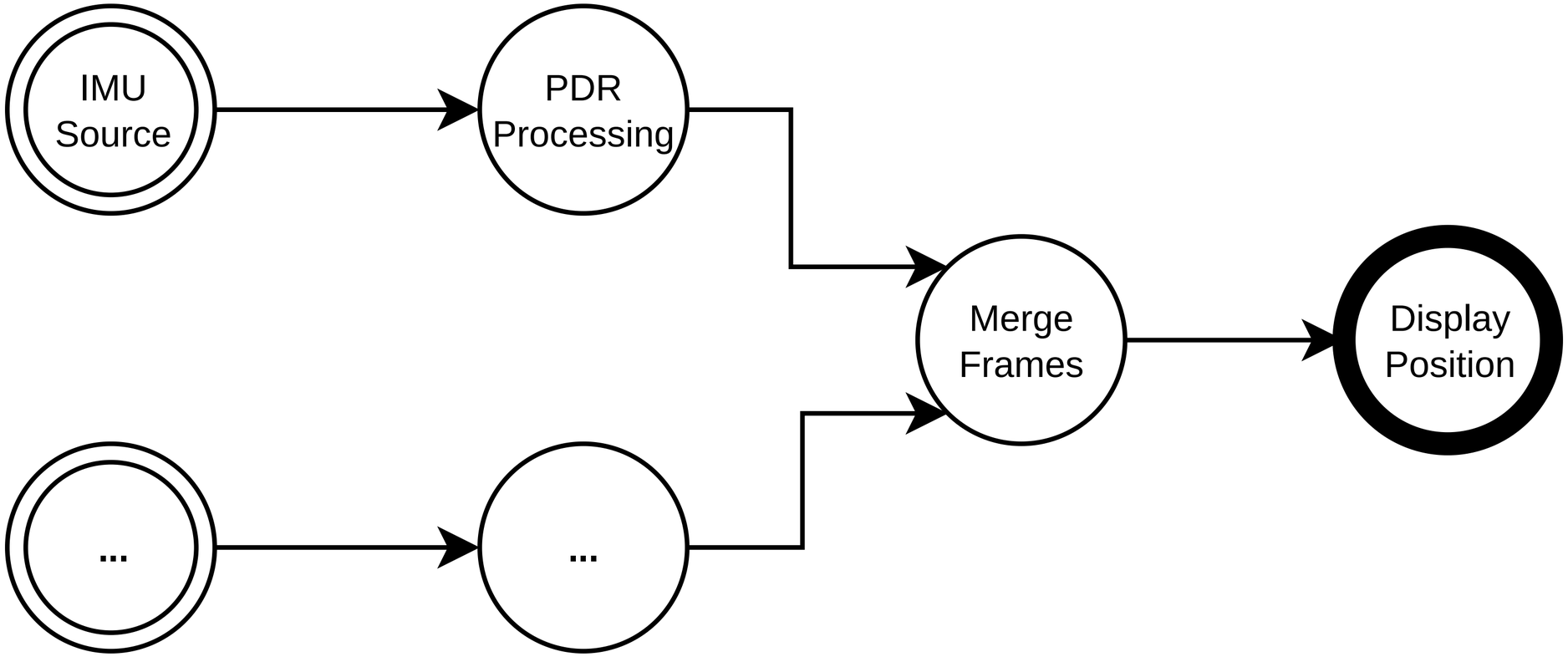


...

Process Network Design ...

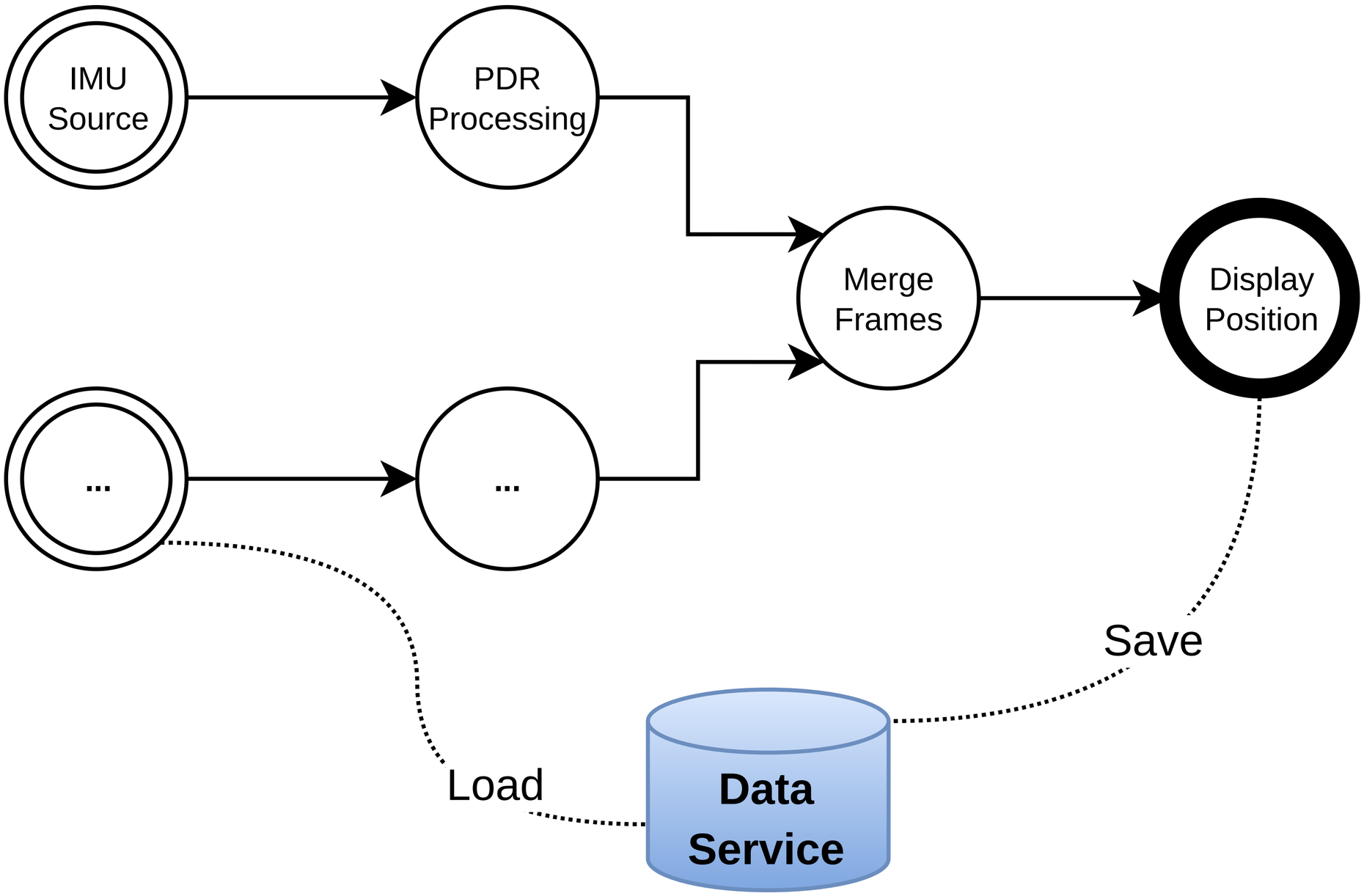
OpenHPS





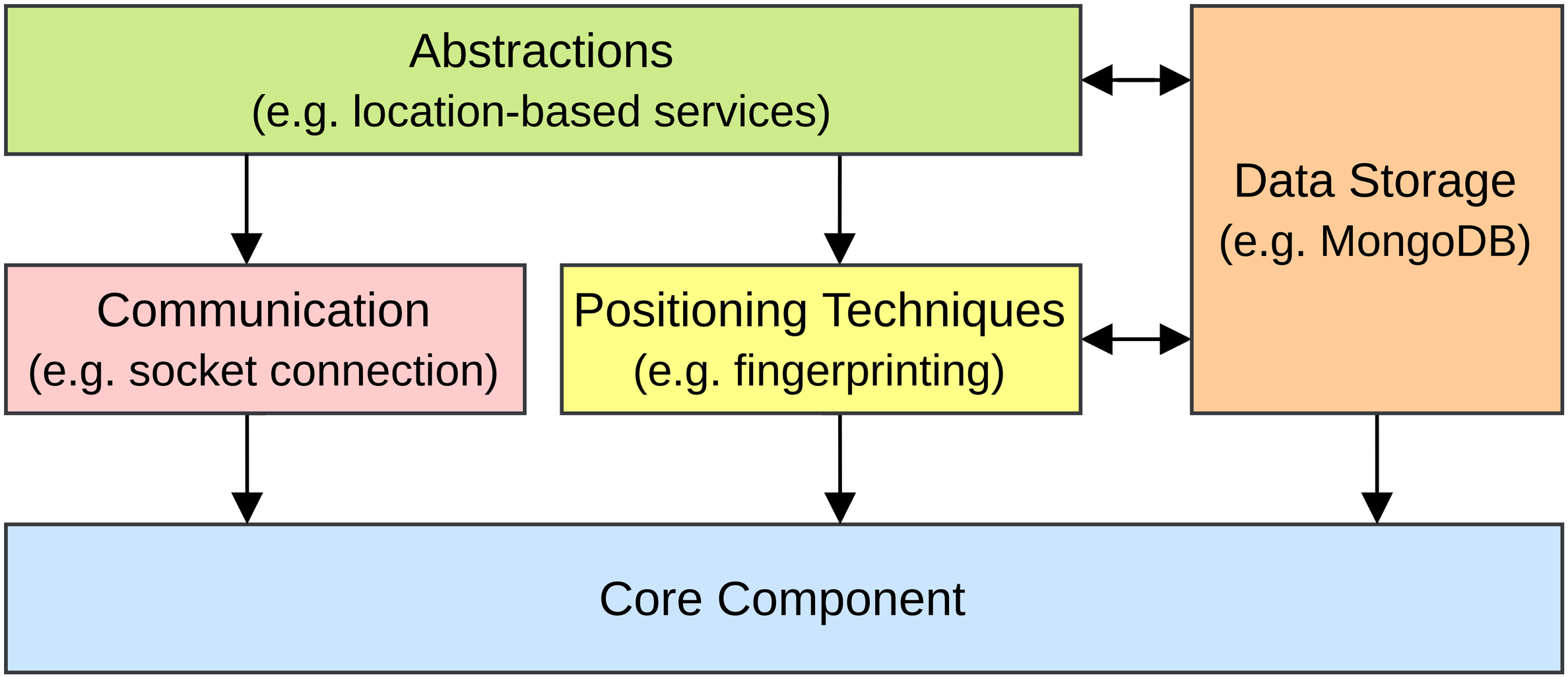
Process Network Design ...

OpenHPS



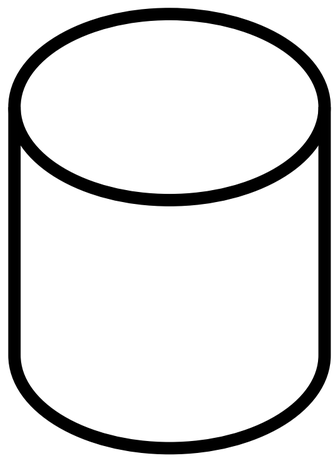
Modularity

OpenHPS

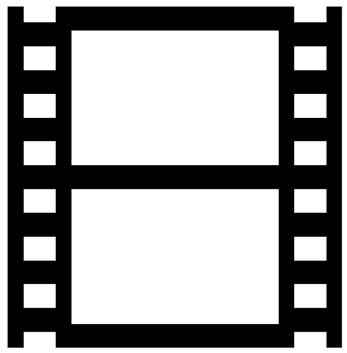


Data Processing

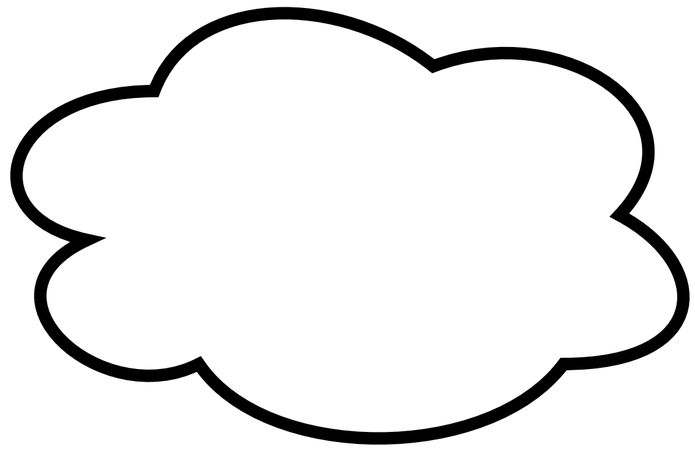
OpenHPS



Knowledge



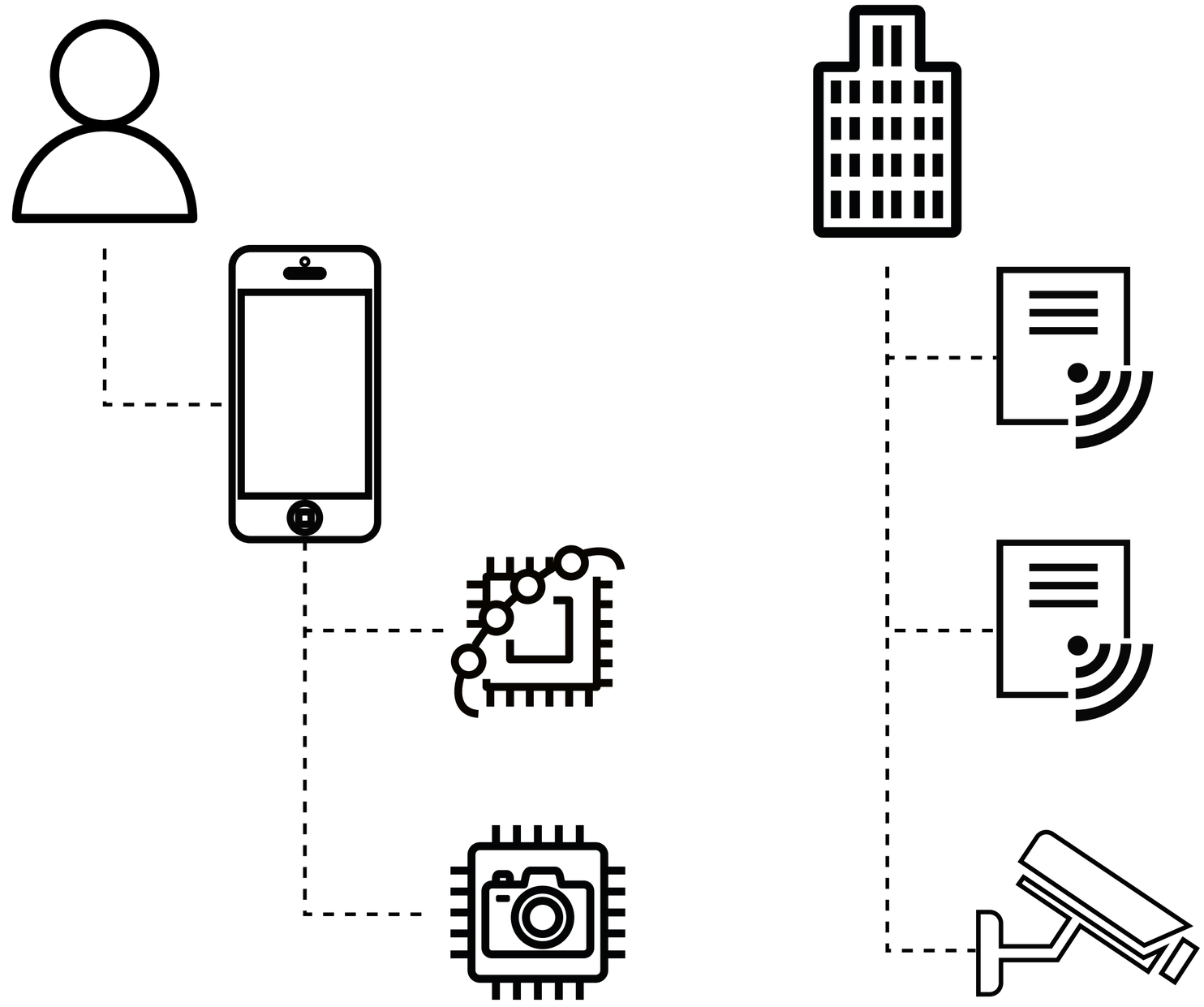
Raw Data



Processed Data

DataObject

OpenHPS



Absolute and Relative Positions

OpenHPS

Absolute

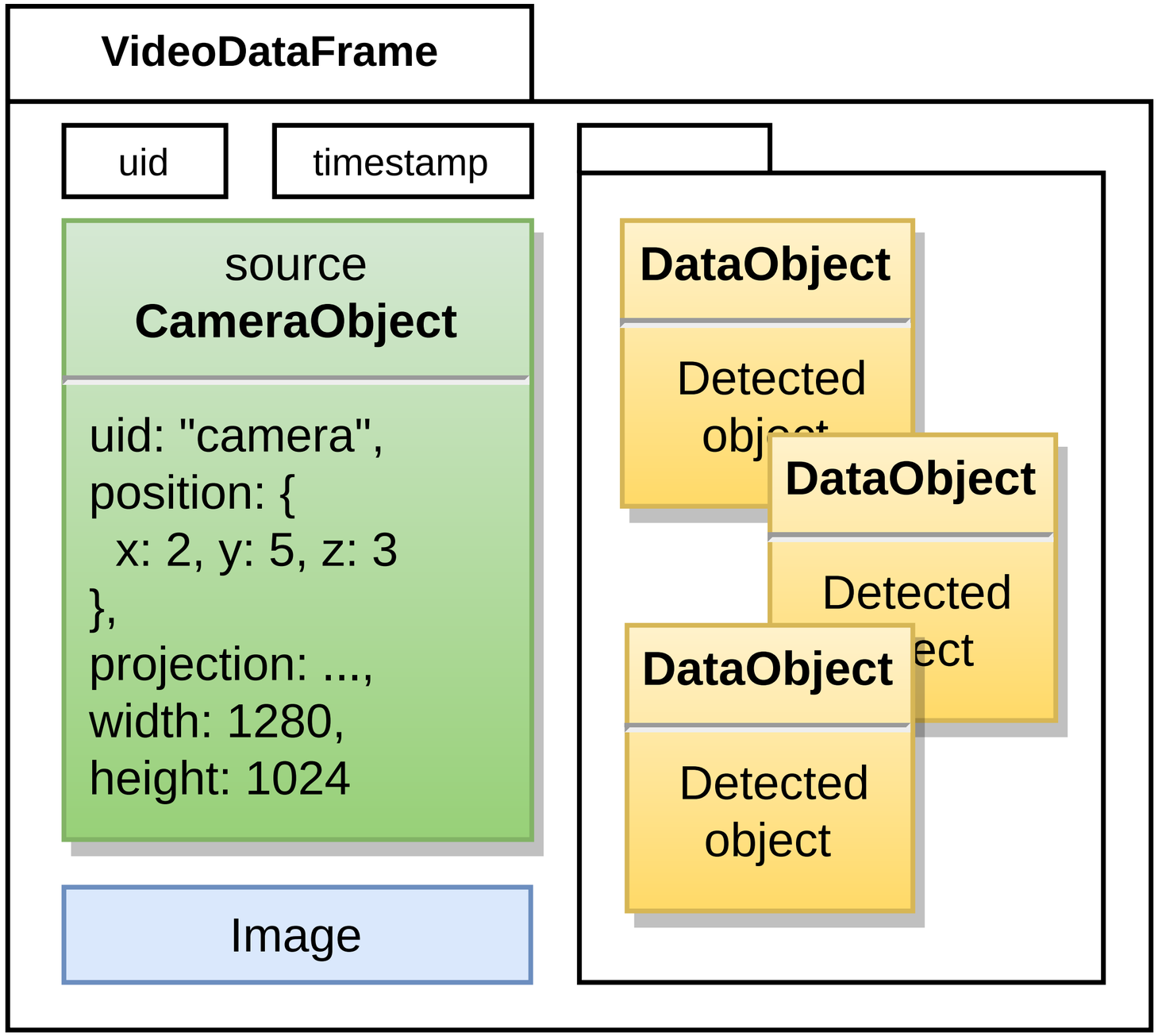
- 2D, 3D, Geographical, ...

Relative

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

DataFrame

OpenHPS



SymbolicSpace

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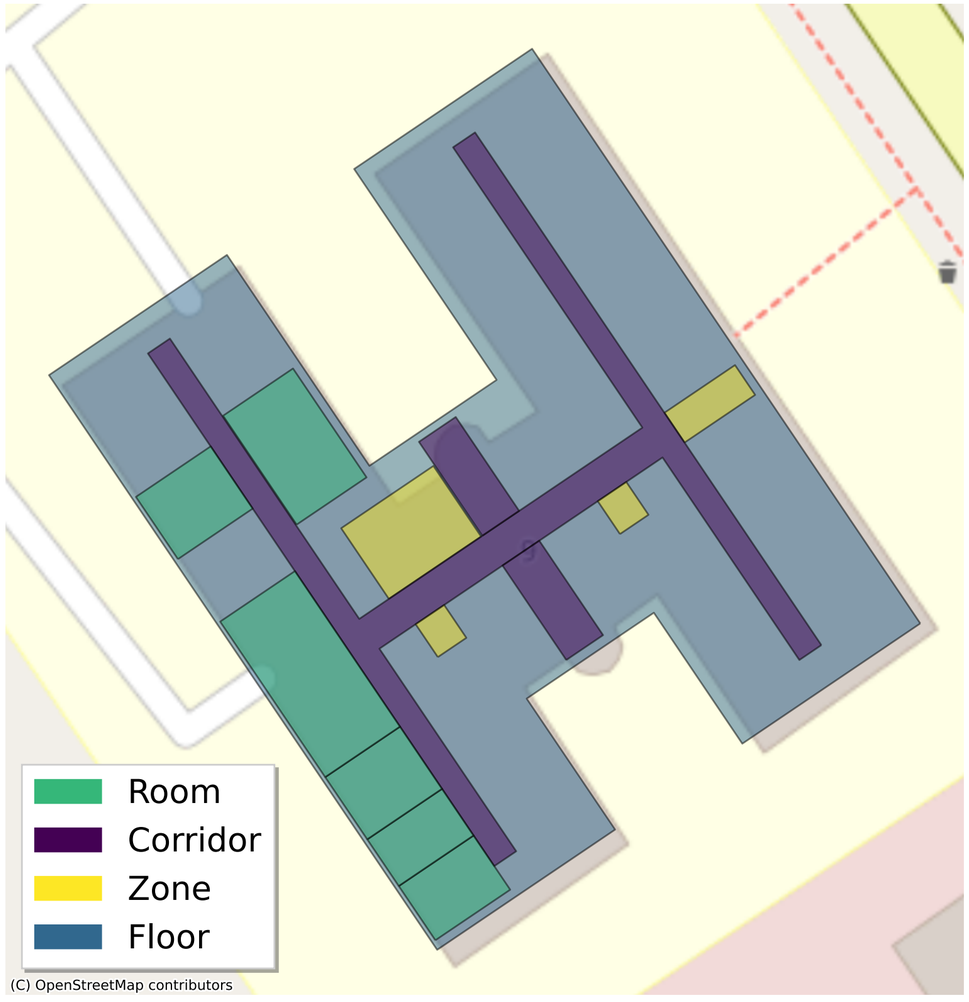
An object that semantically defines a space

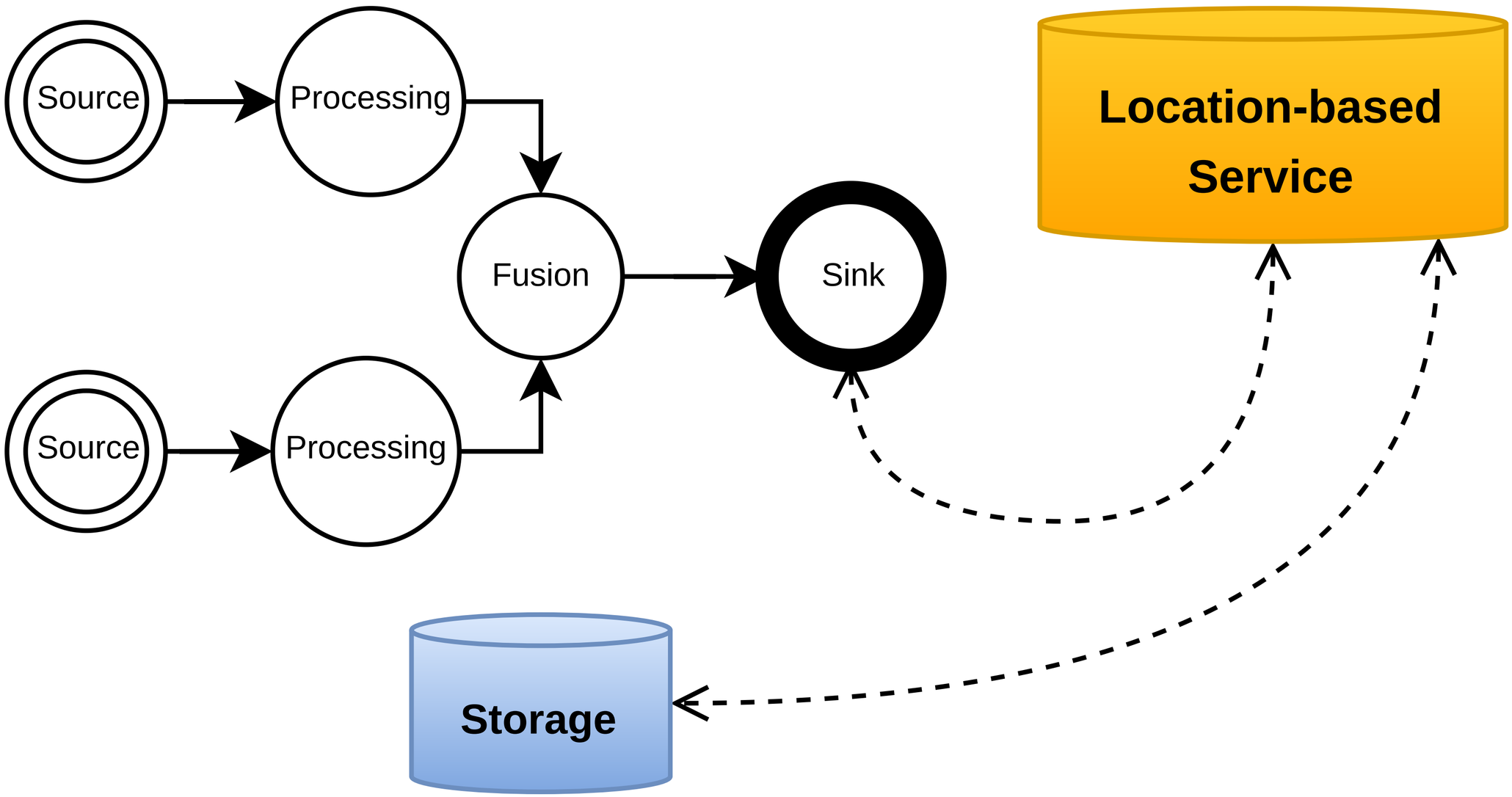
- Spatial hierarchy
- Graph connectivity with other spaces
- Geocoding
- GeoJSON compatibility
- Can be used as a location
- Can be extended ...



Location-based Service

OpenHPS

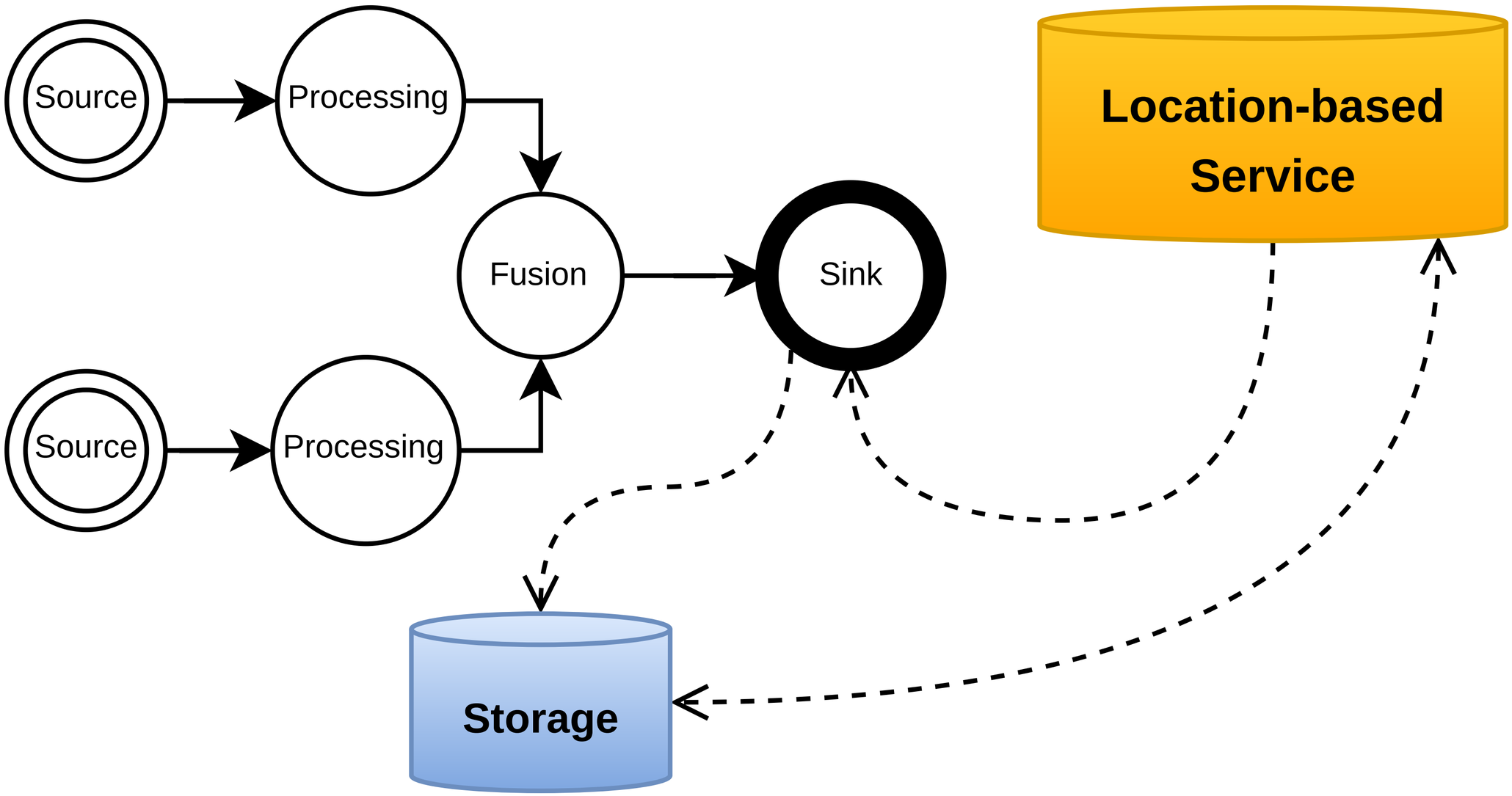
```
getCurrentPosition("me", ...)
```



Location-based Service ...

OpenHPS

```
watchPosition("me", ...)
```



Demonstration

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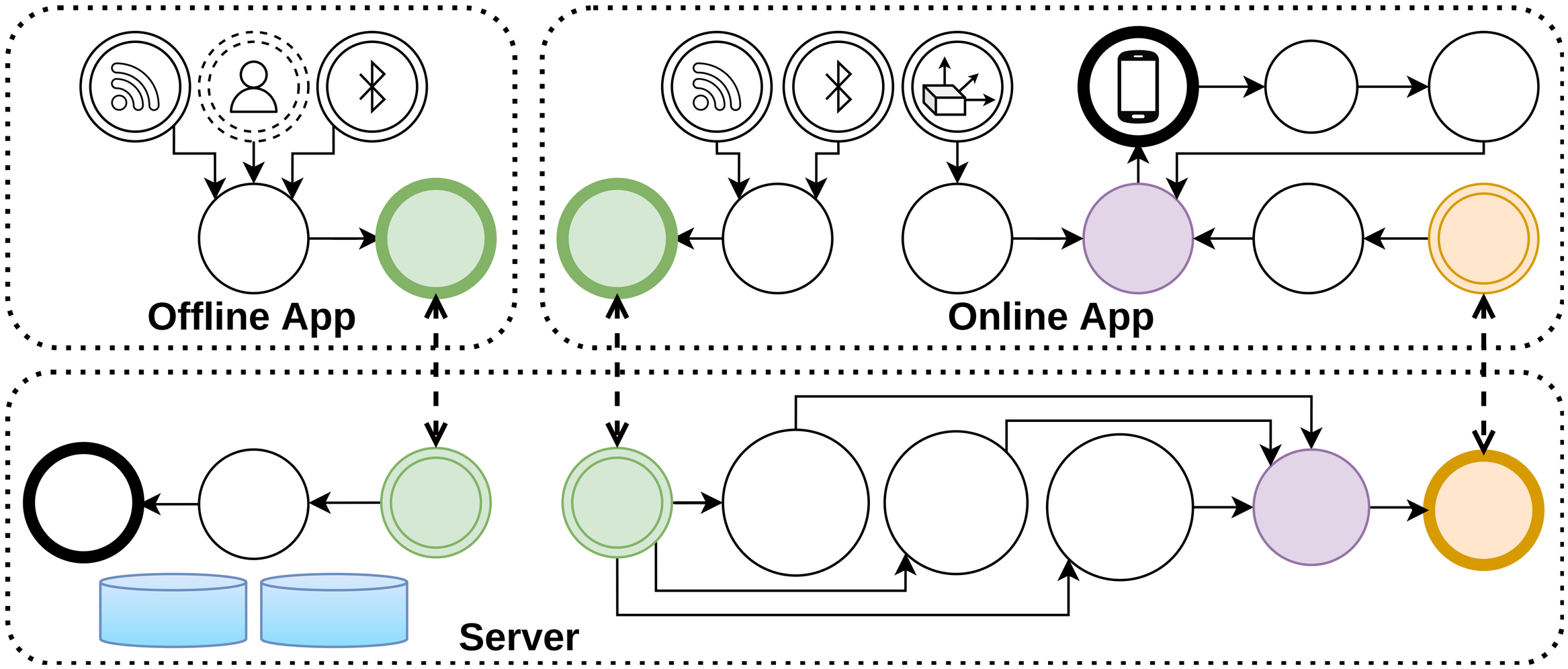
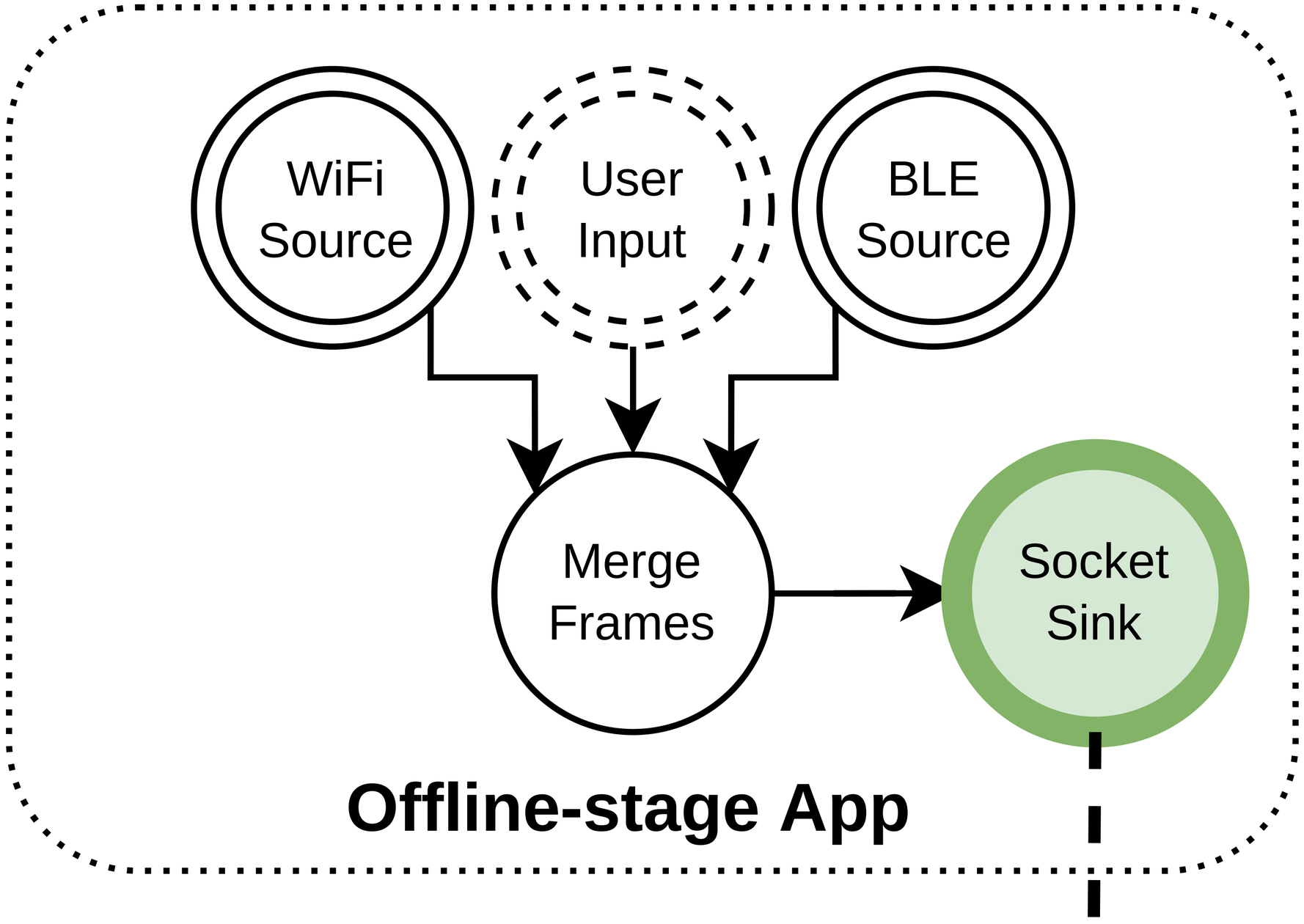
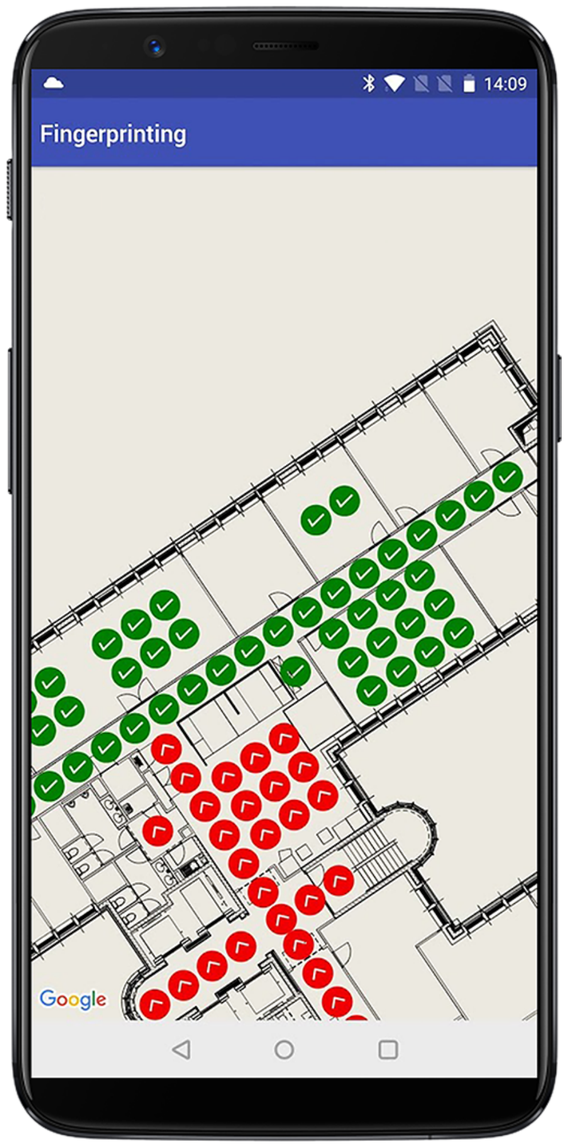
- Indoor positioning **use case**
- Use **existing techniques**
- Validation of **flexibility** and modularity



Positioning Model

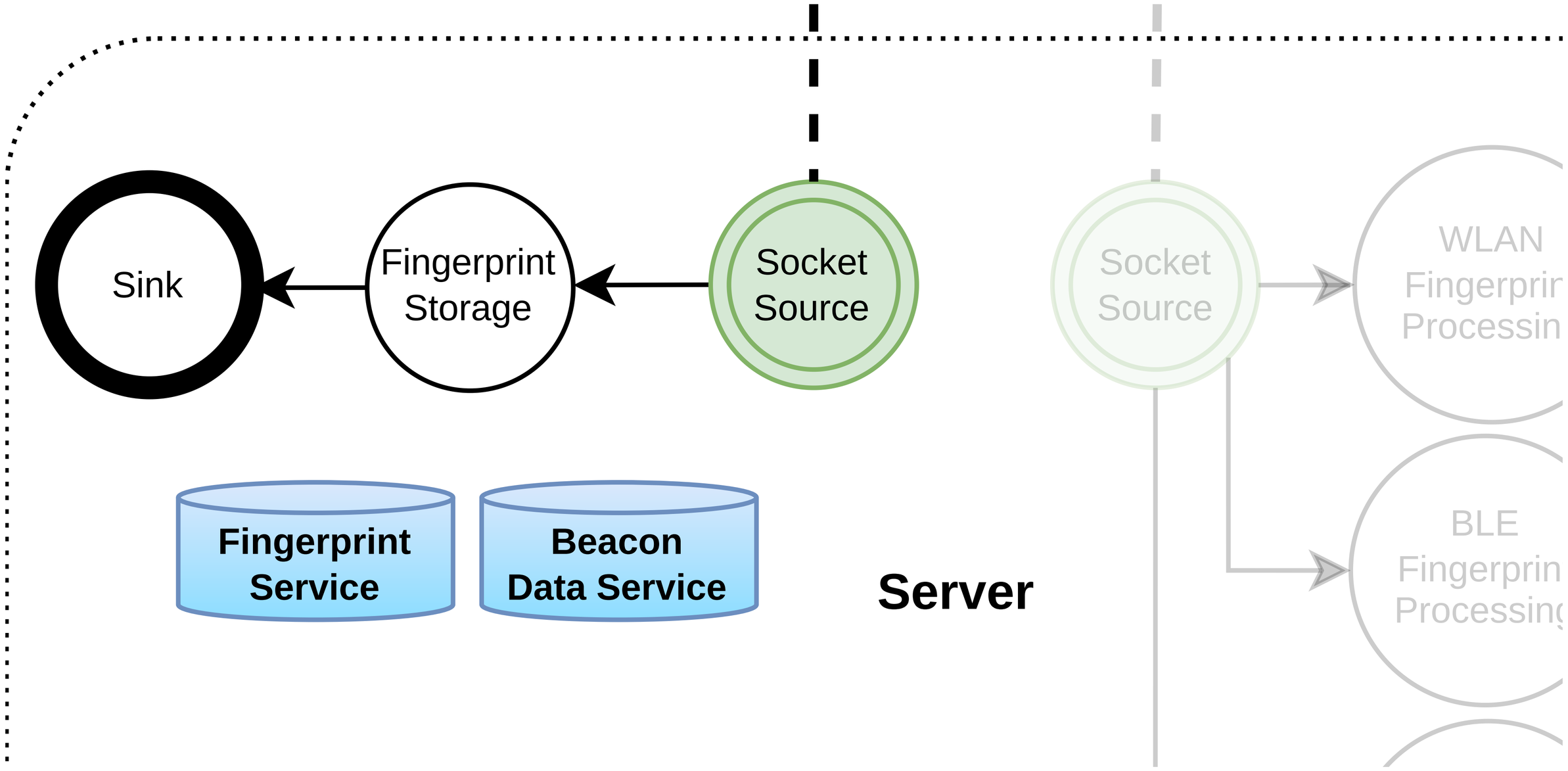
OpenHPS





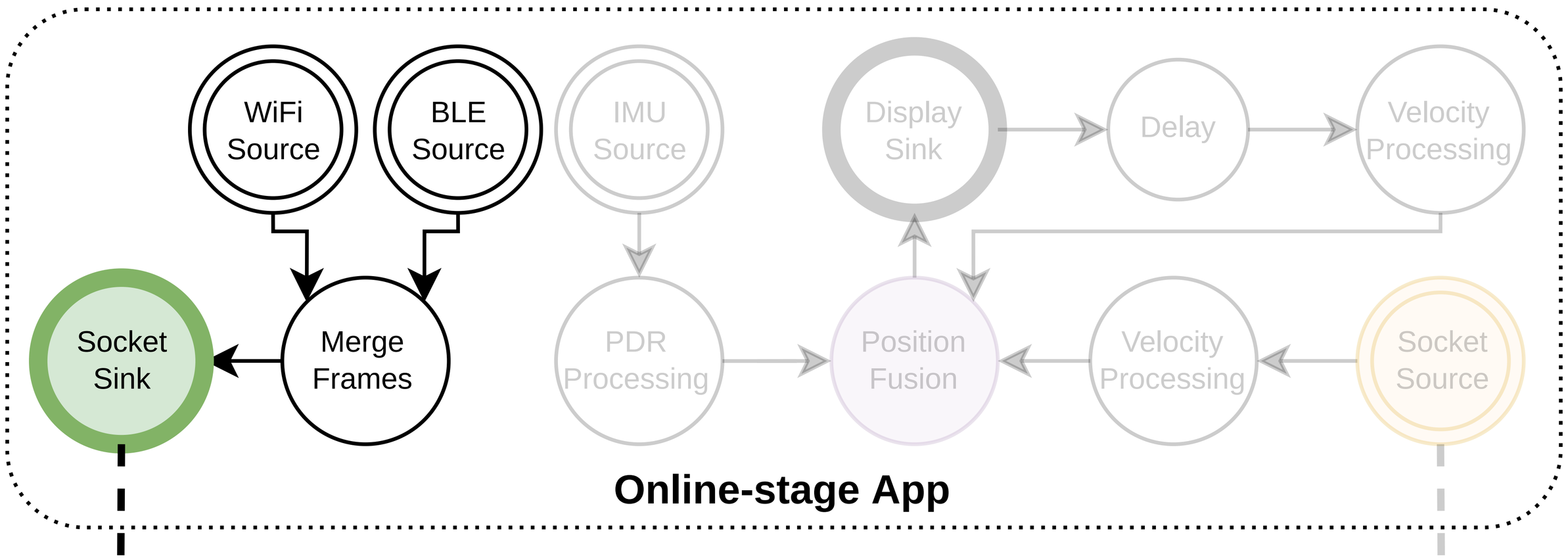
Positioning Model ...

OpenHPS



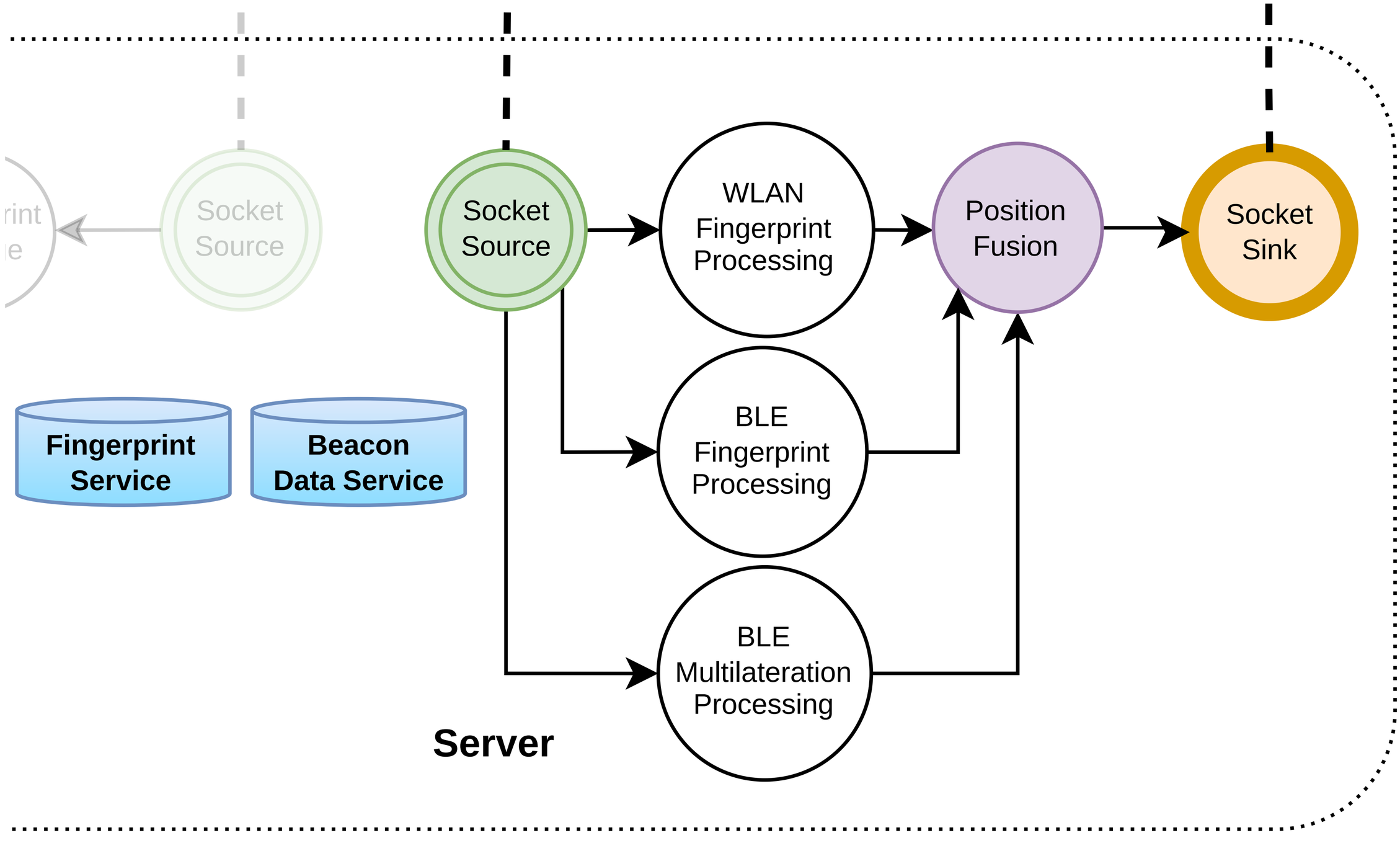
Positioning Model ...

OpenHPS



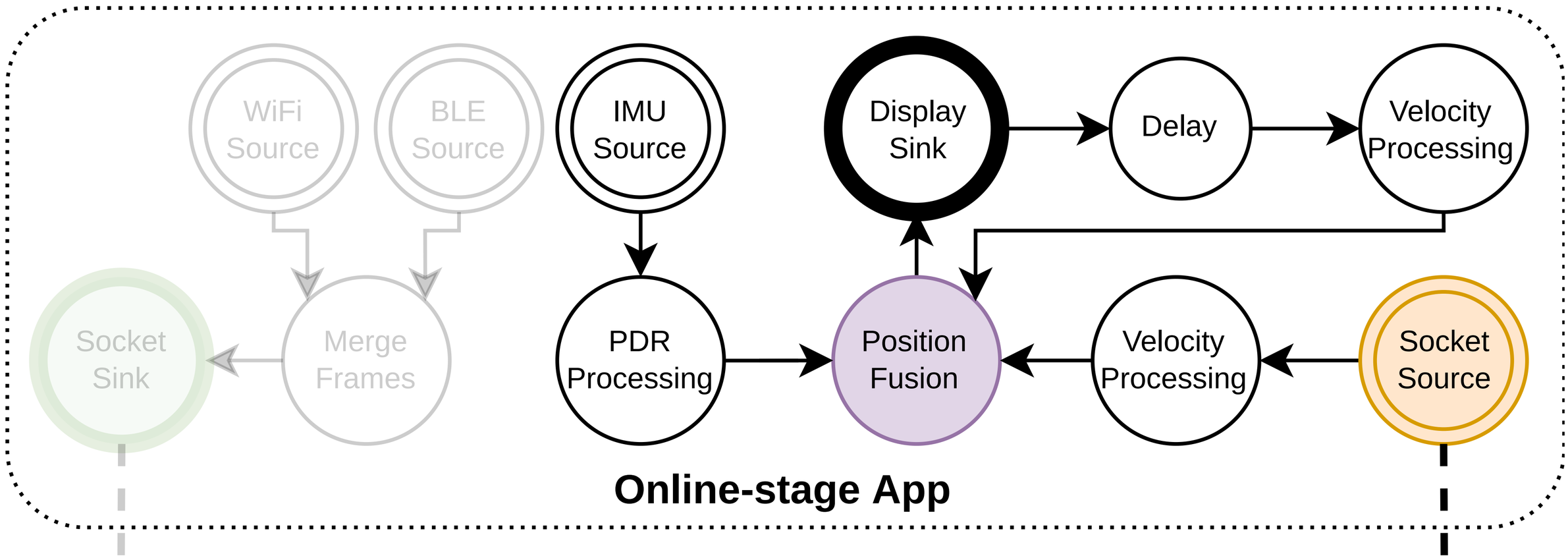
Positioning Model ...

OpenHPS



Positioning Model ...

OpenHPS



Dataset

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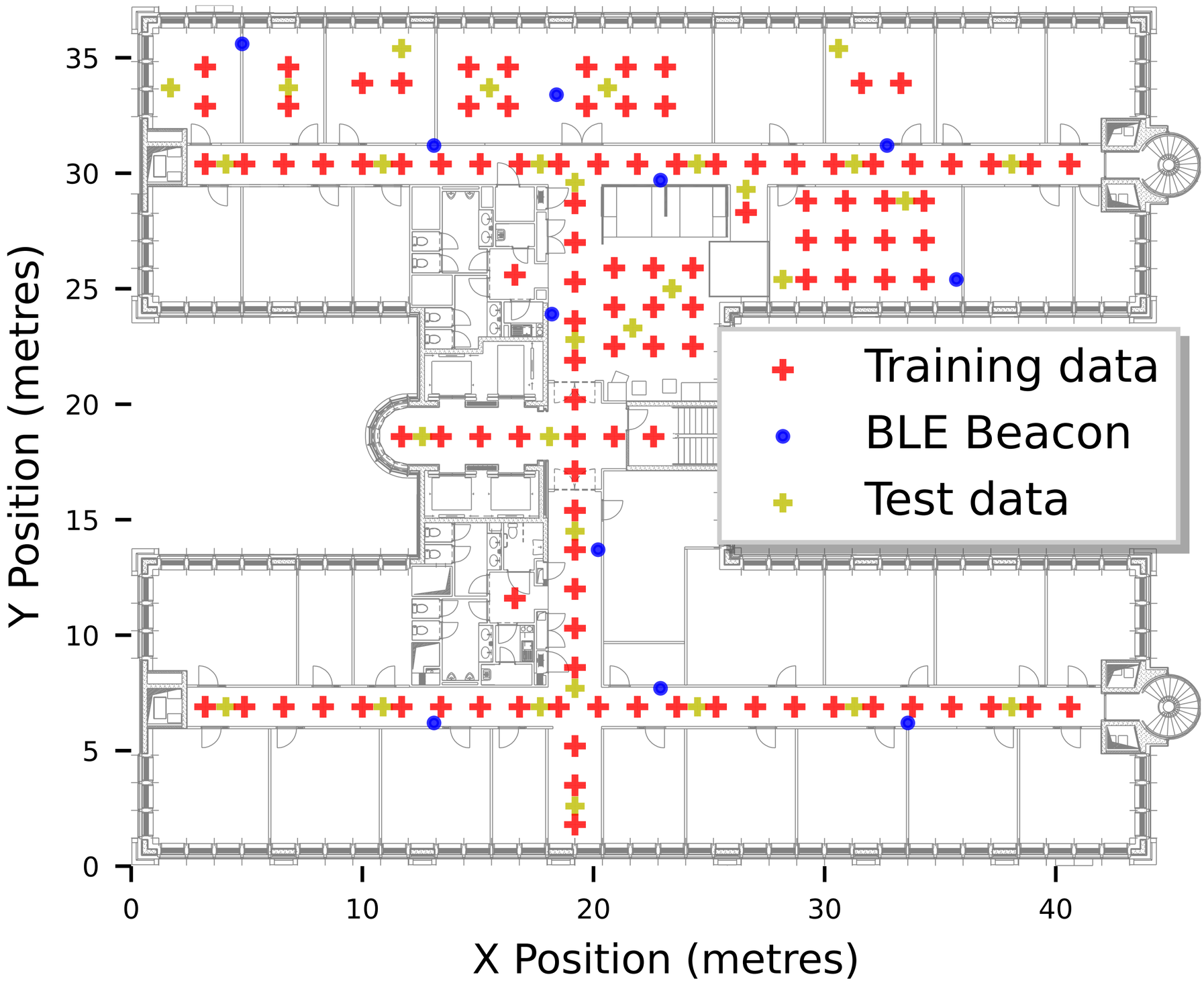


Validation Results

OpenHPS

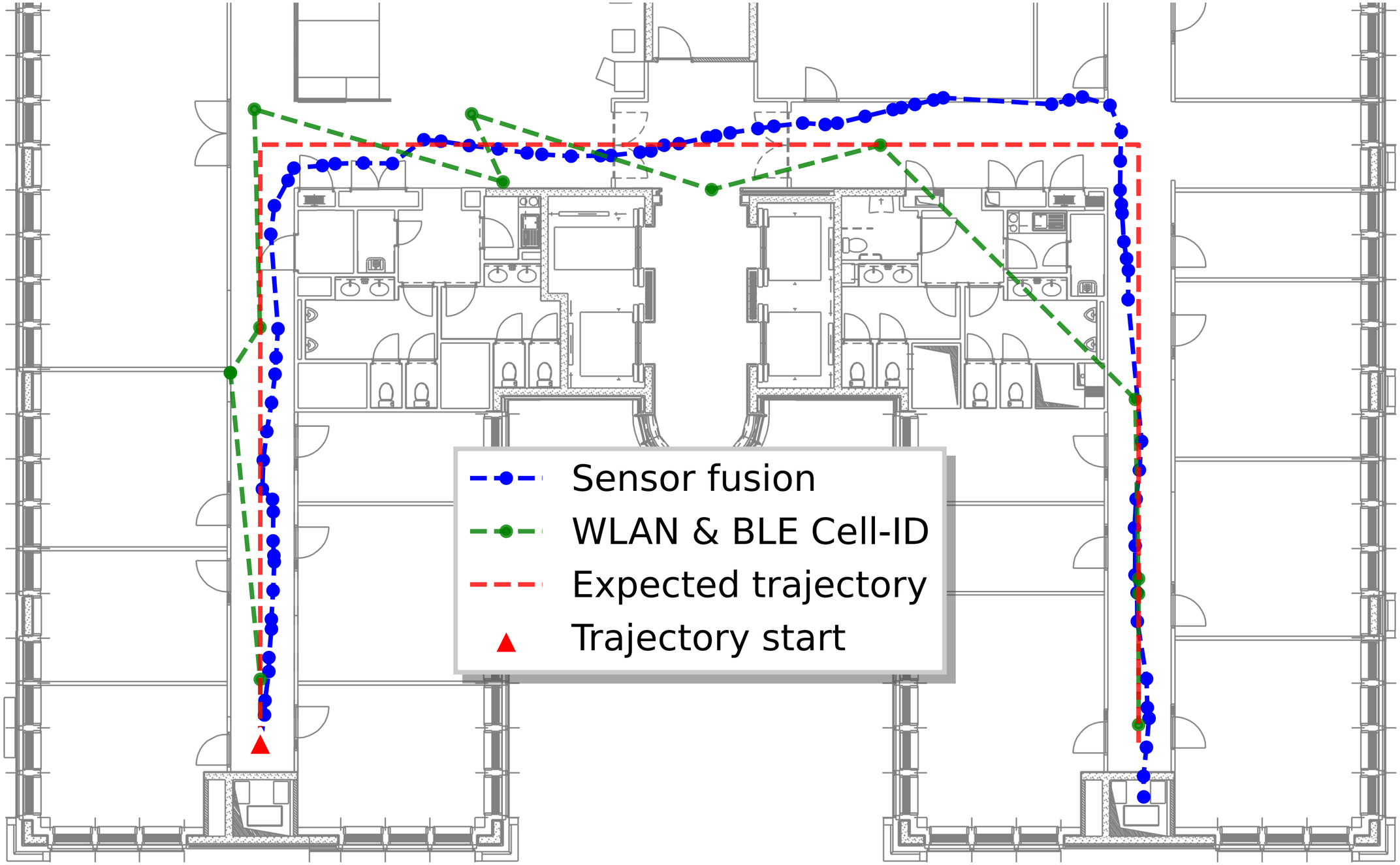
Static Positioning

	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 ...

OpenHPS

Trajectories

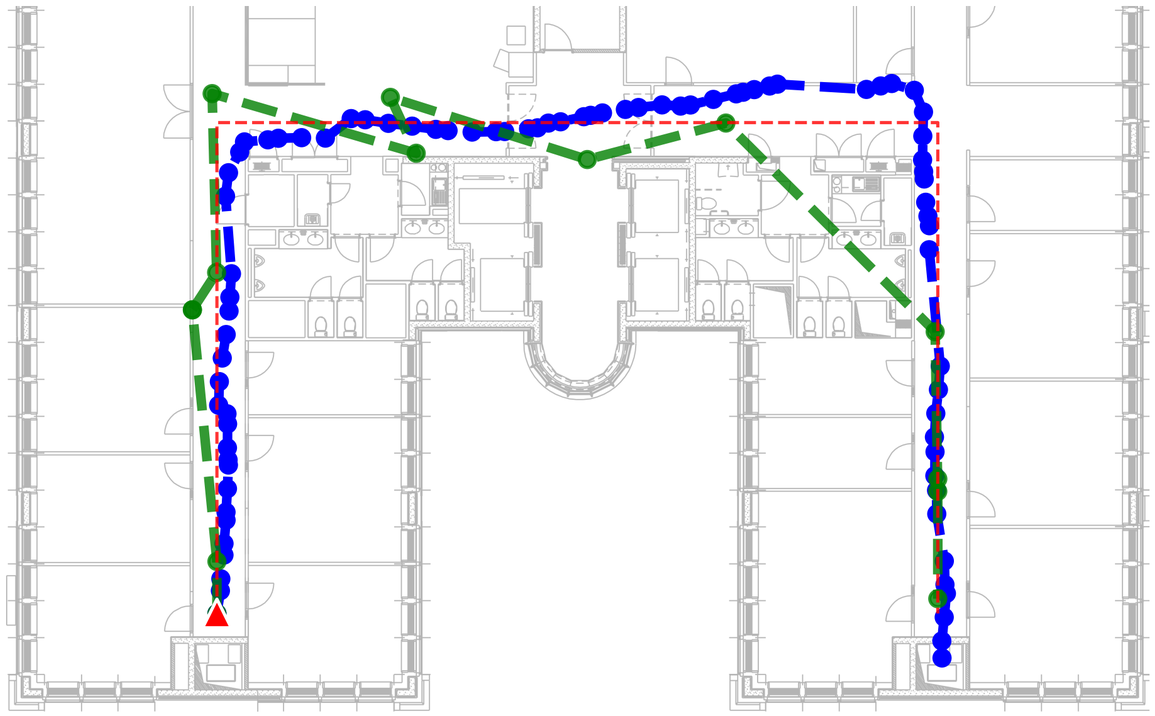


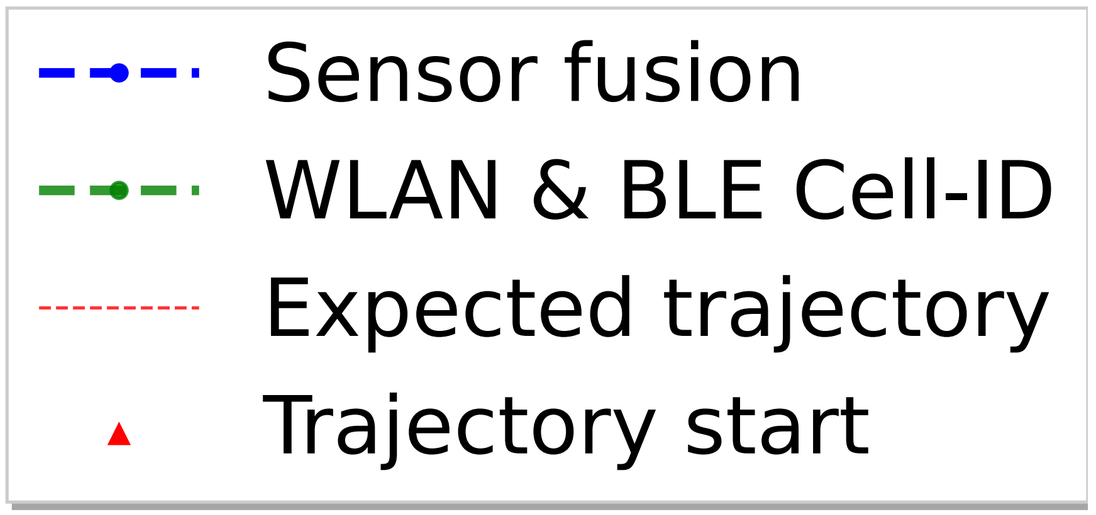
Validation Results ...

OpenHPS

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





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!