Indoor Positioning Using the OpenHPS Framework

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OpenHPS

What is OpenHPS?

OpenHPS

An Open Source Hybrid Positioning System

OpenHPS DOCS BLOG GITHUB

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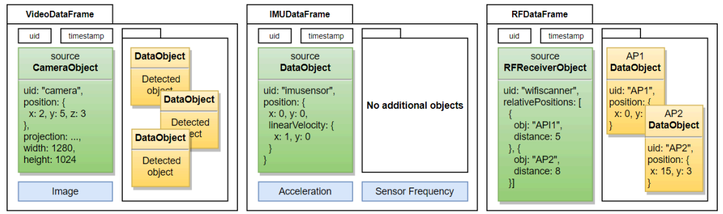
Data Frame

Data frames are envelopes that are transmitted and processed through a positioning model. These frames are created by source nodes (e.g. sensors) and contain one or more data objects needed to process the frame.

A frame should contain a single reading of a sensor (such as an image of a video stream or current acceleration) and not permanent or calculated information.



Creating data frames

OpenHPS is a framework that processes sensor information to retrieve a position for one or more data objects. These objects are contained within an envelope called a data frame.

```
import { DataObject, DataFrame } from '@openhps/core';

const myObject = new DataObject("bsigner", "Beat Signer");
const frame = new DataFrame();
frame.addObject(myObject);
```

(method) DataFrame.addObject(object: DataObject): void

A basic data frame supports the addition of objects. Extended versions of this basic data frame also add additional sensor data.

Creating a custom data frame

Similar to data objects, decorators have to be used to indicate a serializable data frame.

```
import {
    DataFrame,
    SerializableObject,
    SerializableMember
} from '@openhps/core';

@SerializableObject()
export class QRDataFrame extends DataFrame {
    public rawImage: any = undefined;
}
```

What is OpenHPS?

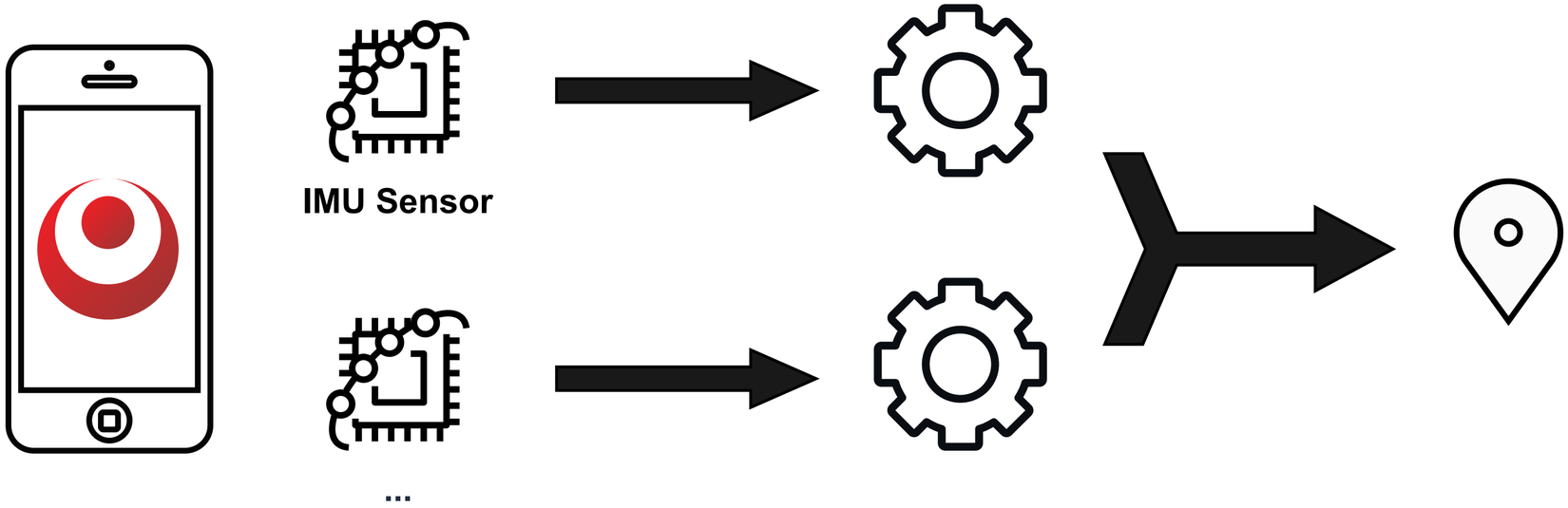
OpenHPS

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

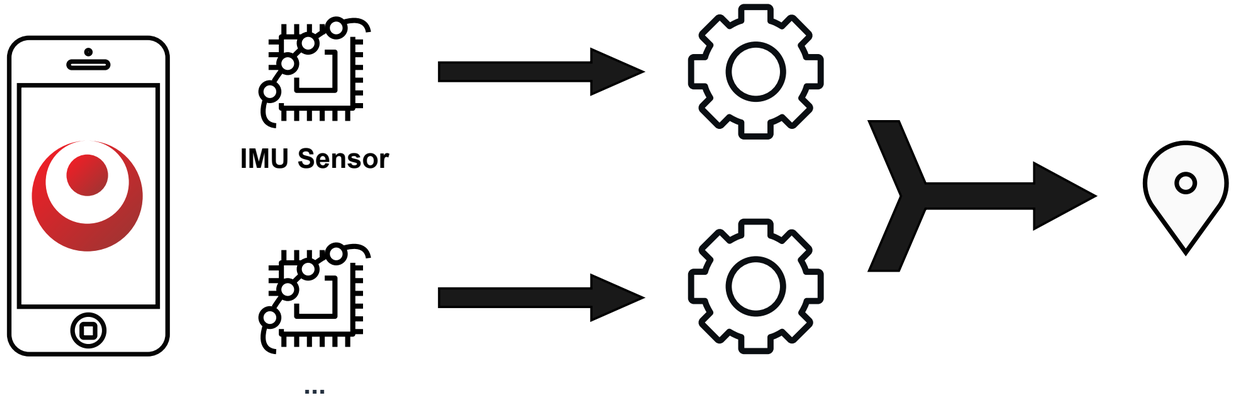
Process Network Design

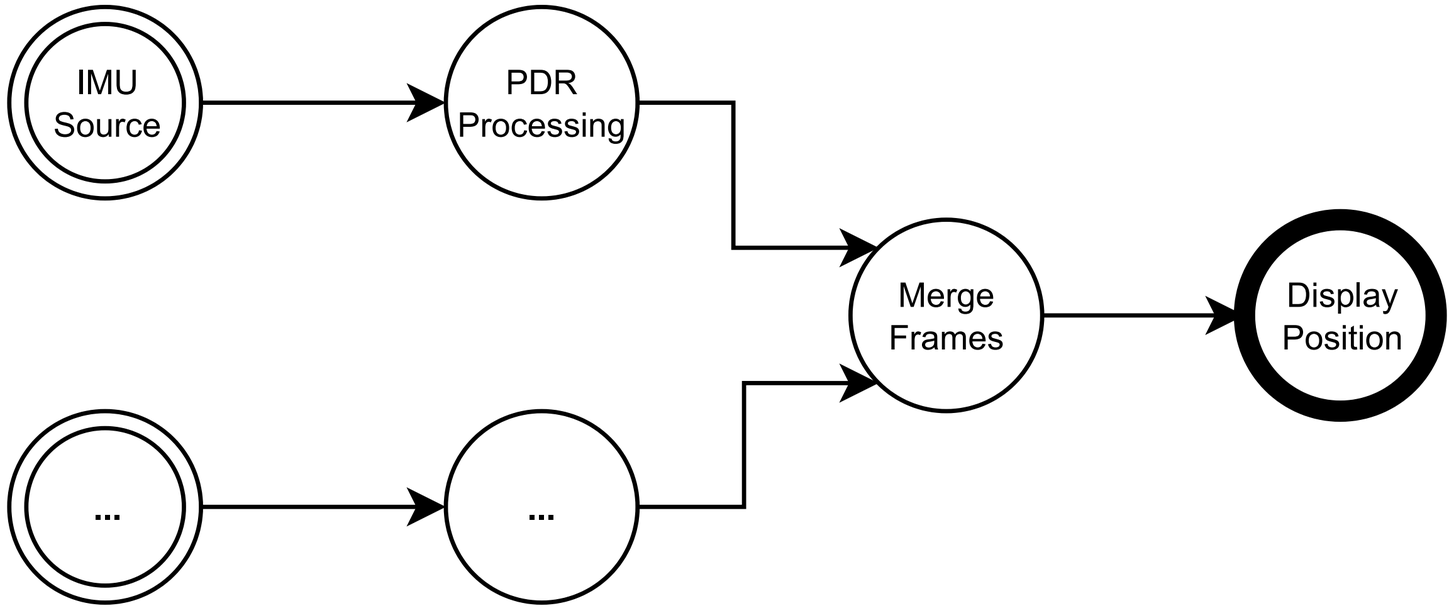
OpenHPS



Process Network Design ...

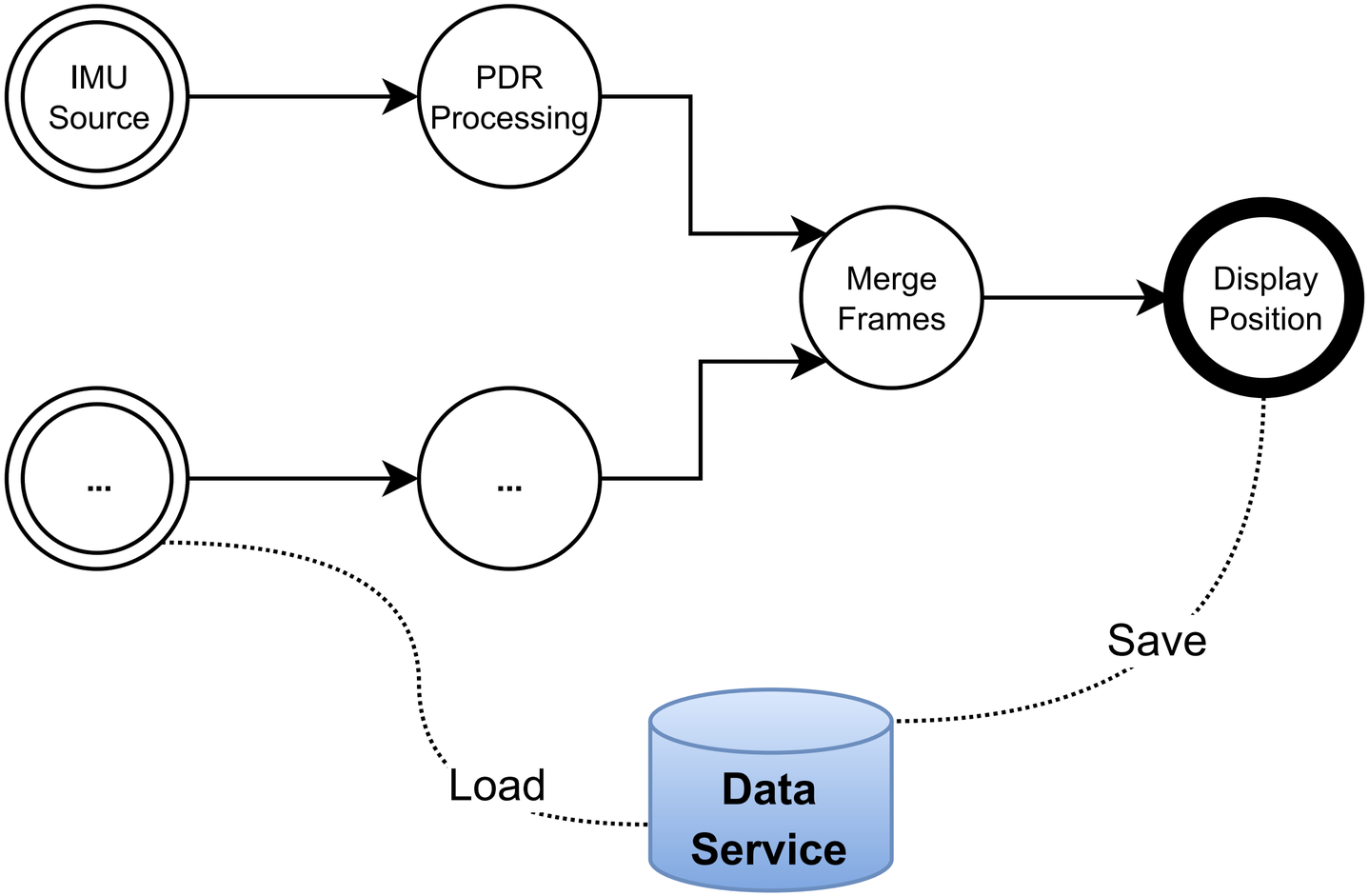
OpenHPS





Process Network Design ...

OpenHPS



Modularity

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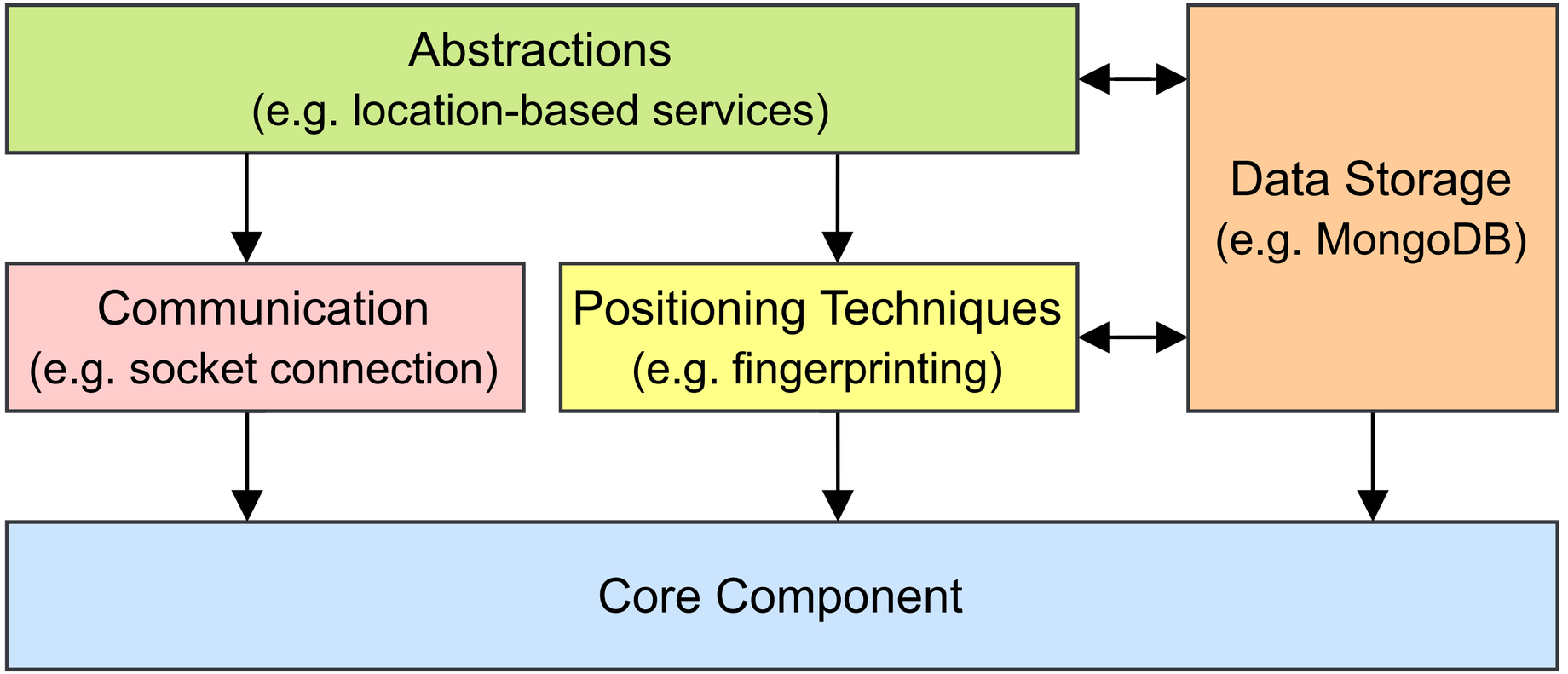

Data Processing

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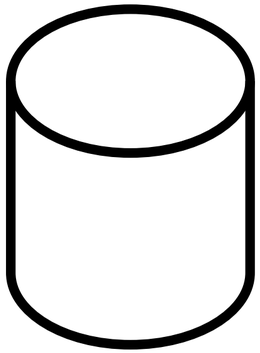
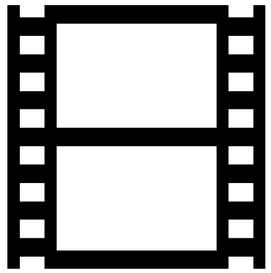
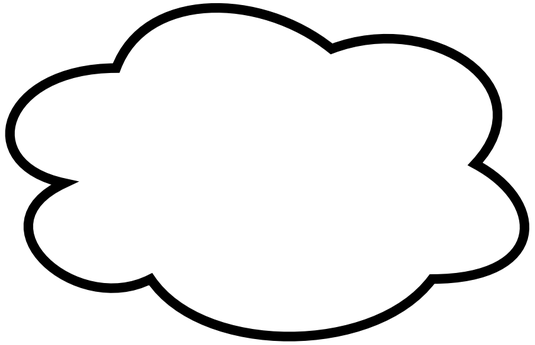


Knowledge



Raw Data



Processed Data

DataObject

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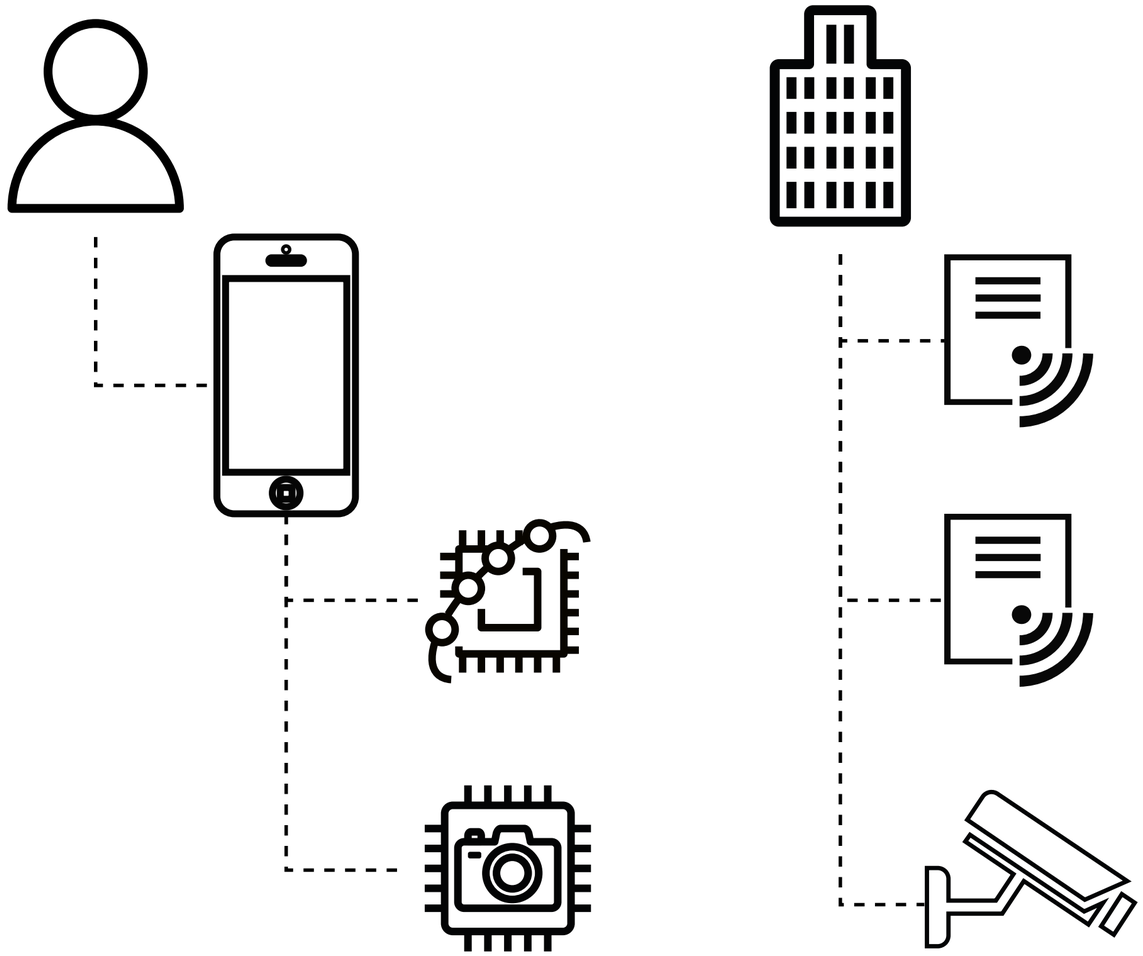

Absolute and Relative Positions

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Absolute

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

Relative

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

DataFrame

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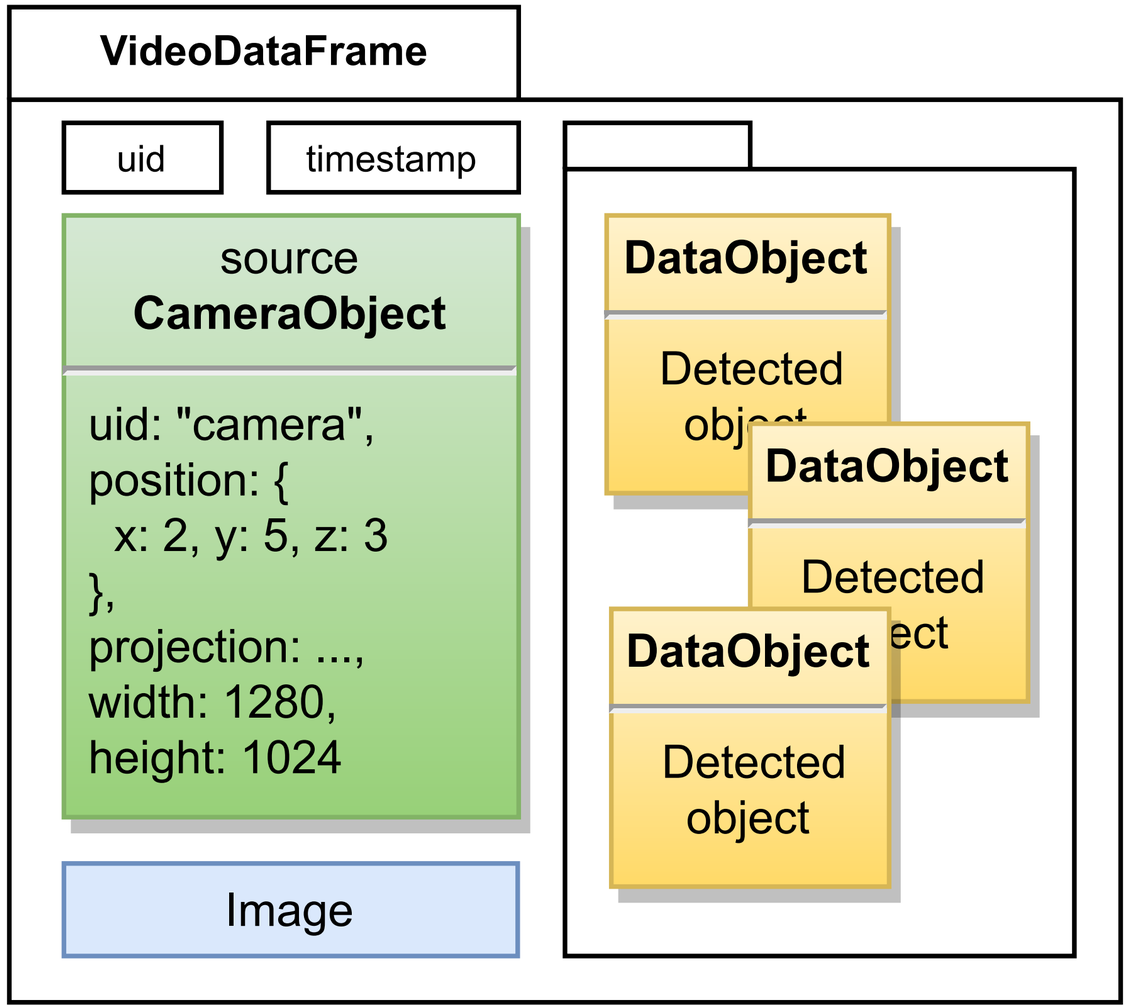

SymbolicSpace

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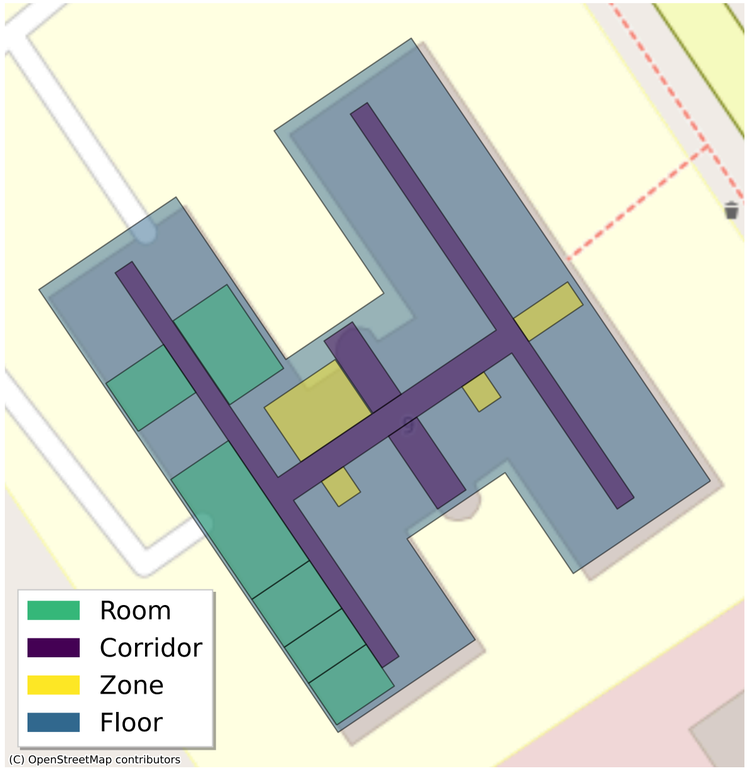
An object that semantically defines a space

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



Location-based Service

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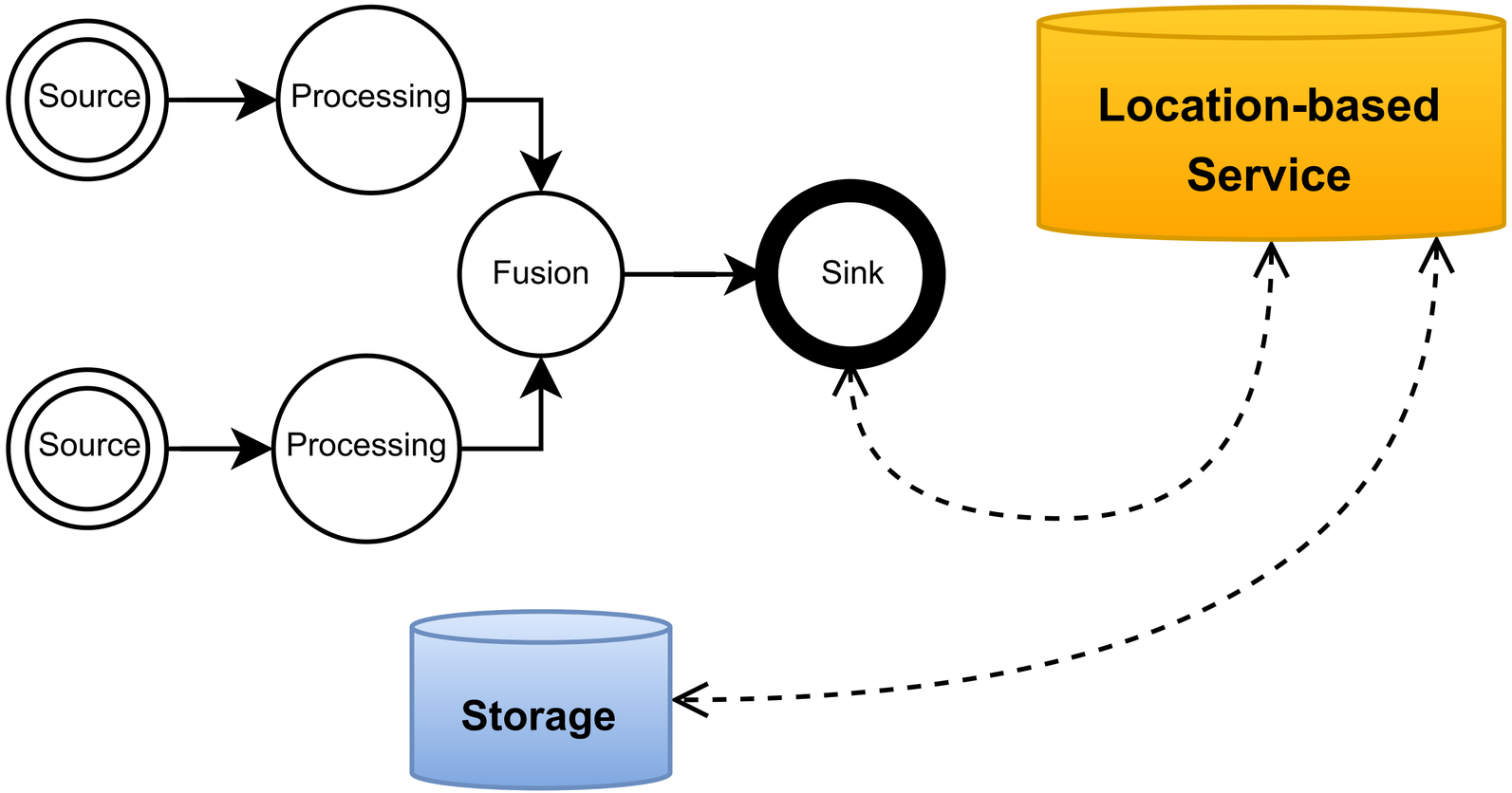
```
getCurrentPosition("me", ...)
```



Location-based Service ...

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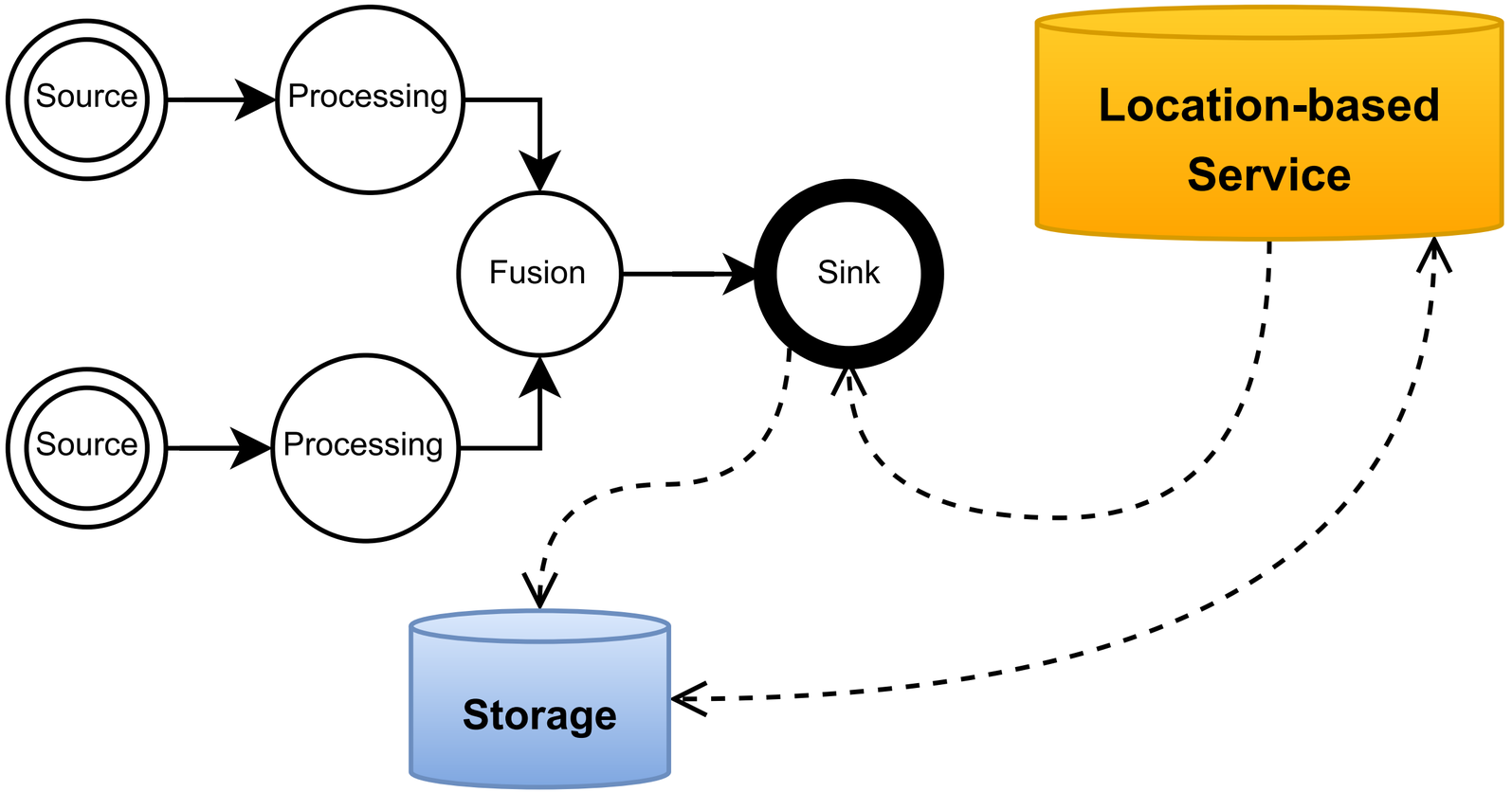
```
watchPosition("me", ...)
```



Demonstration

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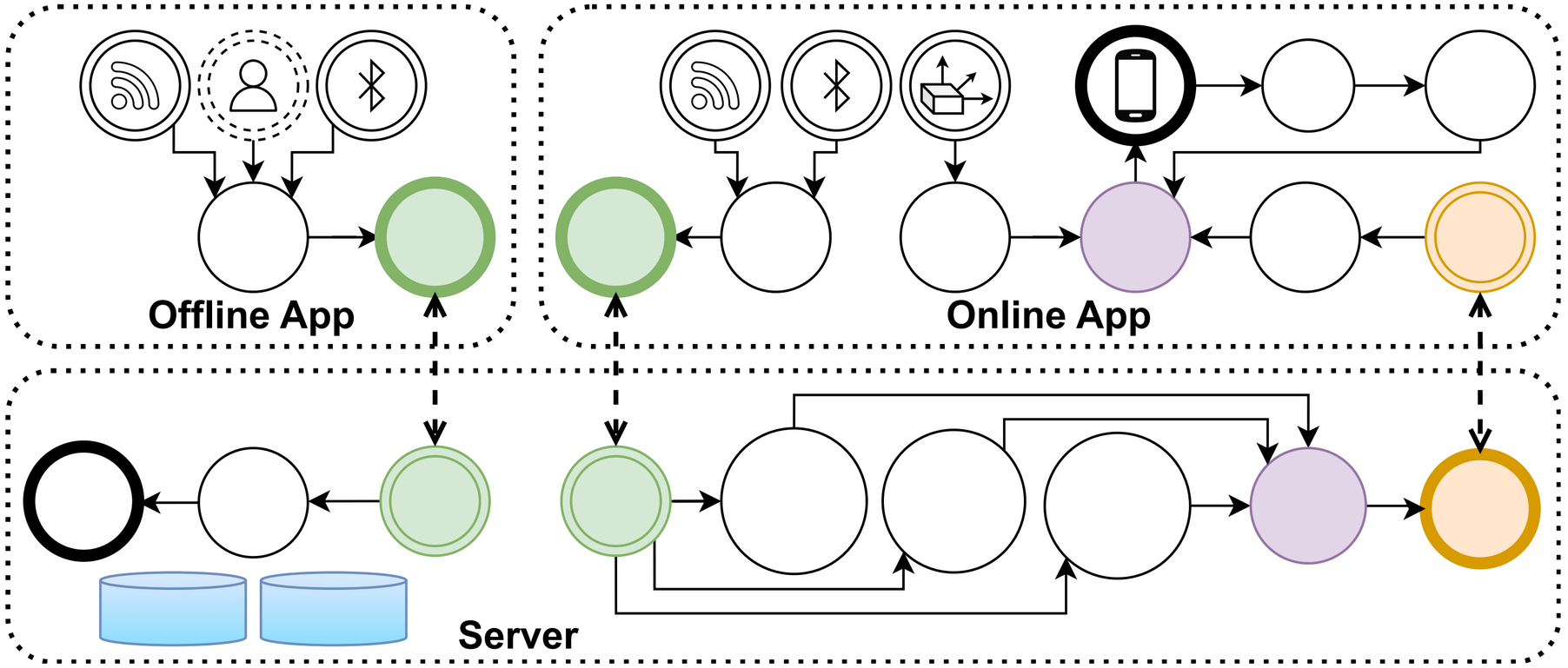
- Indoor positioning **use case**
- Use **existing techniques**
- Validation of **flexibility** and modularity



Positioning Model

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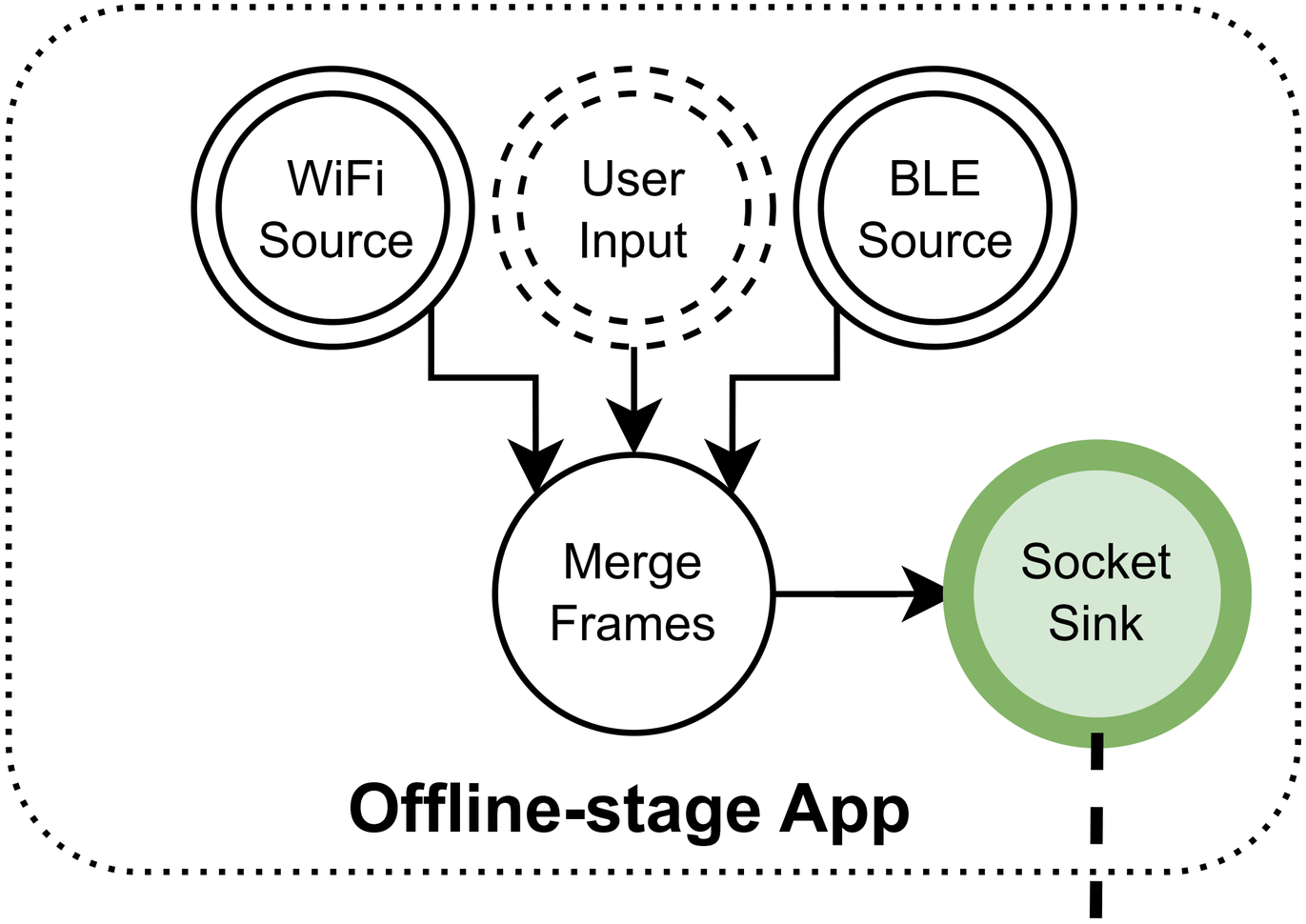
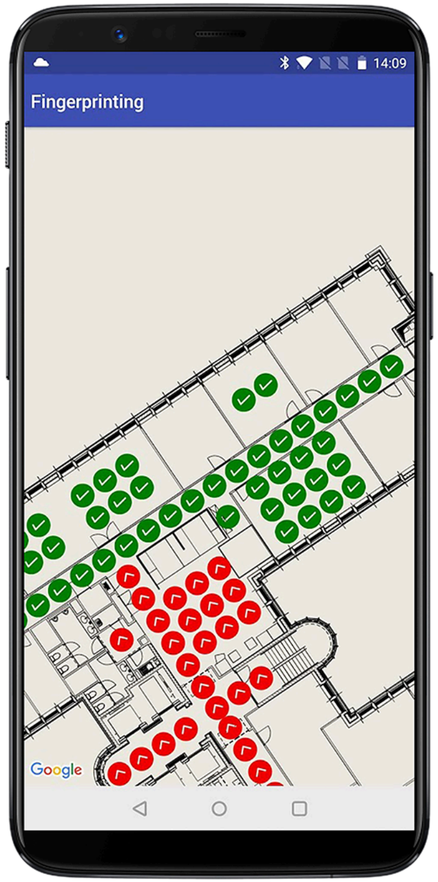
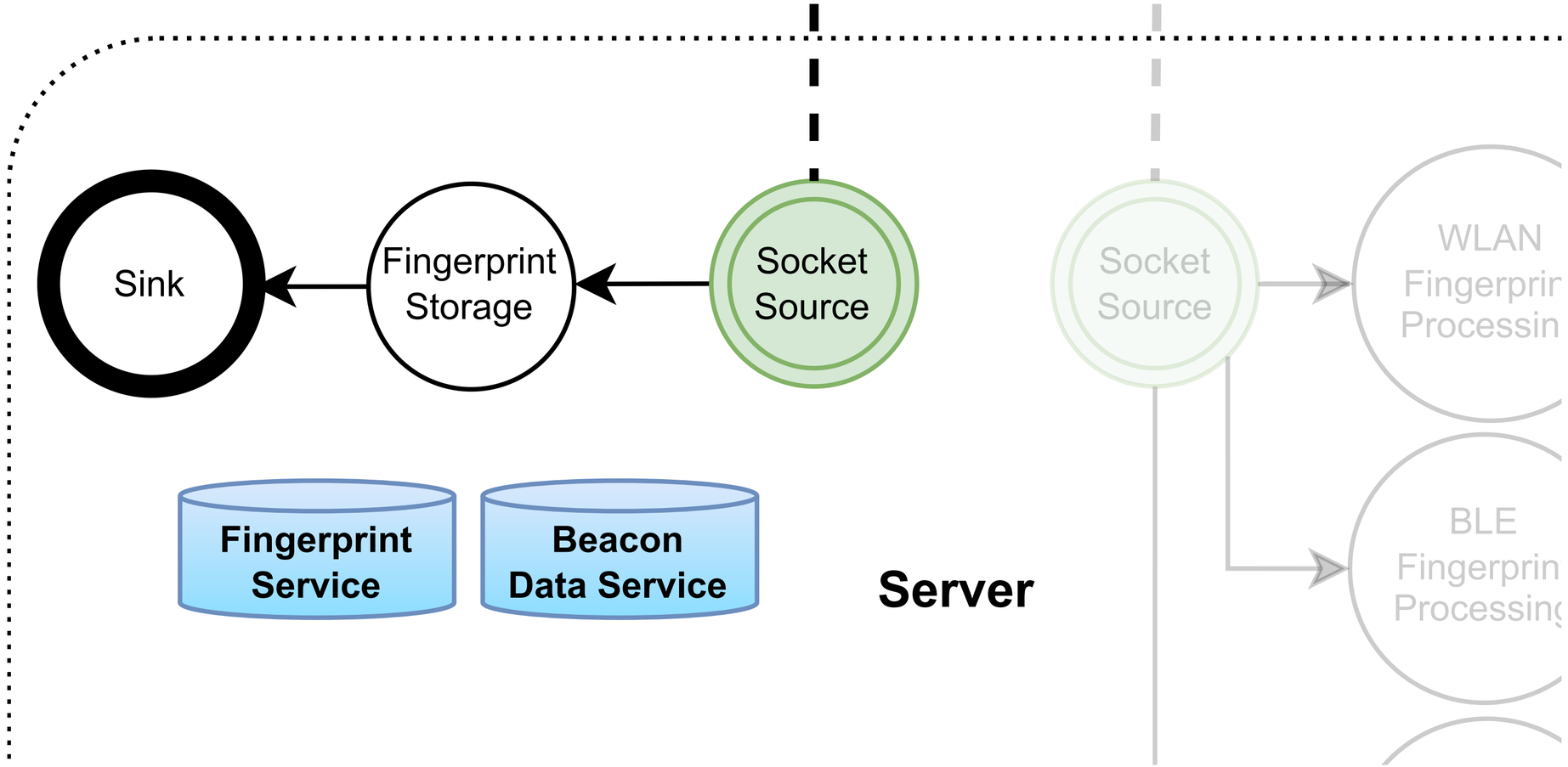




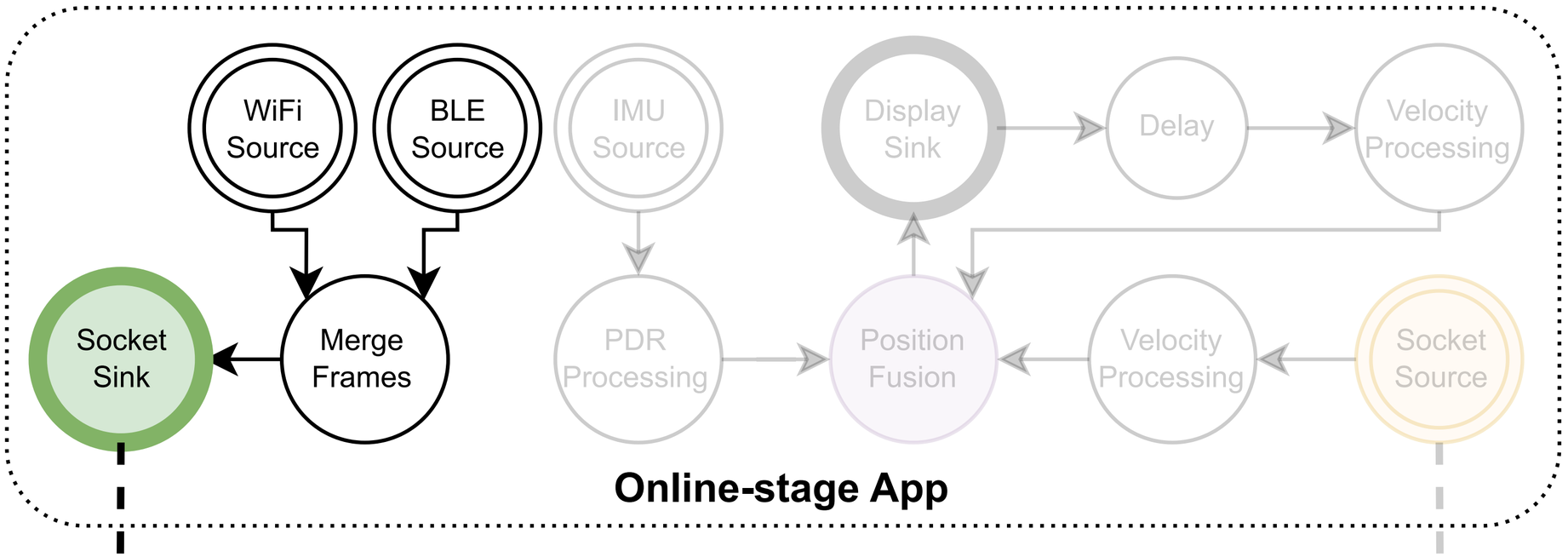
Positioning Model ...

OpenHPS



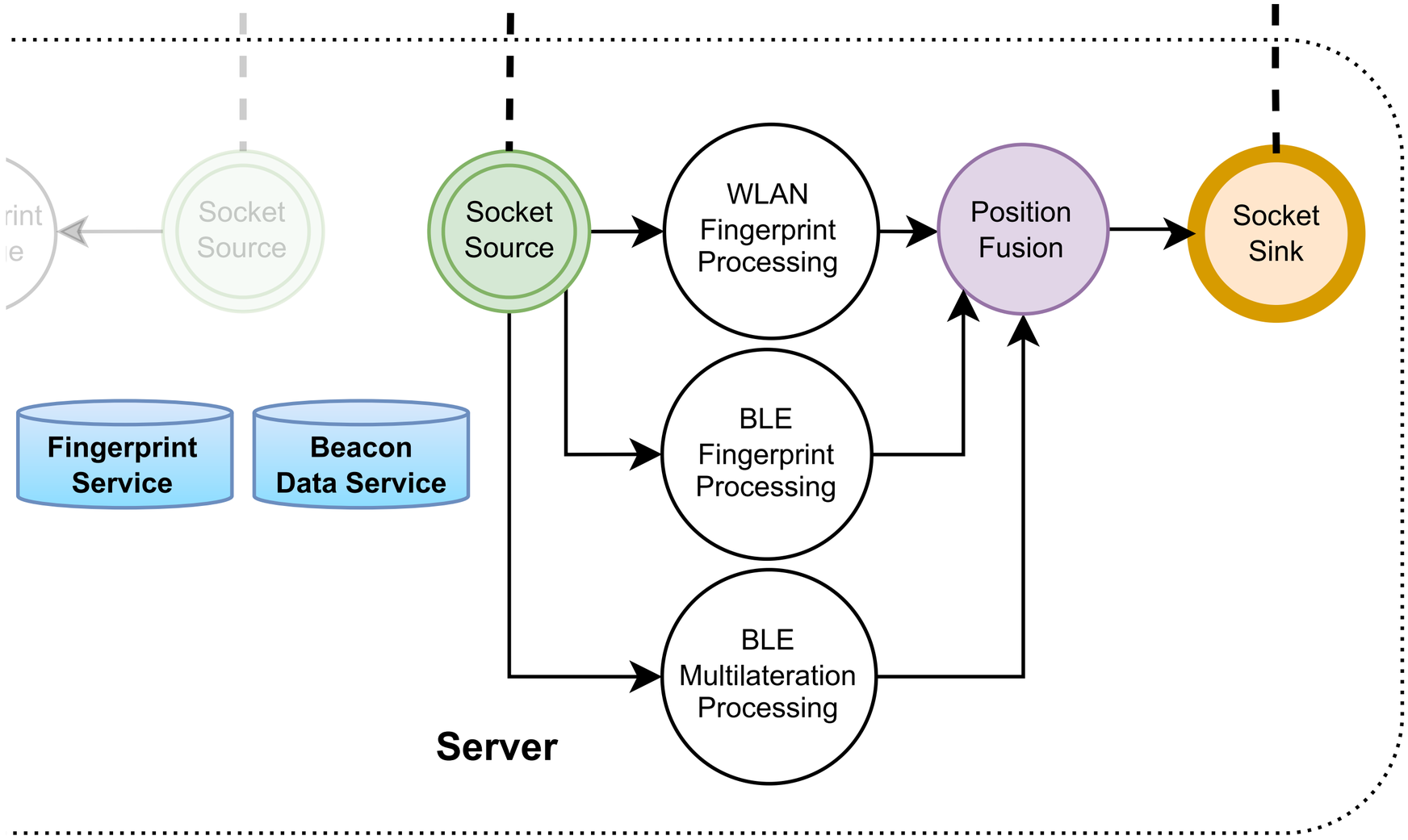
Positioning Model ...

OpenHPS



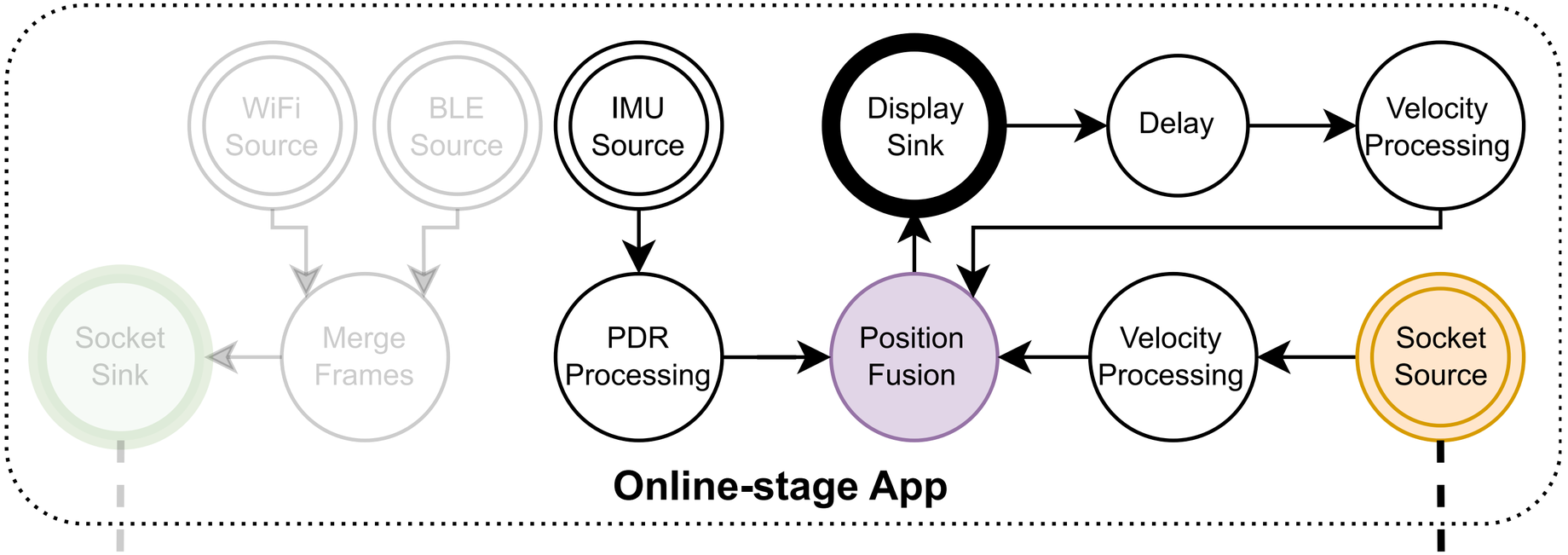
Positioning Model ...

OpenHPS



Positioning Model ...

OpenHPS



Dataset

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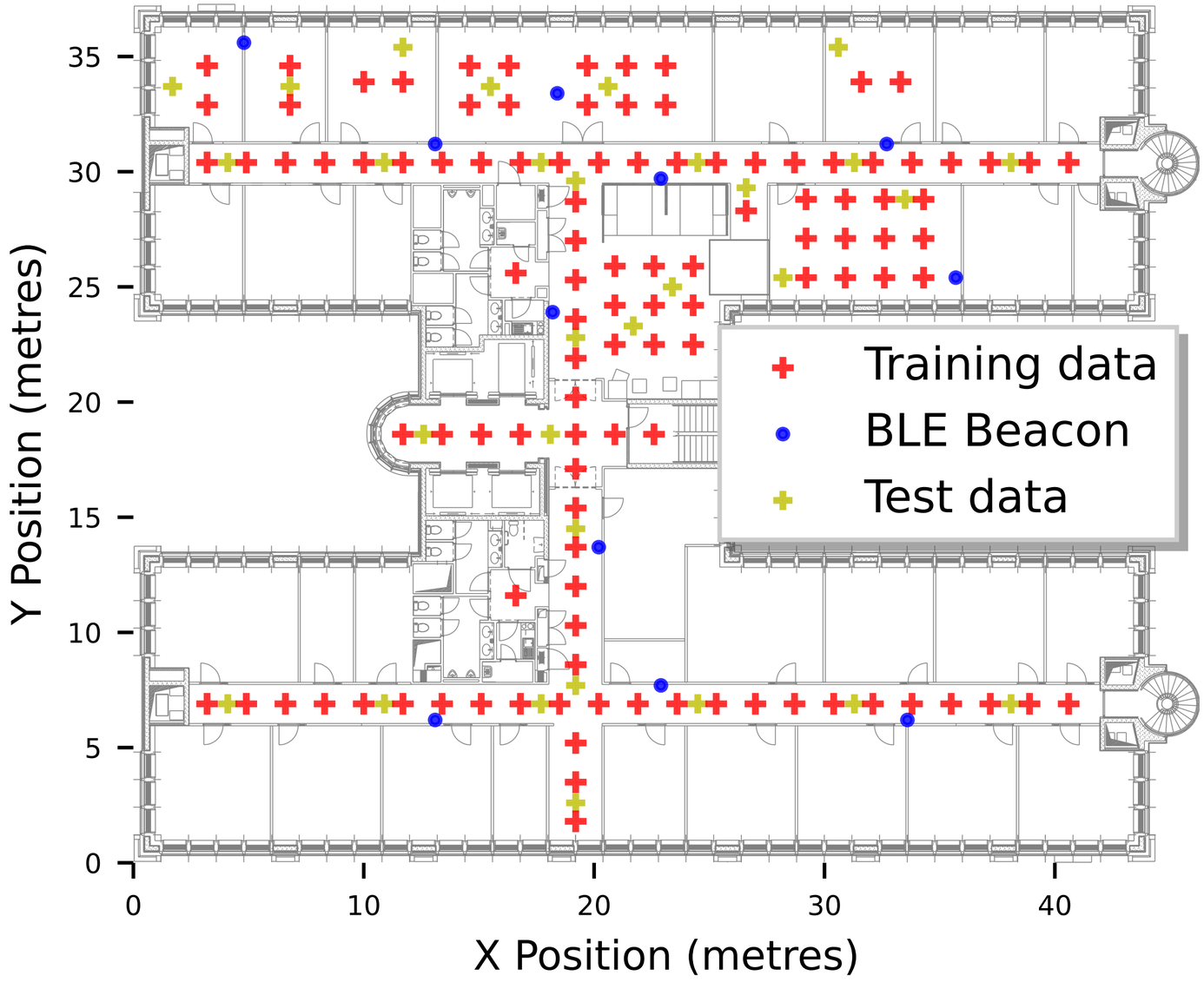

Validation Results

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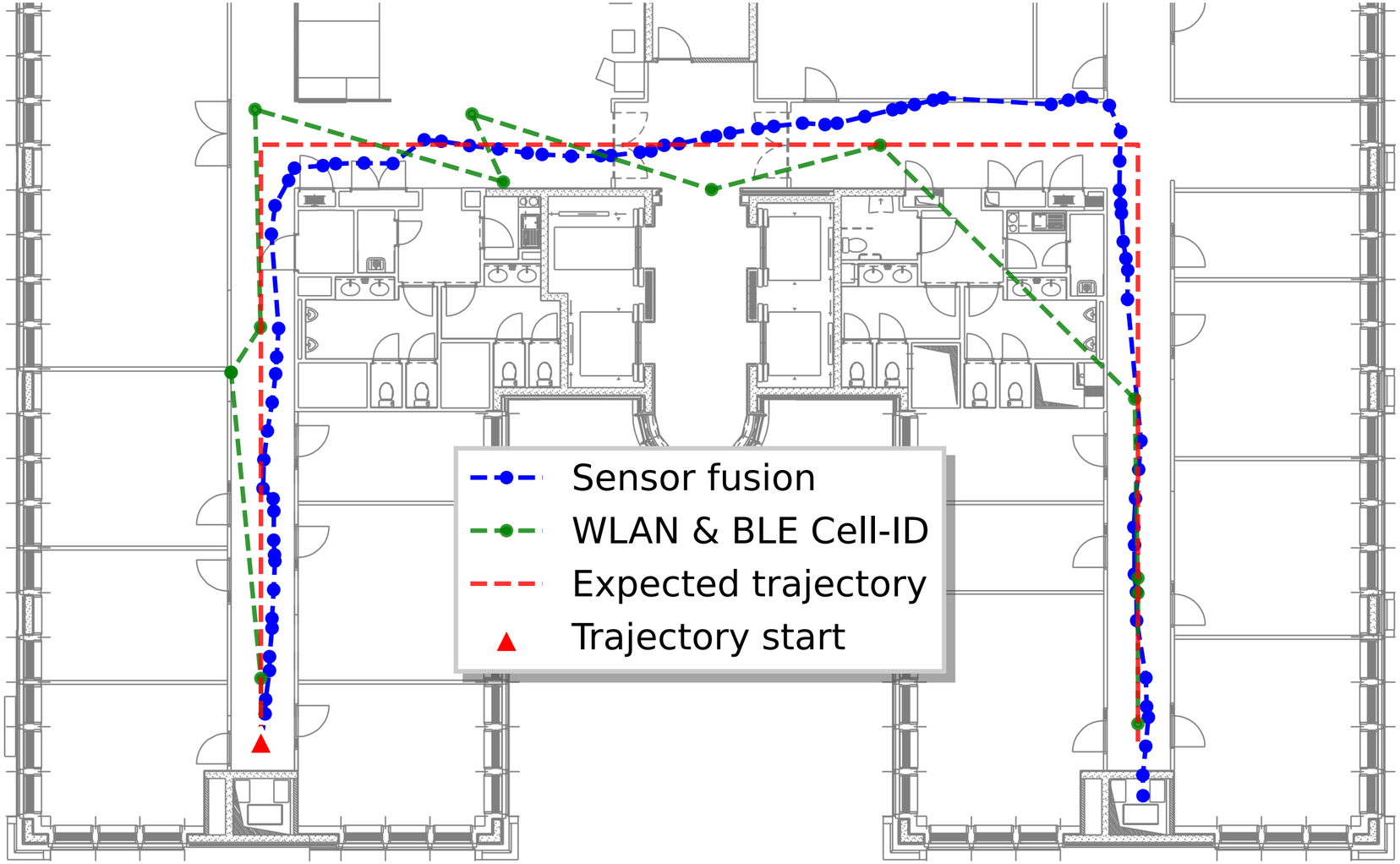
Static Positioning

	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

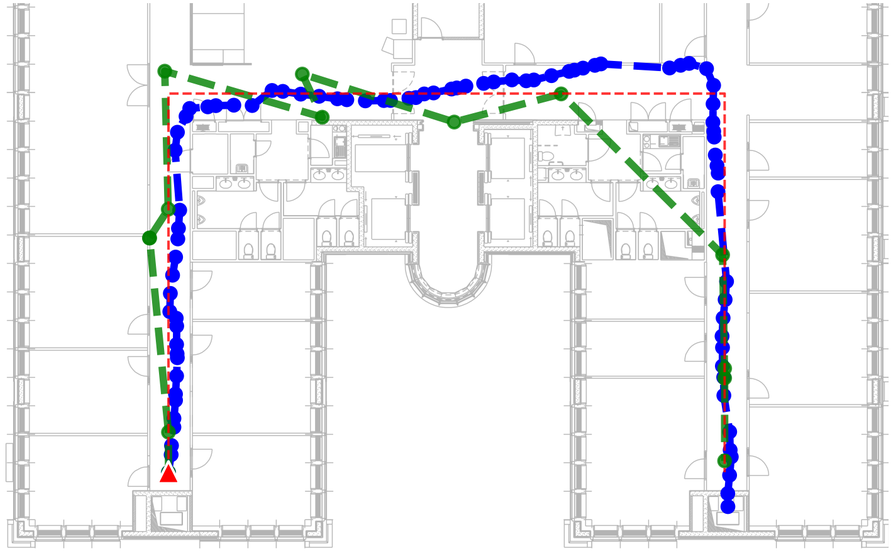


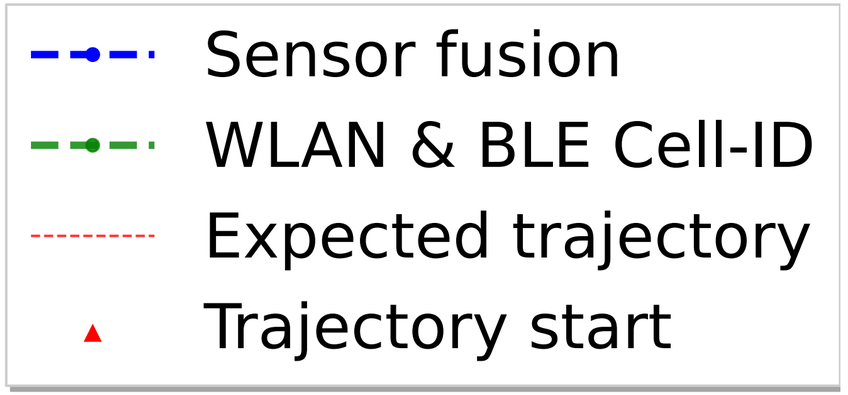
Validation Results ...

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

- 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!