

Indoor Positioning Using the OpenHPS Framework

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What is OpenHPS?



An Open Source Hybrid Positioning System

DOCSBLOGGITHUB

Documentation

Introduction

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Modules

Basic Concepts

Data Object

Data Frame

Creating data frames

Creating a custom data frame

Standard Units

Position and Orientation

Reference Space

Positioning Model

Source Node

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Sink Node

Services

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Remote Service

Threading

Miscellaneous

Examples

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.

VideoDataFrame

uidtimestamp

source

CameraObject

uid: "camera",
position: {
 x: 2, y: 5, z: 3
},
projection: ...,
width: 1280,
height: 1024

Image

DataObject

Detected object

DataObject

Detected object

DataObject

Detected object

IMUDDataFrame

uidtimestamp

source

DataObject

uid: "imusensor",
position: {
 x: 0, y: 0,
 linearVelocity: {
 x: 1, y: 0
 }
}

Acceleration

Sensor Frequency

No additional objects

RFDDataFrame

uidtimestamp

source

RFRReceiverObject

uid: "wifiscanner",
relativePositions: [
 {
 obj: "AP1",
 distance: 5
 },
 {
 obj: "AP2",
 distance: 8
 }]

AP1 DataObject

uid: "AP1",
position: {
 x: 0, y: 0
}

AP2 DataObject

uid: "AP2",
position: {
 x: 15, y: 3
}

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
```

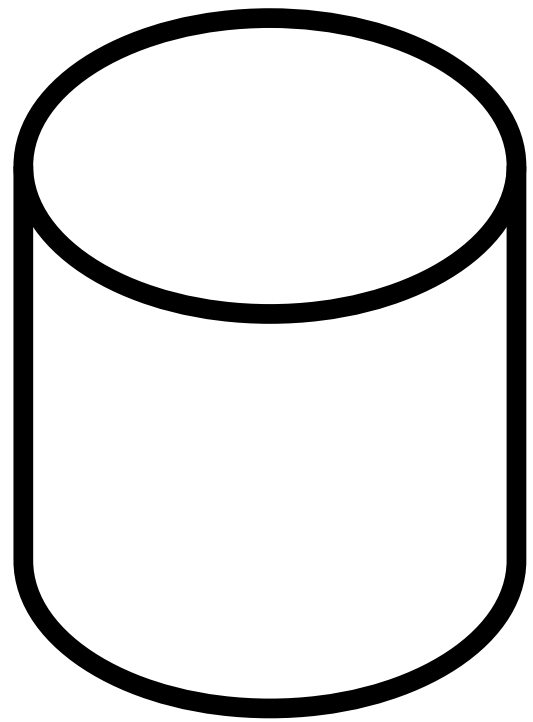
A basic data frame supports the addition of objects. Extended versions of this basic data frame also add additional sensor data.

Creating a custom data frame

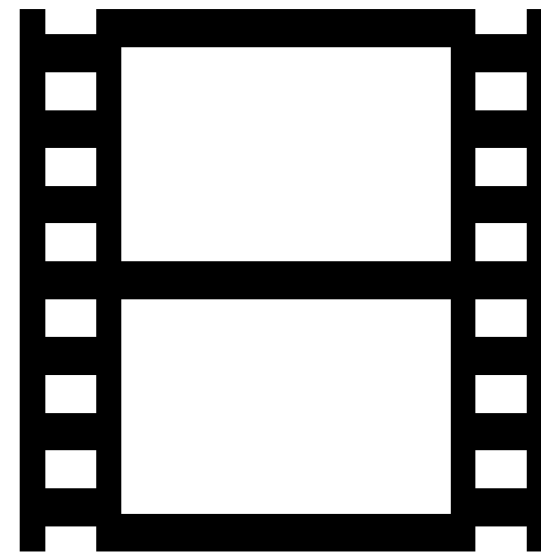
Similar to data objects, decorators have to be used to indicate a serializable data frame.

```
import {  
  DataFrame,  
  SerializableObject,  
  SerializableMember  
} from '@openhps/core';  
  
@SerializableObject()  
export class QRDataFrame extends DataFrame {  
  public rawImage: any = undefined;  
}
```

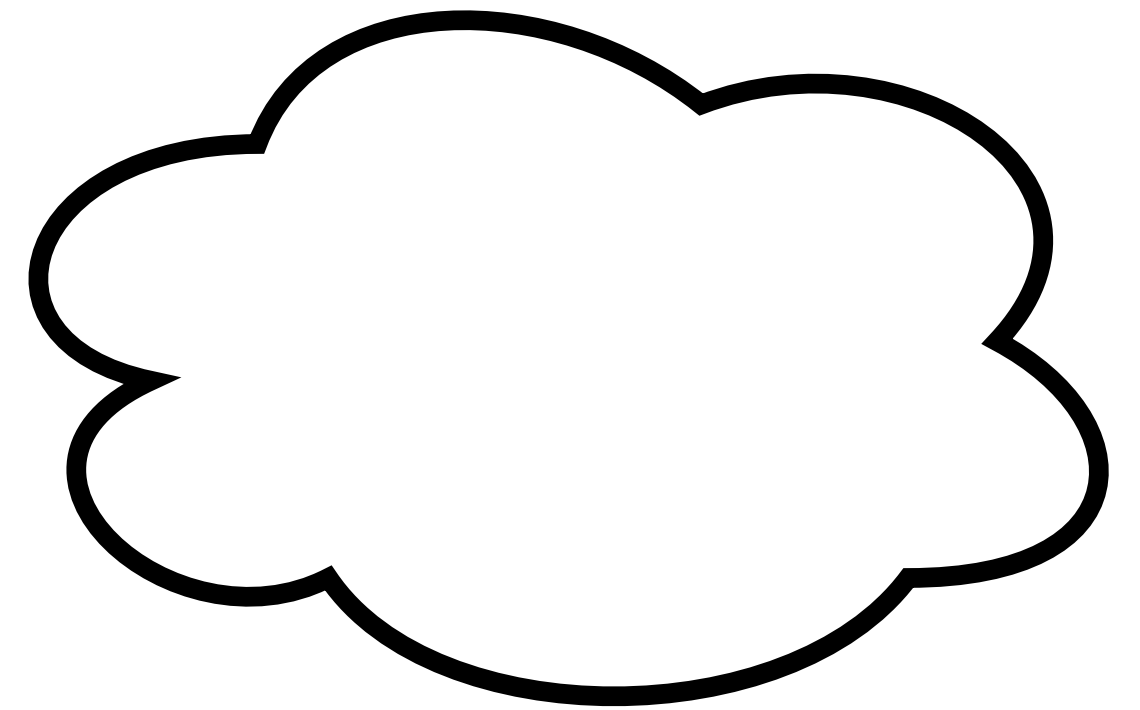
Data Processing



Knowledge



Raw Data



Processed Data

SymbolicSpace

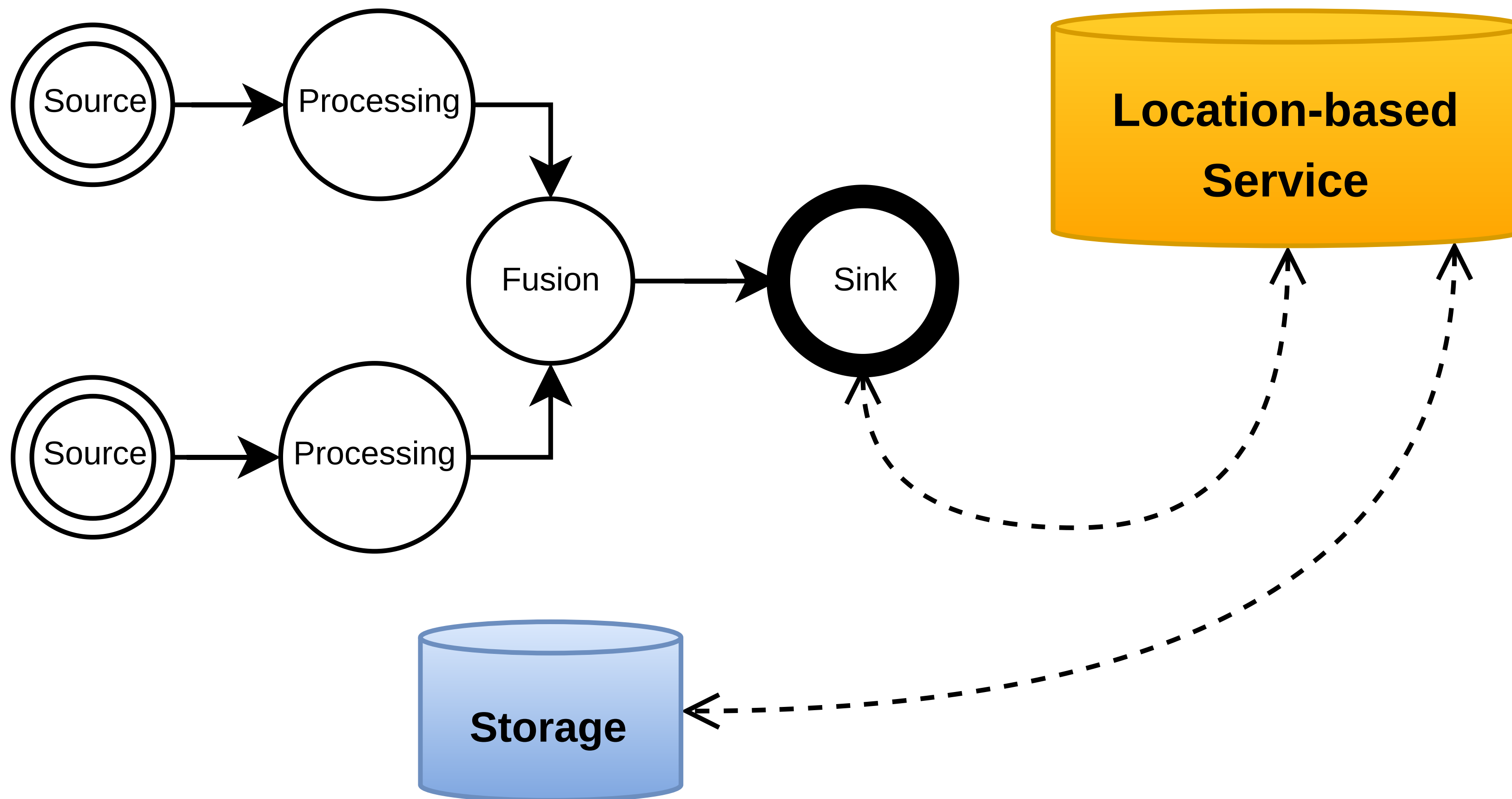
An object that semantically defines a space

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



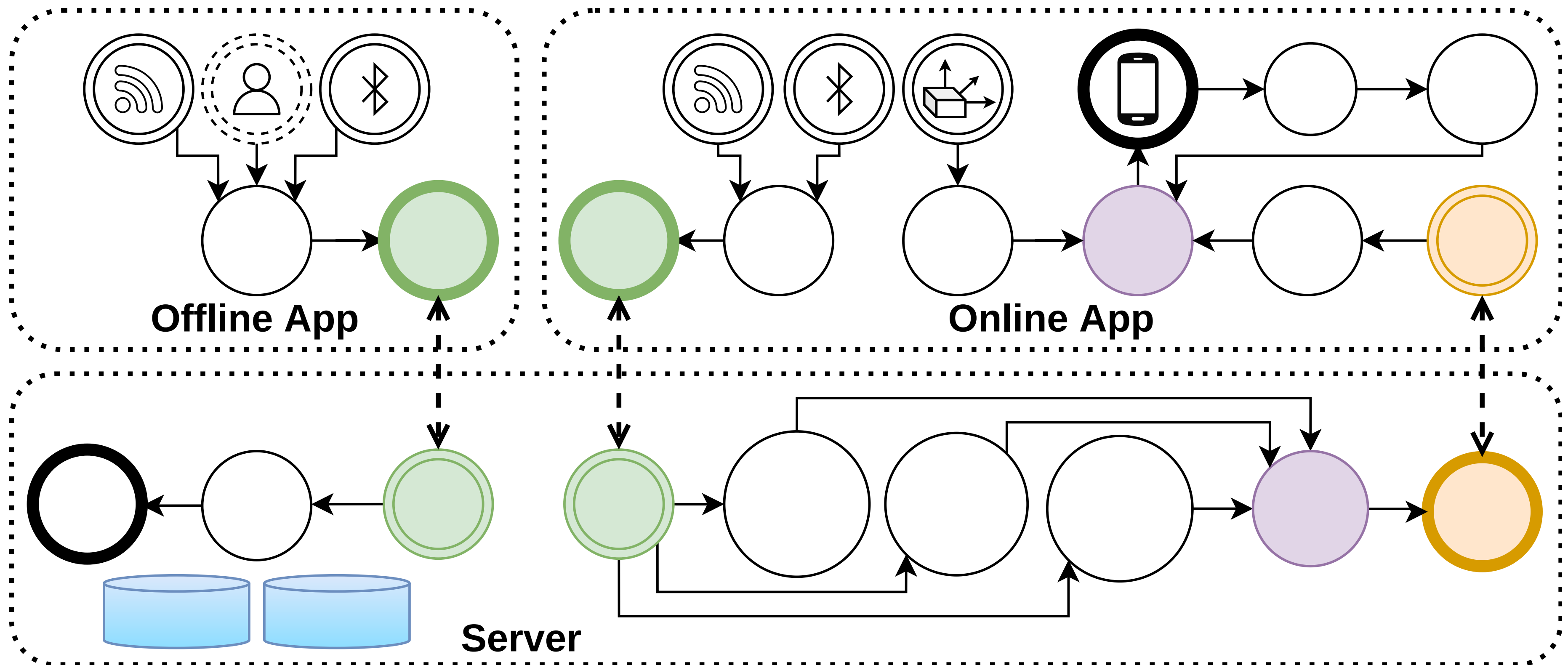
Location-based Service

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

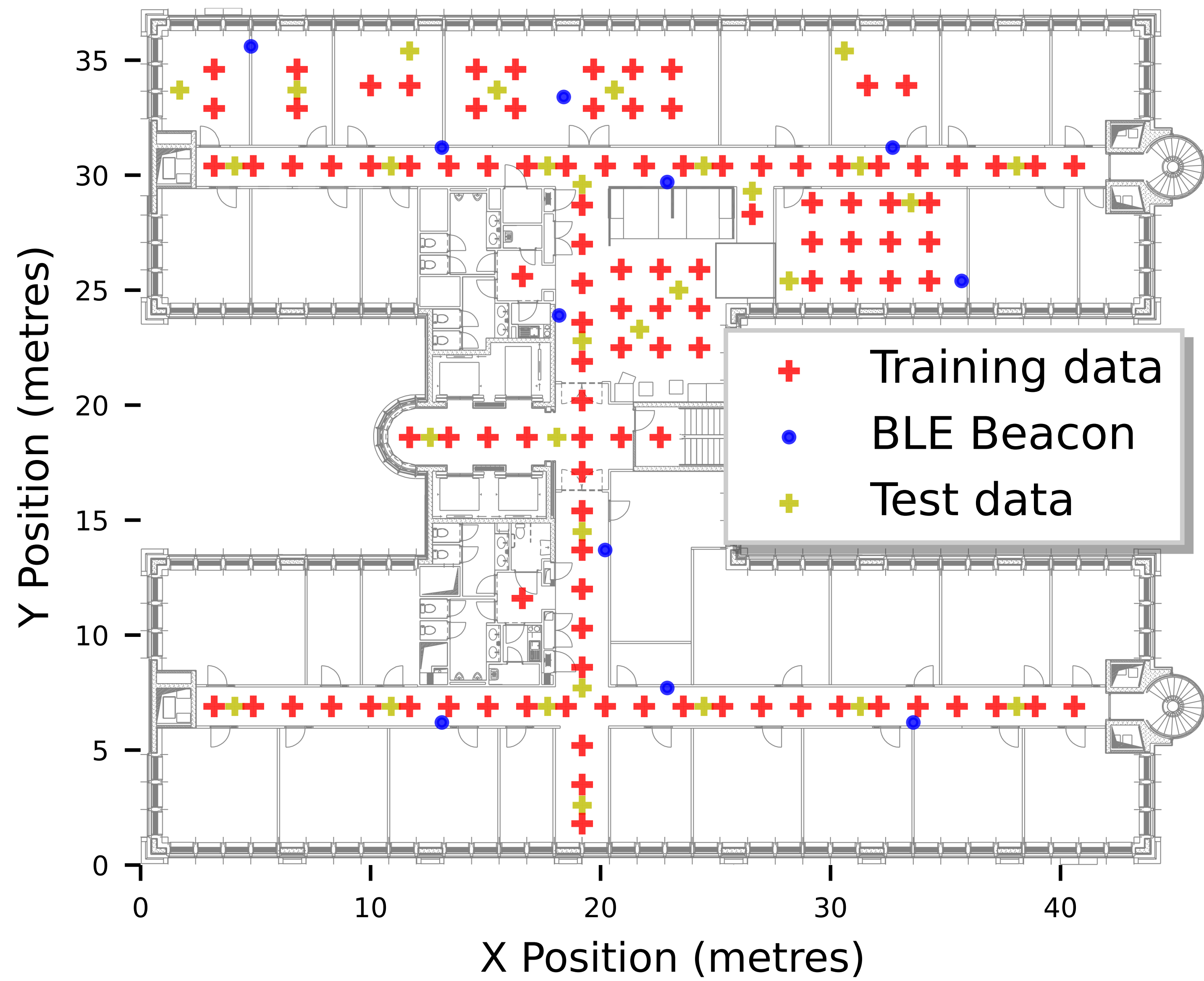


Demonstration

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



Dataset



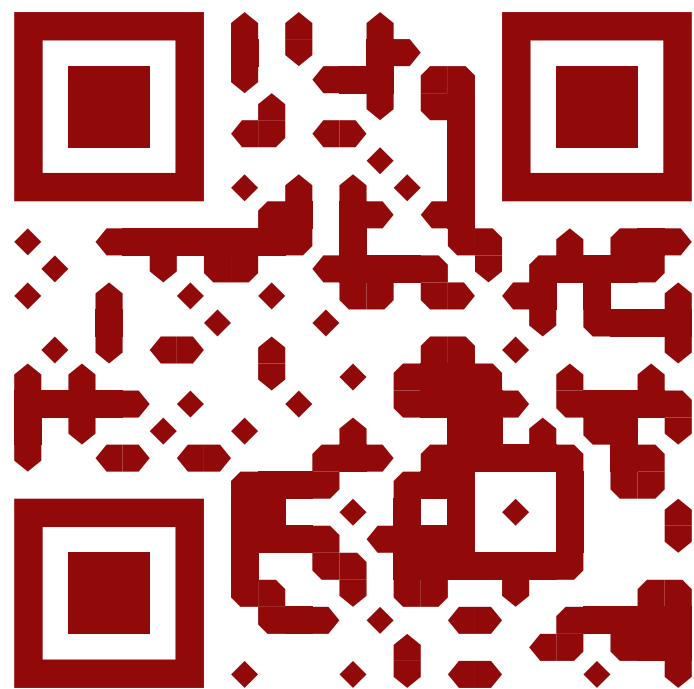
Validation Results

Static Positioning

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

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!