Multiple Ontology Binding in Smart Building Environment

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Outline

1. Introduction
   - Panoptes building
   - Visual sensor network
   - Problematics
   - Objective
2. WiseNET
   - WiseNET ontology
   - Smart camera network
   - Central API
   - Monitor unit
3. Conclusions

Argus Panoptes

Visual sensor network (VSN)

Visual sensor network (VSN)

Classical VSN

Problems of classical VSN

The main problems on classical VSN:

- Data selection
- Data integration
- Privacy protection

Objective

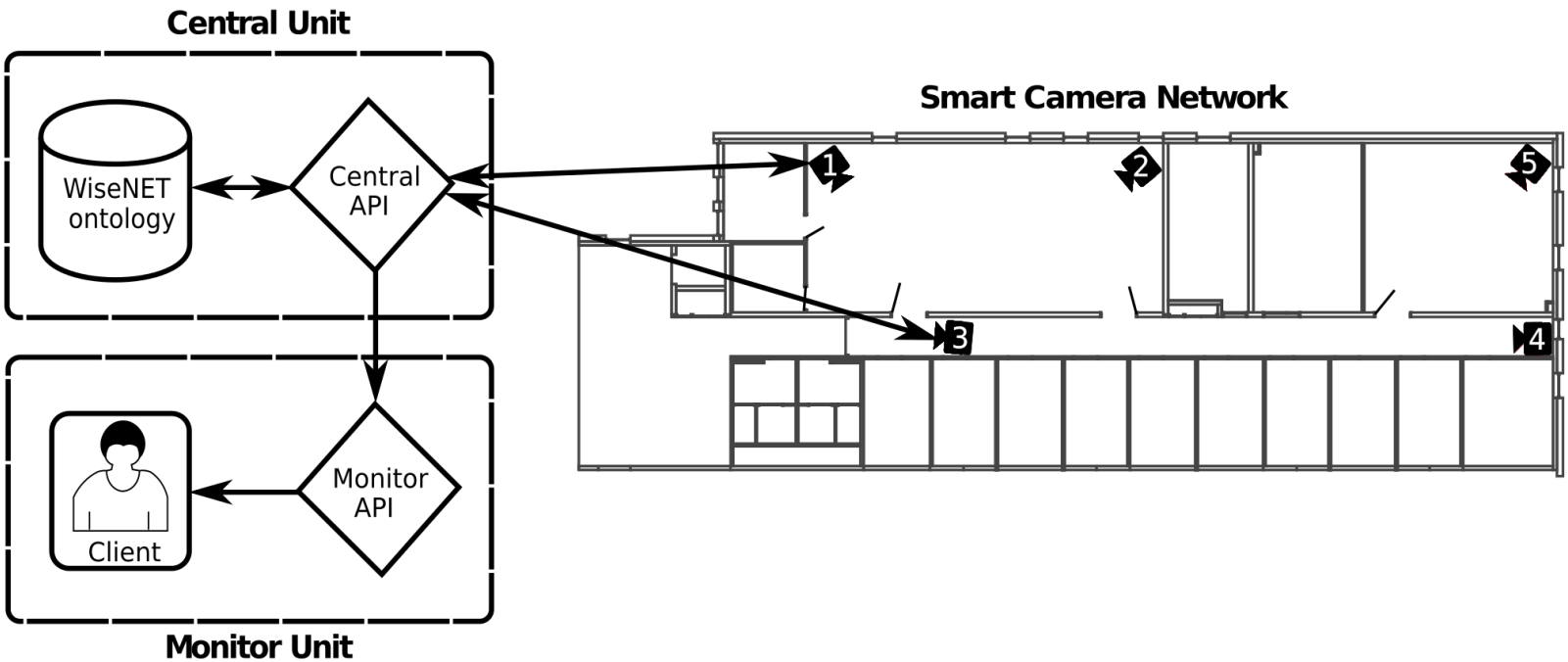
We propose to overcome classical VSN and CV problems by exploiting the data using **smart cameras + semantic information** of the context, such as:

- What the camera observes
- Information about the environment
- Events that may occurred

WiseNET system

Software Architecture

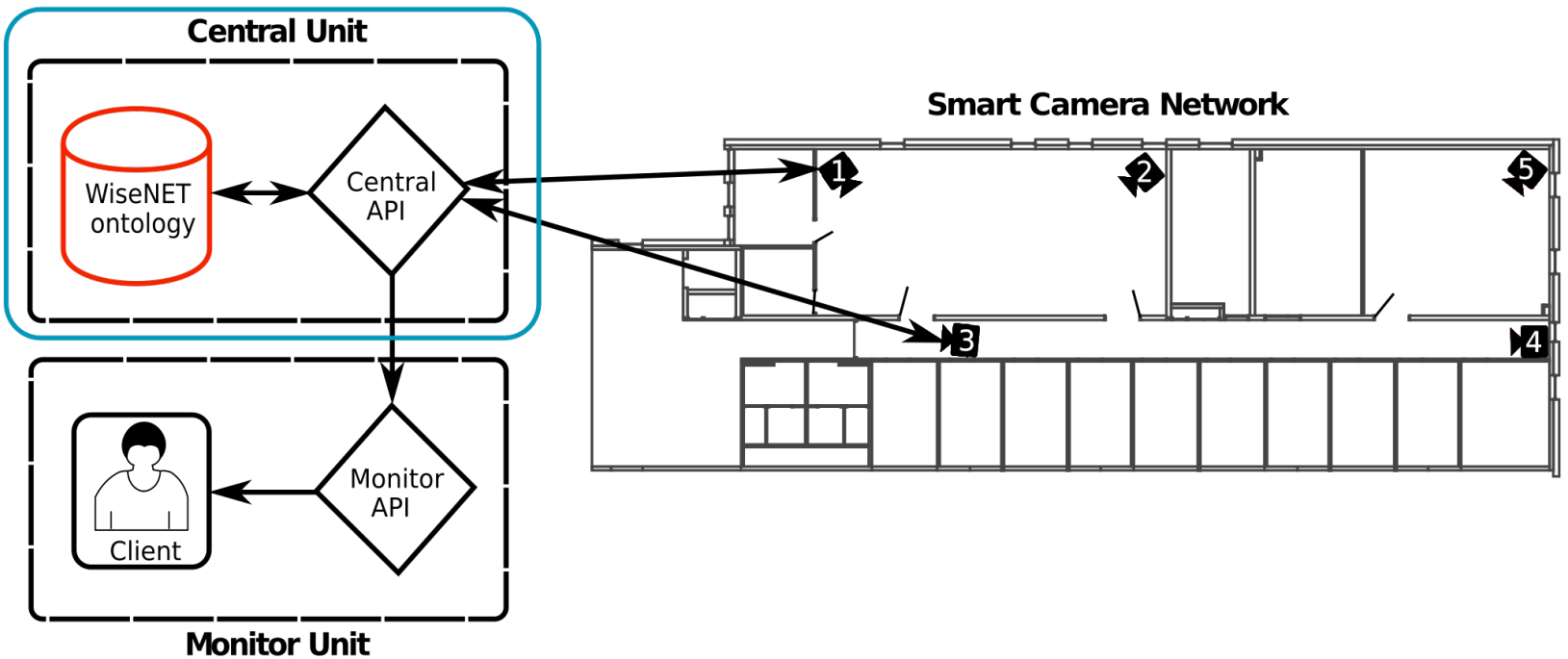
Physical Architecture



WiseNET ontology

Software Architecture

Physical Architecture



Ontology development

1. Ontology scope
2. Links to existing ontologies
3. WiseNET classes and properties

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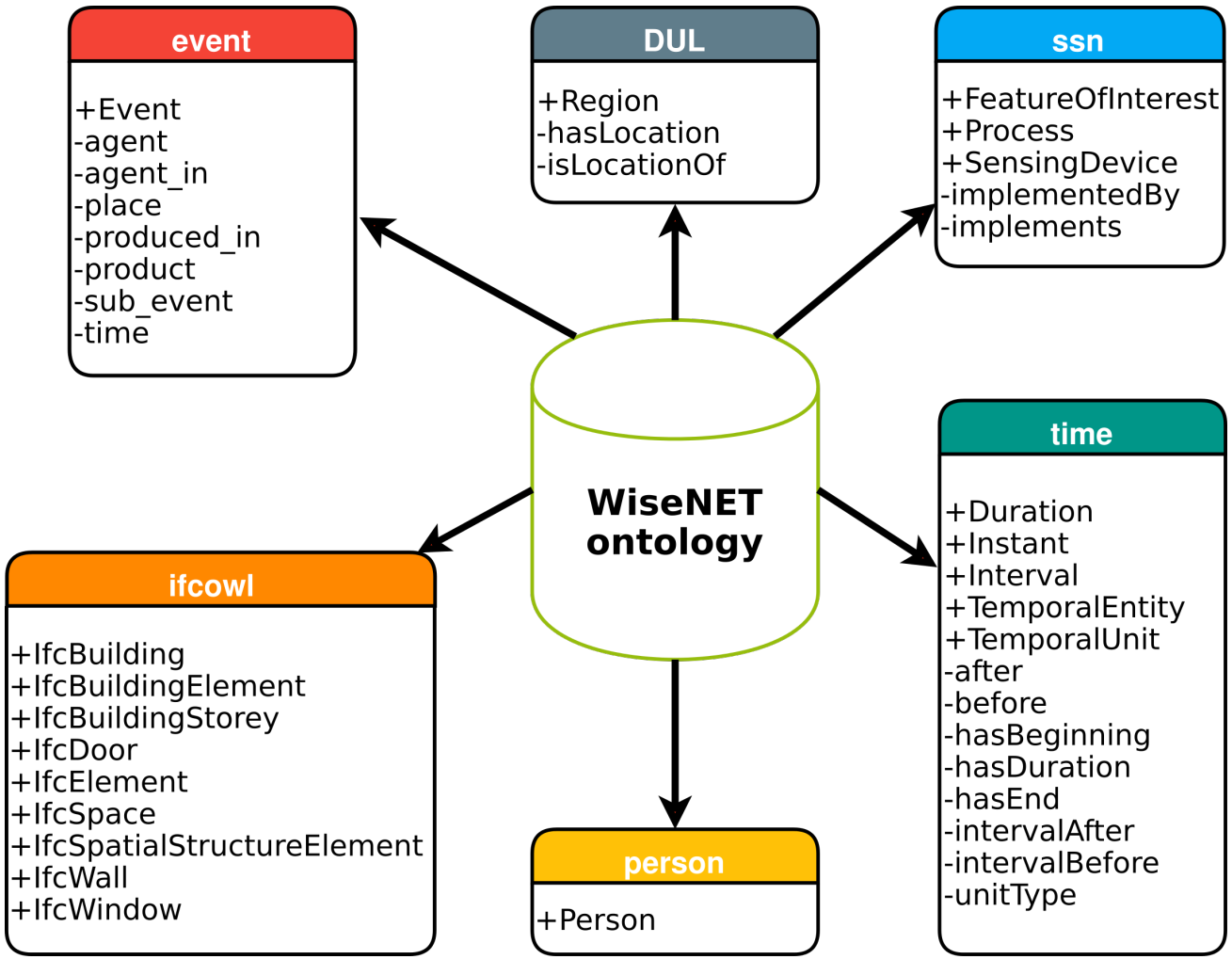
Ontology scope

Competency questions	
How many people are/were in a space?	What is the most visited space in the building?
Where is a specific person?	Which building elements does a camera observes?
How many rooms does a storey has?	Which events happened in the last T minutes?
What are all the spaces connected to space X?	Is somebody in a restricted area?
Is a space empty/occupied?	Which is the most used door in the building?
From which door a person entered/left a space?	How many people entered/left a space in a day?

Ontology development

1. Ontology scope
2. Links to existing ontologies
3. WiseNET classes and properties

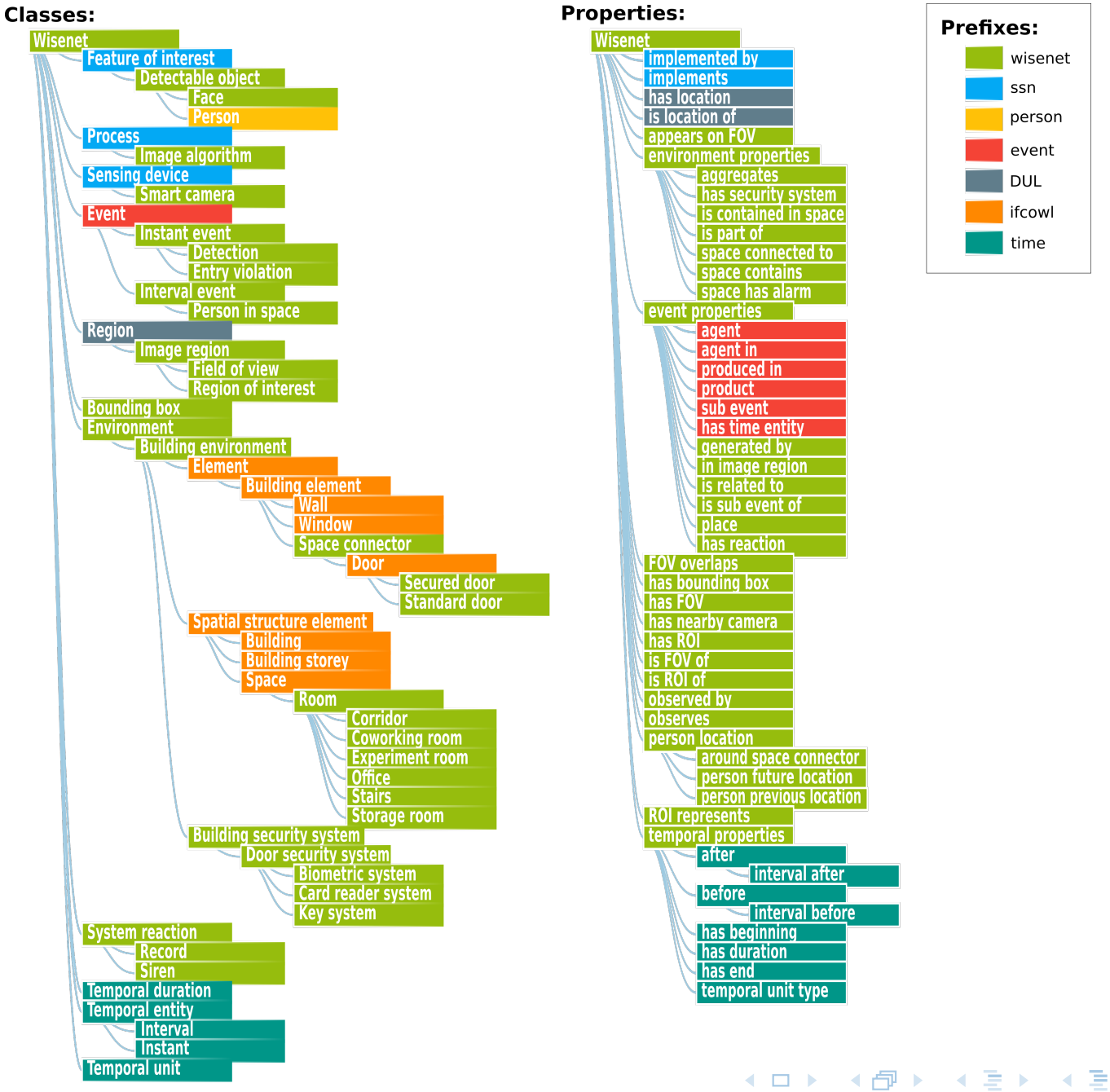
Links to existing ontologies



Ontology development

1. Ontology scope
2. Links to existing ontologies
3. WiseNET classes and properties

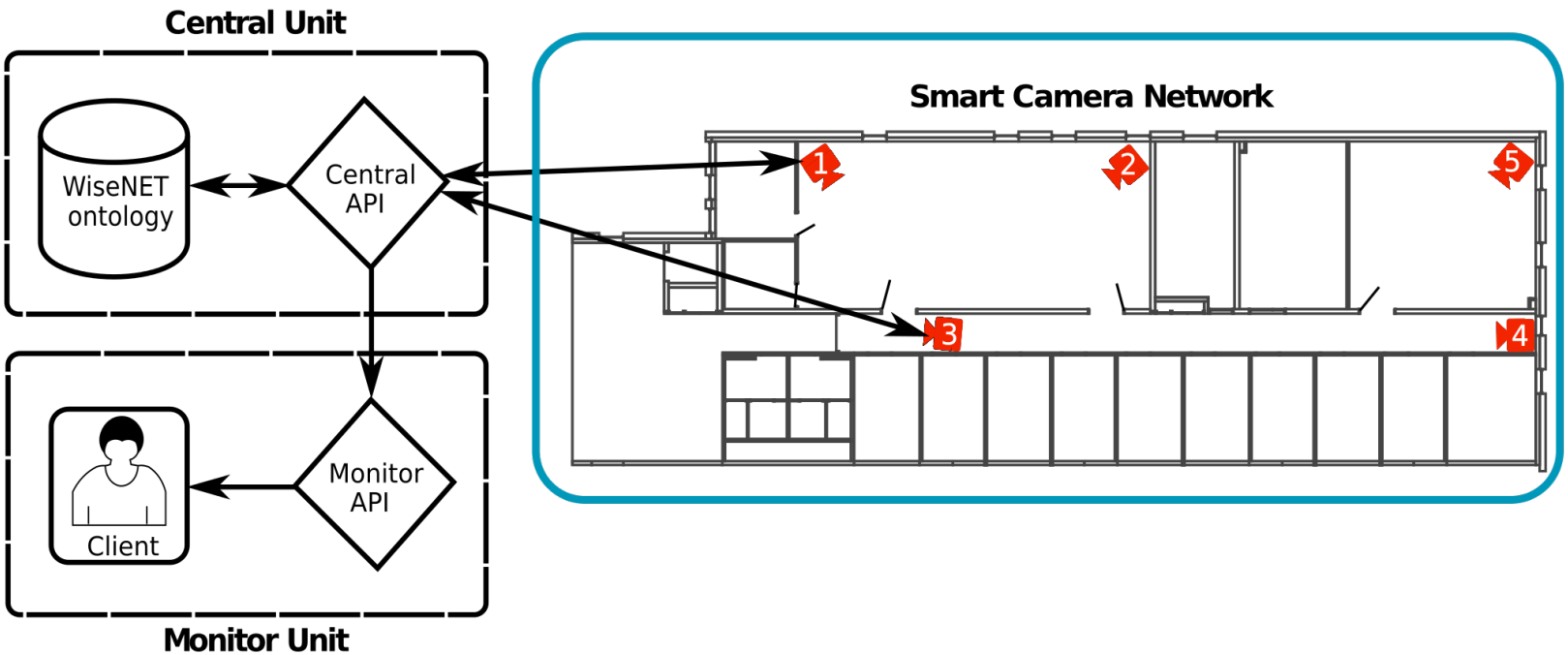
WiseNET vocabulary



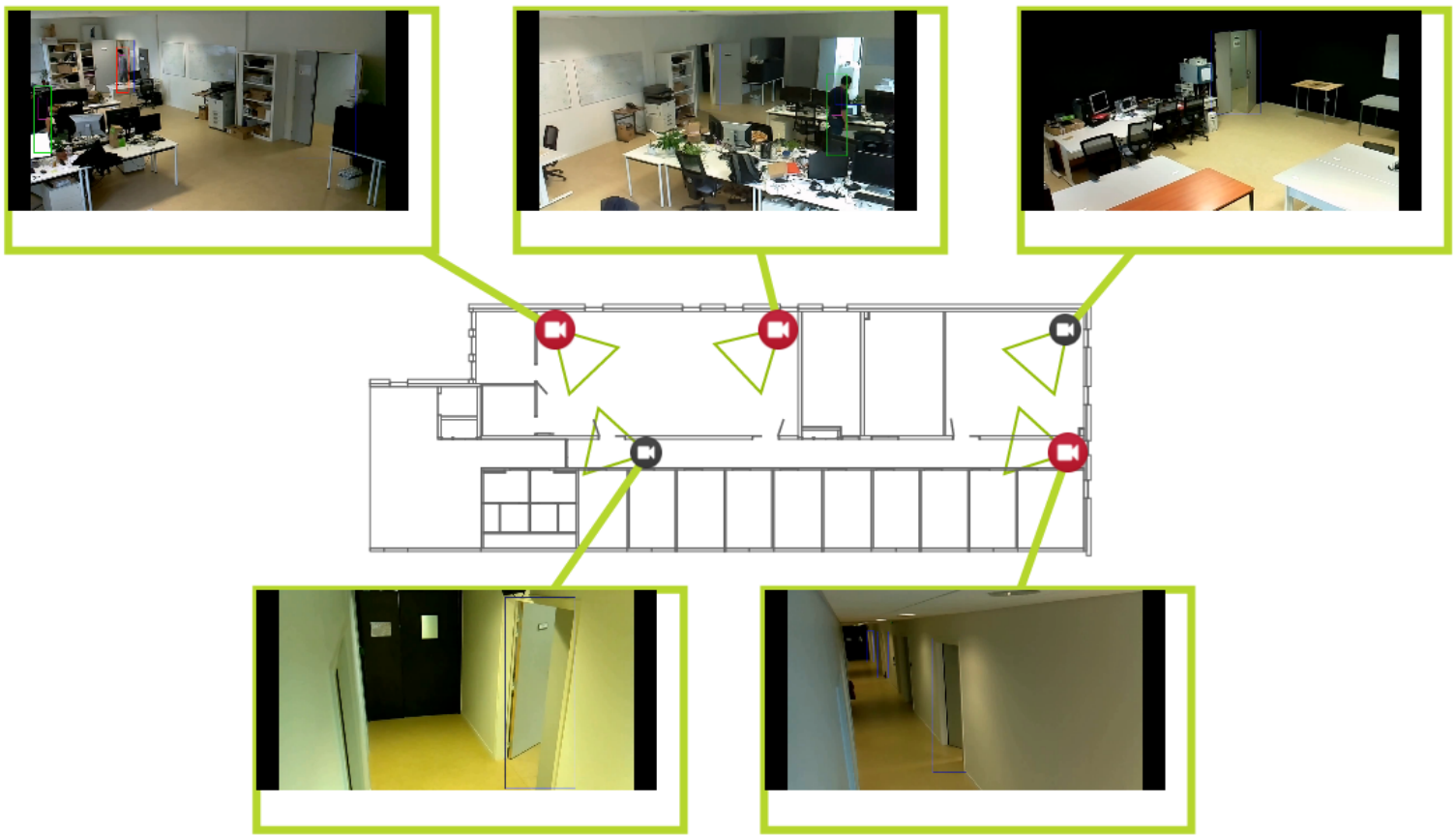
WiseNET - Smart camera network

Software Architecture

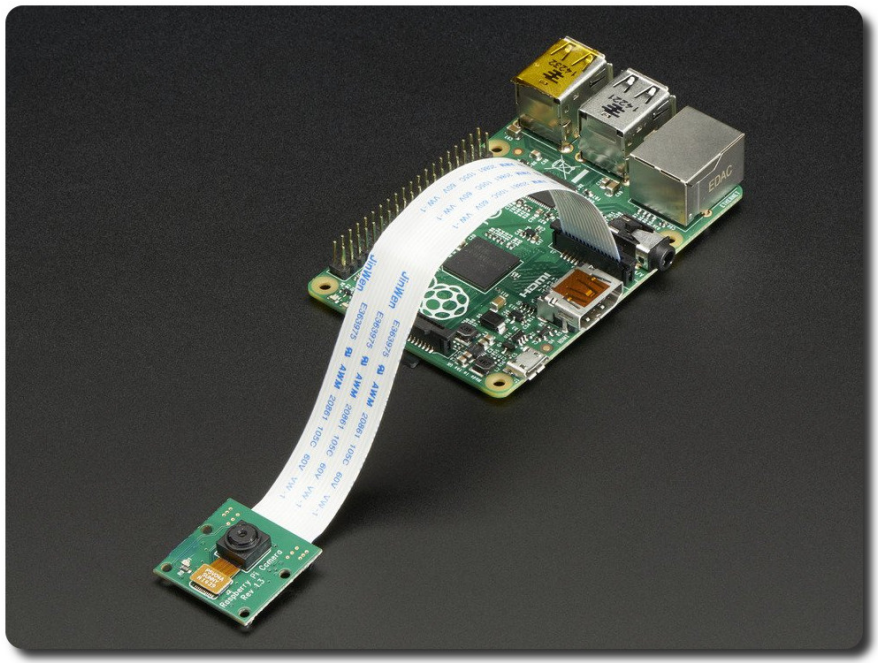
Physical Architecture



WiseNET - Smart camera network



Smart camera



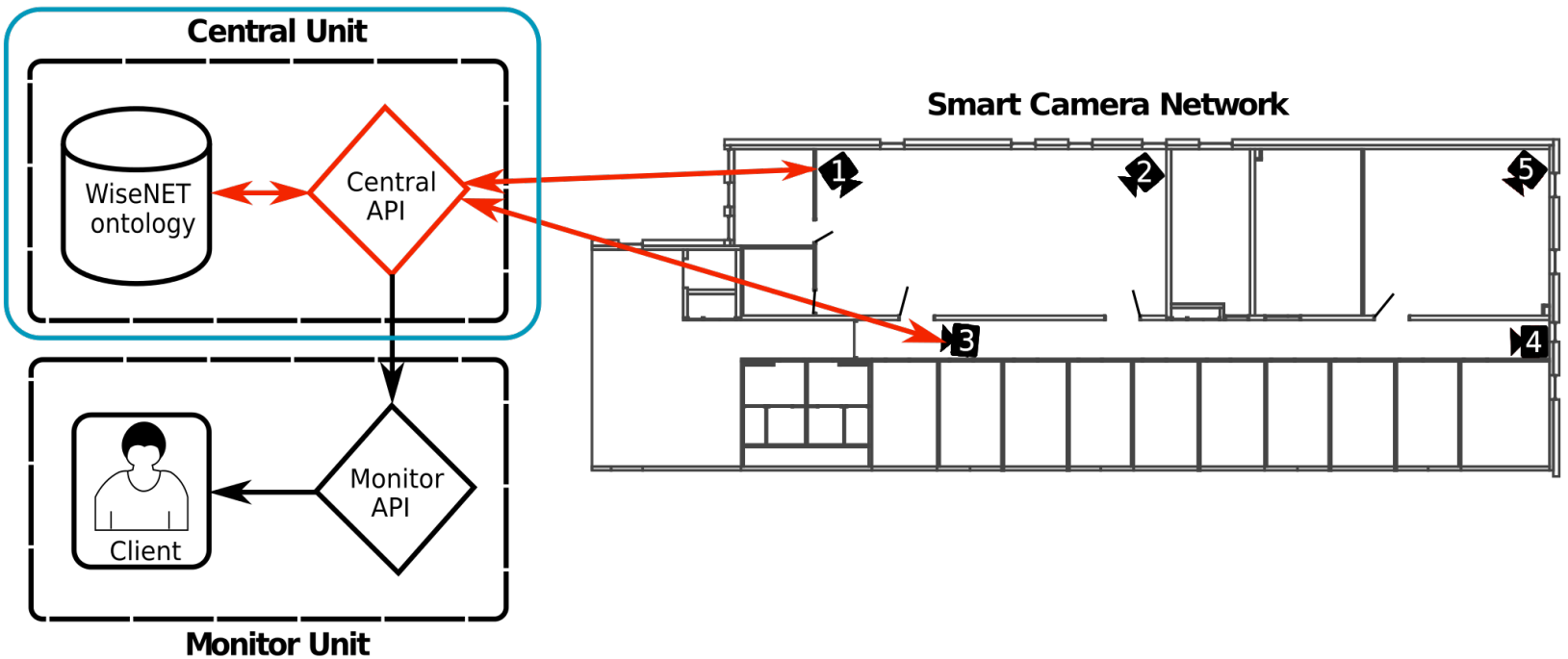
Specifications

- **SoC**: Broadcom BCM2837
- **CPU**: 1.2GHz quad-core ARM Cortex-A53
- **GPU**: Broadcom VideoCore IV
- **RAM**: 1 GB RAM at 900MHz
- **Networking**: 10/100 Ethernet, 2.4GHz 802.11n wireless
- 5 Megapixel sensor
- Video supports 1080p30, 720p60 and 640x480p90
- Fixed-focus

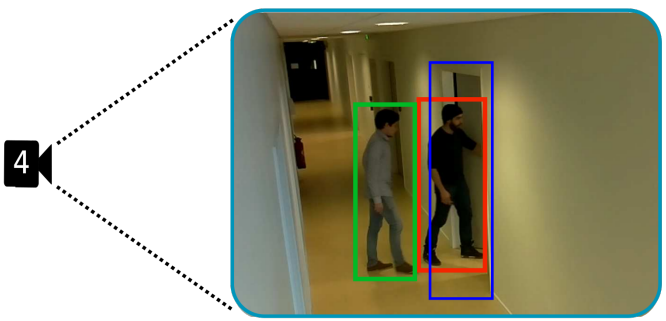
WiseNET - Central unit

Software Architecture

Physical Architecture



Smart camera message

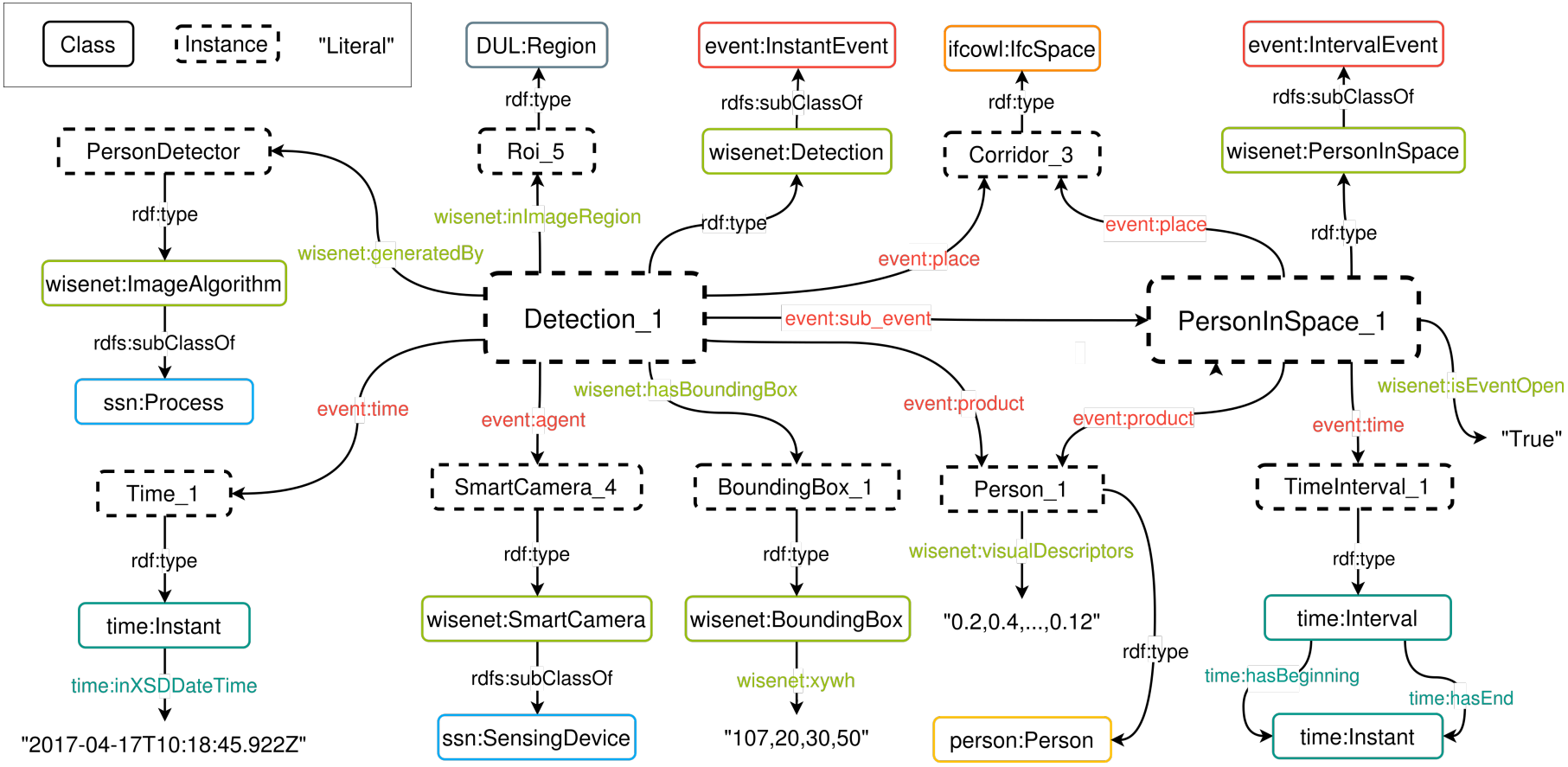


Knowledge Extraction

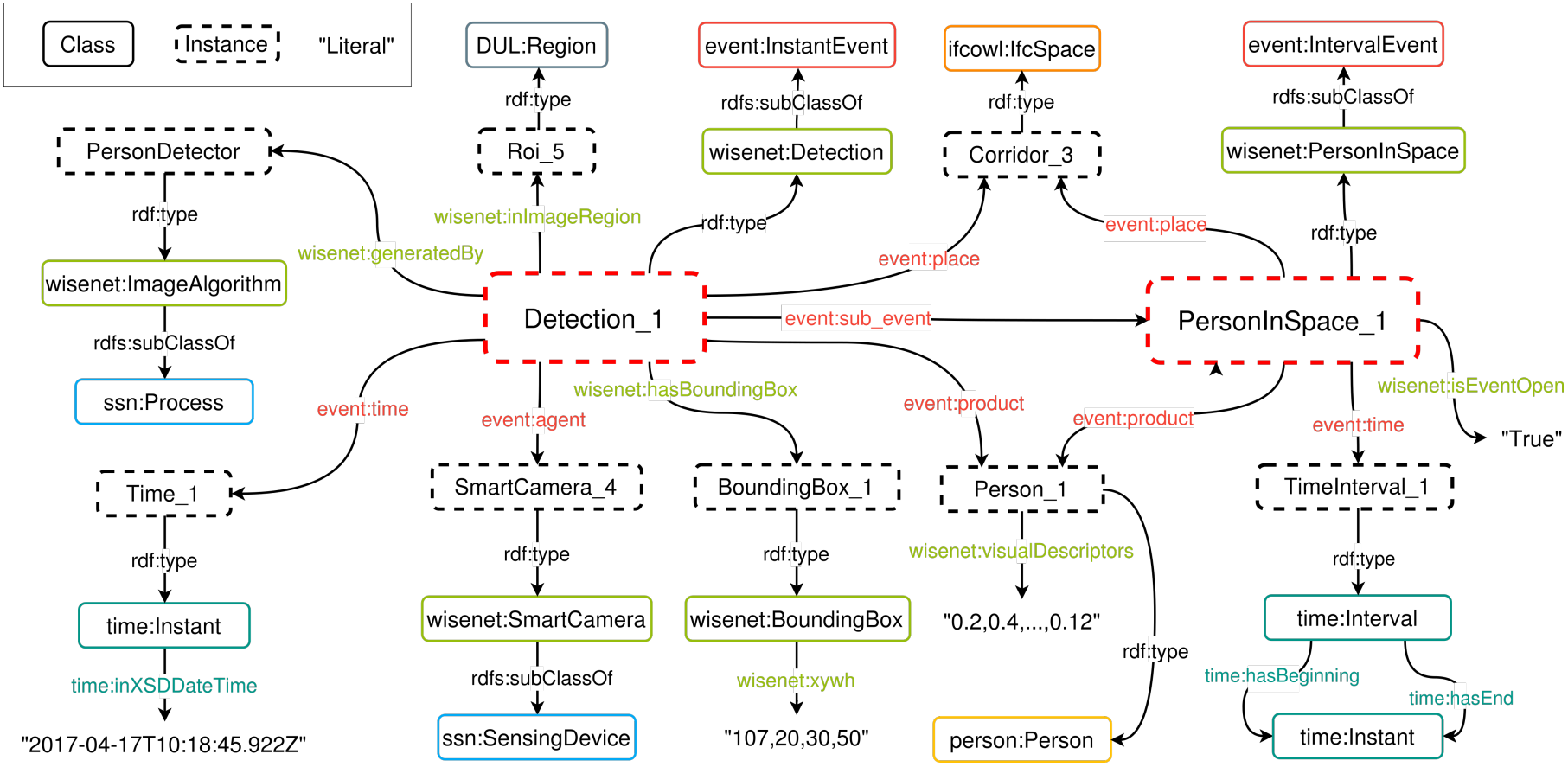
Smart Camera Message


```
{
  "SmartCamera": "SmartCamera_4",
  "inXSDDateTime": "2017-04-17T10:18:45.922Z",
  "detections": [
    {
      "ImageAlgorithm": "PersonDetection",
      "RegionOfInterest": "null",
      "xywh": [82,22,24,52],
      "visualDescriptors": [0.0,0.1,...,0.7]
    },
    {
      "ImageAlgorithm": "PersonDetection",
      "RegionOfInterest": "Roi_5",
      "xywh": [107,20,30,50],
      "visualDescriptors": [0.2,0.4,...,0.12]
    }
  ]
}
```

Semantic graph



Semantic graph



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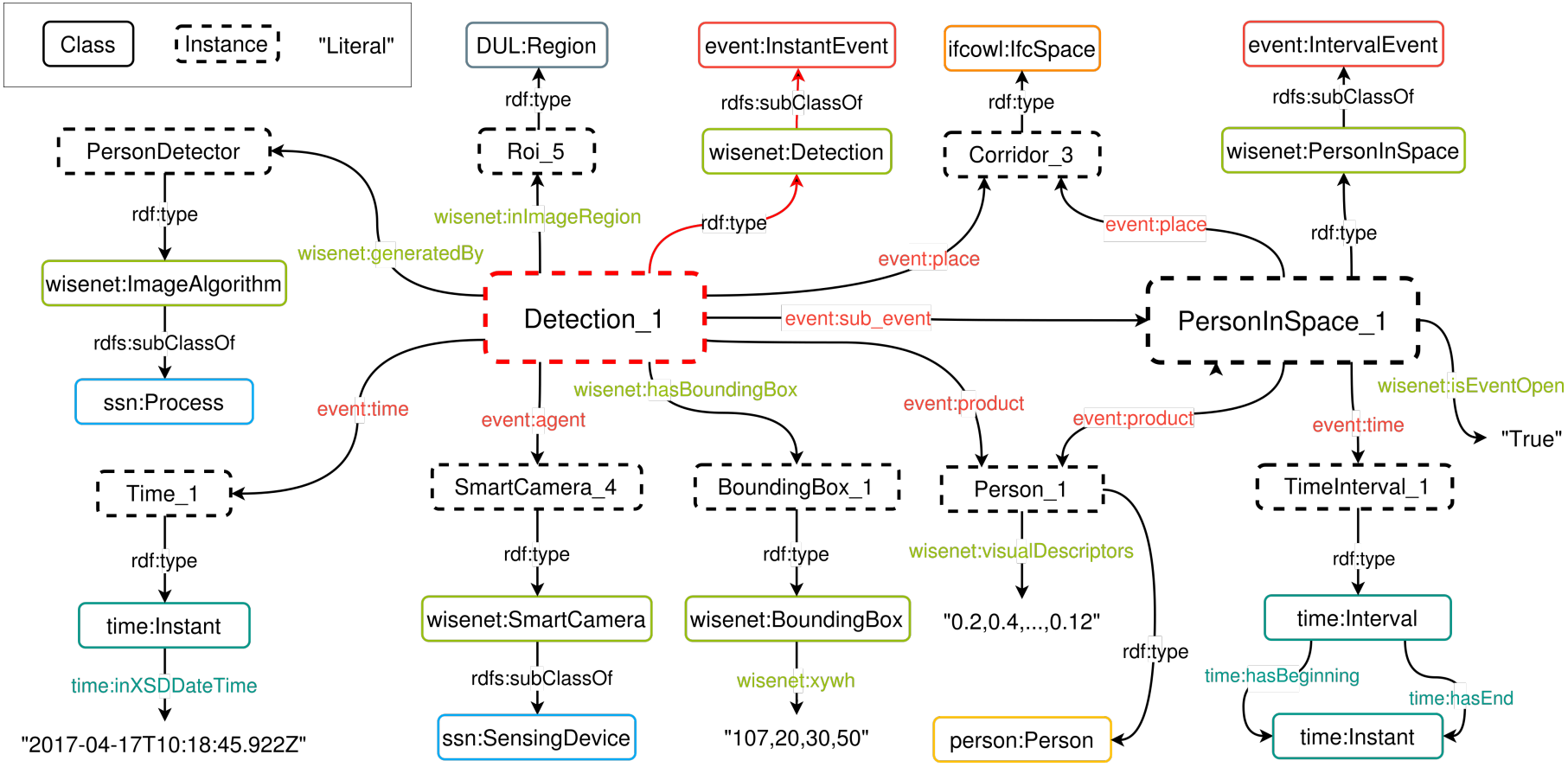

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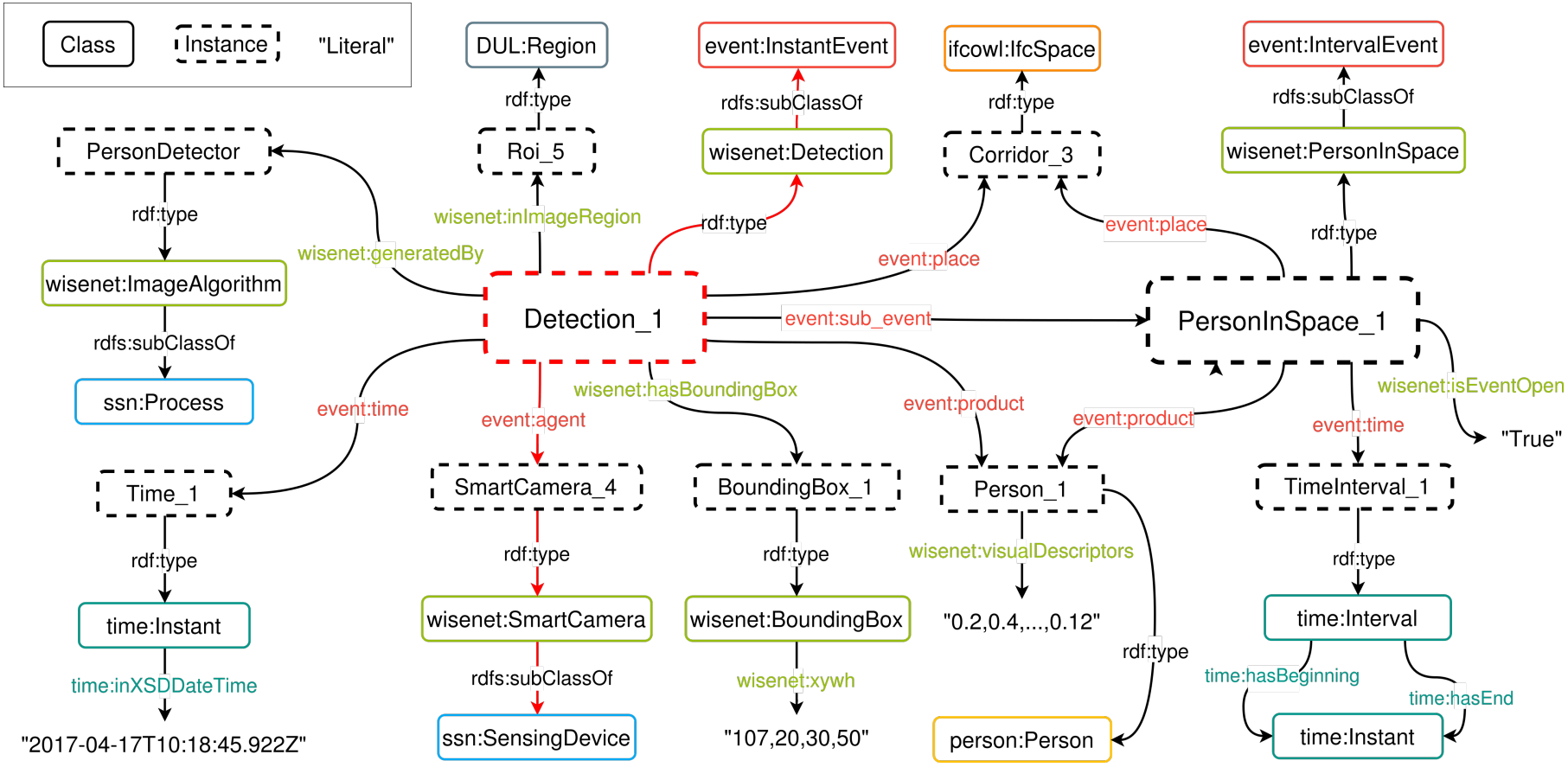

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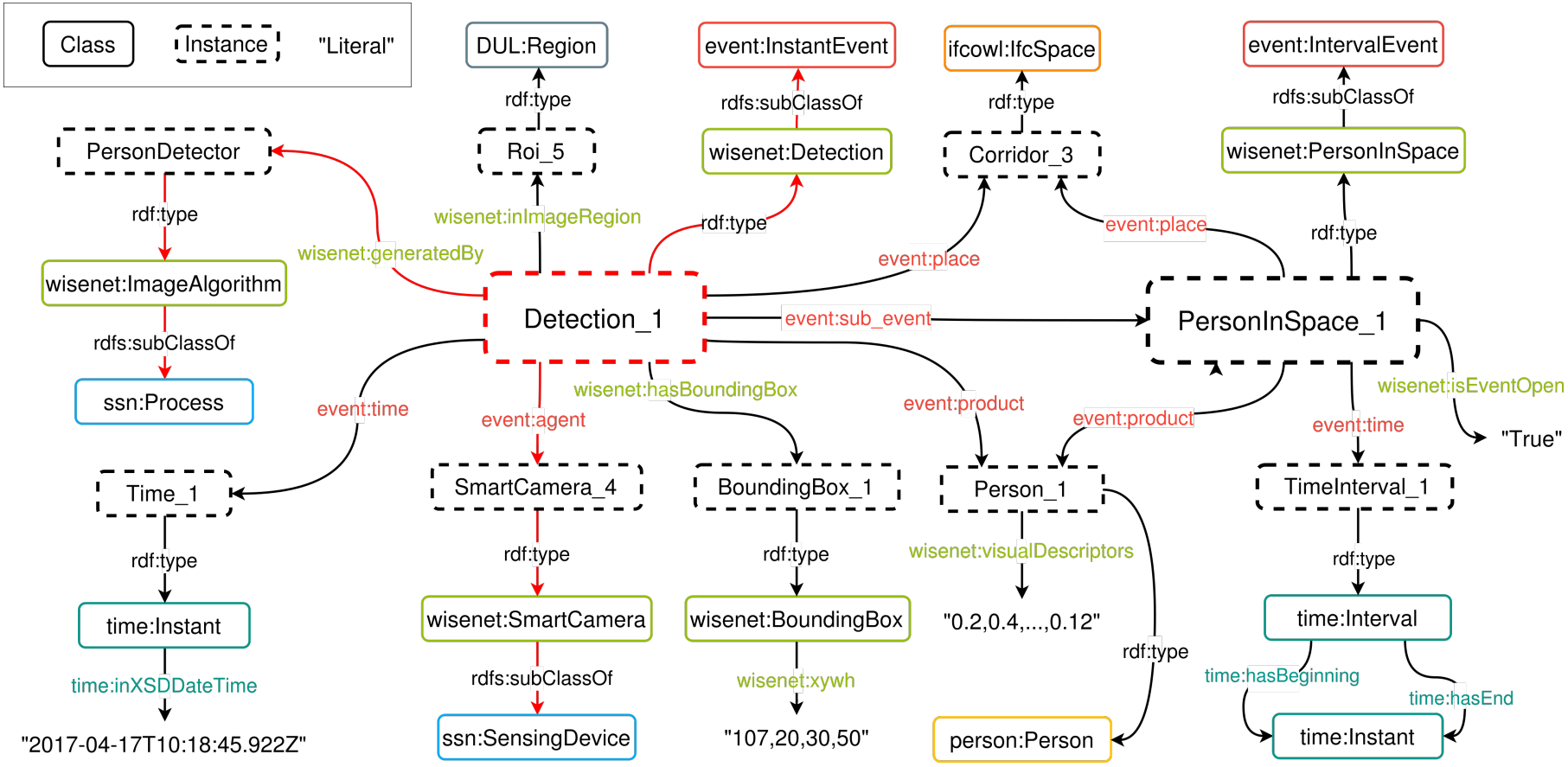
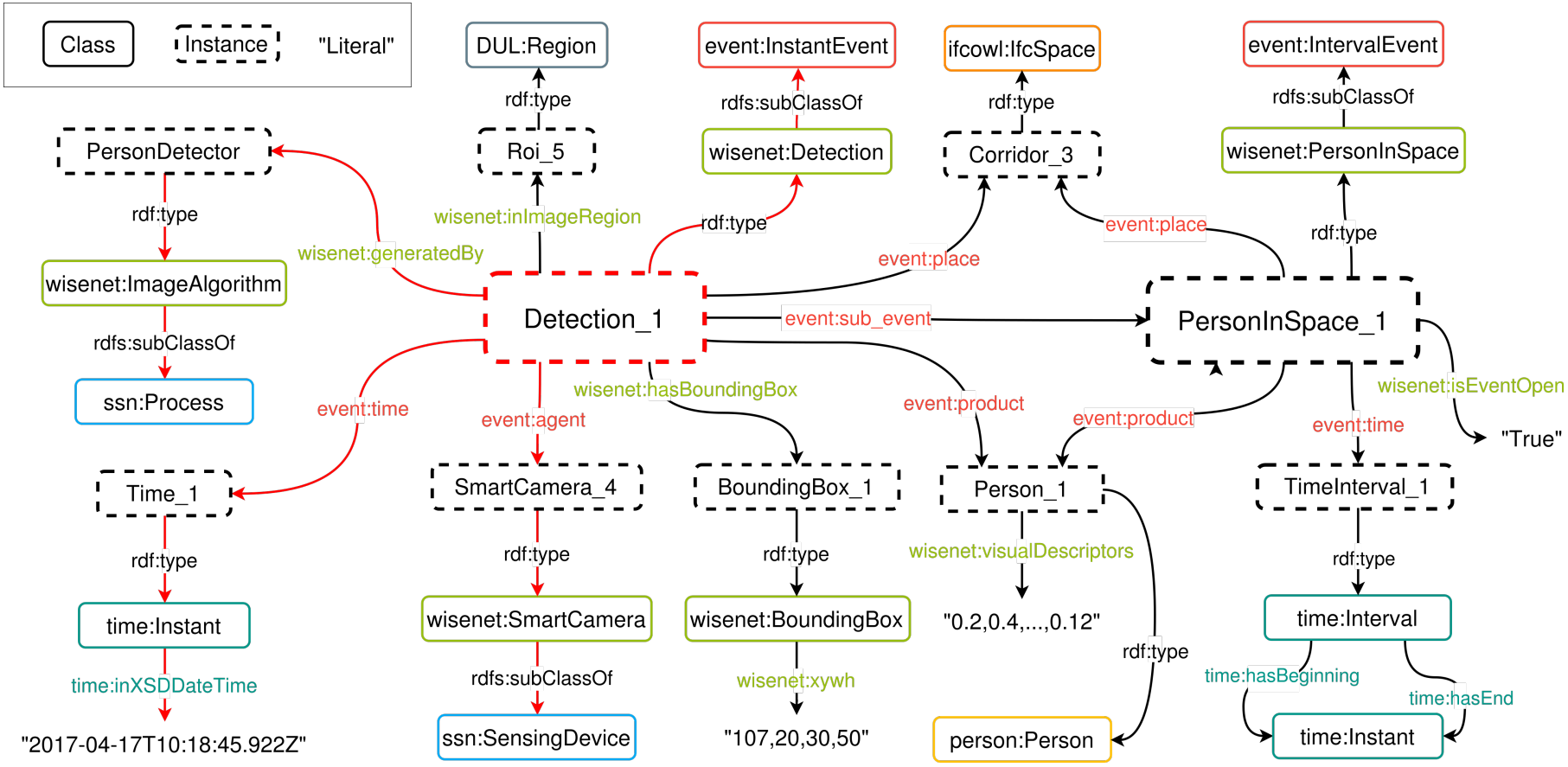
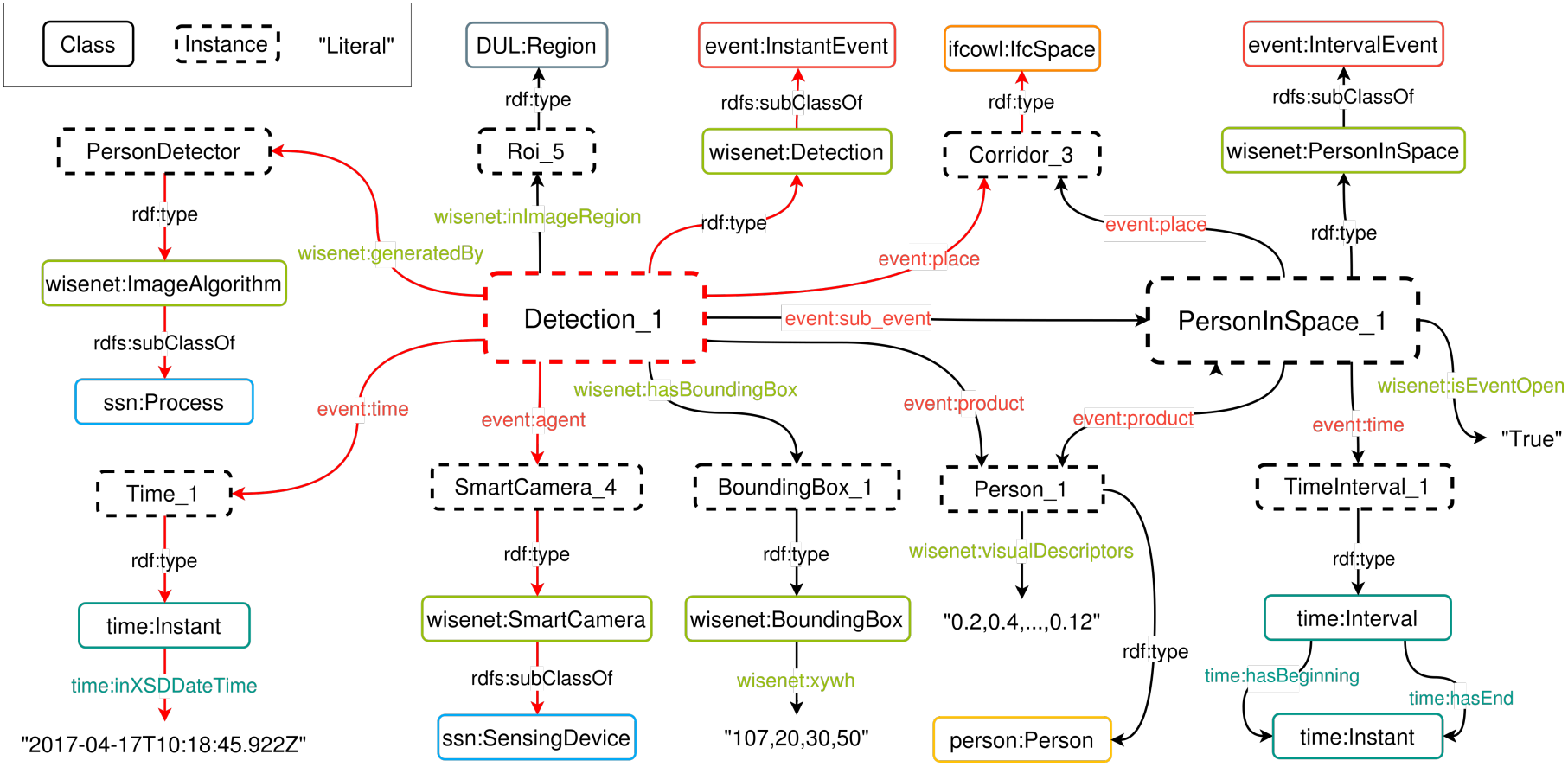


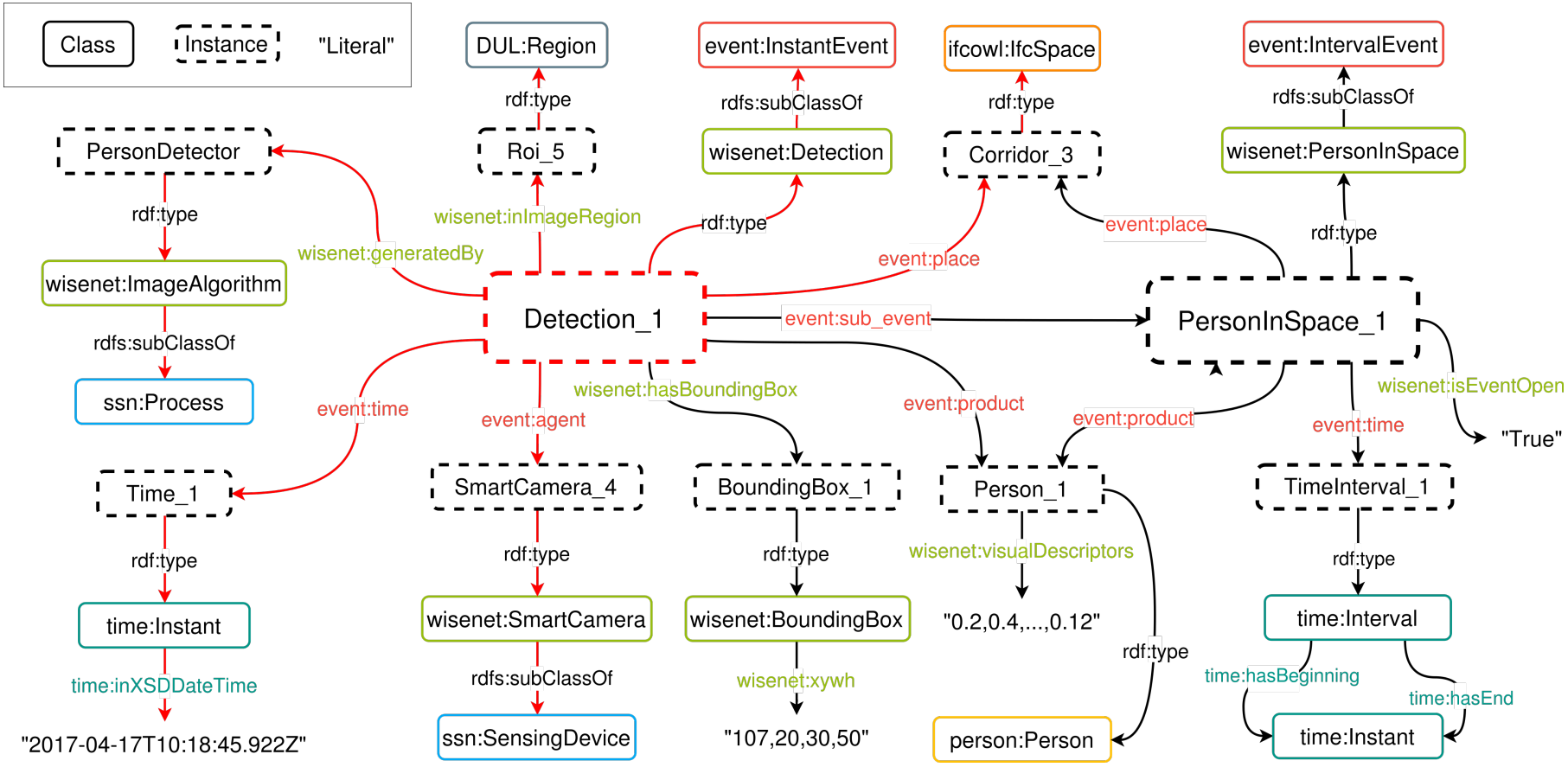
Semantic graph



Semantic graph



Semantic graph



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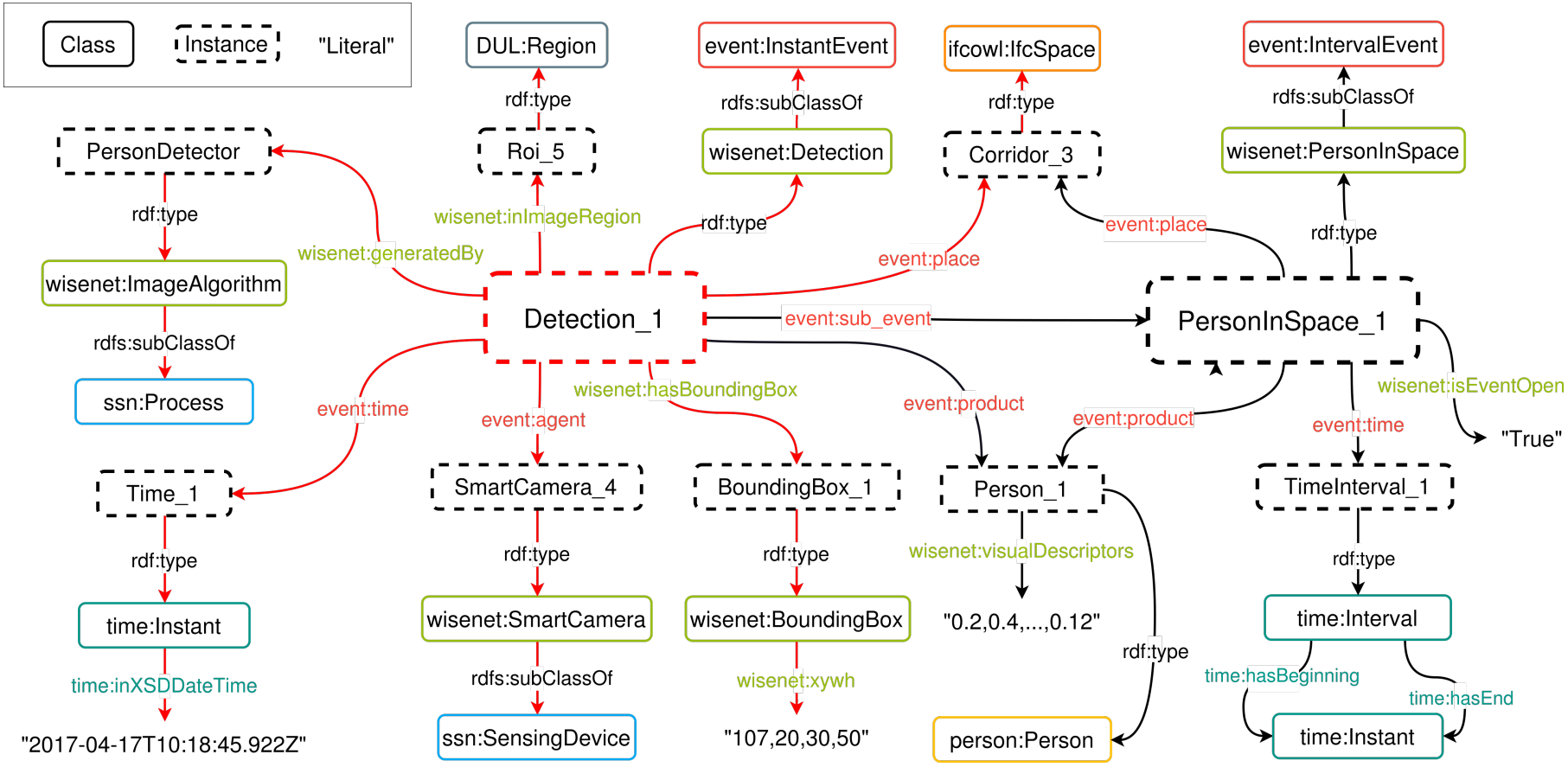

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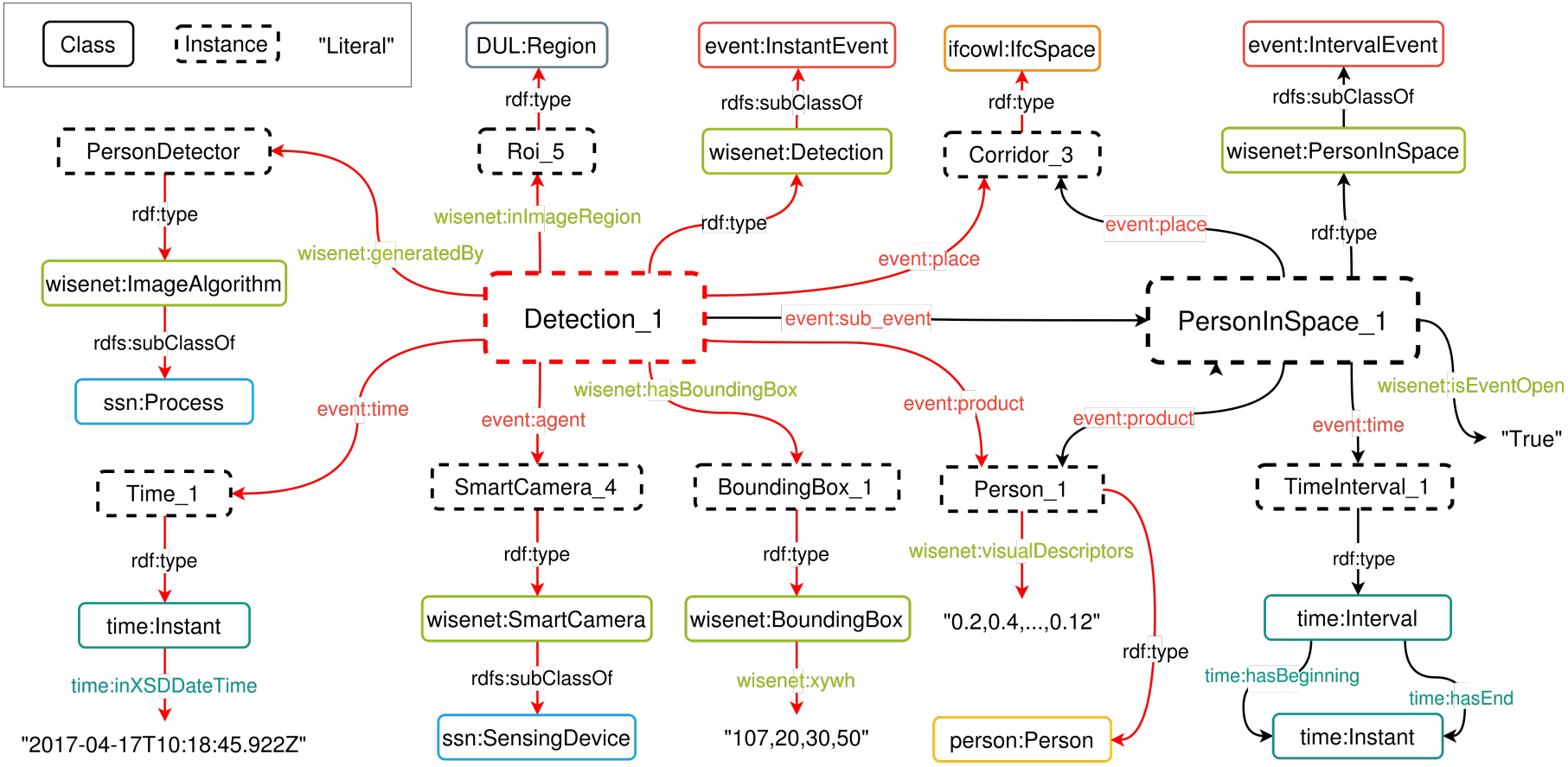
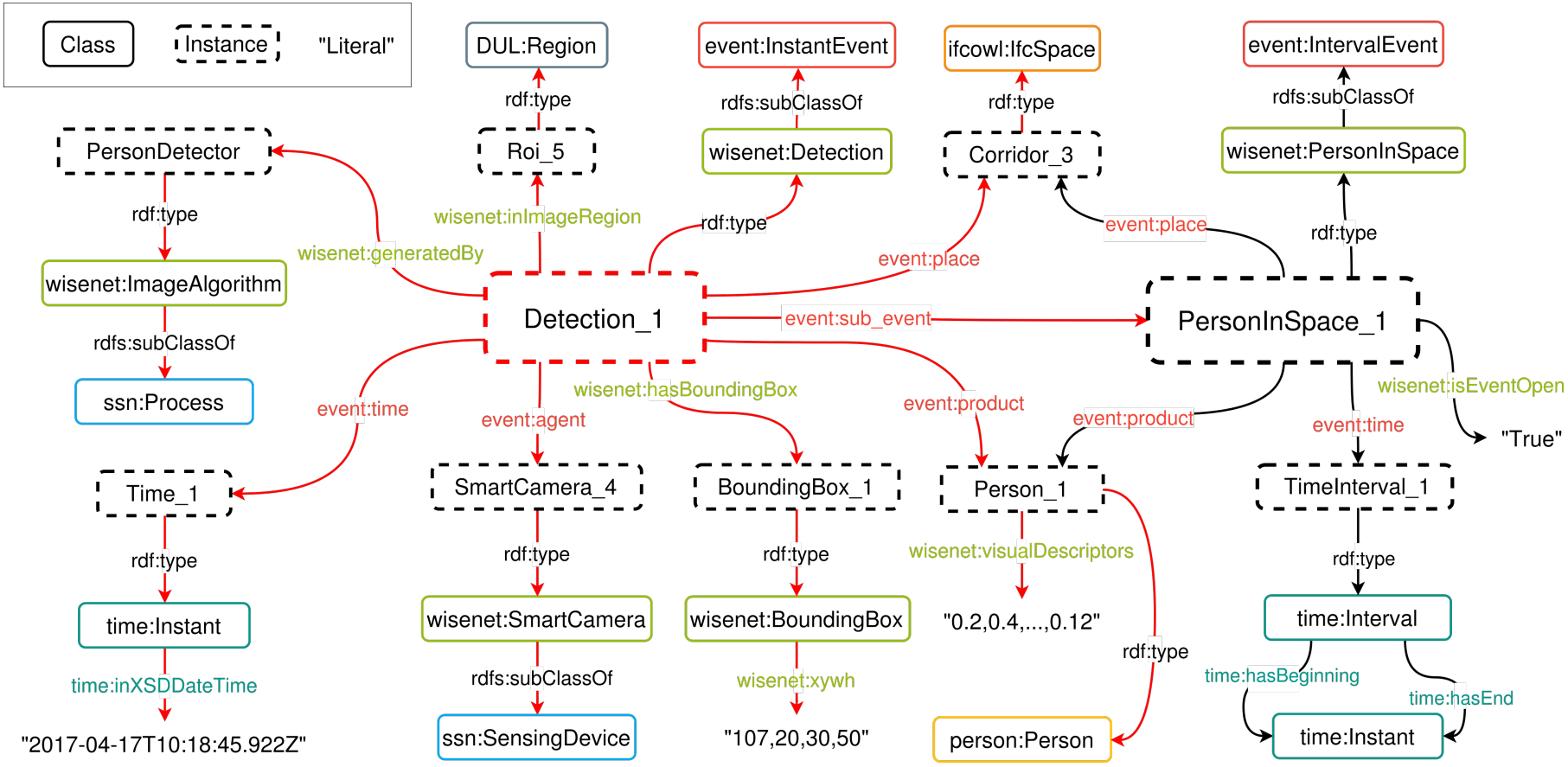


Semantic graph



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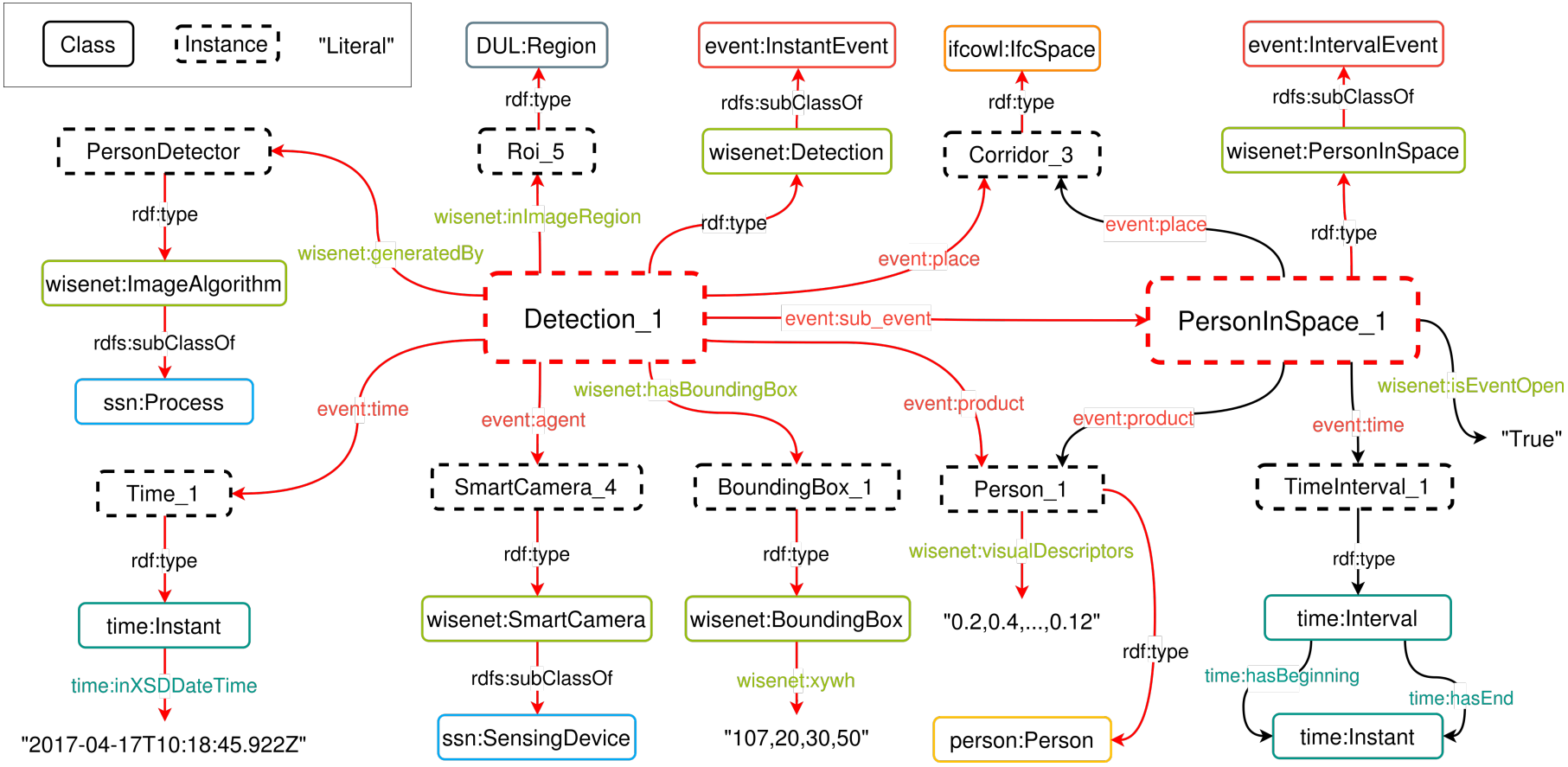

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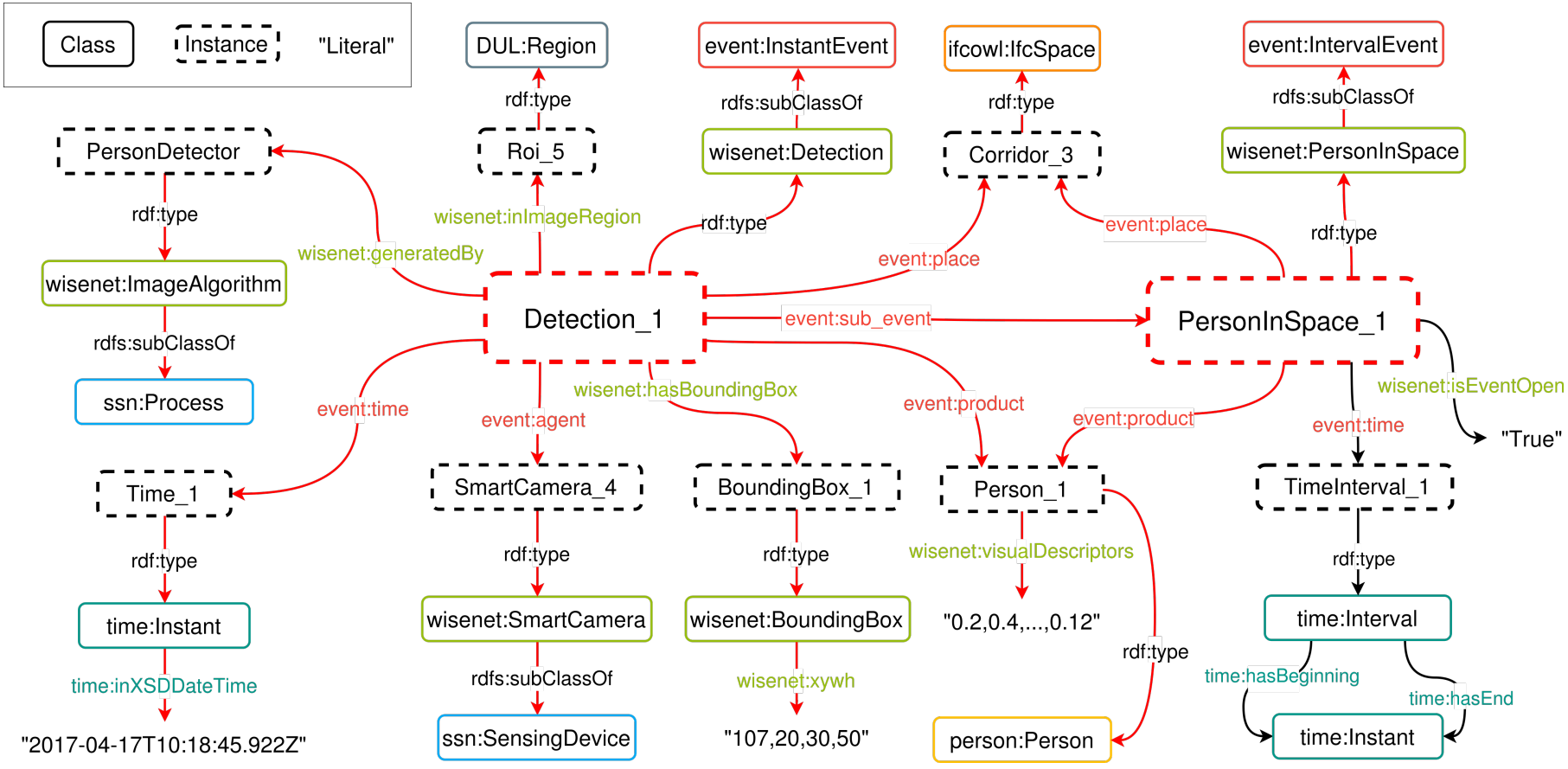

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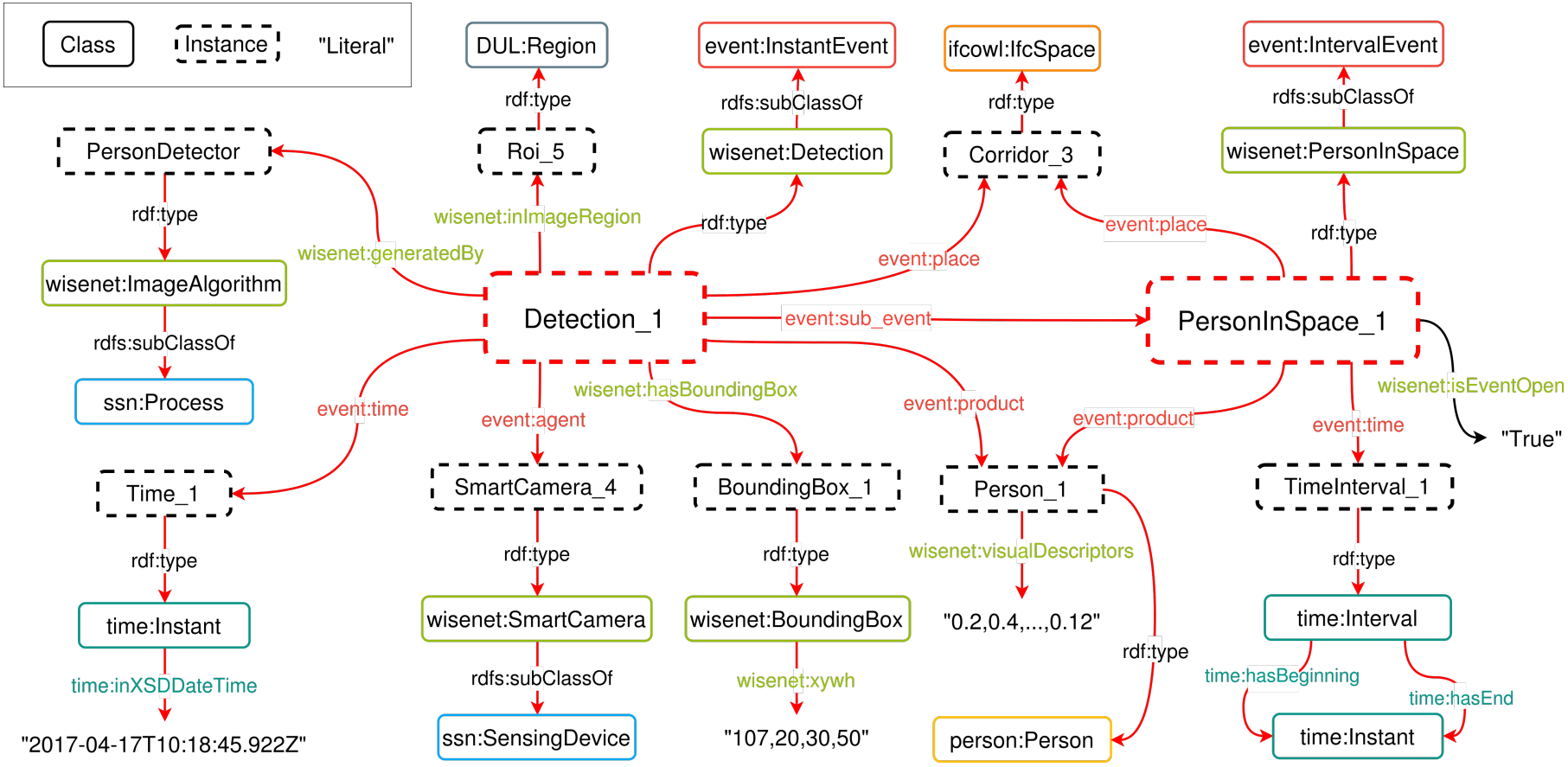

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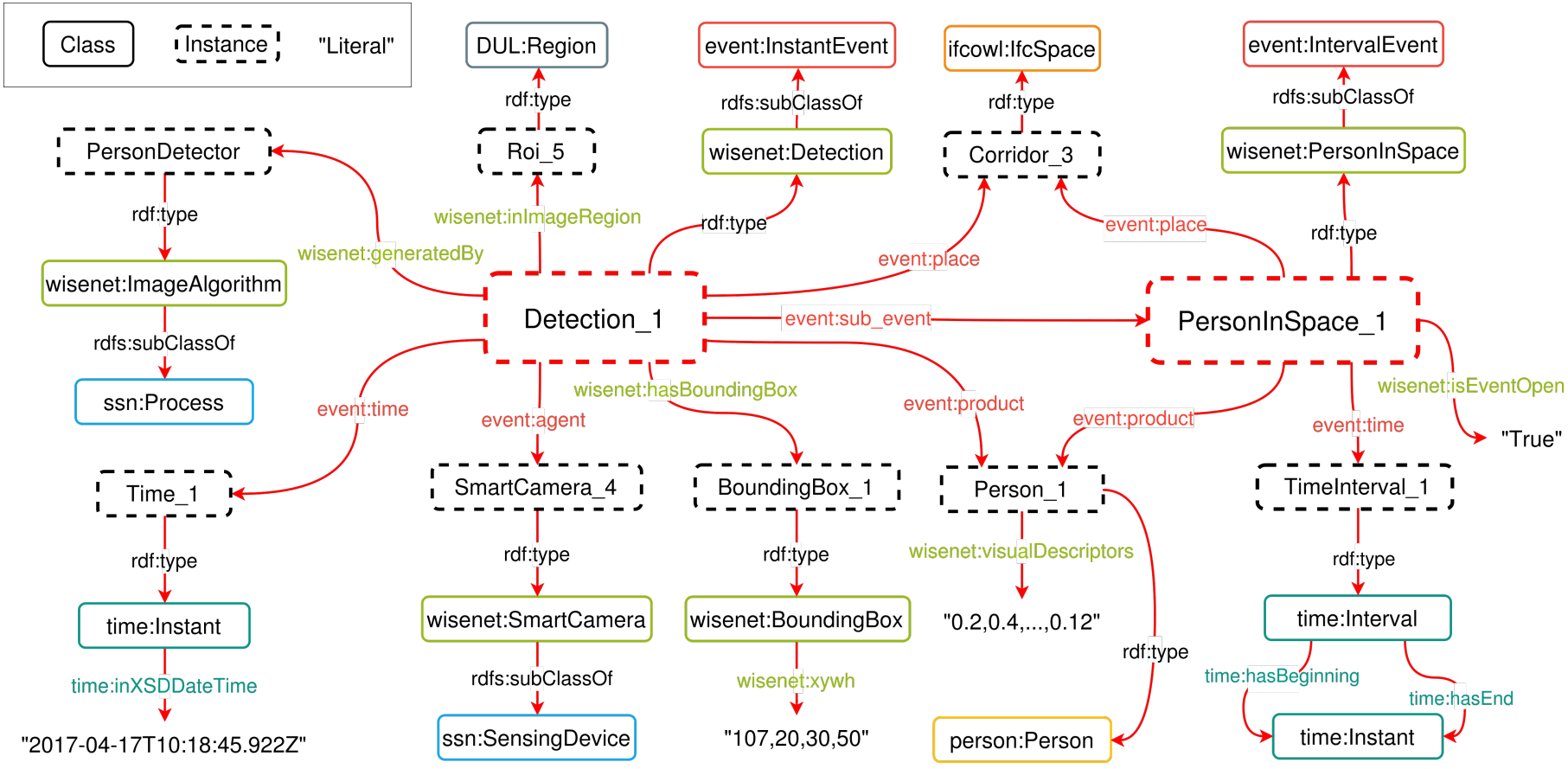
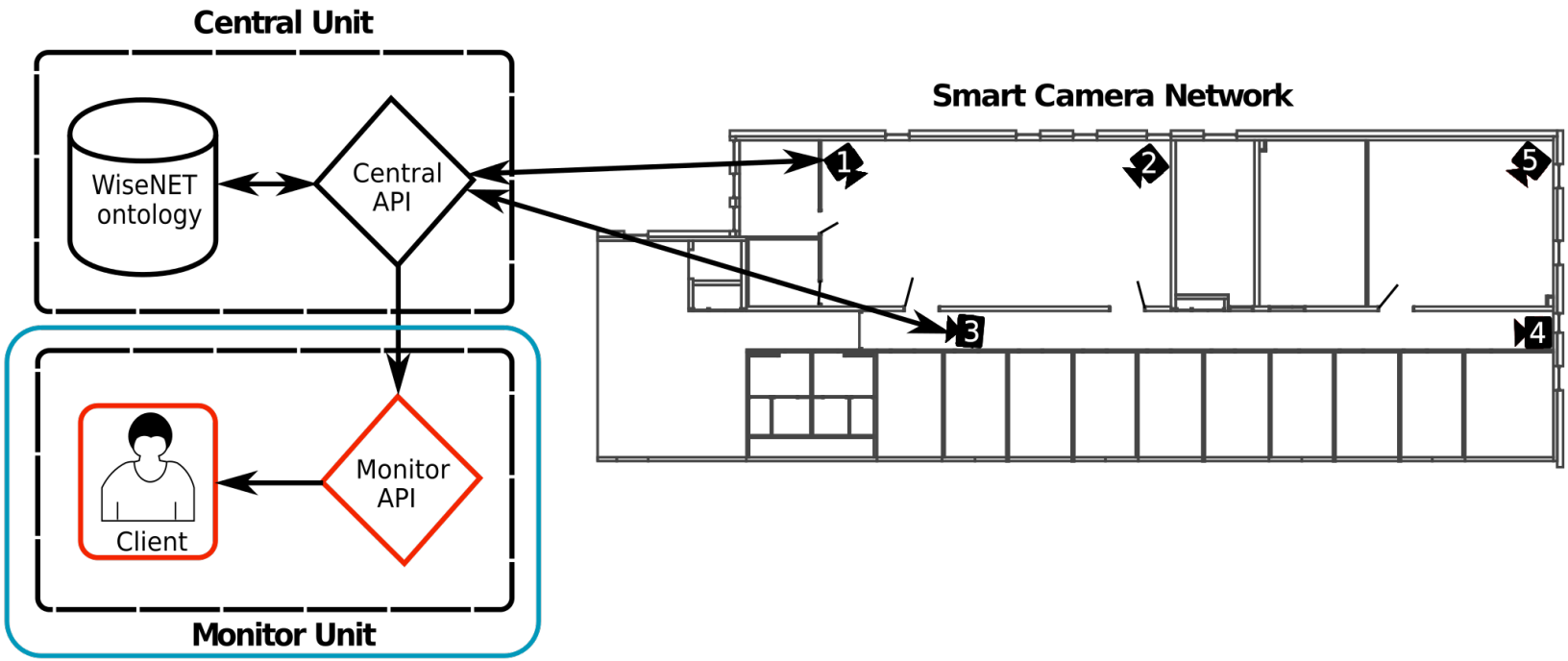


WiseNET - Monitor unit

Software Architecture

Physical Architecture



Monitor unit - Querying

- How many rooms do the storeys have?
- Is a space occupied or empty?
- At what time does a person left a space?
- What is the most used door?
- What is the most visited space?
- How many people was in a space a specific time?

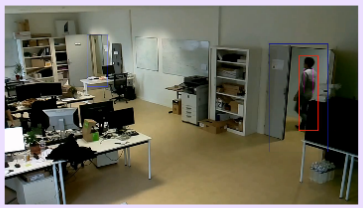
Monitor unit - Querying

How many people was in *Corridor_3* at time *2017-04-17T10:18:45.922Z* ?

```
SELECT COUNT (?x) AS ?numberOfPeople
WHERE {
      ?x rdf:type wisenet:PersonInSpace;
      event:place inst:Corridor_3;
      event:time ?timeInterval.
      ?timeInterval time:hasBeginning/time:inXSDDateTime ?startTime.
      ?timeInterval time:hasEnd/time:inXSDDateTime ?endTime.
      FILTER (?startTime < "2017-04-17T10:18:45.922Z"^^xsd:dateTime &&
            ?endTime > "2017-04-17T10:18:45.922Z"^^xsd:dateTime)
}
```

Monitor unit - Reasoning

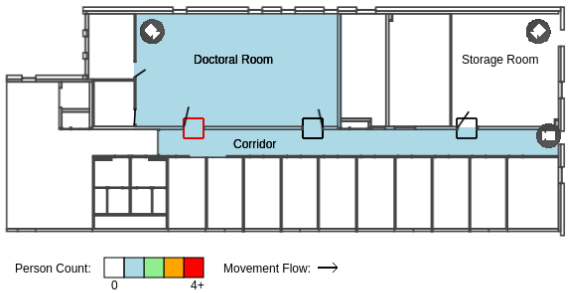
Doctoral Room



Smart Camera Message

2017-04-20T12:15:06.233Z

- Image algortihm : personDetection
  Region Of Interest : ROI_1



Storage Room

Smart Camera Message

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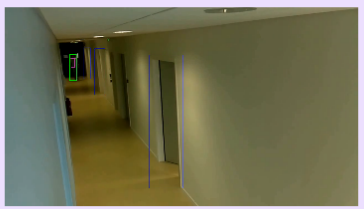
- --
  --
  --

Corridor Room

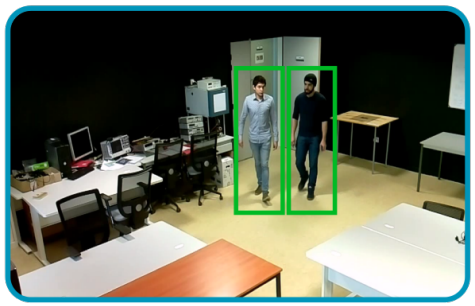
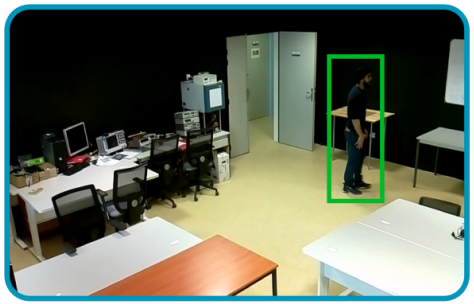
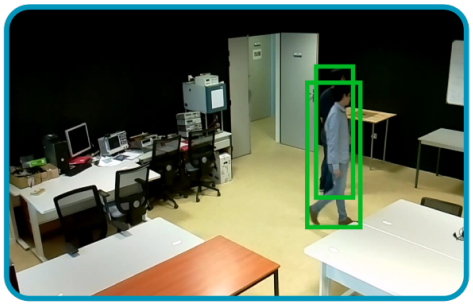
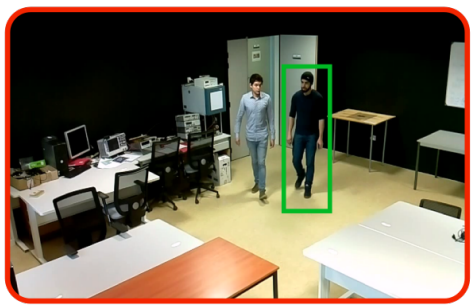
Smart Camera Message

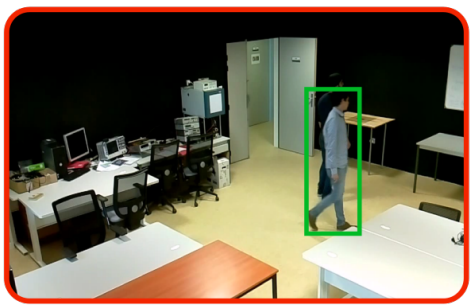
2017-04-20T12:15:06.233Z

- Image algortihm : personDetection



Problems of classical computer vision





Missed Detection

False Detection

Occlusion

Conclusions

- Semantic-based real-time reasoning system, that fuses different sources of data.
- Data selection - solved using computer vision algorithms.
- Data integration - solved by the semantic based system that enables the interoperability.
- The privacy protection - solved by not sending any image just extracting the knowledge of them.
- The main advantage of WiseNET is to produce extra services to building users and to ease the tasks of building managers.
- As a future work we want to prove that a simple visual system + a semantic layer provides an accuracy comparable to deep learning technologies.

Thank you for attention!!

... AnY qUesTioNs ? ...

For more information visit the project website: http://wisenet.checksem.fr/