Data collection and progress monitoring using autonomous rover and IoT

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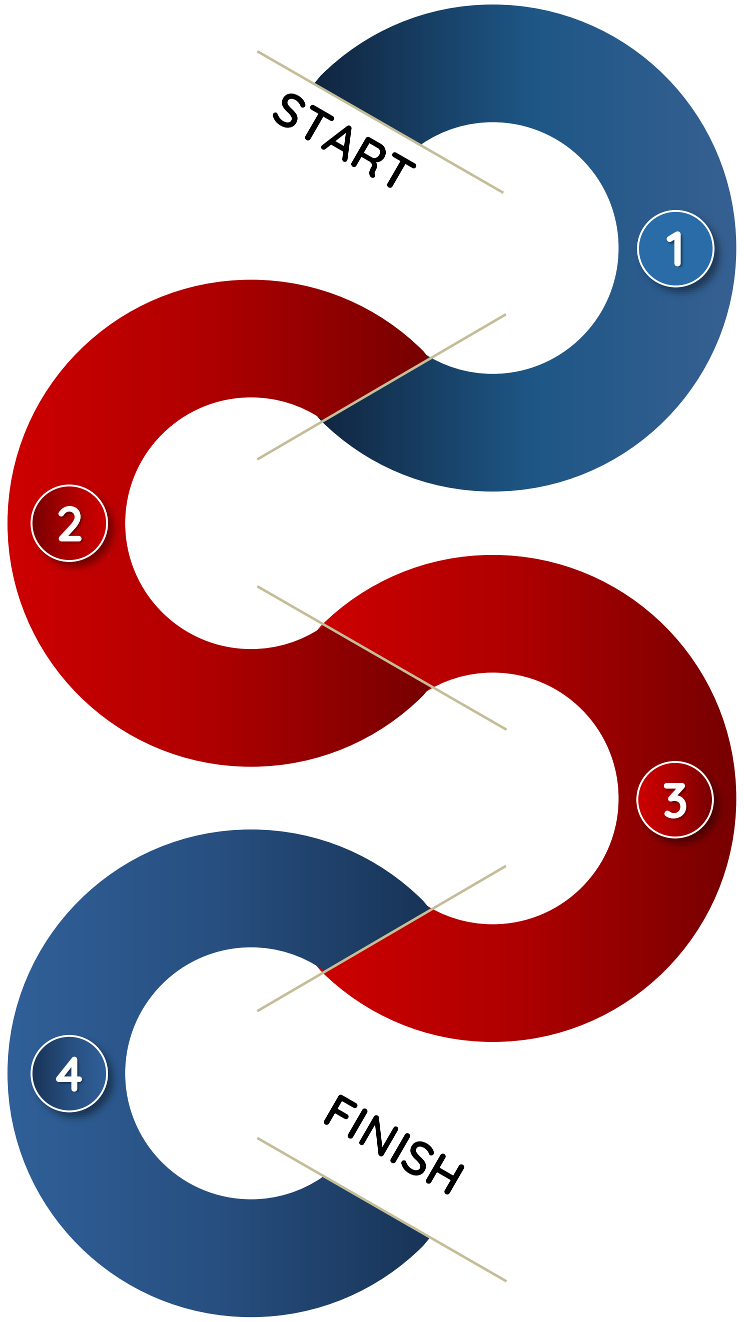
Problem statement

- Progress Monitoring is a manual and time-consuming task
  - Not very accurate
  - Needs to be automated

Research objectives

- Automized progress monitoring on construction site
  - Automated data collection
    - Autonomous robot navigation
    - Autonomous data merging
  - Comparison between as-built and as-planned model
    - 3D reconstruction
  - Automated generation of dashboards

Project Workflow



Data Collection by the Rover

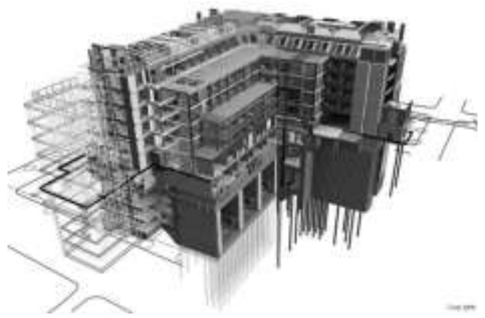
Used to collect video, pictures and point cloud

BLE Beacons Location

Used to collect the position of small elements of the as-built model.

Comparison between as-built model And as-planned 4D model

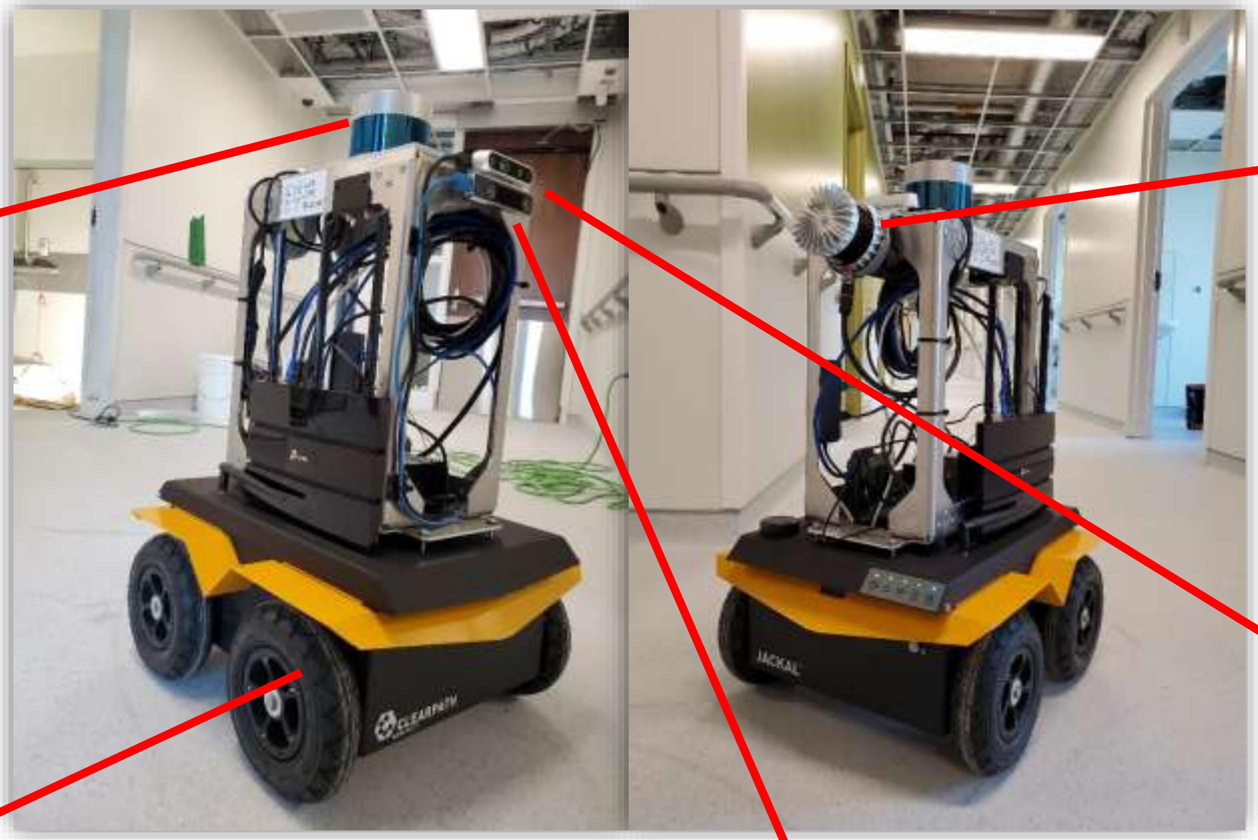
Compare the two models to see the differences



Dashboards of progress monitoring

The final goal is to generate dashboards to help the construction workers on site

The Rover



Velodyne Puck

- 32 laser lines
- Field of View: 360° horizontal and 40° vertical
- Range: 120 m

Ouster OS1 -32

- 32 laser lines
- Field of View: 360° horizontal and 45° vertical
- Range: 120 m

Clearpath JACKAL

- All-terrain vehicle
- Size: 508 x 430 x 250 mm
- Weight: 17 kg
- Max payload: 20 kg
- Max speed: 2.0 m/s
- Run time: 4 hours
- IMU and Wheel Encoders: can help with SLAM

Realsense T265

- Two Fisheye lenses: large field of view
- Inertial Measurement Unit: accurate measurement of rotation and acceleration
- V-SLAM algorithm: tracks camera position and orientation

Realsense D435i

- RGB camera: 1920 × 1080 pixels / 30 frames per second
- Depth: Measures distance to objects in the environment

Goals and challenges

- Modification of A* algorithm
- Path planning based on BIM/IFC semantics

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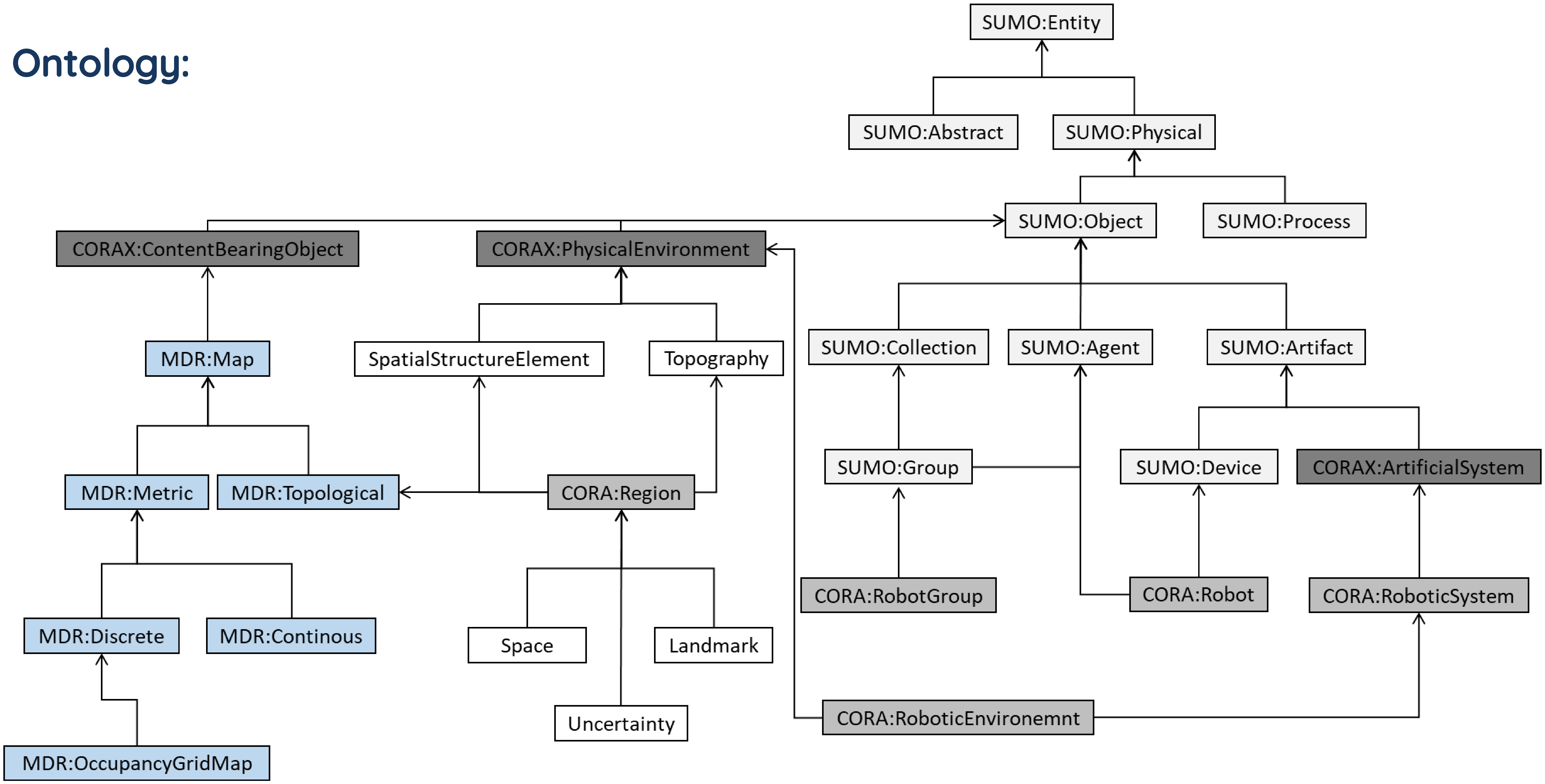
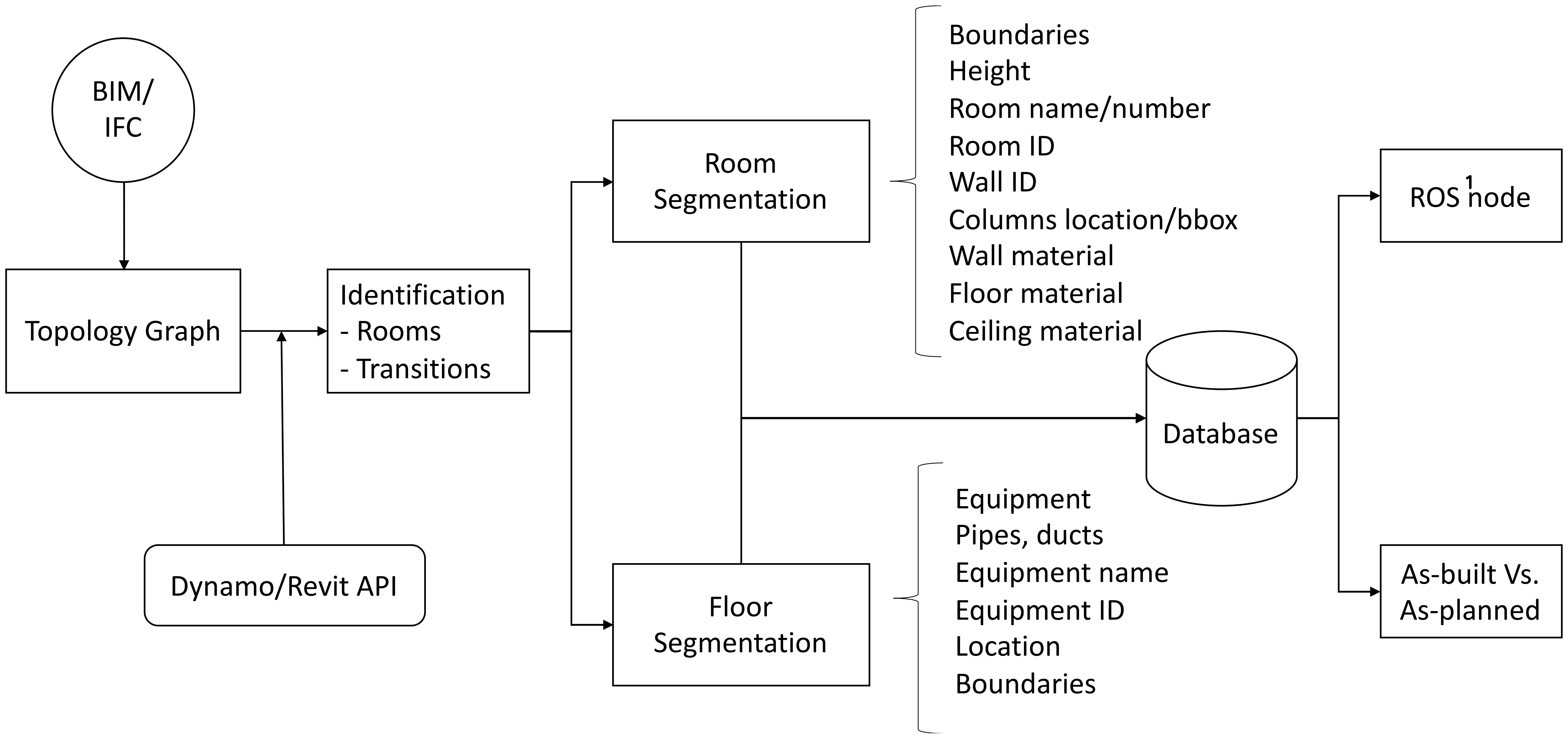
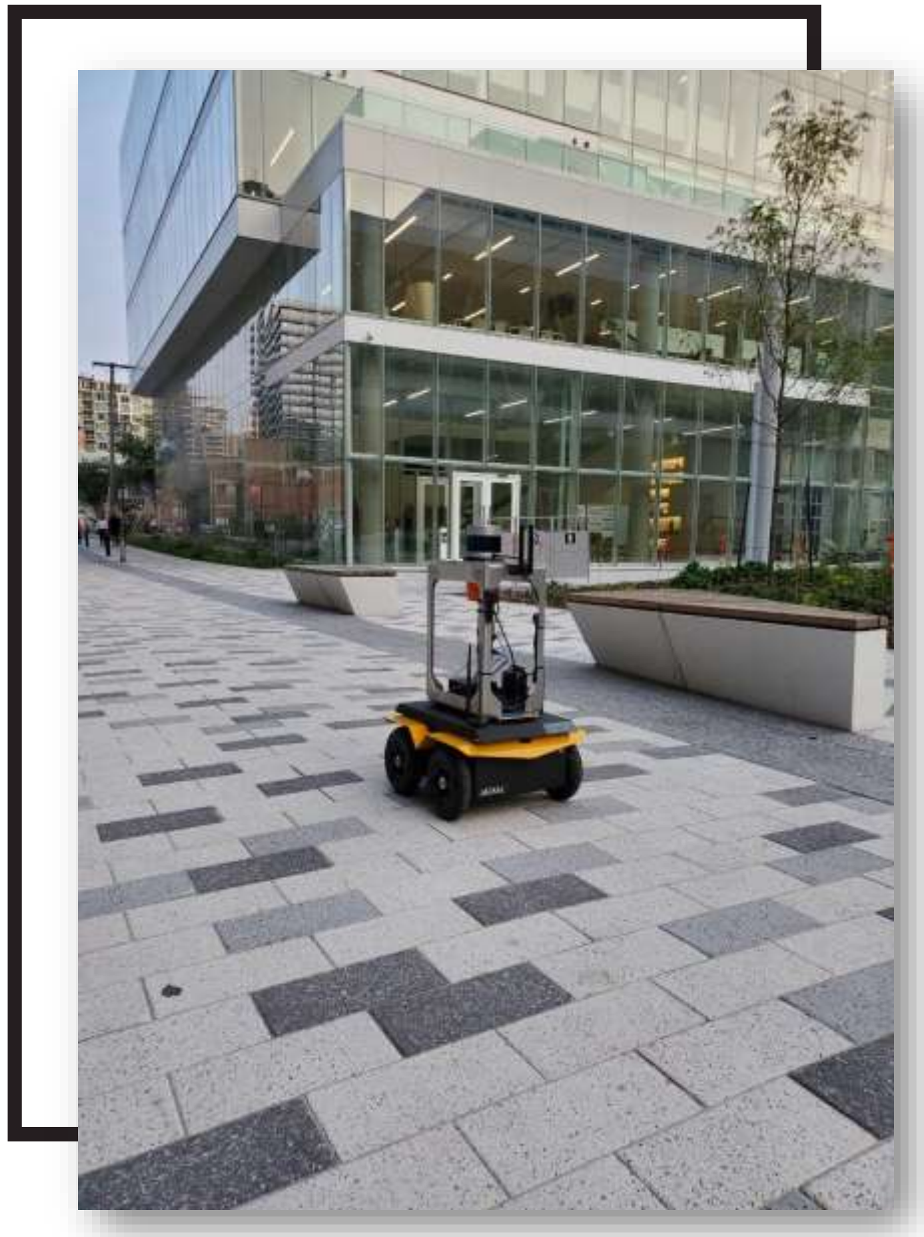
Ontology:

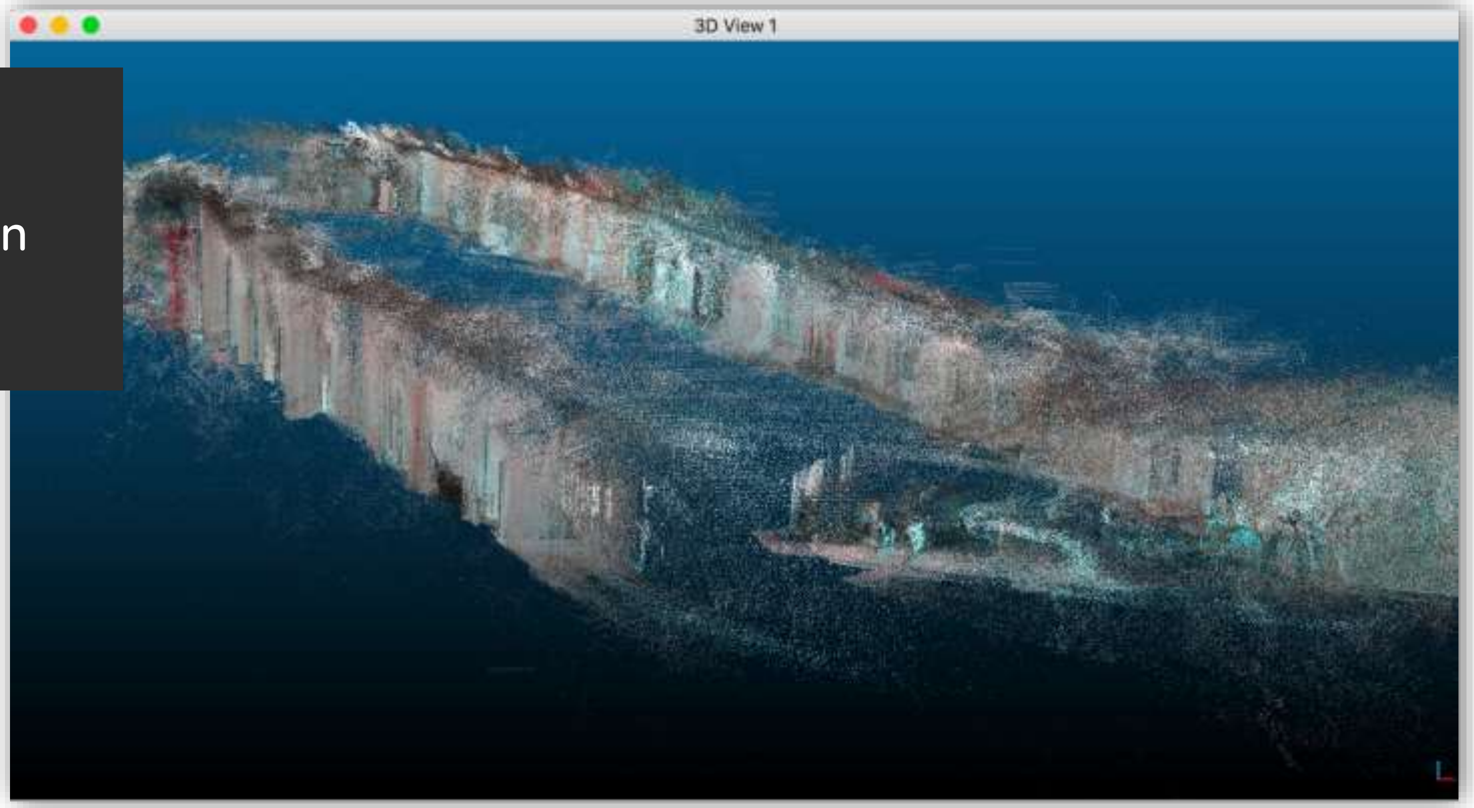

SUMO:Entity
SUMO:Abstract
SUMO:Physical
SUMO:Object
SUMO:Process
CORAX:ContentBearingObject
CORAX:PhysicalEnvironment
MDR:Map
SpatialStructureElement
Topography
SUMO:Collection
SUMO:Agent
SUMO:Artifact
MDR:Metric
MDR:Topological
CORA:Region
SUMO:Group
SUMO:Device
CORAX:ArtificialSystem
CORA:RobotGroup
CORA:Robot
CORA:RoboticSystem
MDR:Discrete
MDR:Continous
Space
Landmark
Uncertainty
CORA:RoboticEnvironemnt
MDR:OccupancyGridMap

Overall dataflow





1 : Robot Operating System



Data Point Cloud

This data point Cloud was collected by the Rover on the CHUM construction Site

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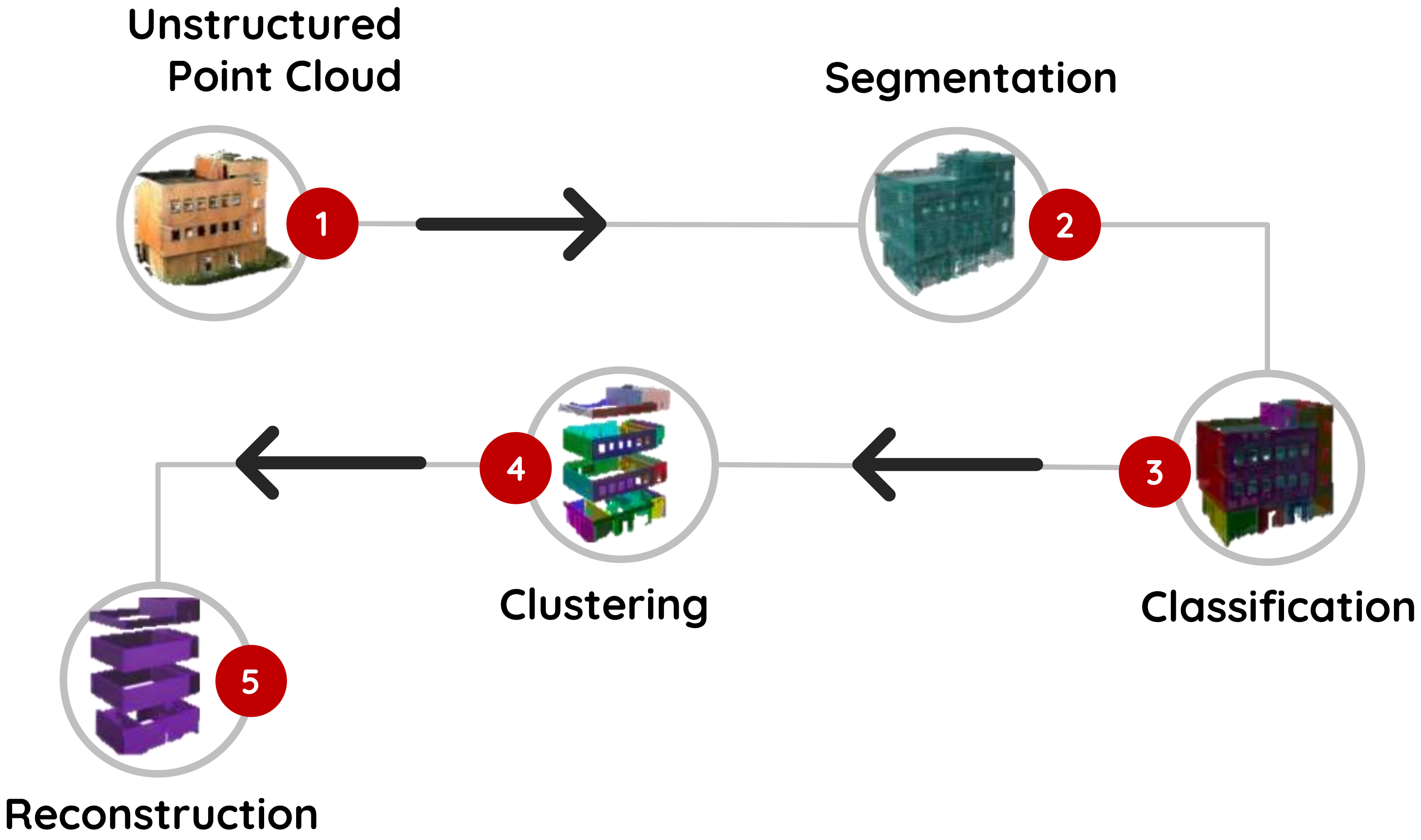
Data Point Cloud

The goal of the data point cloud is to compare the as-built with 4D as-planned model, to see what are the differences

We will use data point cloud to compare LOD200 elements: Walls, Floors, Ceilings

Treatment of the Point Cloud



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BLE Beacons

The goal of the BLE beacons is to localize small elements of the construction to see if they are well positioning.

We will use BLE Beacons to compare small elements: Fire System, Sprinklers…

BLE* Beacons
Confidex Viking
An example of Beacons used in the project

* : Bluetooth Low Energy

1. Place the beacons on an element
2. Localize the element on construction site with Smartphone
3. Process the information to see if the element is well positioned

1 2 3

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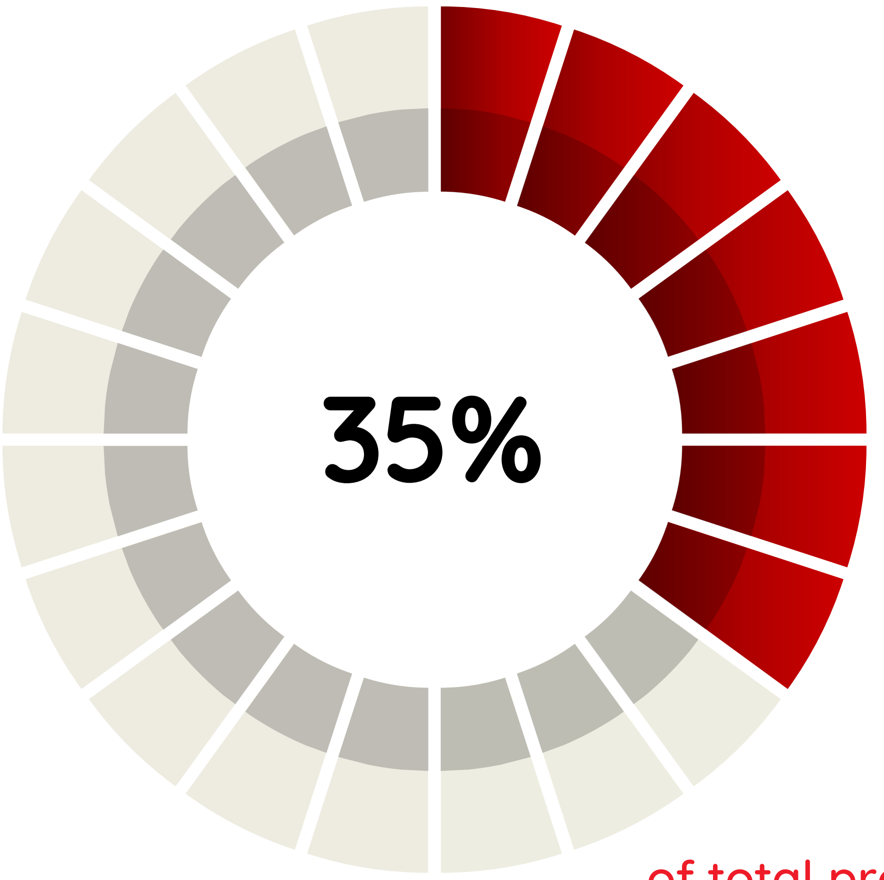
Conclusion

- Project progress
  - Sensor integration
  - Robot Navigation with BIM and without BIM
  - Autonomous navigation on construction site
  - Point Cloud extraction
- Future steps
  - BIM / IFC path planning
  - 3D reconstruction
  - Comparison between the models
  - Semi-automated progress monitoring



of total progress

Thank you for your attention!

We thank our partners: