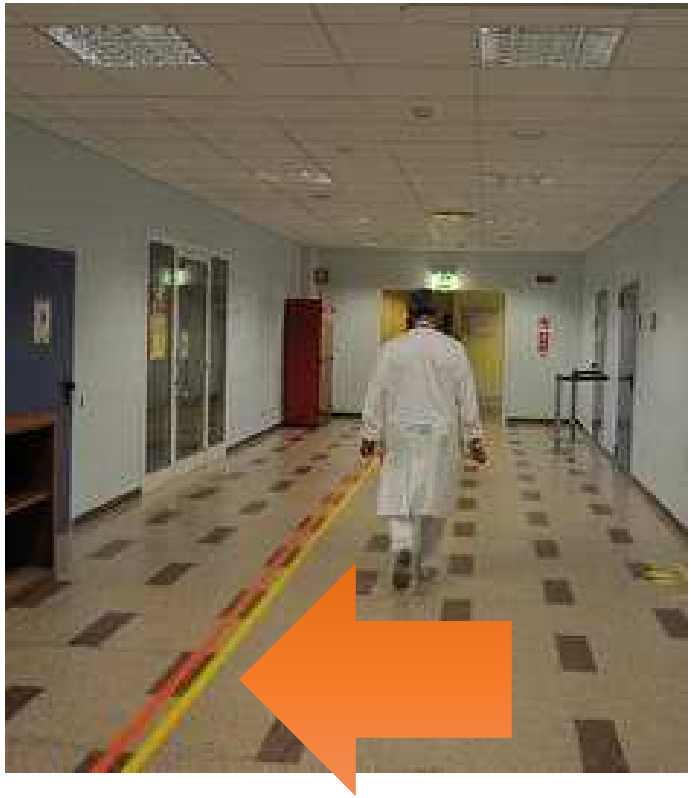
Het i-Locate geïntegreerd indoor-outdoor navigatiesysteem – ontwikkeling, implementatie en eerste ervaringen

Het i-Locate project: rationale, scope en doelen

Giuseppe Conte – Trilogis, Italy

TRADITIONALLY INDOOR ROUTING HAS BEEN BASED ON SIGNALS



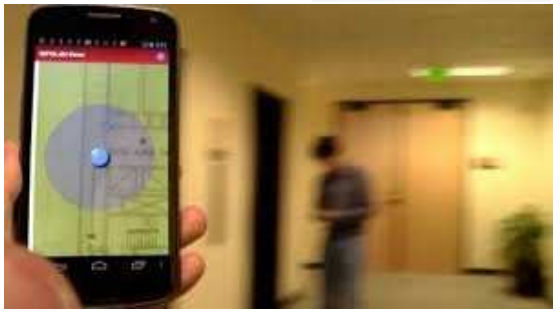
Example of hospital in Trento

RECENTLY, ACCURATE INDOOR LOCALISATION TECHNOLOGIES ARE NOW AVAILABLE FOR INDOOR LOCATION BASED SERVICES (LBS)

NOKIA
Connecting People

Google

ekahau

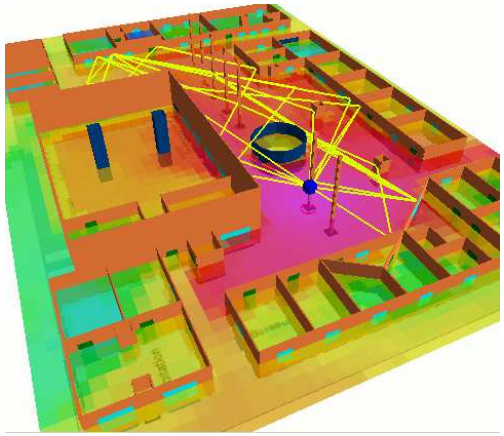


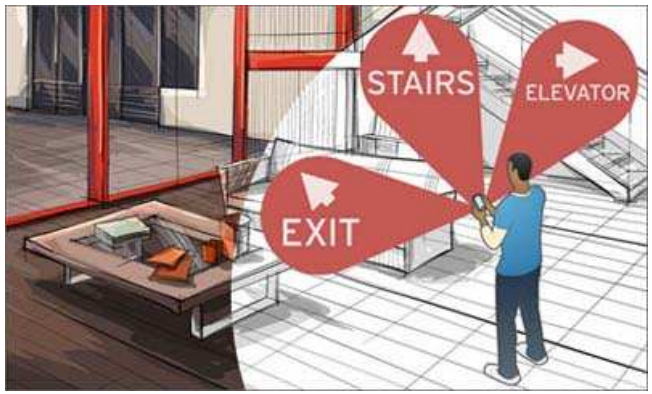
Navizon
ACCURATE POSITIONING ANYWHERE

CISCO SYSTEMS

WHAT ARE LOCATION BASED SERVICES

- Commercially availabile solutions are essentially based on triangulation of radio signal (GPS, WiFi, Bluetooth, ZigBee, mobile telephone cells)
- They should ensure «data fusion» to handle, in an integrated way, localisation both indoor and outdoor.
- Accuracy varies from few meters (WiFi) down to few centimeters (Bluetooth, ZigBee)





THREE MAIN BARRIERS LIMIT THE USE OF HYBRID INDOOR/OUTDOOR LBS

1) Lack of **indoor maps** available as **open data**.
2) **Lack of technological ecosystems** that can use this data for innovative location, routing and asset management services within indoor & outdoor scenarios.
3) **Limited support** to indoor/outdoor LBS by current **GI standards**.

SCOPE

i-locate overcomes these barriers through:

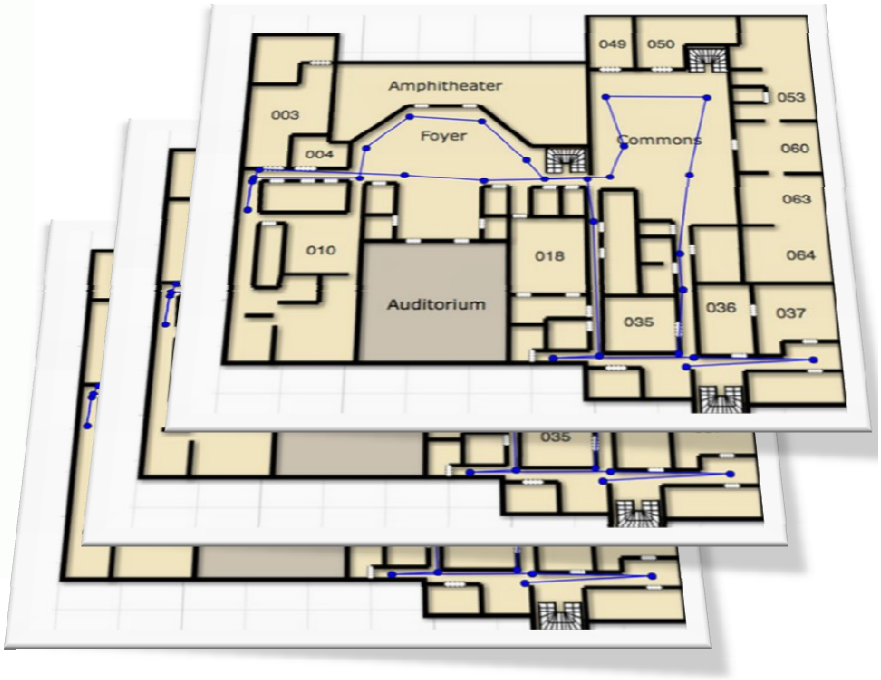
1) The creation of a public geoportal ("hub") for **indoor mapping data** (e.g. "indoor complement" to OpenStreetMap), to share (as **open data**) GI of publicly accessible indoor spaces.
2) The creation of an **open source i-locate toolkit** to enable **interoperable indoor/outdoor** location and tracking of asset (material & people) for **innovative LBS businesses**.
3) The extension of current standards to support indoor/outdoor LBS based on **privacy & security policies**, for the highest protection of personal/critical data.
4) The development of a **mobile client** (App) accessing the toolkit's services via such standards.

OBJECTIVE 1: TO CREATE A «VIRTUAL HUB» FOR INDOOR MAPPING

- Public buildings
- Private **buildings accessible to the public**
- Private properties

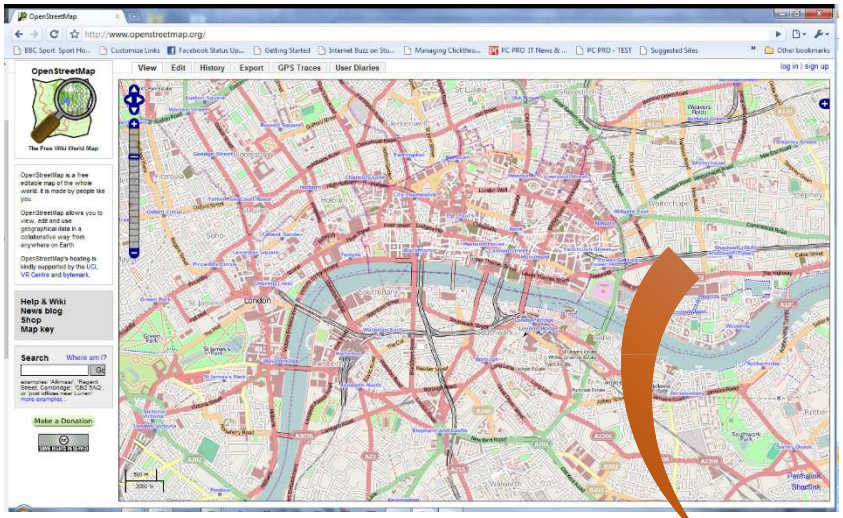
OBJECTIVE 1: TO CREATE A «VIRTUAL HUB» FOR INDOOR MAPPING

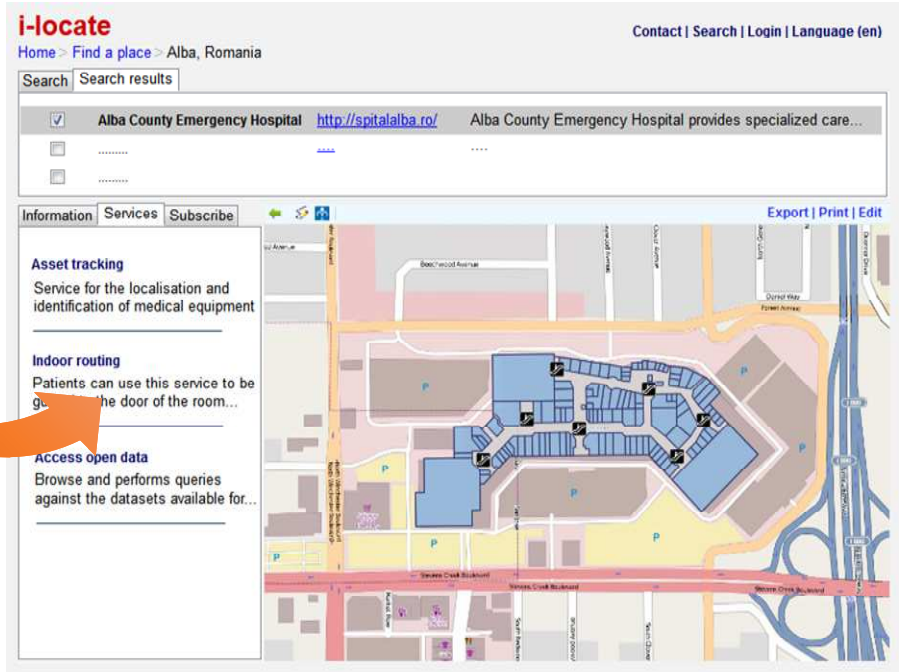
Creation of a single point of entry to open indoor GI in Europe and beyond



OBJECTIVE 1: TO CREATE A «VIRTUAL HUB» FOR INDOOR MAPPING

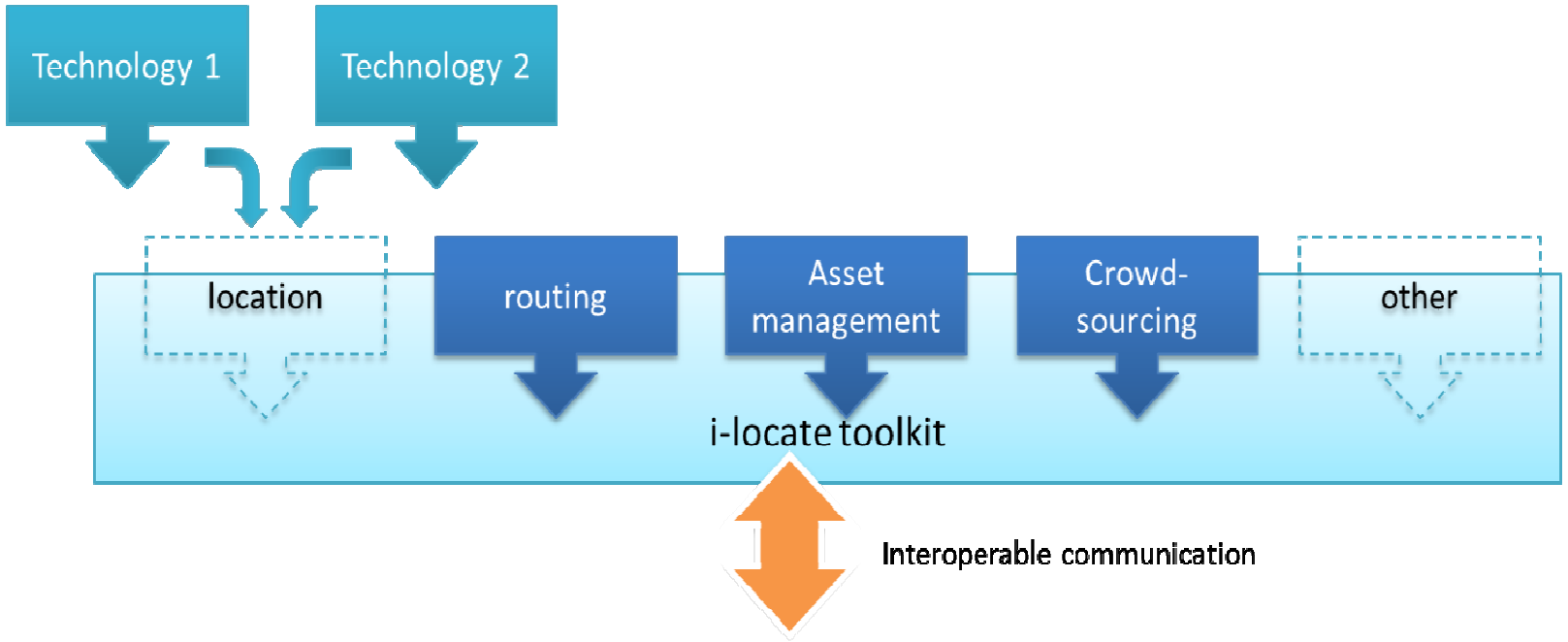
To develop an indoor counterpart to OSM





OBJECTIVE 2: OPEN SOURCE I-LOCATE TOOLKIT

- Provision of interoperable indoor/outdoor LBS
- Web- and mobile-based visualisation and management of open indoor GI
- Crowdsourcing-oriented provision of open GI regarding indoor/outdoor spaces
- Open communication interfaces (open standards)
- Scalability



OBJECTIVE 2: OPEN SOURCE I-LOCATE TOOLKIT

- **Open Source** middleware based on **open standard**
- Ready to deploy **software toolkit** that can be used to easily create innovative businesses

OBJECTIVE 3: THE CREATION OF MOBILE CLIENT-SIDE TECHNOLOGIES

App for iOS and/or Android devices capable to access the toolkit's services

OBJECTIVE 4: SPECIFIC PRIVACY AND SECURITY POLICIES

Technology and the pilots will be built upon a Privacy Impact Assessment (PIA) and a TVRA (Threat, Vulnerability and Risk Analyses)

OBJECTIVE 5: THE EXTENSION OF CURRENT LOCATION BASED STANDARDS

- Primarily OpenLS by OGC to properly cater for requirement of hybrid indoor and outdoor tracking and routing scenarios
- Other contributions on privacy/security standard may be required
- Interoperability is necessary to **maximise takeover** and impact of the project

OBJECTIVE 6: TO PILOT –FOR THE DURATION OF 12 MONTHS- WITHIN A REAL-LIFE OPERATIONAL SCENARIO

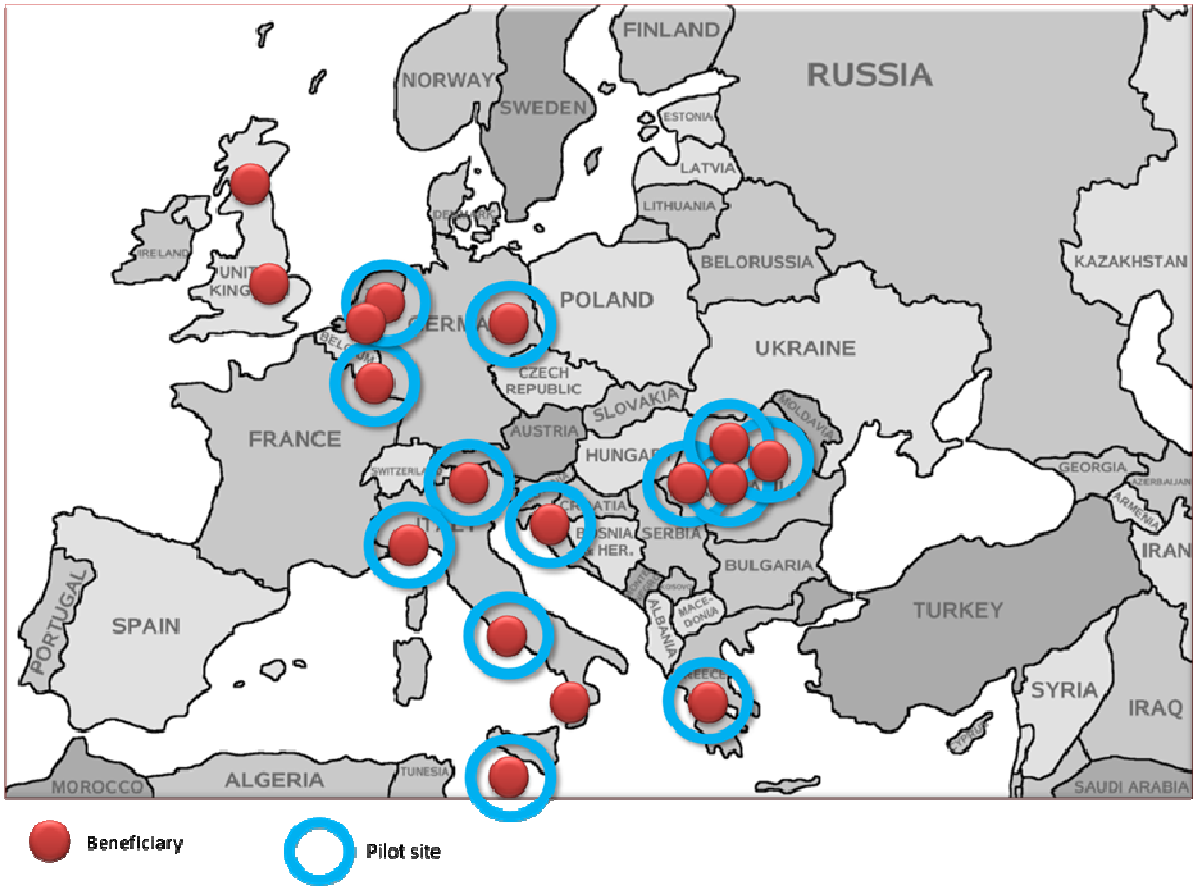
- **Guidance of patients through an health care path**, with the involvement –as final downstream users- of several hospitals and an elderly persons nursing home.

- **Smart tracking & asset management for lean management models**, with the involvement of public health stakeholders, several city councils and a business park.

- **Guiding visitors to reach indoor locations**, with the involvement of health centre facilities, public offices, a university, a worldwide known museum and a business park.

OBJECTIVE 6: TO PILOT –FOR THE DURATION OF 12 MONTHS- WITHIN A REAL-LIFE OPERATIONAL SCENARIO

i-locate will be piloted for **12 months** by real users within **14 real scenarios** in **8 EU countries**



Het i-Locate Indoor-Outdoor Navigatie systeem

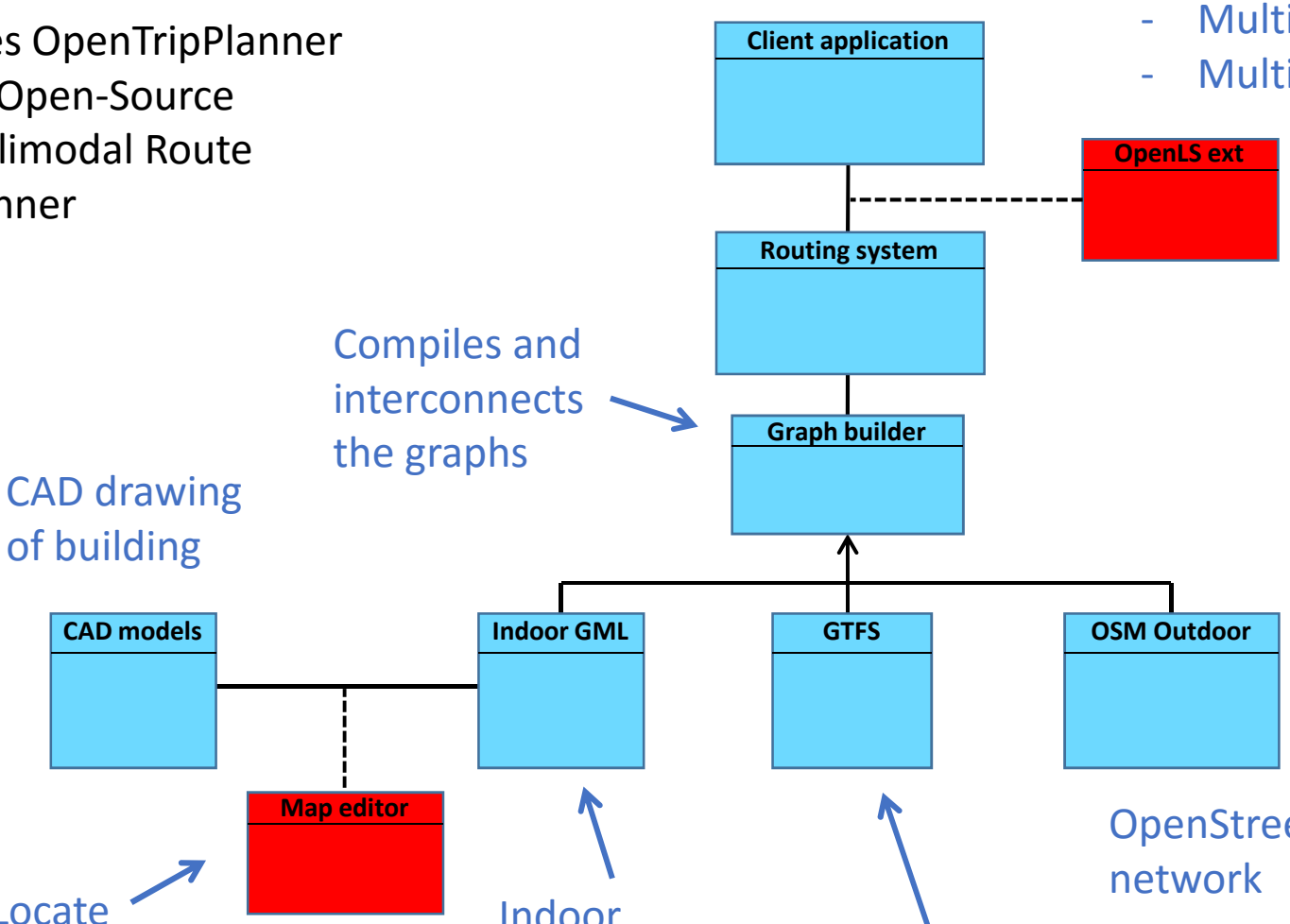
Theo Arentze, Tao Feng, Joran Jessurun,

Ion Barosan, Aant van der Zee, Bauke de Vries – TU/e

ROUTING SYSTEM - DATA AND API

Extension of OpenLS
- Indoor
- Multiple floors
- Multimodal

Uses OpenTripPlanner
An Open-Source
Mulimodal Route
planner



Compiles and interconnects the graphs

CAD drawing of building

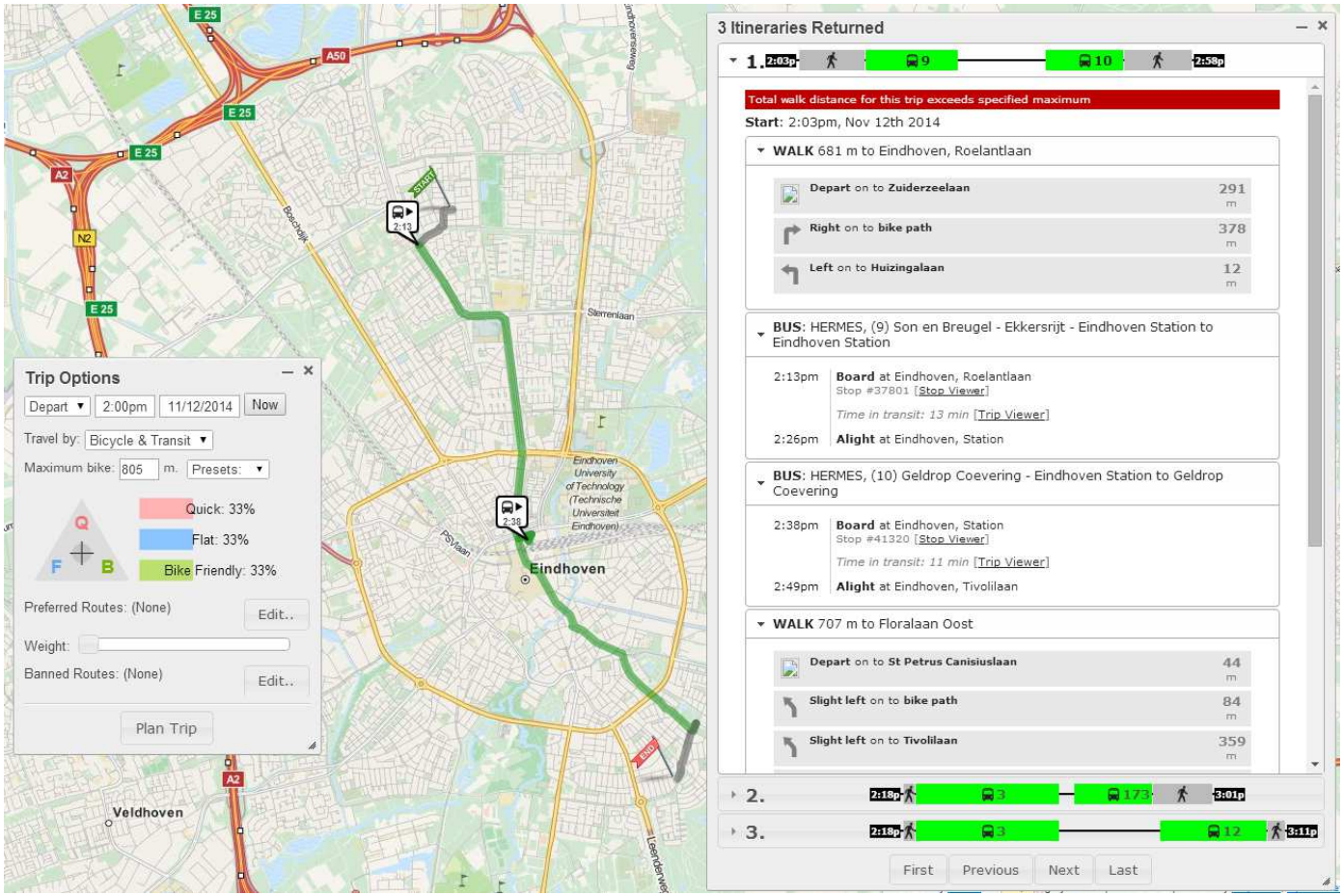
i-Locate portal

Indoor navigation graph

Public transport data standard format

OpenStreetMap road network

OpenTripPlanner: Open-Source multimodal Route Planner



Uses data from GTFS, shapefiles, OpenStreetMap

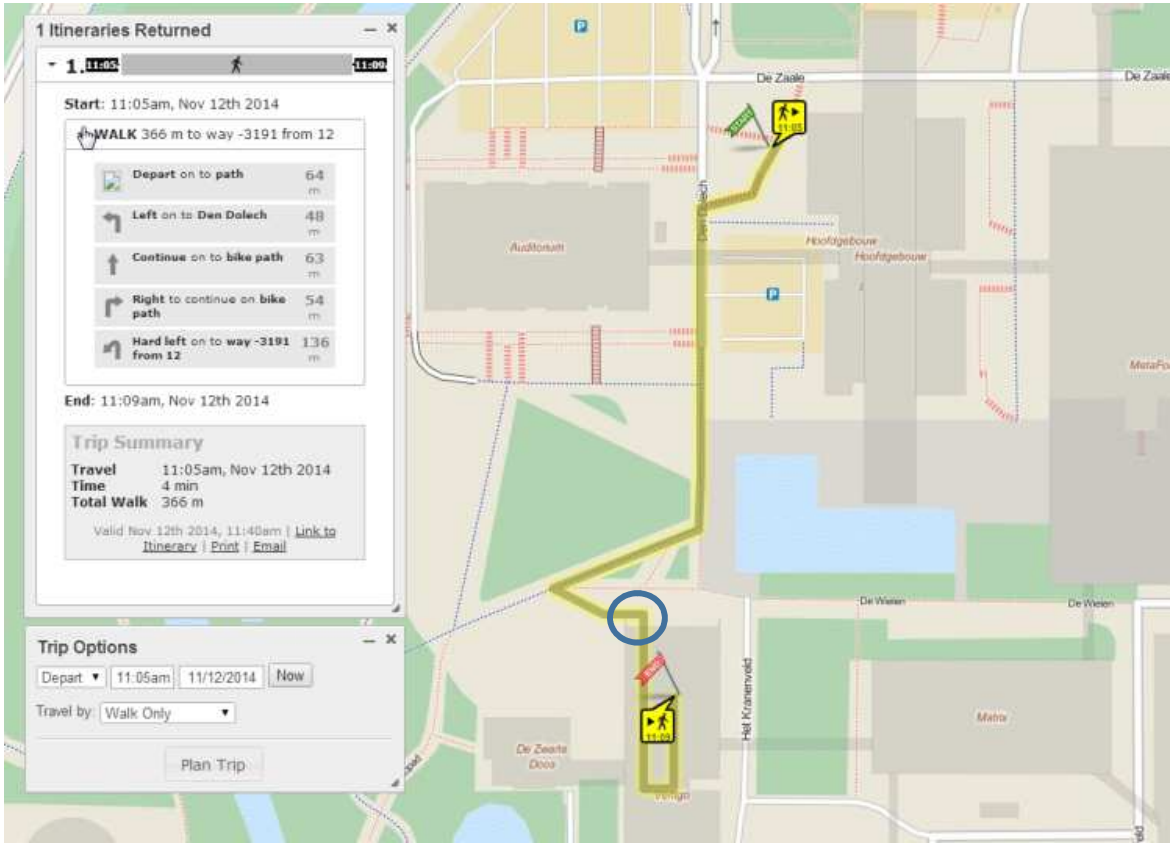
Uses a time-dependent network approach

Plans trips in about 100 ms in a moderate sized city

CONSTRUCTING THE NAVIGATION GRAPH - CHALLENGES

- Interconnecting Indoor and Outdoor
- Interconnecting the Floors of a Building
- Constructing the Navigation Graph for each Floor

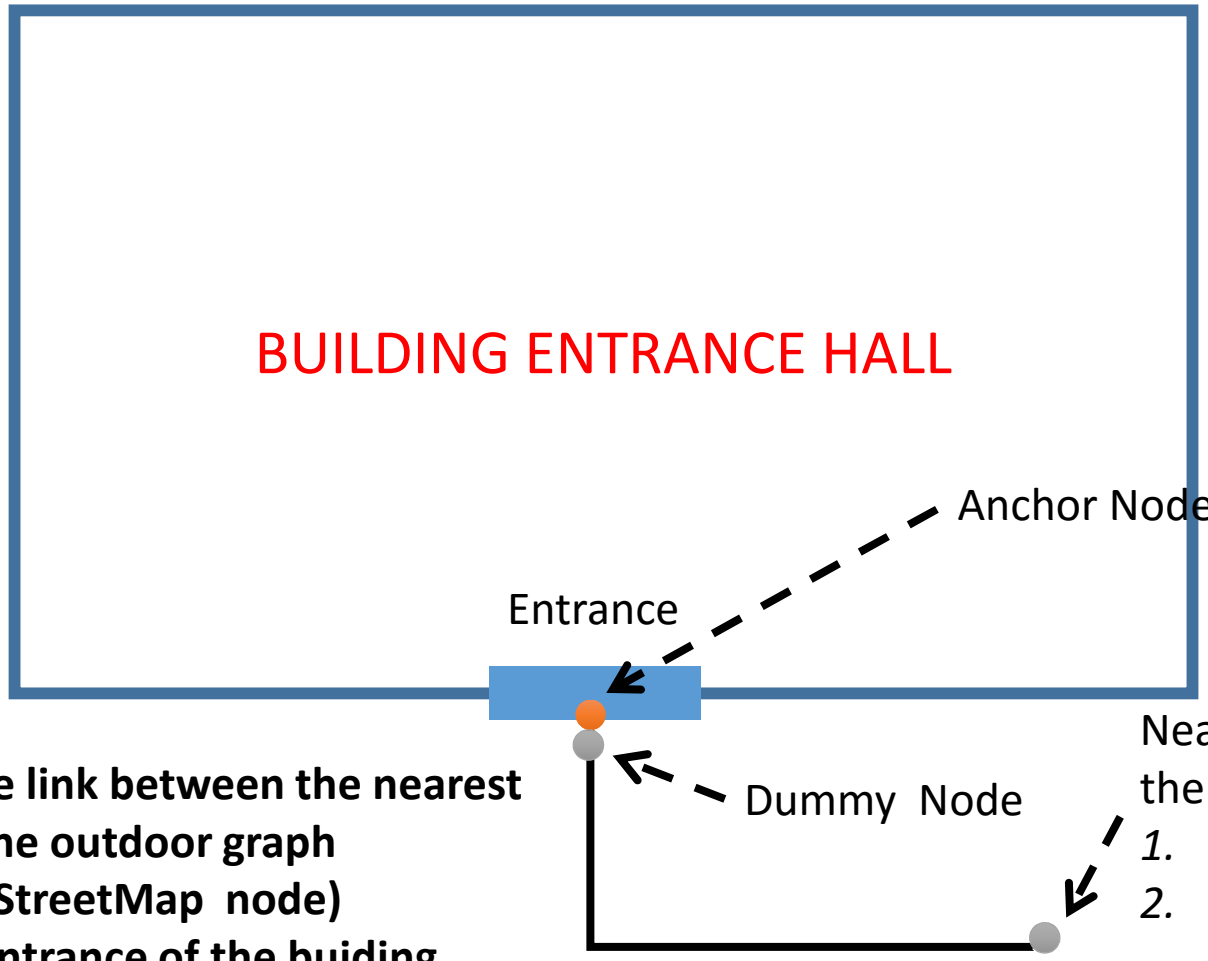
INTERCONNECTING INDOOR - OUTDOOR



Entrance of the building is a special node -

- **anchor point** where outdoor and indoor networks are connected

HALL AND THE ANCHOR NODE



Create the link between the nearest node of the outdoor graph (an OpenStreetMap node) and the entrance of the buiding

Nearest node of the outdoor graph can be :

1. *Pedestrian Node*
2. *Parking Node*

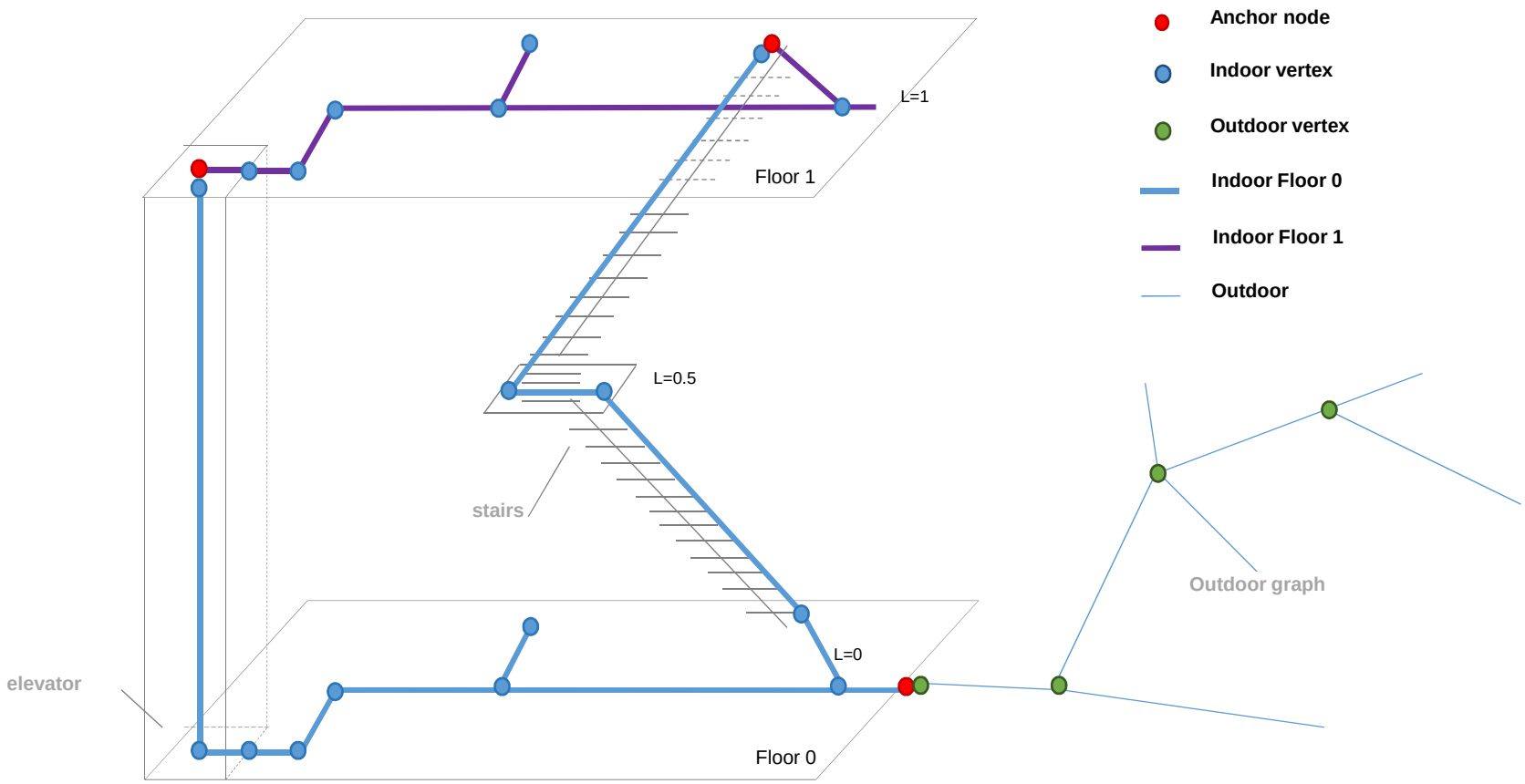
SPECIAL LINKS - VERTICAL CONNECTORS

Natural history museum

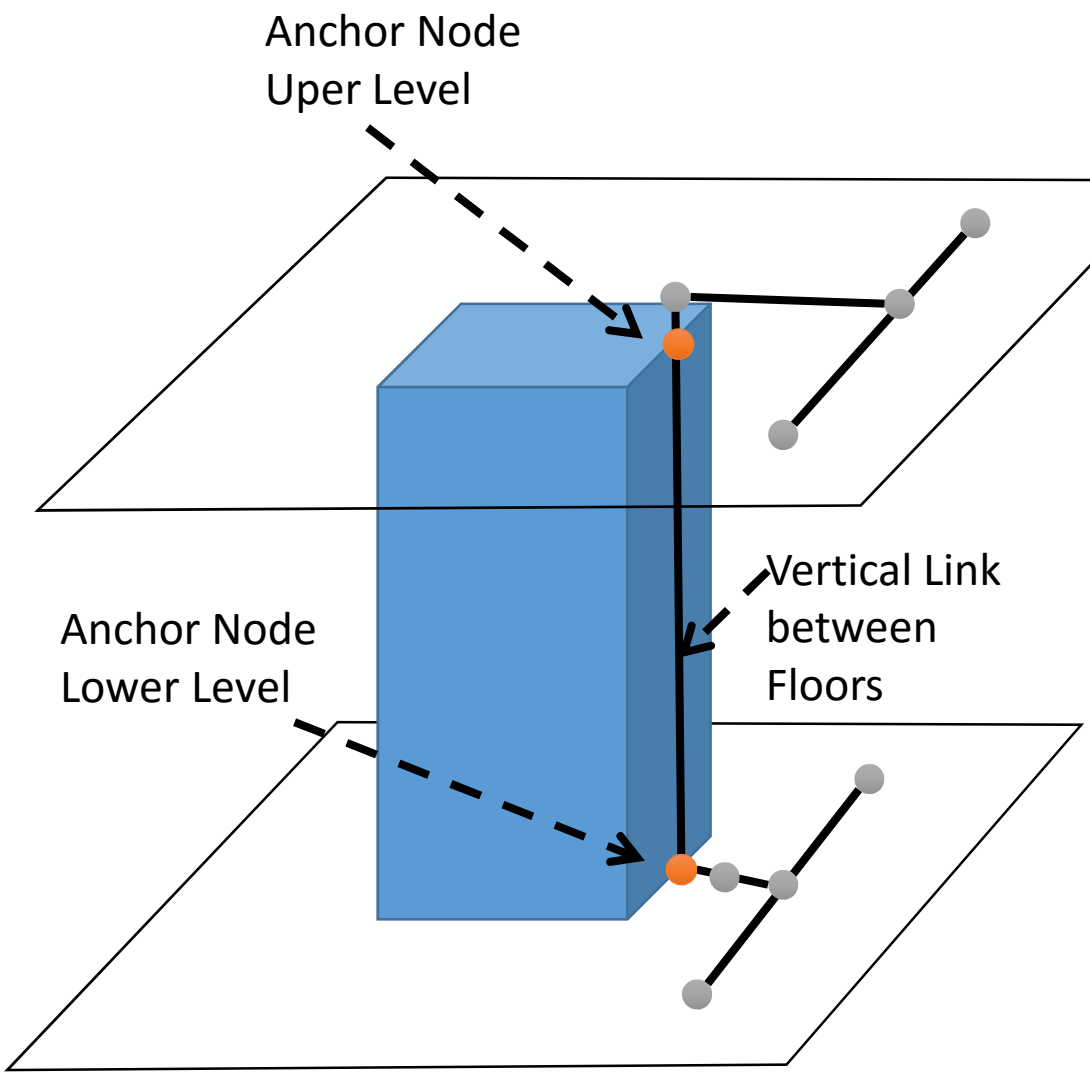
For each floor a graph is constructed

The graphs are interconnected through vertical links representing elevators or stairs

How to build an indoor graph with elevators and stairs



Elevators and Anchor Node



- If the lower level is a floor level (no floors below) then we need only one anchor node – the top one to connect with the first floor node.
- The vertical link needs to be stored on the level where it starts from (the bottom floor)

How to build the Indoor Graphs?

- There are a few cases we have to consider when we create an indoor graph, based on the shape of the rooms we navigate through

- We can navigate through:
  - Corridors, which can be :
    - small or wide

Small Corridor

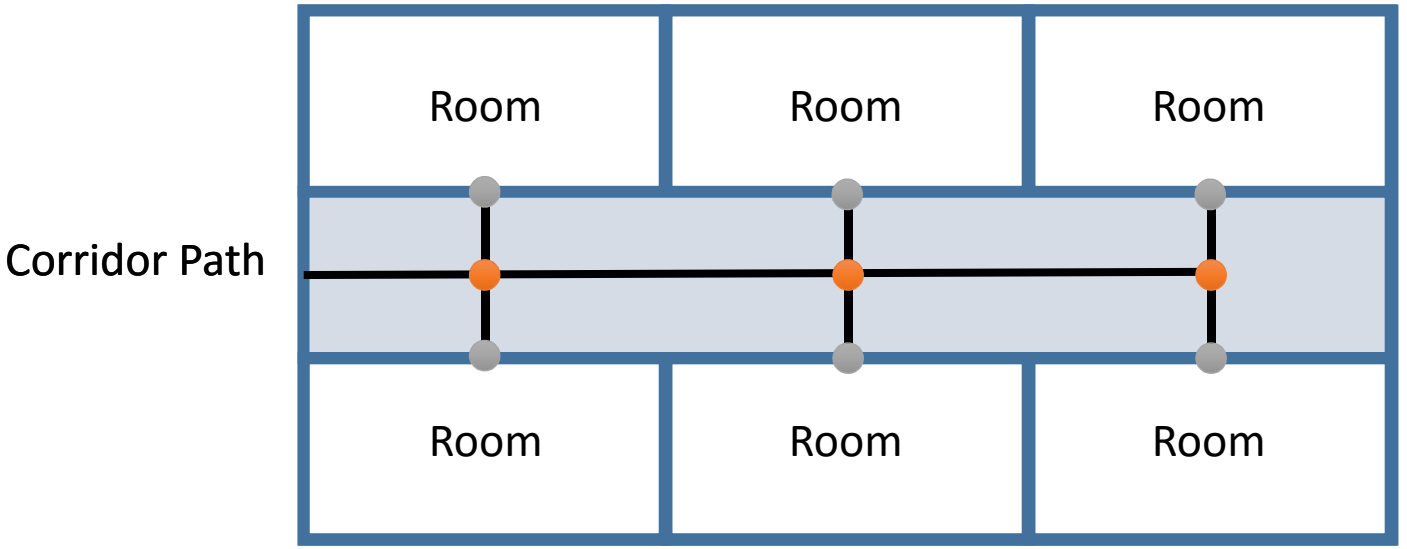
Wide Corridor

  - Hall – a relatively large space, which can be:
    - With or without obstacles

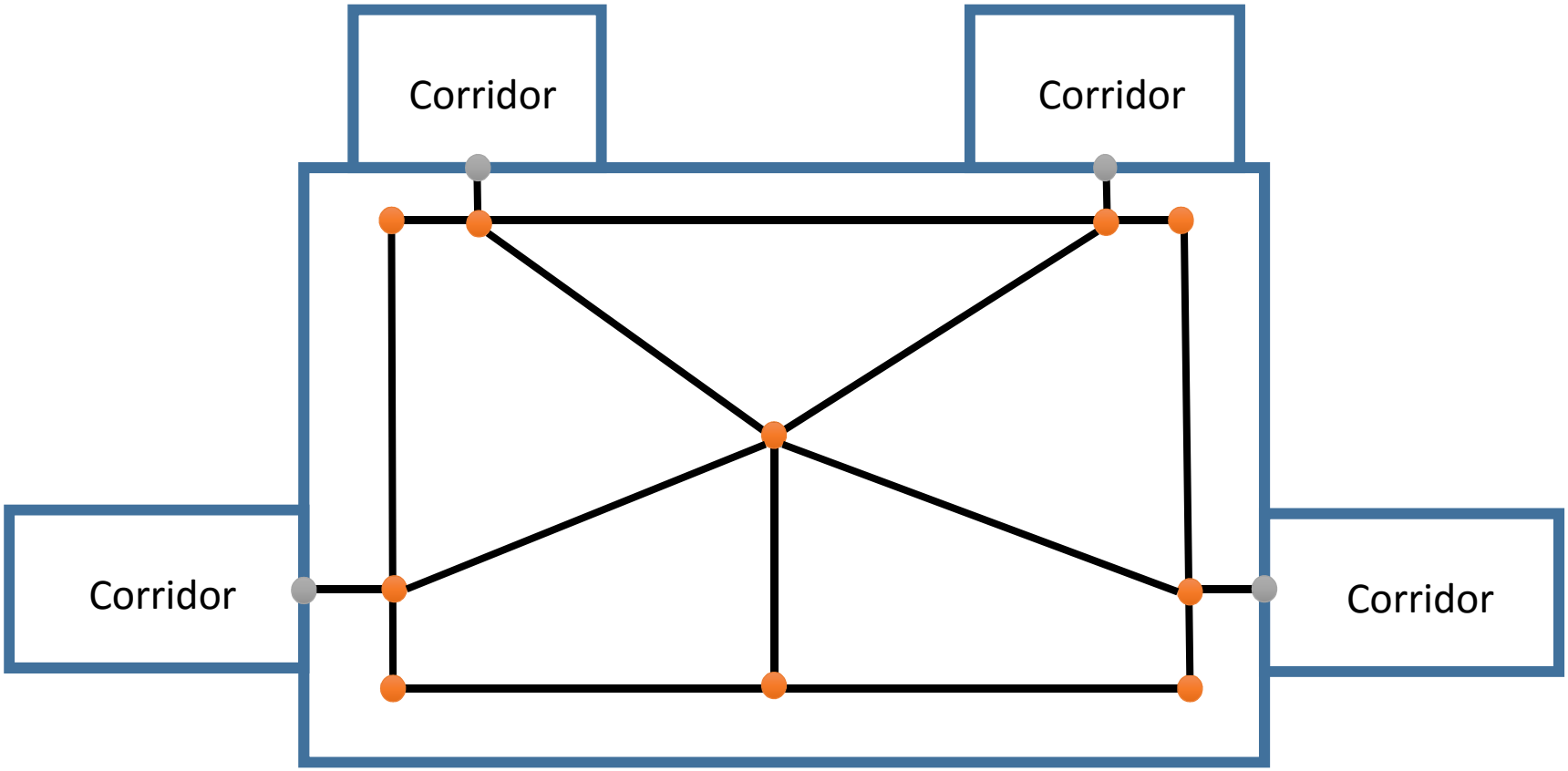
Hall without obstacle

Hall with obstacle

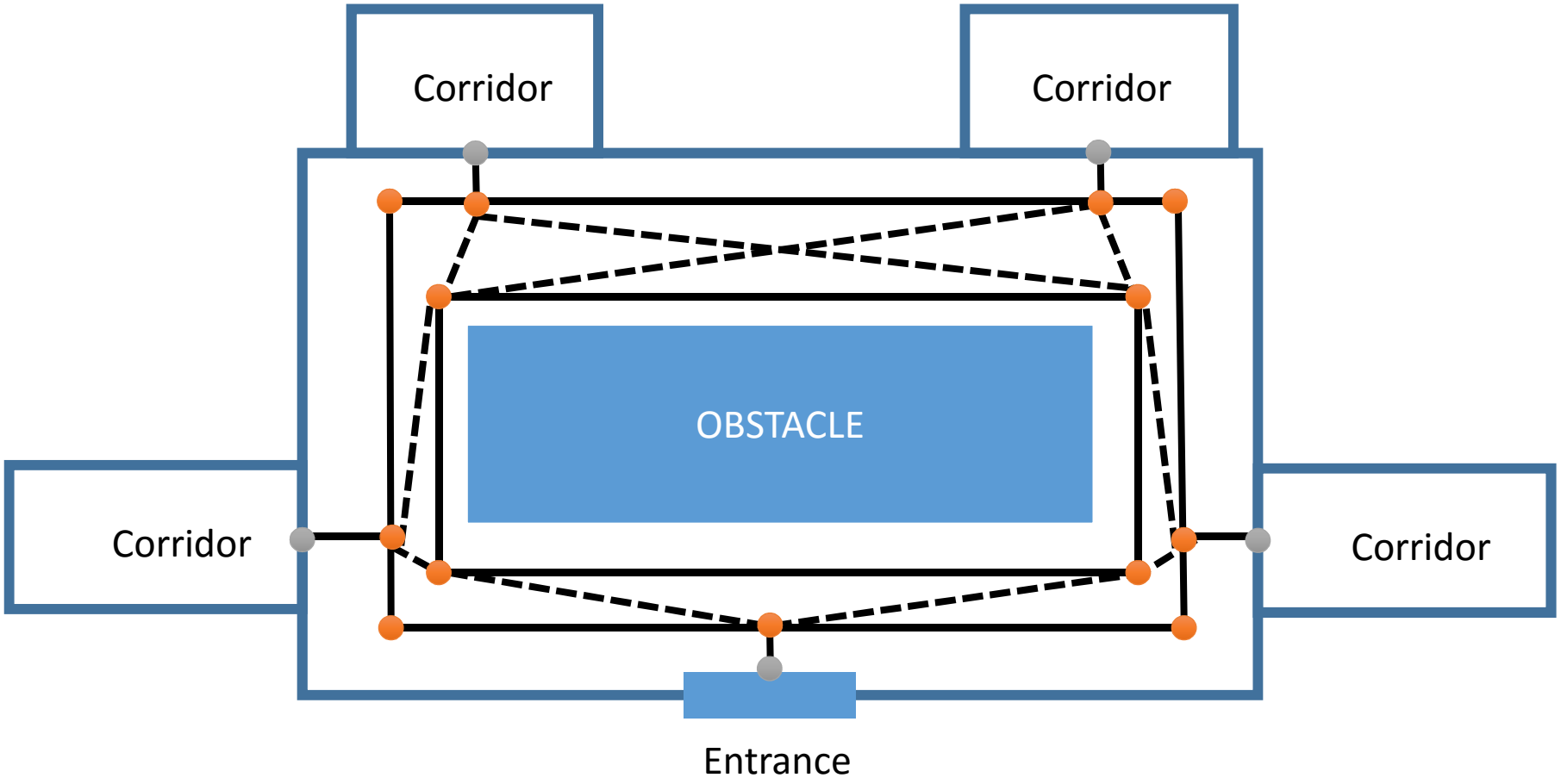
SMALL CORRIDOR



HALL, NO OBSTACLE



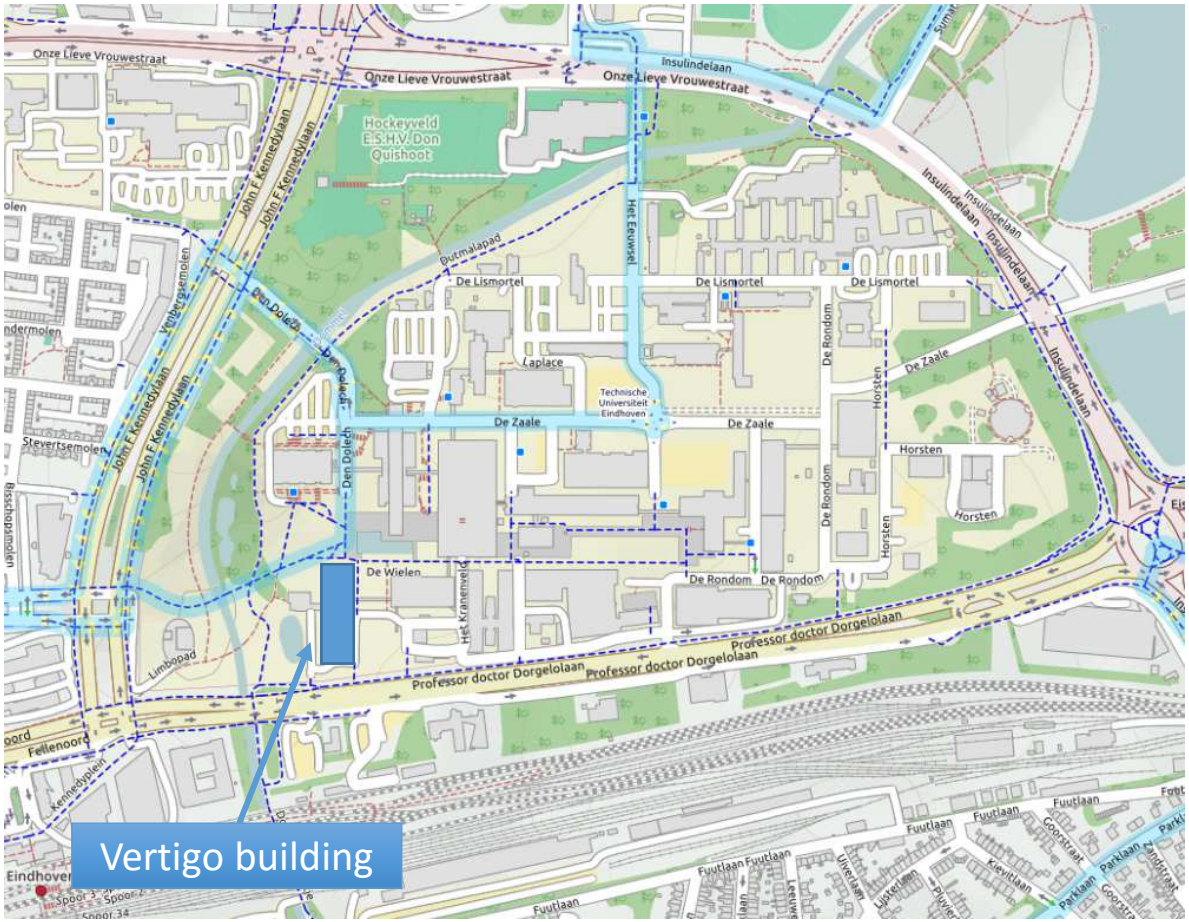
HALL WITH OBSTACLE



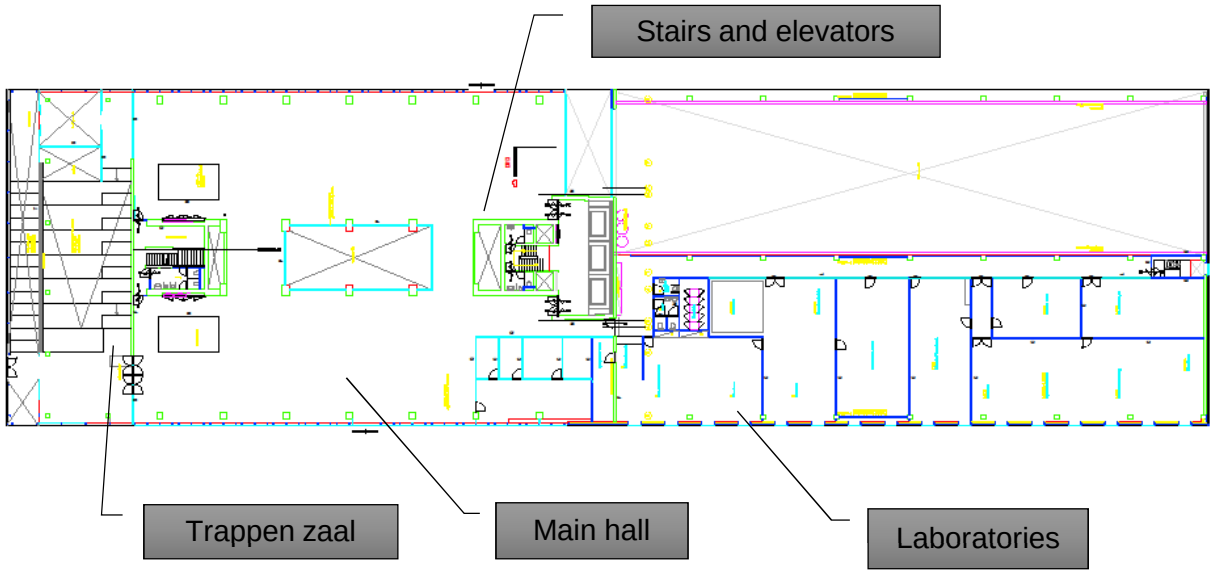
PILOT LOCATION

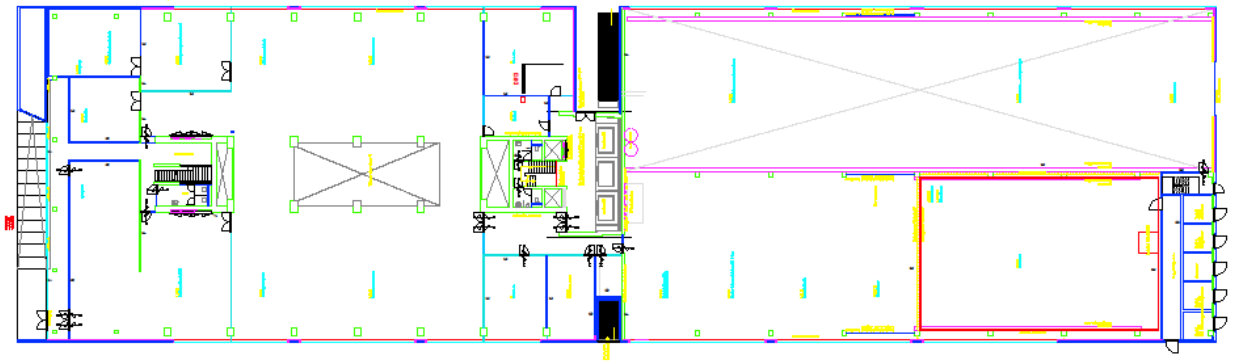
The testing area is the Vertigo building, within the university campus.

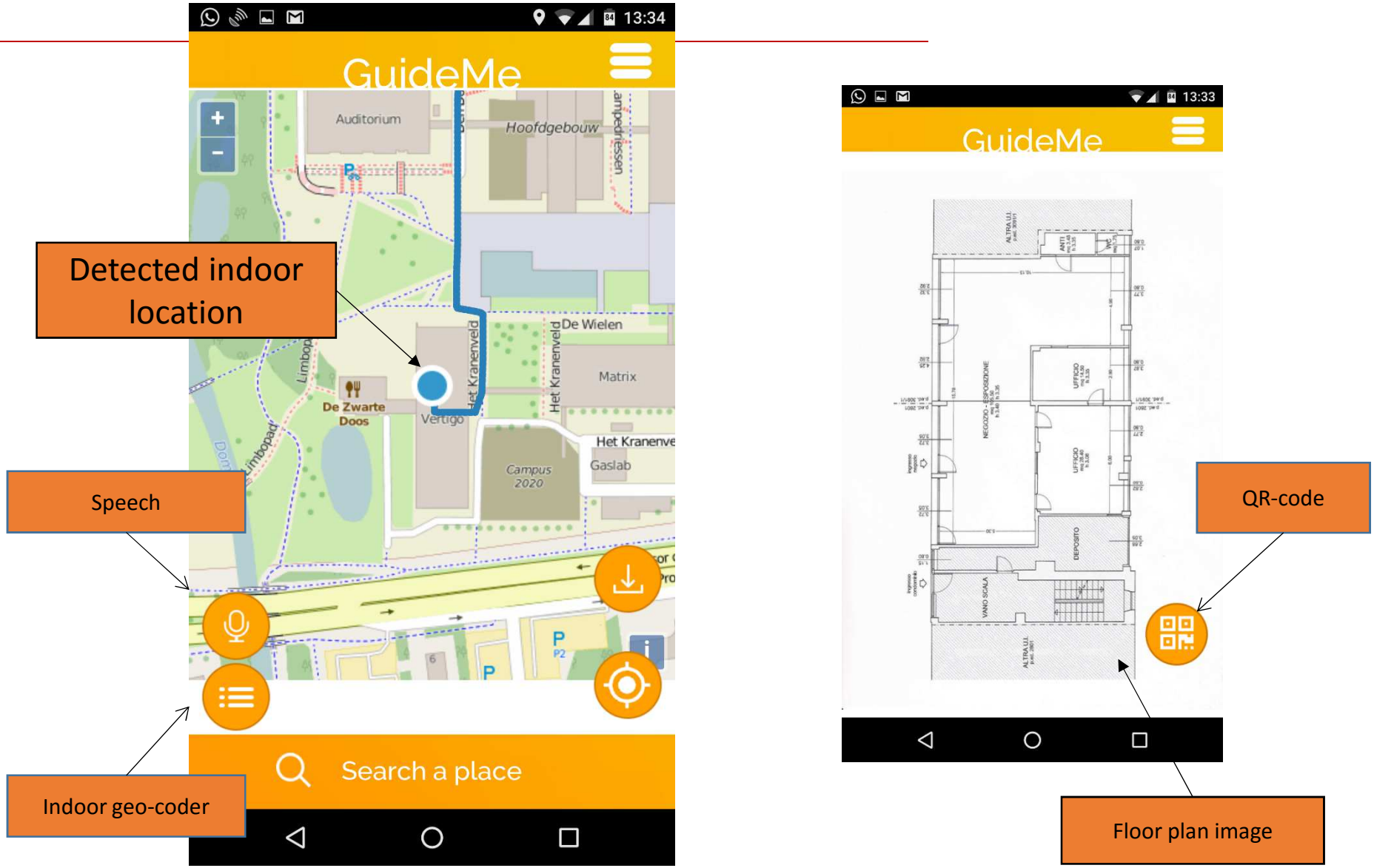
The building has 9 floors.

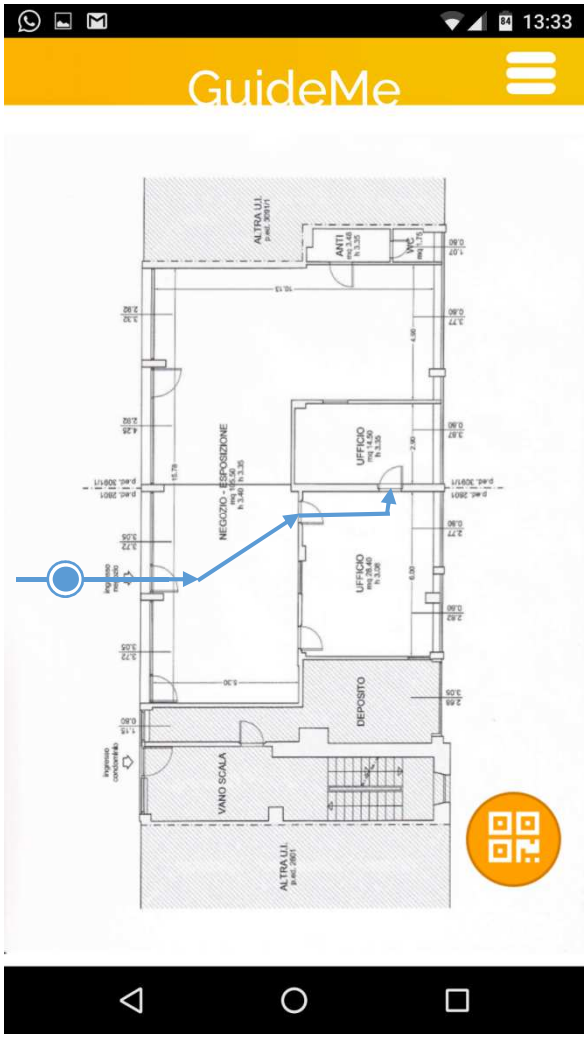


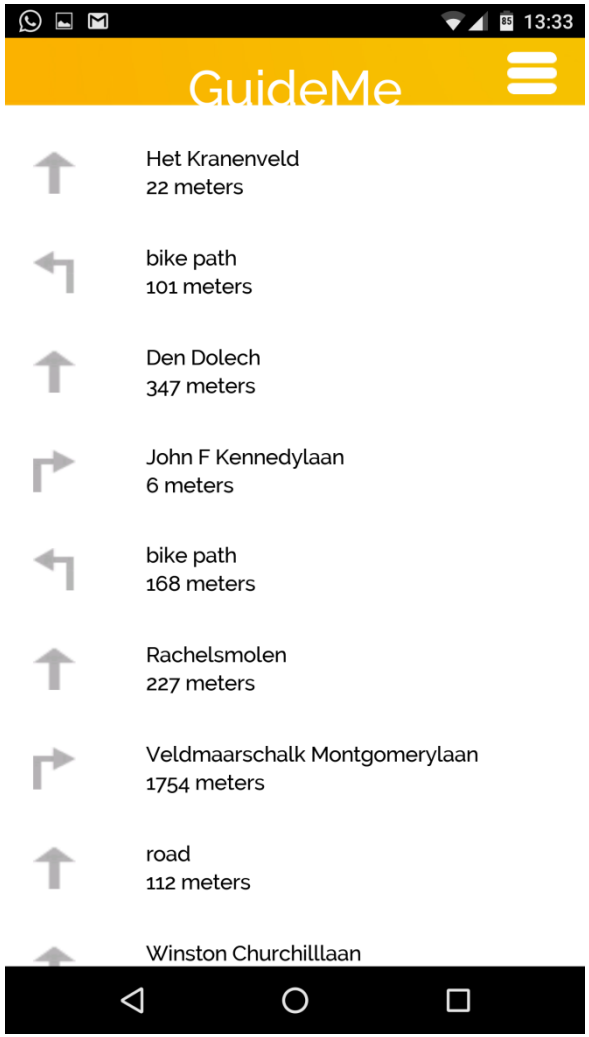
FLOOR PLAN - EXAMPLE






13:34
GuideMe
Auditorium
Hoofdgebouw
De Wielen
Matrix
De Zwarte Doos
Vertigo
Het Kranenveld
Campus 2020
Gaslab
Search a place
13:33
GuideMe
Detected indoor location
Speech
Indoor geo-coder
QR-code
Floor plan image


13:33
GuideMe
ALTRA U.I.
ANTI
UFFICIO
NEGOZIO - ESPOSIZIONE
UFFICIO
DEPOSITO
VANO SCALA
ALTRA U.I.


13:33
GuideMe
Het Kranenveld
22 meters
bike path
101 meters
Den Dolech
347 meters
John F Kennedylaan
6 meters
bike path
168 meters
Rachelsmolen
227 meters
Veldmaarschalk Montgomerylaan
1754 meters
road
112 meters
Winston Churchilllaan

CONCLUSION

- We have developed a routing system for indoor-outdoor navigation
  - A component of the i-Locate middle-ware
  - Multimodal
  - Seamless Indoor-Outdoor
  - Open Source
  - Open Data and Open Standards
    - OpenStreetMap
    - GTFS
    - IndoorGML + map editor

- Currently we are developing a pilot for our own university building
  - Accuracy of WiFi-based indoor localization is still an issue
  - Performance of the navigation system still needs to be tested

THE TEAM

 **Dr. Tao Feng**	 **Ir. Joran Jessurun**	 **Prof. Dr. Theo Arentze**
 **Dr. Ion Barosan**	 **Dr. Aant van der Zee**	 **Prof. Dr. Bauke de Vries**

BEDANKT VOOR UW AANDACHT!