# Indoor Navigation and the Conferest Demo App

**Dept. of Navigation and Positioning**
**Finnish Geospatial Research Institute**
**National Land Survey of Finland**

NLS
FINNISH GEOSPATIAL
RESEARCH INSTITUTE
FGI

# The Finnish Geospatial Research Institute

- Governmental research institute

- About 120 staff
  (roughly 80 scientists)

- Budget roughly 10 MEUR
  (mostly outside financed)

- Highly academic institute
  (nearly 50% staff has PhD
  and 20% are international)



- Publish around 80 ISI Web of Science peer reviewed articles annually
  (150 peer reviewed scientific publications)

- Joint professorships with universities

# Department of Navigation and Positioning

**Navilab**



- Current staff: 23, with 9 PhDs

- Three research groups:

  - Satellite and Radio Navigation (**SaRaNa**)

  - Sensors and Indoor Navigation (**SINa**)

  - Intelligent Mobility and Geospatial Computing (**IMGC**)

- A navigation laboratory with state-of-the-art equipment (signal simulators, roof antennas, repeaters, receivers and sensors)

# Expertise areas of the Department
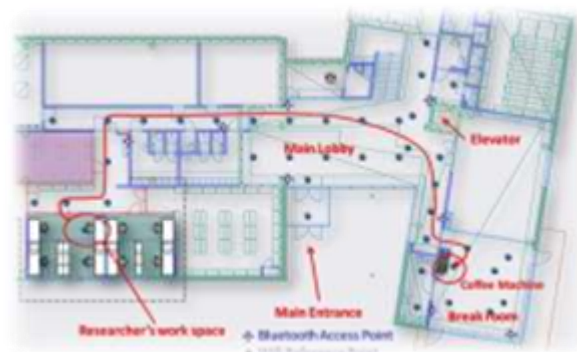
**Satellite navigation**

- GPS, GLONASS, BeiDou, Galileo, IRNSS
- SBAS systems, especially EGNOS
- Interference detection and mitigation
- Software-defined GNSS receivers
- PPP & RTK

**Indoor navigation**

- Sensor integration
- Indoor positioning
- Visual and DTV positioning
- Optical sensors

**LBS and contextual thinking**

- Motion recognition, context awareness
- Positioning in intelligent transportation systems
- Positioning for maritime

# Why do we need indoor navigation?

- People spend 90% of their time indoors
  (https://indoor.lbl.gov/sites/all/files/lbnl-47713.pdf)

- Consumers need navigation in

  - Conferences, malls,
    hospitals, parking halls…

- Location based services
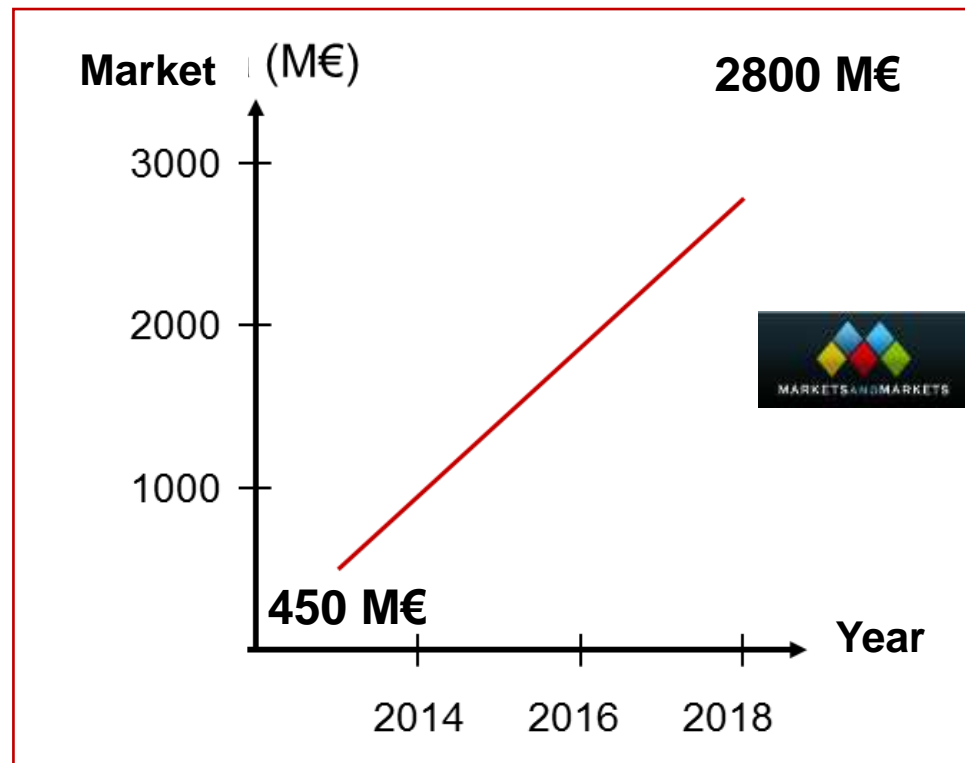
# Challenges in indoor navigation

- Satellite-based positioning is not always feasible indoors.
  - Signals attenuate while they travel through constructions
  - Signals experience multipath when reflecting/scattering off constructions

The resulting position solution is degraded or not available at all
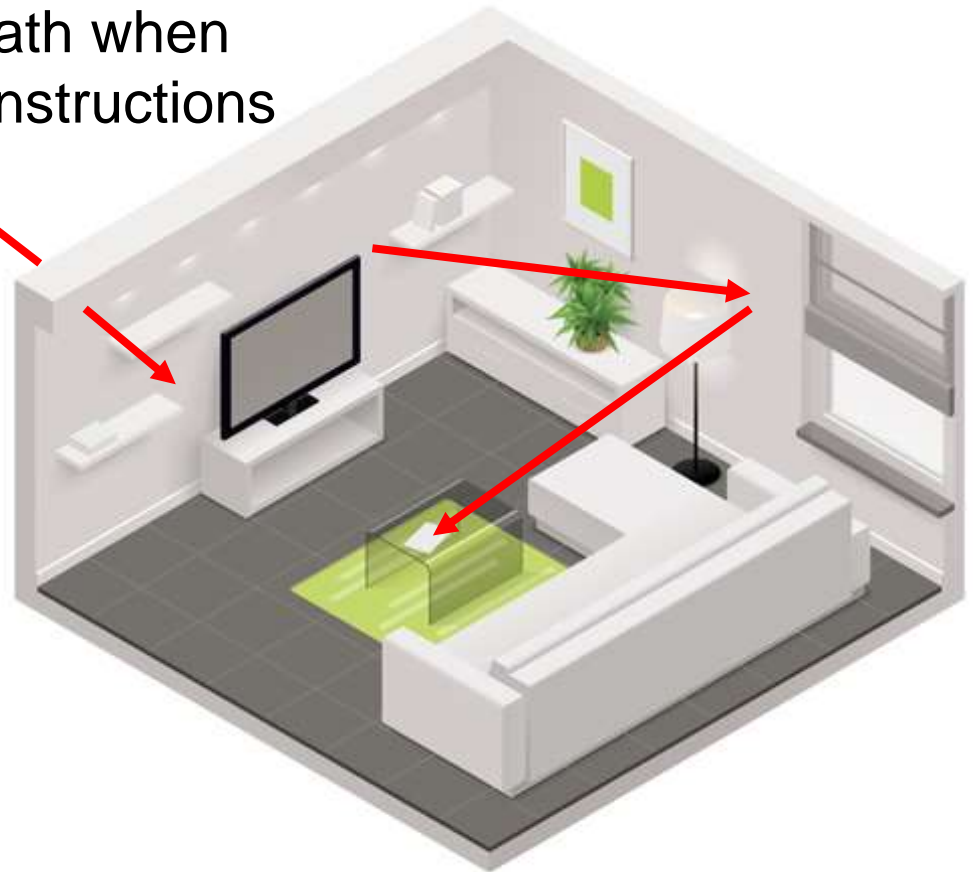
# Conferest application at FIGWW2017
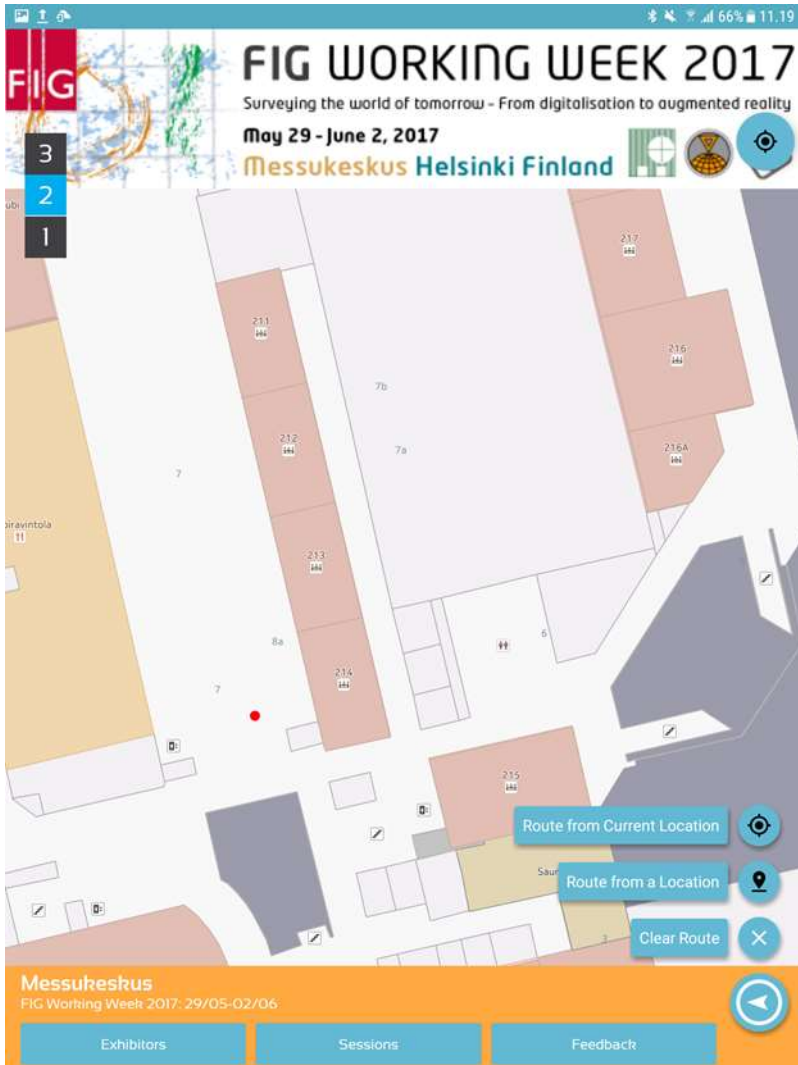


- Positioning everywhere within the conference premises

- Based on HERE's indoor positioning system using WLAN signals

- Routing for the exhibitor area developed by FGI

- Works only for Android due to Apple's decision not to open the WLAN measurements via any public API

# Conferest layout and routing
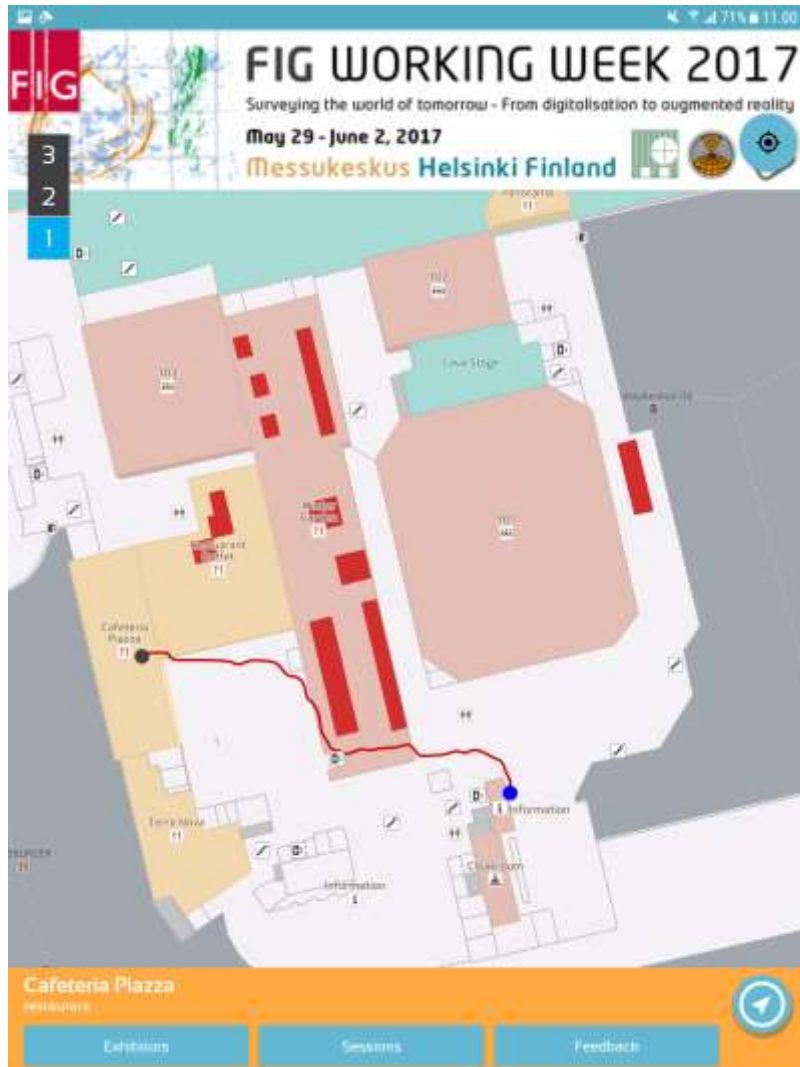


- The exhibitor booths are laid over the HERE Venue map

- Routing is based on the Lee algorithm
  - Lee, C.Y., "An Algorithm for Path Connections and Its Applications", IRE Transactions on Electronic Computers, vol. EC-10, number 2, pp. 364-365, 1961

# Lee's routing algorithm

- Lee's algorthim is one solution to the Maze routing problem

- Routing surface is represented by a 2D array

- Finds a sequence of adjacent cells from point A (user's location) to point B (desired destination)

- If a path exists, it is eventually found:

  - The algorithm ensures the selected route is the shortest.

  - In practice, however, there might be some implementation challenges due to the booth overlaying on the venue map

  - Time and memory complexities $O(N^2)$ for a NxN grid

    - Performs well in a restricted area, but can suffer in larger areas.
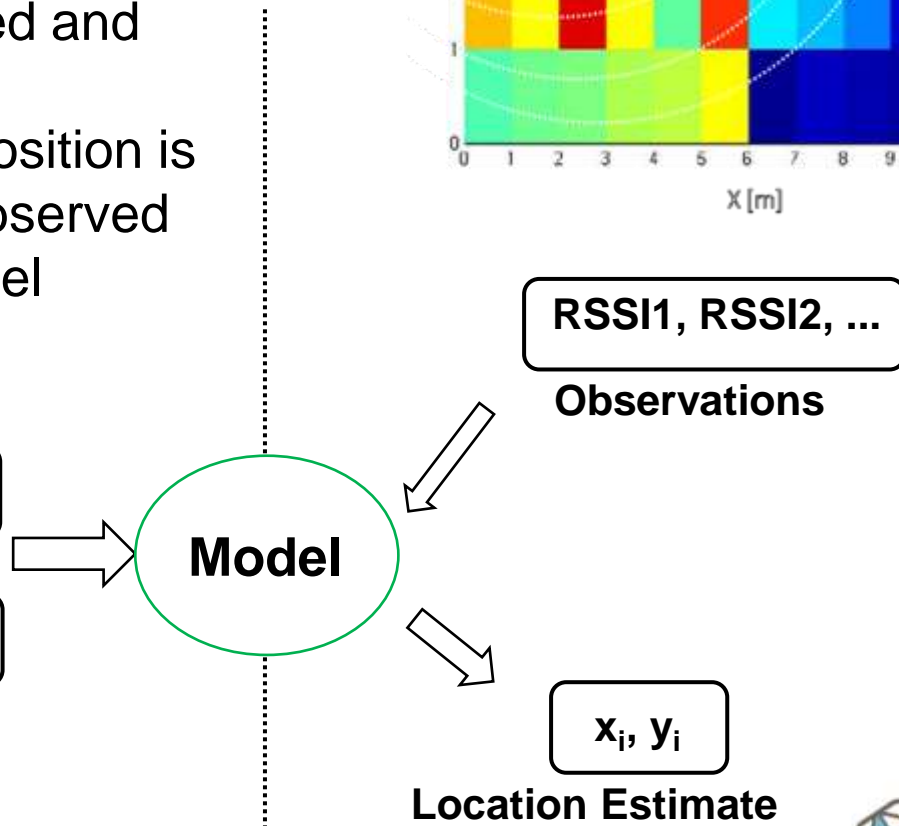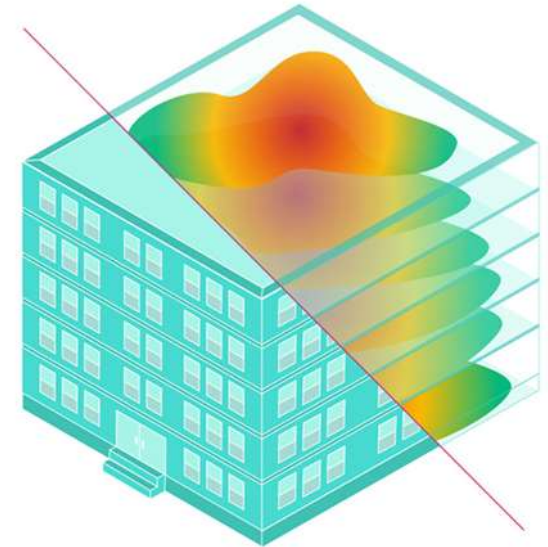
**FIGWW2017's grid**

# WLAN positioning



Two phases:

- Training phase: The prevailing signal environment mapped and modeled
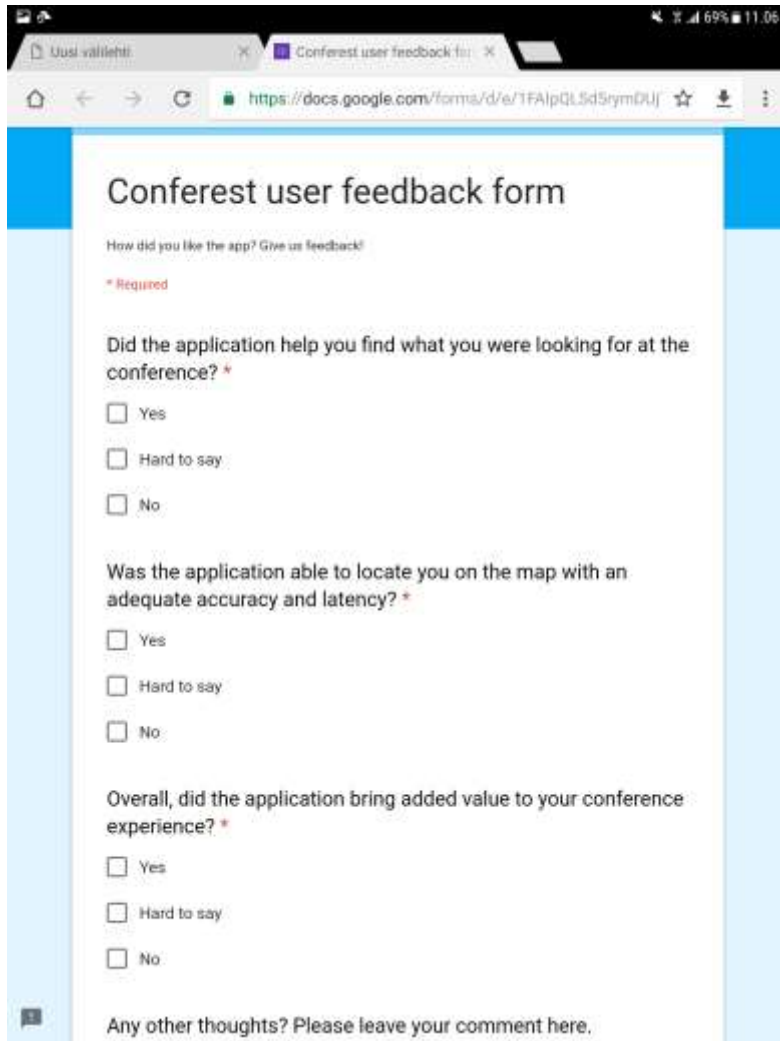- Positioning phase: User position is estimated based on the observed signals and using the model



**x₁, y₁** | **RSSI1, RSSI2, ...**

**x₂, y₂** | **RSSI1, RSSI2, ...**

...

**xₙ, yₙ** | **RSSI1, RSSI2, ...**

**Training Data**

**RSSI1, RSSI2, ...**

**Observations**

**Model**

**xᵢ, yᵢ**

**Location Estimate**
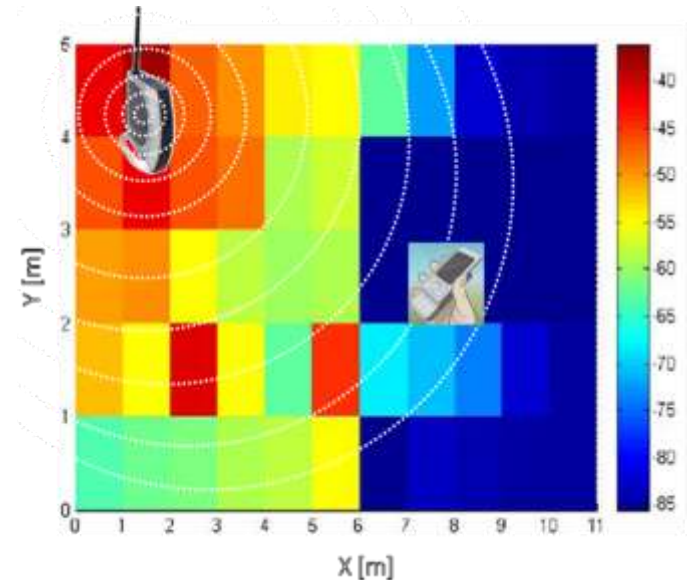
# HERE's positioning system

- HERE's positioning system is robust despite:

  - minor infrastructure changes (e.g. moving radio beacons) and

  - people moving in the environment

- Accuracy 3-5 meters

- Functions also with Bluetooth beacons

  - With beacons, Apple devices can be used also

  - Accuracy 2-3 meters

# Give your feedback



- Please let us know what you think of the application and fill the feedback form
  - sed for further research

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Thank you!