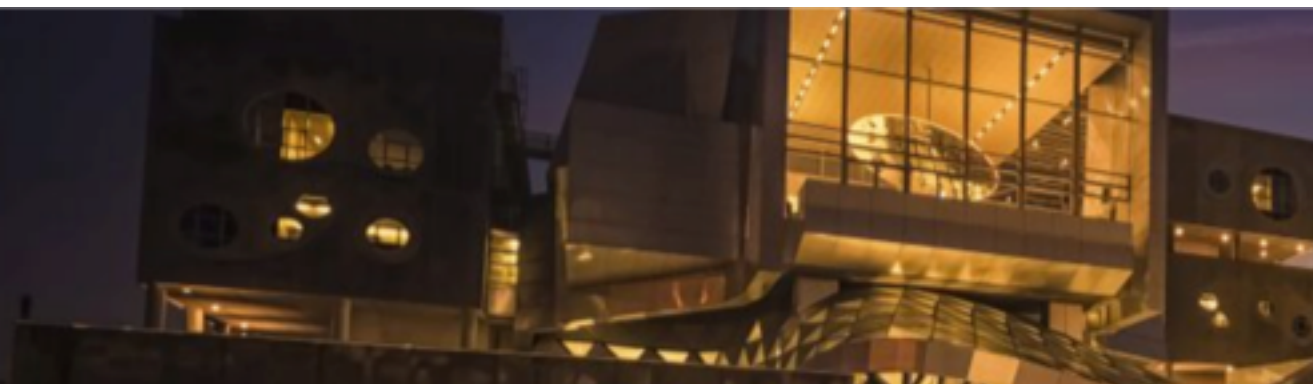# Future Directions for Indoor Information Systems: A Panel Discussion

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MDM'18 Panelists

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Indoor

- **People** spend **80-90%** of their time indoors – USA Environmental Protection Agency 2011.
    - This is the place where most human activity, commerce, transactions, etc happen!
- >**85% of data** and **70% of voice** traffic originates from within buildings – Nokia 2012.

Indoor Applications

- ## Huge spectrum of indoor apps
  - Navigation, Manufacturing, Asset Tracking, Inventory Management
  - Healthcare, Smart Houses, Elderly support, Fitness apps
  - Augmented Reality and many more.
- ## Indoor Revenues expected to reach 10B USD in 2020
  - *ABIresearch, "Retail Indoor Location Market Breaks US$10 Billion in 2020"' Available at: https://goo.gl/ehPRMn, May 12, 2015.*
- ## Indoor Revenues expected to reach 23B USD in 2021
  - *Economist, "New industry has sprung up selling "indoor-location" services to retailers", https://goo.gl/iL5MwQ, Dec 24th 2016.*
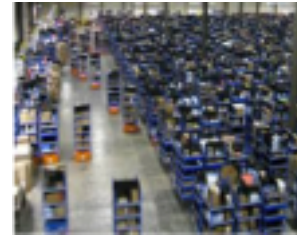
Geographic Information Systems (GIS)

- *GIS* have successfully enabled the management of **moving** objects **outdoors**, since the 1970, in a vast range of apps.
  - e.g., real estate, public health, crime mapping, national defense, sustainable development, natural resources, climatology, landscape architecture, archeology, regional and community planning, transportation and logistics

- **GIS for Indoor?**
  - Different Location Primitives: Satellite technologies **not available** indoor due to the **blockage** of **satellite signals** by building structures.
  - **indoor spaces** are characterized by **complex topologies** (multiple floors, rooms and hallways connected by doors, walls, stairs, escalators, and elevators.)

Navigation   Geographic Mapping   Precision Agriculture   Location-based Services

Positioning Statements

Rasmus S. Andersen
MapsPeople

Indoor Challenges/Drivers

- Colors

- Safety (Wayfinding w/out viewing)

- Voice

- Augmented Reality

- Localization Accuracy

- Privacy

- Branding

- Offline Navigation / Hybrid Online / Offline

- Marketing

Positioning Statements

Christian S. Jensen
Aalborg University

Indoor Challenges/Drivers

- **Diverse indoor settings**
  - Homes, hospitals, public indoor spaces

- **Many more sensors**
  - BT, smart-meter, digital assistants, alarm system, virtual sensors

- **Many more applications/services**
  - Indoor environment, security, "smart"-ness

- **Improved context awareness**

- **Integration**

Indoor Information Systems (IIS)?

- **Specialized GIS** tailored to the **unique challenges pertinent** to indoor spaces, namely:
  - indoor *data management operators* (similarity search, finding highly visited indoor POIs, indoor dense regions, cleansing indoor data, etc.)
  - **indexes** (VIPTree – Indoor Spatial Queries)
  - **data privacy schemes** (TVM)
  - built-in **data-driven localization algorithms (**using Wi-Fi fingerprinting, Bluetooth, camera, etc.)
  - Crowdsourcing (GraphSLAM, Anyplace)
- Take fresh look at the following:
  - New Indoor Operators/Indexes
  - Multidimensional Sensor Data
  - Velocity
  - Privacy
  - Big Data
  - …

Question 1

- **Is the vision of stand-alone IIS credible or will IIS remain an application of GIS?**

  - Growing interest towards more GIS integration, where *OGC's IndoorGMl standard*, GeoJson.org or any other standard that may appear in the future becomes fully inter-operable.

  - The question here is whether IIS will evolve into independent system software, or whether IIS will continue to be an application of traditional GIS?
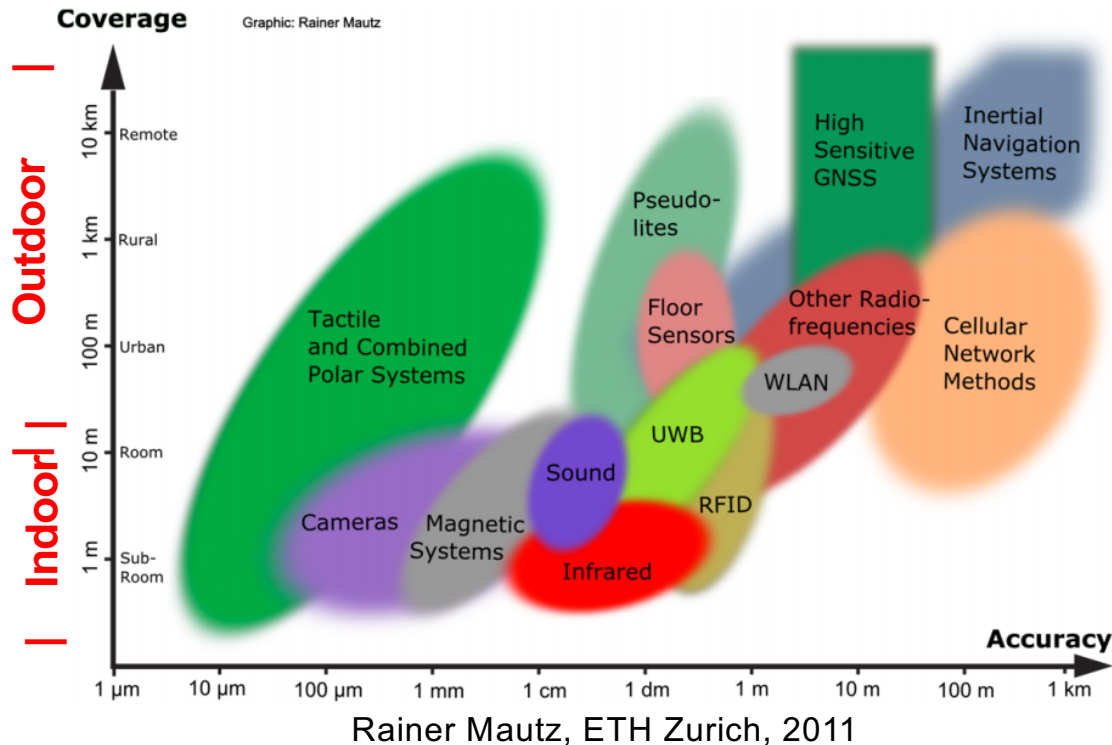
Question 2

- ## **What are the right architectures for IIS?**
  - **GIS** has been founded since their advent on **RDBMS** (e.g., PostGIS on Postgres, ArcGIS on any DBMS) or even common **file system folders**.
  - IIS are emerging in an era where the data management landscape has **shifted towards big data architectures** that are highly parallel and distributed architectures for **spatial** (e.g., Geospark, SparkGIS, SpatialHadoop), **spatio-temporal/timeseries data processing** (e.g., DITA) or even **document-oriented** data processing (e.g., Couchbase) appropriate for **Web 2.0** scenarios?

Question 3

- **How does the type of indoor environment change operational requirements of IIS?**
  - Indoor environments are obviously very diverse, from **conventional building structures** (e.g., house, shopping mall, airport, library, hospital), to **moving objects** (e.g., ships, airplanes, buses), to **underground environments** (e.g, underground mines).
  - How **reusable** will IIS become to **different application scenarios in the future?** Will the trend of application-specific IIS remain the norm (e.g., for navigation, for inventory tracking, etc.)?
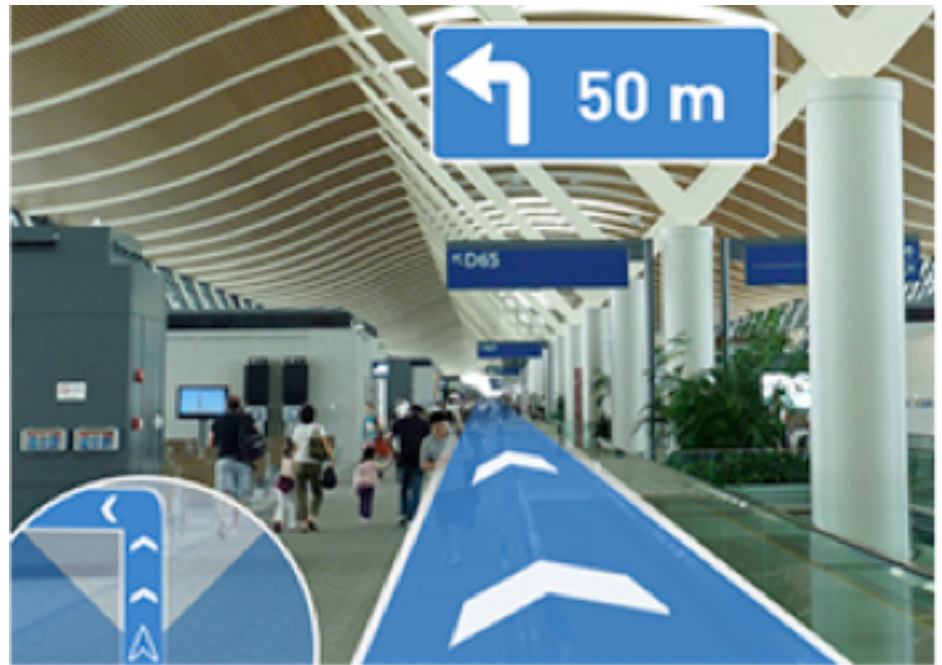
Question 4

- **How are different localization technologies complicating the task of managing indoor data?**

Rainer Mautz, ETH Zurich, 2011

Question 5

- **What is the role of next generation interactive media technologies to IIS?**
  - Augmented Reality
  - Virtual Reality
  - Mixed Reality

Question 6

- **What are the most prominent Privacy and Ethical aspects you see with IIS?**
  - IIS can possibly track custodians at a fine granularity even if these never engaged in a given service (e.g., by downloading an app on their smartphone).
  - Is GDPR or other data privacy regulation imposing a requirement for privacy-by-design principles inside the IIS engine (operators, indexes)?

Question 7 & 8

- **Q7: What are the killer (top) queries to answer in mobile indoor data analytics?**

  - Spatio-Temporal Analytics, Anomaly detection, Association Rule Learning, Clustering, Classifica-tion, Privacy Issues. **=> ideas for PhD students & new synergies/collaborations?**

- **Q8: Are IIS expected to have a commercial/real impact in the near future?**

  - e.g., Manufacturing, Navigation, Marketing and Shopping Analytics, Healthcare, Museums, IoT?
  - Anything bigger?