

3D indoor navigation: the new challenge

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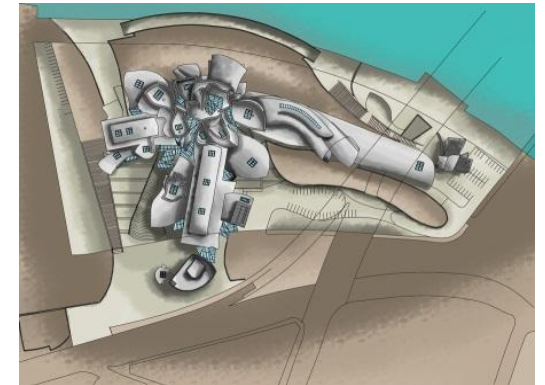
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Vice chair OGC SWG IndoorGML

Chair ISPRS WG IV/VII 3D indoor modelling and navigation

Content

- Why indoor?
- Existing applications
- Challenges
- Space subdivision



Guggenheim museum, Bilbao

Why Indoor?

- 87% of day people spend indoors
- 60 % of the population lives in cities
- Our buildings are getting increasingly complex



Outdoor vs. Indoor

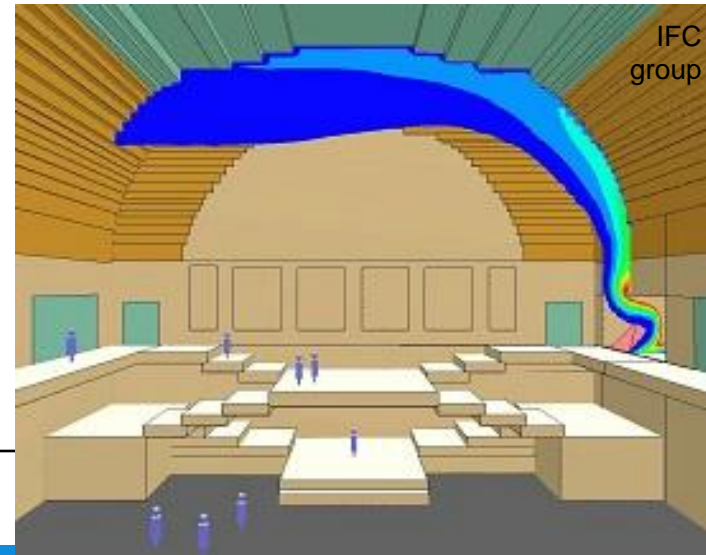
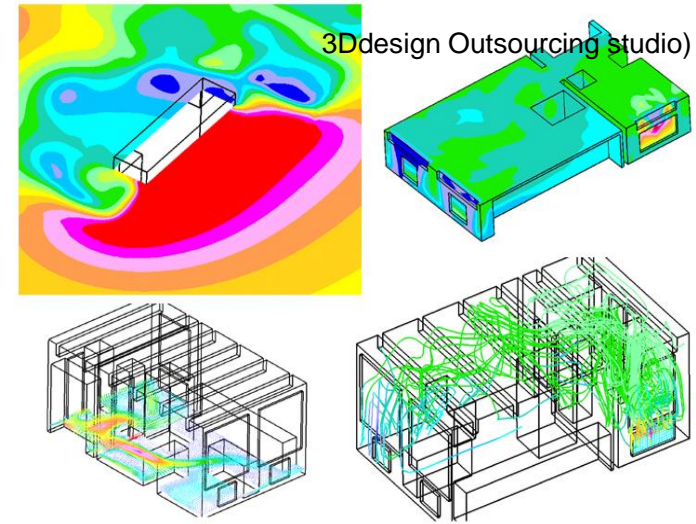


Indoor and enclosed spaces

- Closed spaces (no good overview)
 - Limited sunshine/artificial lights (sense of time)
 - No natural shadows (orientation)
 - Man-made structures (different perception)
 - Various obstacles and narrow spaces (movement)
 - Air quality (influenced reactions)
 - Crowd (movement in all directions)
 - Hidden objects (X 'is in' Y)
 - ...
-
- All above influences the modelling and analysis of indoors

Applications indoors

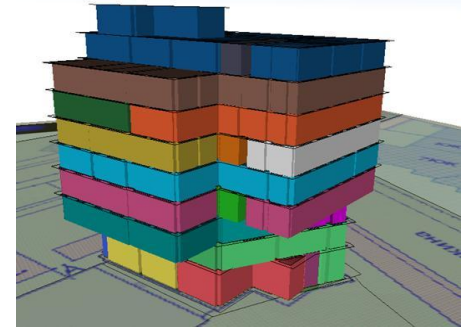
- Airflow modelling
- Smoke modelling
- Facility management
- Interior design



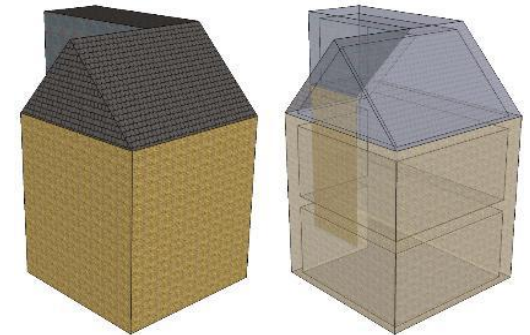
Applications indoors

- Cadastre
- Net open area
- Risk management
- Emergency management
- Navigation

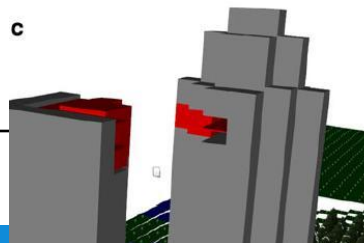
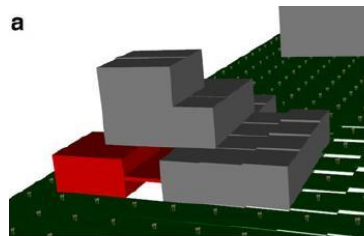
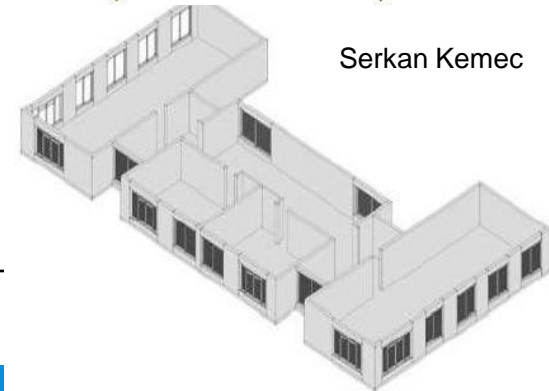
Marian de Vries



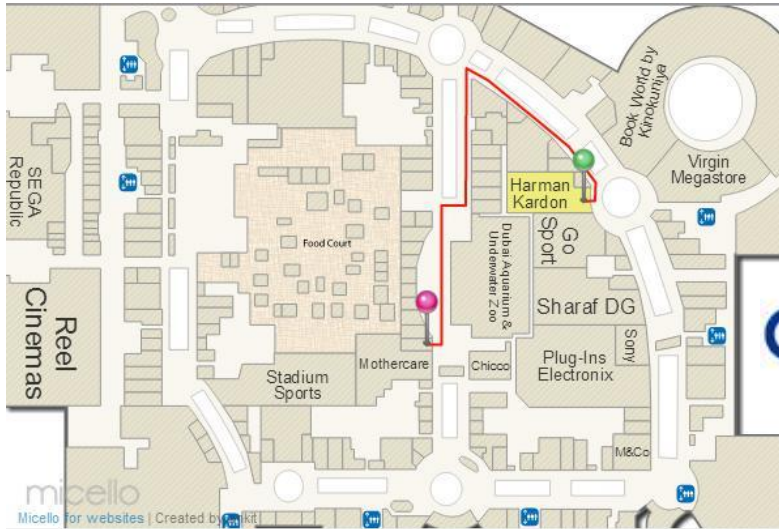
Roeland Boeters



Serkan Kemec



Retail



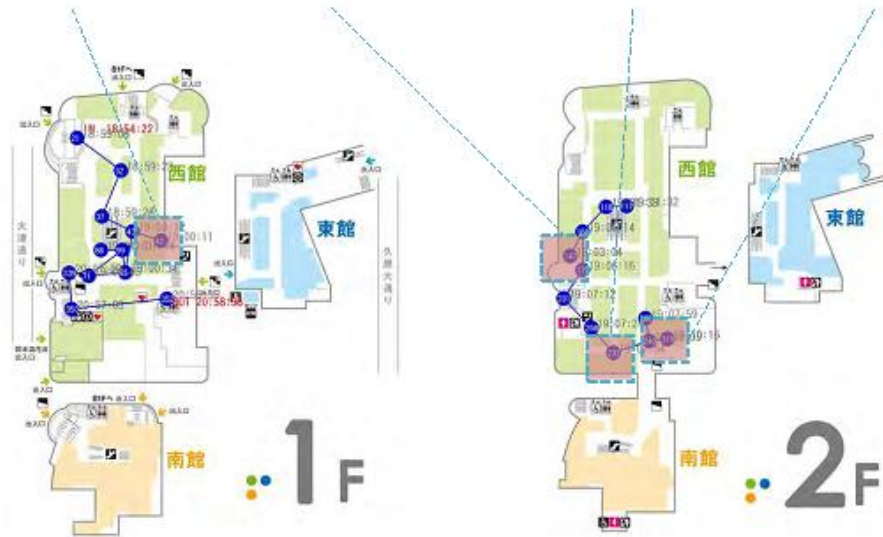
Store Inventory



Analysis of user behaviour

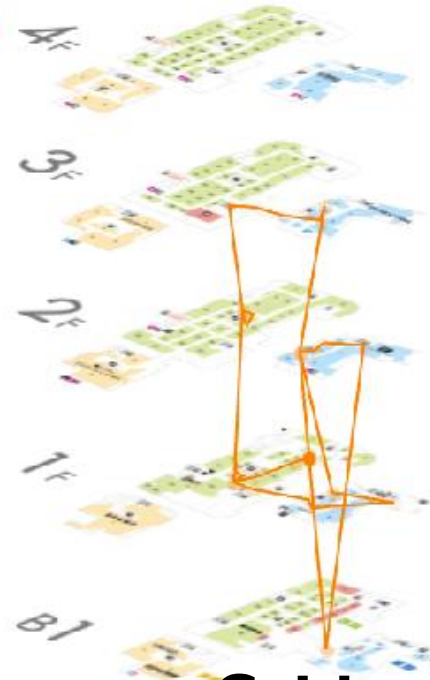
PROTOTYPE①

shopA → shopB → shopC → shopD



Analyzing points

- Total BLE log—device collected the most data?
- which is most attractive shop (user's POI)?



Navigate:

- **Avoid crowds**
- **Get to most visited shop**
- **Get to Myshop**
- **Guide me (Mypath)**

Current indoor navigation apps:

Many specialised applications: robot and human navigation

- Based on floor plans or 2.5 D surfaces (**vertical information is largely ignored**)
- Geometric approaches (**no thematic semantics such as doors, windows, number of doors in rooms, etc.**)
- Network/Grid for navigation is predefined (**no dynamic derivation**)
- **Obstacles** are largely ignored
- Granularity is coarse (**shape of room is approximate**)
- Individual guidance (**no simultaneous navigation of several users**)
- Walk and drive as locomotion modes (**no fly, no speed control**)

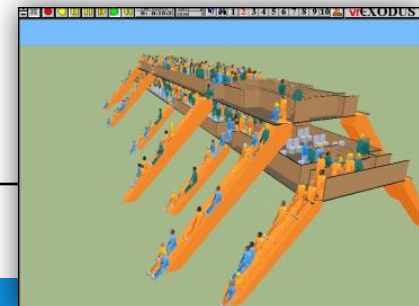
Where can we go?

- Navigation in public buildings (*get to rooms*)
- Navigation to info desks/booths in exhibitions/airports (*get to parts of rooms*)
- Navigation in construction sites (*changing environments*)
- Orientation in libraries /shopping malls (*finding books in shelves, finding favorite items*)
- Maintenance/repair operations inside buildings
ceilings/floors/walls (*failure in utilities*)
- Navigating to mobile facilities (*finding trailers, people*)
- Navigation for emergency response (*get out to safe place, get in to rescue*)
- Avoidance of obstacles (*above, below*)



UbiCOM

VERRES, Greenwich University



Indoor Challenges and Opportunities

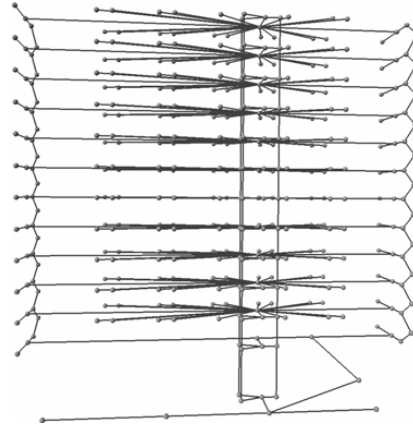
Indoor3D, Cape Town, December 2013

	Acquisition and Sensors	Data Structures and Modelling	Visualization	Navigation	Applications	Legal Issues and Standards
Existing problems ↓ Emerging problems	Variable lighting conditions	Software tool	Web and mobile devices	Navigation models	Indoor modelling for crisis response	Unification of outdoor and indoor models
	Variable occupancy, automated feature removal	Diversity of Indoor Environments	PoI and landmarks strategies	Automated space subdivision	Augmented systems	The diversity of indoor environments
	Sensor fusion			Optimal routing	Gaming	
					Industrial applications	
		Real-time modelling		Navigation queries and multiplicity of targets		
	Mobility	Dynamic abstraction	Real-time change visualization	Travelling imperatives	Natural description of indoor environments	Security and levels of access
	Real-time acquisition of dynamic environments	Discovering the context of space	Complexity visualization	Discrete vs continuous navigation models	Real-time decision support	Privacy
	Learning the composition of space	Integration with GIS/BIM	Aural cues			Copyright

Problem: How to create a network?



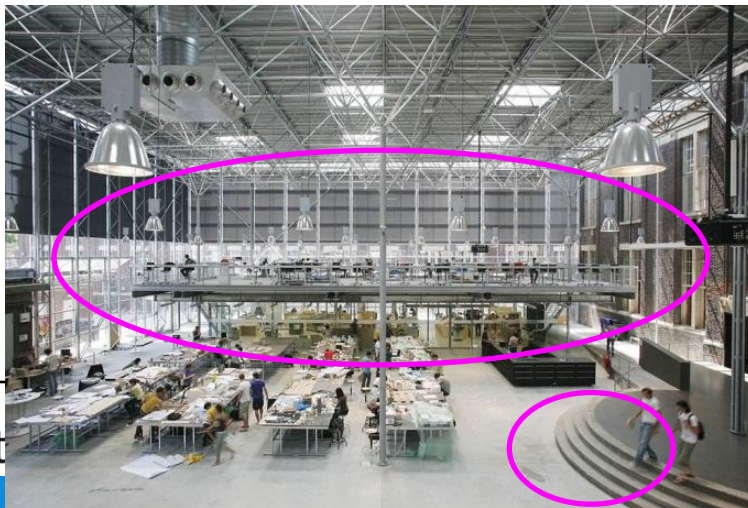
How?



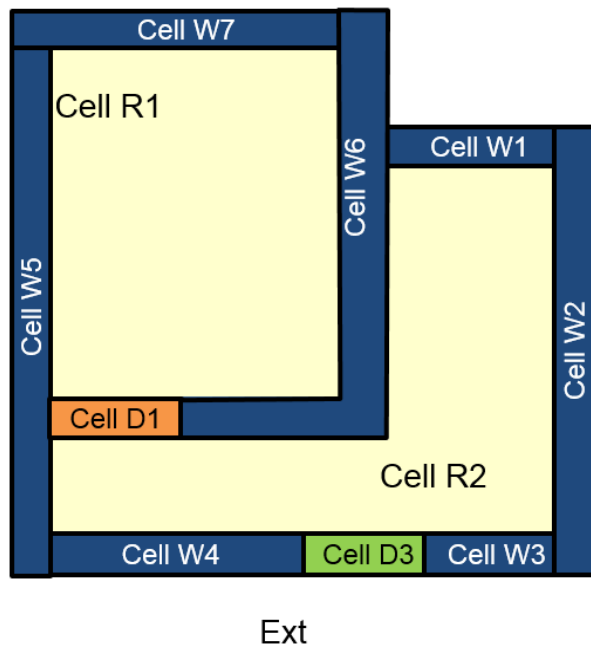
User 1



User 2

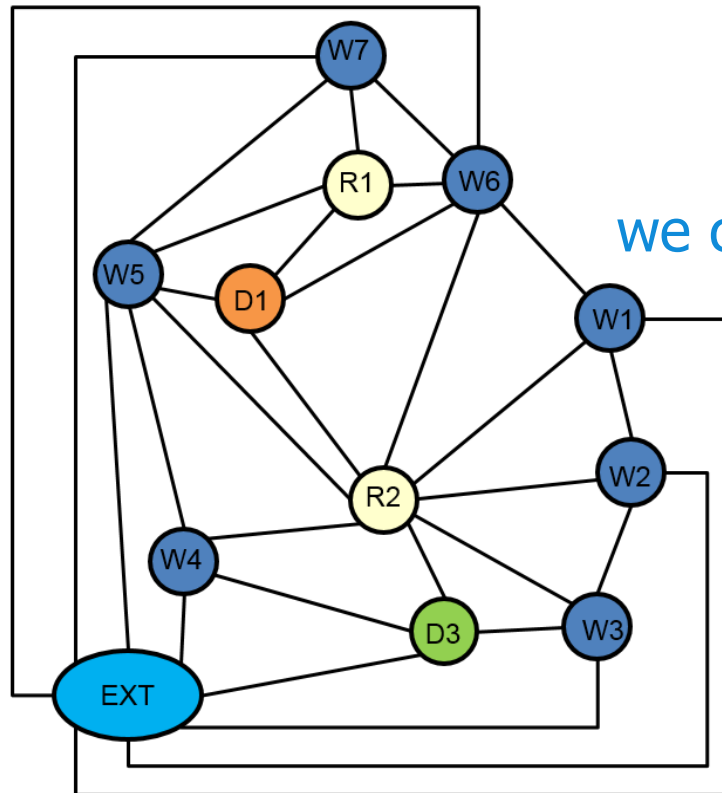


Duality space (basis for IndoorGML)



Primal Space

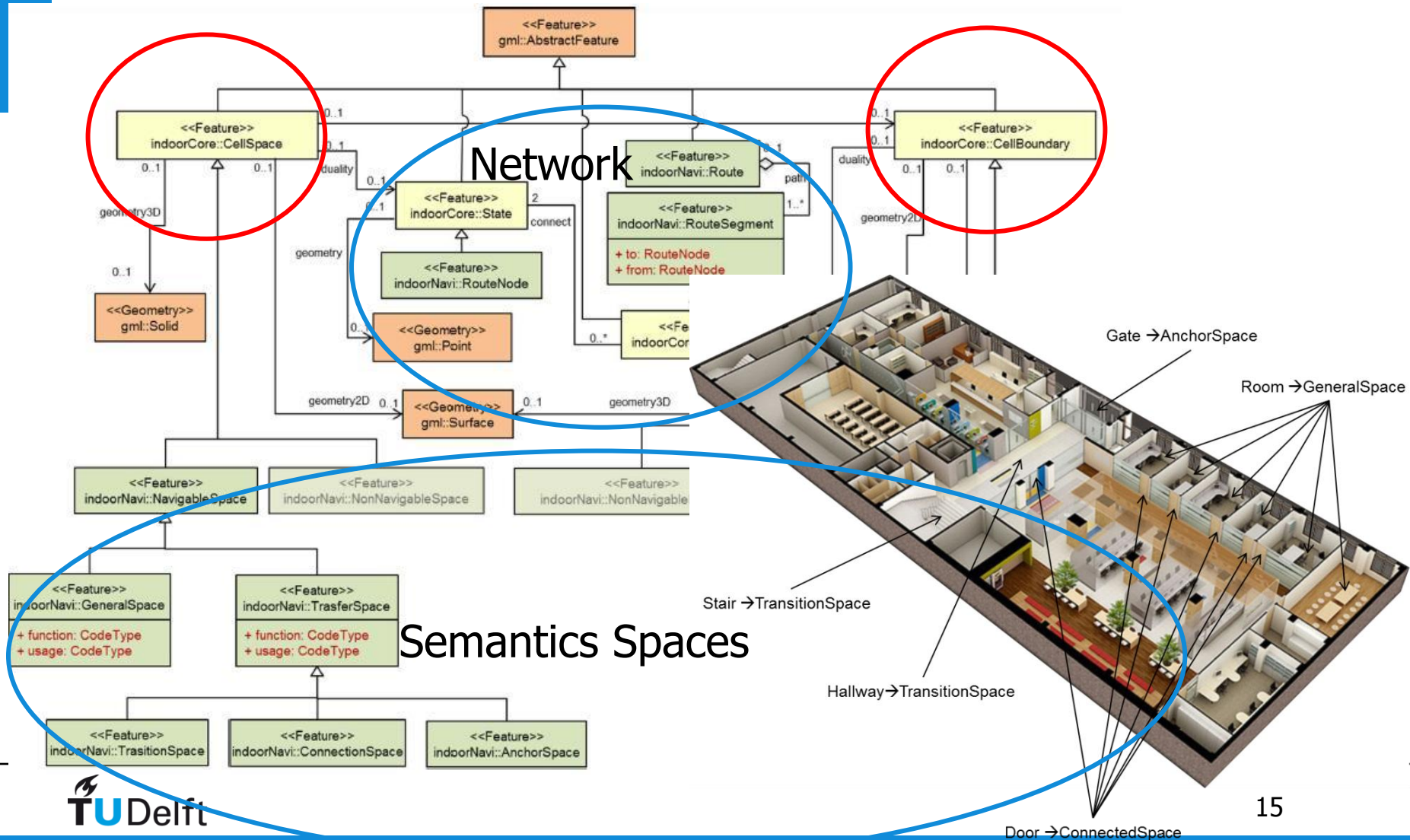
Adjacency Graph



Dual Space

If we know
the semantics
we can navigate!!!

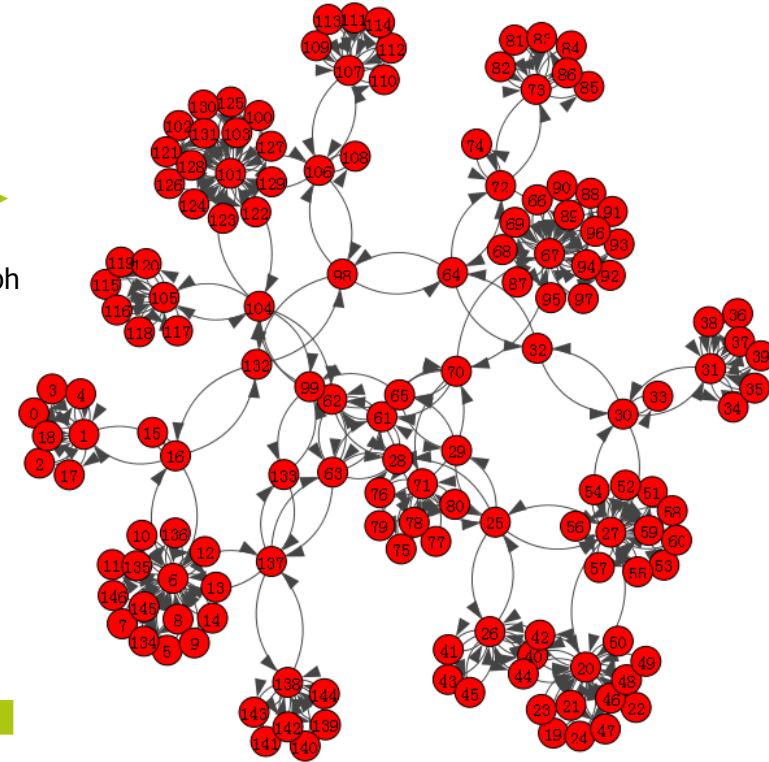
IndoorGML – just adopted as OGC standard



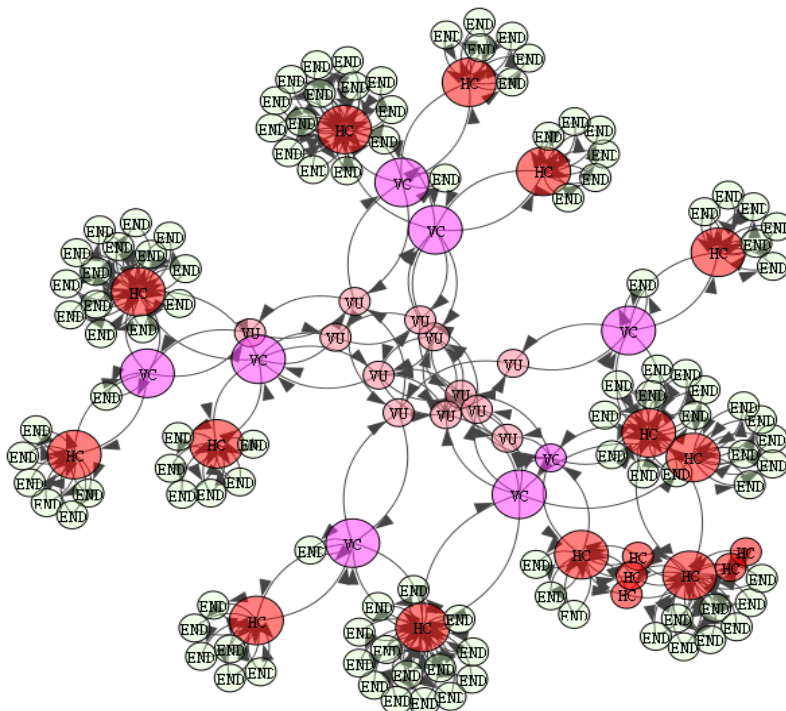
Network + semantics



Connectivity graph

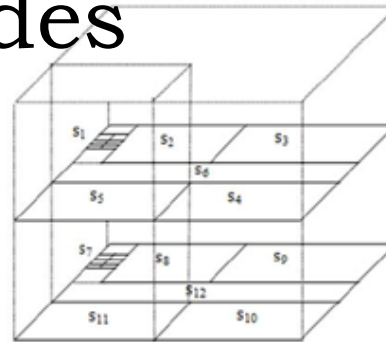
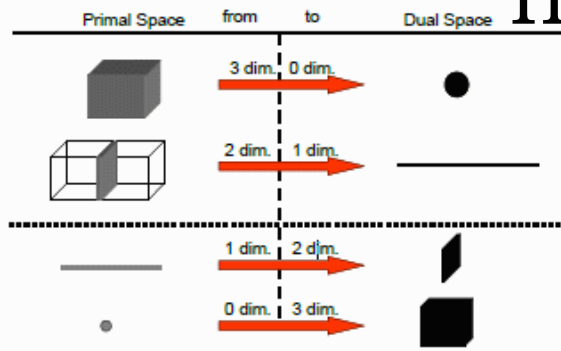


Connectivity graph + semantics

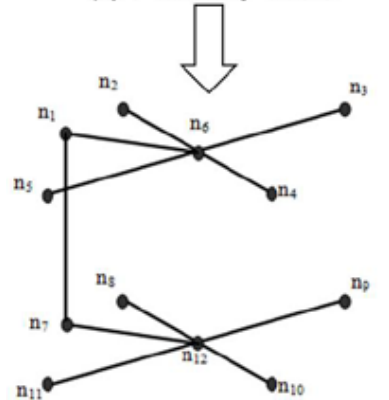


How much granularity is needed?

In many cases we need more nodes

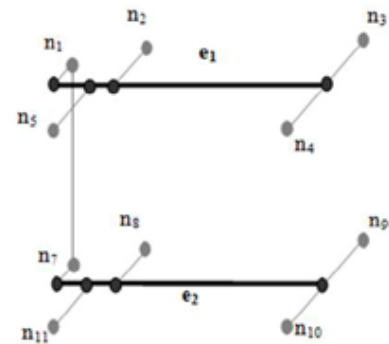
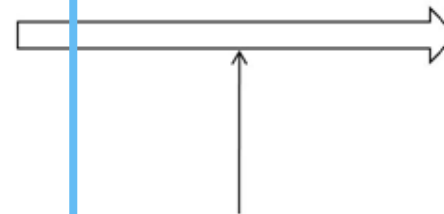


(a) Geometry Model

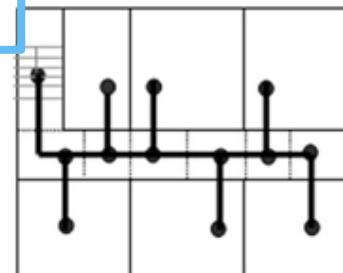


(b) Logical Network Model

This requires subdivisions

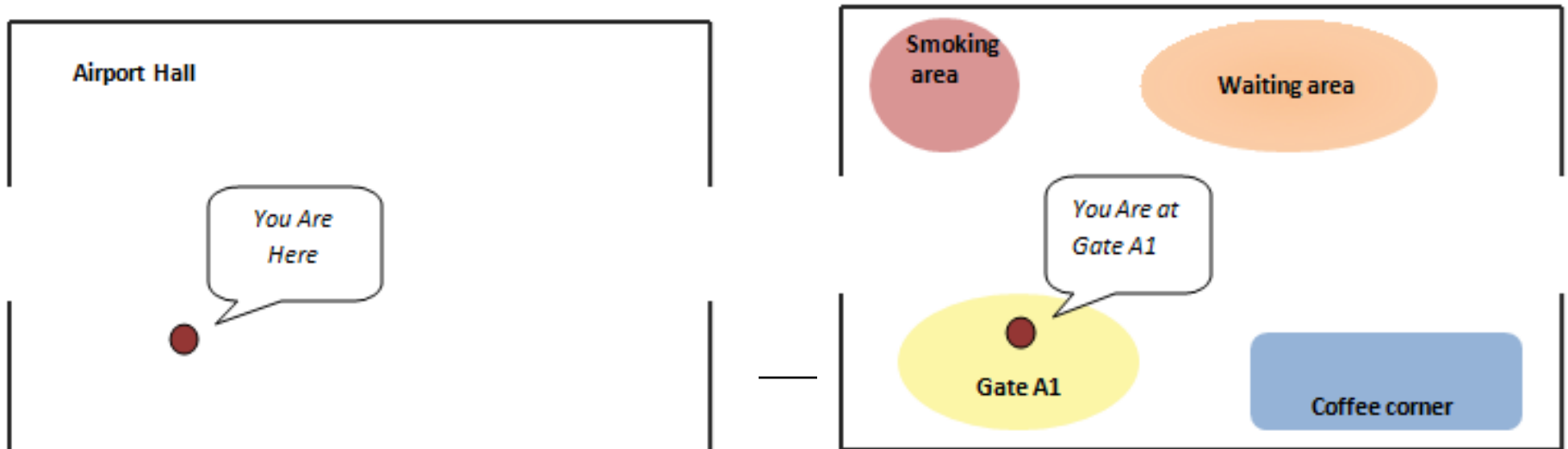


(c) Geometry Network Model



Room subdivision

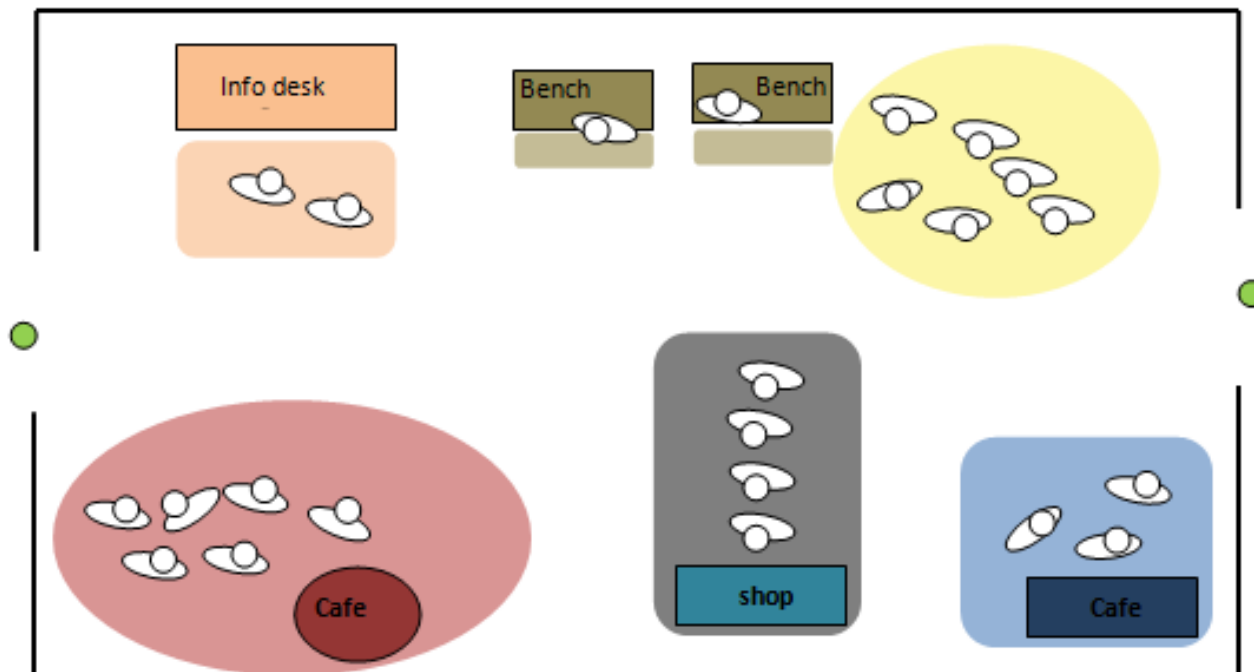
- Rooms are represented as single indivisible spaces or subdivided according to geometric criteria
 - No descriptive localisation
 - No possibilities to navigate to those areas

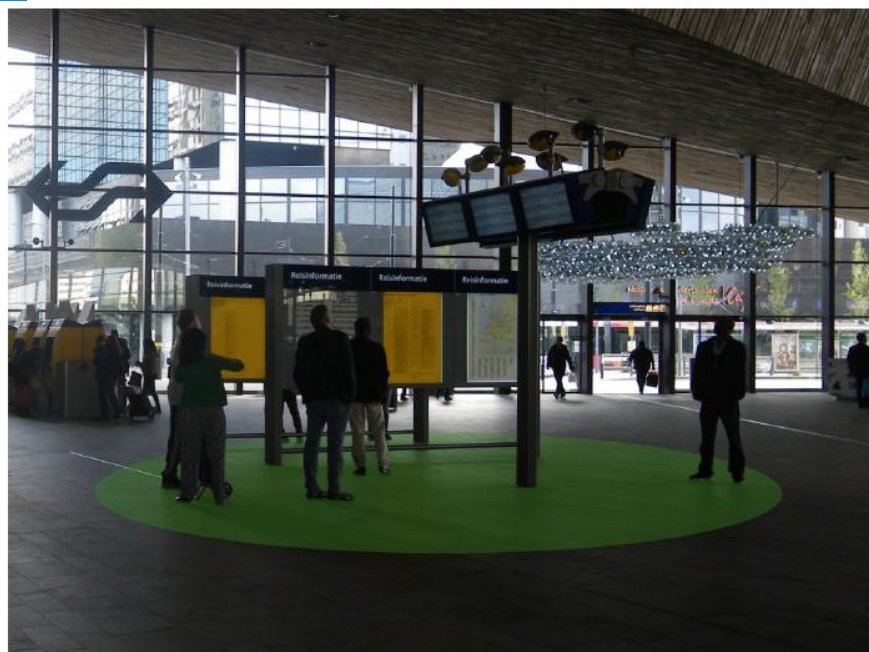


Influence of functional areas

- People: presence and their behaviour
- Objects in indoor environment

Marija Krūminaitė





Marija Krūminaitė

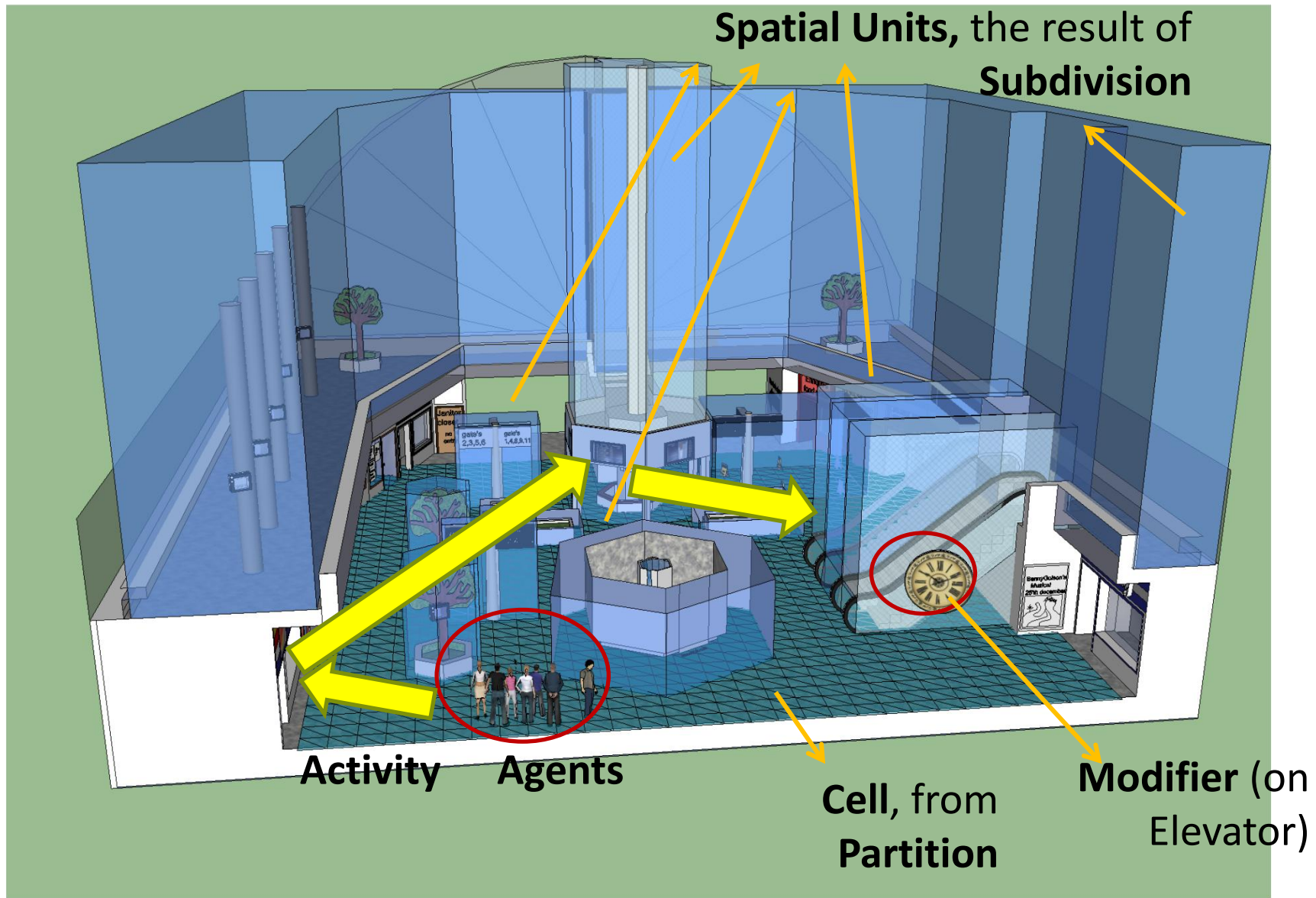
Framework for space subdivision

- ***Space, Sub-space, Partition***
- ***Agent***: client in certain navigation
- ***Activity***: task and navigation behavior performed by an *agent*.
- ***Resource***: things that an *agent* can use in a *sub-space* or take from a *sub-space*.
- ***Modifier***: define what event impacts which *agents/resources/activities* and on which aspects.

Time's up!

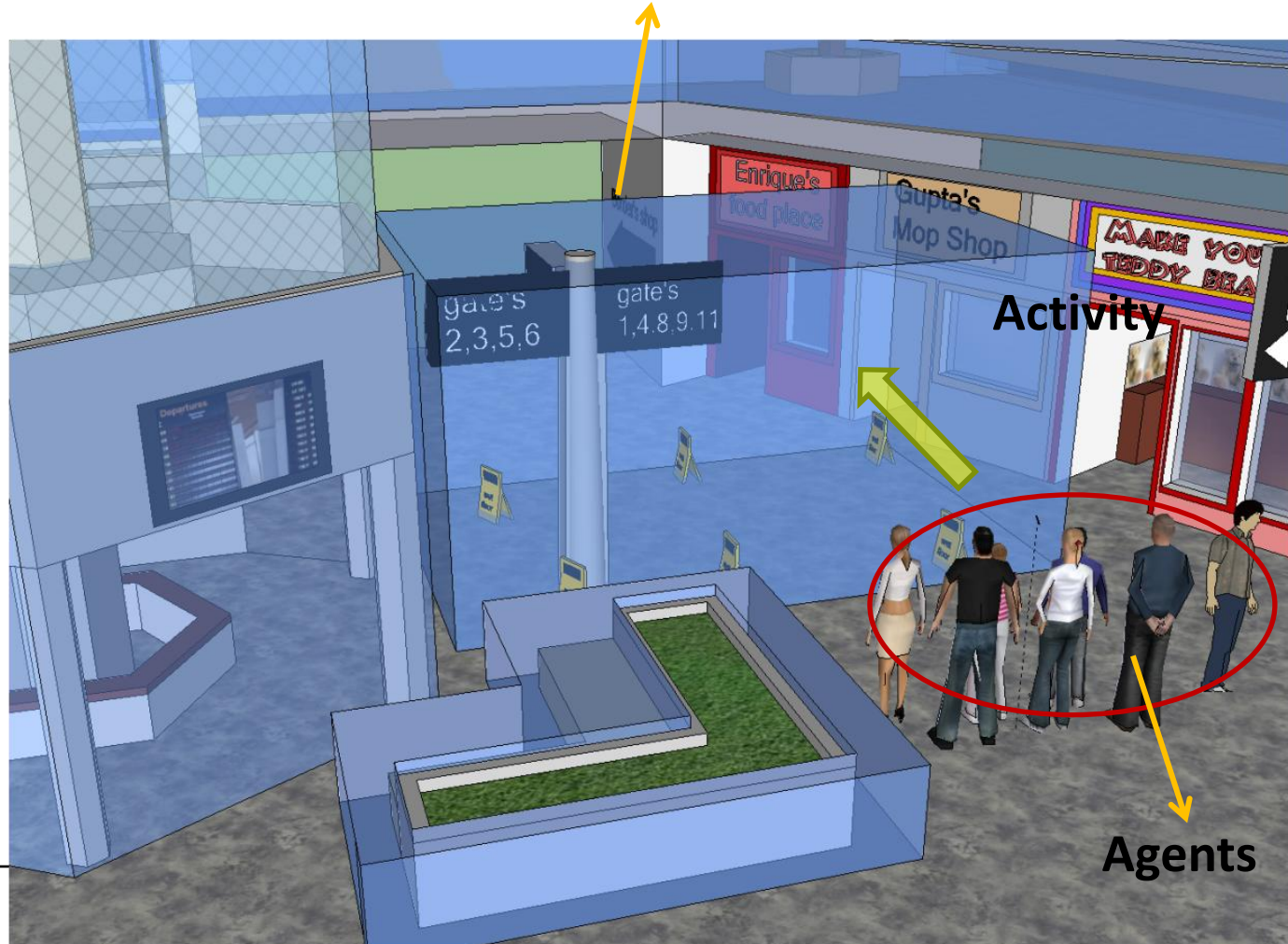


Zlatanova, S., L. Liu, and G. Sithole, 2013. A Conceptual Framework of Space Subdivision for Indoor Navigation. ISA '13 Proceedings of the Fifth ACM SIGSPATIAL International Workshop on Indoor Spatial Awareness, ACM New York, NY, USA. pp. 44-48

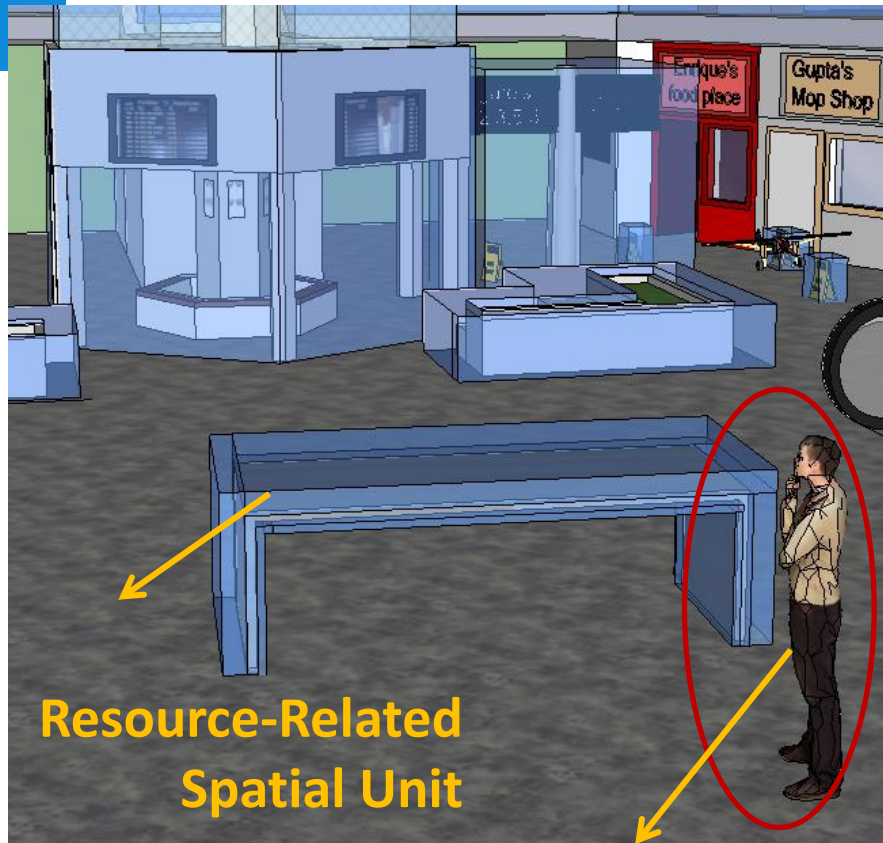


SU may depend on the time

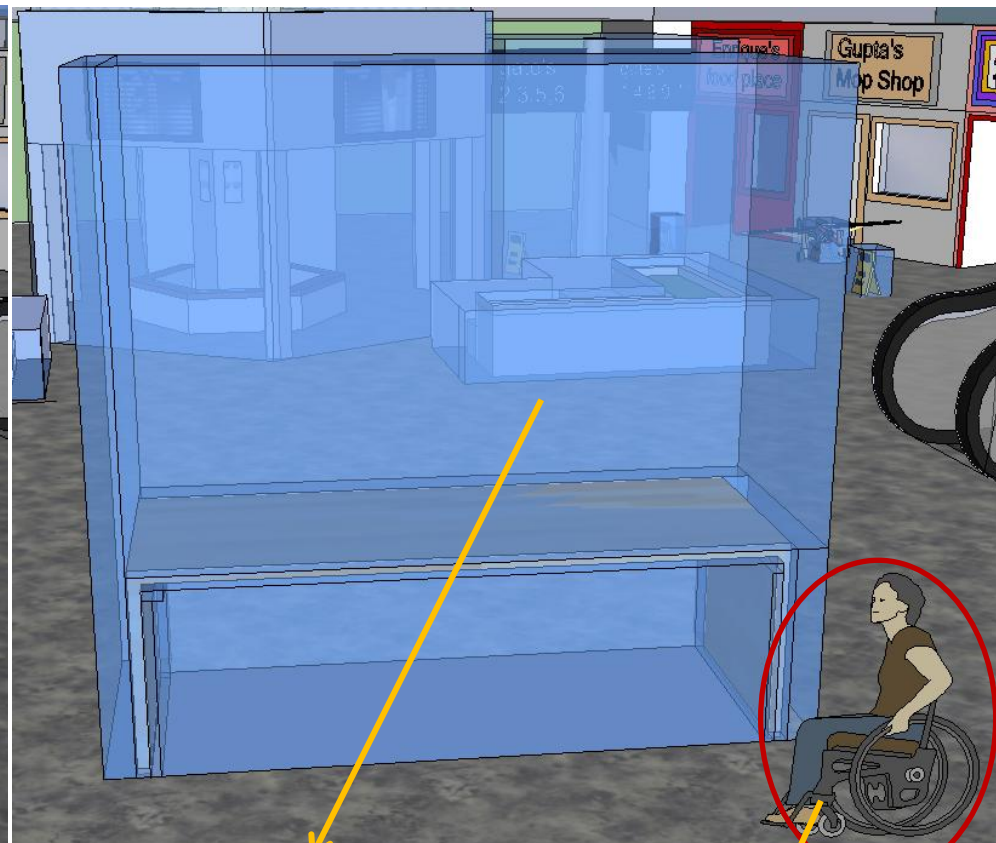
Resource-Related Spatial Unit (Temporal)



SU may depend on the agent



Agent



Resource-Related Spatial Unit

Agent

Challenges in Indoor mapping and Modelling

	Acquisition and Sensors	Data Structures and Modelling	Visualization	Navigation	Applications	Legal Issues and Standards
<p>Existing problems</p> <p>↓</p> <p>Emerging problems</p>	Variable lighting conditions	Software tool	Web and mobile devices	Navigation models	Indoor modelling for crisis response	Unification of outdoor and indoor models
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Thanks!



nheim