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IndoorGML – Candidate Standard for Indoor Spatial Information

90th OGC Technical Committee

Washington, DC

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26 March 2014

Before starting...



- Not (InDoorGML, Indoor GML, In Door GML)
- the correct name is IndoorGML like CityGML



<Source: Google Earth 3D>

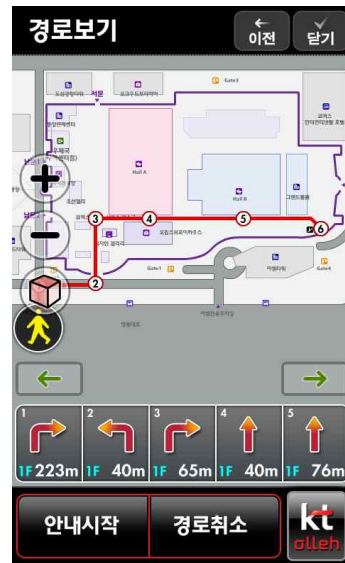


<Source: Google Earth 3D>

Applications

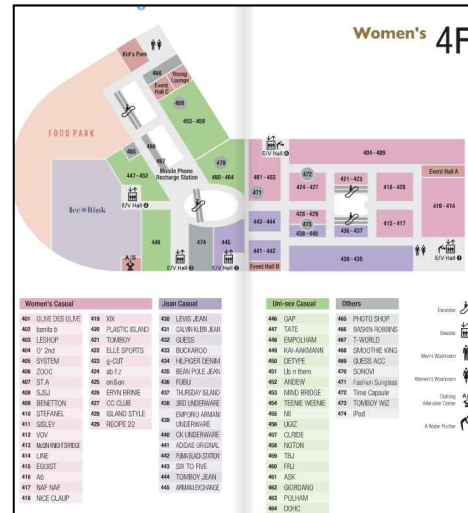


Indoor LBS



Indoor Robot

Indoor Geo-Portal



Indoor mCommerce



Emergency Control



Hospital



Cruise Ship



Services for handicapped persons

Prior work on indoor space



- IFC: Mainly focused on BIM
- CityGML: LoD 4: Interior space
- KML
- others

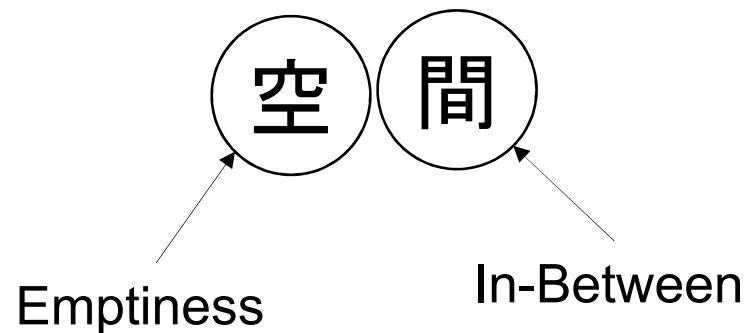


Basic Ideas

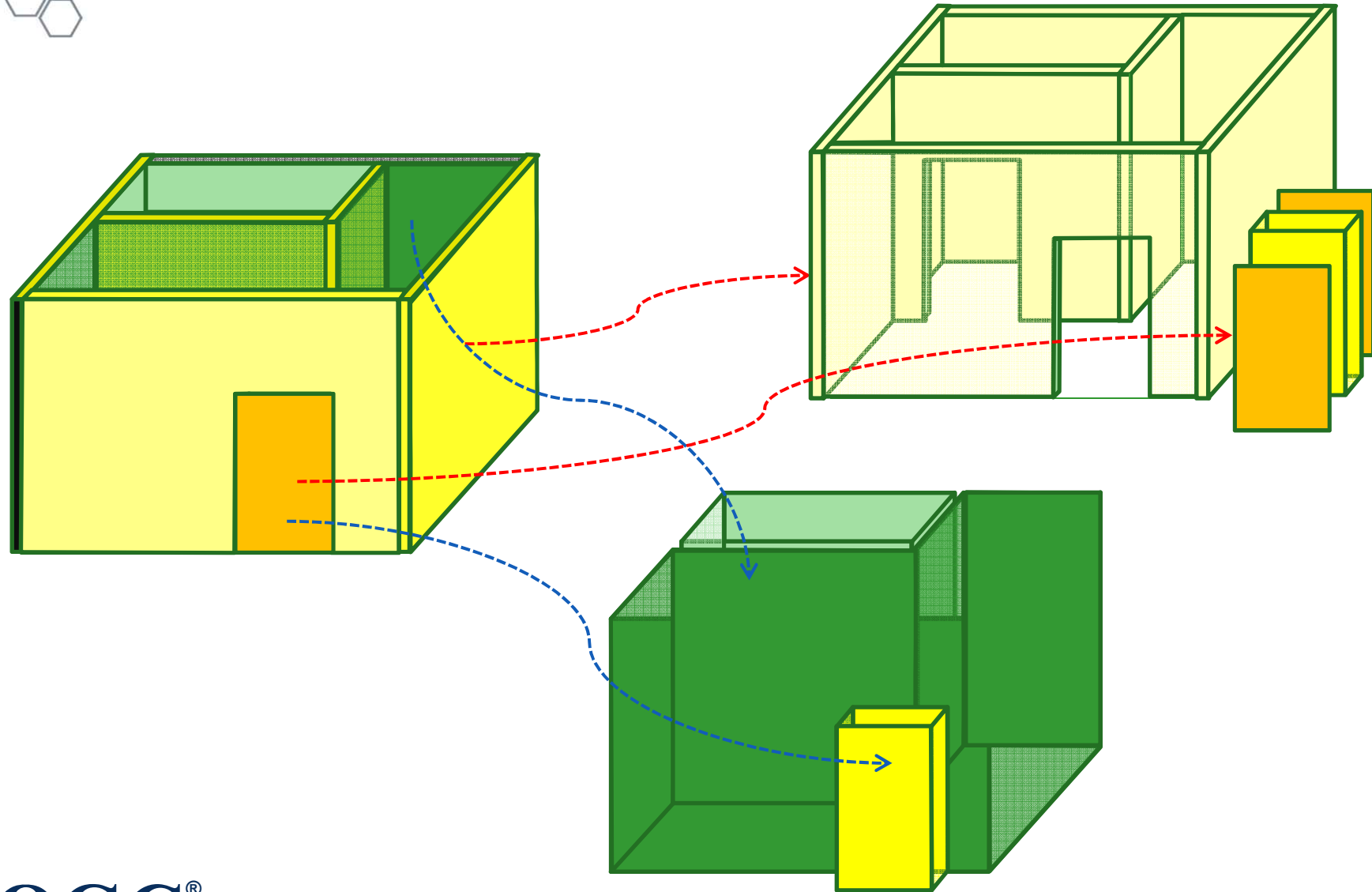


Space

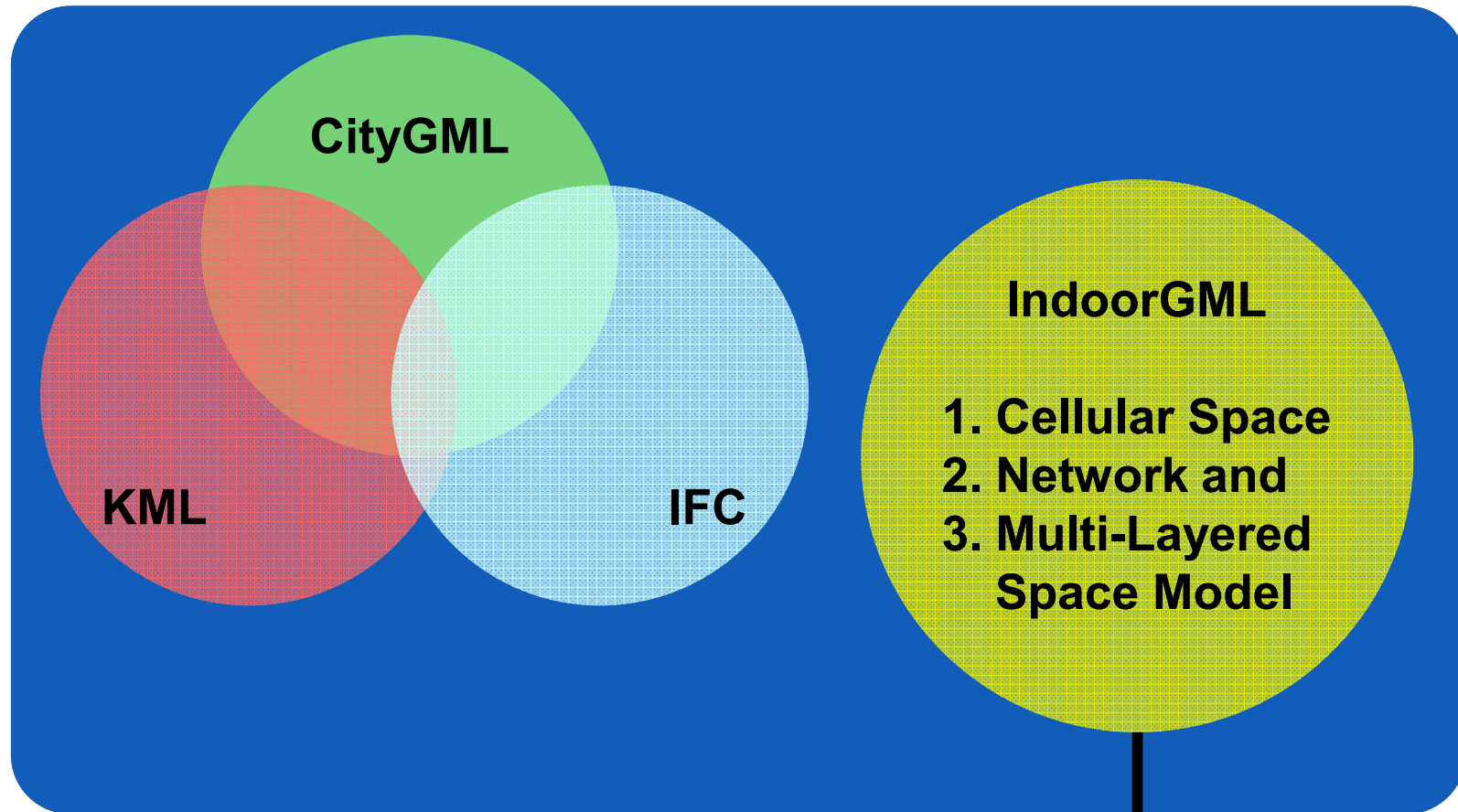
*a **boundless** extent in which objects and events occur and have position* – in online Britannica



Basic Ideas – Components vs. Space



IndoorGML as a complement



Indoor positioning is out of scope

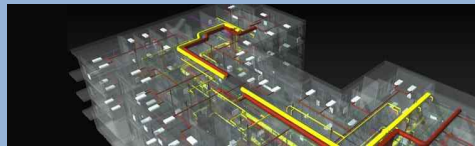
IndoorGML and Other Standards



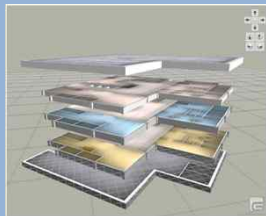
IndoorGML



IFC



KML



CityGML



2D Indoor Floor Plan



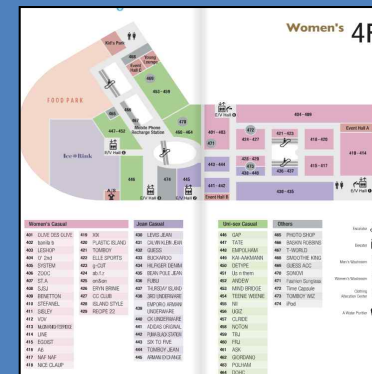
Services for
handicapped
persons



Fire exit

Emergency
Control

Application



Indoor mCommerce

Indoor LBS



Indoor Robot

IndoorGML based on Cellular Space Model



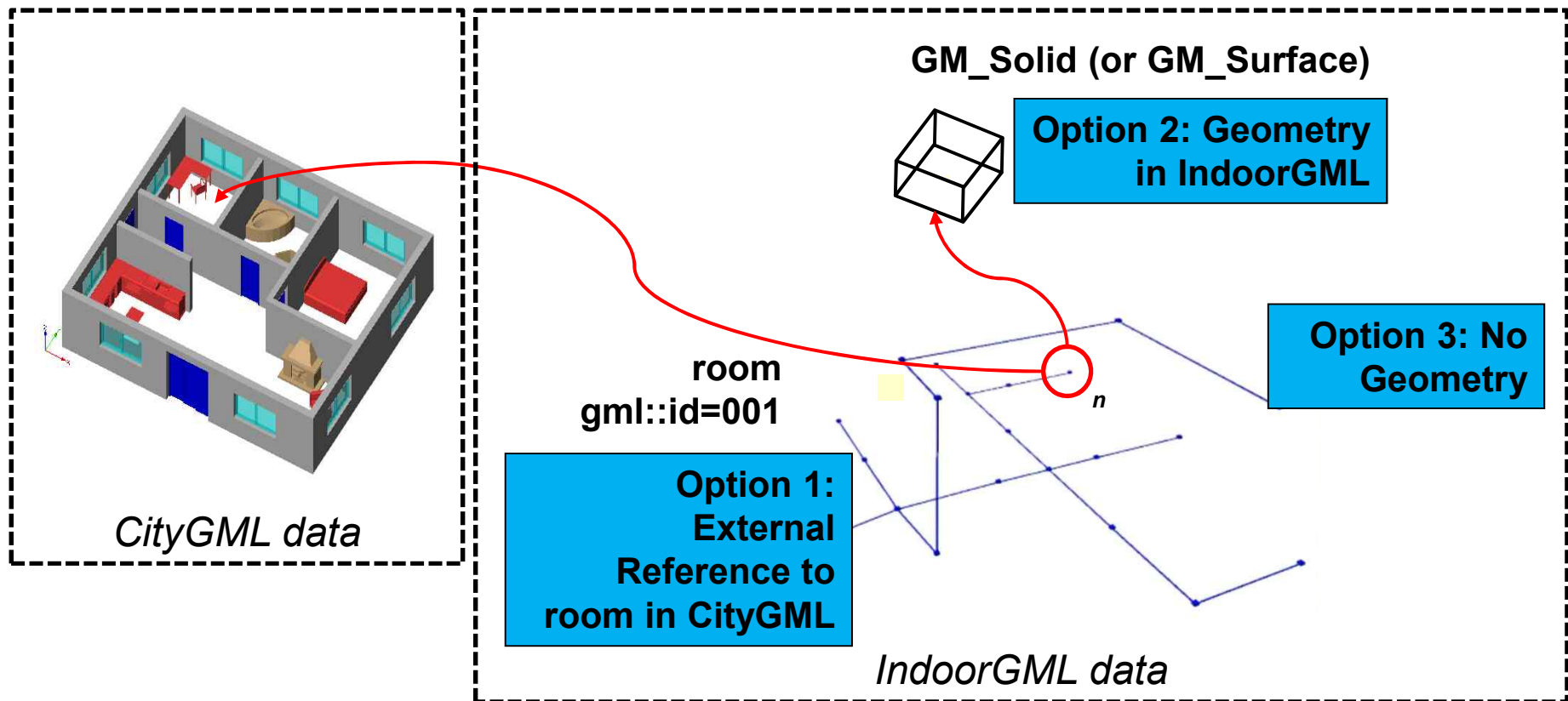
- A given space is defined as a set of (Non-Overlapping) cell spaces
 - $C_i \cap C_j = \phi$
 - $\bigcup C \subseteq U$
(e.g. Shadow area of sensor coverage)
 - Given indoor Space U : 2D or 3D
 - Each cell has Cell ID.
- 4 aspects of cellular space
 - Geometry
 - Topology
 - Multi-Layered Structure
 - Semantics



Geometry



Three options to represent geometry of each cell

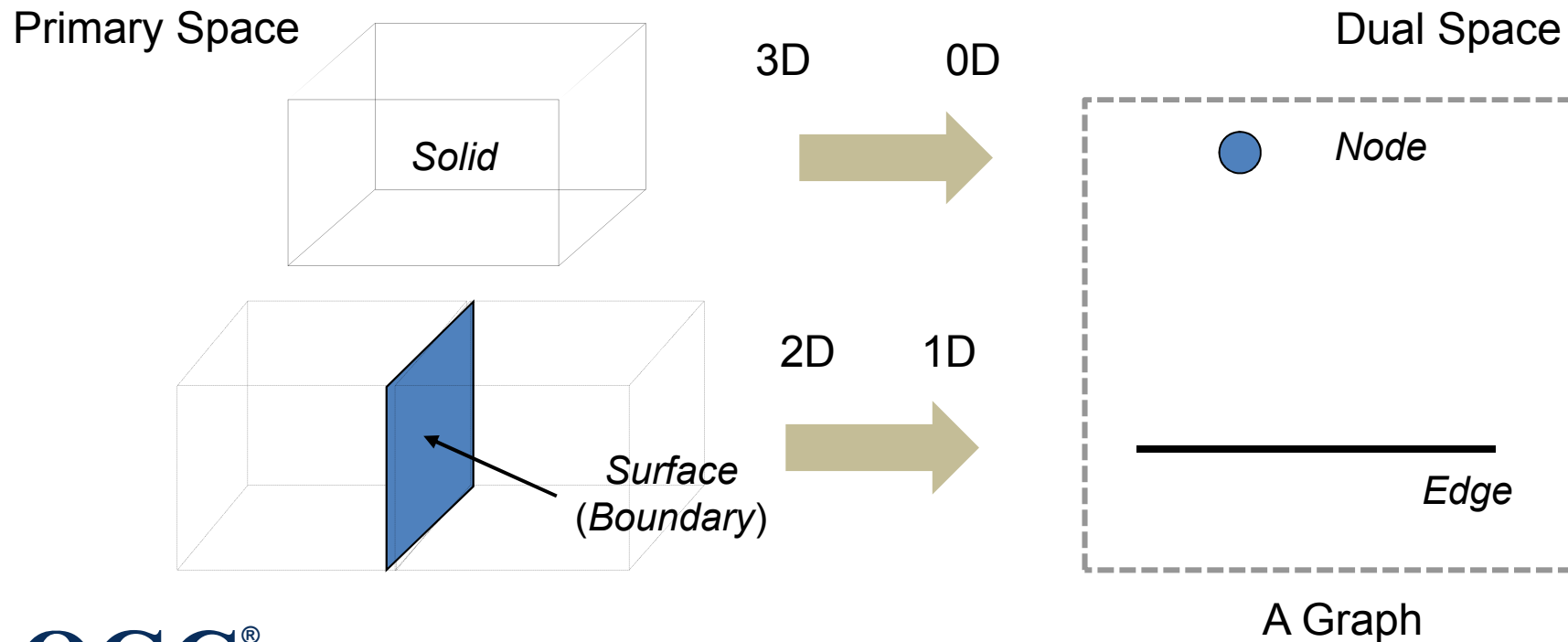


Topology between Cells

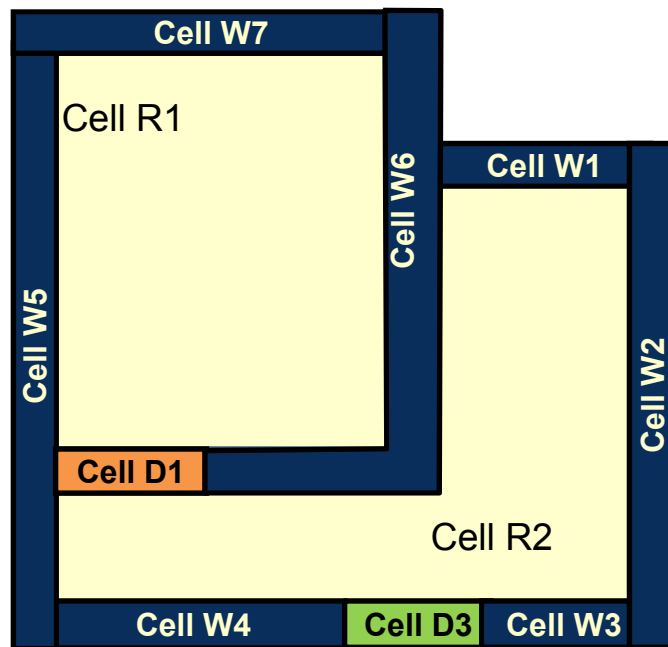


- Poincare Duality

- Conversion from original (primal space) to dual space
- Given a N -D (e.g. 3D) space, conversion from k D object $\rightarrow N-k$ (e.g. $3 - k$) D objects



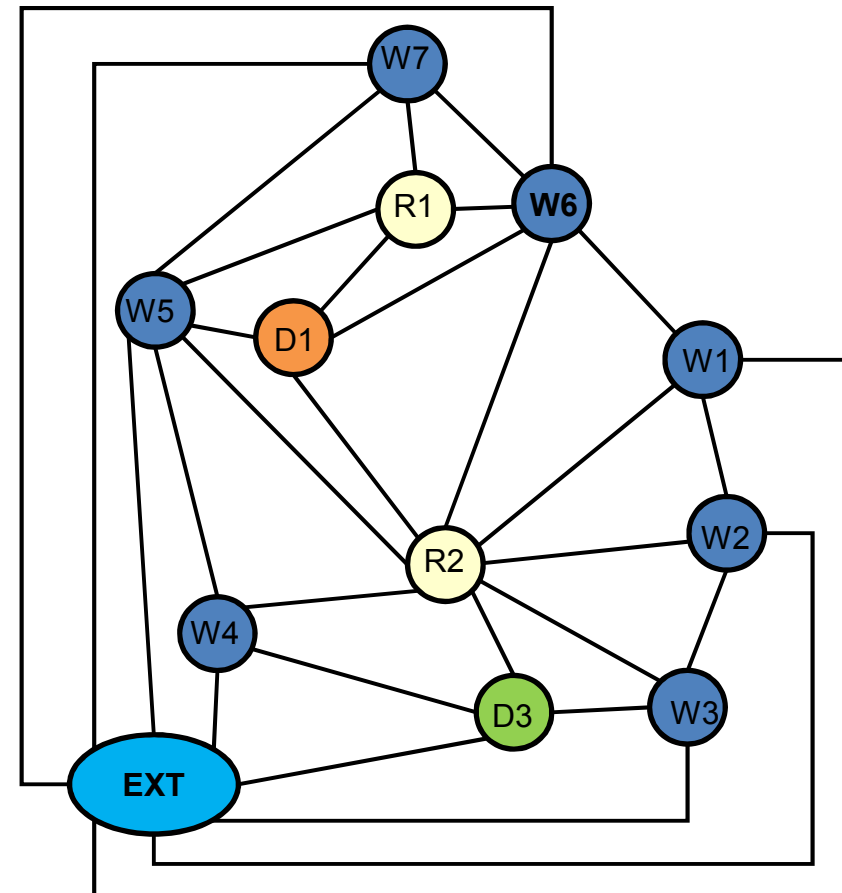
Topology between Cells



Ext

Primal Space

Adjacency Graph

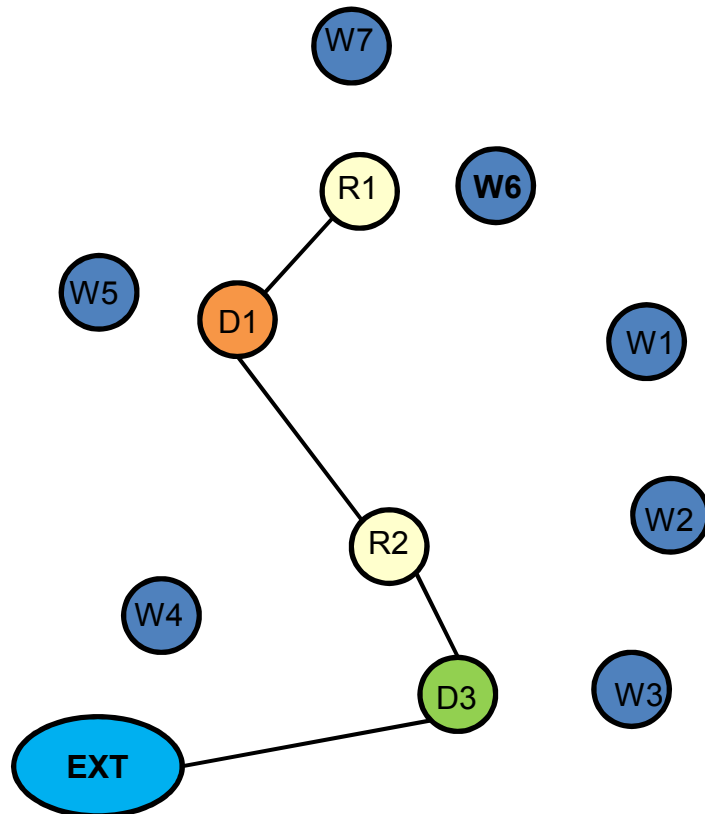


Dual Space

Topology between Cells



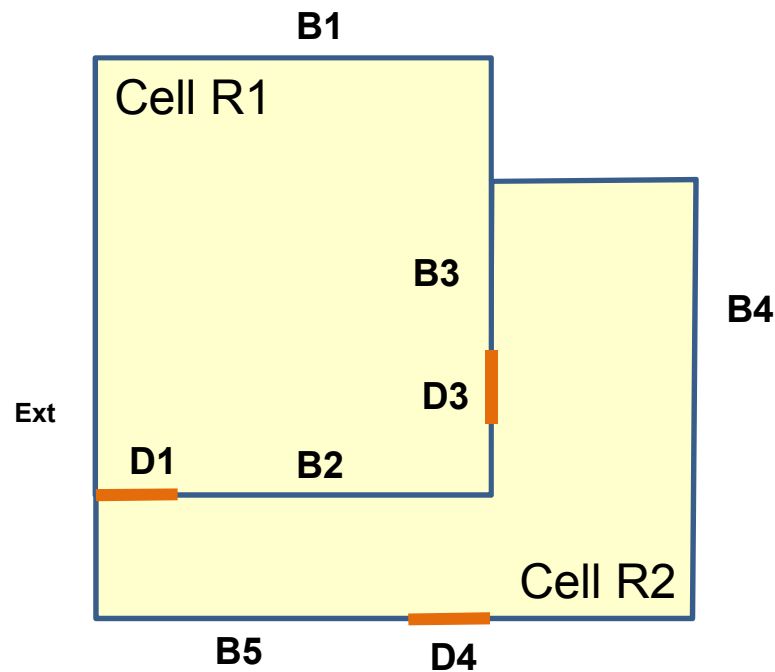
Connectivity
Graph



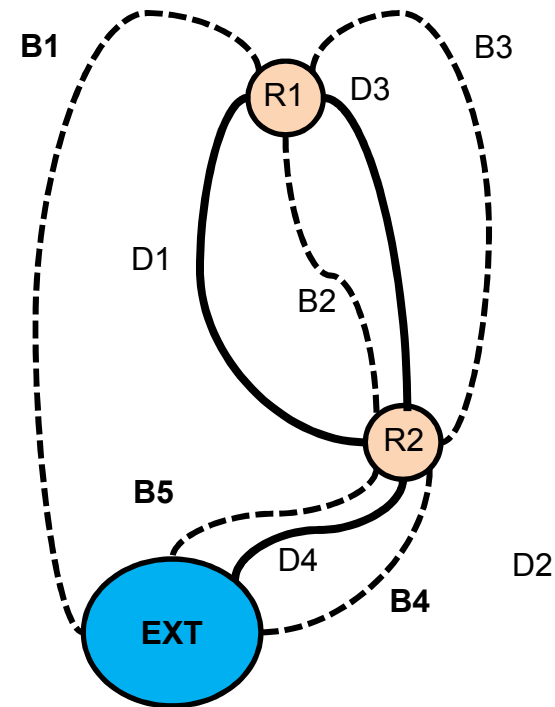
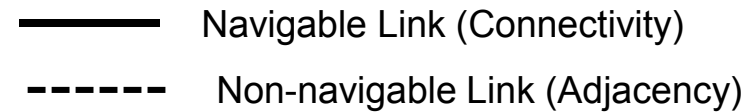
Topology between Cells



Example: Wall and Door as Space Boundary

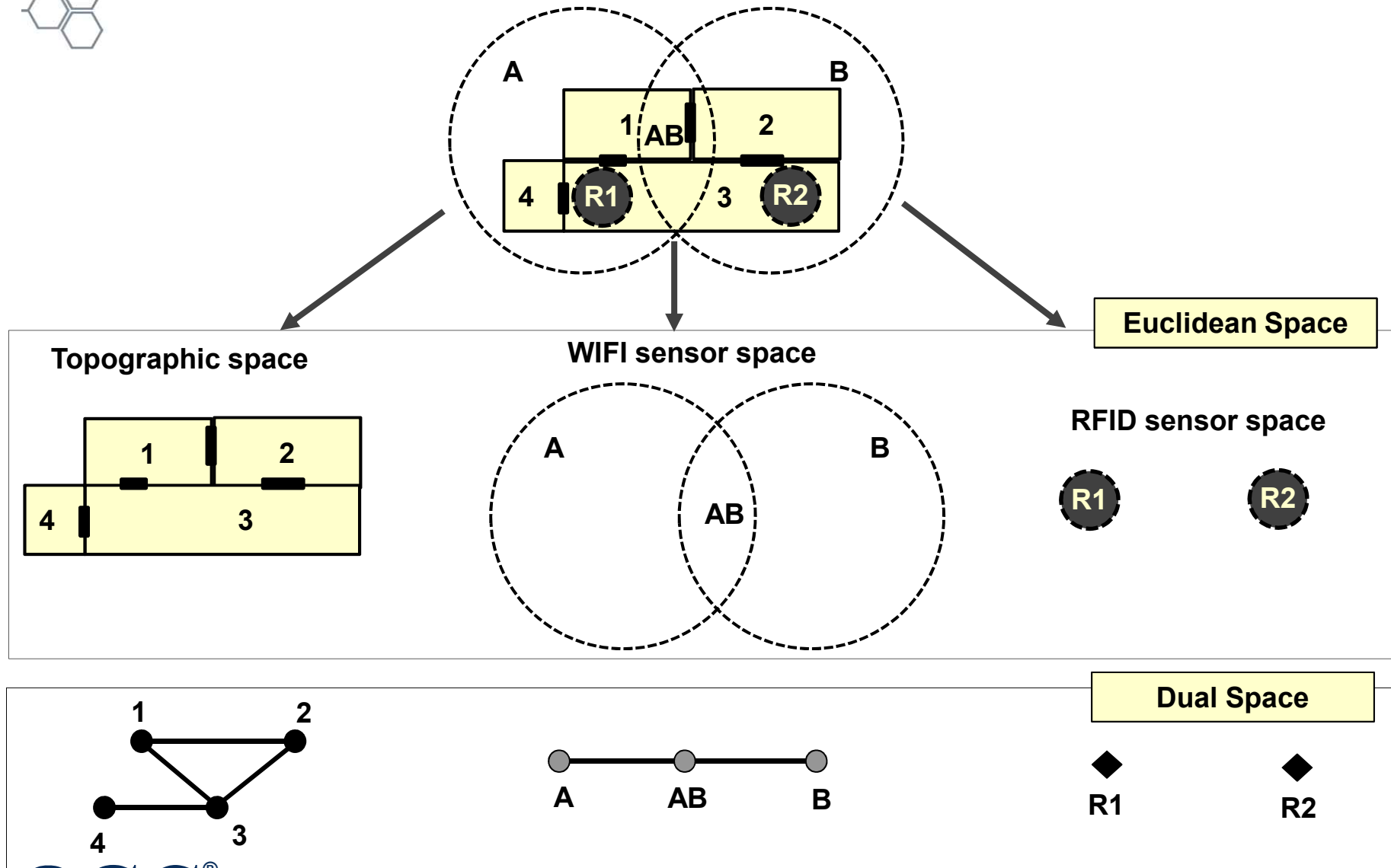


Topographic Space

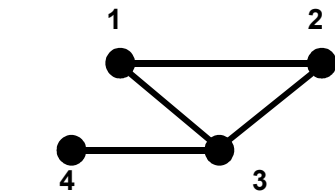


Dual Space

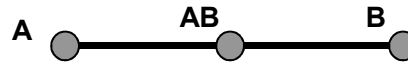
Multi-Layered Space



Multi-Layered Space – Inter-layer relation



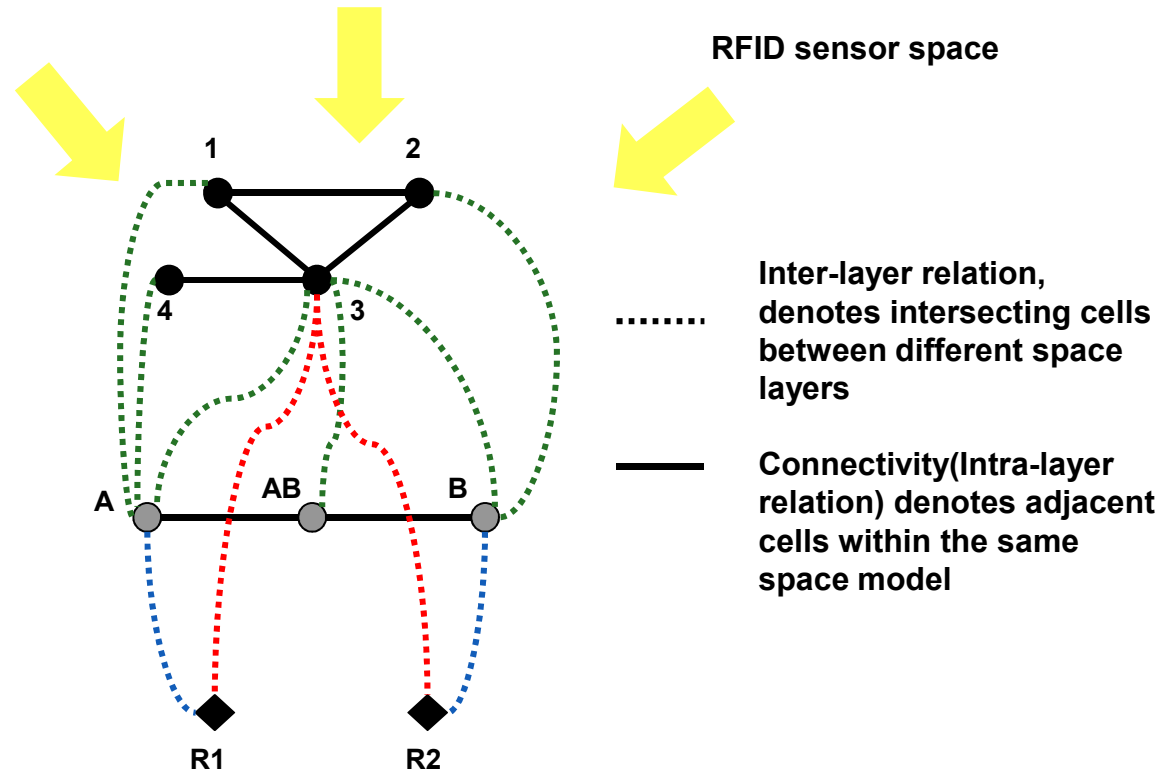
Topographic space



WFI sensor space



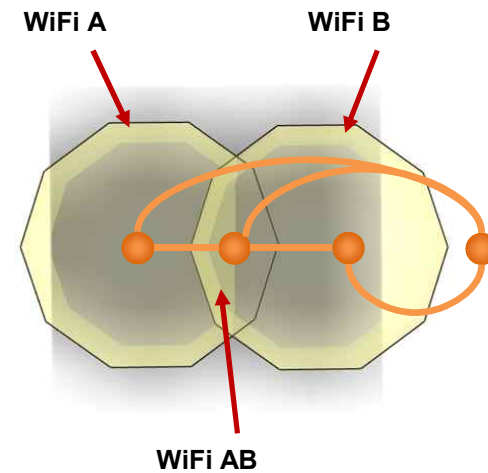
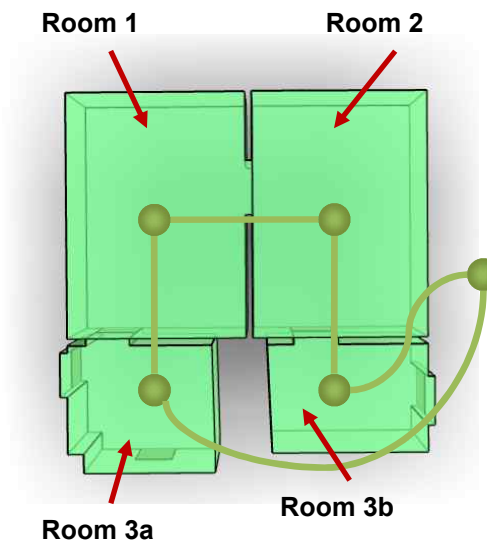
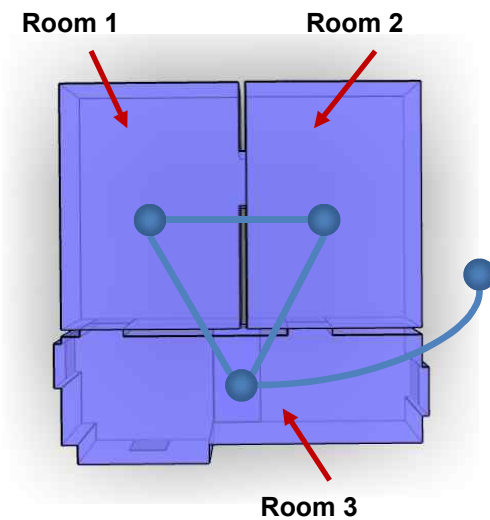
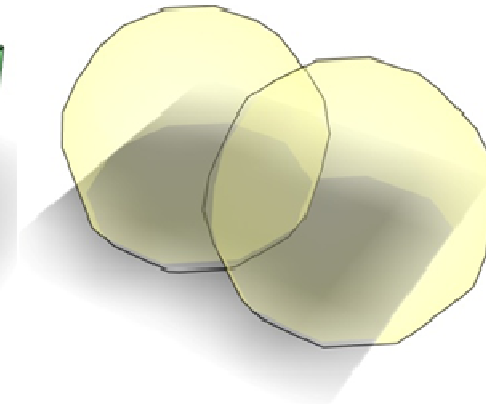
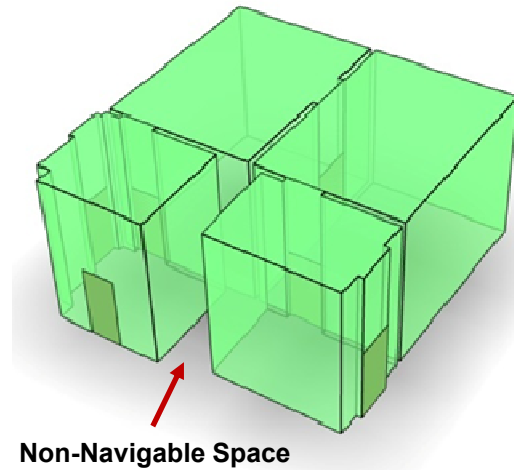
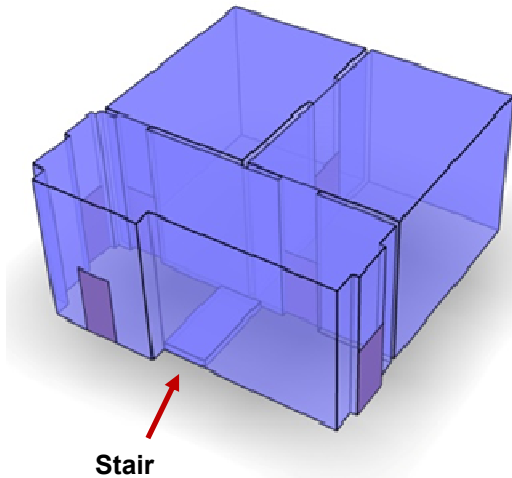
RFID sensor space



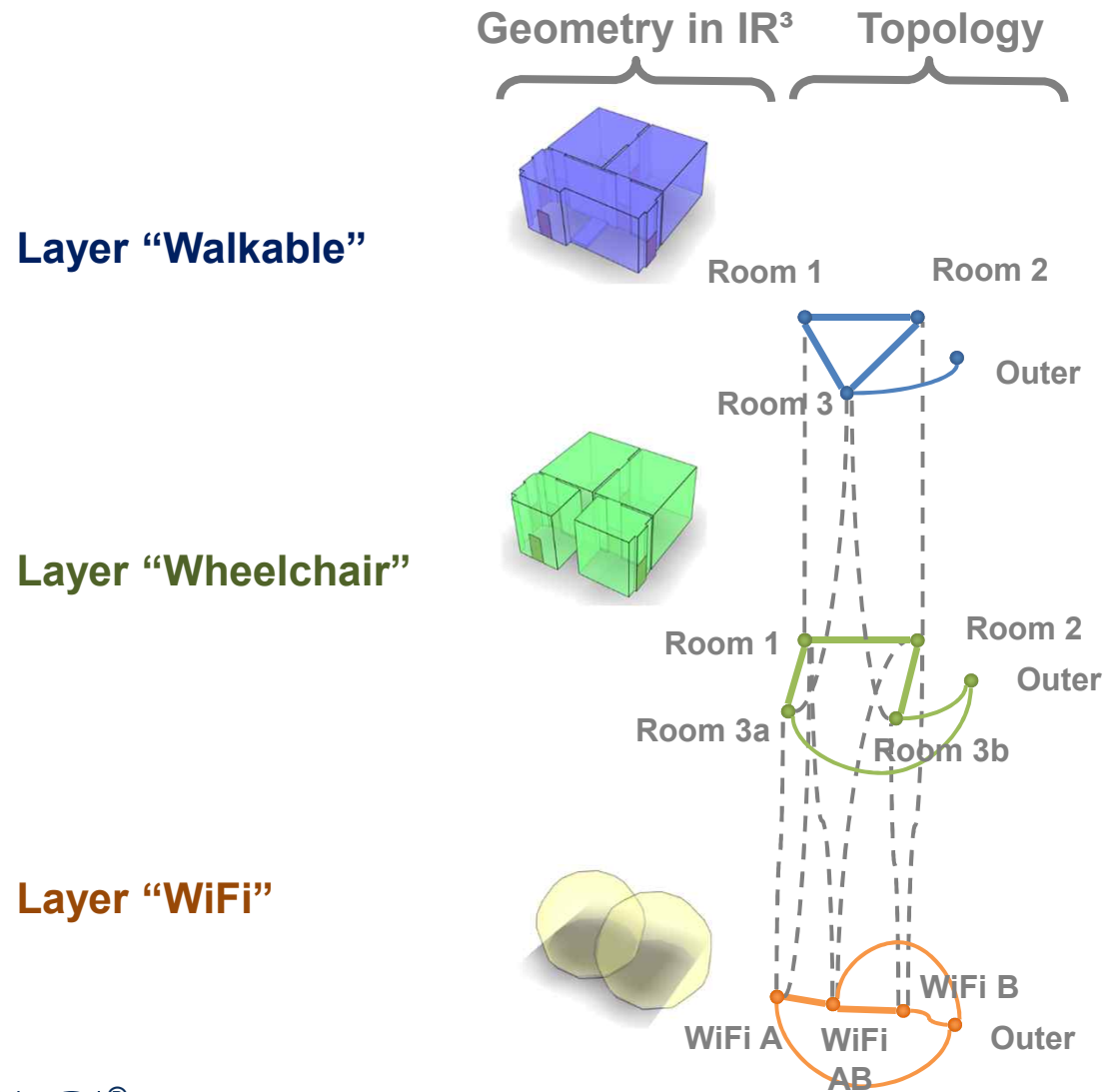
.....
Inter-layer relation,
denotes intersecting cells
between different space
layers

—
Connectivity(Intra-layer
relation) denotes adjacent
cells within the same
space model

Example – Multi-Layered Space



Example – Multi-Layered Space



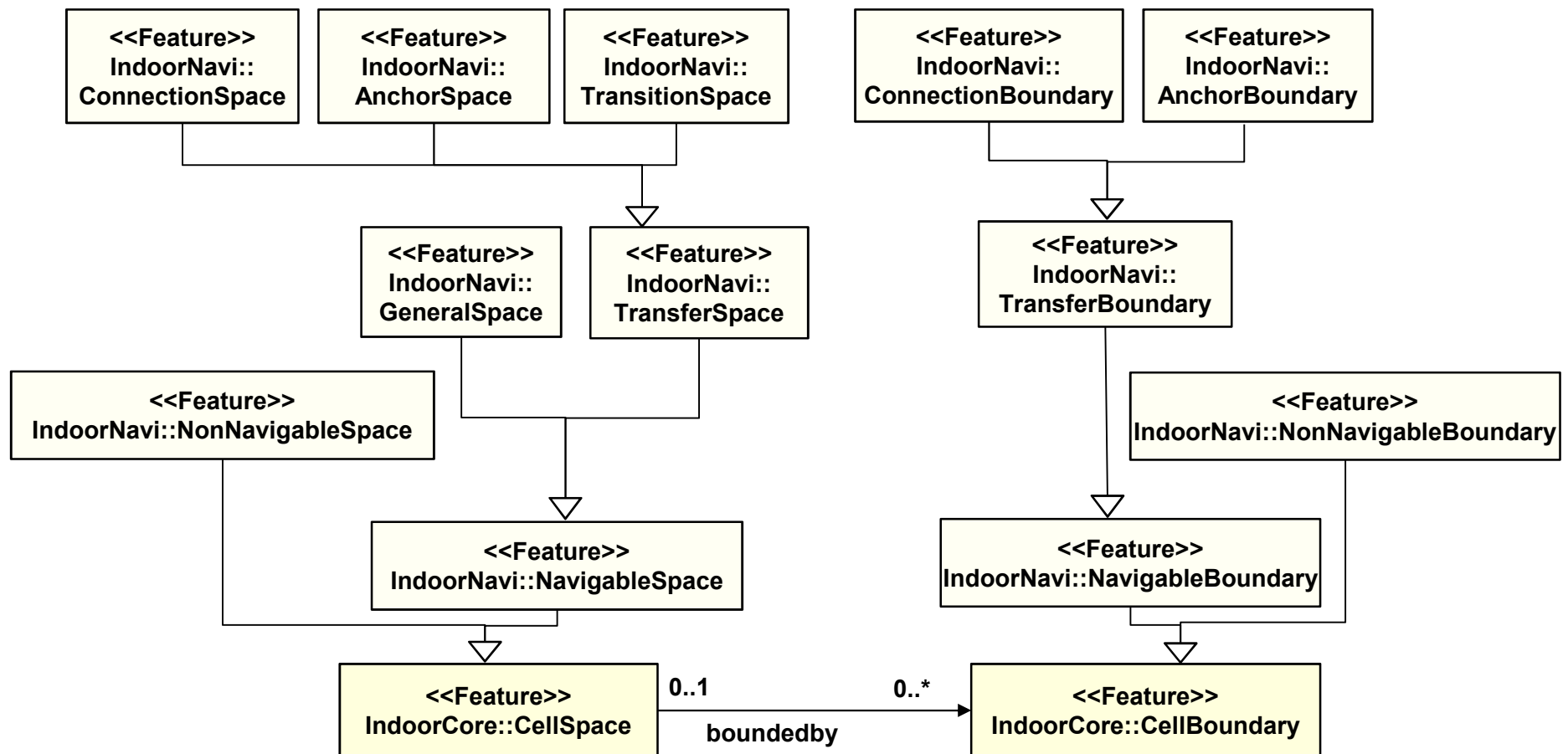
Semantics



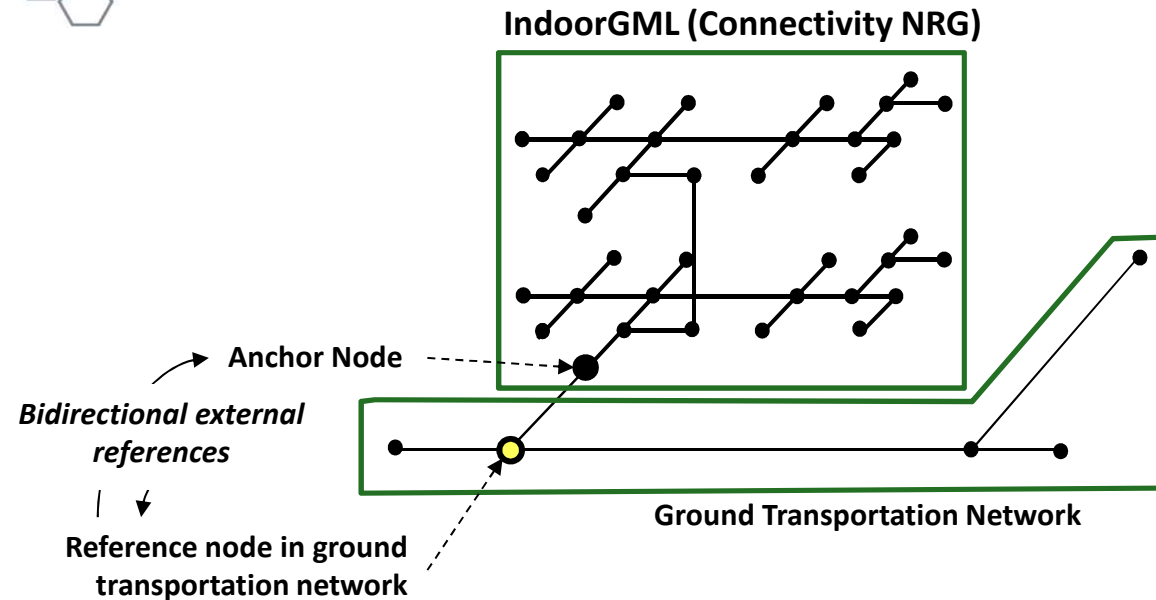
- Semantic Interpretation of Indoor Space
 - Classification of Indoor Space
 - Example – Room, Door, Corridor, Stair Space, Elevator Shaft, Gate

- Definition of Attributes
 - Names, Usage, Functions, etc..
 - Directions
 - Accessibility

Semantic Extension for Navigation



Indoor Navigation Module – Anchor Node



Anchor Node also contains

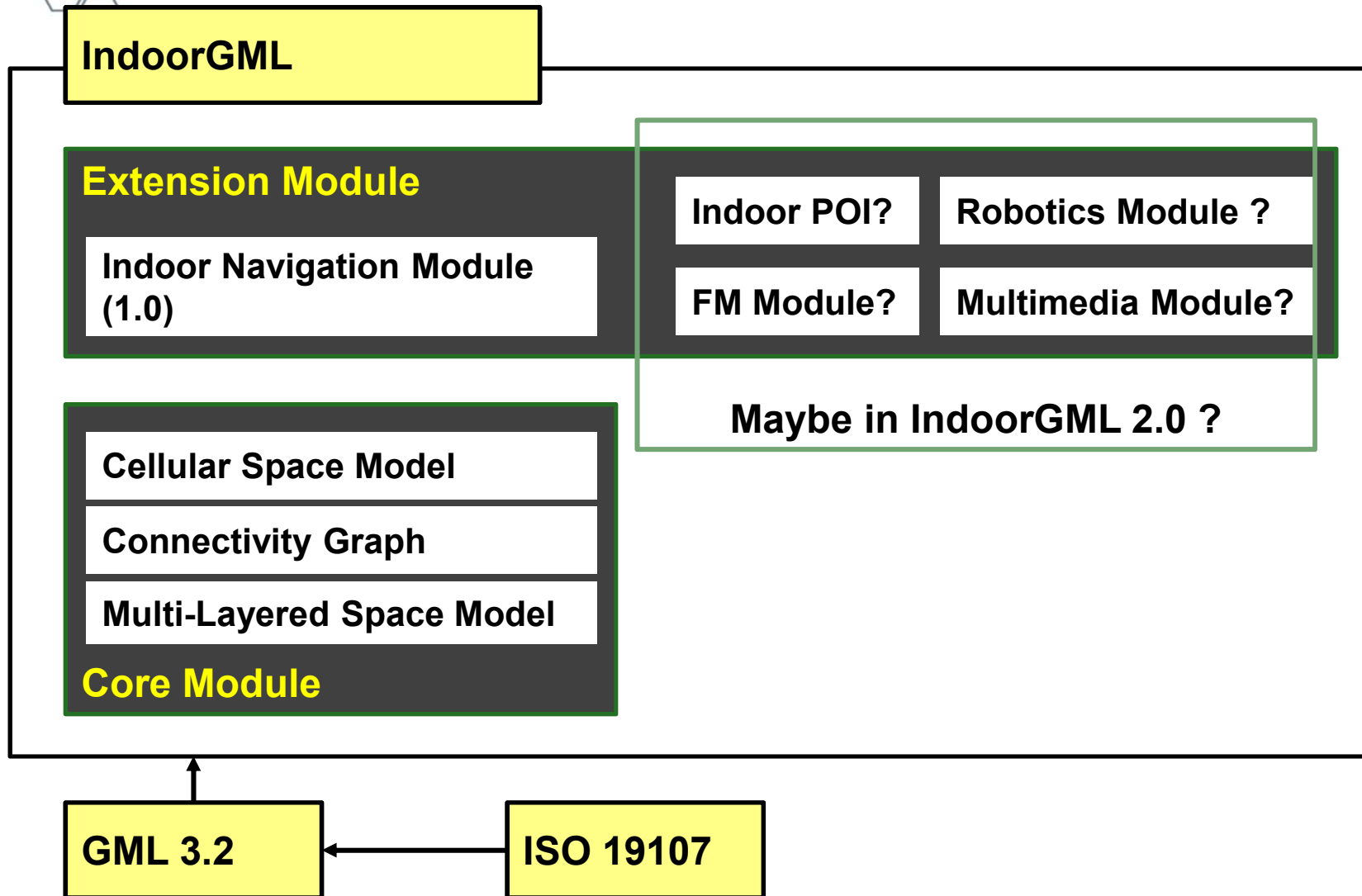
- Conversion Parameters

- rotation origin point (x_0, y_0, z_0)
- rotation angles (α, β, γ) along x , y , and z -axis),
- rescaling factor (s_x, s_y, s_z) , and
- translation vector (t_x, t_y, t_z)

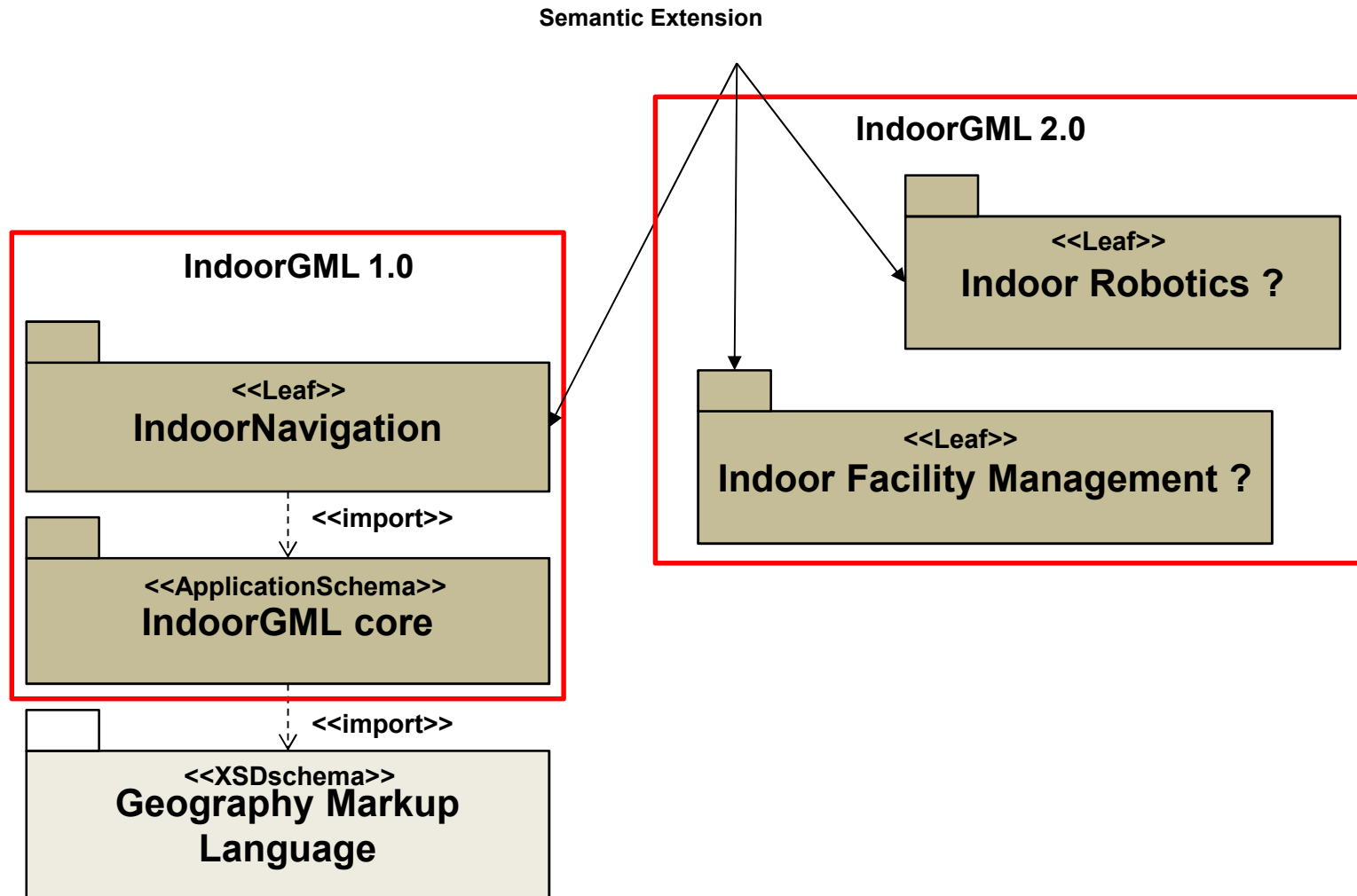
- Other attributes

- URL of fingerprint map
- Address

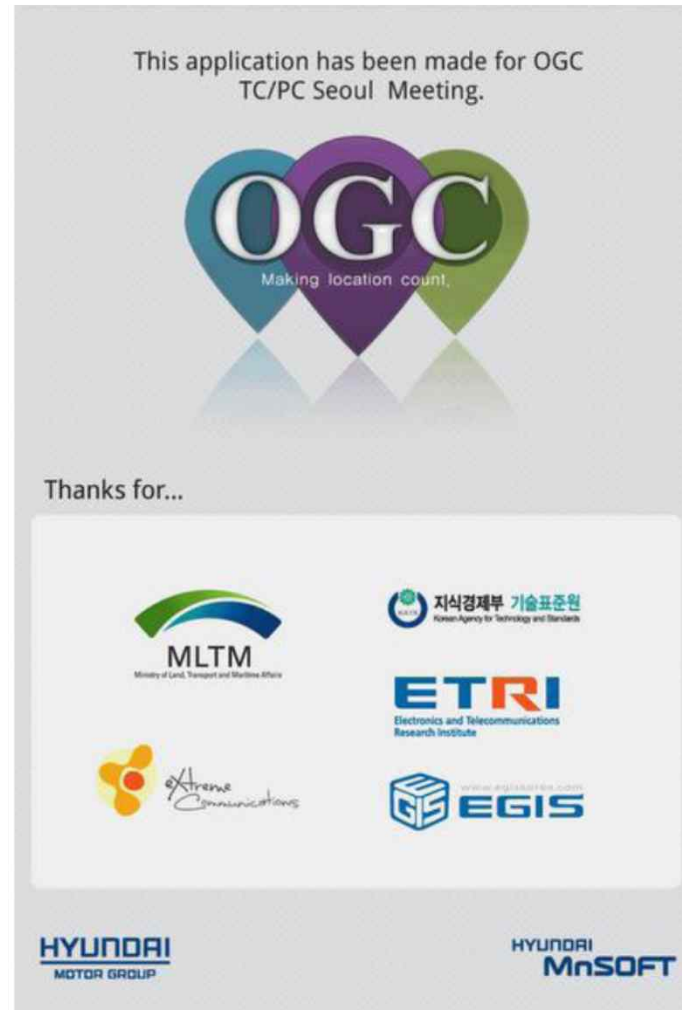
Basic Components of IndoorGML



Semantic Extension – Future Plan



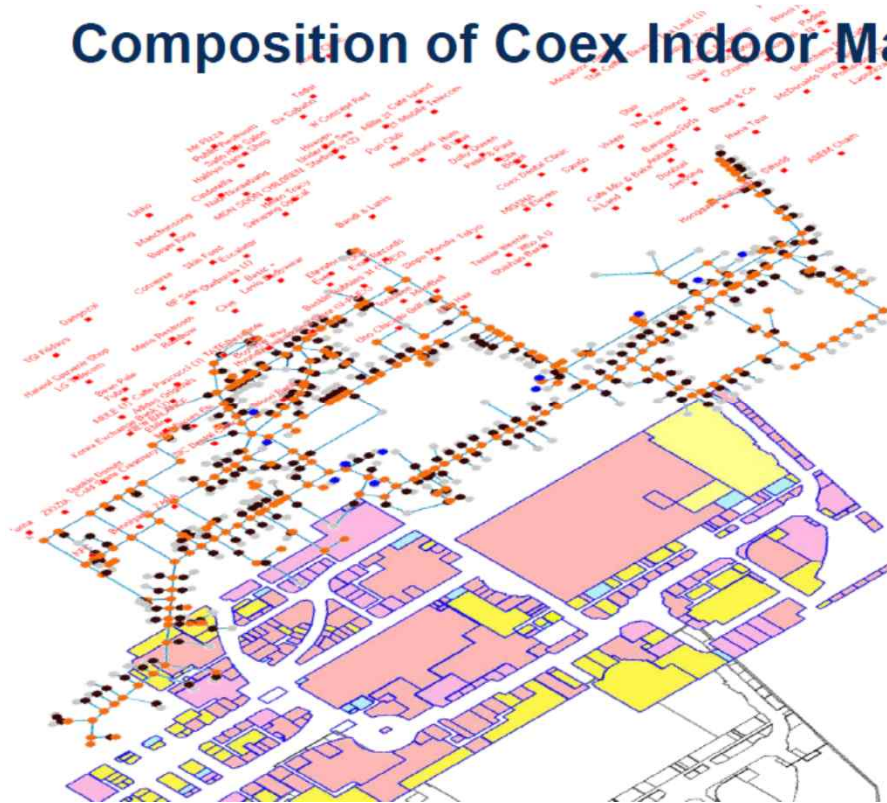
Use-Case – Venue Map Service (COEX, Seoul)



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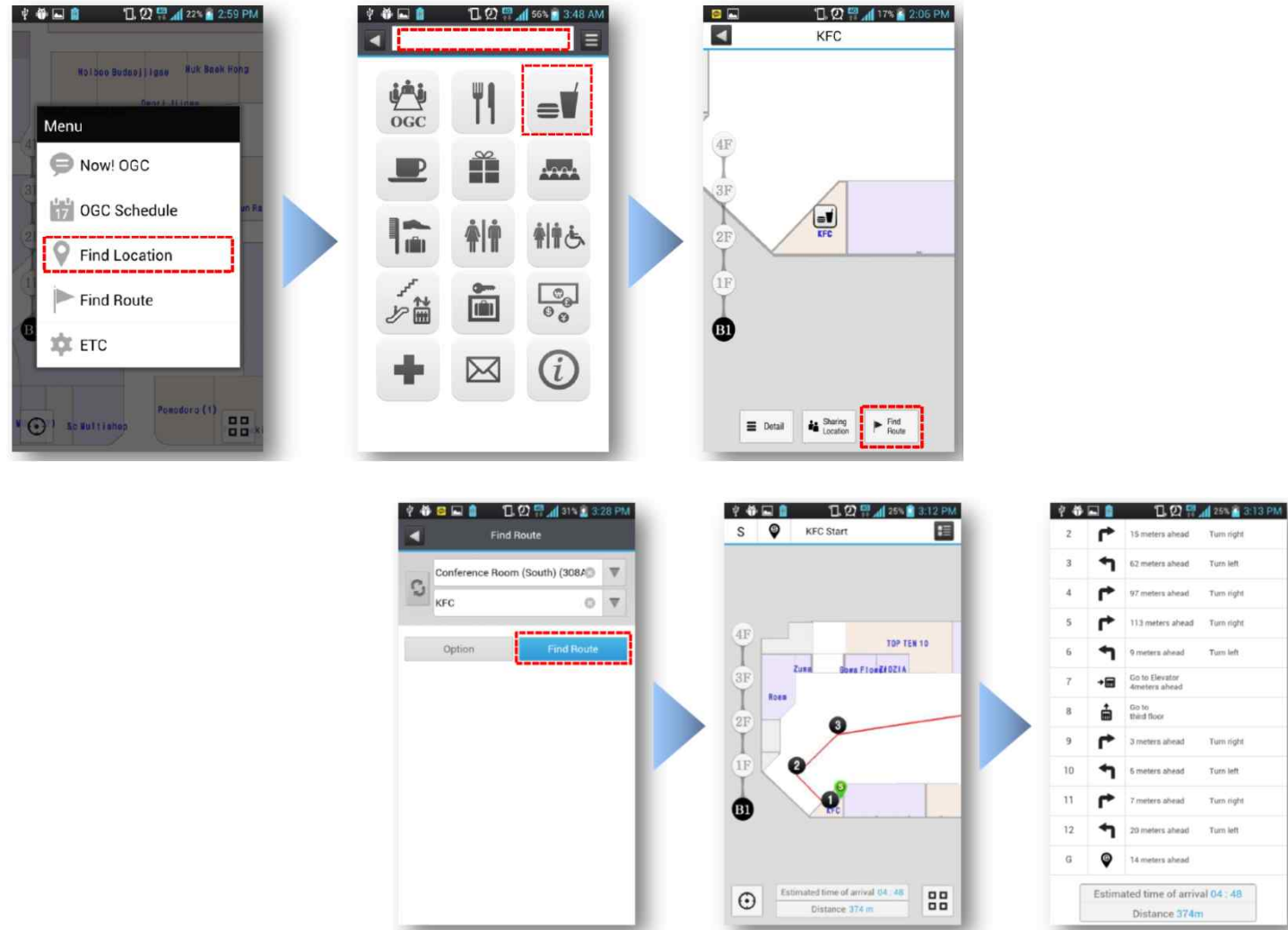


Composition of Coex Indoor Map

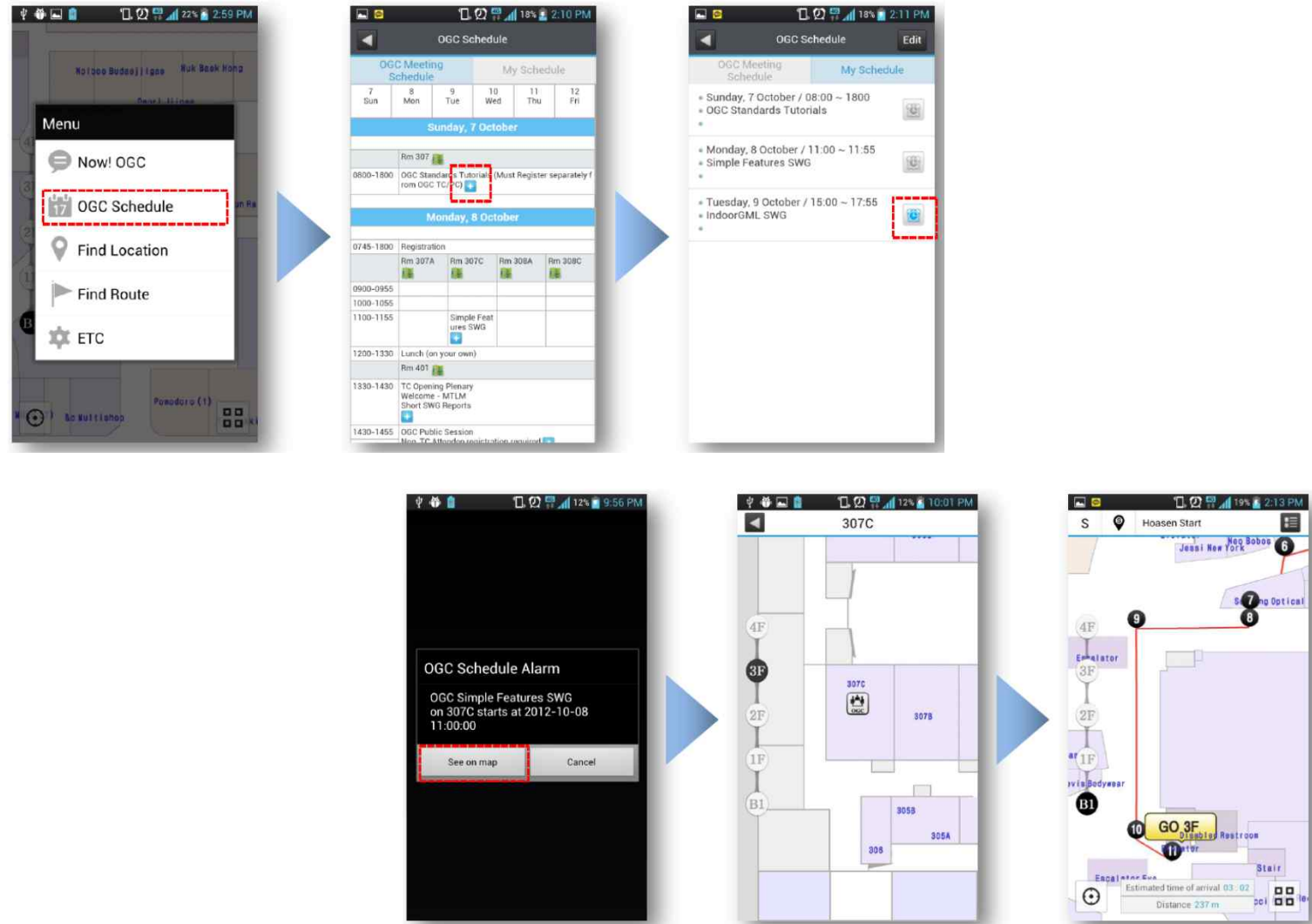


- POI Data
- Network Data (Topology)
 - Geometric Topology
- Space Data

Use-Case – Venue Map Service (COEX, Seoul)



Use-Case – Venue Map Service (COEX, Seoul)



Demands from other standards



- ISO/TC204 WG 17 (Nomadic Devices of ITS Systems)
 - Extension of road navigation standards for covering outdoor space AND Indoor Space in a seamless way
 - NWIP: Adopted on May 7, 2012 (ISO 17438-1) – Part I

Indoor navigation for personal and vehicle ITS station

– Part 1: General information and use cases definition

– Part 3: Requirements and specification for indoor positioning reference data format

– Part 4: Personal/Vehicle and central ITS stations interface requirements and specification for indoor map and indoor positioning reference data

- IEEE RAS(Robotics and Automation Society)
 - Indoor maps for localization and navigation of robots
 - IEEE MDR (Map Data Representation for Robots)
 - WG established in Nov. 2011
 - To be published in 2014

Useful Links



- indoorgml.net