IndoorGML
80th OGC Technical Committee
Austin, Texas (USA)
Ki-Joune Li
Pusan National University, South Korea
lik@pnu.edu
March 20, 2012

Copyright © 2012 Open Geospatial Consortium
Background

87%
Tag for indoor space

<Source: Google Earth 3D>
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

- IEEE RAS (Robotics and Automation Society)
  - Indoor maps for localization and navigation of robots
Prior work for indoor space

• IFC: Mainly focused on BIM

• CityGML: LoD 4: Interior space

• KML

• others
Why IndoorGML?

- Geometry
- Visualization

CityGML

KML

IFC
Why IndoorGML?

CityGML
- Geometry
- Visualization

KML

IFC

Navigation ??
For example, CityGML

- LoD 4 (Interior space)
  - How to compute the optimal path

  navigation network

- Specification of location
  - “How many persons are in [(12.456, 43.203),(12.488, 43.257)]?” or “How many persons are in room 422 of Building C-28?”

  Symbolic notion of space
IndoorGML as complements

CityGML
KML
IFC
IndoorGML as complements

1. Symbolic Space + Network and
2. Multi-Layered Space Model
IndoorGML as complements


CityGML
IFC
KML
IndoorGML as complements

1. Symbolic Space + Network and
2. Multi-Layered Space Model

Geometry is out of scope
IndoorGML and Other Standards

IndoorGML + One of

- IFCxml
- CityGML
- KML
- Multi-Level 2D
- Image
Two Components of IndoorGML

- IFCxml
- CityGML
- KML
- Multi-Level 2D
- Image
Two Components of IndoorGML

- IndoorGML
  - IFCxml
  - CityGML
  - KML
  - Multi-Level 2D
  - Image
Two Components of IndoorGML

Scope of the Standard

IndoorGML

IFCxml  CityGML  KML  Multi-Level 2D  Image
Two Components of IndoorGML

Scope of the Standard

IndoorGML

Topology

- IFCxml
- CityGML
- KML
- Multi-Level 2D
- Image

OGC®

Copyright © 2012 Open Geospatial Consortium
Two Components of IndoorGML

Scope of the Standard

IndoorGML

Topology

+ 

IFCxml  CityGML  KML  Multi-Level 2D  Image

Geometry

Copyright © 2012 Open Geospatial Consortium
Two Components of IndoorGML

Scope of the Standard

IndoorGML

Symbolic Space and Geometric Graph

Topology

IFCxml  CityGML  KML  Multi-Level 2D  Image

Geometry
Two Components of IndoorGML

Scope of the Standard

IndoorGML

Symbolic Space and Geometric Graph

Multi-Layered Space Model

Topology

IFCxml  CityGML  KML  Multi-Level 2D  Image

Geometry

Copyright © 2012 Open Geospatial Consortium
CityGML + IndoorGML
CityGML + IndoorGML

CityGML

Copyright © 2012 Open Geospatial Consortium
CityGML + IndoorGML

Copyright © 2012 Open Geospatial Consortium
2D Image + IndoorGML
2D Image + IndoorGML
2D Image + IndoorGML
2D Image + IndoorGML
Symbolic space and topology

- **Symbolic Space:**
  - Location is identified by Symbolic Code of Cell (e.g. Room Number)
  - Topology is mandatory

- **Indoor Symbolic Space:**
  - Represented by geometryc graph 
    \[ G = (V, E) \]
    \[ V = \{ n \mid n = (c_{ID}, p, attr), c_{ID}: \text{cell ID}, p: \text{representative point of } c_{ID} \} \]
    \[ E = \{ (n_s, n_e, attr) \mid attr: \text{distance} \} \]

- **Geometry**
  - ONLY for NODE (Point) and Edge (Curve)
  - NOT 3D Geometry for features like walls, rooms, corridors, etc..
Example
Example
Multiple-Layered Space Model

- An given indoor space is differently interpreted
Example – Multi-Layered Space

Stair

Non-Navigable Space

Room 1

Room 2

Room 3

Room 1

Room 2

Room 3a

Room 3b

WiFi A

WiFi B

WiFi AB
Example – Multi-Layered Space

Layer “Walkable”

Layer “Wheelchair”

Layer “WiFi”
Example – Multi-Layered Space
Example - Sensor deployment and tracking
Example - Sensor deployment and tracking
Example - Sensor deployment and tracking
Example - Sensor deployment and tracking

- R1
- C1
- R2
Example - Sensor deployment and tracking
Example - Sensor deployment and tracking
Example - Sensor deployment and tracking

\[ S_i \]

\[ R1 \]

\[ C1 \]

\[ R2 \]
Example - Sensor deployment and tracking

\[ S_i \]

\[ R1 \]

\[ C1 \]

\[ R2 \]
Example - Sensor deployment and tracking

\[ S_i \]

\[ R1 \]

\[ C1 \]

\[ R2 \]
Example - Sensor deployment and tracking
Example - Sensor deployment and tracking
Example - Sensor deployment and tracking

$S_i$  
R1  
C1  
R2

$R1 \rightarrow C1 \rightarrow R2$
Data Model of IndoorGML – Geometric Graph
Data Model of IndoorGML – Geometric Graph
Data Model of IndoorGML – Geometric Graph
IndoorGML – Example of multi-layered model

WiFi

RFID

Low Security Zone

High Security Zone

Topographic Subspaces

Main Topographic Layer

Copyright © 2012 Open Geospatial Consortium
Examples – Avatar movement in 2nd Life
Examples – Avatar movement in 2nd Life
Examples – Avatar movement in 2nd Life

DEMO Video
Examples – Browsing indoor map
Examples – Panoramic images and IndoorGML

Panoramic spot

EveryScape

P1

P2

P3

P4

P5

Navigation arrow

Panoramic spot
Examples – Panoramic images and IndoorGML

EveryScape

Panoramic spot
Navigation arrow

Copyright © 2012 Open Geospatial Consortium
Examples – Panoramic images and IndoorGML

EveryScape

Panoramic spot

Navigation arrow
Examples – Panoramic images and IndoorGML

Panoramic spot 1

Panoramic spot 2

Panoramic spot 1

Panoramic spot 2
Example

Floor plan

Panoramic images

Instance document

Copyright © 2012 Open Geospatial Consortium
Example – Panoramic Browser by IndoorGML

DEMO Video
Issues

• Node and Edge definition
• Space subdivision
Issues – Node and edge definition
Issues – Node and edge definition
Issues – Node and edge definition
To avoid collision between avatars or robots
Issues – Space Subdivision
Issues – Space Subdivision

Convex-Hull Division
Issues – Space Subdivision
Milestones - 2012

First SWG Meeting

March 2012
Austin Meeting

Discussion on Draft v.0.1

September 2012
Exeter Meeting

Writing draft v.0.1

Writing draft v.0.2

Writing draft v.0.3

Experiment

SWG voting for 30-days public comments

January 2013
Redland Meeting
Milestones - 2013

- Development of IndoorGML tools
- Experiments of IndoorGML

Submission for public comments

SWG voting for 30-days public comments

Jan. 2013 Redland Meeting

Feb. 2012

Public comments

30-days public comments

March 2012

Reflecting public comments

Discussion for comments and replies

April 2013 OGC TC Meeting

Revised version

Revised version

Submission to TC

June 2013 OGC TC Meeting
Summary

• IndoorGML
  – Symbolic Space and Topology
  – Multi-Layered Space Model

• IndoorGML: Geometric Graph
  – State: Node(Point)
  – Transition: Edge(Curve)

• IndoorGML >> Indoor Navigation

• What is out of scope
  – Geometry of 3D Features
  – Indoor Positioning Technology
Thank you