IndoorGML

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

87%
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?

- Geometry
- Visualization

CityGML

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


CityGML
KML
IFC
IndoorGML
IndoorGML as complements

- CityGML
- KML
- IFC

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

Copyright © 2012 Open Geospatial Consortium

11
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

Copyright © 2012 Open Geospatial Consortium
Two Components of IndoorGML

Scope of the Standard

IndoorGML

Topology

Scope of the Standard

IndoorGML

Topology

ICFxml  CityGML  KML  Multi-Level 2D  Image

Geometry
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 + IndoorGML

CityGML

IndoorGML

Copyright © 2012 Open Geospatial Consortium
2D Image + IndoorGML
2D Image + IndoorGML
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 geometric graph
    \[ G = (V, E) \]
    \[ V = \{ n | n = (c_{ID}, p, attr), \ c_{ID}: \text{cell ID, } p: \text{representative point of } c_{ID} \} \]
    \[ E = \{ (n_s, n_e, attr) | \ attr: \text{distance} \} \]

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

Geometry in IR³

Topology

Layer “Walkable”

Layer “Wheelchair”

Layer “WiFi”
Example – Multi-Layered Space

User entering the floor

User intended exit

Room 1

Room 2

Room 3a

Room 3b

WiFi A

WiFi B

WiFi AB

Routing

Localization

Tracking

Copyright © 2012 Open Geospatial Consortium
Example - Sensor deployment and tracking
Example - Sensor deployment and tracking
Example - Sensor deployment and tracking

![Diagram of sensor deployment and tracking](image)

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

\[ S_i \]

\[ R1 \]

\[ C1 \]

\[ R2 \]
Example - Sensor deployment and tracking

\[ S_i \]

\[ R1 \]

\[ C1 \]

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

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

Low Security Zone

High Security Zone

Topographic Subspaces

Main Topographic Layer

Copyright © 2012 Open Geospatial Consortium
Examples – Avatar movement in 2\textsuperscript{nd} Life
Examples – Avatar movement in 2nd Life
Examples – Avatar movement in 2\textsuperscript{nd} Life

DEMO Video
Examples – Browsing indoor map
Examples – Browsing indoor map

My office
Rest room
Path#1
Path#2
Path#3
Path#4
Path#5
Path#6
Path#7
Spatial Temporal Database Lab
423
424
422
421
420
419
419
418
417
416
415
414
413
412
411
W
M
Stairs
Stairs
Conference Room
Conference Room
403
404
405
406
407
408
409
410

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

EveryScape

Panoramic spot

Navigation arrow
Examples – Panoramic images and IndoorGML
Examples – Panoramic images and IndoorGML
Example

Floor plan  Panoramic images  Instance document

<multiLayeredGraph>
<spaceLayerMember>
<SpaceLayer gml:id="PanoramicViewLayer">
<class>topographic</class>
<state>
<pano:panoramicState gml:id="state1">
<topoNode>
<gml:Node gml:id="node1">
<gml:pointProperty>
<gml:Point>
<gml:pos>1000 2000 0</gml:pos>
</gml:Point>
</gml:pointProperty>
</gml:Node>
<pano:imageSrc>1.jpg</pano:imageSrc>
<pano:width>5400</pano:width>
<pano:height>2700</pano:height>
<pano:typeOfPanorama>equirectangular</pano:typeOfPanorama>
<pano:direction>
<gml:DirectionVector>
<gml:vector>-1 0 0</gml:vector>
</gml:DirectionVector>
</pano:direction>
</pano:panoramicState>
</state>
...
<transition>
<Transition>
<topoEdge>
<gml:Edge>
<gml:directedNode xlink:href="#node1"/>
</gml:Edge>
</topoEdge>
<state xlink:href="#state1"/>
<state xlink:href="#state2"/>
</Transition>
</transition>
</SpaceLayer>
</spaceLayerMember>
</multiLayeredGraph>
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**: Experiment
- **Writing draft v.0.2**: Experiment
- **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

- Development of IndoorGML tools
- Experiments of IndoorGML

Submission for public comments → Public comments → Reflecting public comments → Revised version → Submission to TC

- SWG voting for 30-days public comments
- SWG voting for submission to TC voting


Discussion for comments and replies

30-days public comments
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