FIG Working Week 2024
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Accra, Ghana
Your World, Our World: Resilient Environment and Sustainable Resource Management for All

Use case of National Digital Twin Standard for Buildings

Seunghun Kang, Republic of Korea
(LX Standards & Quality Department)
ksh0204@lx.or.kr

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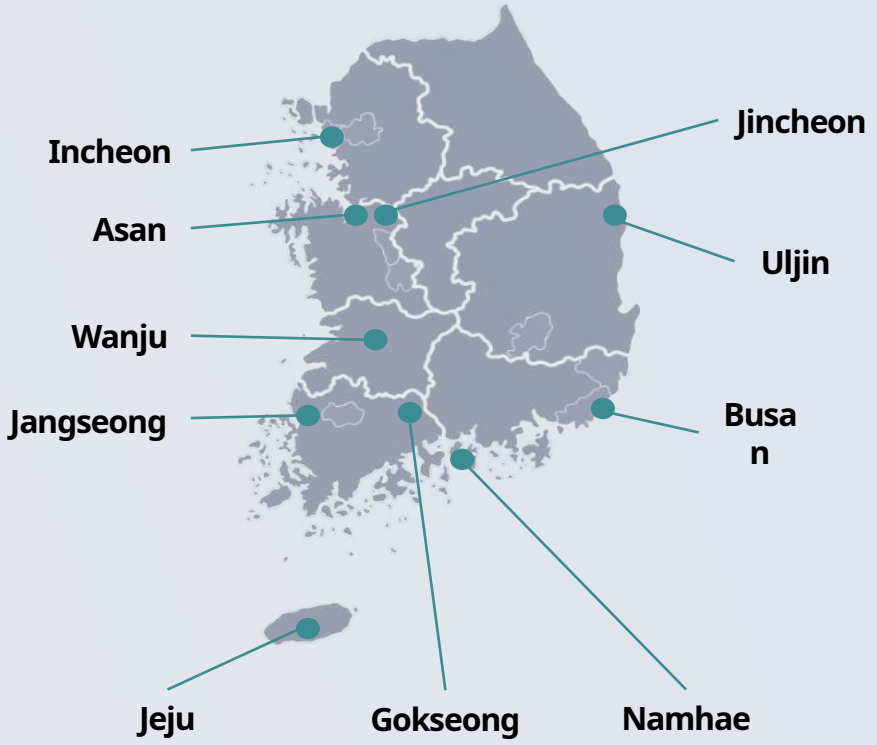
Creating Data of National Digital Twin



Development of Standards for National Digital Twin

International Organization for Standardization

Open Geospatial Consortium

ISO 19107
ISO 19109
ISO 19157
ISO 19115
ISO 19131

NDT Building

- **KS X 6808-1** Data model
- **KS X 6808-2** Data quality
- **KS X 6808-3** Metadata
- **KS X 6808-4** Data product specifications

CityGML 3.0

- Building
- Transportation
- Indoor
- Terrain
- Underground

Digital

Shape | **Phenomenon**

Conceptual Level | **Domain Level** | **Instance Level**

Identifying Problems between standards and data

Conceptual / Domain Level Standards

ISO 19131	KS X 6808-4
ISO 19110	
ISO 19157	KS X 6808-2
ISO 19115	KS X 6808-3
ISO 19103	KS X 6808-1
ISO 19107	CityGML 3.0
ISO 19109	

International Organization for Standardization

Open Geospatial Consortium

What is mean in the UML?

So many standards...

How can I apply Standards ?

Data Production

Identifying Problems between standards and data

Conceptual / Domain Level Standards

- ISO 19131 — KS X 6808-4
- ISO 19110
- ISO 19157 — KS X 6808-2
- ISO 19115 — KS X 6808-3
- ISO 19103
- ISO 19107
- ISO 19109 — KS X 6808-1, CityGML 3.0

International Organization for Standardization

Open Geospatial Consortium

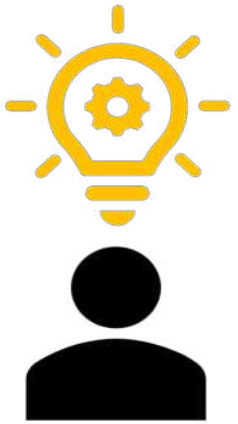
Methodology for data production based on Standards

- Building Data Product Specification
- Building Feature Catalogue
- Building Data Quality Report

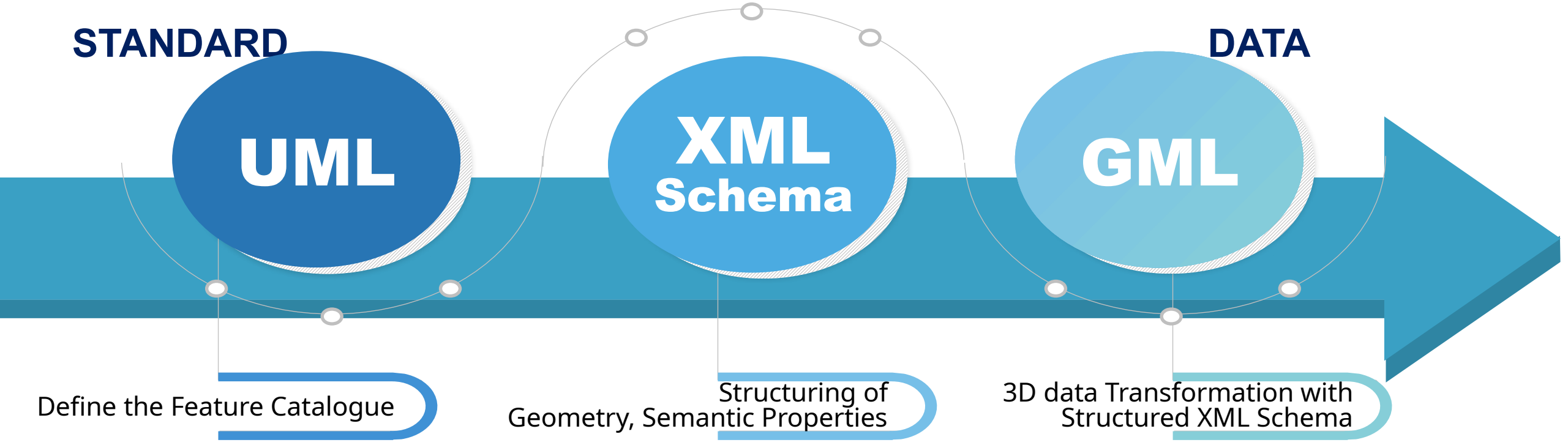
Sample data set Based on Standards

- Building Data Model (UML)
- Building Data Model Schema (XSD)
- Building Data (GML)

Data Production



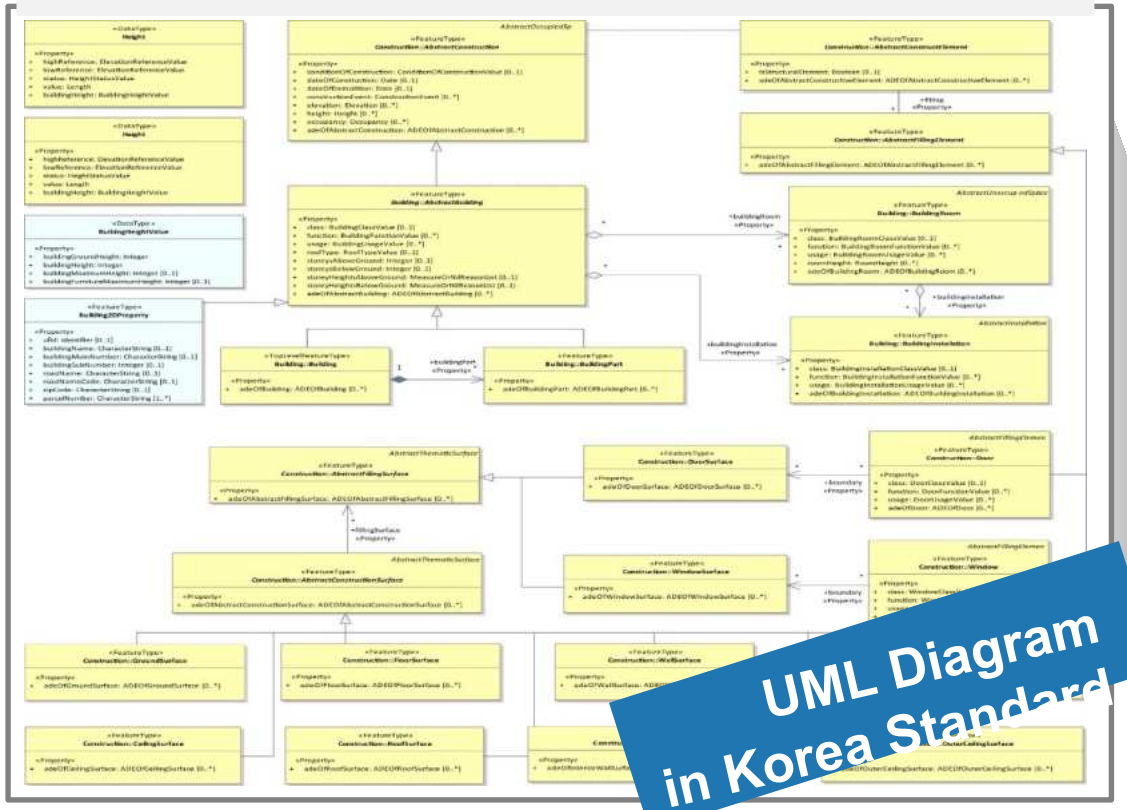
Sample Dataset based on Standard



USECASE for this Project

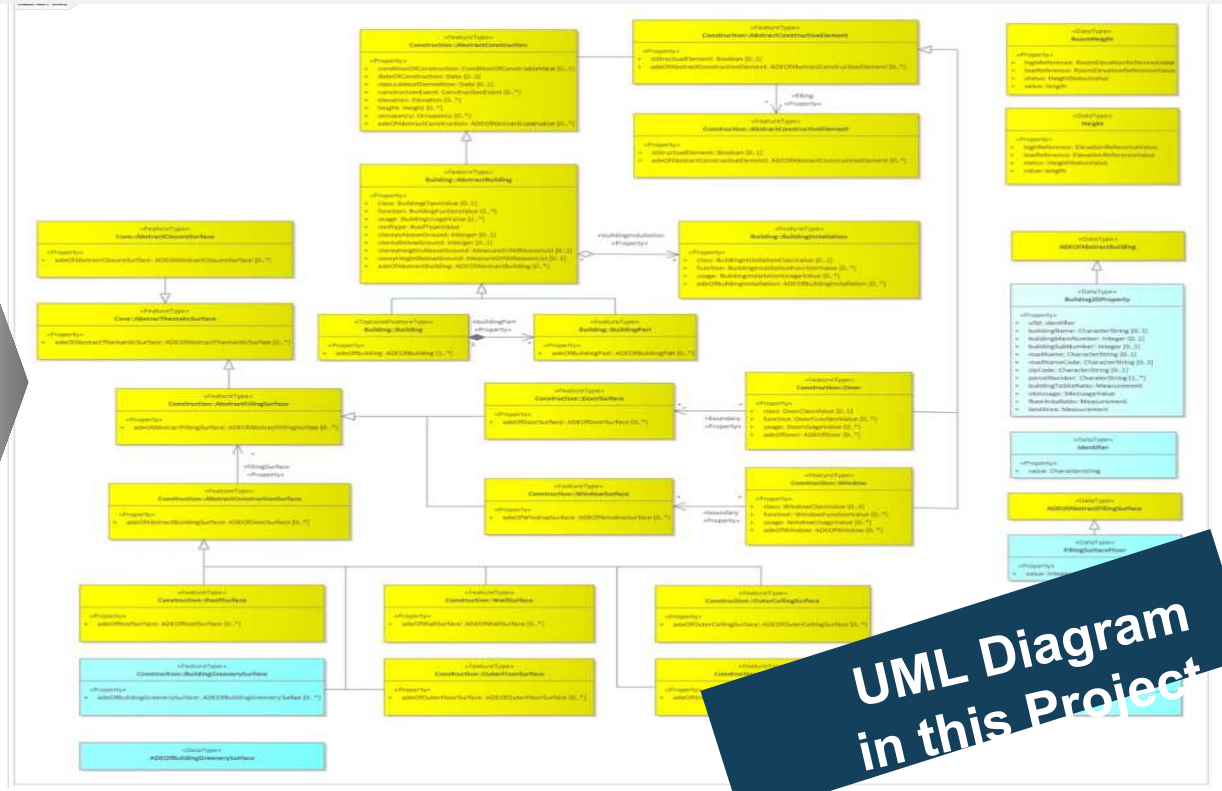
Computation service of Building permit areas

NDT Building – Part 1: Data model



UML Diagram in Korea Standard

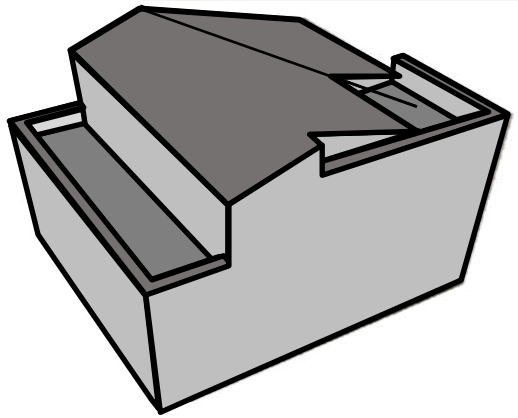
Computation service of Building permit areas



UML Diagram in this Project

Feature Catalog for Building

UML



Building

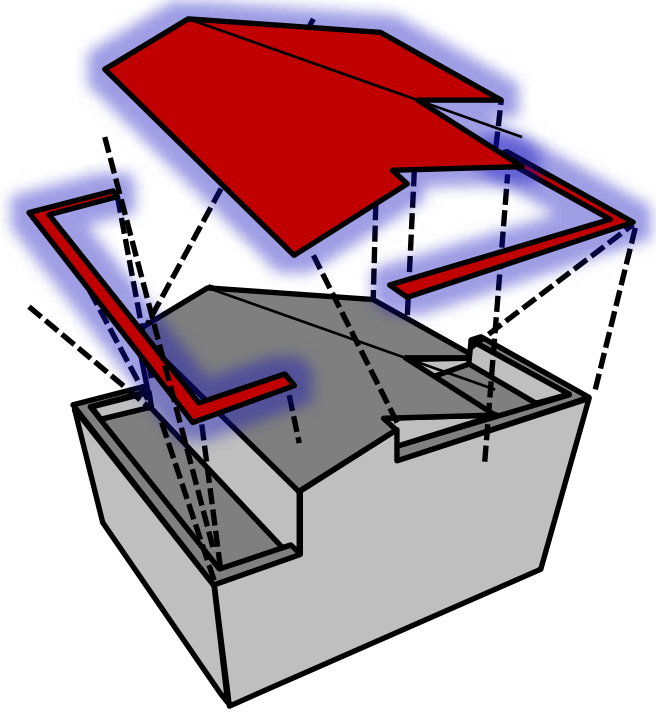
Building Feature Catalogue

ISO 19110

CityGML 3.0

- Geometry
- Semantic
- Properties

Feature Catalog for Building



Building - RoofSurface

Building Feature Catalogue

International Organization for Standardization

ISO 19110

Open Geospatial Consortium

CityGML 3.0

Core::lod 1 MultiSurface
Core::lod 2 MultiSurface
Core::lod 3 MultiSurface

Building::roofType (지붕 종류)

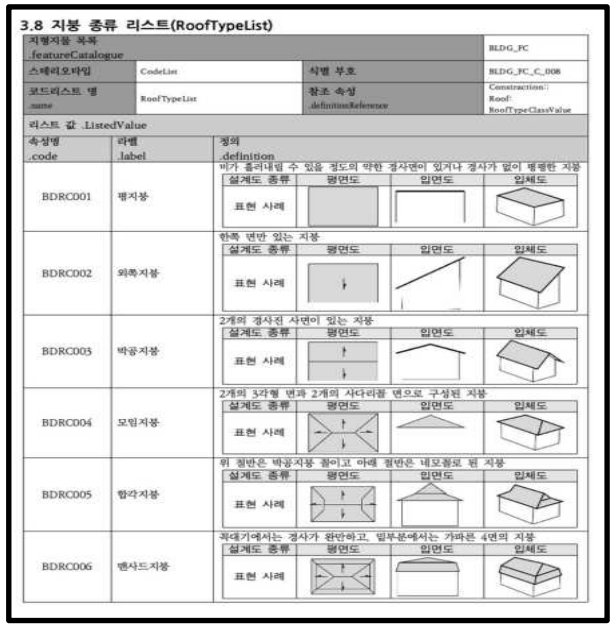
Geometry

Semantic

Properties

Create XML Schema

Building Feature Catalogue



3.8 지붕 종류 리스트(RoofTypeList)

지형지물 목록 .featureCatalogue			BLDG_FC
스테레오타입	CodeList	식별 부호	BLDG_FC_C_008
코드리스트 명 .name	RoofTypeList	참조 속성 .definitionReference	Construction::Roof::RoofTypeClassValue

리스트 값 .ListedValue

속성명 .code	라벨 .label	정의 .definition
BDRC001	평지붕	비가 흘러내릴 수 있을 정도의 약한 경사면이 있거나 경사가 없이 평평한 지붕
BDRC002	외쪽지붕	한쪽 면만 있는 지붕
BDRC003	박공지붕	2개의 경사진 사면이 있는 지붕
BDRC004	모임지붕	2개의 3각형 면과 2개의 사다리꼴 면으로 구성된 지붕
BDRC005	합각지붕	위 절반은 박공지붕 꼴이고 아래 절반은 네모꼴로 된 지붕
BDRC006	맨사드지붕	꼭대기에서는 경사가 완만하고, 밑부분에서는 가파른 4면의 지붕

CodeList XML

```
▼<Root xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
 ▼<text>
    <code>BDRC001</code>
    <label>평지붕</label>
    <definition>비가 흘러내릴 수 있을 정도의 약한 경사 면이 있거나 경사가 없이 평평한 지붕</definition>
  </text>
 ▼<text>
    <code>BDRC002</code>
    <label>외쪽지붕</label>
    <definition>한쪽 면만 있는 지붕</definition>
  </text>
 ▼<text>
    <code>BDRC003</code>
    <label>박공지붕</label>
    <definition>2개의 경사진 사면이 있는 지붕</definition>
  </text>
 ▼<text>
    <code>BDRC004</code>
    <label>모임지붕</label>
    <definition>2개의 3각형 면과 2개의 사다리꼴 면으로 구성된 지붕</definition>
  </text>
 ▼<text>
    <code>BDRC005</code>
    <label>합각지붕</label>
    <definition>위 절반은 박공지붕 꼴이고 아래 절반은 네모꼴로 된 지붕</definition>
  </text>
 ▼<text>
    <code>BDRC006</code>
    <label>맨사드지붕</label>
    <definition>꼭대기에서는 경사가 완만하고, 밑부분에 서는 가파른 4면의 지붕</definition>
  </text>
</Root>
```

RoofTypeValue.xml

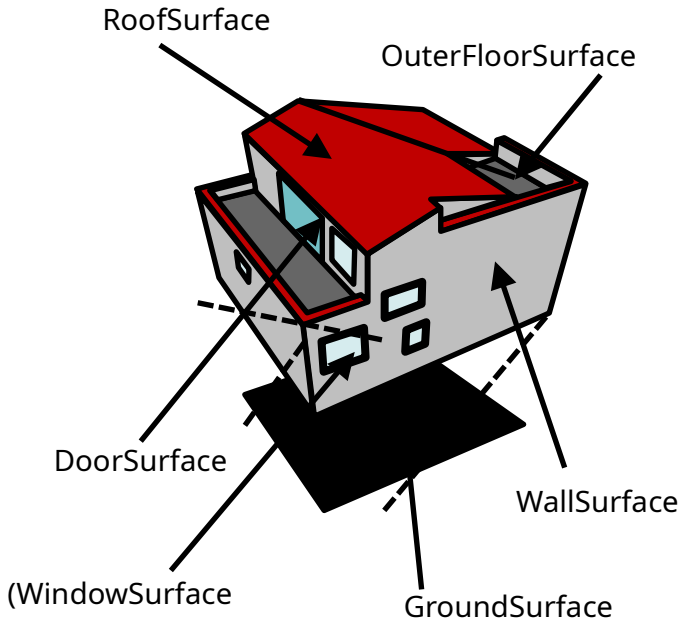
XML Schema

NDT_Building .xsd

* XSD (XML Schema Definition)

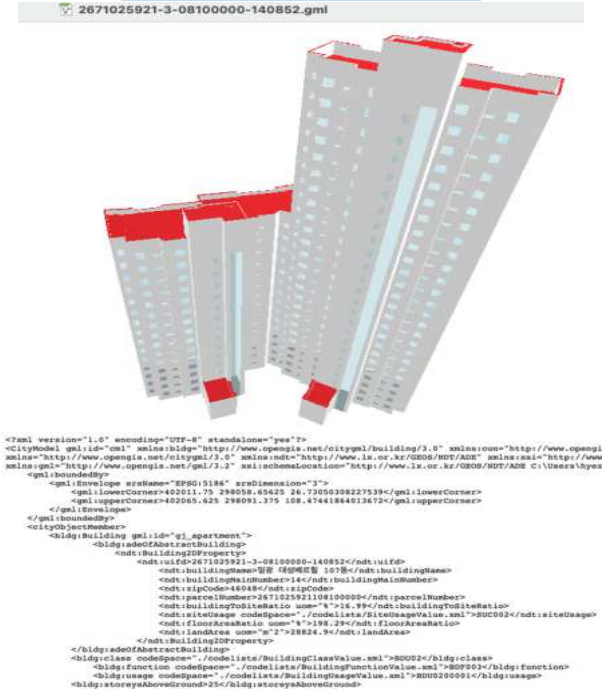
Create GML Data

Feature



XML Schema

GML



Create GML Data

GML

실증 데이터 : 부산광역시 기장군 아파트

2671025921-3-08100000-140852.gml

XML Schema based on UML

Applying Building Parts

gj_apartment(_part1, _part2)

```
<core:cityObjectMember>
    <bldg:Building gml:id="gj_apartment">
        <bldg:class codeSpace="./codelists/BuildingClass.xml">BDU02</bldg:class>
        <bldg:function codeSpace="./codelists/BuildingFunction.xml">BDC003</bldg:functi
        <bldg:usage codeSpace="./codelists/BuildingUsage.xml">BDU0200001</bldg:usage>
        <bldg:storeysAboveGround>25</bldg:storeysAboveGround>
        <bldg:storeysBelowGround>0</bldg:storeysBelowGround>
        <bldg:adeOfAbstractBuilding>
            <ndt:Building2DProperty>...</ndt:Building2DProperty>
        </bldg:adeOfAbstractBuilding>
        <bldg:buildingPart>
            <bldg:BuildingPart gml:id="gj_apartment_part1">...</bldg:BuildingPart>
        </bldg:buildingPart>
        <bldg:buildingPart>
            <bldg:BuildingPart gml:id="gj_apartment_part2">...</bldg:BuildingPart>
        </bldg:buildingPart>
    </bldg:Building>
</core:cityObjectMember>
```

Inserting Properties of the Building(Using the CodeList)

Core Properties, ADE Extension Properties

```
<core:cityObjectMember>
    <bldg:Building gml:id="gj_apartment">
        <bldg:class codeSpace="./codelists/BuildingClass.xml">BDU02</bldg:class>
        <bldg:function codeSpace="./codelists/BuildingFunction.xml">BDC003</bldg:function>
        <bldg:usage codeSpace="./codelists/BuildingUsage.xml">BDU0200001</bldg:usage>
        <bldg:storeysAboveGround>25</bldg:storeysAboveGround>
        <bldg:storeysBelowGround>0</bldg:storeysBelowGround>
        <bldg:adeOfAbstractBuilding>
            <ndt:Building2DProperty>
                <ndt:ufid>2671025921-3-08100000-140852</ndt:ufid>
                <ndt:buildingName>[illegible]</ndt:buildingName>
                <ndt:buildingMainNumber>14</ndt:buildingMainNumber>
                <ndt:zipCode>46048</ndt:zipCode>
                <ndt:parcelNumber>2671025921108100000</ndt:parcelNumber>
                <ndt:buildingToSiteRatio>16.99</ndt:buildingToSiteRatio>
                <ndt:siteUsage>[illegible]</ndt:siteUsage>
                <ndt:floorAreaRatio>98.29</ndt:floorAreaRatio>
                <ndt:landArea uom="m2">28824.9</ndt:landArea>
```

Applying the Semantic information

```
<bldg:buildingPart>
    <bldg:BuildingPart gml:id="gj_apartment_part1">
        <core:boundary>
            <con:GroundSurface gml:id="G0010104_Ground">...</con:GroundSurface>
        </core:boundary>
        <core:boundary>
            <con:RoofSurface gml:id="G00100001D_Roof">
                <core:lod3MultiSurface>...</core:lod3MultiSurface>
            </con:RoofSurface>
        </core:boundary>
        <core:boundary>
            <con:RoofSurface gml:id="G00100001T_Roof">...</con:RoofSurface>
        </core:boundary>
        <core:boundary>
            <con:WallSurface gml:id="G00100001D_Wall">...</con:WallSurface>
        </core:boundary>
```

Inserting the Properties(Level of Building)

```
<con:WallSurface gml:id="G0010504">
    <con:adeOfAbstractConstructionSurface>
        <ndt:floor>5</con:floor>
    </con:adeOfAbstractConstructionSurface>
    <lod3MultiSurface>...</lod3MultiSurface>
<con:fillingSurface>
    <con:WindowSurface gml:id="G00105041W">
        <con:adeOfAbstractFillingSurface>
            <ndt:floor>5</con:floor>
        </con:adeOfAbstractFillingSurface>
        <lod3MultiSurface>...</lod3MultiSurface>
    </con:WindowSurface>
</con:fillingSurface>
<con:fillingSurface>
    <con:WindowSurface gml:id="G00105042W">
        <con:adeOfAbstractFillingSurface>
```

Create GML Data

GML

실증 데이터 : 부산광역시 기장군 아파트

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XML Schema based on UML

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<core:cityObjectMember>
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        <bldg:function codeSpace="./codelists/BuildingFunction.xml">BDC003</bldg:functi
        <bldg:usage codeSpace="./codelists/BuildingUsage.xml">BDU0200001</bldg:usage>
        <bldg:storeysAboveGround>25</bldg:storeysAboveGround>
        <bldg:storeysBelowGround>0</bldg:storeysBelowGround>
        <bldg:adeOfAbstractBuilding>
            <ndt:Building2DProperty>...</ndt:Building2DProperty>
        </bldg:adeOfAbstractBuilding>
        <bldg:buildingPart>
            <bldg:BuildingPart gml:id="gj_apartment_part1">...</bldg:BuildingPart>
        </bldg:buildingPart>
        <bldg:buildingPart>
            <bldg:BuildingPart gml:id="gj_apartment_part2">...</bldg:BuildingPart>
        </bldg:buildingPart>
    </bldg:Building>
</core:cityObjectMember>
```

Create GML Data

GML

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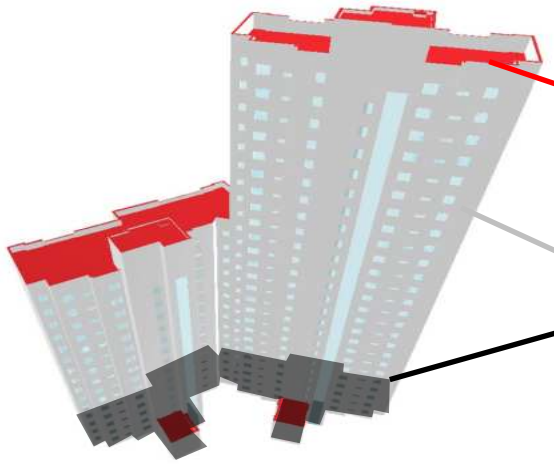
        <bldg:usage codeSpace="./codelists/BuildingUsage.xml">BDU020000</bldg:usage>
        <bldg:storeysAboveGround>25</bldg:storeysAboveGround>
        <bldg:storeysBelowGround>0</bldg:storeysBelowGround>
        <bldg:adeOfAbstractBuilding>
            <ndt:Building2DProperty>
                <ndt:ufid>2671025921-3-08100000-140852</ndt:ufid>
                <ndt:buildingName>일광 대성베르힐 107동</ndt:buildingName>
                <ndt:buildingMainNumber>14</ndt:buildingMainNumber>
                <ndt:zipCode>46048</ndt:zipCode>
                <ndt:parcelNumber>2671025921108100000</ndt:parcelNumber>
                <ndt:buildingToSiteRatio>16.99</ndt:buildingToSiteRatio>
                <ndt:siteUsage>일반주거지역</ndt:siteUsage>
                <ndt:floorAreaRatio>198.29</ndt:floorAreaRatio>
                <ndt:landArea uom="m2">28824.9</ndt:landArea>
```

Create GML Data

GML

실증 데이터 : 부산광역시기장군 아파트



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        </core:boundary>
        <core:boundary>
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                <core:lod3MultiSurface>...</core:lod3MultiSurface>
            </con:RoofSurface>
        </core:boundary>
        <core:boundary>
            <con:RoofSurface gml:id="G00100001T_Roof">...</con:RoofSurface>
        </core:boundary>
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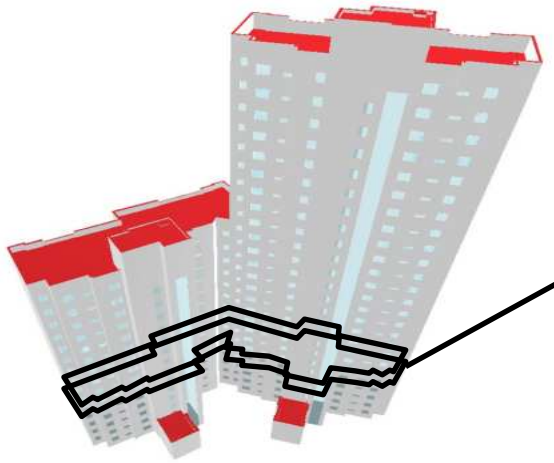
        </core:boundary>
```

Create GML Data

GML

실증 데이터 : 부산광역시 기장군 아파트

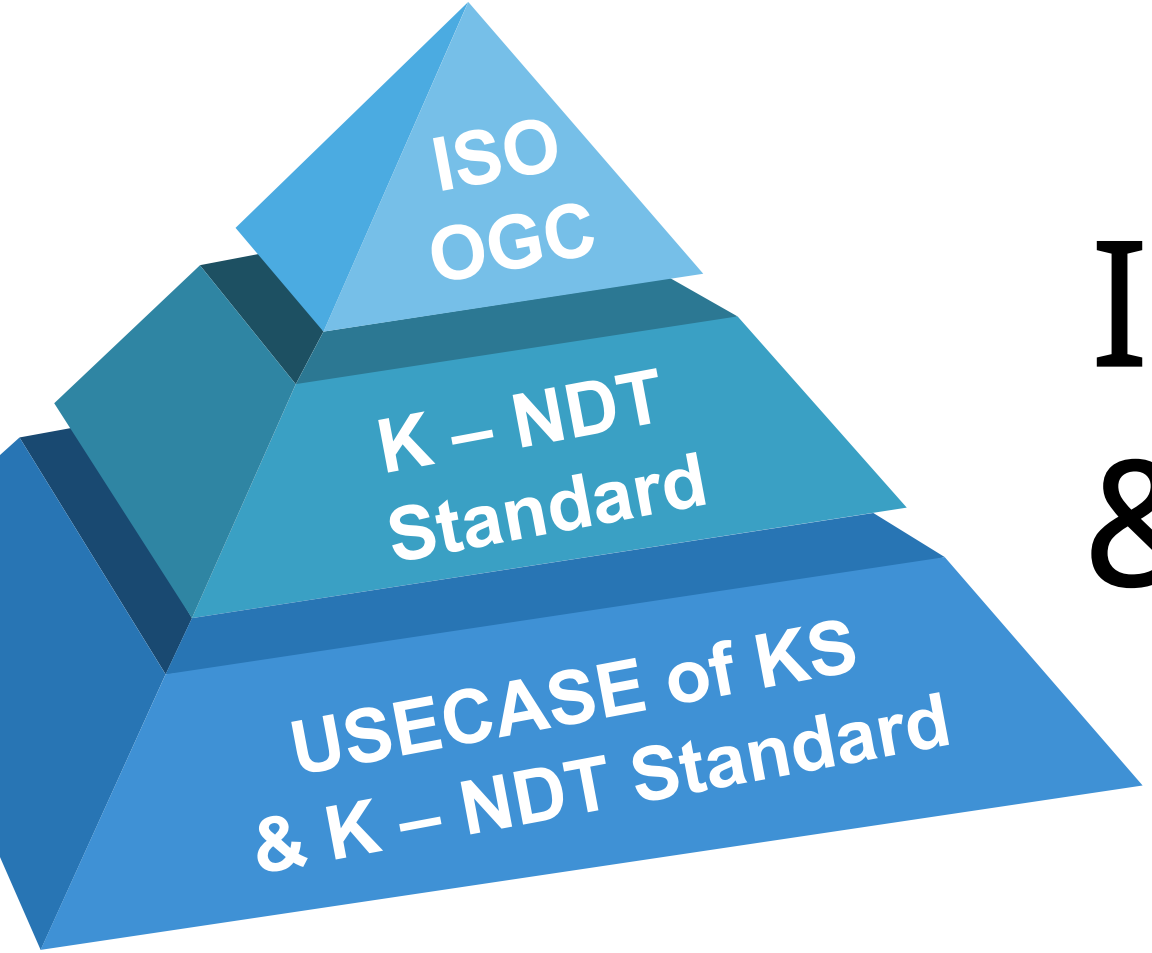


2671025921-3-08100000-140852.gml

XML Schema based on UML

Inserting the Properties(Level of Building)

```
<con:WallSurface gml:id="G0010504">
    <con:adeOfAbstractConstructionSurface>
        <ndt:floor>5</con:floor>
    </con:adeOfAbstractConstructionSurface>
    <lod3MultiSurface>...</lod3MultiSurface>
<con:fillingSurface>
    <con:WindowSurface gml:id="G00105041W">
      <con:adeOfAbstractFillingSurface>
          <ndt:floor>5</con:floor>
      </con:adeOfAbstractFillingSurface>
      <lod3MultiSurface>...</lod3MultiSurface>
    </con:WindowSurface>
  </con:fillingSurface>
  <con:fillingSurface>
    <con:WindowSurface gml:id="G00105042W">
      <con:adeOfAbstractFillingSurface>
```



Sharing for Interoperability & Sustainability

SUSTAINABLE DEVELOPMENT GOALS | International Federation of Surveyors supports the Sustainable Development Goals

Commission 10

Digital Technologies in Construction – The Future Vision of BIM

Serving Society for the Benefit of People and Planet