



FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

Presented at the FIG Working Week 2024,
19-24 May 2024 in Accra, Ghana

Use case of National Digital Twin Standard for Buildings

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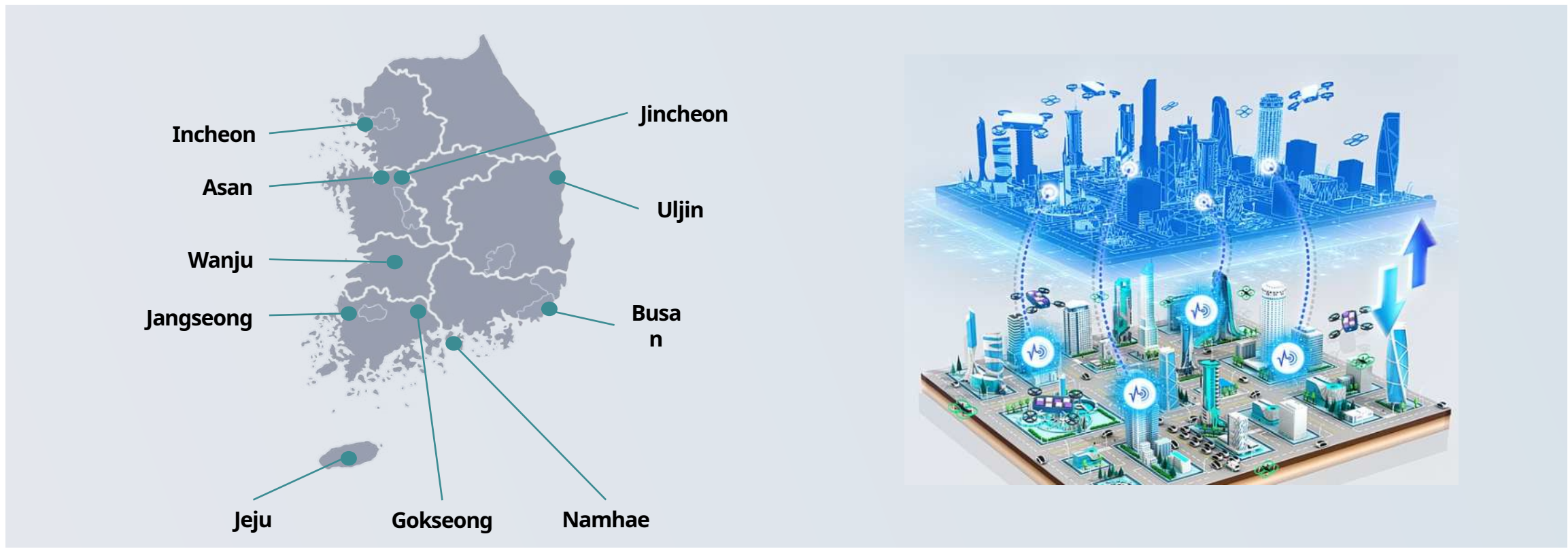
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Creating Data of National Digital Twin



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Development of Standards for National Digital Twin



CityGML 3.0

Digital

- 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

- Building**
- Transportation**
- Indoor**
- Terrain**
- Underground**

- Shape**
- Phenomenon**



Conceptual Level

Domain Level

Instance Level

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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






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Identifying Problems between standards and data

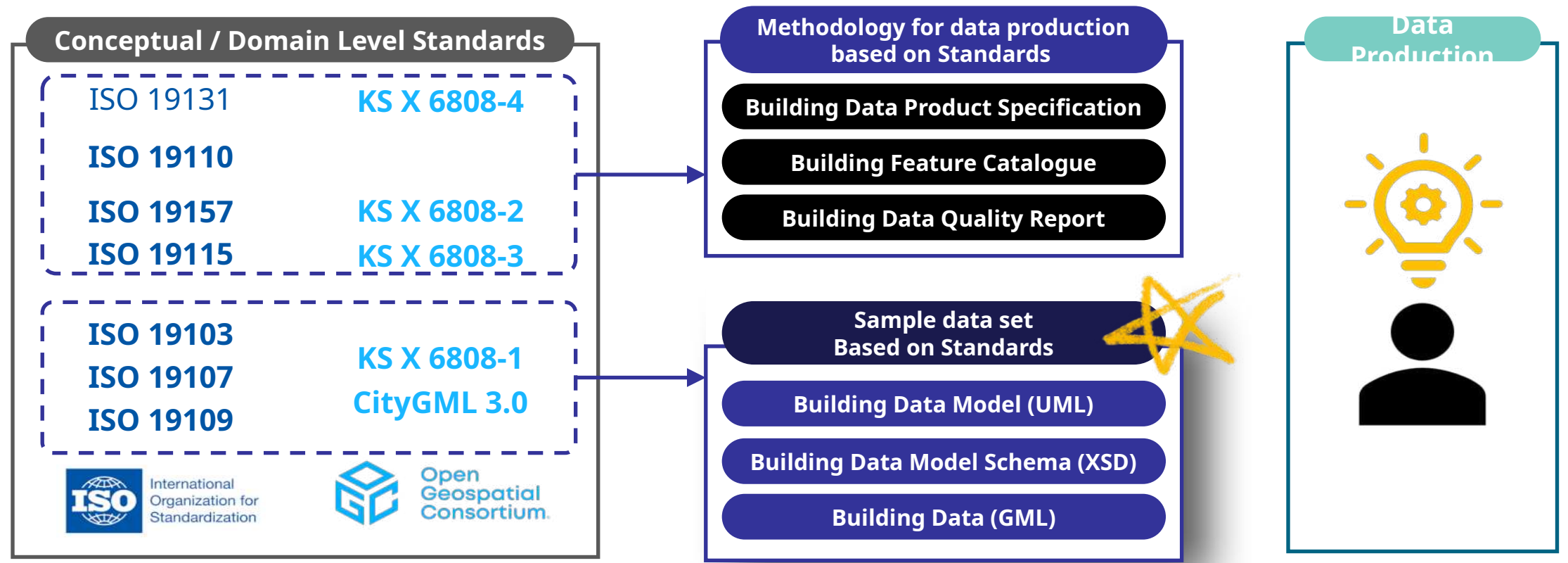




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Sample Dataset based on Standard

STANDARD



Define the Feature Catalogue

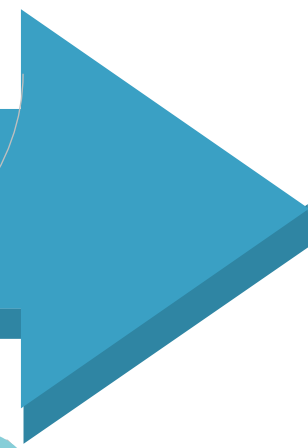


Structuring of
Geometry, Semantic Properties

DATA



3D data Transformation with
Structured XML Schema



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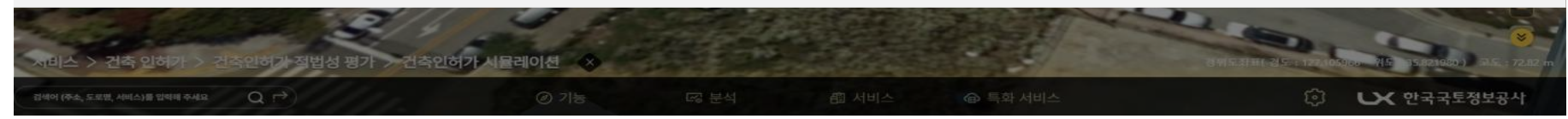
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USECASE for this Project



Computation service of Building permit areas



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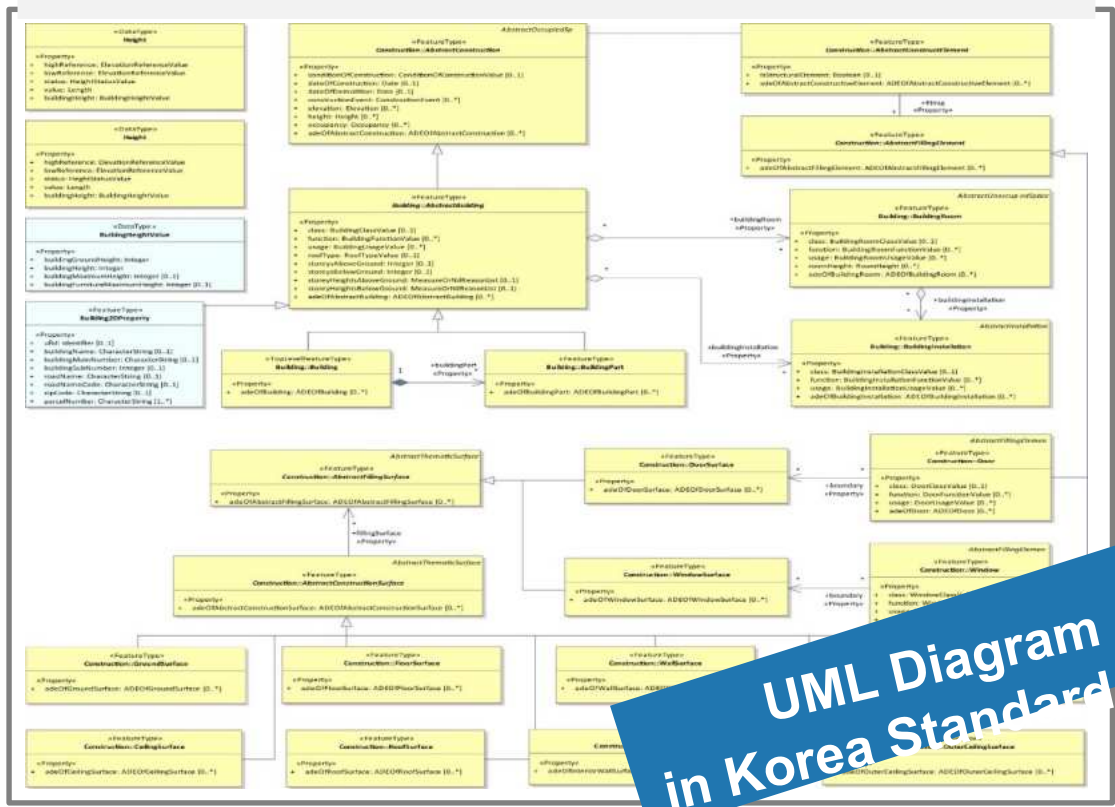
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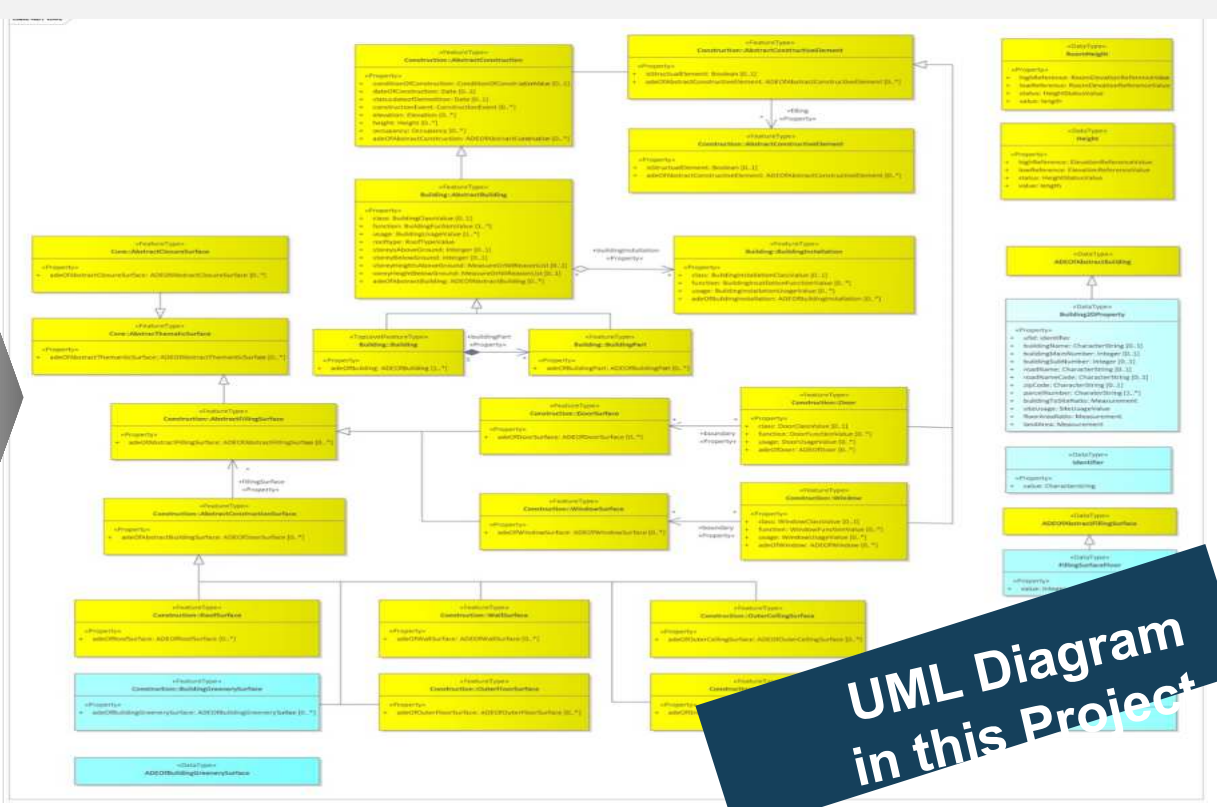
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NDT Building – Part 1: Data model



UML Diagram
in Korea Standard

Computation service of Building permit areas



UML Diagram
in this Project



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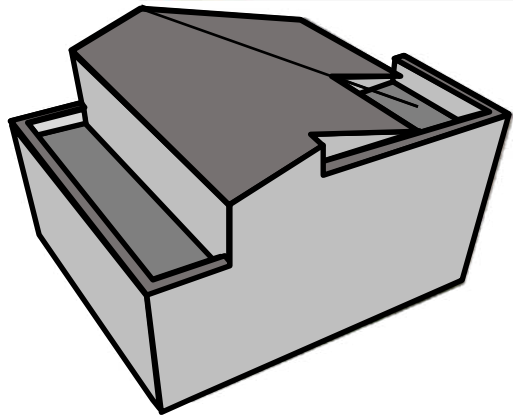
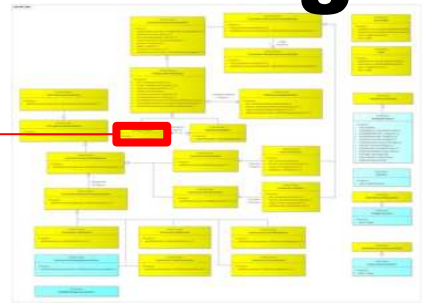
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Feature Catalog for Building

UML



Building

Building Feature Catalogue


 International Organization for Standardization
ISO 19110


 Open Geospatial Consortium
CityGML 3.0

Geometry

Semantic

Properties



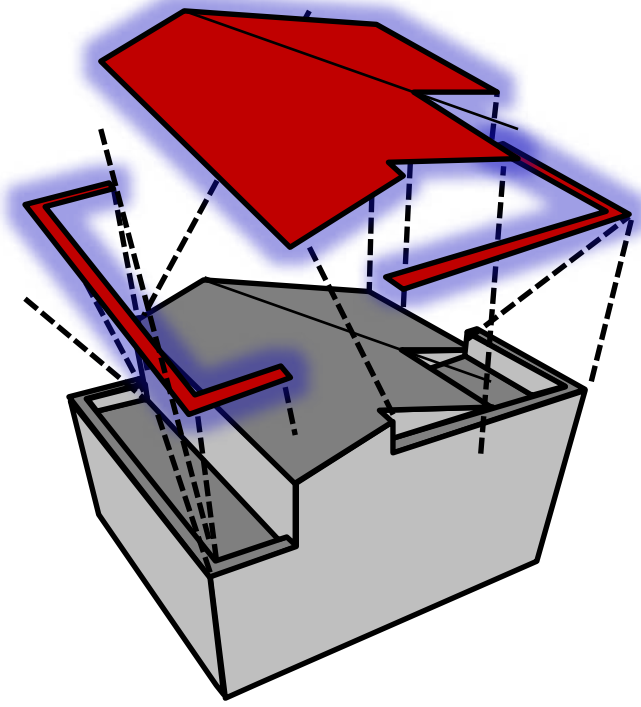
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Feature Catalog for Building



Building - RoofSurface

Building Feature Catalogue

International Organization for Standardization

ISO 19110

CityGML 3.0

2.6 지붕면(RoofSurface)

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

Building::roofType (지붕 종류)

지붕면 ID	지붕면 이름	지붕면 유형	지붕면 설명	지붕면 이미지
RoofType01	평지붕	평지붕	지붕면이 수평인 지붕	
RoofType02	사다리꼴 지붕	사다리꼴 지붕	지붕면이 사다리꼴인 지붕	
RoofType03	인접 지붕	인접 지붕	지붕면이 인접한 지붕	
RoofType04	기타 지붕	기타 지붕	기타 지붕	

Geometry

Semantic

Properties



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Create XML Schema

Building Feature Catalogue

3.8 지붕 종류 리스트(RoofTypeList)

지형지물 목록 featureCatalogue	CodeList	식별 부호	BLDG_FC
스테리오타입		식별 부호	BLDG_FC_C_008
코드리스트 명 name	RoofTypeList	참조 속성 definitionReference	RoofTypeClassValue
리스트 값 ListedValue			
속성명 code	라벨 label	정의 definition	
BDRC001	평지붕	평면도 종류 평면도 입면도 입체도 비가 흘러내릴 수 있을 정도의 약한 경사면이 있거나 경사가 없이 평평한 지붕	
BDRC002	외곽지붕	외곽지붕 종류 평면도 입면도 입체도 한쪽 면만 있는 지붕	
BDRC003	박공지붕	박공지붕 종류 평면도 입면도 입체도 2개의 경사진 사면이 있는 지붕	
BDRC004	모임지붕	모임지붕 종류 평면도 입면도 입체도 2개의 3각형 면과 2개의 사다리꼴 면으로 구성된 지붕	
BDRC005	합각지붕	합각지붕 종류 평면도 입면도 입체도 위 절반은 박공지붕 같고 아래 절반은 네모꼴로 된 지붕	
BDRC006	맨사드지붕	맨사드지붕 종류 평면도 입면도 입체도 꼭대기에서는 경사가 완만하고, 밑부분에서는 가파른 4면의 지붕	

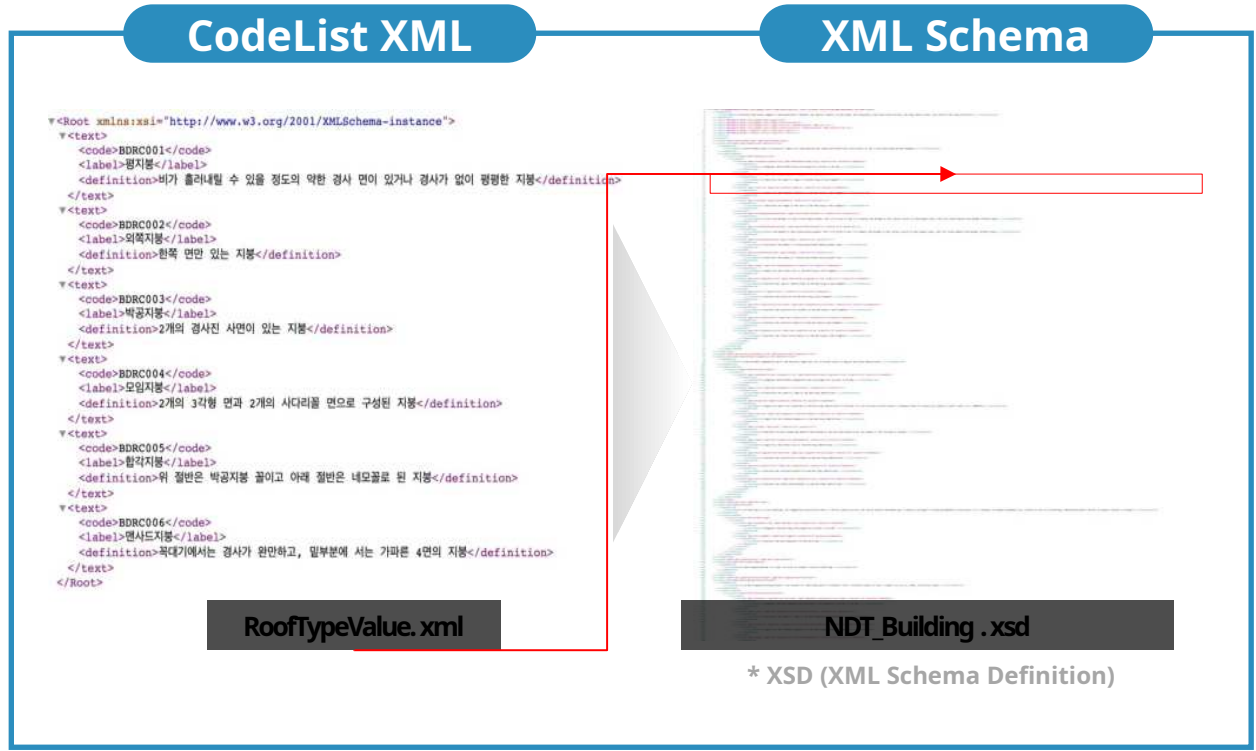




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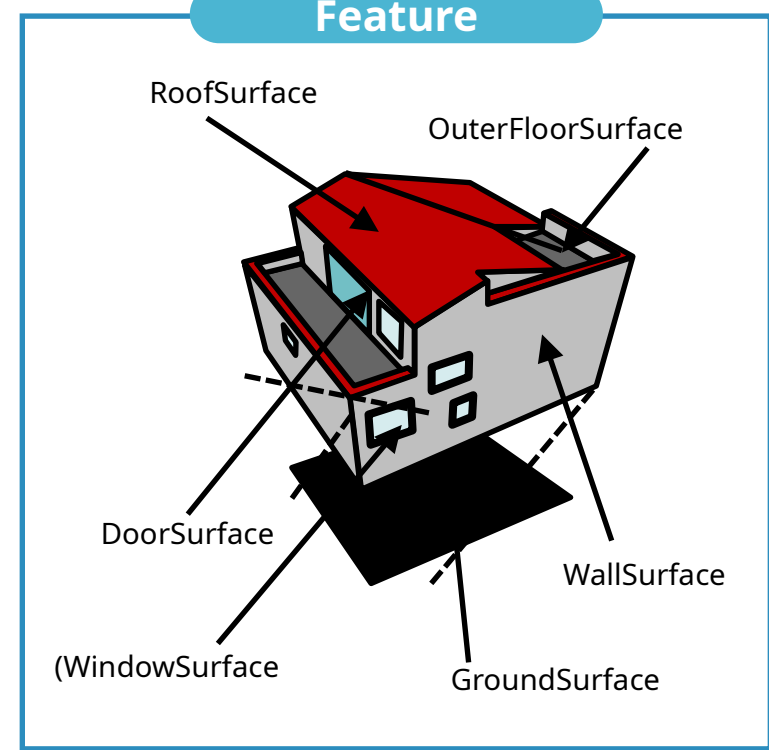
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Create GML Data

Feature



XML Schema

GML

```

2671025921-3-08100000-140852.gml
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<CityModel gml:id="gml" xmlns:bdg="http://www.opengis.net/citygml/building/3.0" xmlns:com="http://www.opengis.net/def/citygml/com/3.0" xmlns:inst="http://www.1x.or.kr/OGIS/INT/ADM" xmlns:ral="http://www.opengis.net/def/citygml/3.2" xmlns:schemalocation="http://www.1x.or.kr/OGIS/INT/ADM/CUsers/thysa" />
<gml:Envelope srsName="EPSG:5186" srsDimension="3">
  <gml:lowerCorner>402011.73 298058.65425 26.73050308227539</gml:lowerCorner>
  <gml:upperCorner>402045.443 298093.376 268.4741844013672</gml:upperCorner>
</gml:Envelope>
<cityObjectMember>
  <city:Building gml:id="gml.apartment">
    <bdg:BuildingProperty>
      <bdg:sdofAbstrActBuilding>
        <inst:uuid>2671025921-3-08100000-140852</inst:uuid>
        <bdg:buildingName>아파트 107동</bdg:buildingName>
        <bdg:buildingLotNumber>14</bdg:buildingLotNumber>
        <bdg:rigCode>44048</bdg:rigCode>
        <bdg:parcelNumber>267102592108100000</bdg:parcelNumber>
        <bdg:buildingToiletRatio uom="8">14.99</bdg:buildingToiletRatio>
        <bdg:siteUsage codeSpace="/codeList/siteUsageValue.xml">SU003</bdg:siteUsage>
        <bdg:floorAreaRatio uom="8">198.29</bdg:floorAreaRatio>
        <bdg:landUse uom="8">29834.9</bdg:landUse>
      </bdg:sdofAbstrActBuilding>
    </bdg:BuildingProperty>
    <bdg:class codeSpace="/codeList/BuildingClassValue.xml">B0002</bdg:class>
    <bdg:function codeSpace="/codeList/BuildingFunctionValue.xml">B00003</bdg:function>
    <bdg:usage codeSpace="/codeList/BuildingUsageValue.xml">B00020001</bdg:usage>
    <bdg:storeyAboveGround>25</bdg:storeyAboveGround>
  </city:Building>
</cityObjectMember>

```

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Create GML Data

GML

실종 데이터 : 부산광역시기장군 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:Function>
    <bldg:usage codeSpace="." /codelists/BuildingUsage.xml">BDU020001</bldg:usage>
    <bldg:storeysAboveGround>25</bldg:storeysAboveGround>
    <bldg:storeysBelowGround>0</bldg:storeysBelowGround>
    <bldg:adeOfAbstractBuilding>
      <ndt:Building2DProperty .../>
    </bldg:adeOfAbstractBuilding>
    <bldg:buildingPart>
      <bldg:BuildingPart gml:id="gj_apartment_part1">...</bldg:BuildingPart>
    </bldg:buildingPart>
    <bldg:BuildingPart gml:id="gj_apartment_part2">...</bldg:BuildingPart>
    </bldg:buildingPart>
  </bldg:Building>
</core:cityObjectMember>
```

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>
  </bldg:BuildingPart>
</bldg:buildingPart>
```

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">BDU020001</bldg:usage>
    <bldg:storeysAboveGround>25</bldg:storeysAboveGround>
    <bldg:storeysBelowGround>0</bldg:storeysBelowGround>
    <bldg:adeOfAbstractBuilding>
      <ndt:Building2DProperty>
        <ndt:ufid>671025921-3-08100000-140852</ndt:ufid>
        <ndt:buildingName>G0010104</ndt:buildingName>
        <ndt:buildingMainNumber>14</ndt:buildingMainNumber>
        <ndt:zipCode>60043</ndt:zipCode>
        <ndt:parcelNumber>6021025921-3-08100000</ndt:parcelNumber>
        <ndt:buildingToSiteRatio>16.99</ndt:buildingToSiteRatio>
        <ndt:siteUsage>RES</ndt:siteUsage>
        <ndt:floorAreaRatio>98.29</ndt:floorAreaRatio>
        <ndt:landArea uom="m2">28824.91</ndt:landArea>
      </ndt:Building2DProperty>
    </bldg:adeOfAbstractBuilding>
  </bldg:Building>
</core:cityObjectMember>
```

Inserting the Properties(Level of Building)

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

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GML

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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>

```

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XML Schema based on UML

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" BDU020000</bldg:usage>
    <bldg:storeysAboveGround>25</bldg:storeysAboveGround>
    <bldg:storeysBelowGround>0</bldg:storeysBelowGround>
    <bldg:adeOfAbstractBuilding>
      <ndt:Building2DProperty>
        <ndt:ufid>671025921-3-08100000-140852</ndt:ufid>
        <ndt:buildingName>길광 대성메르빌 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>
      </ndt:Building2DProperty>
    </bldg:adeOfAbstractBuilding>
  </bldg:Building>
</core:cityObjectMember>

```



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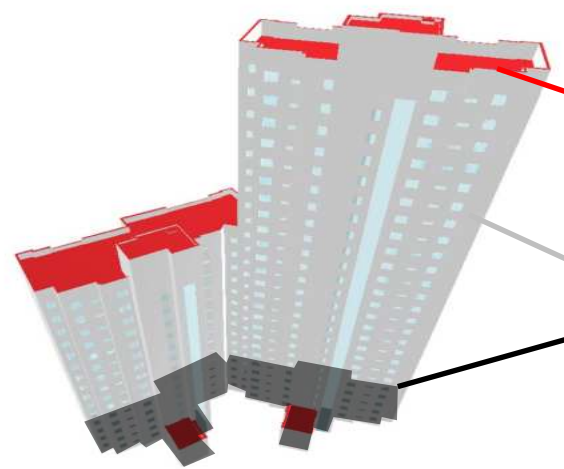
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XML Schema based on UML

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>
  </bldg:BuildingPart>
</bldg:buildingPart>

```

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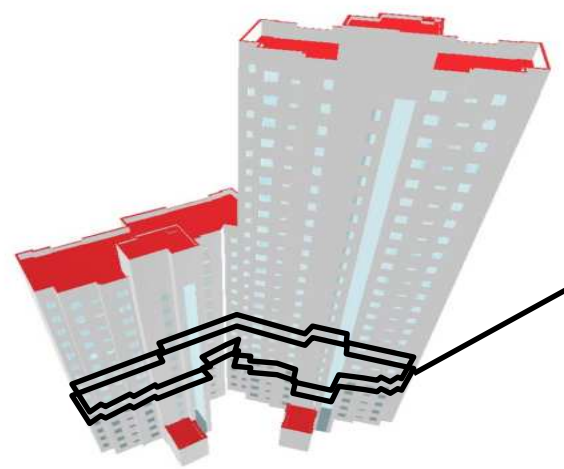
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XML Schema based on UML

Inserting the Properties(Level of Building)

```

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

```

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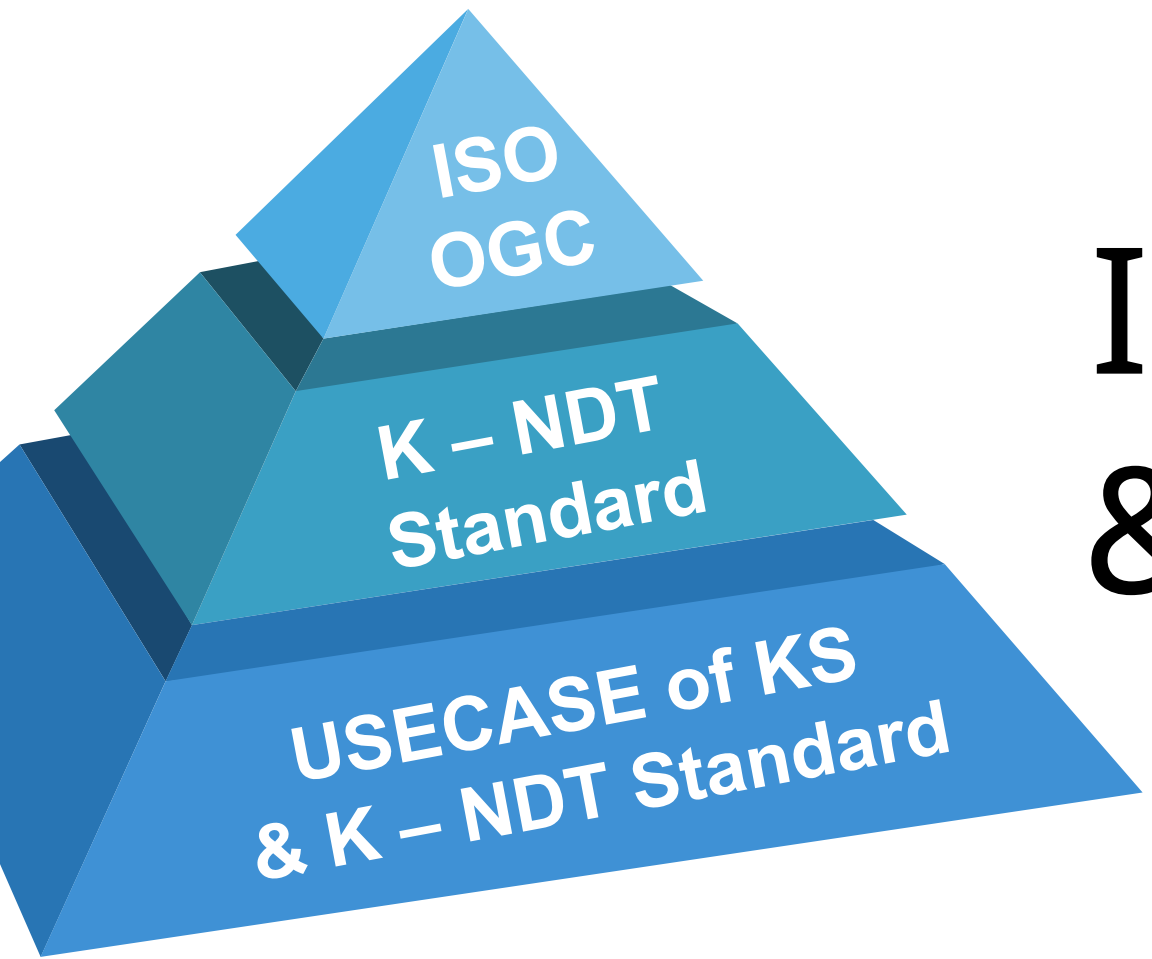


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Sharing for Interoperability & Sustainability





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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



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