



Development of XML schemas for Implementation of a 3D Cadastral Data Model

4th International FIG 3D Cadastre Workshop,
9-11 November 2014, Dubai, United Arab Emirates

Ali Aien

Abbas Rajabifard

Mohsen Kalantari

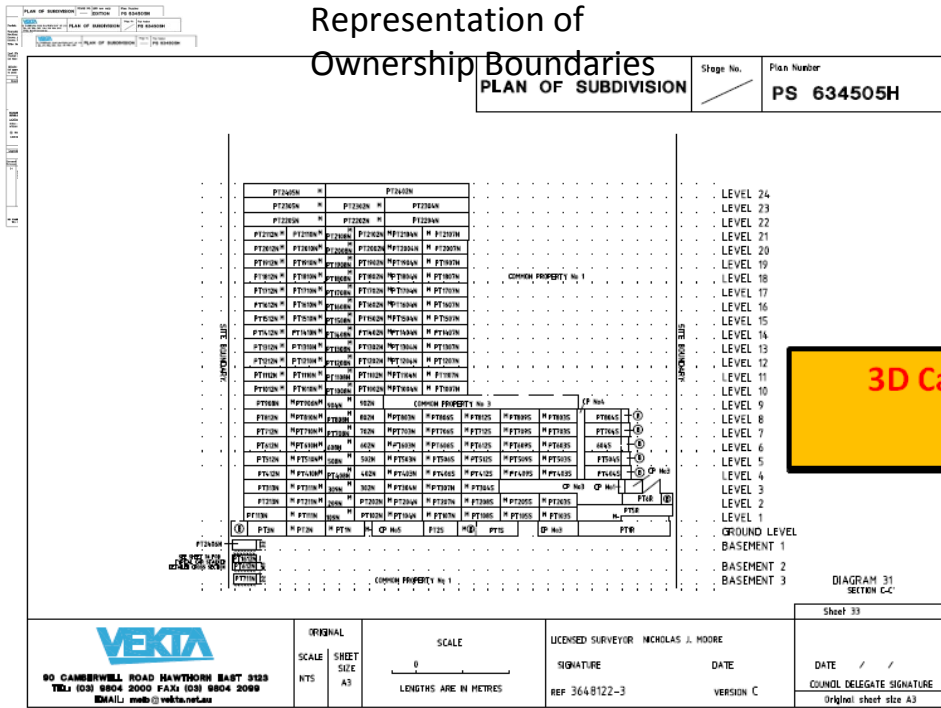
Ian Williamson

Davood Shojaei



3D Cadastre and Data Model

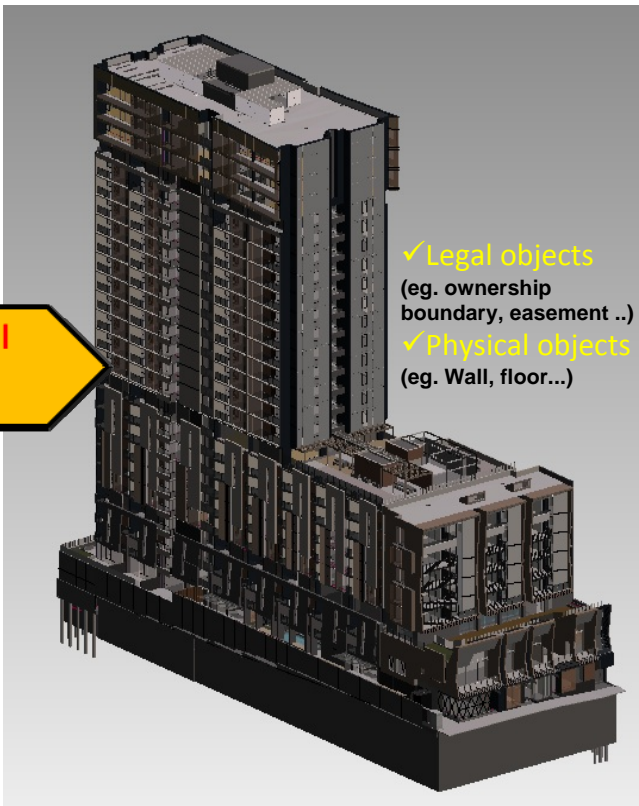
Paper based
Representation of
Ownership Boundaries



3D Cadastral Data Model
(3DCDM)

- Includes:
- ✓ Legal objects
 - ✓ Physical objects

Digital Representation of Ownership
Boundaries and Physical objects



Existing cadastral data models

- The Core cadastral data model (Henssen, 1995)
- FGDC (FGDC, 1996)
- ArcGIS Parcel Data Model (Meyer, 2001)
- DM.01. (Steudler, 2005)
- Legal Property Object (Kalantari et al., 2008)
- ePlan (ICSM, 2009)
- [LADM- ISO 19152 \(ISO19152, 2012\).](#)



CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
AND ADMINISTRATION



THE UNIVERSITY OF
MELBOURNE

Assessment of existing cadastral data models

Criteria	Description
Core objects	What are the core objects of the data model?
Basic spatial unit	What are the basic spatial units of the data model?
Other forms of spatial units	Does the data model have other forms of spatial unit?
Reference documents	What are the data sources?
Applications	In what applications can the data model be used for?
Inclusion of other types of interests	Whether or not other types of interests are considered in the data model?
Temporal aspects	Whether or not temporal aspects of interests are considered?
Management and representation of stratified RRRs	How does the data model render stratified RRRs?
Semantic-level	In what level does the data model support semantics?
Physical objects	How does the data model support the physical counterparts of legal objects?



CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
AND ADMINISTRATION



THE UNIVERSITY OF
MELBOURNE

Summery of the assessment

- ✓ Challenge 1: Existing cadastral data models do **not incorporate physical object**.
- ✓ Challenge 2: Existing cadastral data models are **not semantically enriched**.



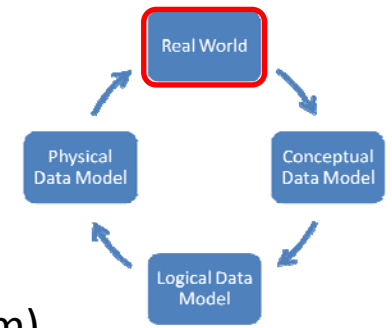
CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
& LAND ADMINISTRATION



THE UNIVERSITY OF
MELBOURNE

Business Analysis

- Assess **needs of users** of 3D cadastres
 - Identify **data elements** of 3D cadastres
-
- ✓ ICSM members (Permanent Committee in Cadastral Reform)
 - ✓ Land and Property information in 3D Workshop, Melbourne
 - ✓ 2nd International workshop on 3D Cadastres, Delft, the Netherlands
 - ✓ Placement in Land Victoria
 - ✓ Literature review

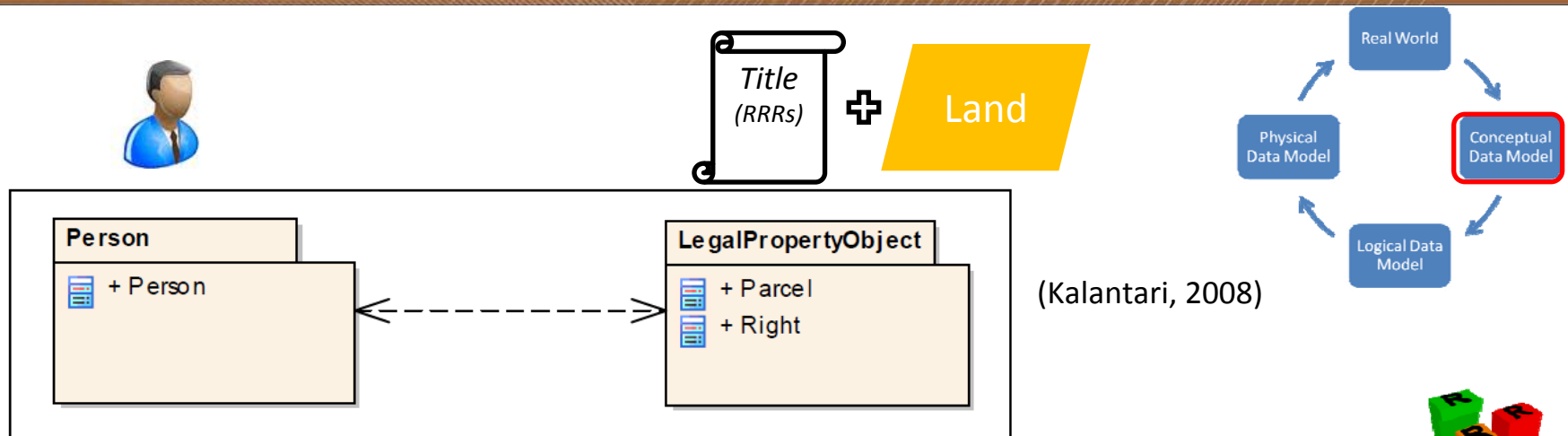


CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
IN LAND ADMINISTRATION



THE UNIVERSITY OF
MELBOURNE

Concept of Legal Property Object



- ✓ Combines every interest and its spatial extent
- ✓ Facilitates the incorporation of a wide range of interests

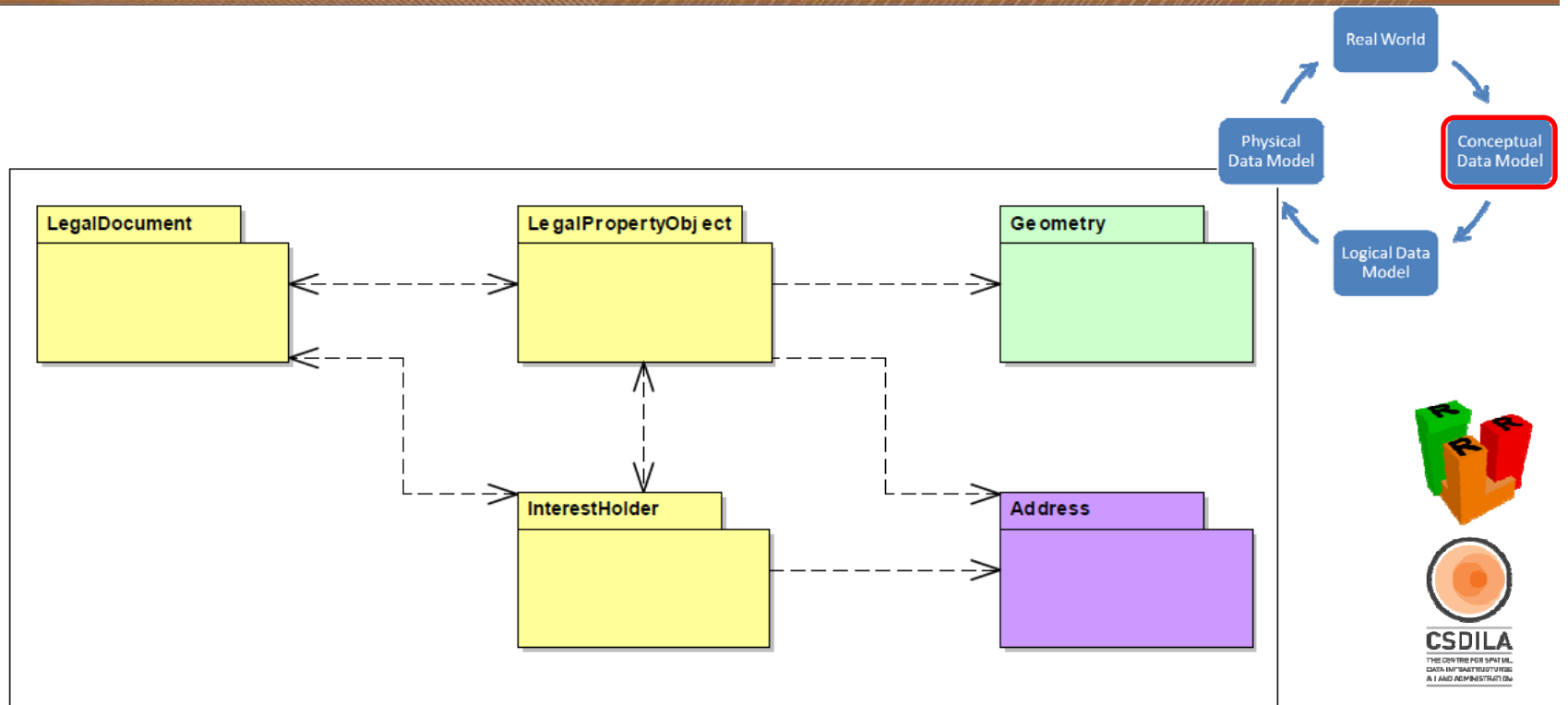


CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
AND ADMINISTRATION



THE UNIVERSITY OF
MELBOURNE

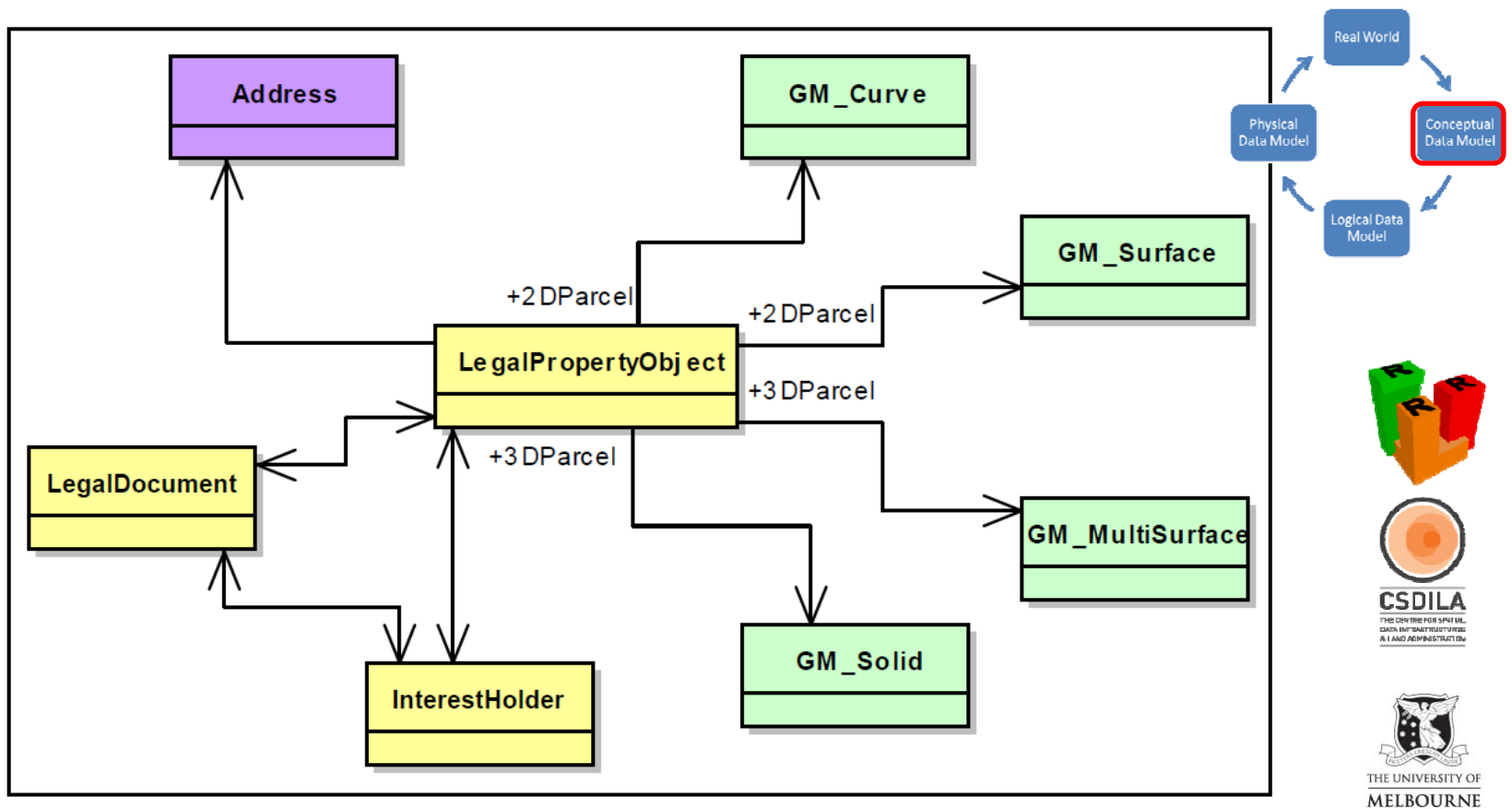
Utilisation of Legal Property Object in the 3DCDM model



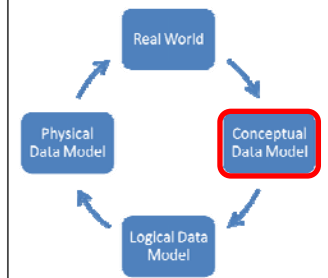
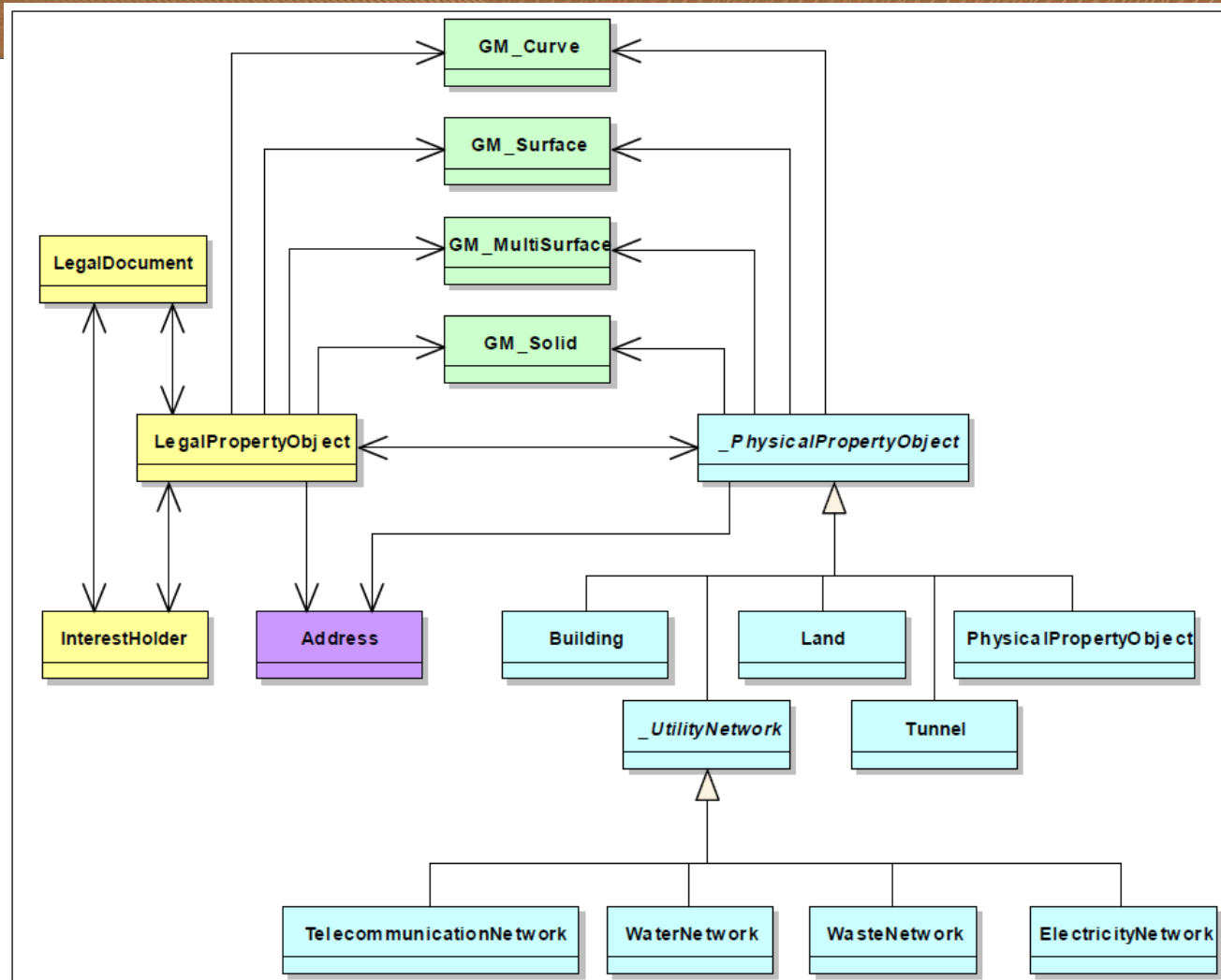
CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
AND ADMINISTRATION



The 3DCDM model and 3D data



The 3DCDM model and integration with Physical Object

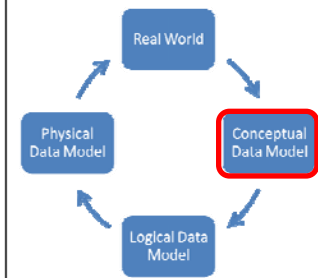
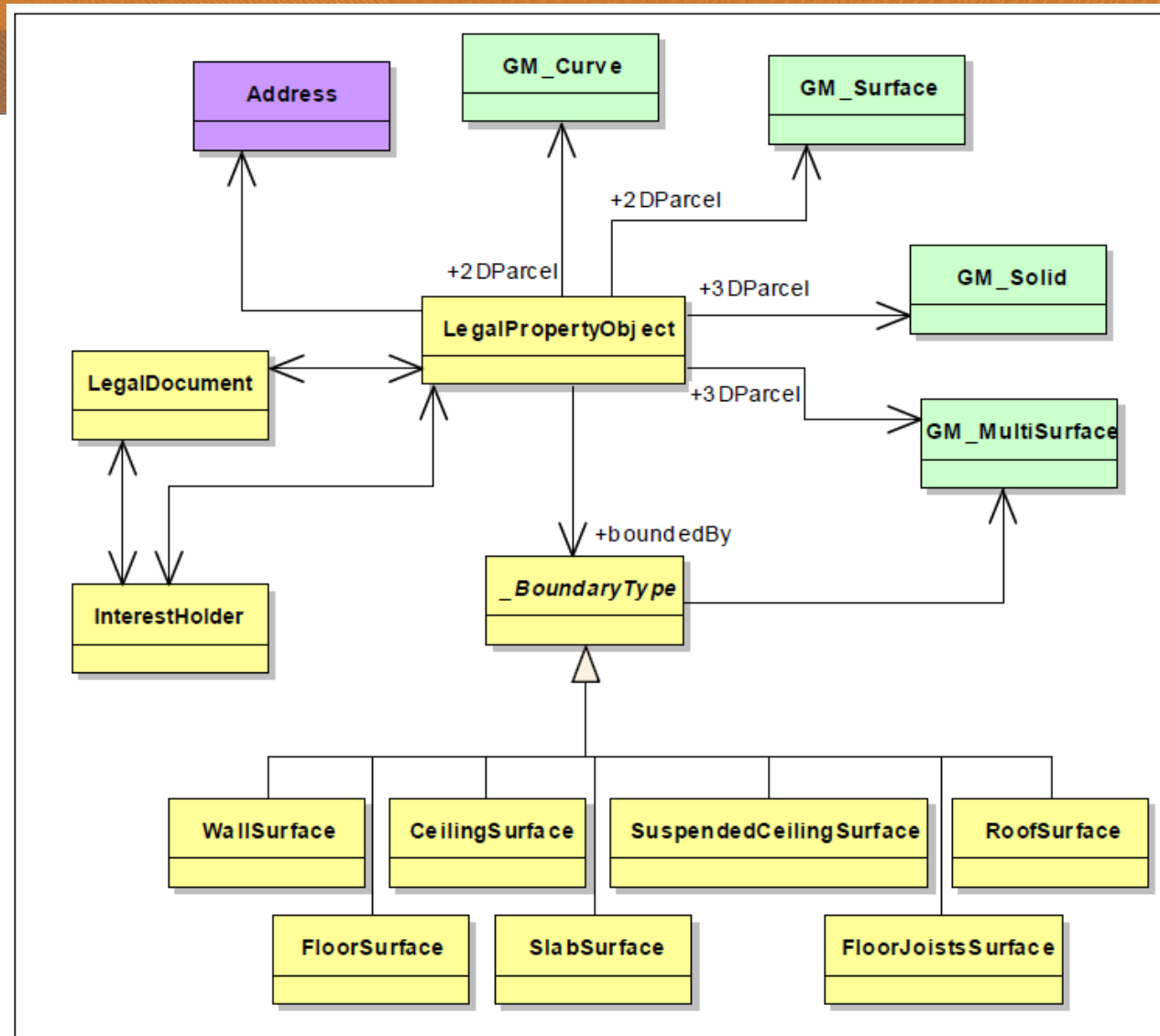


CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
IN LAND ADMINISTRATION

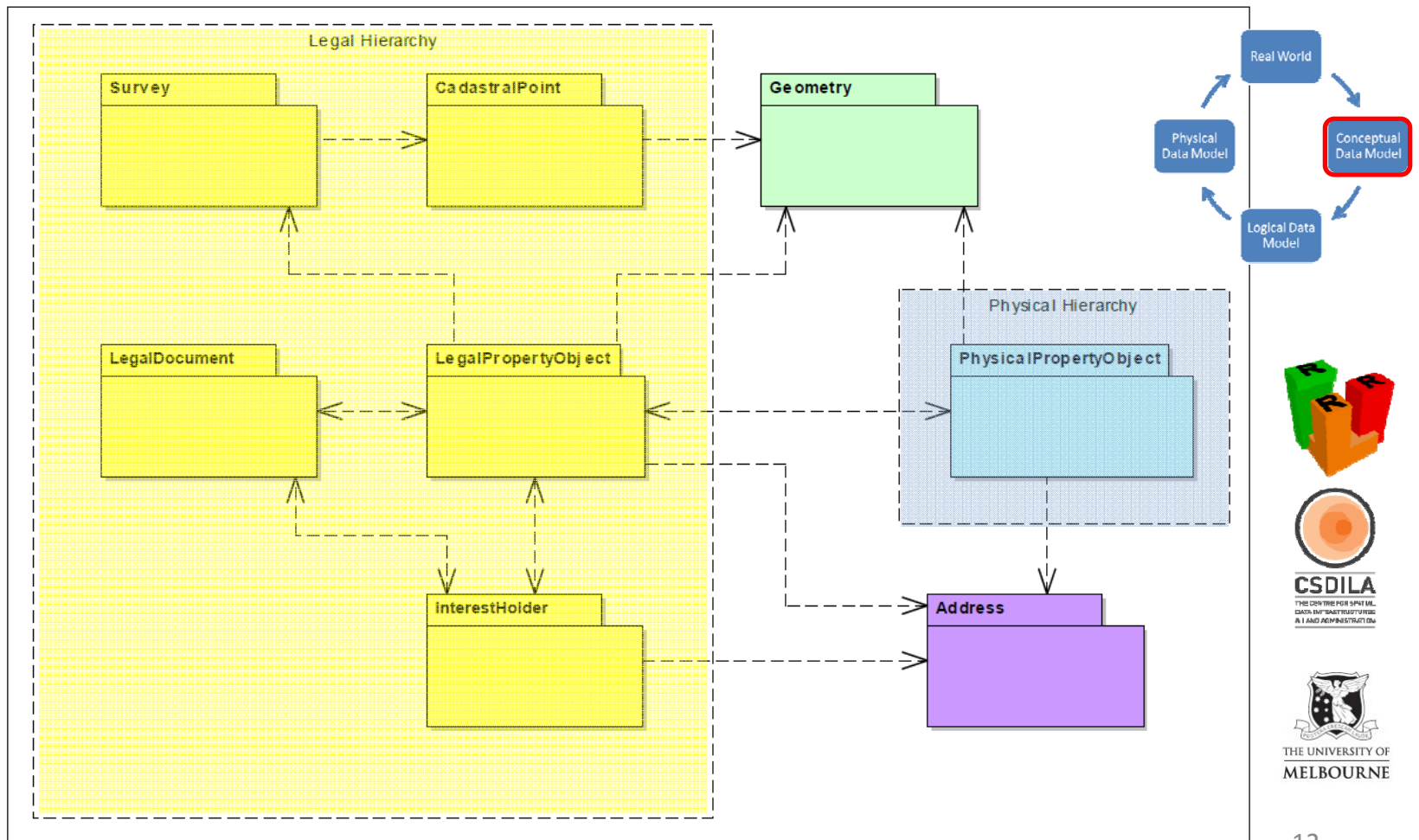


THE UNIVERSITY OF
MELBOURNE

The 3DCDM model and Semantics



Conceptual data model of the 3DCDM model

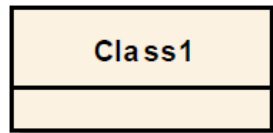


CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
PLANNING AND ADMINISTRATION

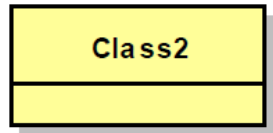


THE UNIVERSITY OF
MELBOURNE

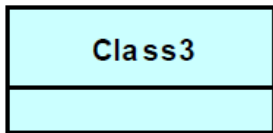
Colours in the 3DCDM model



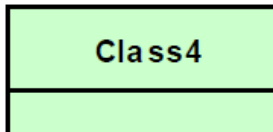
3DCDM's **root model** features



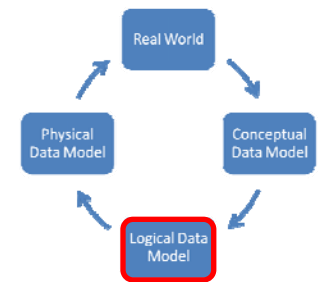
3DCDM's **legal** hierarchy features



3DCDM's **physical** hierarchy features



3DCDM's **GML** features

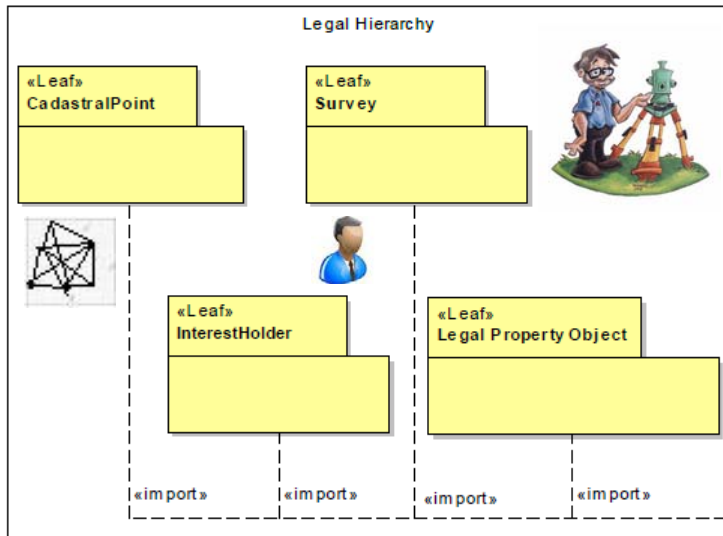


CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
AND ADMINISTRATION

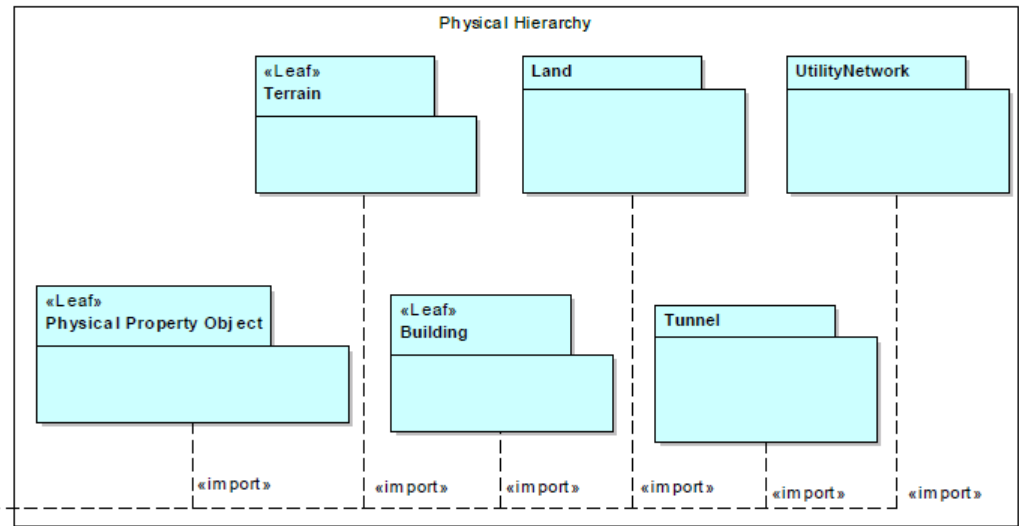


THE UNIVERSITY OF
MELBOURNE

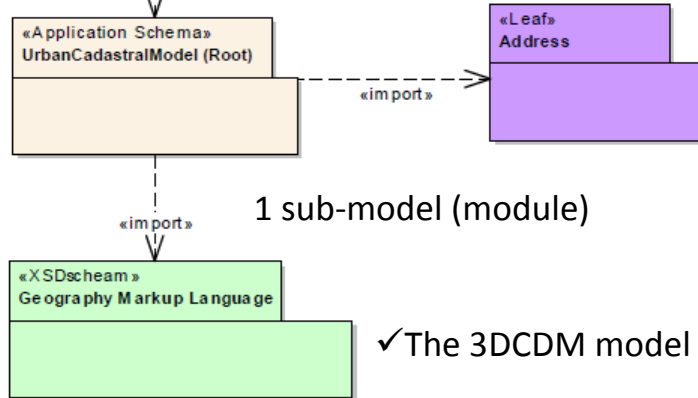
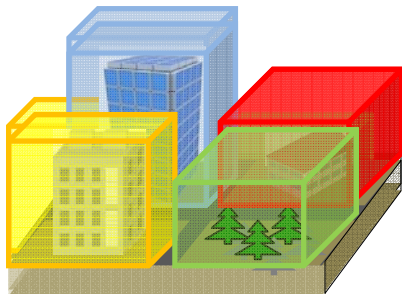
Separate modules and hierarchies in the 3DCDM model



4 sub-models (modules)



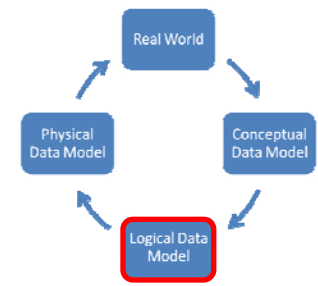
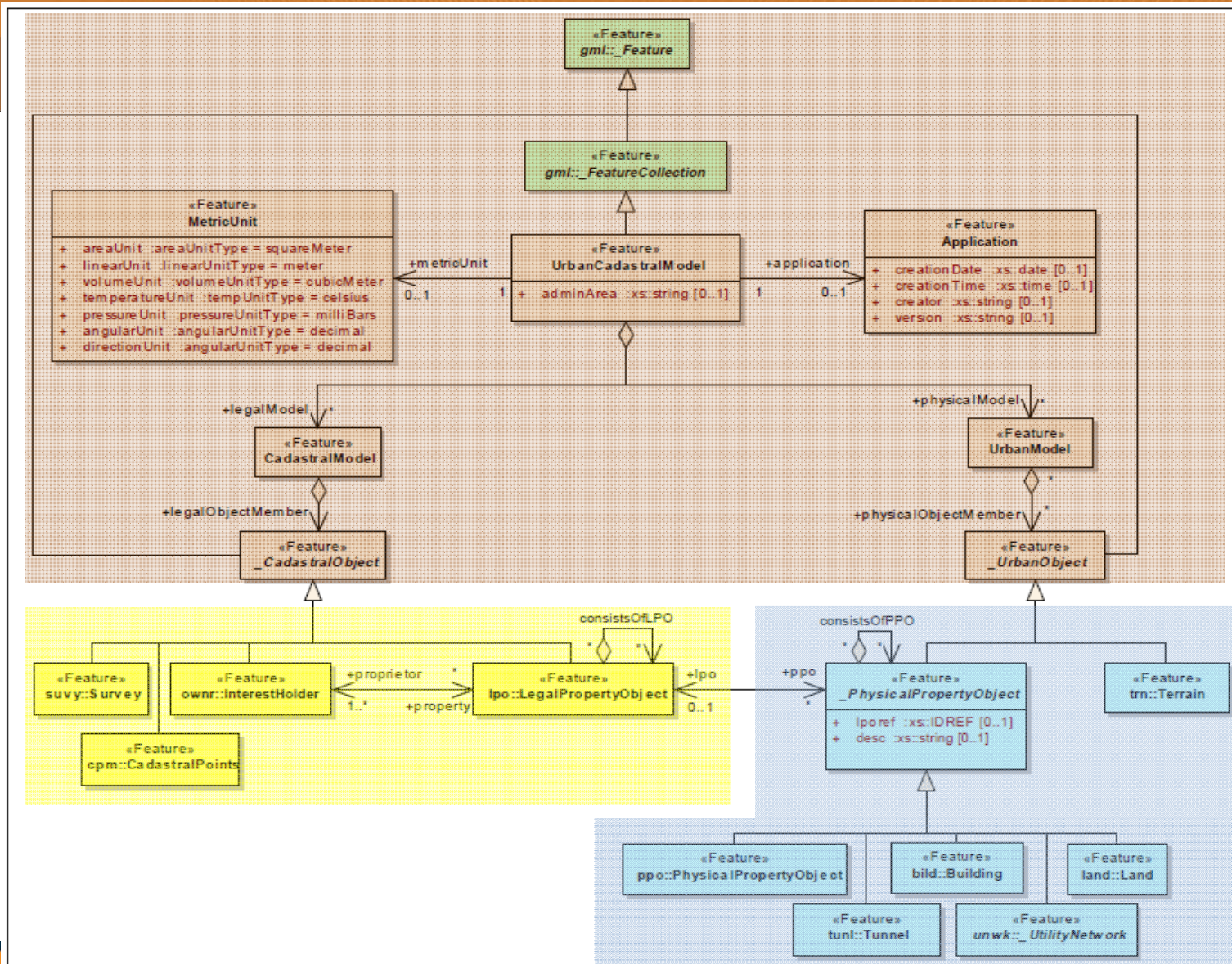
6 sub-models (modules)



1 sub-model (module)

✓The 3DCDM model has **11 sub-models (modules)**.

3DCDM Root module

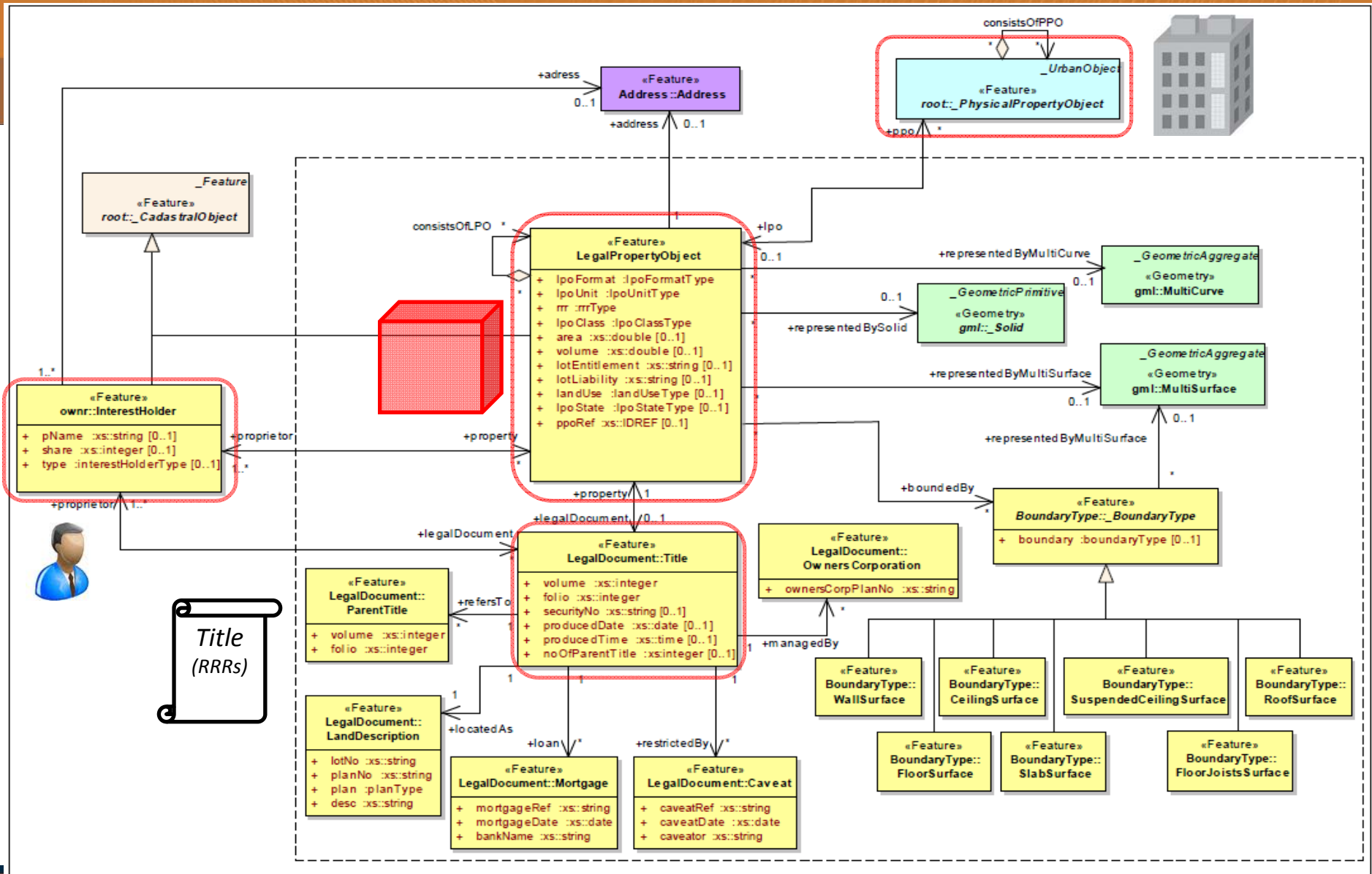


CSDILA
THE OFFICE FOR SPATIAL
DATA INFRASTRUCTURE
AND ADMINISTRATION

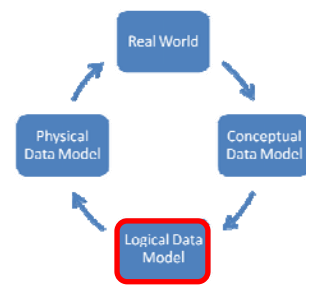
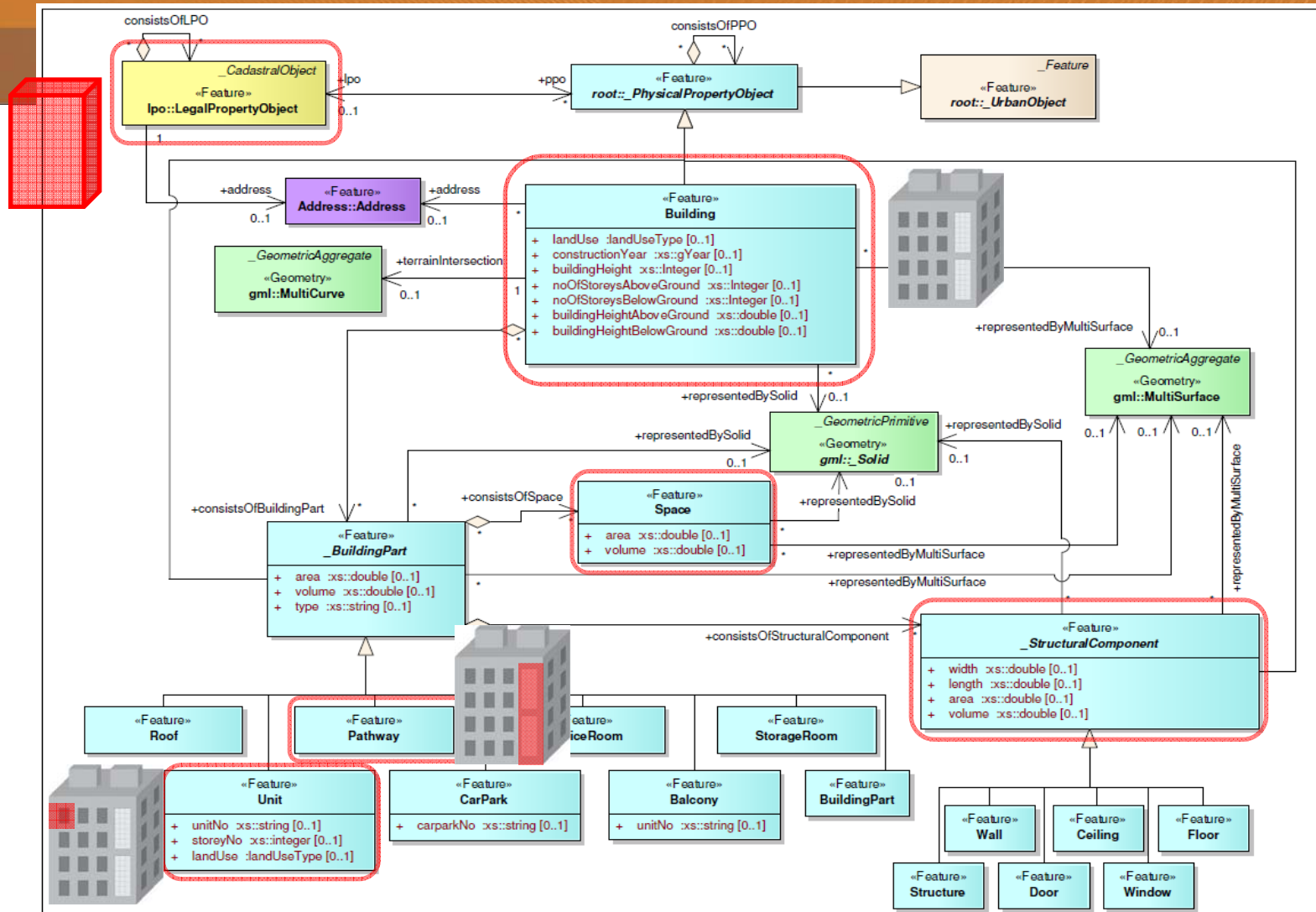


THE UNIVERSITY OF
MELBOURNE

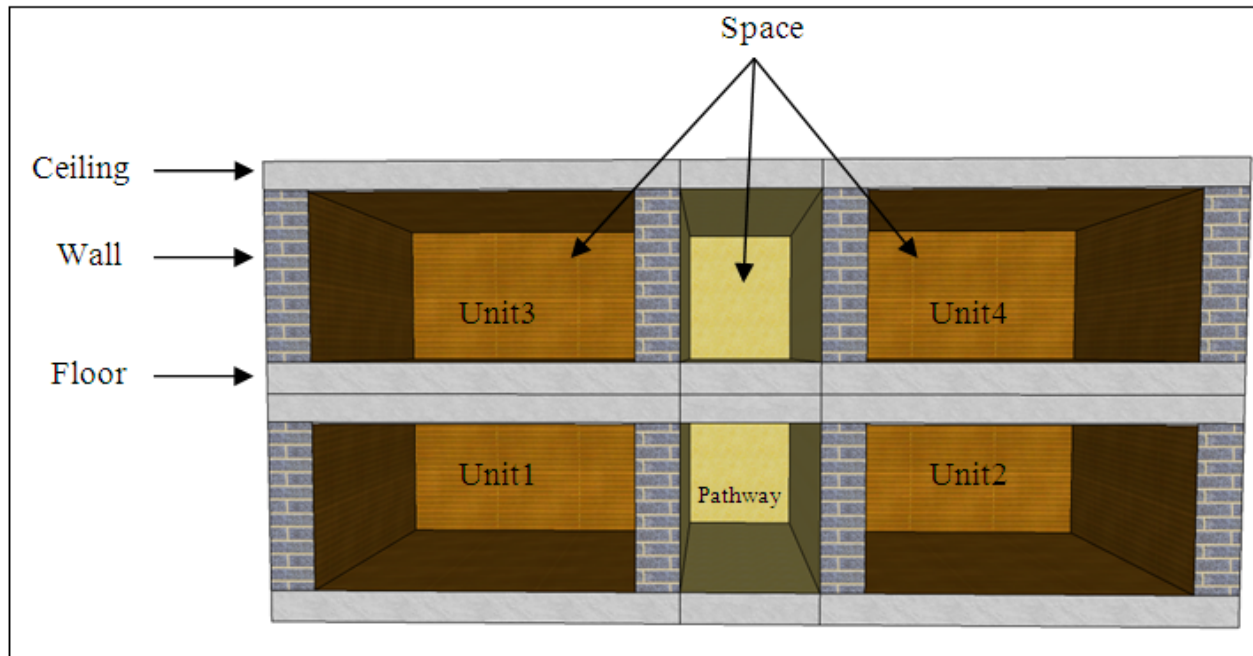
3DCDM LegalPropertyObject module



3DCDM Building module



Building model (space and structure)



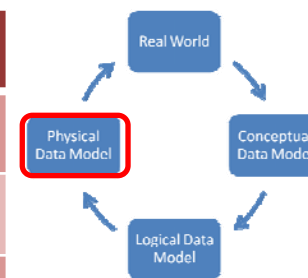
CSDILA
THE CENTRE FOR SPATIAL
DATA ANALYSIS AND
ADMINISTRATION



Implementation

List of XML schemas

3DCDM module	URI	prefix
3DCDM Root	http://www.csdila.unimelb.edu.au/3DCDM/1.0	root
LegalPropertyObject	http://www.csdila.unimelb.edu.au/3DCDM/lpo/1.0	lpo
InterestHolder	http://www.csdila.unimelb.edu.au/3DCDM/owner/1.0	ownr
Survey	http://www.csdila.unimelb.edu.au/3DCDM/survey/1.0	suvy
CadastralPoints	http://www.csdila.unimelb.edu.au/3DCDM/cadastralpoint/1.0	cpm
Building	http://www.csdila.unimelb.edu.au/3DCDM/building/1.0	bild
Land	http://www.csdila.unimelb.edu.au/3DCDM/land/1.0	land
Tunnel	http://www.csdila.unimelb.edu.au/3DCDM/tunnel/1.0	tunl
UtilityNetwork	http://www.csdila.unimelb.edu.au/3DCDM/utility/1.0	unwk
PhysicalPropertyObject	http://www.csdila.unimelb.edu.au/3DCDM/ppo/1.0	ppo
Terrain	http://www.csdila.unimelb.edu.au/3DCDM/terrain/1.0	tern

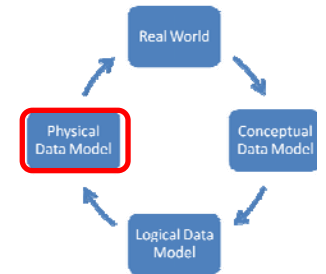
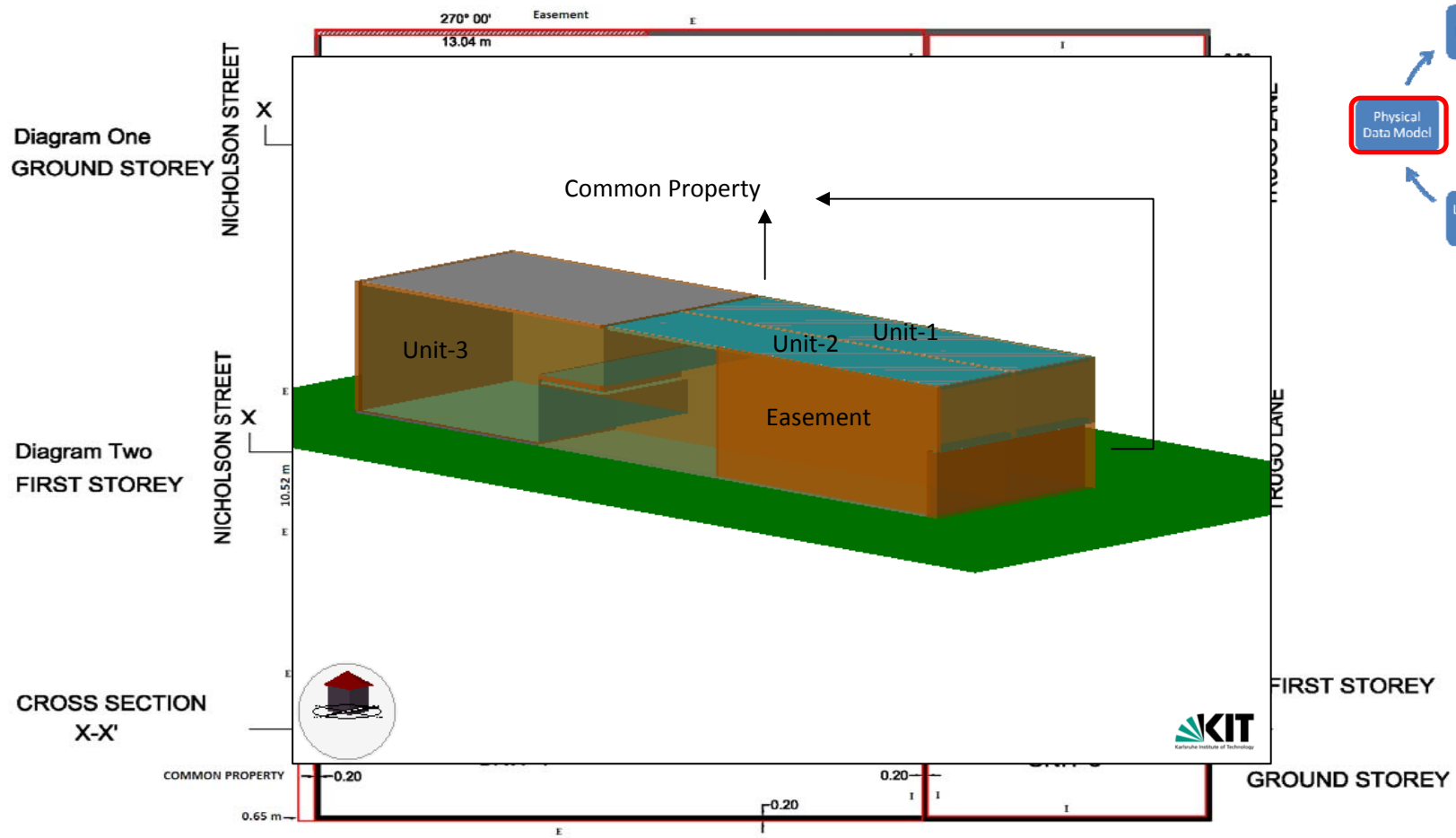


CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
IN LAND ADMINISTRATION



THE UNIVERSITY OF
MELBOURNE

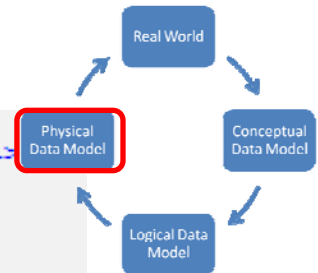
Real case example- Model validation



Real case example

```
<!-- Root Element -->
<?xml version="1.0" encoding="utf-8"?>
<UrbancadastralModel
  gml:id="ID_3DCDM_Example"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://www.csdila.unimelb.edu.au/3DCDM/1.0"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:build="http://www.csdila.unimelb.edu.au/3DCDM/building/1.0"
  xmlns:lpo="http://www.csdila.unimelb.edu.au/3DCDM/lpo/1.0"
  xmlns:owner="http://www.csdila.unimelb.edu.au/3DCDM/owner/1.0"
  xmlns:survey="http://www.csdila.unimelb.edu.au/3DCDM/survey/1.0"
  xmlns:cpm="http://www.csdila.unimelb.edu.au/3DCDM/cadastralpoint/1.0"
  xmlns:tm="http://www.csdila.unimelb.edu.au/3DCDM/terrain/1.0"

  xsi:schemaLocation="
    http://www.csdila.unimelb.edu.au/3DCDM/1.0 http://www.csdila.unimelb.edu.au/3DCDM/schema/3DCDMBase.xsd
    http://www.csdila.unimelb.edu.au/3DCDM/building/1.0 http://www.csdila.unimelb.edu.au/3DCDM/schema/Building.xsd
    http://www.csdila.unimelb.edu.au/3DCDM/lpo/1.0 http://www.csdila.unimelb.edu.au/3DCDM/schema/LegalPropertyObject.xsd
    http://www.csdila.unimelb.edu.au/3DCDM/owner/1.0 http://www.csdila.unimelb.edu.au/3DCDM/schema/InterestHolder.xsd
    http://www.csdila.unimelb.edu.au/3DCDM/survey/1.0 http://www.csdila.unimelb.edu.au/3DCDM/schema/Survey.xsd
    http://www.csdila.unimelb.edu.au/3DCDM/cadastralpoint/1.0 http://www.csdila.unimelb.edu.au/3DCDM/schema/CadastralPoint.xsd
    http://www.csdila.unimelb.edu.au/3DCDM/terrain/1.0 http://www.csdila.unimelb.edu.au/3DCDM/schema/Terrain.xsd
  ">
<!-- Metadata -->
```



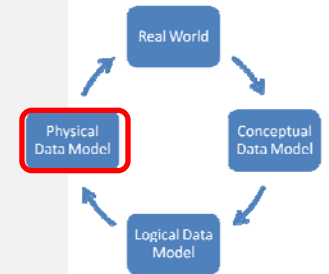
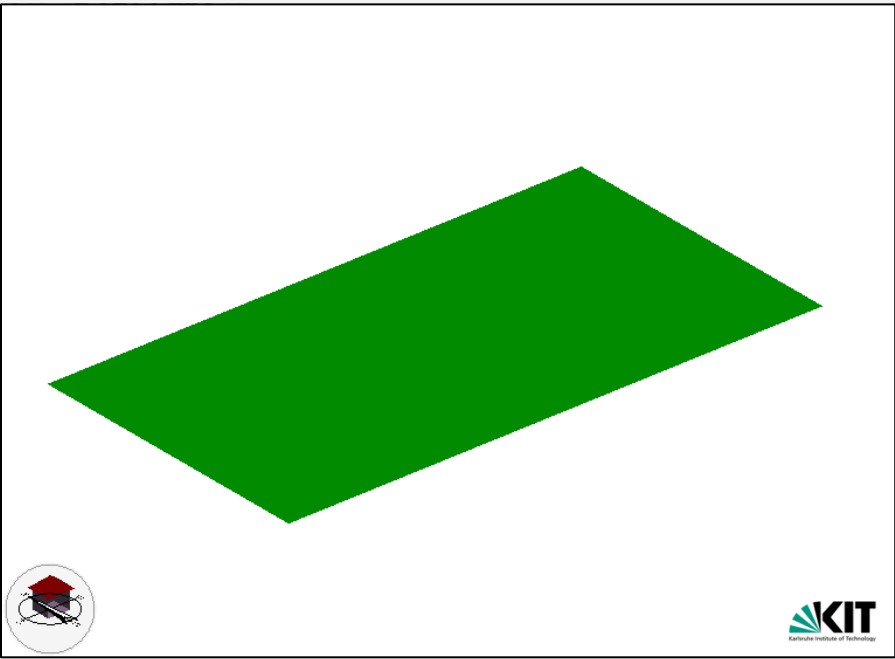
CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
AND ADMINISTRATION



THE UNIVERSITY OF
MELBOURNE

Real case example

```
<!-- TIN -->
<physicalModel>
  <UrbanModel>
    <physicalObjectMember>
      <tm:Terrain gml:id="DCDM_TIN_1">
        <tm:terrainSource>
          <tm:TIN gml:id="TIN_1">
            <tm:tinSource>
              <gml:Polygon>
                <gml:coordinates>
                  <!-- TIN coordinates -->
                </gml:coordinates>
              </gml:Polygon>
            </tm:tinSource>
          </tm:TIN>
        </tm:terrainSource>
      </tm:Terrain>
    </physicalObjectMember>
  </UrbanModel>
</physicalModel>
<!-- Physical Model -->
```



CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
PLANNING AND ADMINISTRATION



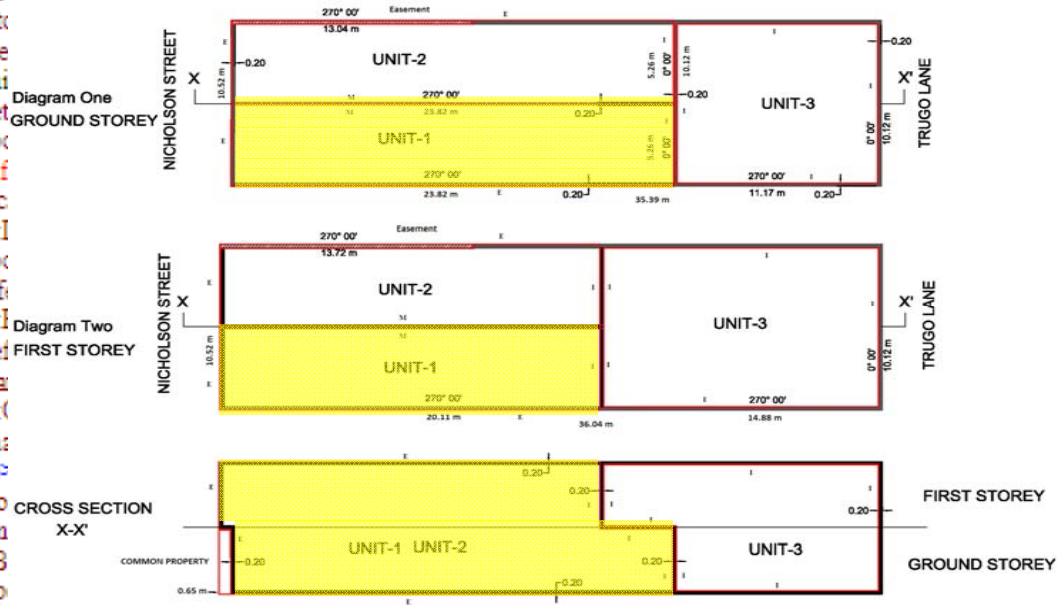
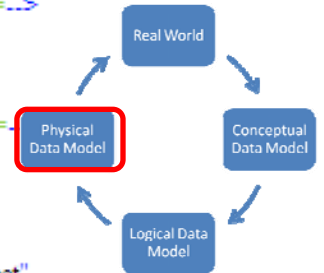
THE UNIVERSITY OF
MELBOURNE

Real case example

```

<!-- Physical Model -->
<physicalModel>
  <UrbanModel>
    <physicalObjectMember>
      <bild:Building gml:id="DCDM_Building_Unit1" landUse="residential" constructionYear="1994" buildingHeight="6"
        noOfStoreysAboveGround="2" noOfStoreysBelowGround="0">
        <!-- Unit1 -->
        <bild:consistsOfBuildingPart>
          <bild:Unit gml:id="DCDM_Unit_1" landUse="residential" lpoRef="LOT-1">
            <gml:name>Unit_1</gml:name>
            <!-- UNIT_1's Legal Counterpart -->
            <lpo>
              <lpo:LegalPropertyObject gml:id="LOT-1" lpoClass="lot" lpoUnit="single" lpoFormat="3DParcel"
                name="LOT-1" lpoState="created" rrr="ownership" lotEntitlement="35" lotLiability="35">
                <lpo:address>
                  <lpo:Address flatNumber="1" propertyNumber="143" streetName="Nicholson" streetType="street"
                    Suburb="Footscray" postCode="3011" state="VIC" country="Australia"/>
                </lpo:address>
                <lpo:address>
                </lpo:address>
                <lpo:proprietor>
                </lpo:proprietor>
                <lpo:owner:Integer type="family"/>
                </lpo:owner:Integer>
                <lpo:proprietor>
                </lpo:proprietor>
                <lpo:legalDocument>
                </lpo:legalDocument>
                <lpo>Title f
                </lpo>Title f
                <lpo:loc
                </lpo:loc
                <lpo:loc
                </lpo:loc
                <lpo:ref
                </lpo:ref
                <lpo:ref
                </lpo:ref
                <lpo:ma
                </lpo:ma
                <lpo:(
                </lpo:(
                <lpo:m:
                </lpo:m:
                <lpo>Title>
                </lpo>Title>
                <lpo:legalDo
                </lpo:legalDo
                <lpo:represent
                </lpo:represent
                <lpo:representedB
                </lpo:representedB
                <lpo:LegalProp
                </lpo:LegalProp
            </lpo>
          </bild:Unit>
        </bild:consistsOfBuildingPart>
      </bild:Building>
    </physicalObjectMember>
  </UrbanModel>
</physicalModel>
<!-- PhysicalPropertyObject -->

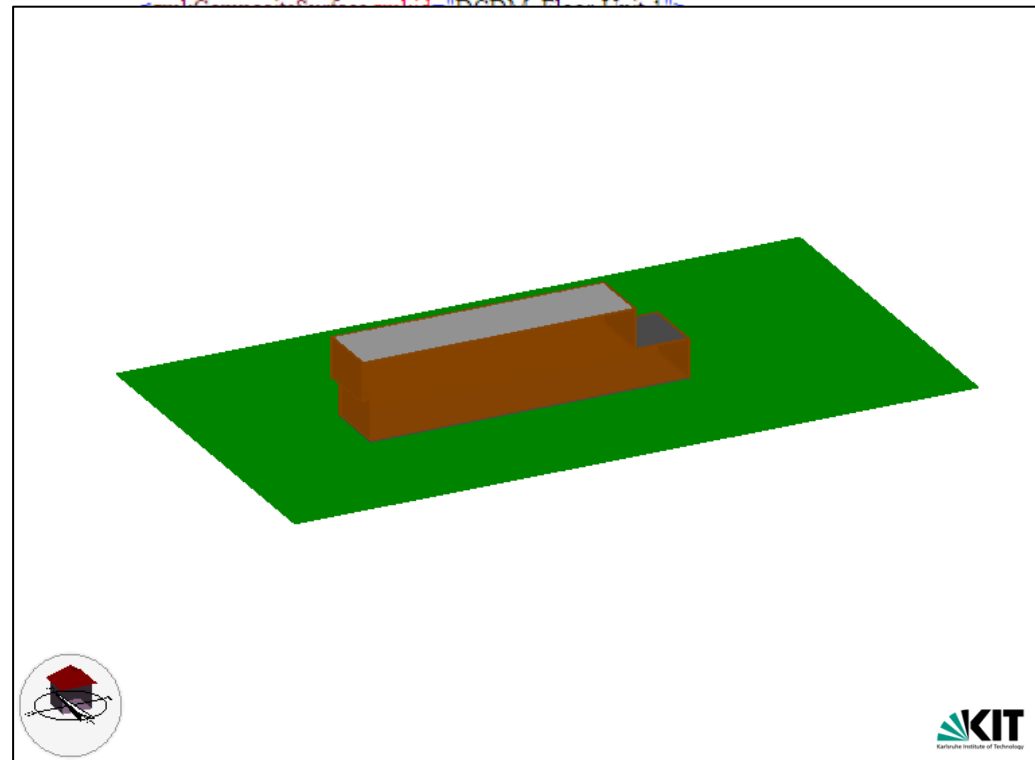
```



Real case example

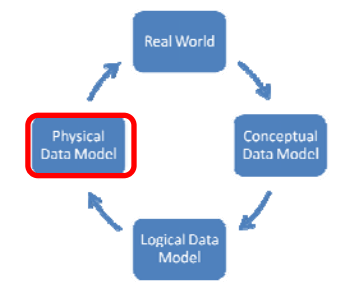
```

<!-- Floor-Unit1 -->
<bild:consistsOfStructuralComponent>
  <bild:Floor gml:id="DCDM_Floor_Unit_1">
    <bild:representedByMultiSurface>
      <gml:MultiSurface gml:id="DCDM_Floor_Unit-1">
        <gml:surfaceMember>
          <gml:Surface gml:id="DCDM_Floor_Unit-1"
  
```



```

<gml:exterior>
  <gml:LinearRing>
    <gml:posList>1000.630 1000.000 0.000 1024.700 1000.000 0.000 1024.700 1000.000
    0.100 1000.630 1000.000 0.100 1000.630 1000.000 0.000
  </gml:posList>
  
```



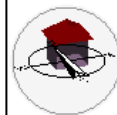
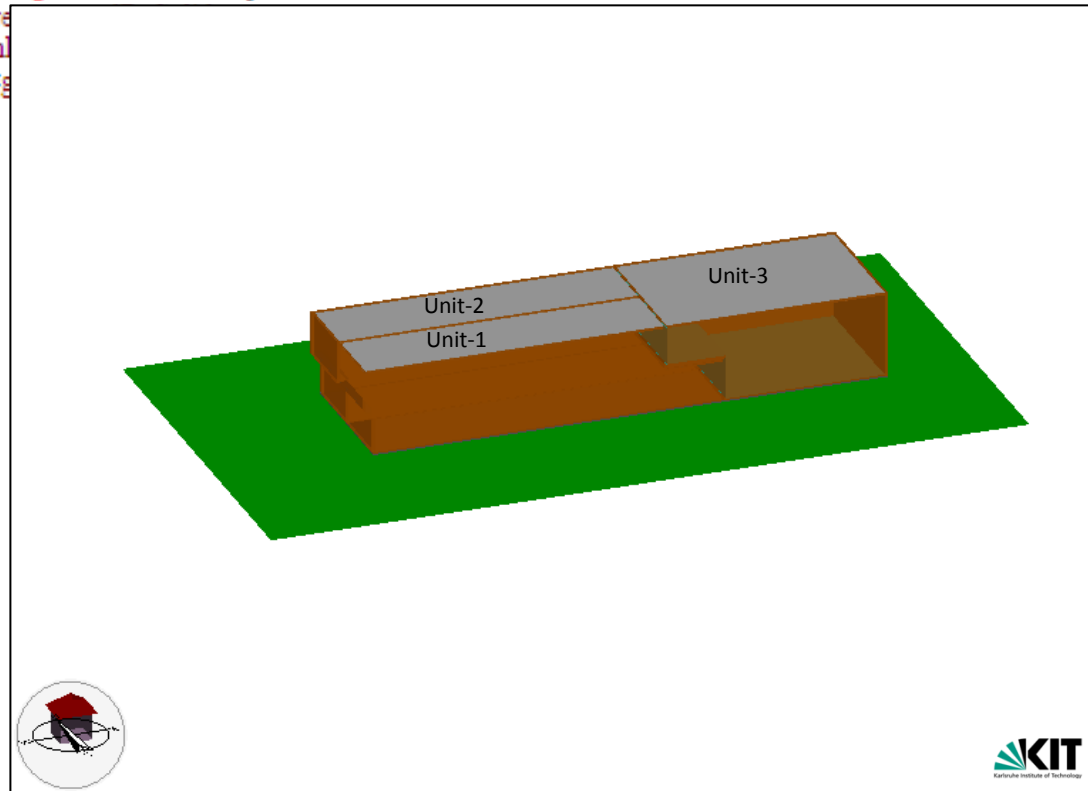
CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
AND ADMINISTRATION



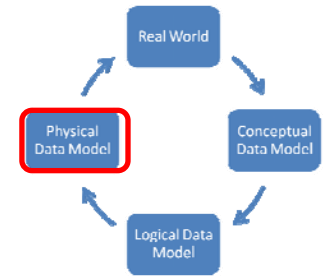
THE UNIVERSITY OF
MELBOURNE

Real case example

```
<!-- Space_Unit1 -->  
<bild:consistsOfSpace>  
<bild:Space gml:id="DCDM-Space-Unit-1">  
<bild:re...>  
<gml...>  
<gml...>
```



```
<gml:name="UNIT_1_Floor_Sound_Exterior" gml:name="...>  
<gml:exterior>
```



CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
IN LAND ADMINISTRATION



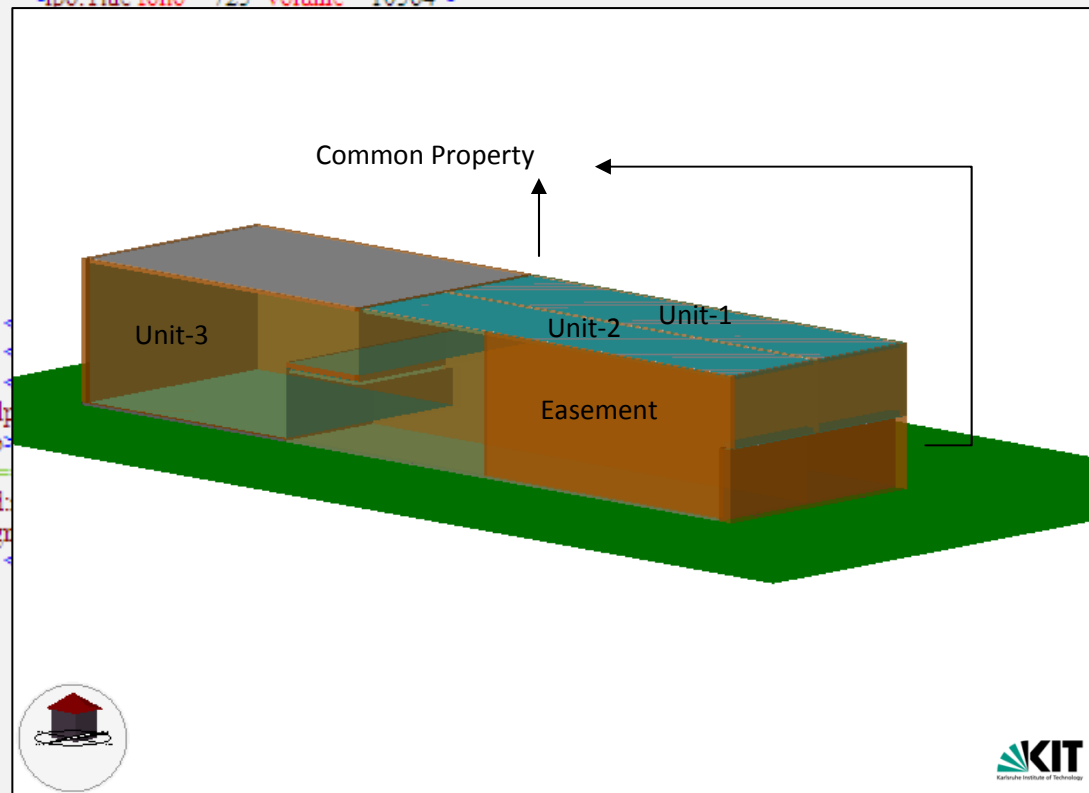
THE UNIVERSITY OF
MELBOURNE

Real case example

```

<!-- Easement Wall -->
<bild:Wall gml:id="DCDM_Easement_Wall" lpoRef="Easement">
  <!-- PartyWall's Legal Counterpart -->
  <lpo>
    <lpo:LegalPropertyObject gml:id="Easement" lpoClass="easement" lpoUnit="single" lpoFormat="3DParcel"
      name="Easement" lpoState="created" rrr="easement">
      <lpo:legalDocument>
        <lpo:Title folio="725" volume="10564">

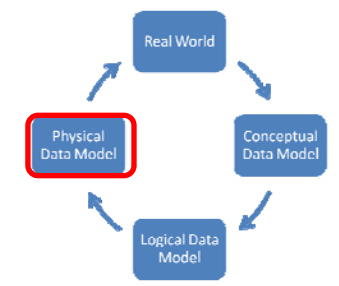
```



```

</lpo>
</lpo>
<!-- Floor Easement Level2 -->
<gml:surfaceMember>
  <gml:Polygon gml:id="GML_Floor_Easement_Level2_legal">

```



CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURE
IN LAND ADMINISTRATION



THE UNIVERSITY OF
MELBOURNE



Thank you

