Survey of Israel
המרכז למיפוי ישראל

Steps towards 3D Cadastre and ISO 19152 (LADM) in Israel

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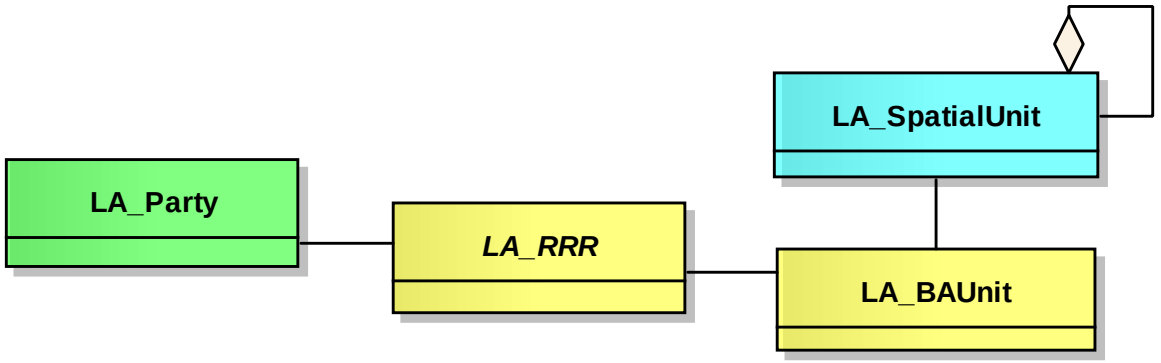


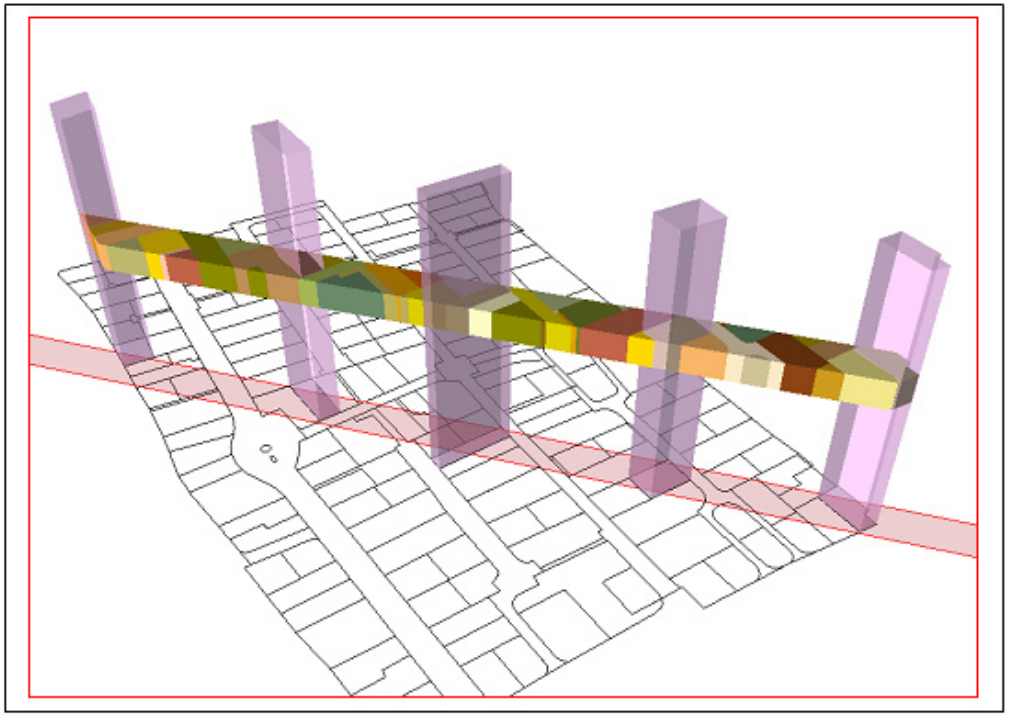
Israel 3D subparcel concept, previous investigations

- 3D subparcel is temporarily created by subtraction form 3D column implied by 2D base parcel

- In single transaction for a infrastructure object many temporary 3D subparcels are created (involving multiple owners)

- Within transaction these join in single 3D parcel with own ID within block (same RRR/Party)

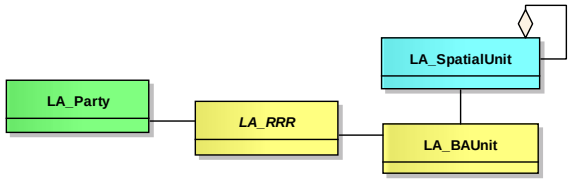
Illustration:
Shoshani et al. 2005



Land Administration Domain Model ISO 19152 (LADM)

- Model includes:
  - Spatial part (geometry, topology)
  - Extensible frame for legal/administrative part
- Object-orientation → expressions in UML
- Model Driven Architecture (MDA)
- FIG proposed LADM to ISO/TC211, January 2008
  and became accepted standard December 2012: ISO 19152

Motivation LADM
Reasons to apply LADM

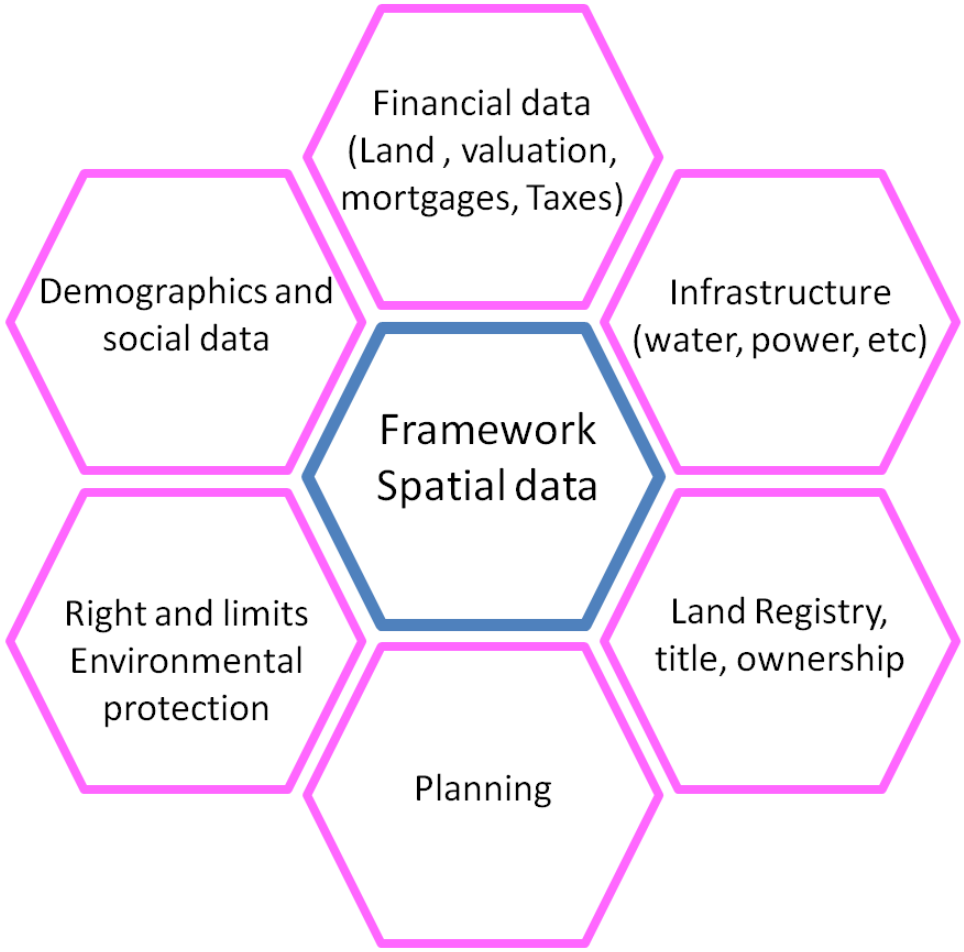


- LADM collective experience of experts from many countries (FIG)
- LADM is based on consensus and adopted by ISO (and CEN)
- LADM allows *meaningful data exchange: 1. within country*, SDI-setting (other types of data), 2. between countries/states (same type)
- LADM covers complete land administration spectrum: survey, cadastral maps, rights, restrictions, responsibilities, mortgages, persons, etc.
- LADM focuses on information, not on process/organization aspect
- LADM is modular (packages) and extensible → country profiles
- LADM allows *integrated 2D and 3D representation* of spatial units
- LADM supports both formal and informal RRRs
- LADM links essential land information data to source documents, both spatial (survey) and legal (title, deed)

LADM compliance will seldom be main reason for new system in country
→ every system needs upgrades: consider becoming LADM compliant!

Rainbow project: Unified property database (*distributed*), Location Based Business Intelligence (LBBI) system

- LADM covers data from various government parties and can support digital collaboration
- Various organizations are source of different RRRs with either:
  - own geometry
  - ref's cadastral parcels



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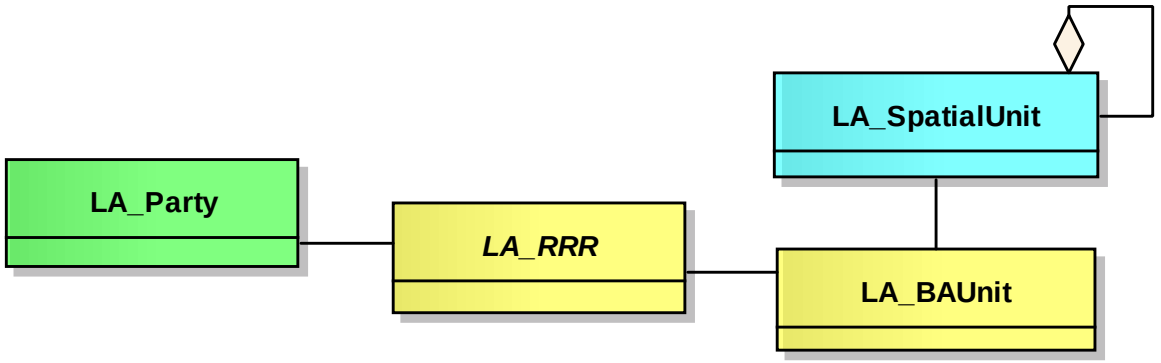

1. Background
2. LADM and SDI
3. Israeli 3D LADM country profile
4. Implementation
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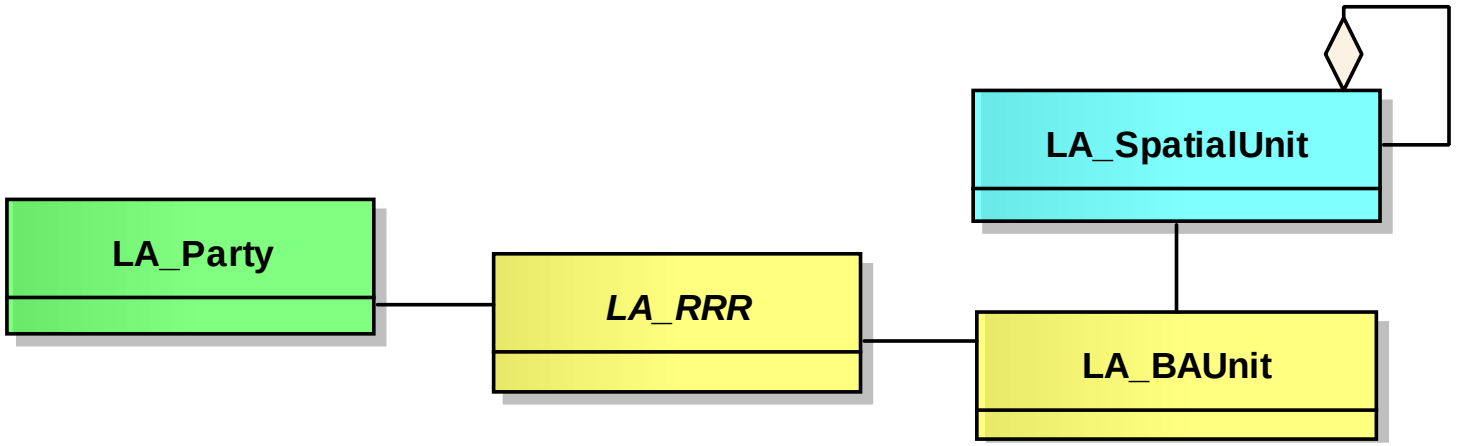
ISO 19152 core in action
Land Administration Domain Model

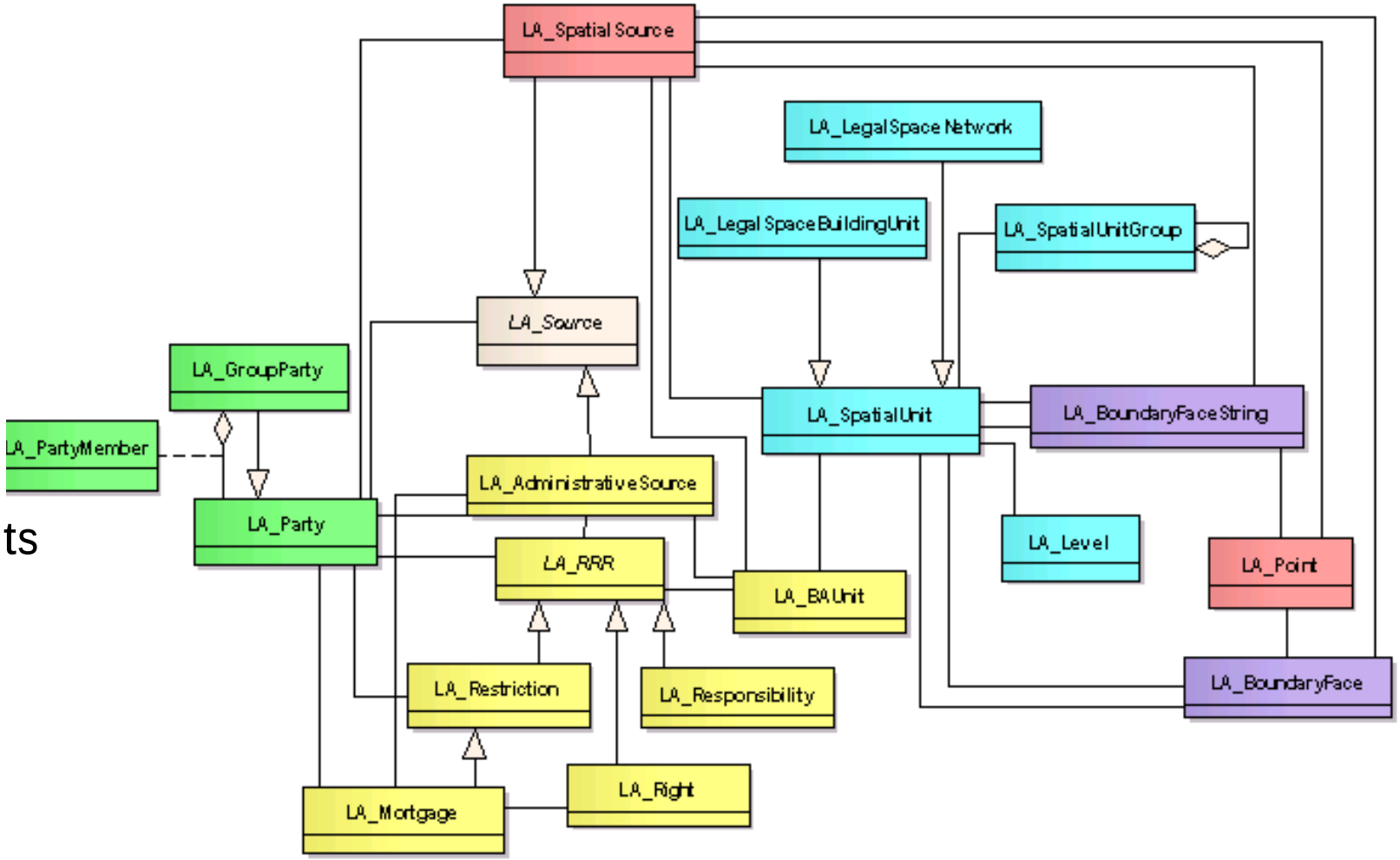
- *LA_Party* Peter has *LA_RRR* ownership on *LA_BAUnit* Peter's estate consisting of 2 *LA_SpatialUnit* parcels (with same LA_RRR)

- LA_BAUnit stands for Basic Administrative Unit



LADM Diagram

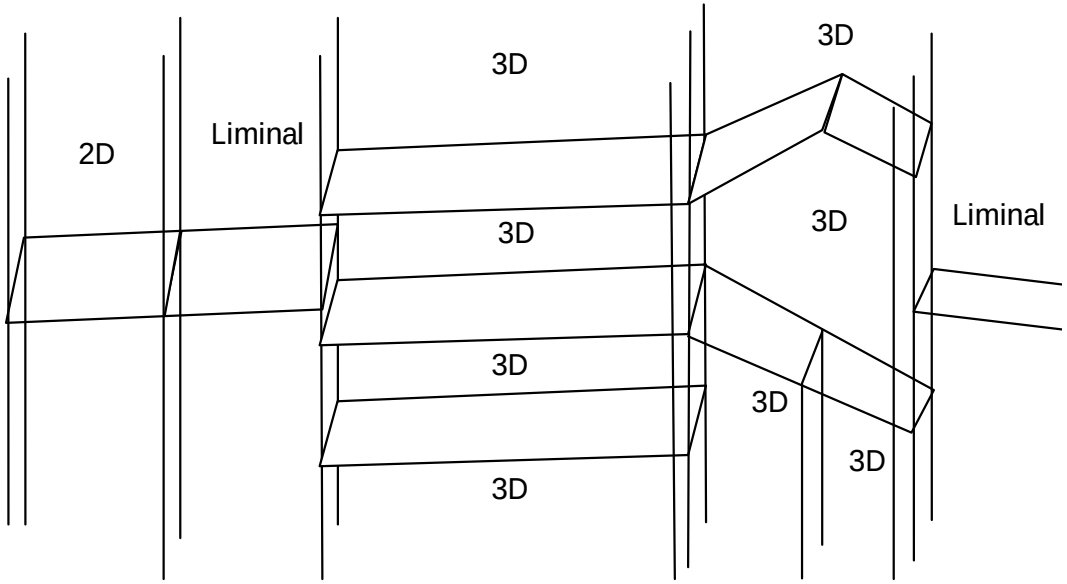
- Parties
  → green
- RRRs
  → yellow
- Spatial Units
  → blue
- Surveying
  → pink
- Mapping
  → violet

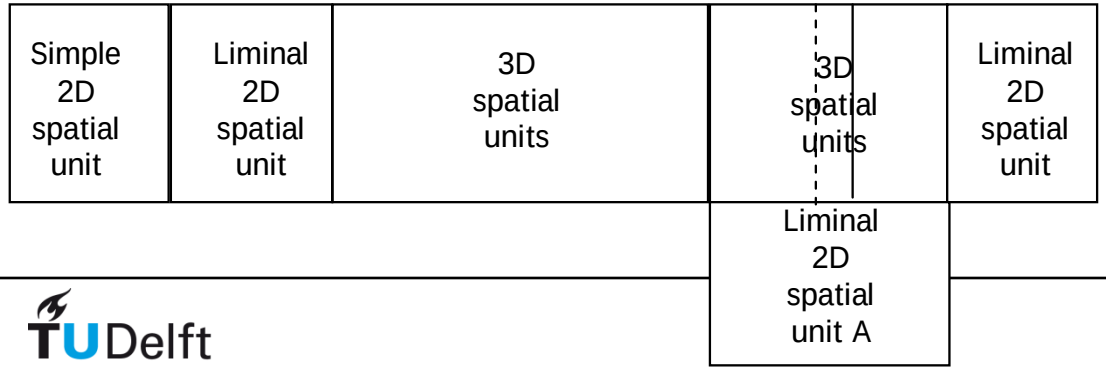


RRR supports all land rights

2D and 3D Integration

- between 2D and 3D spatial unit transition via *liminal* spatial units



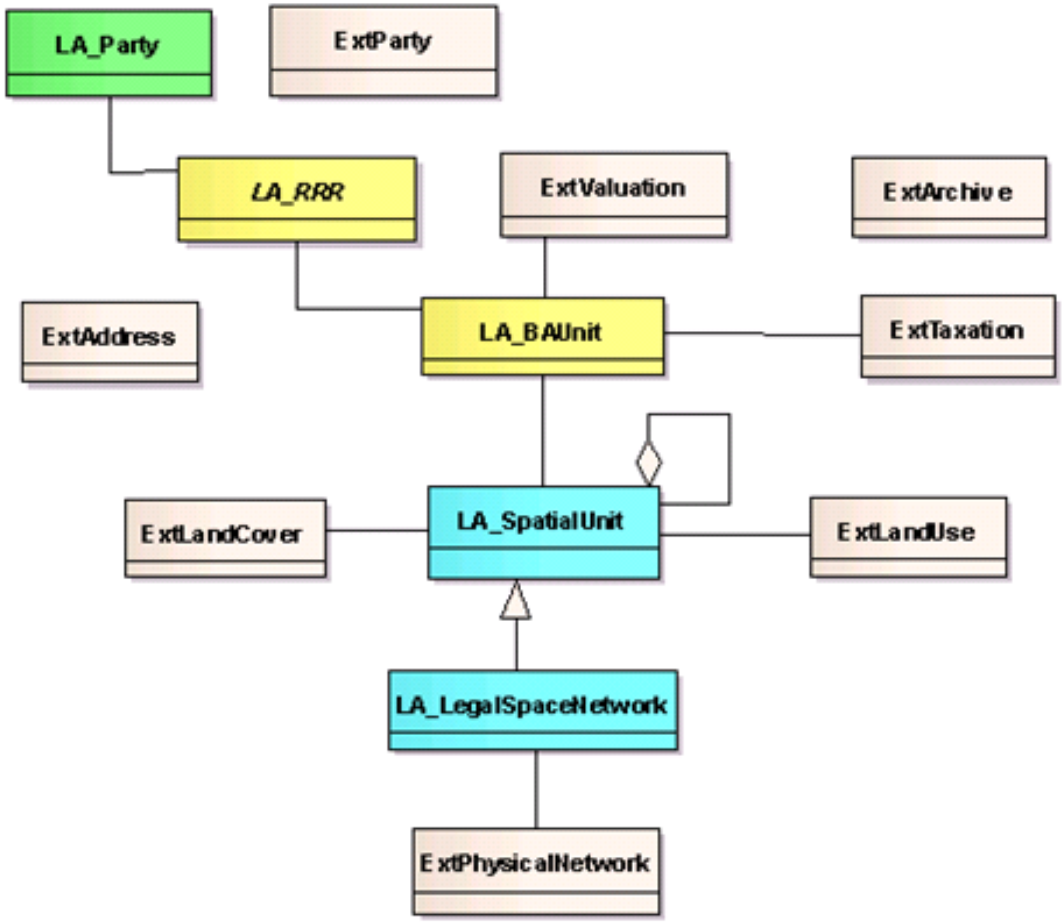


- Liminal spatial units are 2D parcels, but are stored as 3D parcels

- Liminal spatial units are delimited by a combination of LA_BoundaryFace and LA_BoundaryFaceString objects

LADM and external classes

- Determine scope LA
- Apply SDI thinking
- Link to external registrations:
  - Address
  - Party (person)
  - Valuation
  - Taxation
  - LandCover
  - LandUse
  - PhysicalNetwork (utility)
  - ...



Spatial Information Infrastructure

- Standards needed as users are at unknown distance
  → ISO LADM (and CEN)
- Network of related information sources, blueprints for
  → Address, Building, Party, Taxation, Valuation, Network, LandUse,..
- Remote users might need/refer to historic version
  → All object classes need to be versioned objects

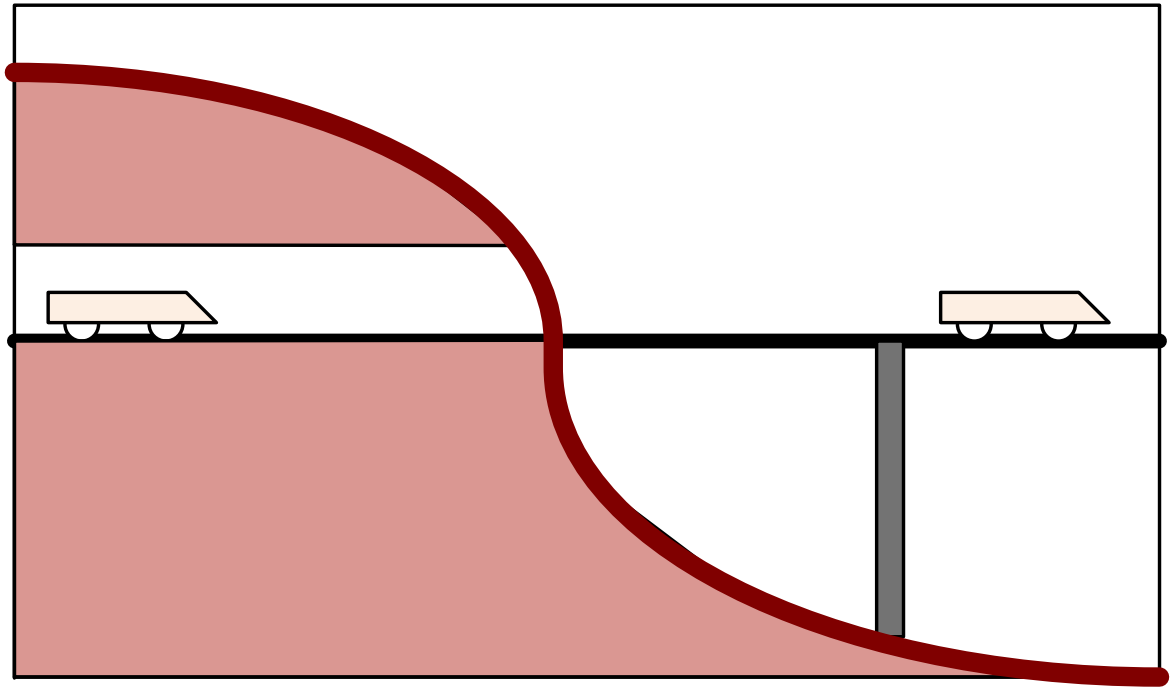
- Maintain consistency: subscription on update warnings
- Legal counterparts of physical objects
- Information assurance (contracts)

- In LADM, external classes as *<<blueprint>>* and expected to be defined in more detail elsewhere (other standard)

SDI for other reference data

- Terrain elevation (earth surface) not part of land administration
- Via SDI this data may be obtained in order to be able if a 3D parcel is above, below the surface (or both)

- In 3D Cadastre: absolute coords (additional option relative coords)
- 3D Parcel does not change when Earth surface changes!



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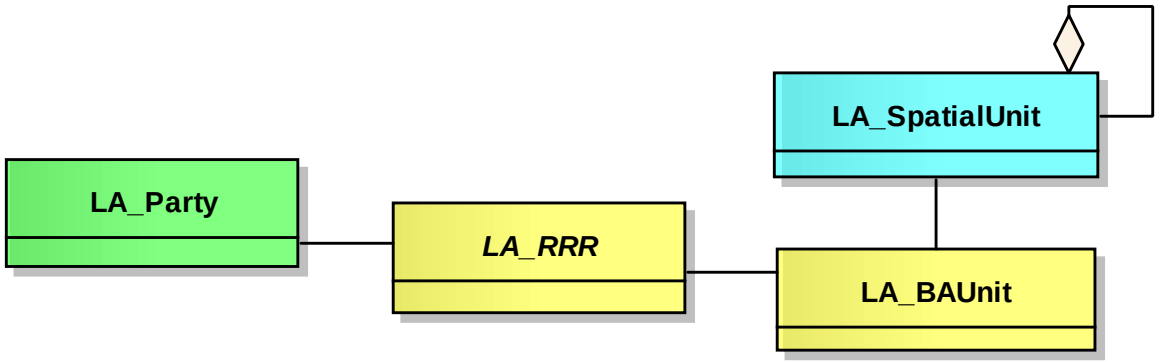
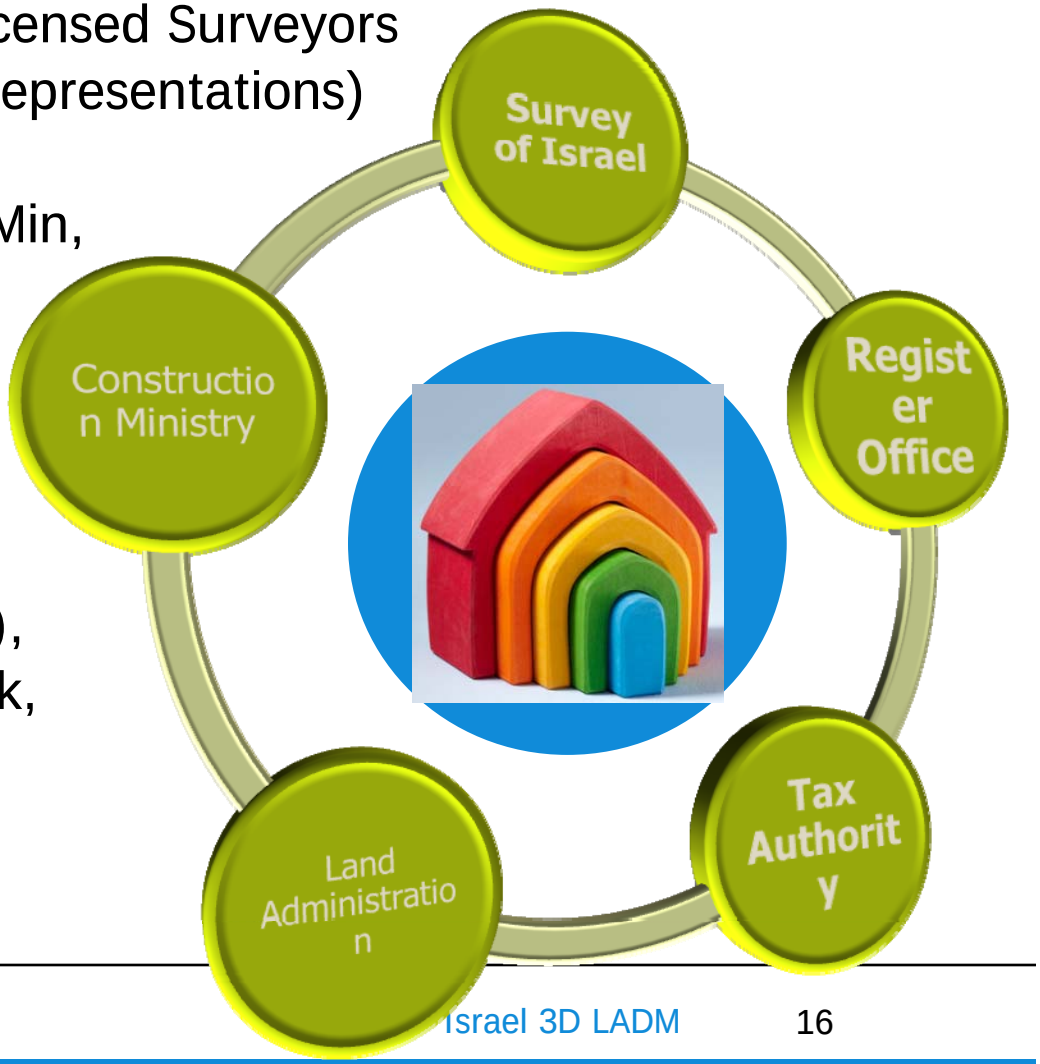


Introduce Israel 3D LADM

- Design, develop and test a complete LADM country profile for 2D and 3D cadastral registration system in Israel
- Partly based on the existing Israel LA system and new developments inspired by the LADM standard
- Attempt to cover all Israel LA related information in the model → data maintained by different organizations
- Several novel aspects for the Israel LA may be introduced: 3D, integrated history, link to sources, link spatial-legal, BAUnit concept, topology, quality ISO 19115, unique id's all data, ...

Towards an Israel SDI approach meaningful exchange

1. Survey of Israel (SOI) + Licensed Surveyors (LSs, creating new 2D/3D representations)
2. Land Registry (LR, Justice Min, register apartments in 3D)
3. Israel Land Authority (ILA, 93% Israel government)
4. Others: Interior Min (plans), Construction Min, Tax, Bank, Municipalities,..



Scope of Israel 3D Cadastre, checklist of FIG 3D Cadastre WG

- What are the types of 3D cadastral objects?
  → *Both a. related to (future) constructions (buildings, pipelines, tunnels, etc.), and b. any part of 3D space (airspace, subsurface)*

- 3D Parcels also for simple apartments/ condominium buildings?
  → *Not in short term (use 2D floor plans), May be in longer term*

- 3D Parcels for infrastructure objects, such as long tunnels, pipelines, cables: divided by surface parcels or single object?
  → *Only divided by blocks (so join subparcels in block)*

- For representation of 3D parcel, has legal space own geometry or specified by referencing to existing topographic objects
  → *Own geometry*

IL_LADM Country Profile

- Israel country profile based on inheriting LADM classes
- 'IL_' is the prefix for the Israel country profile, covering both the spatial and administrative parts
- Classes in IL_LADM model are derived directly or indirectly from LADM classes (and may be extended with new attributes or even new classes when needed)

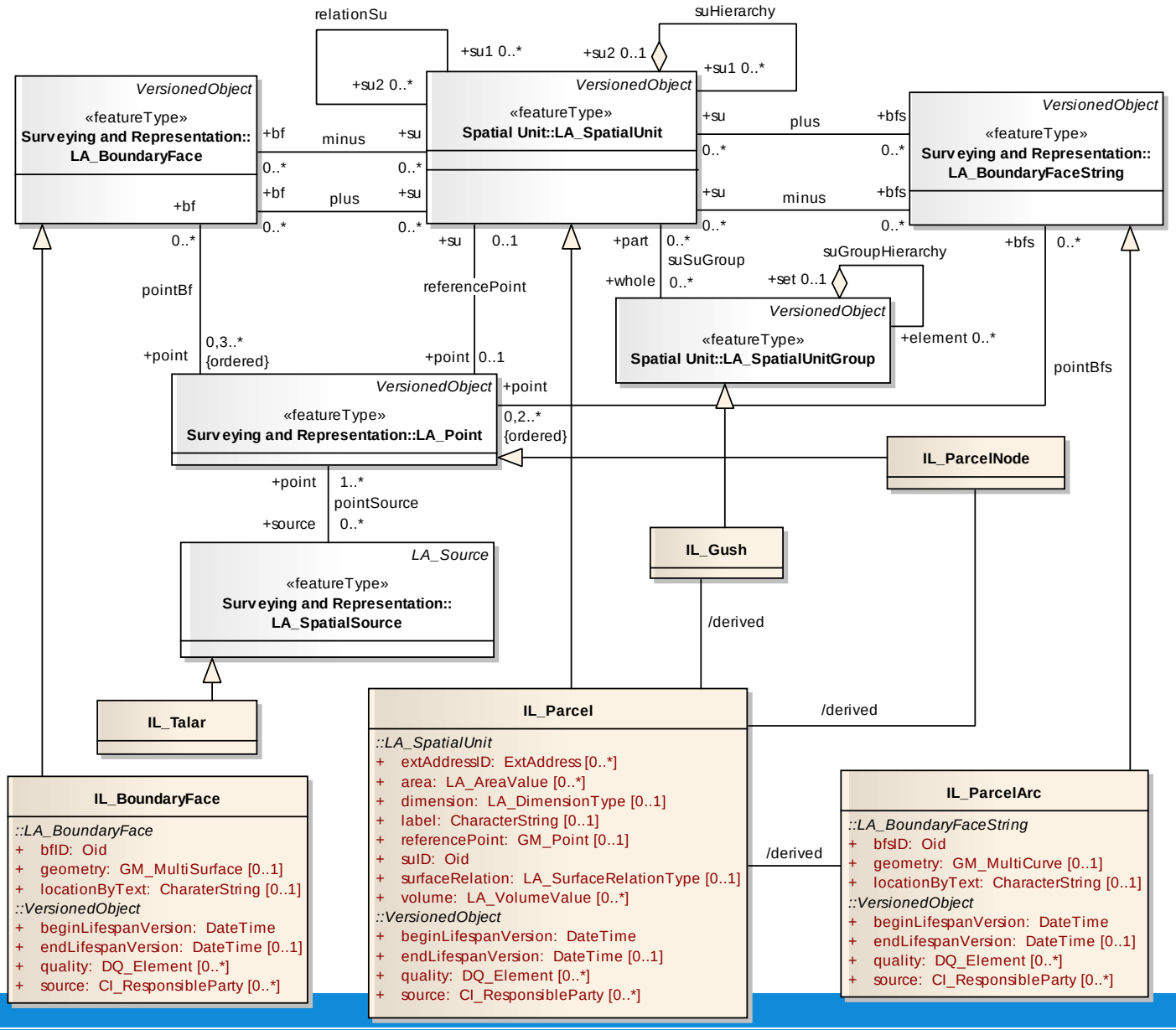
Initial mapping between the key concepts of BNKL and LADM

BNKL	**LADM**	**remark**
Gush	LA_SpatialUnitGroup	
Parcel	LA_SpatialUnit	
Parcel_arc	LA_BoundaryFaceString	
	LA_BoundaryFace	No 3D currently in BNKL
Parcel_node	LA_Point	
Talar	LA_SpatialSource	
	LA_BAUnit	Not explicit in BNKL
	LA_RRR	In scope of Land Registry
	LA_AdministrativeSource	In scope of Land Registry
	LA_Party	In scope of Land Registry

IL_LADM Country Profile (administrative part)

- Administrative part of Israel LADM country profile with data from various organizations (SOI, LR, ILA,..)
- To be developed...

IL_LADM Country Profile (spatial part, very first draft…)



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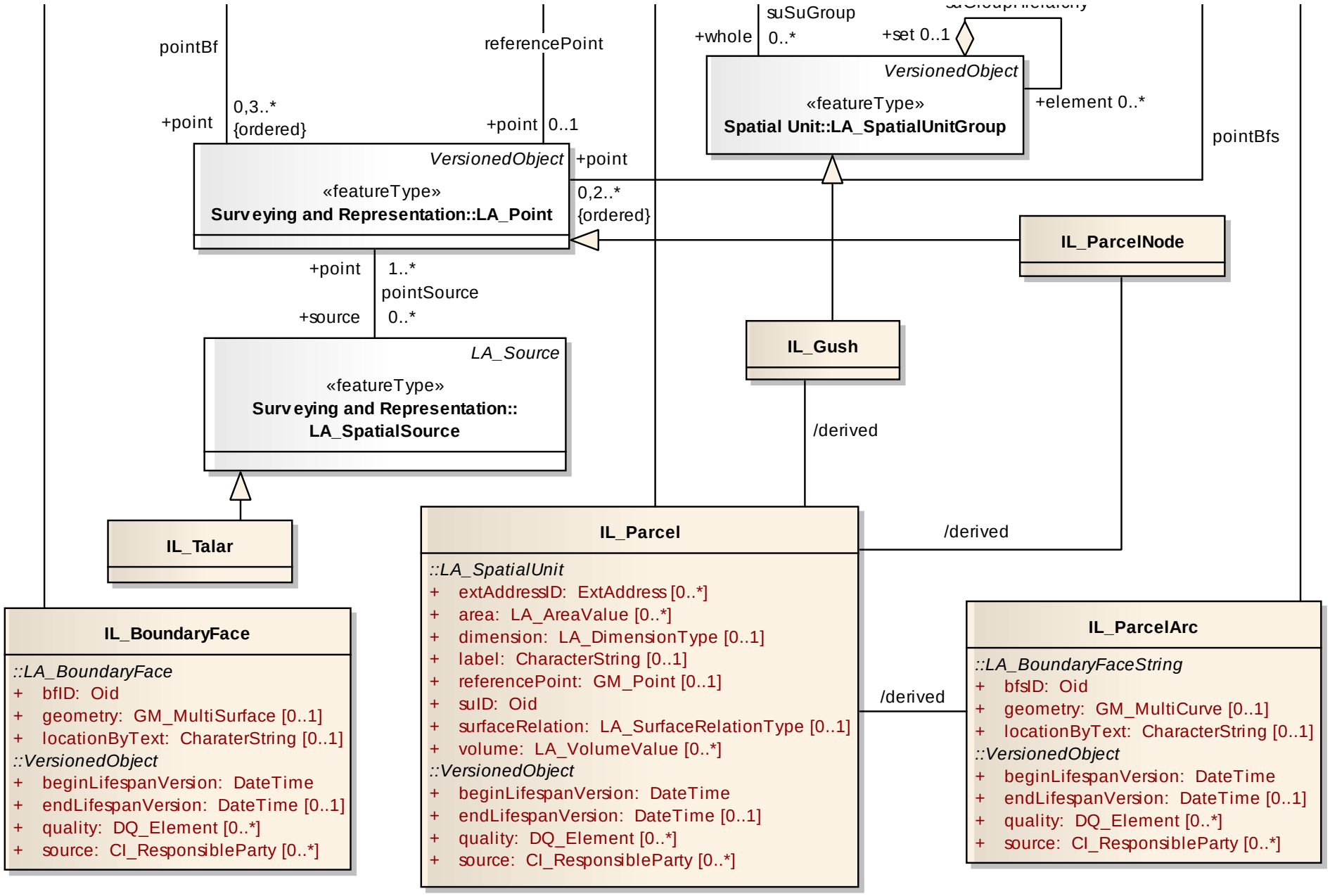
pointBf
referencePoint
suSuGroup
+whole
0..*
+set 0..1
VersionedObject
«featureType»
Spatial Unit::LA_SpatialUnitGroup
+element 0..*
+point
0,3..*
{ordered}
+point
0..1
VersionedObject
«featureType»
Surveying and Representation::LA_Point
+point
0,2..*
{ordered}
pointBfs
IL_ParcelNode
+point
1..*
pointSource
+source
0..*
LA_Source
«featureType»
Surveying and Representation::
LA_SpatialSource
IL_Gush
/derived
IL_Talar
IL_Parcel
/derived
::LA_SpatialUnit
+ extAddressID: ExtAddress [0..*]
+ area: LA_AreaValue [0..*]
+ dimension: LA_DimensionType [0..1]
+ label: CharacterString [0..1]
+ referencePoint: GM_Point [0..1]
+ suID: Oid
+ surfaceRelation: LA_SurfaceRelationType [0..1]
+ volume: LA_VolumeValue [0..*]
::VersionedObject
+ beginLifespanVersion: DateTime
+ endLifespanVersion: DateTime [0..1]
+ quality: DQ_Element [0..*]
+ source: CI_ResponsibleParty [0..*]
IL_BoundaryFace
::LA_BoundaryFace
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+ geometry: GM_MultiSurface [0..1]
+ locationByText: CharaterString [0..1]
::VersionedObject
+ beginLifespanVersion: DateTime
+ endLifespanVersion: DateTime [0..1]
+ quality: DQ_Element [0..*]
+ source: CI_ResponsibleParty [0..*]
/derived
IL_ParcelArc
::LA_BoundaryFaceString
+ bfsID: Oid
+ geometry: GM_MultiCurve [0..1]
+ locationByText: CharacterString [0..1]
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+ beginLifespanVersion: DateTime
+ endLifespanVersion: DateTime [0..1]
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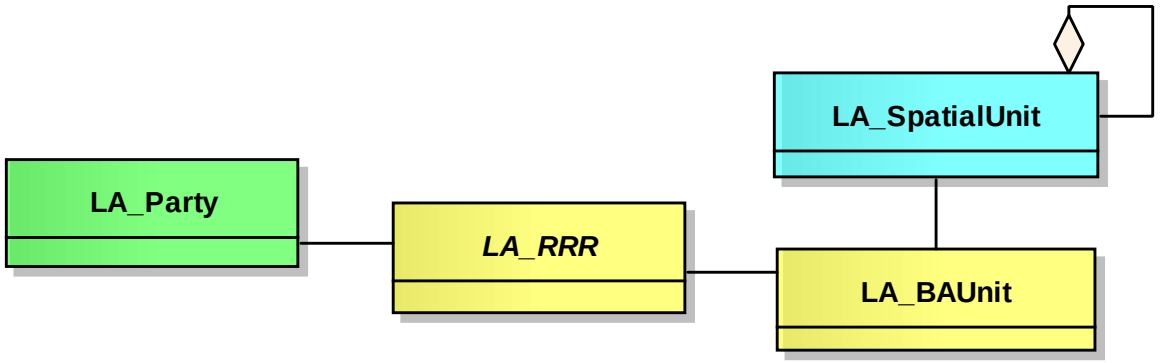
LADM Country Profile (more model considerations)

- All information in the system should originate from source documents
- In case of spatial source documents; i.e. subdivision/mutation plans (TALAR) there are links with spatial unit and point tables
- In case of administrative source documents (i.e titles) there are associations with RRRs (incl. mortgage) and BAUnit
- Unique identifier for all objects in model (not only parcels) →crucial for SDI (links with LR, ILA)

LADM Country Profile (even more model considerations)

- There may be cases (in the future) where one BAUnit (with same RRRs attached) has multiple Spatial Units
- To make the model comprehensive and future proof, a range of spatial units is supported: 2D and 3D
- Various types of spatial units may be organized in levels, e.g.:
  1. Base layer with parcels
  2. Apartment right
  3. Utilities, tunnels, pipelines, etc.
  4. Other 3D subparcels (joined)

Contents



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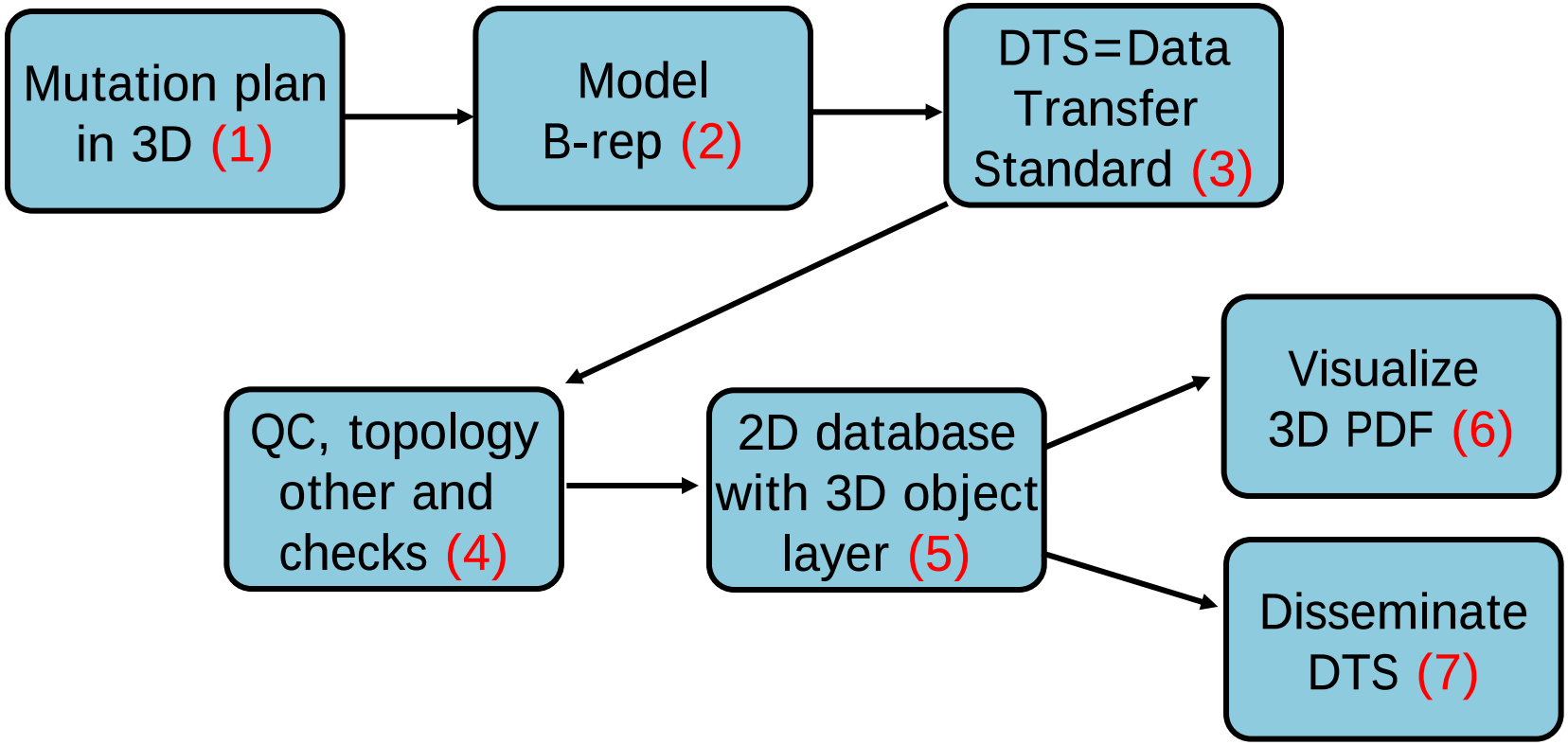
Technical model: basis for implementation

Consider the whole 3D Cadastre processing chain:



3D Data sources: survey (or design?) → create 3D geometry (1+2)

- Direct survey in 3D, might be challenging, e.g. how to survey a subsurface object or an airspace object?
  Experience from Queensland, Australia shows that a lot of the submitted 'survey plans' do seam to have a CAD origin...

- For existing physical objects with legal spaces attached:
  1. Upgrade existing 2D floor plans to 3D volumes:
     manual initially, in the future more automation
  2. If no plans available, then do a survey. Laser scan based measurement may be more effective than Tachymeter

- New buildings designed (CAD) direct in 3D, with limited additional effort (and clear guidelines) result in 3D cadastral objects → *complete development workflow chain*

3D Solid CityGML with LADM extension: DTS from Russian prototype (3)

```
<?xml version="1.0" encoding="utf-8"?>
<CityModel xmlns="http://www.opengis.net/citygml/1.0"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns:xlink="http://www.w3.org/1999/xlink"
 xmlns:generic="http://www.opengis.net/citygml/generics/1.0"
 xmlns:gml="http://www.opengis.net/gml"
 xsi:schemaLocation="http://www.citygml.org/citygml/1/0/0
http://schemas.opengis.net/citygml/1.0/cityGMLBase.xsd
http://www.opengis.net/citygml/generics/1.0
http://schemas.opengis.net/citygml/generics/1.0/generics.xsd">
 <gml:name>TU Delft example 3D Parcel for Cadastre</gml:name>
 <gml:boundedBy>
   <gml:Envelope srsDimension="3" srsName="urn:ogc:def:crs:EPSG:7.6:7415">
   <gml:lowerCorner srsDimension="3">84936.169 444962.883 0.0 </gml:lowerCorner>
   <gml:upperCorner srsDimension="3">86082.217 446807.742 90.0 </gml:upperCorner>
  </gml:Envelope>
 </gml:boundedBy>
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  <generic:GenericCityObject gml:id="Parcel_1">
   <creationDate>2011-04-01</creationDate>
   <generic:class>LA_LegalSpaceBuildingUnit</generic:class>
   <generic:lod4Geometry>
    <gml:Solid>
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       <gml:surfaceMember>
        <gml:Polygon>
         <gml:exterior>
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           <gml:pos>85511.709 445170.399 0.0</gml:pos>
           <gml:pos>85510.892 445172.368 0.0</gml:pos>
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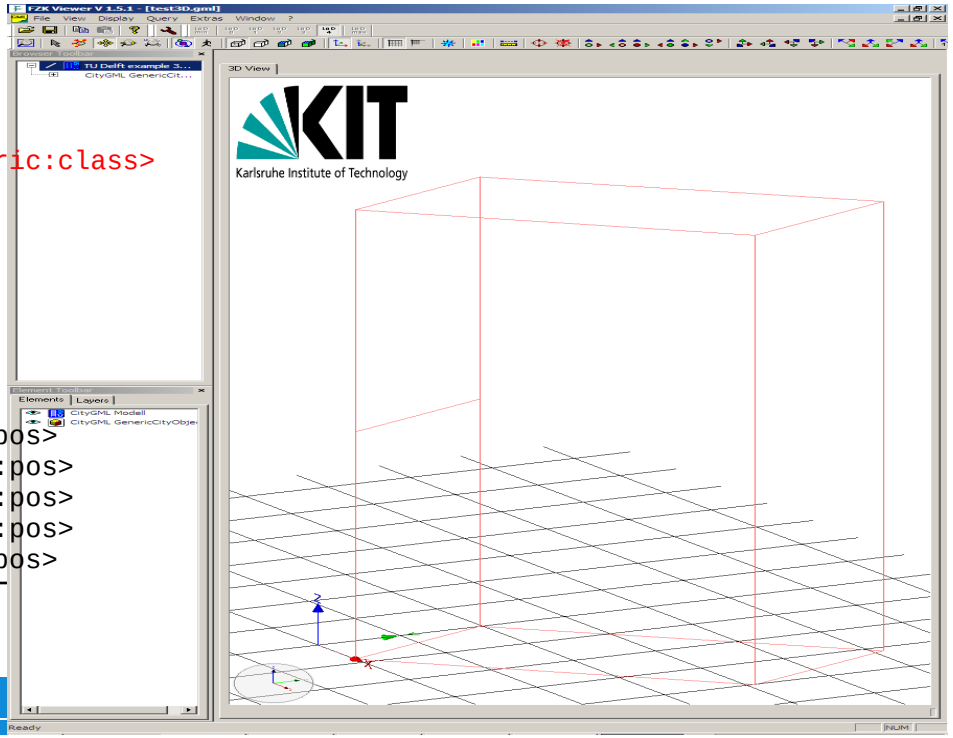

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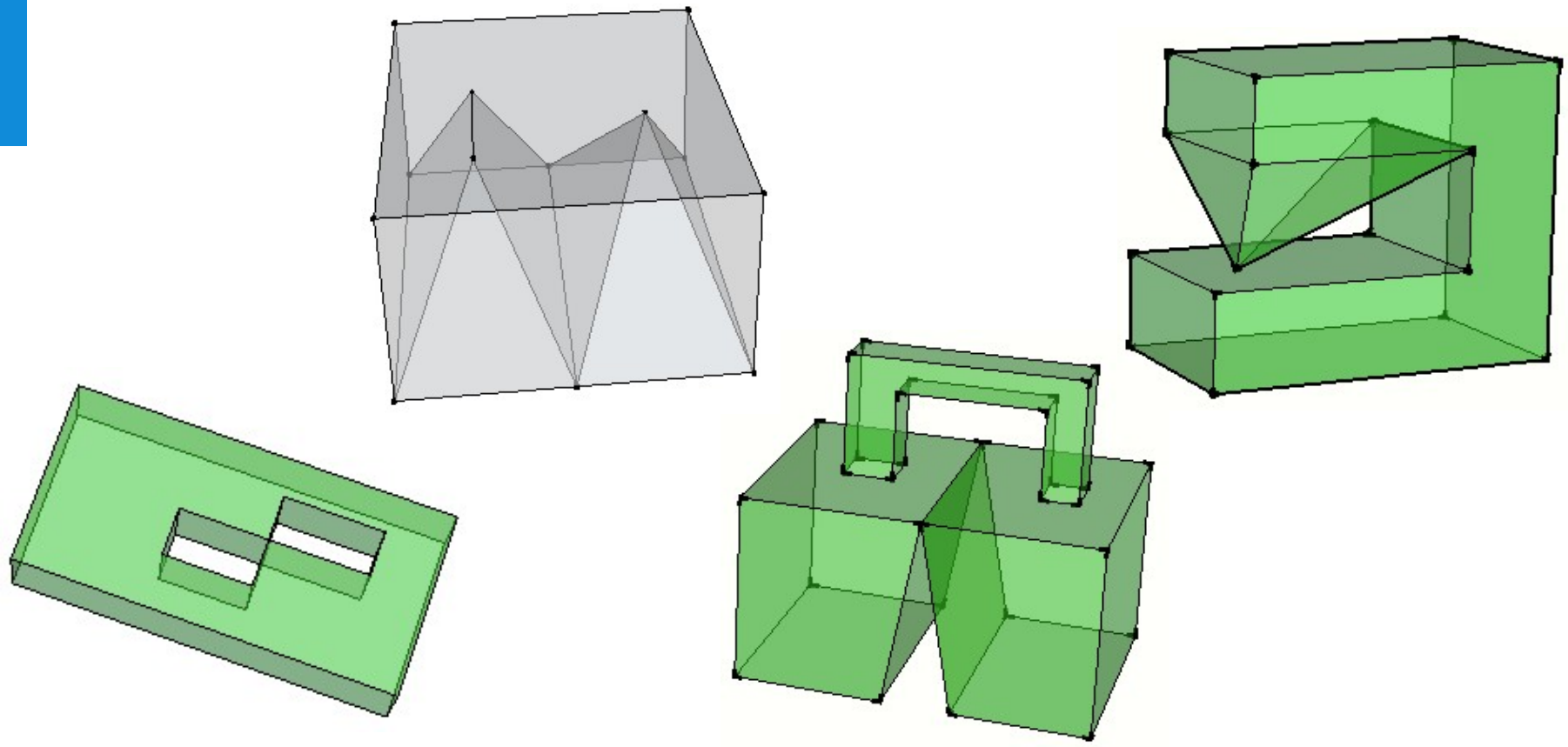
Automated quality check: data complete, topology ok, etc. (4)

- Automated checking, nice example (20 years experience): Sudarshan Karki, Rod Thompson and Kevin McDougall *Development of validation rules to support digital lodgement of 3D cadastral plans.* In: CEUS, Vol. 37, 2013, 12 p. (note submission via ePlan, data encoded in LandXML)

- *Queensland Land Title Act, 1994* specifies 2 methods for defining 3D cadastral objects:
  1. Building Format Plans ('2D' floor plans for the different levels) and
  2. Volumetric Format Plans (true 3D geometric description)

- In addition to the Land Title Act there are directions specifying details for the submission of survey/mutation plans: *Registrar of Titles Directions for Preparation of Plans*, Section 10

Non trivial 3D quality check (4): Valid, but non 2-manifold 3D Parcels

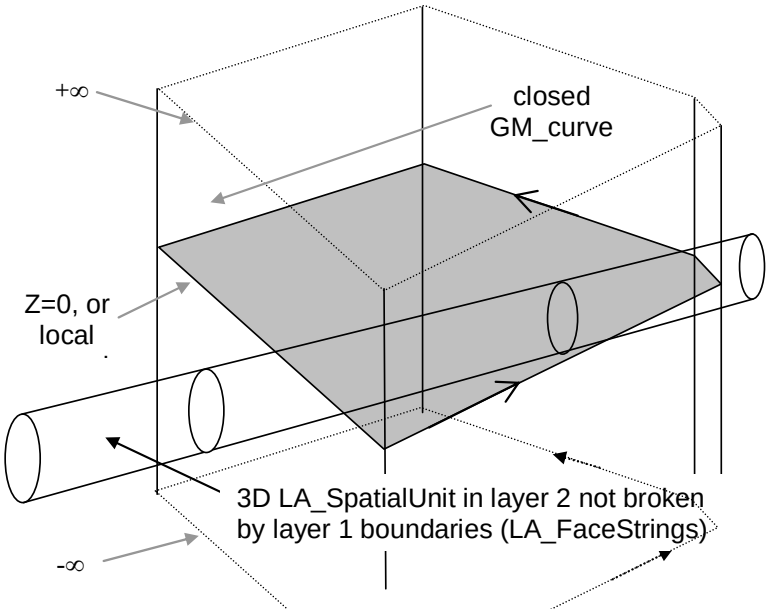


Single object correctness rule: *interior connected*

Illustrations by Shen Ying (Wuhan University, visiting TU Delft)

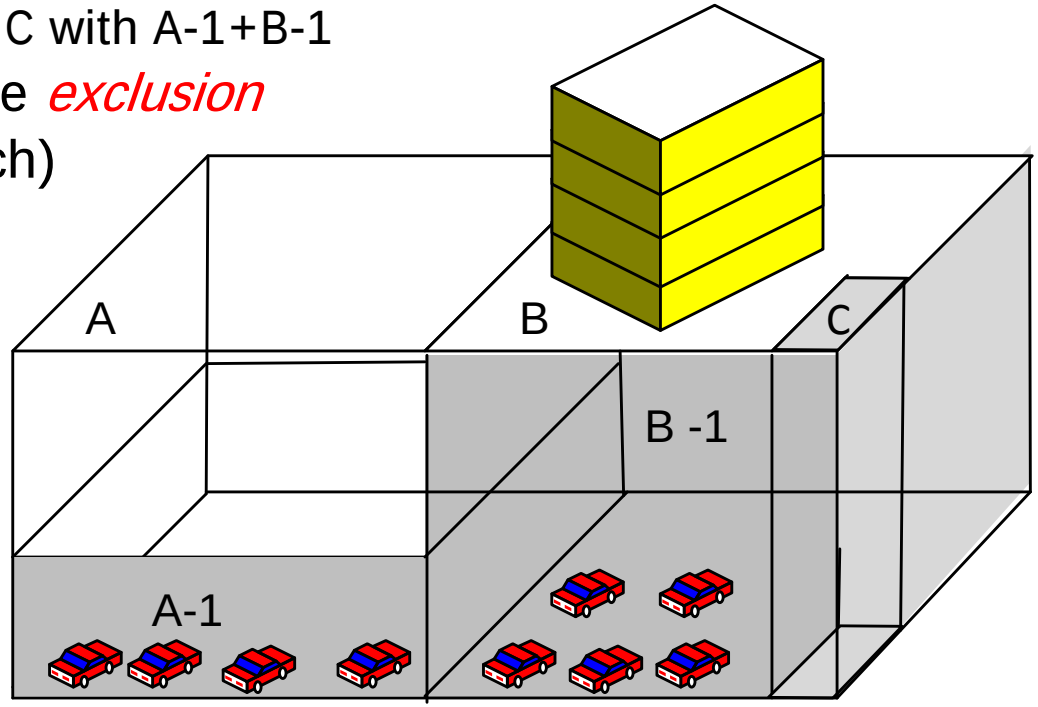
Existing 2D database extended with 3D LA_Level (5)

- LA_Level organization based on content or structure:
  - example 1, content-based: one layer with 'primary' (strongest) rights, another layer with rights that can be added/subtracted (e.g. restrictions)
  - example 2, structure-based: one layer with topologically structured parcels (one part of the country), another layer with (unstructured) line based parcels (other part of country)
- can also be used in 3D context: one layer 'normal' parcels, another layer with subtracted 3D parcels
- Note: again quality checks at database level, just to be sure (4)

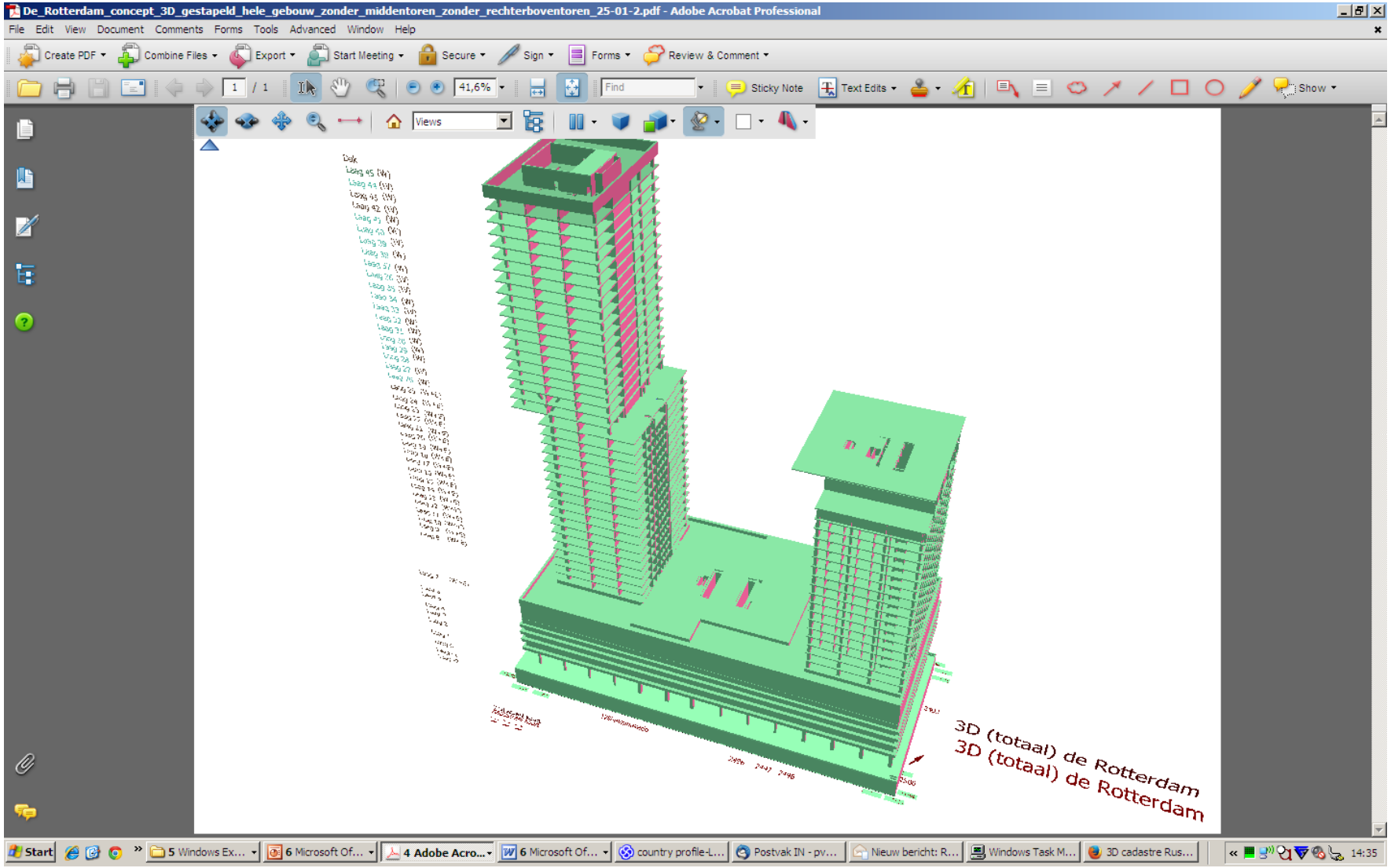


3D case: parking below 2 other parcels (5)

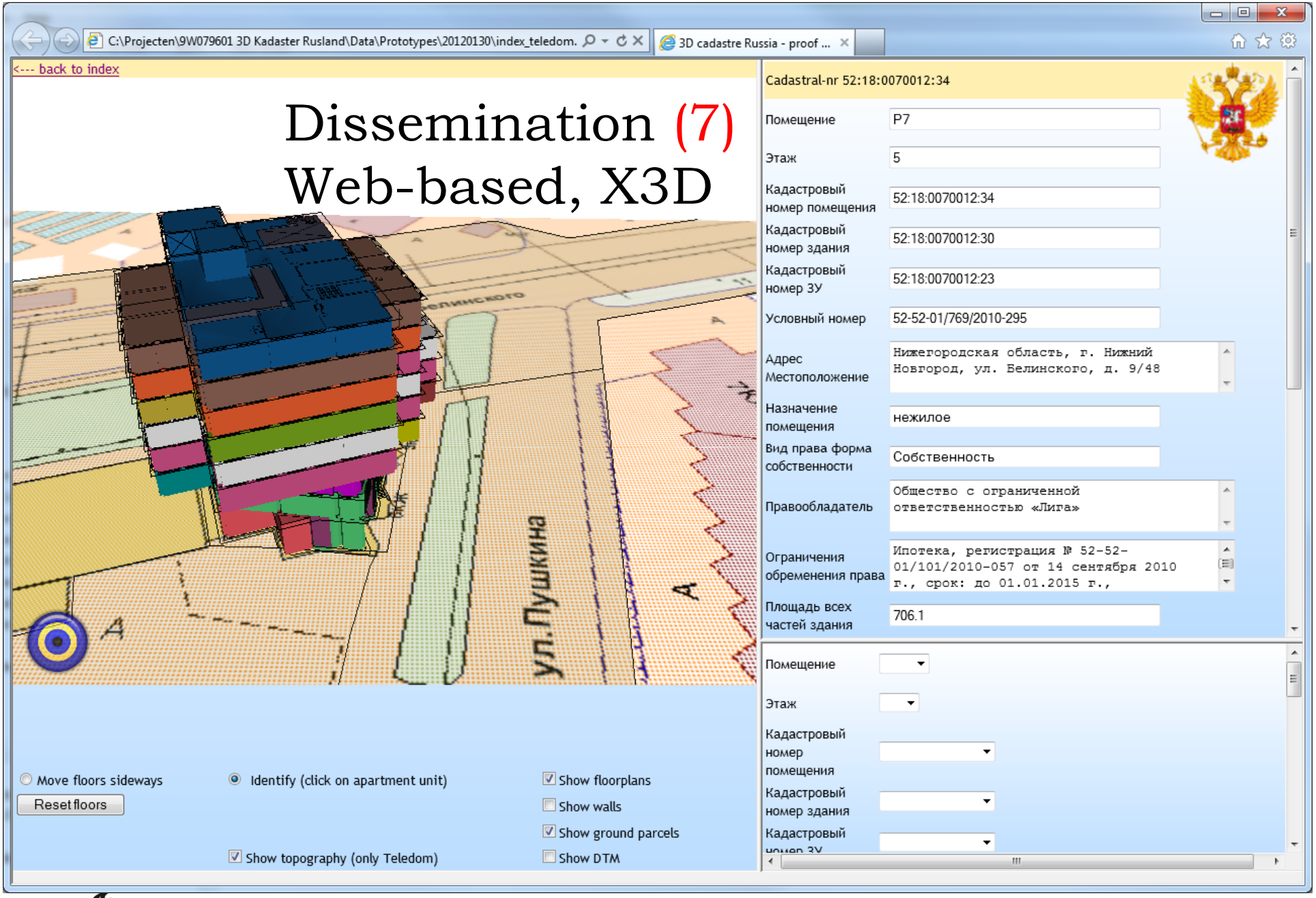
- There are different ways to in LADM to model 3D parcels
- With LA_Level approach the illustrated case could be modeled
  - 3 parcels (A, B, C) in 2D parcel level, implying 3D columns
  - 1 parcel (A-1+B-1) in 3D parcel level
  - LA_BAUnit to combine C with A-1+B-1
- A and B 3D column have *exclusion* (from LA_Level approach)
- C has *extension* (via LA_BAUnit)



3D PDF, NL example (6)



Dissemination (7)
Web-based, X3D



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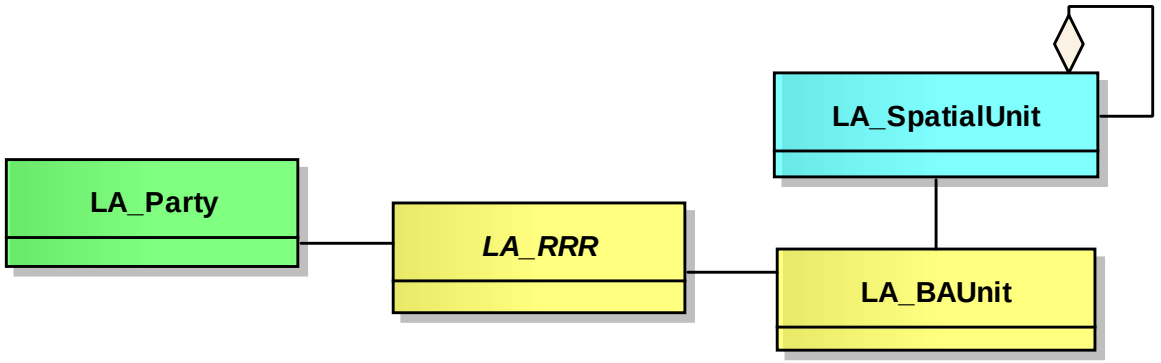

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Conclusion

- The development of draft Israel LADM country profile needs to be a national activity (with one initiating organization: SOI)
- Conversion of conceptual model to technical model: from UML diagram, to database tables SQL DDL scripts for data storage or XML (LandXML → InfraGML, CityGML, BIM) for exchange format
- Develop regulations/formats for digital 3D mutation plans
- Consider complete development life cycle of rural+urban areas all related to cadastral registration (Parties, RRRs, Spatial Units) and more and more these will involve 3D descriptions.
- Creating appropriate web-interface for SOI/LR/ILA data access

Intention more than 3D Cadastre
…full life cycle in 3D

Involved steps (order differs per country):

1. Develop and register zoning plans in 3D
2. Register (public law) restrictions in 3D
3. Design new spatial units/objects in 3D
4. Acquire appropriate land/space in 3D
5. Request and provide (after check) permits in 3D
6. Obtain and register financing (mortgage) for future objects in 3D
7. Survey and measure spatial units/objects (after construction) in 3D
8. Submit associated rights (RR)/parties and their spatial units in 3D
9. Validate and check submitted data (and register if accepted) in 3D
10. Store and analyze the spatial units in 3D
11. Disseminate, visualize and use the spatial units in 3D