Initial design of an LADM-based 3D Cadastre Case study from Korea

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1.1 Background

- Cadastre Reform Project started in this year in Korea.
- 3D cadastre will be implemented nation-wide.
- LADM is in stage of final approval.
- Co-operation between Korea and The Netherlands started.
  - A joint research and development (R&D) project related to the realization of 3D cadastre is the main focus of this international co-operation.

- Korean side
  - Korea Cadastral Survey Corporation (KCSC)
  - University of Seoul, Dep. of Geo-informatics
- Netherlands side
  - Kadaster
  - Delft University of Technology
  - University of Twente (ITC)

5 persons signed a MOU in April 2012

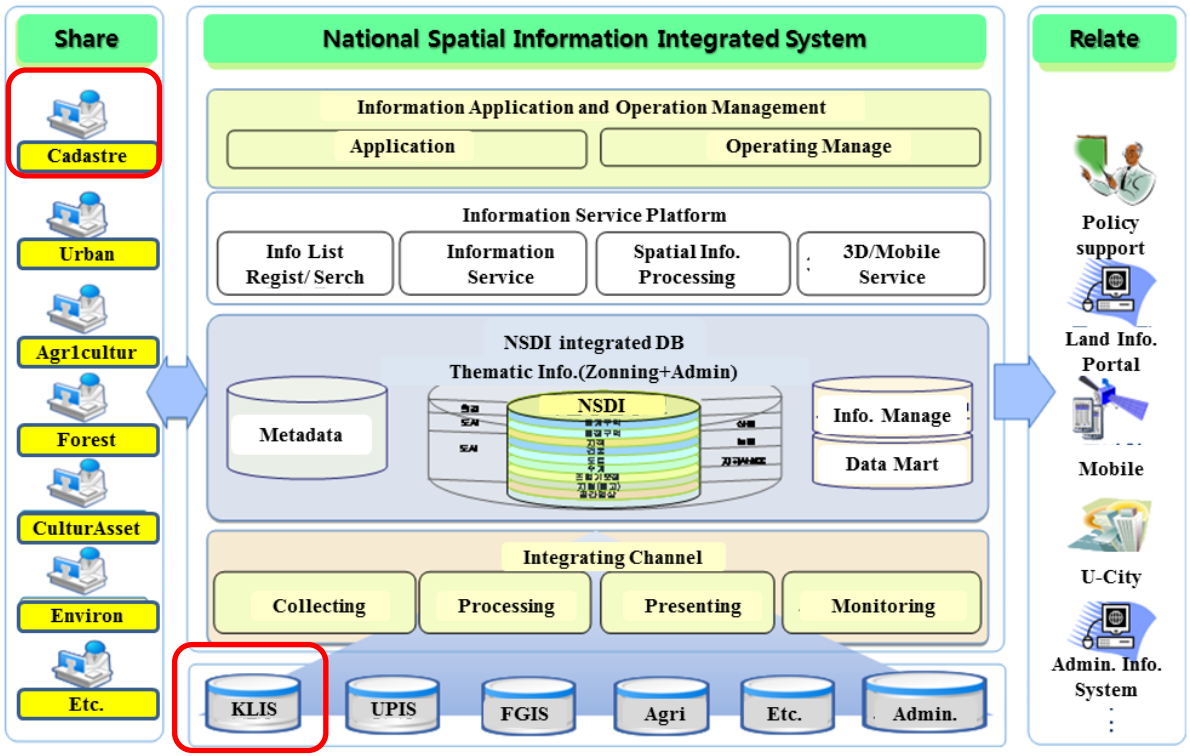
1.2 Objectives

We wish to seek the 3D cadastre implementation direction that aligns the implementation of this international standard with the results of research and the pilot projects in Korea.

- **SDI of Korea is briefly introduced**. And the status of legal development and the institutional improvement to achieve a 3D cadastre is discussed
- **Introduces the LADM**, with a focus to 3D cadastral functionality and requirement related to working within an information infrastructure
- **Proposes alignment between LADM and the development of a 3D cadastre in Korea** based on the experiences and functional requirements derived from the pilot project.

2.1 Cadastre in the SDI(1)

- Korean government is building the SDI since 2001 and **integrating the information scattered over many organization.**
- Korea Land Information System(KLIS) is connected to the NSIIS.



*Functionality of **National Spatial Information Integrated System** of Korea.*

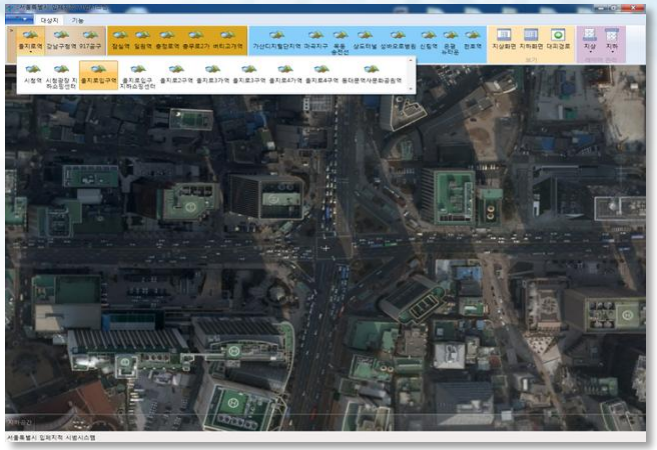
2.1 Cadastre in the SDI(2)

- The government is embedding various types of spatial information (including SDI) into the **NSIOP to service via the 3D Web** environment.
- 2D cadastral boundary(yellow line) will be changed to 3D in the near future.

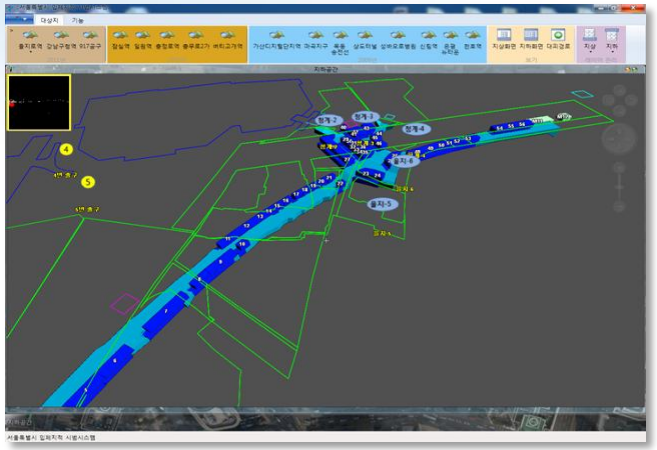
3D Web service of the ***National Spatial Information Open Platform*** *(http://www.vworld.kr)*

2.2 Results of the Pilot project(1)

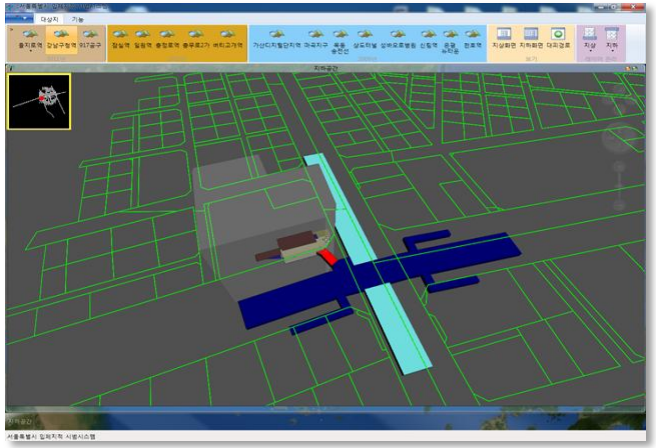
- 3D Cadastral pilot system was constructed for several sites.



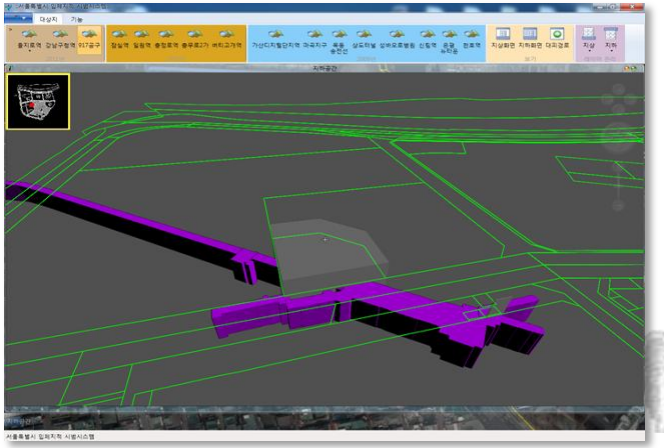
Aerial Photo



Underground Shopping mall



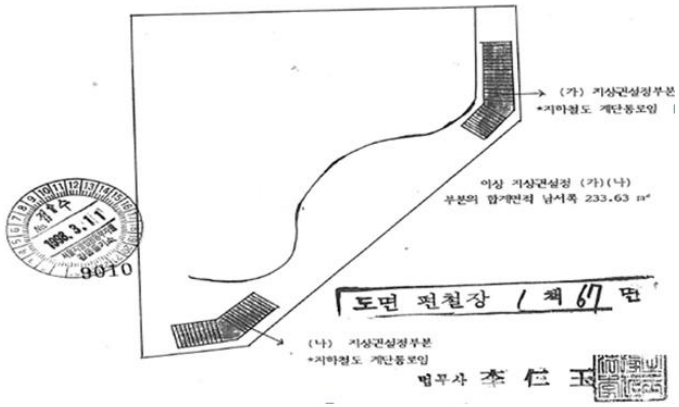
Subway Stations



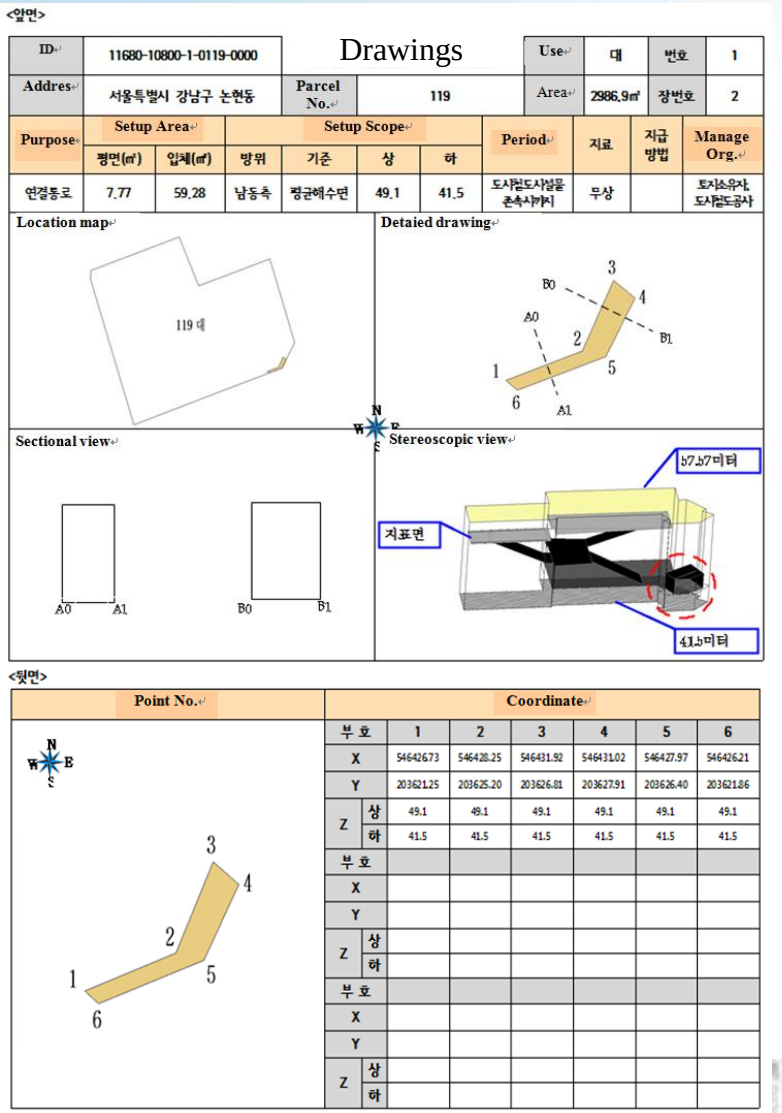
Subway station & pathway

2.2 Results of the Pilot project(2)

- Seoul government has delivered the **'Task guideline for the condominium leasehold right'**.
- The objective of this guideline is to **clarify ownership** – and use rights for a systematic and efficient **management of the underground public facilities** – based on accurate surveying of their 3D location.



Current Drawing for the Condominium leasehold right registration

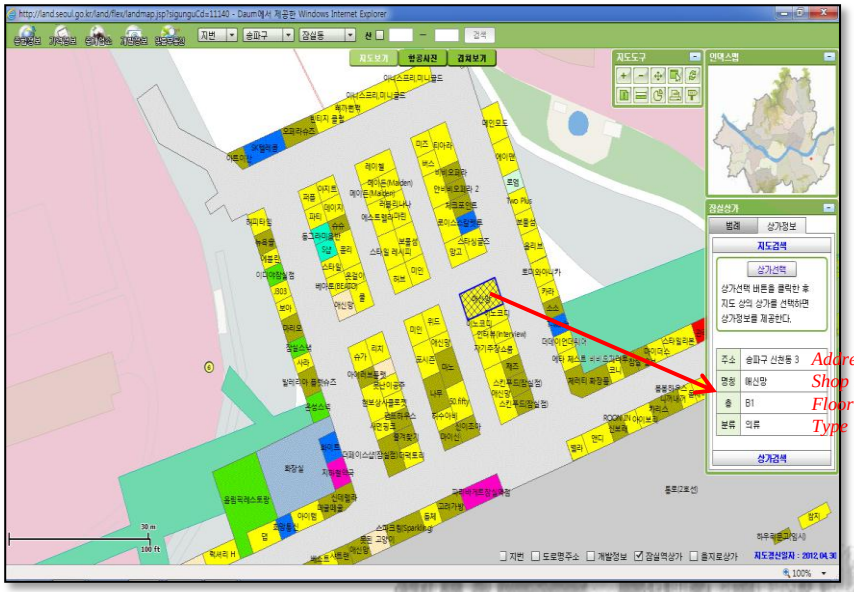


New Drawings

2.2 Results of the Pilot project(3)

- Seoul Government expects to manage underground shopping centers more efficiently.
- Seoul added the **underground shopping center information** collected from the Uljiro Station during the pilot project
- **Real Estate Portal of Seoul** (http://land.seoul.go.kr) provide attributes like address, name, toilets, exit gate number etc.

Underground shopping center



Information of each shop

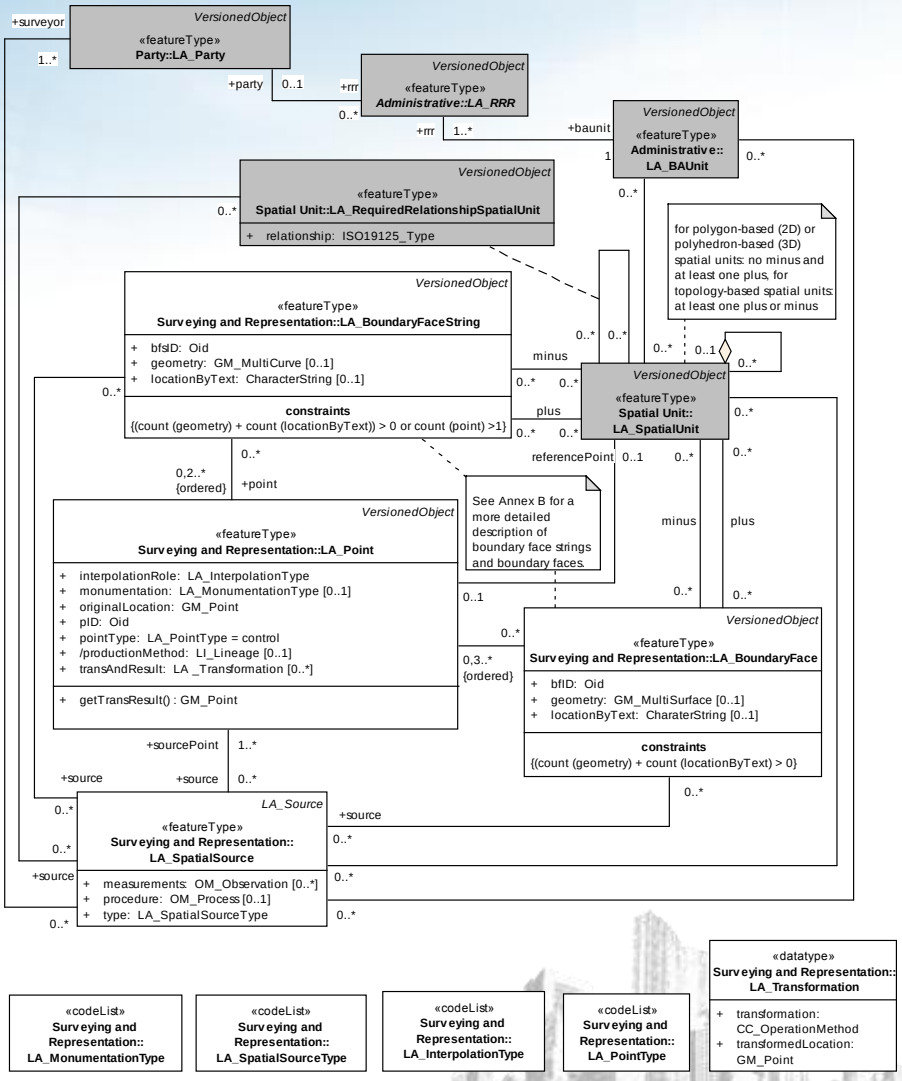
2.3 Cadastral Reform Project Law

- The cadastre reform project is a long-term national project which will run until the year 2030 and will involve approximately **38 million land parcels** being resurveyed.
- **3D spatial data will be constructed as a part of the reform project** aiming at the establishment of the Korean 3D cadastre.
- New cadastral registration items are defined in the enforcing rules(No.14, Article 13) of the **Cadastral Reform Project Law**.

- **Article 10 the Law** : the collection of parcel information (i.e. items of the new cadastre registration book) could be conducted in parallel to the cadastral resurvey.
- **Article 4 of the enforcing rules** : defines the 'formation sheet to collect parcel information'.

3.1 3D Aspects in the LADM(1)

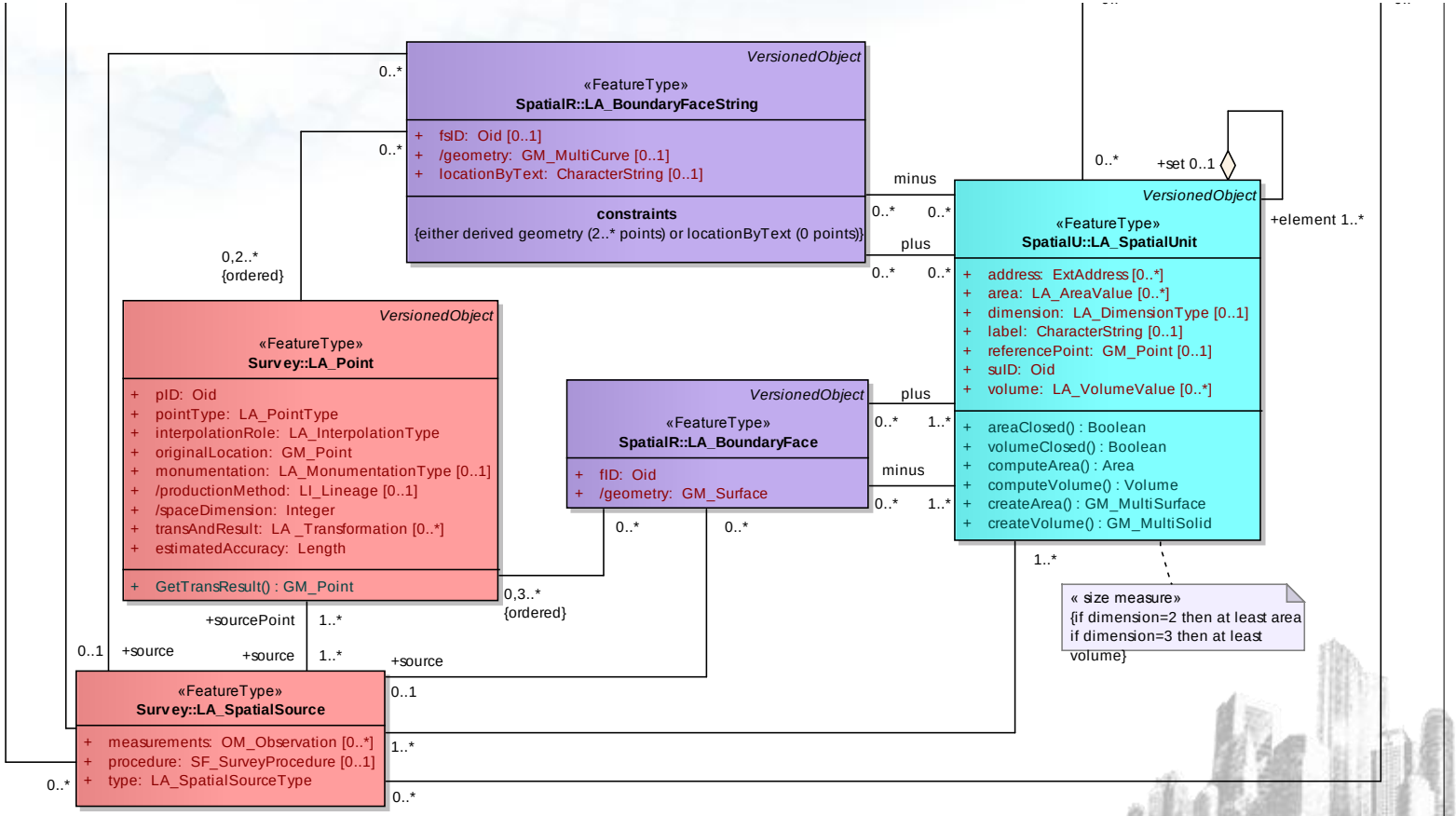
- **Korea wants to examine in which way the LADM** and its basic classes spatial unit, party, RRR and basic administrative unit can be implemented.
- Specific attention is paid to aspects relevant for information infrastructure (or NSDI) **based implementation in LADM**
- **The 3D NSDI of Korea** is providing an excellent framework to realize this referencing between 3D cadastral and 3D real-world (topographic) objects.



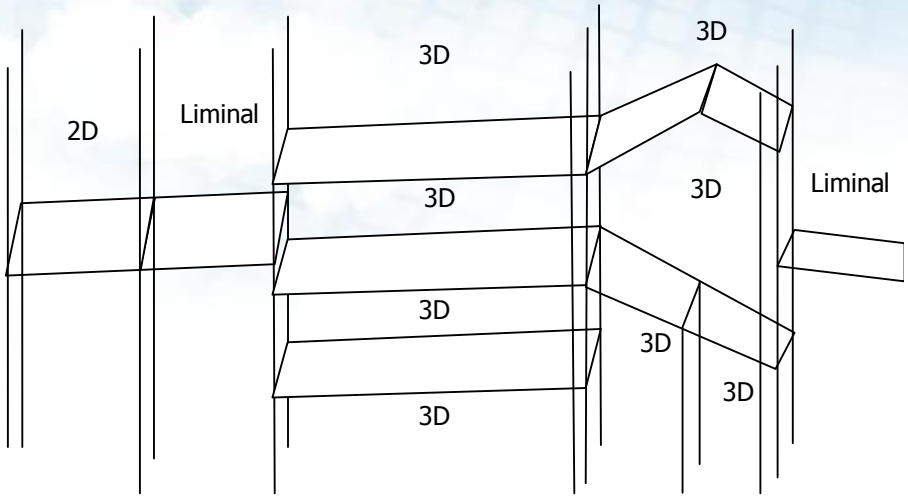
LADM Surveying and Representation Package with associations to basic classes

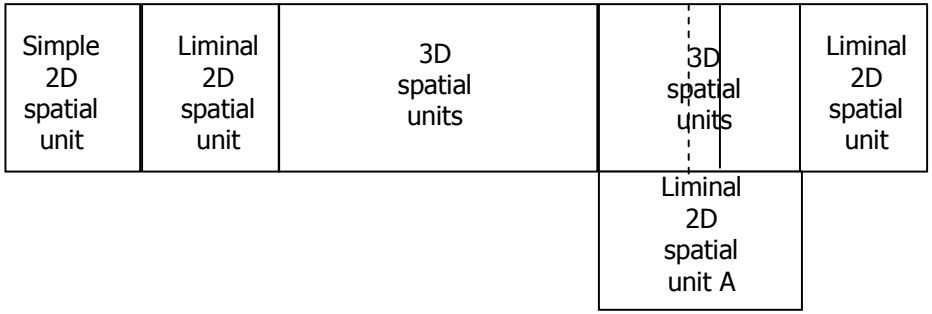
3.1 3D Aspects in the LADM(2)

- 2D polyline (GM_curve) implies string of vertical faces: **LA_BoundaryFaceString**
- True 3D described with arbitrary oriented faces: **LA_BoundaryFace**



3.1 3D Aspects in the LADM(3)





- 2D (open prisms) and 3D (bounded volumes) integration 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

3.2 LADM and SDI(1)

- Building an effective SDI starts by defining 'key' data sets, e.g. on addresses, persons, companies, buildings or land rights
- Important that these are standards based → can be understood externally (e.g. LADM)
- LA is one of the information cornerstones and has important relationships with other key data sets: both spatial (e.g. buildings) and non-spatial (persons)

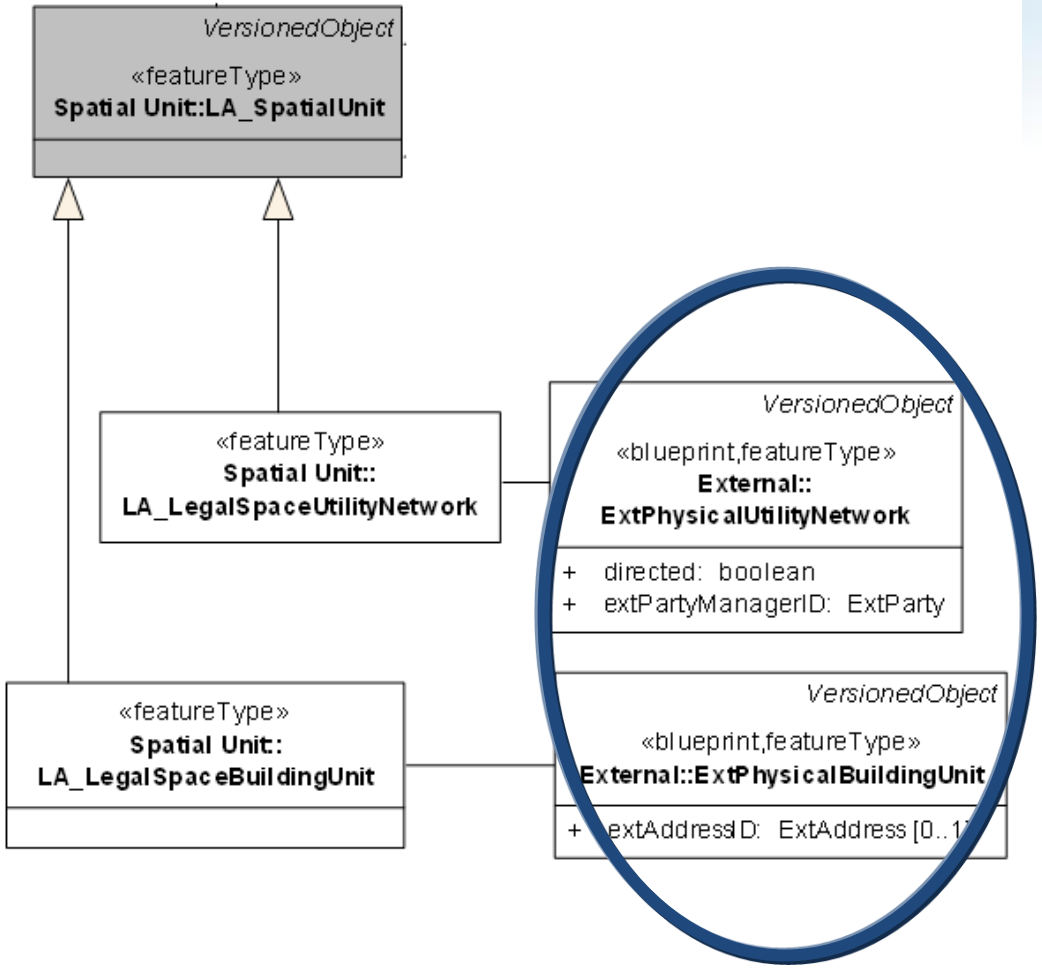
- The SDI enables good co-operation between these various (geo-)information sources
- Resulting requirements for model to create well maintained links between instances of different key data sets (and avoid copying data):
  1. Objects with unique id's
  2. Objects with versioning support (might refer to outdated version)
- Provided in LADM by LA_VersionedObject

3.2 LADM and SDI(2)

- 3D Cadastre needs often arrive due to real-world situations objects; e.g. complex building or other 3D construction (requiring a certain right in 3D space)
- To keep, in SDI, setting the LA registration consistent with other registration (with real-world object) create explicit relationships between corresponding instances in the different key registers

- Important that other key registers are also 3D; e.g. buildings and utilities
- The Korean NSDI is well developed w.r.t. the 3D representations

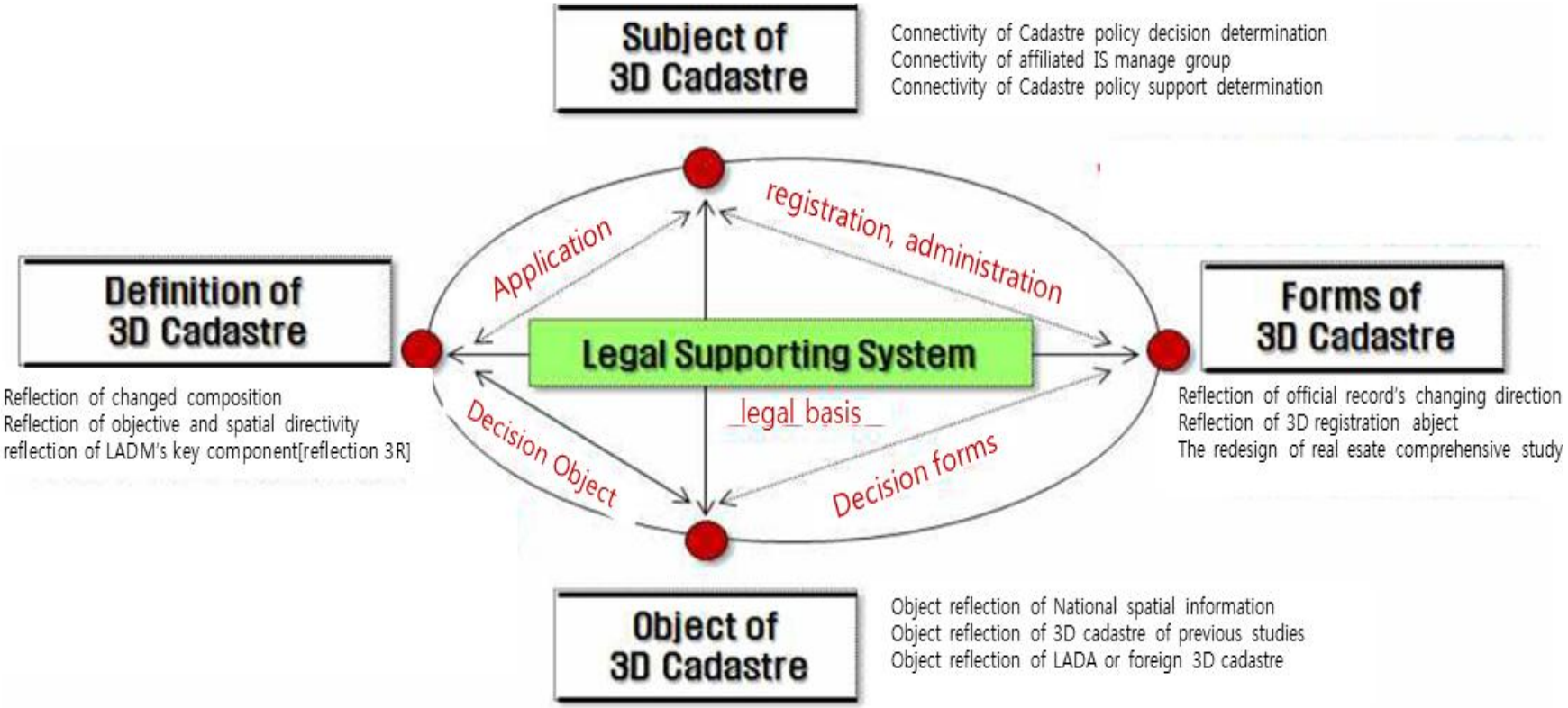
3.2 LADM and SDI(3)



- LADM does not model the other key registers
- However, <<blueprint>> stereotype is provided for some (often 3D) cases:
  - ExtPhysicalUtilityNetwork
  - ExtPhysicalBuildingUnit
- This allows at model level linking with external classes (without knowing all model details of external class)

4.1 Framework of 3D Cadastre

- In order to re-define the Cadastre in Korea, the re-definition should reflect the historical changes of **3D cadastre components**, and be compatible to the LADM basic classes, especially RRR (rights, restrictions, and responsibilities).



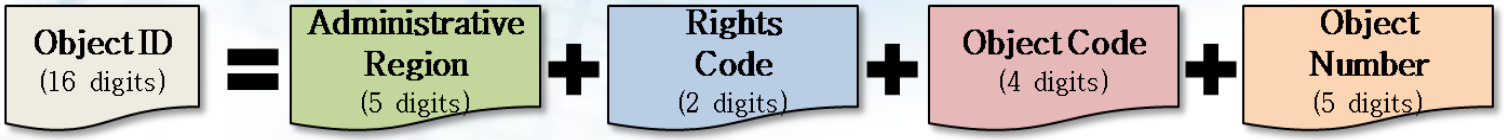
*Framework for application of **3D cadastre***

4.2 Alignment with LADM(1)

- The 3D cadastral system should not only cover positional information(x,y,z) about registration objects but also **rights information**.
- The system has to include a lot of useful functions to provide the **services** immediately to the general public as well as experts.
- Different organizations may **communicate** on the basis of standardized administrative and technical update processes.
- Use international spatial standards and national spatial data infrastructures.
- 3D spatial information should **be registered, managed, and utilized**.
- The system should have **'well defined' interfaces** which can provide the link to the information that users want to refer to (anywhere, anytime).
- **Database history (versioning) is supported in LADM** (external object referencing, including 'deleted' objects or versions and information assurance) and object identification.

4.2 Alignment with LADM(1)

- **Object IDs** should be defined in order to specify the relationships between objects,

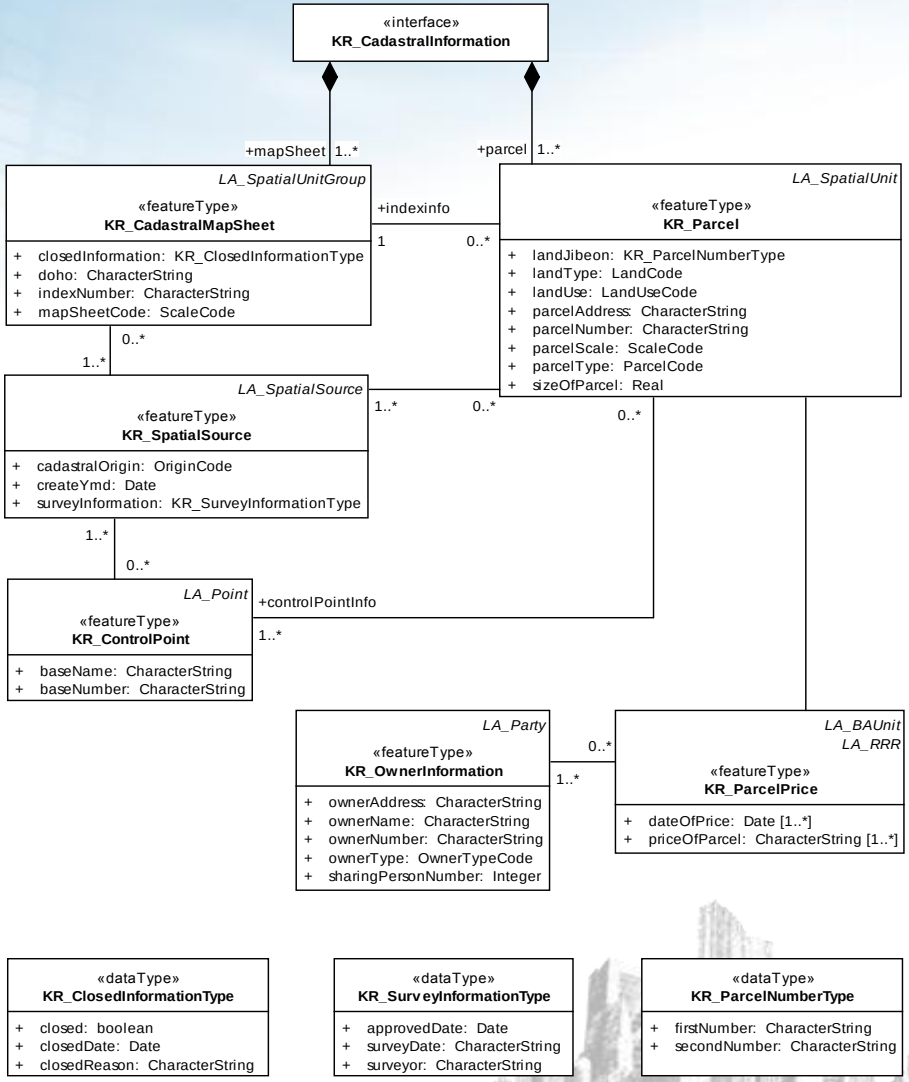


Composition of Object ID

- **Building's registration** is already required and regulated in Korea, but the present cadastral system does not register that information yet.
- LADM allows the inclusion of references from the cadastre (in case of an LA_LegalSpaceBuildingUnit) to the corresponding building unit in the 'external' building registration.
- Inclusion of **Control Points**. This is possible with LADM, it contains a comprehensive Survey functionality.
- **Visualization functionality** (dynamic) has to be provided by system created based on the LADM designed database with careful attention for 3D display and interaction.

4.3 Design of the next generation CDM(1)

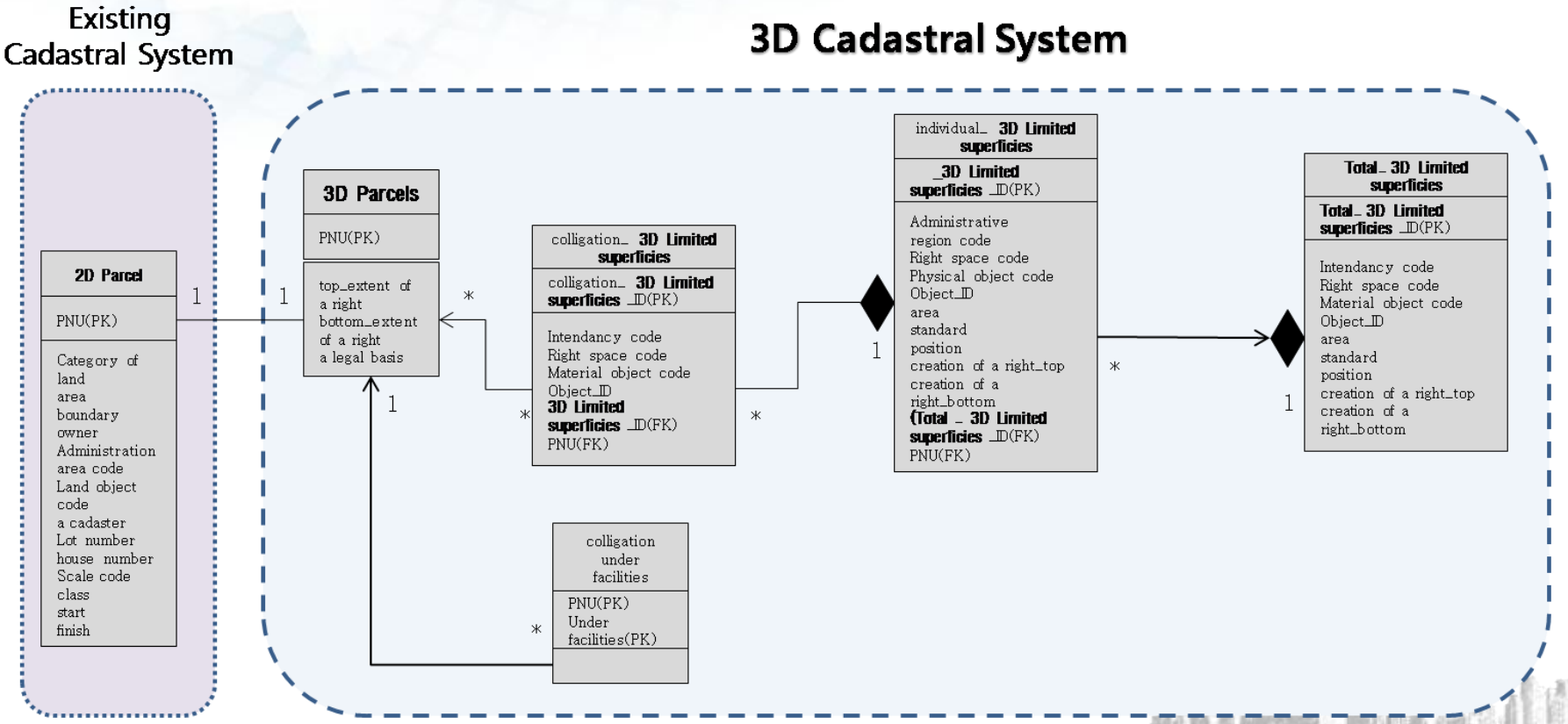
- There is already an initial **integration of KLIS and LAS via LA_Party and spatial units** through RRRs.
- **Spatial source, map sheet and control points** are the main alignment with LADM.
- **3D Superficies** has to be introduced a specialization of LA_SpatialUnit.
- **3D Physical objects** should be possible to represent.



*ISO FDIS, **Korean Country Profile** from Annex D, Figure D.9 of ISO (2012)*

4.3 Design of the next generation CDM(2)

- A first draft of the **link** between **the new cadastral system** and the **existing administrative system** is presented.
- Superficies are included (total, individual and colligation).

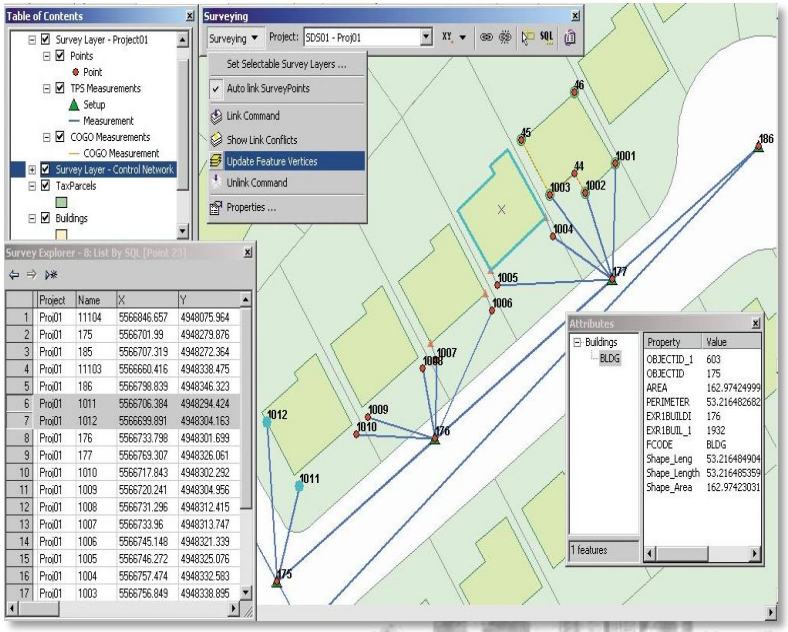


*Database schema design of **3D limited superficies** and parcel*

4.3 Design of the next generation CDM(3)

- The **current cadastral information** provides only simple contents such as parcel boundaries, parcel numbers, land categories, and neat line information.
- Building's information on the parcel and physical objects with space rights must be registered in the **next generation cadastral system**.

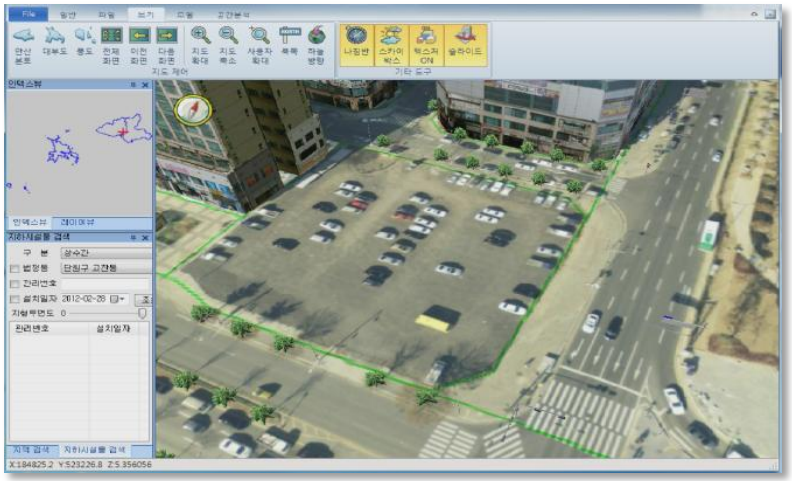
***Current contents** of cadastral information service*



Next generation contents

4.3 Design of the next generation CDM(4)

- An example of the 3D cadastral information system for expert use. For example, 3D cadastral administrative management system, flight simulation, flood simulation, 3D buffer, urban planning, road building simulation, viewing right analysis, and LiDAR scanning data management system.
- Currently, **Seoul government** developing their own **3D cadastral administrative management system** to support experts' decision making and to offer administrative services for the citizens.



3D cadastral administrative management system

Usage example(Viewing Right))

5. Conclusions

- Korea has excellent information and communications infrastructures to build the 3D cadastral system based on information technology skills (enabling the effective realization of the SDI).
- In the case of a 3D cadastre there is even more tendency to refer to external registration(buildings, utility networks, etc.) compared to the traditional 2D cadastre.
- In order to build 3D cadastral system required as below
  - **Legislation of the related laws and regulations for legal guarantees**
  - **Interagency agreement for data sharing**
  - **Strong commitment of the highest policy-maker**
  - **System developed with international standards**
- The co-operation between Korea and The Netherlands brings together the expertise to develop a 3D Cadastre that will meet the high expectations.


THANK YOU