

3D MODELLING FOR MULTIPURPOSE CADASTRE (MPC)

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CONTENT

1. INTRODUCTION

2. 3D SPATIAL AND THEMATIC SEMANTIC INFORMATION

- Cadastre
- Marine Cadastre
- Underground Utility

3. 3D MODELLING APPROACH

4. LADM AND 3D CADASTRE ALTERNATIVES FOR THE MALAYSIAN MPC

- Benefits of the Malaysian MPC

5. CONCLUSIONS AND FUTURE WORKS

INTRODUCTION

- Currently 2D cadastre mapping is practiced in Malaysia which provides vital land and property information like ownerships of the parcels for most parts of the country.
- However, in the very near future, 2D information may no longer be able to serve the community, especially in more complex situations such as buildings above roads in some large cities and towns such as Kuala Lumpur



INTRODUCTION

- Three dimensional (3D) modelling of cadastral objects such as legal spaces of and around buildings, utility networks and other spaces is one of the future aspects for the Malaysian **multipurpose cadastre (MPC)**.
- The Malaysian MPC model should be within the frame work of the **LADM (Land Administration Domain Model)** where the generation of the UML model that complies with the concept of LADM for the Malaysian MPC can be indicated and addressed.

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3D SPATIAL AND THEMATIC SEMANTIC INFORMATION

- **Spatial** - unique parcel identifier, the area and the geometry and topology of the land parcel with the data of the footprints of the building, floor area and the geometry of the building
- **Thematic semantic** - the owner identity or number, owner name, parcel history, number of floors, floor height, volume space, type of lease and etc.
- **The spatial unit package** defines spatial units as being a 2D (land) or 3D (space) spatial units, legal spaces around buildings and utility networks, these include topological spatial units, polygon spatial units, line spatial units, point spatial units and text spatial units (ISO19152, 2012).

3D SPATIAL AND THEMATIC SEMANTIC INFORMATION

- **Cadastre**

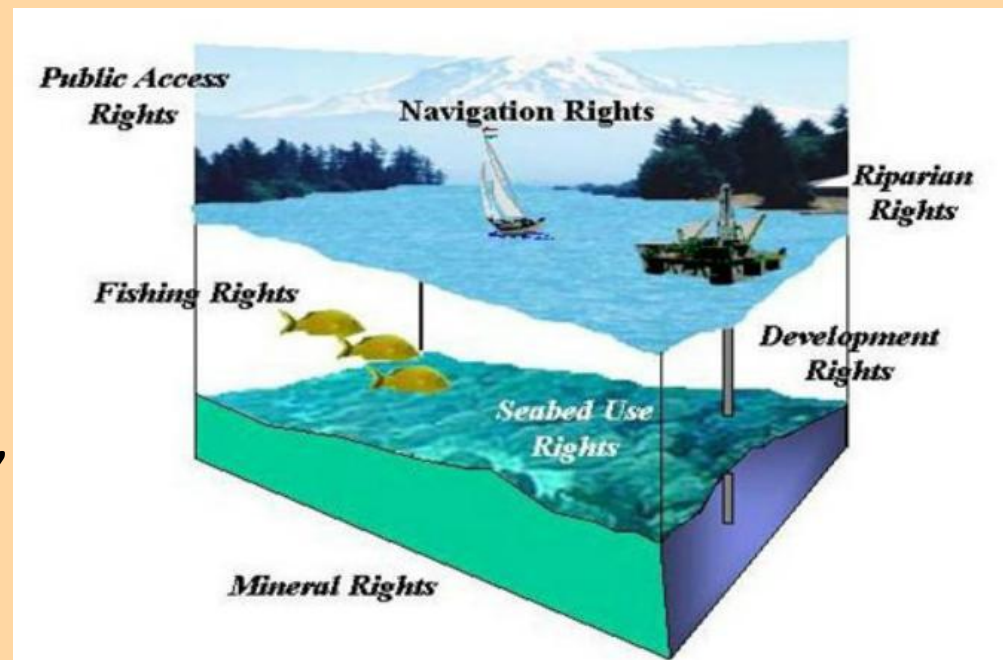
- shows the record of the interests associated with the land
- described as the rights, restrictions and responsibilities (RRR) associated with the land.
- include the geometric dimensions of the parcel, the interest, ownership and value among other attributes of the land.

3D SPATIAL AND THEMATIC SEMANTIC INFORMATION

- **Marine Cadastre**

- Marine cadastre is currently new in Malaysia despite the fact that it is a maritime country.

- various rights for the marine cadastre as, Public access, navigation, Fishing, Airspace, Seabed Use, Development, Mineral, Water Column and Riparian



Rights for Marine cadastre (Nichols et al., 2000)

3D SPATIAL AND THEMATIC SEMANTIC INFORMATION - Marine Cadastre

- The current principle on cadastre is geared towards addressing land and extents to the High Water Marks (HWM) for countries sharing boundaries with water bodies such as the ocean.
- However often land is being introduced as being in relation to the earth surface which invariably includes the land and sea surface
- marine cadastre system can record all the complexities associated with the determination of the spatial extents, rights, interests, property rights, restrictions and responsibilities within the marine jurisdiction.

3D SPATIAL AND THEMATIC SEMANTIC INFORMATION - Marine Cadastre

- Marine objects can be described as sea surface objects, water volume object, seabed objects, sub seabed objects, these can be demarcated up to a country's Exclusive Economic Zone (EEZ).
- The rights for marine cadastre are overlapping (in projected 2D) by their nature - the management usually for the benefit of the country and stakeholders up to its EEZ.
- Marine parcels or lots can be integrated with the current LADM to make them compatible with the marine environment.

3D SPATIAL AND THEMATIC SEMANTIC INFORMATION

- **Underground Utility**

- 3D underground utility themes has been identified as one of the important layers that requires to be integrated in a cadastre database
- A central utility database will enhance knowledge about underground utilities
- the location and exact utility rights to serve as a basis for the city authority to establish exact locations (also legal space around the utility) for the various utility networks in a city.
- via the SDI the legal space and the physical object can be related/linked.

3D SPATIAL AND THEMATIC SEMANTIC INFORMATION - Underground Utility

- Currently underground utility networks are developed in 2D – difficulties to present height, type, width and colour
- can be handled more efficient in a 3D environment – problem is unsupported or lacks geometry type in a spatial database.
- Three main problems have been identified:
 - Cadastre databases not integrated with underground databases and other databases e.g. taxation
 - Softwares available are currently in 2D.
 - Visualization of utility networks difficult to interpretate due to the 2D maps, inadequate information on height

3D SPATIAL AND THEMATIC SEMANTIC INFORMATION - Underground Utility

- More efforts are required to fully integrate underground utility networks into the Malaysian MPC.
- The integration of the underground utility networks with current 3D city models being explored, initial results of this is shown in figures below.



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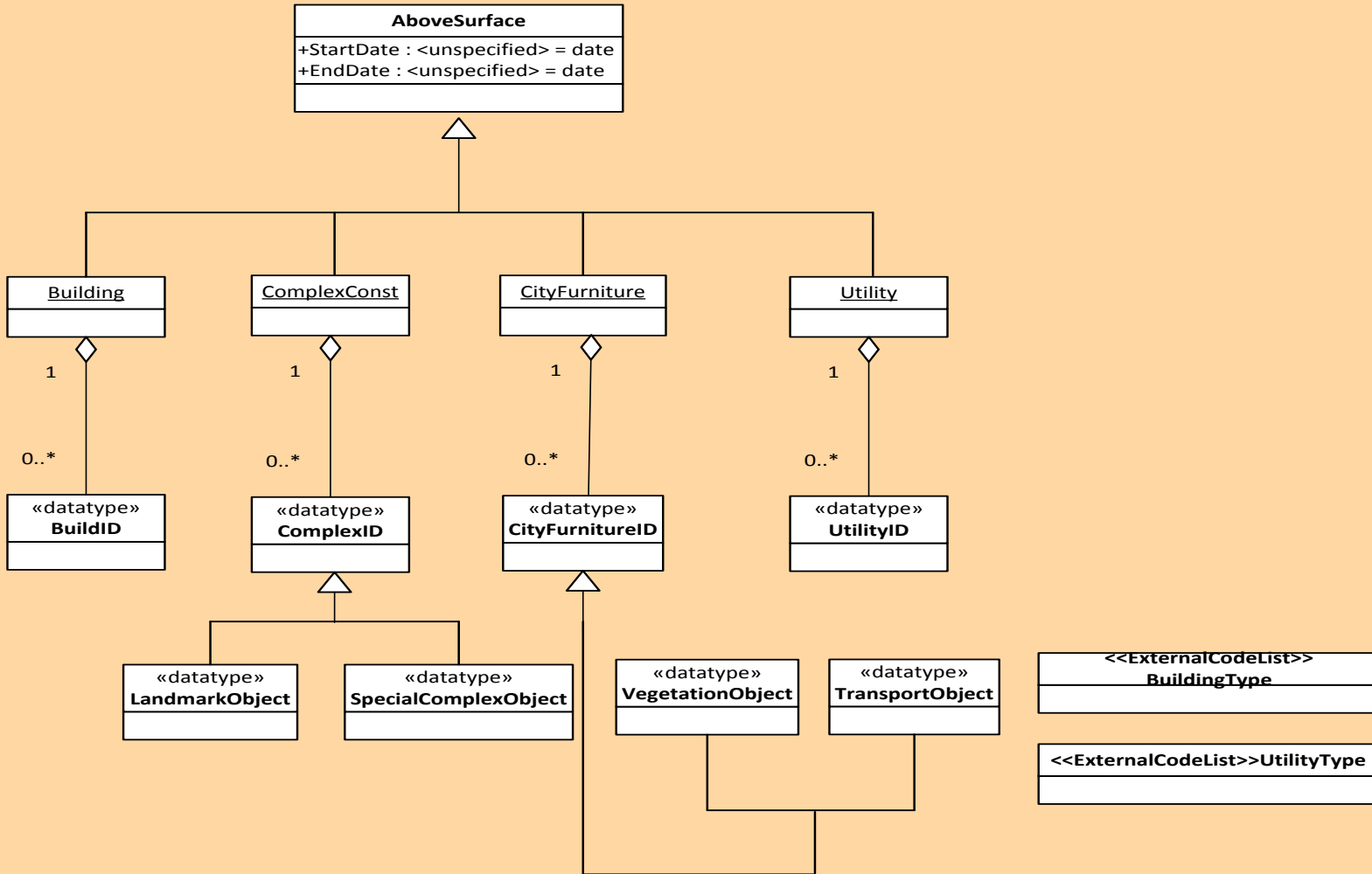
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3D MODELLING APPROACH

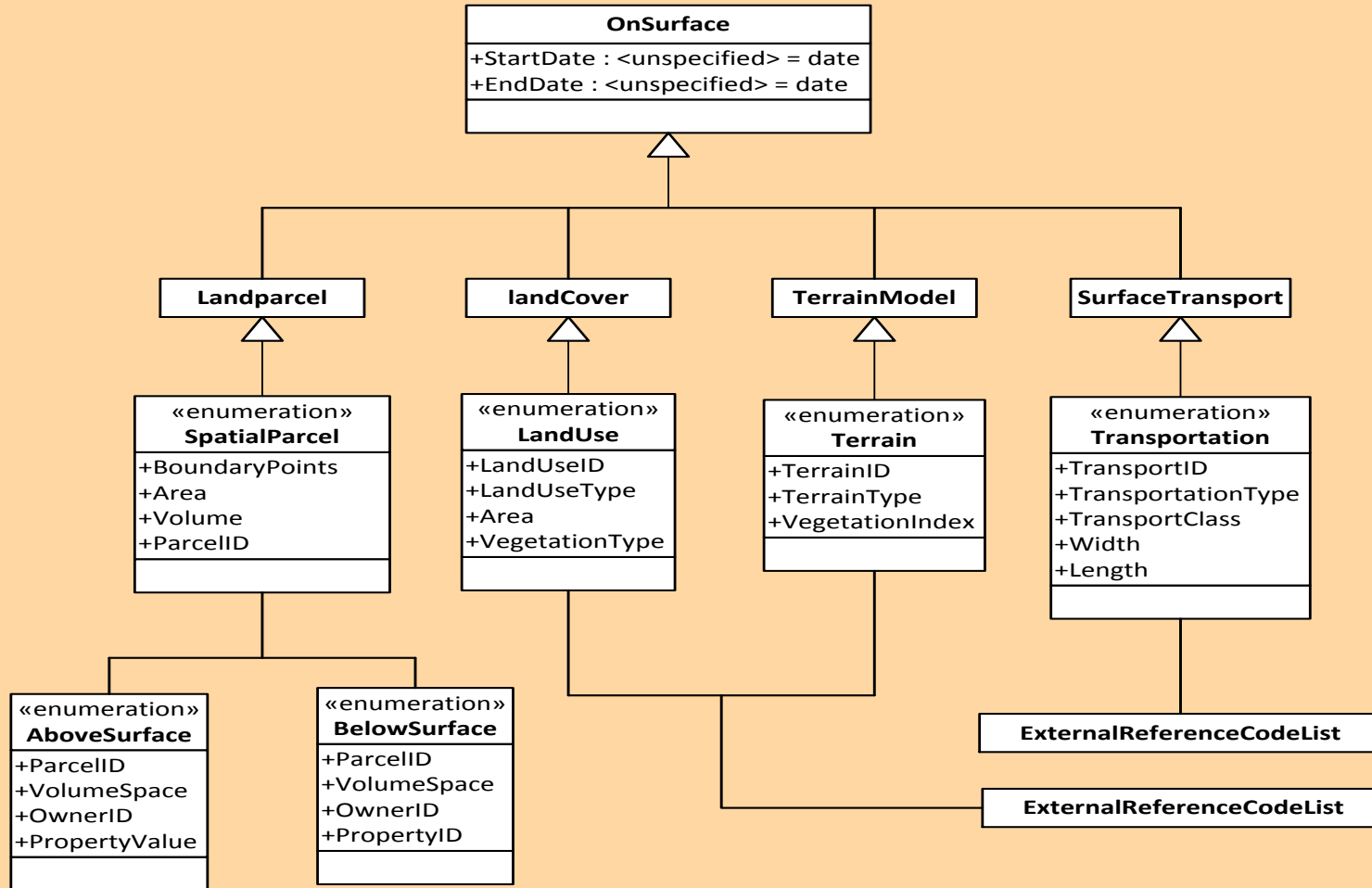
- **3D TEN** (tetrahedral network) is used to generate the basic cube using a tetrahedral mesh - used to represent volume parcels for buildings or any other features on a parcel of land.
- 3D GIS property data can be represented for features above and below the land parcel – more accurate geometry for 3D volume parcels or spaces
 - The above surface object identifies buildings, complex buildings such as mosques and city landmarks, city furniture and others
 - Below surface classes considers man-made constructions, utility, rock type and geology for the subsurface.
- The parcel identification (ID) for the on surface is linked to parcel ID's for the strata and stratum for the Malaysian 3D cadastre.

3D MODELLING APPROACH



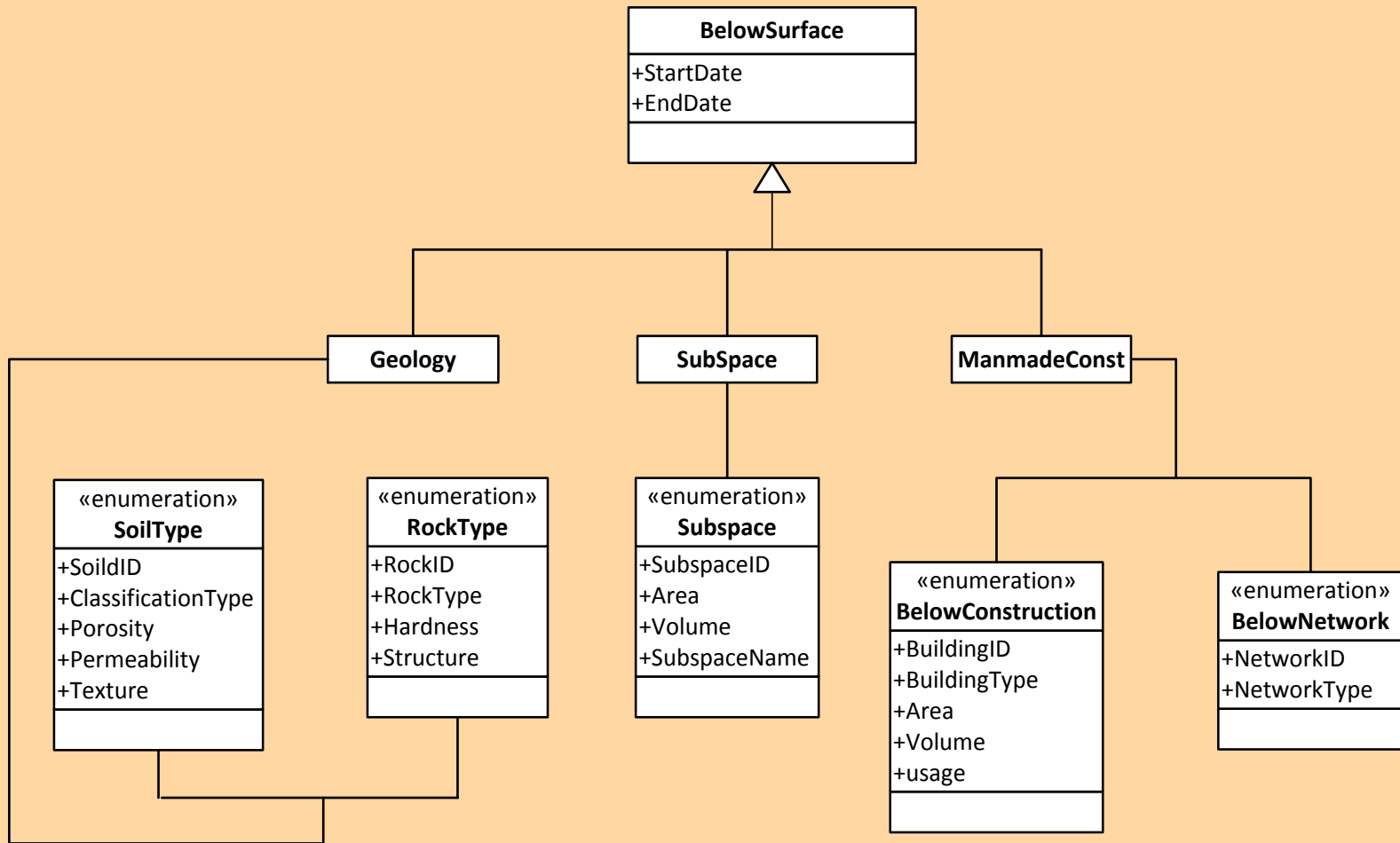
The Above Surface features and datatypes

3D MODELLING APPROACH



On Surface classes and data enumerations

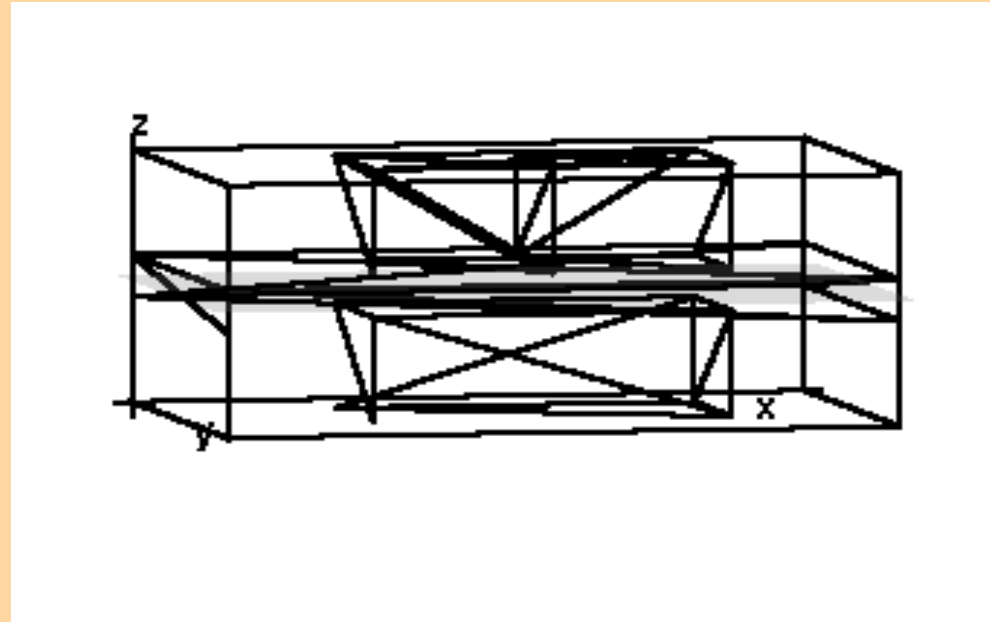
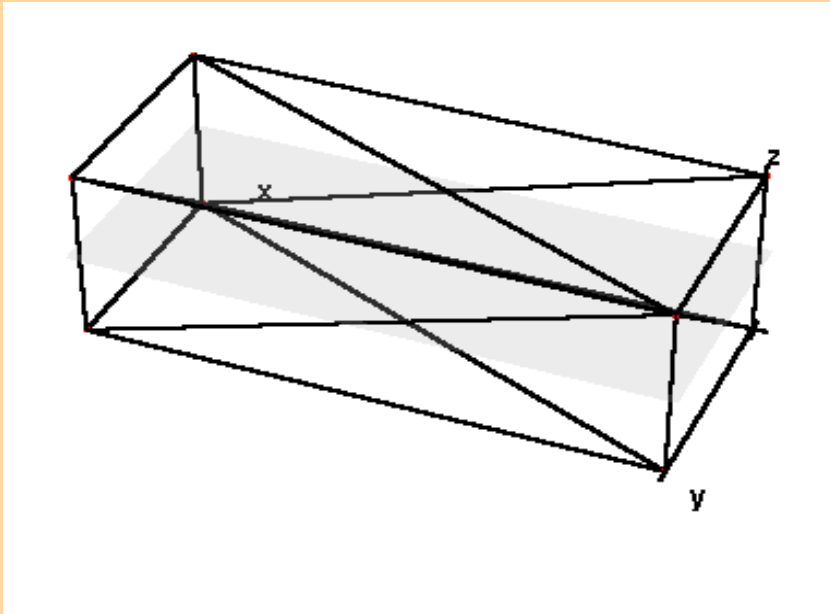
3D MODELLING APPROACH



Below Surface classes and data enumerations

3D MODELLING APPROACH

- The concept for representing volume parcels in 3D for land parcels for the 3D cadastre is also represented belows



Wireframe generated from 3D TEN for unified volume parcels

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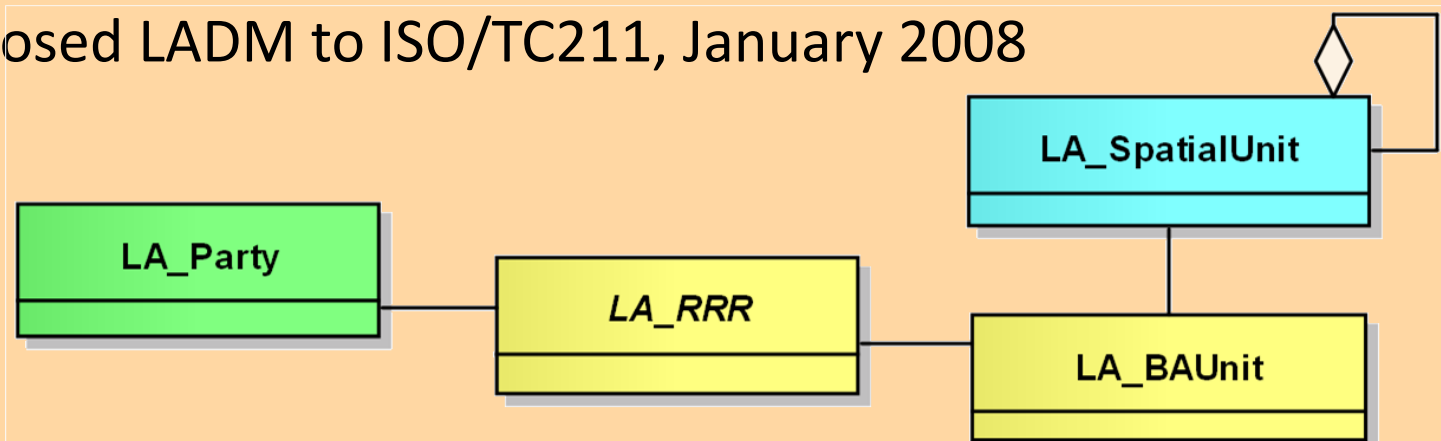
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LADM AND 3D CADASTRE ALTERNATIVES FOR THE MALAYSIAN MPC

- The LADM is a conceptual model, and not a data product specification
- The purpose of the LADM is not to replace existing systems, but rather to provide a formal language
- In this presentation the focus is on the spatial part of the model and less on the legal/admin parts of the model
- The main reason to apply the LADM is to reuse the collective knowledge from many countries in land administration and to have unambiguous definitions of the key concepts.

Land Administration Domain Model ISO 19152 (LADM)

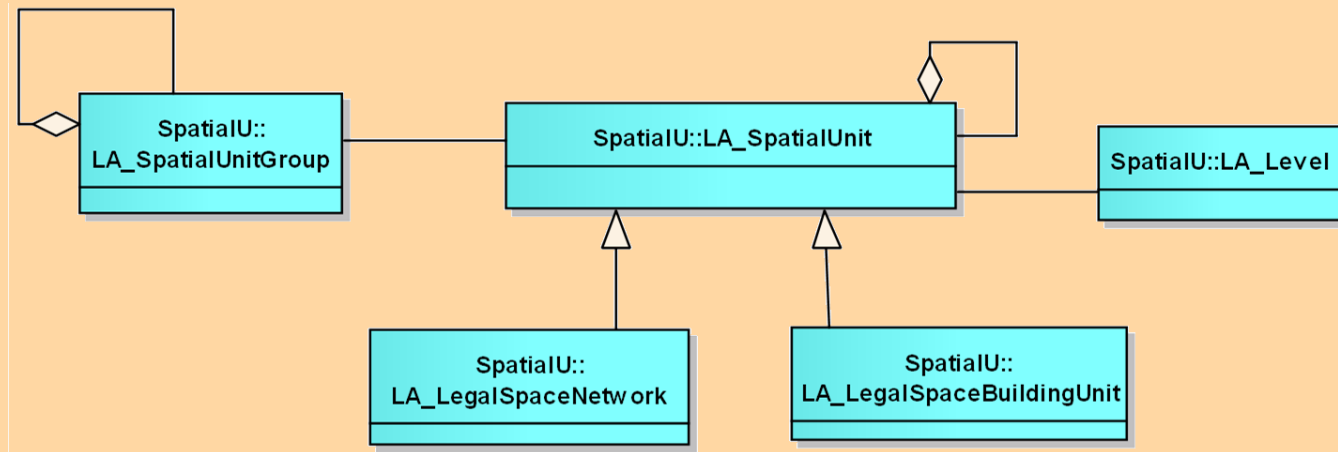
- Model includes:
 - Spatial part (geometry, topology)
 - Extensible frame for legal/administrative part
- Object-orientation → expressions in UML
- Model Driven Architecture (MDA)
- FIG proposed LADM to ISO/TC211, January 2008



The 4 basic classes of the LADM (from ISO/TC211, 2012)

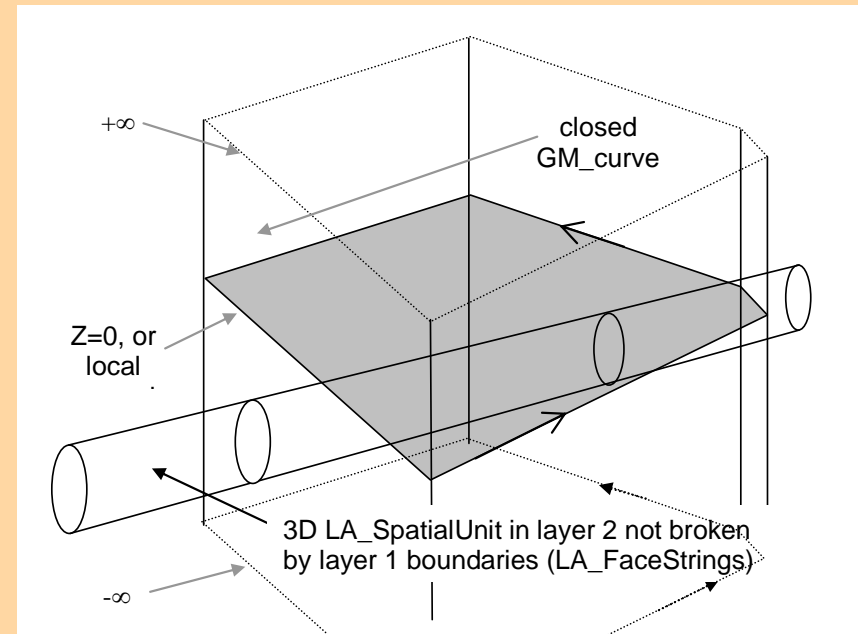
LA_SpatialUnit (alias LA_Parcel)

- LA_SpatialUnit specializations: network, building unit
- organized in LA_Level based on structure or content
- 5 types: point, text (unstructured) line, polygon, and topology
- **2D and 3D integrated without complicating 2D**



LADM AND 3D CADASTRE ALTERNATIVES FOR THE MALAYSIAN MPC

- For the Malaysian country profile:
 - the integrated support for both 2D and 3D parcels is very useful
 - the specialization of LA_SpatialUnit with the subclass LA_LegalSpaceUtilityNetwork is very appropriate.
- Therefore the 2D/3D spatial representation aspects of the LADM are further discussed.
- For 3D marine objects there is not yet an existing generic class in the LADM, so this has to be added in the country profile

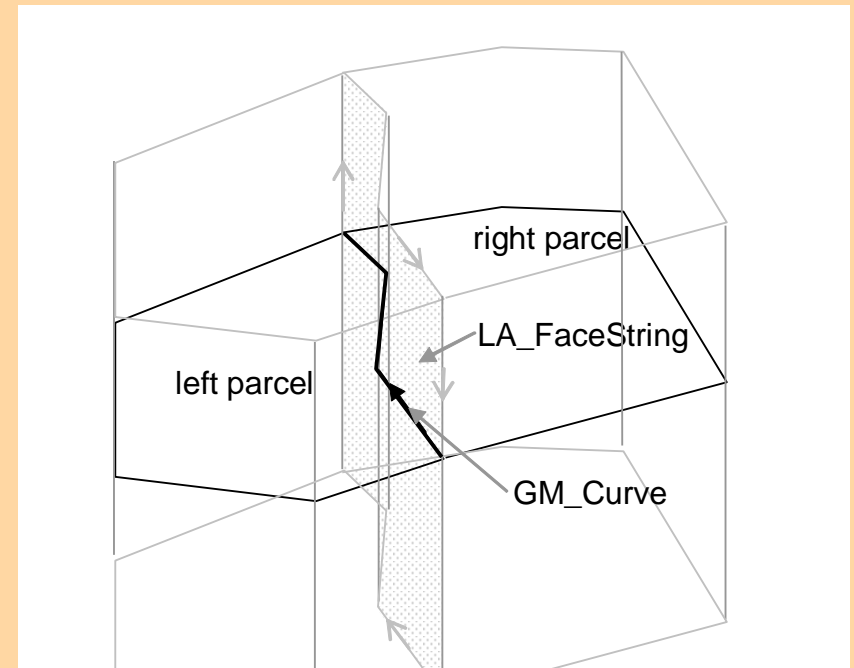
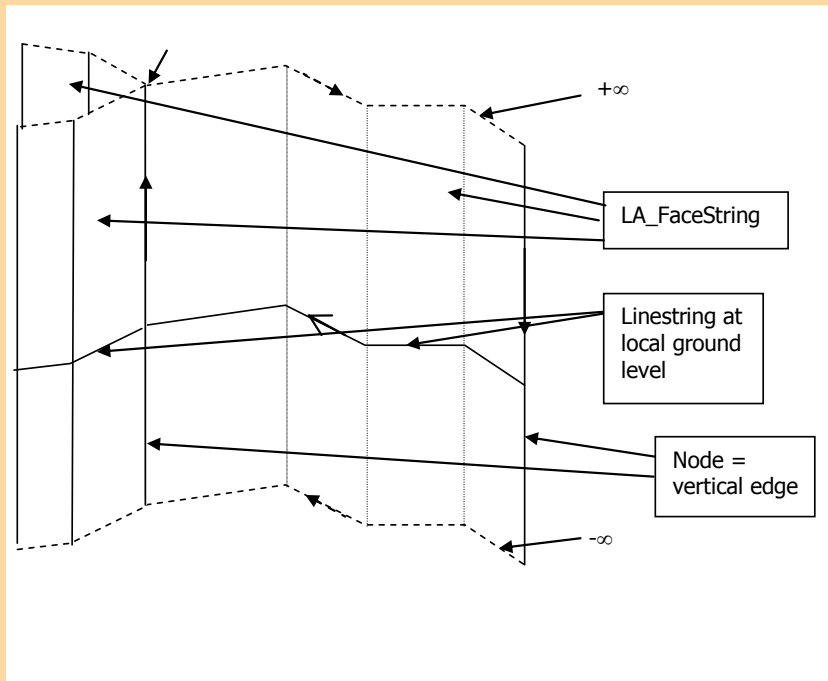


LADM AND 3D CADASTRE ALTERNATIVES FOR THE MALAYSIAN MPC

- The marine cadastre objects have a true 3D nature and therefore really need 3D Cadastre support.
- There are no (GIS or spatial DBMS) systems that support 4D (3D with time integrated) primitives and also the LADM does not support this.
- The modelling of these objects is based on separate 3D spatial description and additional temporal objects.

2D Parcels and their 3D Interpretation

- Observation: 2D description implies 3D prismatic volume
- 2D polyline (GM_curve) implies string of vertical faces



LADM AND 3D CADASTRE ALTERNATIVES FOR THE MALAYSIAN MPC

- Benefits of the Malaysian MPC
 - **As an integrated LIS**, it can exhibit data on ownership, rights and all encumbrances associated with the land parcel
 - Inventory of all land parcels with information for the strata and stratum will **strengthen property ownership**.
 - National Underground Utility Database for Malaysia when incorporated in the MPC will **streamline the provision of essential utility services** such as electricity, water, sewerage, etc.
 - The compatibility of LADM to allow the **creating of new generic class in the LADM (Marine Cadastre)**, so this can be added as the country profile

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CONCLUSIONS AND FUTURE WORKS

- The Malaysian MPC model is compatible with the LADM
- The benefits to be derived from the MPC with the incorporation of 3D modelling and underground utility have been enumerated.
- The proposed approach for incorporating 3D modeling could be implemented for the MPC by the authorities.
- The MPC must be integrated to include marine parcels and the strata and stratum condition unified.
- More research work have to be done especially on the 3D Marine Cadastre to be integrated within Malaysian MPC using the LADM with new generic class in Malaysia country profile

THANK YOU...