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3D Perspective towards the Modelling and Applications of Cadastral Building Data in Taiwan

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Here are three important ideas

Nation Digital Twin Project in Taiwan

Current 3D cadastral building data in Taiwan

Application Schema Design

UML Application Schema 2

Case Study

Detached House Congregate Housing



Nation Digital Twin Project in Taiwan

Nation Digital Twin Project

National Base Map

Three-dimensional building data

- Photogrammetry
- Topographic mapping
- Data managed by cadastral organizations

Property rights data

Ministry of the Interior (MoI)

Cadastre Database

- cadastral maps Two-dimensional parcels and associated land adminstration information.
- building data Tabular format containing registration details.





Nation Digital Twin Project in Taiwan



The Ministry of the Interio

"Towards 3D Smart Land - National Base Map Spatial Data Infrastructure Project" county (city) governments

Three-Dimensional Cadastral Building Integration Project



spanning from 2021 to 2025





Citv**GM**

Current 3D cadastral building data in Taiwan

A circulation and exchange standard for 3D cadastral buildings.

A 3D spatial representation and circulation strategy

Positioning points & A cadastral model of building properties



Positioning points

Singular point defined by 3D coordinates

- Assign 3D coordinates to each building number.
- Manual adjustments (topology).
- The elevation is estimated.
- Associated to the registration data (identifier).
 Before ▲

After $\begin{bmatrix} 202 \\ \end{bmatrix}$

A cadastral model of building properties

Boundary representation

- Main building and ancillary building (floor plan).
- Extruding the height (construction plan).
- Cadastral maps, aerial photograp **5**, and DEM.



 Integrate into the current building registration process and cover the building information accumulated in the past.



Application Schema Design



- CityGML 2.0 is an international standard that has modeled 3D city data.
- LOD can describe 3D buildings with different levels of detail.
- Integrate with other domains which also use CityGML 2.0.

Building module, it falls short in adequately representing the diverse cadastral characteristics from a semantic perspective.

- Correspond to various property model. Include "building", "floor", "building number", "main building and ancillary buildings".
- Record different types of buildings in Taiwan, such as townhouse, detached house, mansions, apartment, etc.

STRATEGY

SHORT

CityGML 2.0 ADE

- Cadastral building property model: CityGML 2.0 ADE.
- Positioning points of building numbers: GML 3.1.1(CityGML 2.0 does not accommodate the use of 3D points for modeling Level of Detail 0 (LOD0) buildings,



UML Application Schema Cadastral model of building properties

- **Property Building**: Model the characteristics of the property of a single building.
- **Floor**: Pertinent spatial extent and attributes to an individual floor within a building.
- **Building Number Management Unit**: Spatial extent and attributes associated with a specific building number. Serves as a fundamental reference in the proposed schema, necessitating the establishment of relationships with other feature classes.
- **Property Unit**: Records the spatial extent and attributes of both the main and ancillary buildings corresponding to a specific building number.













UML Application Schema

Point-based building number positioning data

BuildingNumber

- The geometric data refers to the GM_Point class as outlined in ISO 19107.
- Derived from building registration data and encompass parcel, buildingNumber, address, registerDate, registerReason, purpose, material, totalArea, floorCount, floorLevel, constructionDate, buildingLicense, floorHeightSource, and elevationModel.
- Floor height: differentiates between default and actual floor heights.
- ElevationModel: specifies whether the height information is relative to the terrain.









A circulation and exchange standard for 3D cadastral buildings.

A 3D spatial representation and circulation strategy

Positioning points & A cadastral model of building properties



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Positioning points

Singular point defined by 3D coordinates

- In line with international standards and open format circulation.
- Clear semantic meanings.
- Represent of different types of buildings.
- Integrate into the current building registration process and covers the building information accumulated in the past.

Cadastres

- Cadastral and building data will not only have 3D spatial representation, but also use standard models to improve the interoperability of circulation and exchange.
- Assign 3D coordinates to each building number. CityGML 2.0 ADE (Application Domain Extensions)
- Manual adjustments (topology).
- The elevation is estimated.
- Associated to the registration data (identifier).
 Before ▲



A cadastral model of building properties

Boundary representation

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Building Number Positioning Point Project

- Assign three-dimensional coordinates to each building number.
- Each building number is mandated to possess a singular positioning point.
- The central coordinates of the land parcel are calculated as a preliminary value.
- Manual adjustments are made by referencing scanned building plane survey data.
- A building comprises multiple floors, each with distinct building numbers: the initial values may coincide and require further adjustment.
- A single building share a single building number (e.g., a townhouse): only one positioning point corresponding to the floor nearest to the ground is recorded (first floor or basement).
- The elevation of the building positioning points is estimated based on the respective floor, with the elevation determined by the vertical center of that floor.
- The actual floor height is unavailable from the building's completion chart, a predetermined floor height is utilized instead.

The generated building number positioning points are linked to building registration data and disseminated in shapefile format.

The establishment of building positioning point data for buildings registered prior to 2021 will be completed by 2025.



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Verification project

National Land Surveying Center (NLSC)

Assessing and ensuring the quality of the completed data.

Phase 1 Inspection: Systematic checks with registration data.

A thorough evaluation to ascertain the consistency of the building number positioning points with the building registration data.

Phase 2 Inspection: Evaluation of Location and Attributes.

An initial assessment is conducted to determine whether the location of the building number positioning points adheres to the requisite topological constraints.

Phase 3 Inspection: Review from a Property Perspective.

Subdivided into two components:

- automated checks identify overlapping building number point locations at the same level. a)
- manual verification is the location of the building number point aligned with the floor? b)

Building Number Positioning Operation Guidelines.

S09 Platform Verification Tool.



It is essential that the positioning points are situated within the designated land and the corresponding buildings.

Building number positioning points are accurately located within the building units.







The automatic check patterns of errors by S09

Pattern	Explanation	Color
Not within parcel	Building number positioning point is not within the related parcel.	pink
Not within building	Building number positioning point is not within the building polygons in the electronic maps.	light blue
Attribute mismatch	The attribute value of building number do not match the content in the cadastral database.	blue
Share the same coordinates	Building numbers at the same floor share the same coordinates.	orange
Redundant/repeated positioning points	Every building number corresponds only one positioning point.	green
Multiple errors	More than two types of errors found	red

national FIG Workshop on LADM & 3D LA 24-26 September 2024, Kuching, Malaysia

Conclusion



3D cadastral building data - creation and sharing



COMPATIBLE

3D Model A 3D cadastral building property model and the corresponding building number positioning points have been developed to accommodate registered building data from both before and after 2021.

Standard

The proposed schema categorizes building units into four classes, based on the extension of the CityGML 2.0 Building module.



The design ensures that 3D building data in Taiwan, derived from both survey and cadastral domains, is compatible with CityGML 2.0 standards.

Application

An advantage of 3D cadastral building data is its capacity to provide household-level geospatial reference, which enhances the potential for smart city and digital twin applications through precise positioning.

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Thank You For Listening

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