FIG WORKING WEEK 2023
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Protecting Our World, Conquering New Frontiers

A multi-level space unit framework for 3D buildings to facilitate the development of digital twin

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Presented by Shan-Ju,Yang

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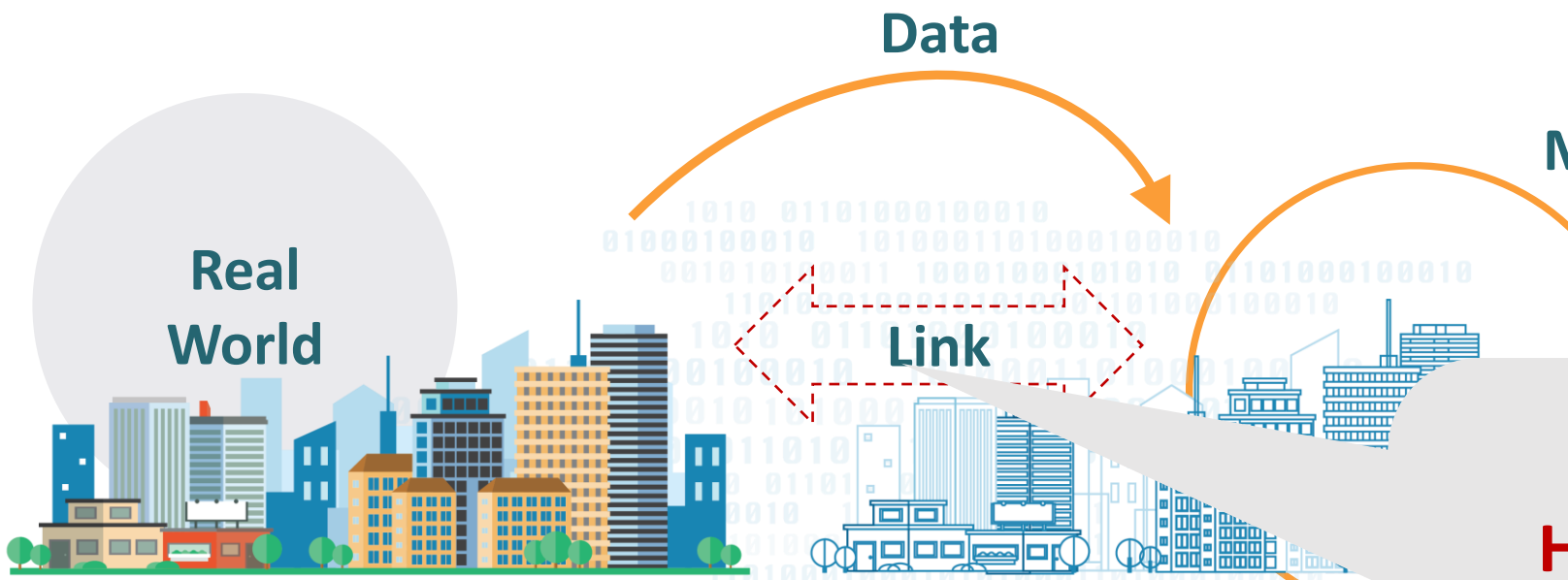
Introduction

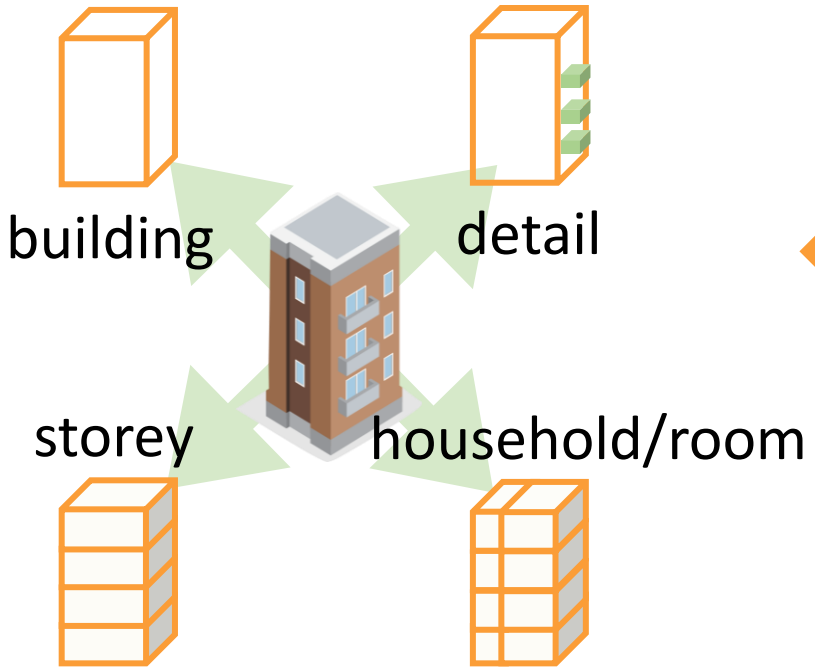
Digital twin is a digital representation of real-world asset



How to construct virtual models that meet digital twin's demands?

Introduction

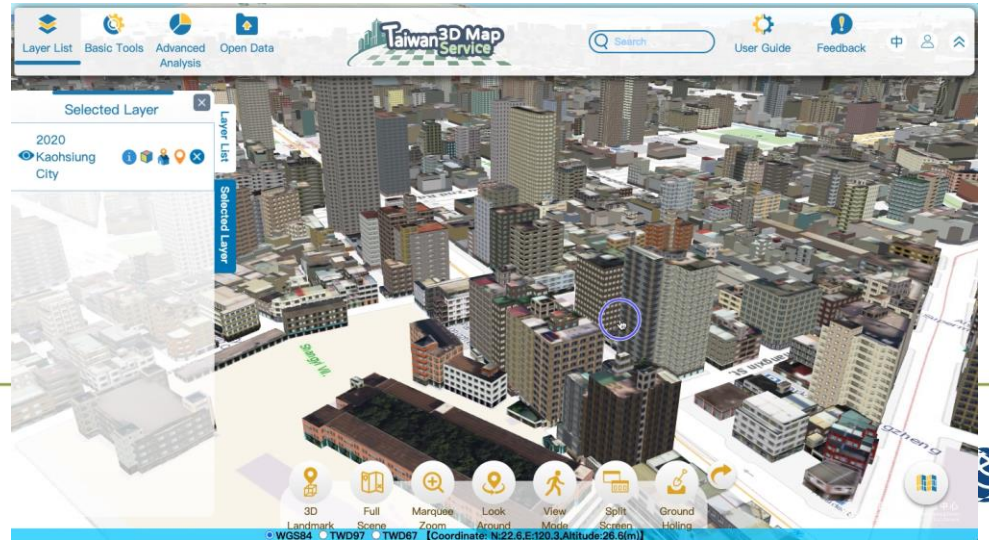
Modelling Perspective



Textual Descriptions

Building Act/Building Technical Regulation/
Land Administration/Cadastral …

Semantic space unit without geometry representation

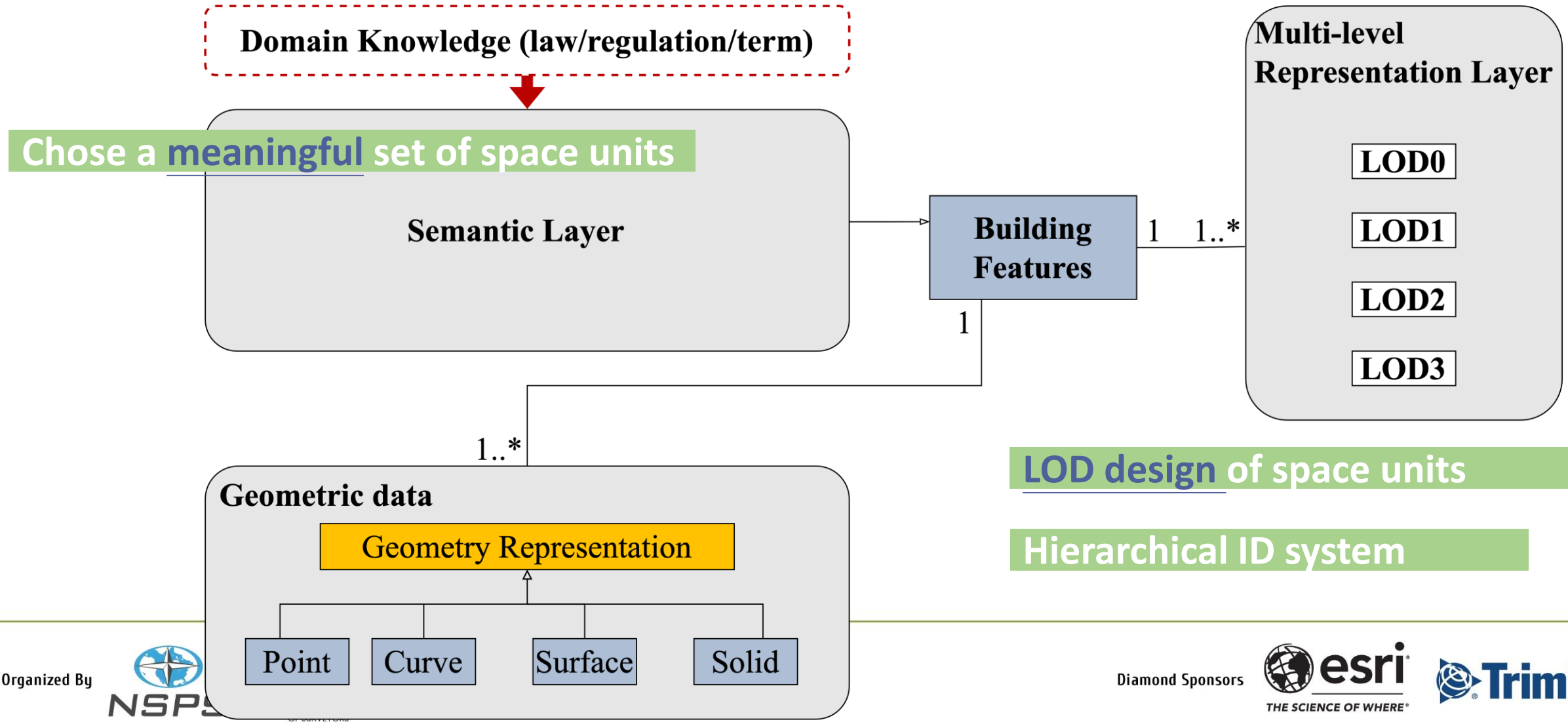


Introduction

Lack of the consistent specifications and standards

① No clarify specifications for the basic space unit.
② Have challenge to manage multiple sources, representations, and versions.
③ Inter-connection for different space unit

- **Interoperability issues**
- **Cross-domain integration challenges**

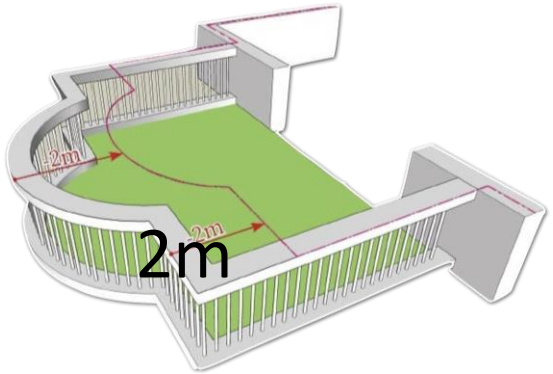


LOD design of space units

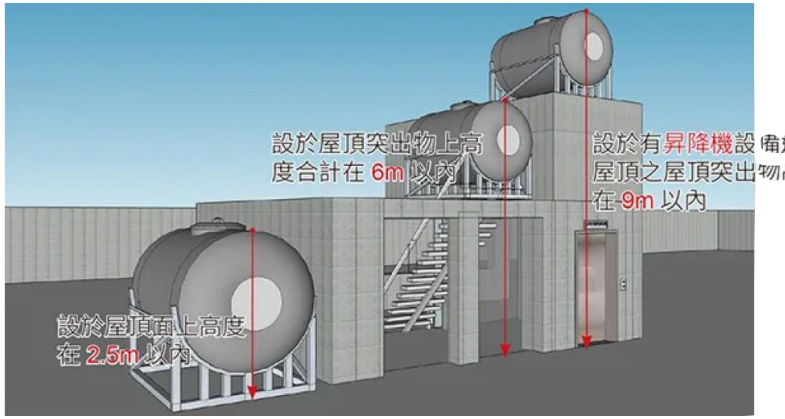
Hierarchical ID system

Space unit based on building laws and specifications

- Building Act
- Building Technical Regulations



22 Semantic Space units

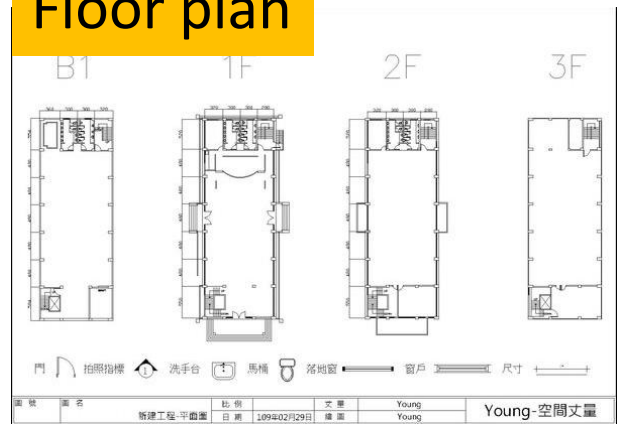


2.5m/ 6m/ 9m

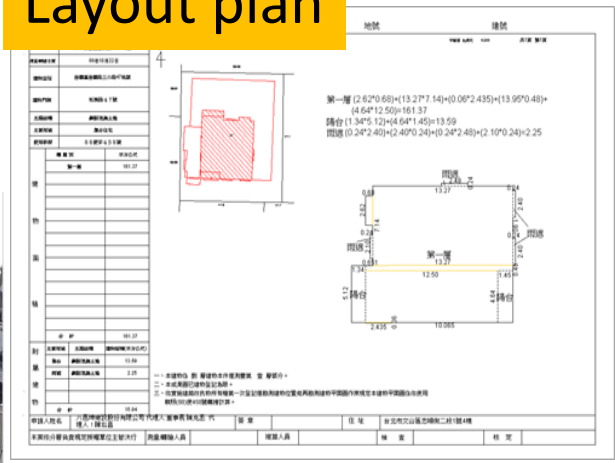
Building Act/ Building Technical Regulations
Building blocks
Building
Storey
Household
Roof superstructures
Bridge way
Arcades
Balcony
Terrace
Water tank/ water tower
Roof overhangs
Canopy
Planter box
Platform
Stair
Parapet, firewall
Roof details
Door
Window

Surveying	Method	Semantic Space Units
Indoor	Building Floor Plan	22
	Building Layout Plan	17
Outdoor	Mesh model	14
	1/1000 topographic maps	3
	Taiwan E-map	1

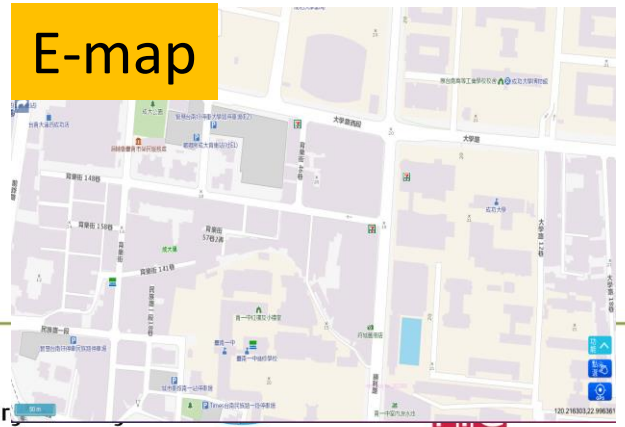
Floor plan



Layout plan



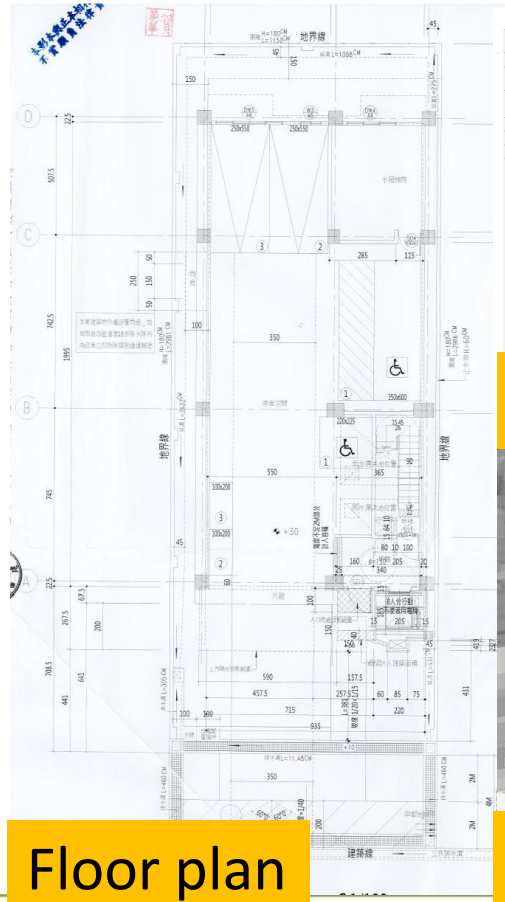
E-map



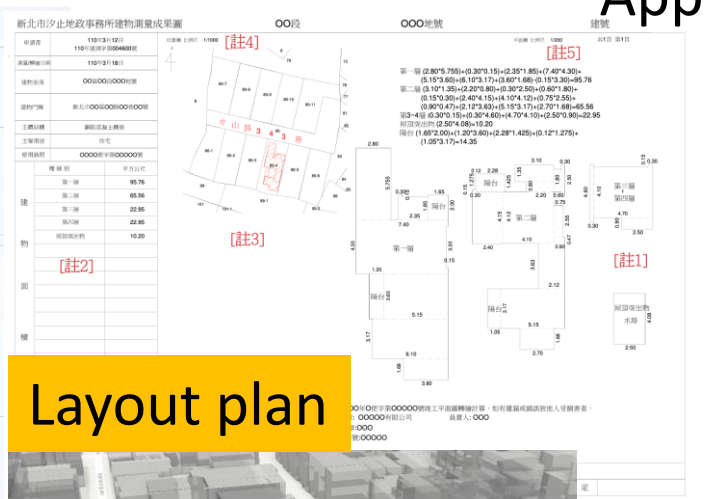
1/1000

Mesh

Indoor mapping ← function — Application — visualization → **Outdoor mapping**



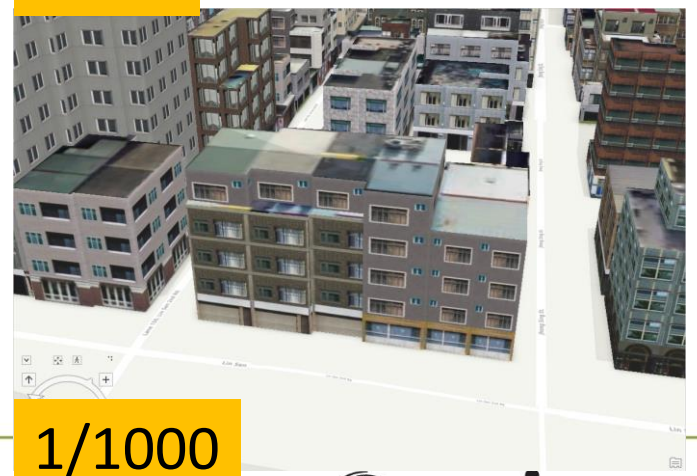
Floor plan



Layout plan

3D property building model

Mesh



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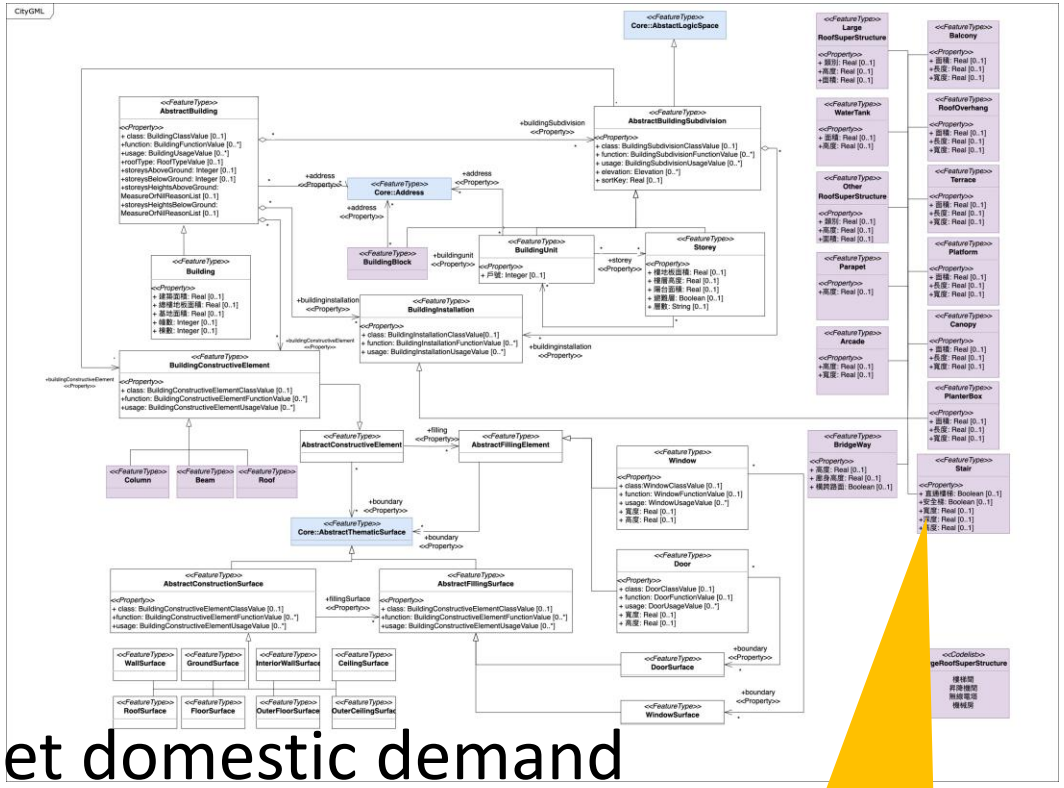
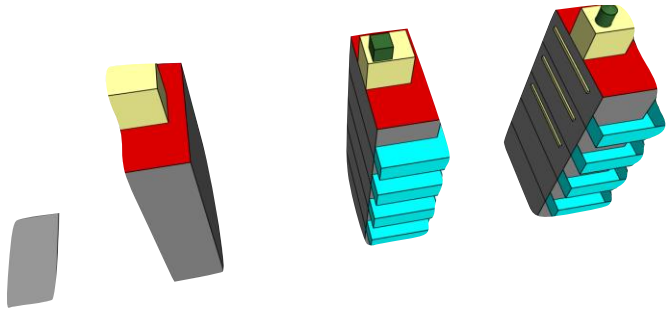
CityGML modelling and ID system



Meet domestic demand

ADE

General				
LOD	**LOD0**	**LOD1**	**LOD2**	**LOD3**
Feature Complexity	Maximum generalization	6m*6m/3m	4m*4m/2m	All detail
Dimensionality	Point/ Multicurve/ Multisurface	Solid/ Multisurface	Solid/ Multicurve/ Multisurface	Solid/ Multicurve/ Multisurface
Quality	Lower than LOD1	5m	2m	0.5m
Laws and Regulations				
Building blocks			•	•
Building	•	•	•	•
Storey	•	•	•	•
Household			•	•
Wallsurface		•(outer edge)	•	•
Floorsurface		•(outer edge)	•	•
Ceilingsurface		•(outer edge)	•	•
Roof superstructures		•	•	•
Bridge way		•	•	•
Arcades		•	•	•
Balcony		<--	•	•
Terrace		<--	•	•
Water tank/ water tower			•	•
Roof overhangs			<--	•
Canopy			<--	•
Planter box			<--	•
Platform			<--	•
Stair			<--	•
Parapet, firewall				•
Roof details				•
Door				•
Window				•



(a) (b) (c) (d)

LOD0 LOD1 LOD2

1/1000

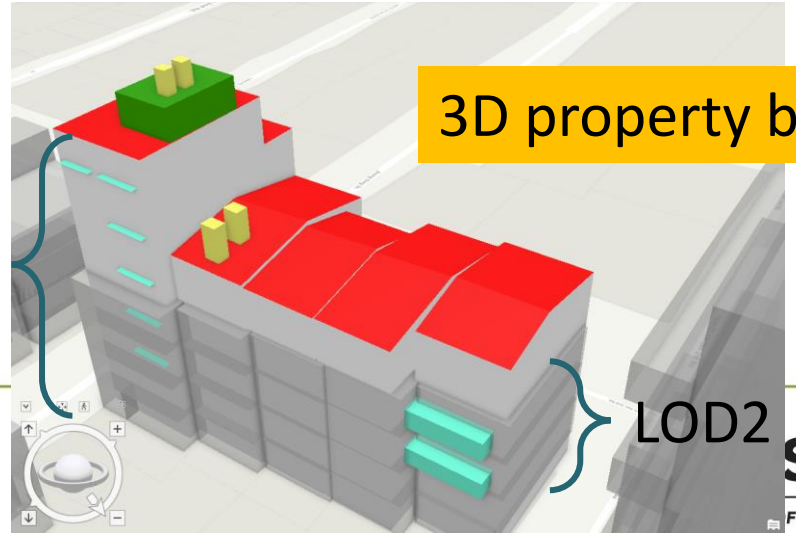
LOD1

Same building from different perspectives

overbuild

mesh

LOD2



3D property building model

LOD2

Cross domain application

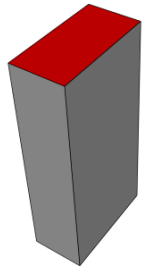
I want a building with balcony

Associate different levels of space units

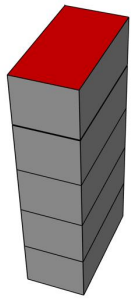
Building

Storey

Structure

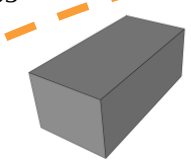


<lod1Solid>
1R8K75NV65



<lod1Solid>
1R8K75NV65

Aggregate
1R8K75NV65_001
1R8K75NV65_002
1R8K75NV65_003
1R8K75NV65_004
1R8K75NV65_005



<lod1Solid>
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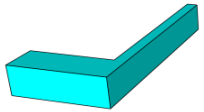
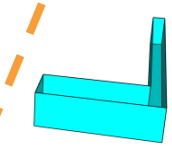


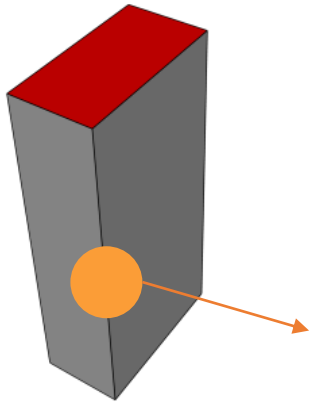
<lod1Solid>
1R8K75NV65_005_Balcony_01



<lod2MultiSurface>
1R8K75NV65_005_Balcony_01

Multi-representation

Cross domain application



store

<lod1Solid>
1R8K75NV65

5EPUFAQB_01252000

Business Registration
Tax ID number
Trading name
Trading address
Authorized capital
Date of Incorporation
Location of Company
Industrial classification
Database Time

Household
HouseholdID
HouseholdID_version
Building number
Address
Usage
Material
Completion date
CreationDate
TerminateDate
ValidFrom
ValidTo

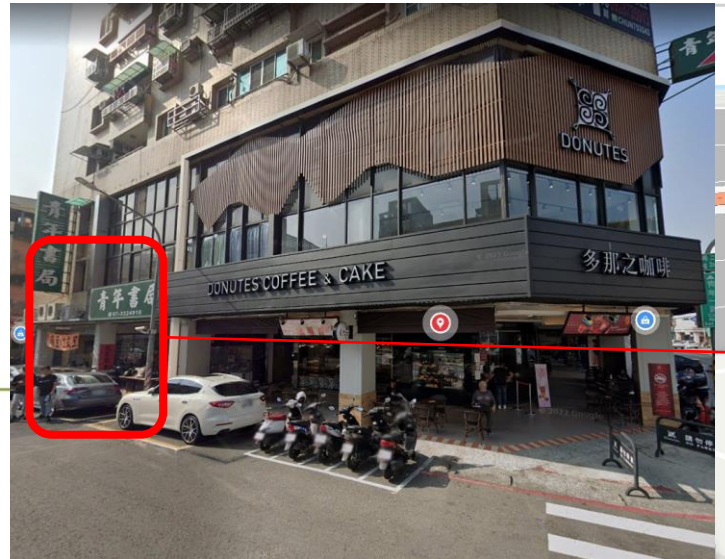
Building
BuildID

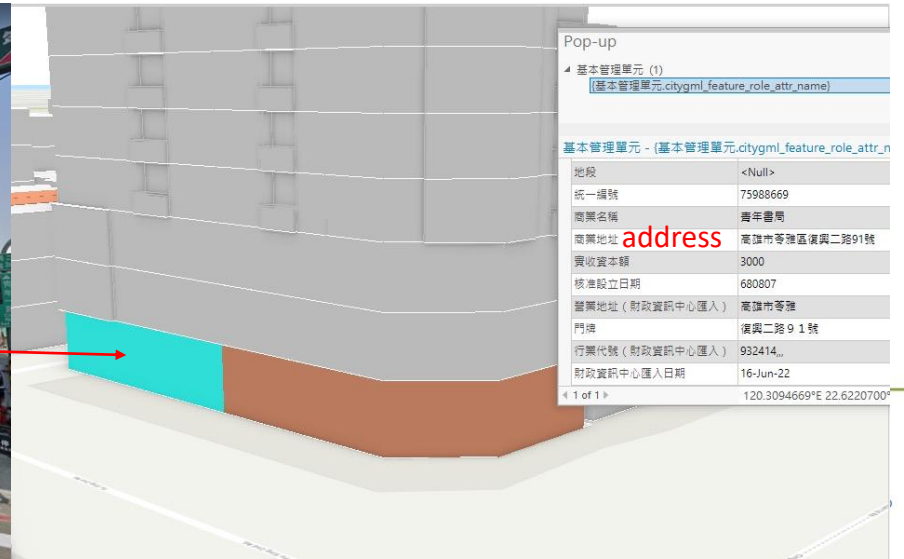
5EPUFAQB — LOD1, LOD2, LOD3

Storey
StoreyID

5EPUFAQB_001 — LOD1, LOD2, LOD3

Other building structure
StructureID





Conclusion

- Propose multi-level space unit framework in compliance with domestic building regulations and laws
- LOD specifications help clarify the specification of the space unit.
- Expanding data inter-connections and supports 3D analysis and app development.

Future work

- Build feature database
- Develop an environment for multi-level space unit

Thank You for Listening

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