WORKING WEEK 2025
AND
Locate25
THE NATIONAL GEOSPATIAL CONFERENCE
Collaboration, Innovation and Resilience: Championing a Digital Generation
FIG Geospatial Council of Australia
Brisbane, Australia 6–10 April

Utilizing the BIM-based standard for supporting 3D digital representation of legal spaces in major infrastructure projects

Authors:

Lanxuan Shen (PhD Candidate, Presenter)
Dr. Behnam Atazadeh
Dr. Serene Ho
Prof. Abbas Rajabifard

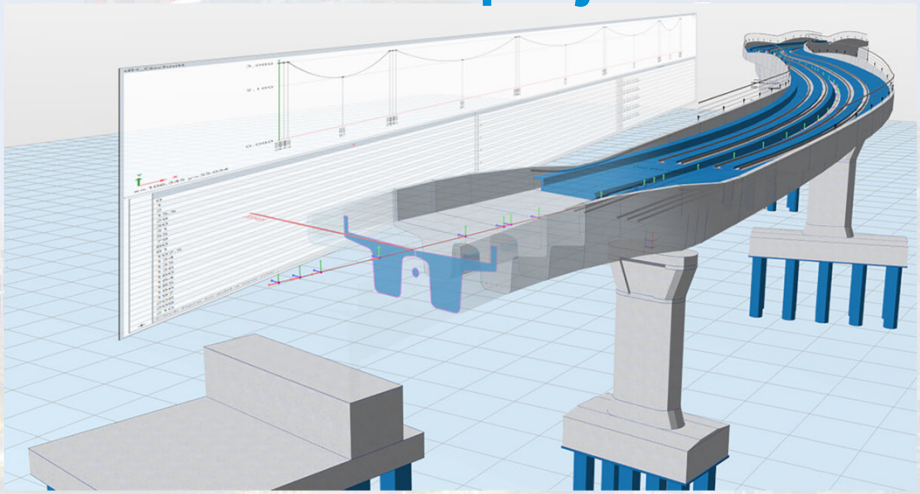

FIG Working Week 2025, Brisbane, Australia
3D Land Administration and LADM II (C7)
9 April 2025

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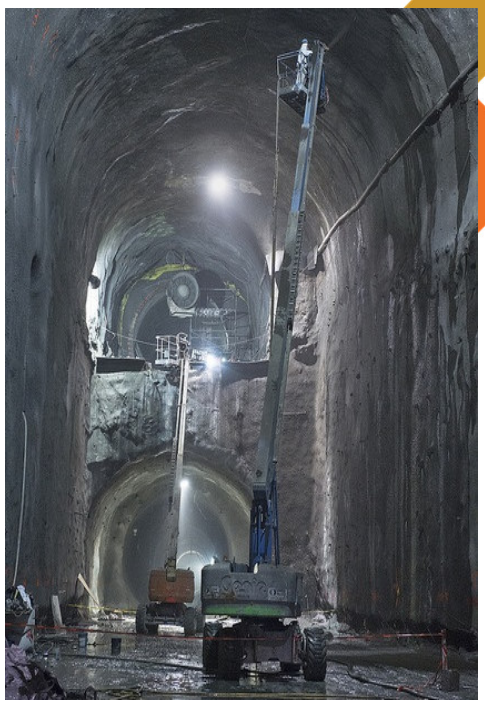
Overview

- Introduction
- Methodology
- Requirements for Major Infrastructure Projects
- IFC Pertinent Entities for 3D Land Administration
- Prototype 3D Model for Major Infrastructure Projects
- Discussion & Future Works

Major Infrastructure Projects & Value



- **Essential Services & Resilience**

Critical for ensuring the continuous delivery of essential services (water, energy, transport, telecommunications)

- **Strategic Funding**

$225 billion is allocated for general government sector infrastructure funding, by 2023-2024 (A pathway to infrastructure resilience, 2021)

⇨ **Complex spatial relationship & Large scale**

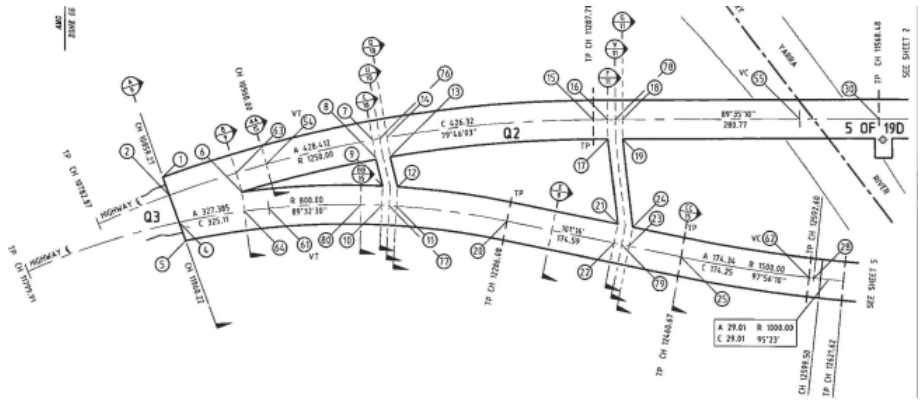
Challenges in land administration for major infrastructure

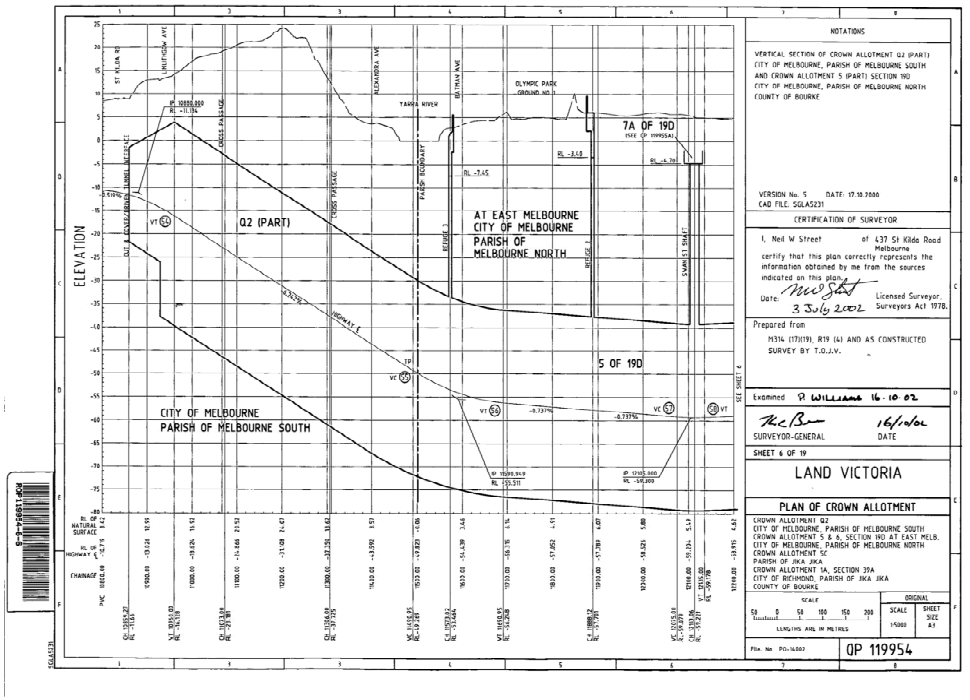
- **Complexity of legal space representation**
  - ***Unlike buildings:***
  1. span multiple land parcels,
  2. cross public and private properties,
  3. extend above and below ground

  - ***Challenges in defining:***
  1. ownership spaces/boundaries,
  2. RRRs (Rights, Restrictions, and Responsibilities)

Challenges in land administration for major infrastructure

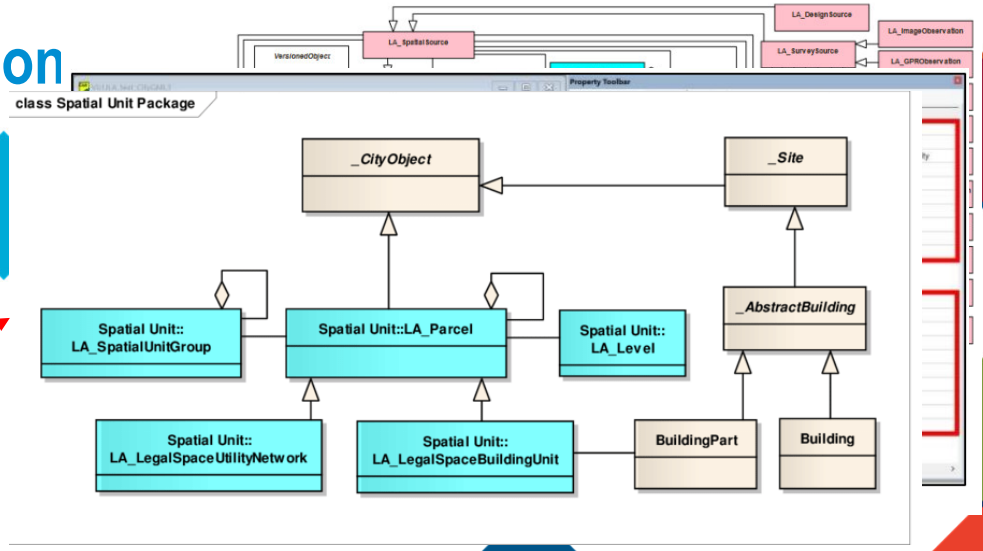
- **Traditional 2D Land Administration Methods**
  - ***Scale issues:*** *complex spaces & dynamic boundaries*
  - ***Spatial issues****: overlaps & potential conflicts*
  - ***Visualization issues:*** *relationships between structures*





Current 3D data models for land administration

Model type	Data model	Example
Legal data model	ePlan, LADM I & II	Kara et al., 2024
Physical data model	CityGML & LandInfra	Saeidian et al., 2023
Integrated data model & extensions	CityGML-LADM	Saeidian et al., 2023
	LADM-IndoorGML	Kim et al., 2021



Limitations for major infrastructure projects

Limitations for major infrastructure projects

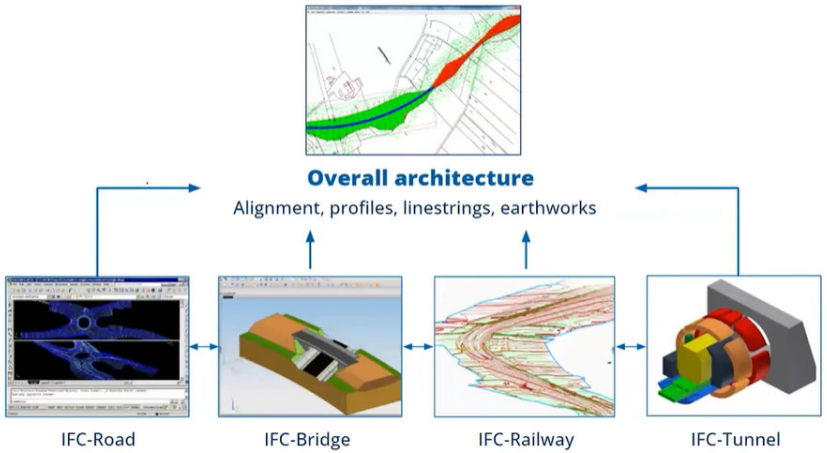
Limitations for major infrastructure projects

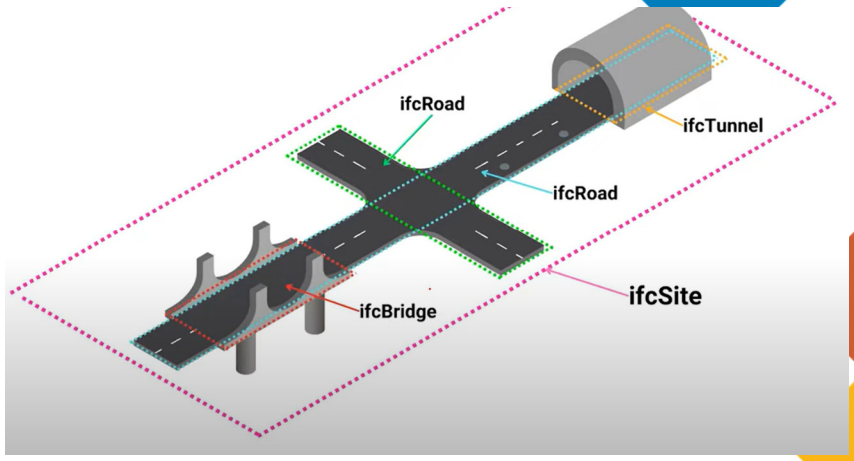
- City scale cannot fully represent major infrastructure projects.
- Limited handling of complex geometries.
- Limitations of 3D representation of level of details.
- At early stage, not mature and widely used yet.
- Legal data representation

BIM-based data model for legal spaces

- ***IFC standards:***

Physical structures + Legal Rights, Restrictions, Responsibilities (RRRs) information





Problem

- Current land administration systems and 3D data models lack the capability to accurately **represent, integrate, and manage legal spaces in major infrastructure projects**. This research investigates **how IFC can be adapted to support the 3D digital representation of legal spaces** in these projects.

Aim

- Aims to explore how the **IFC standard** can be harnessed to support the **3D digital representation** of **legal spaces** in major infrastructure projects.

Methodology

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1.Major infrastructure projects

2.Legal spaces in Victoria, Australia

1)Primary parcels

2)Secondary interests

STEP 1: Requirements

STEP 2: Relevant IFC entities

1.IFC entities examination and investigation

2.BIM for physical data modelling

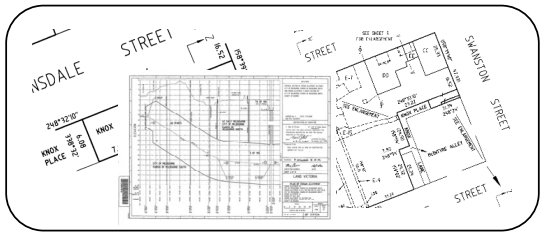
1.Case area selection in Victoria, Australia

1)A part of tunnel project and surrendering structures

2.Prototype IFC model creation and visualization

1)Integration of physical and legal data

STEP 3: Prototyping



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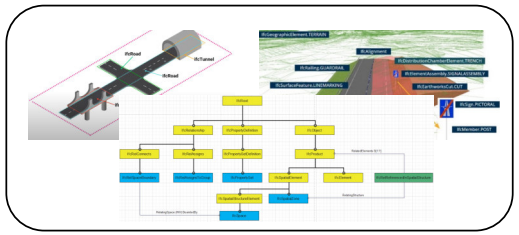

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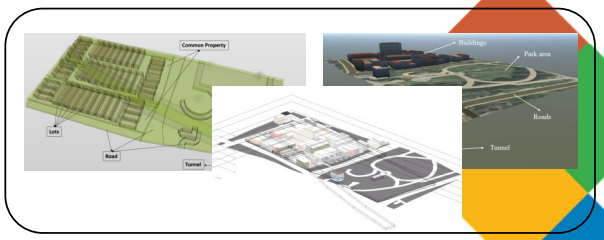


Requirements

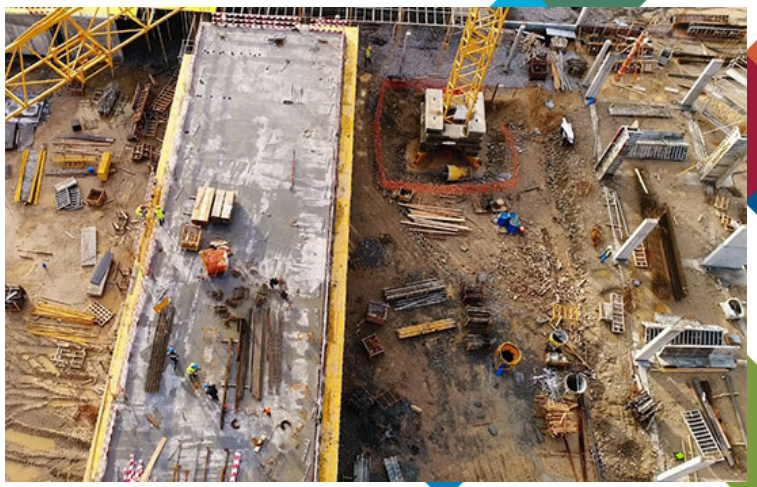
- **Physical data**
  - *Built environment data*
  - *Natural environment data*
- **Legal data**
  - *3D Legal spaces*
  - *3D Legal boundaries*
  - *Survey data*

STEP 1: Requirements | STEP 2: Relevant IFC entities | STEP 3: Prototyping

Requirements

- **Physical data for infrastructure projects**

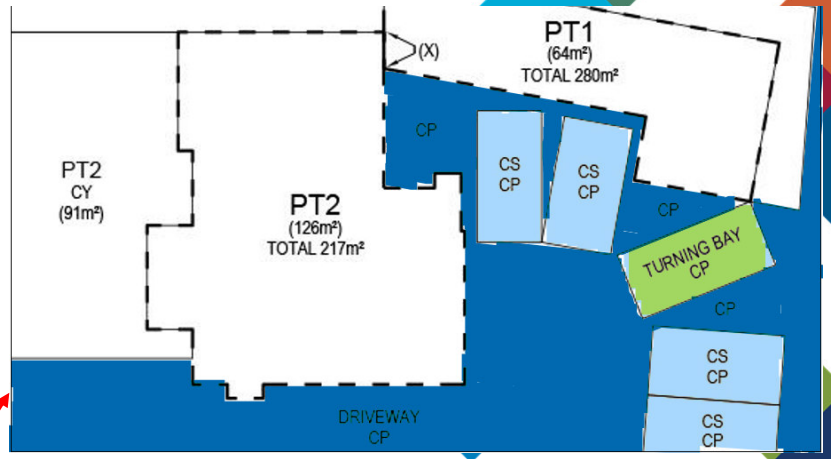
Physical data	Explanation and examples
Built environment data	For **transport infrastructure** like tunnels, bridges, roads, and railways, this includes dimensions (e.g., length, width, height), materials, and capacity.
	Utility networks, including electricity, water, gas, and telecommunication systems, require information on cable and pipeline positions, material types, and network layout.
Natural environment data	For **transport infrastructure**, this includes soil composition, groundwater levels, and climate patterns such as temperature and humidity, which impact structural stability.
	Utility networks require environmental considerations, such as underground conditions, water quality monitoring, and the impact on local ecosystems.

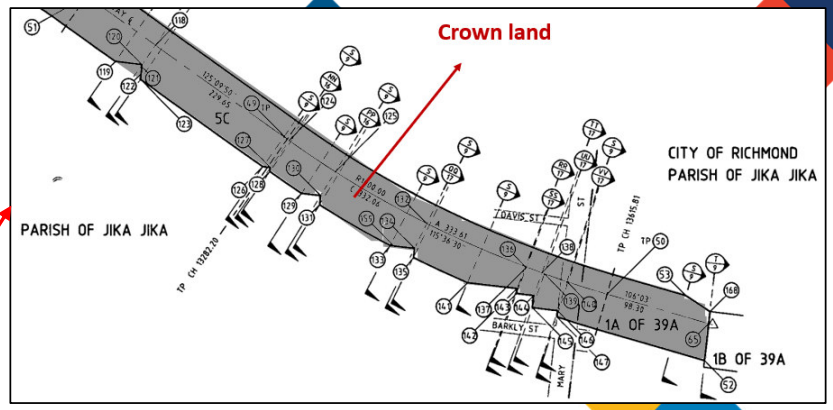


Requirements

- **Legal spaces for infrastructure – Primary parcels**

3D Legal spaces	Examples
Primary parcels	
Lot and Stage Lot	E.g. Buildings, storage, basements, shopping malls, private parking, etc.
Common Property	This interest is for the benefit and use of some/all lots and is defined by unlimited (for the benefit of all owners) and limited (must be used by a specific group of owners) common property.
Reserve	E.g. Parks or similar amenities
Road	E.g. Carriageway, pavement, verge, curb, etc.
Crown Land – Crown Allotment/Portion	E.g. Railways, tunnels, public parking, walkways, train stations, etc.

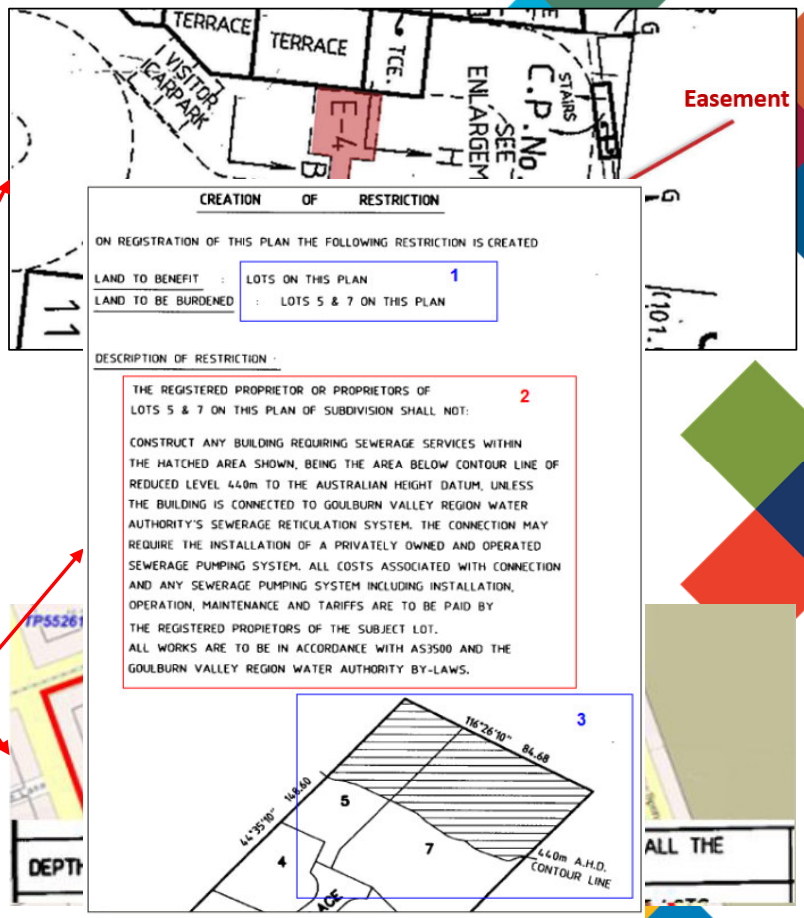




Requirements

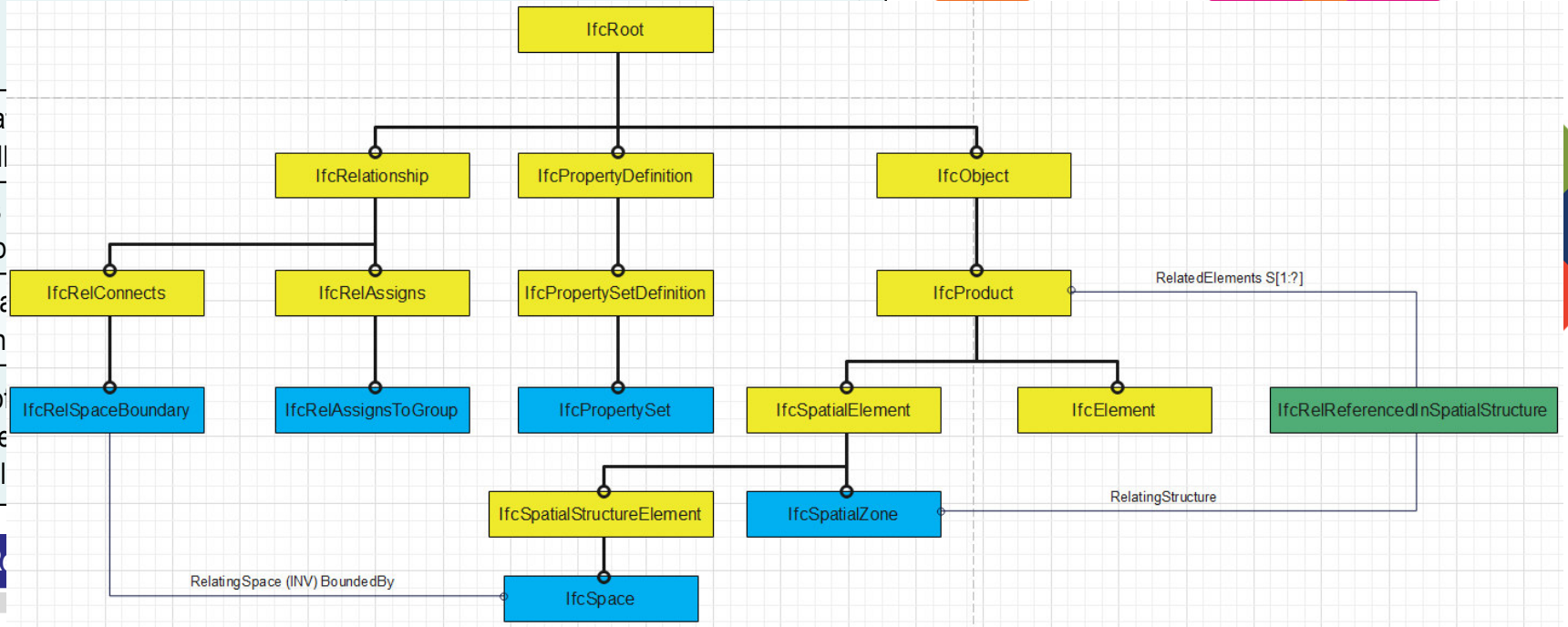
- **Legal spaces for infrastructure – Secondary interests**

Secondary interests	
Easement	E.g. Pathways and walkways for the supply of utilities.
Depth Limitation	E.g. Restrictions on the depth of water, electricity, gas, sewerage pipelines, tunnels, excavation depth for bridge foundations, etc.
Airspace	E.g. Height restrictions for buildings, bridges, construction equipment, telecommunications towers, etc.
Restriction	E.g. Building height restrictions, vegetation restrictions, environmental protection areas, etc.
Crown Land Service	E.g. Granting permits, leases, or licenses



IFC Pertinent entities for 3D land administration

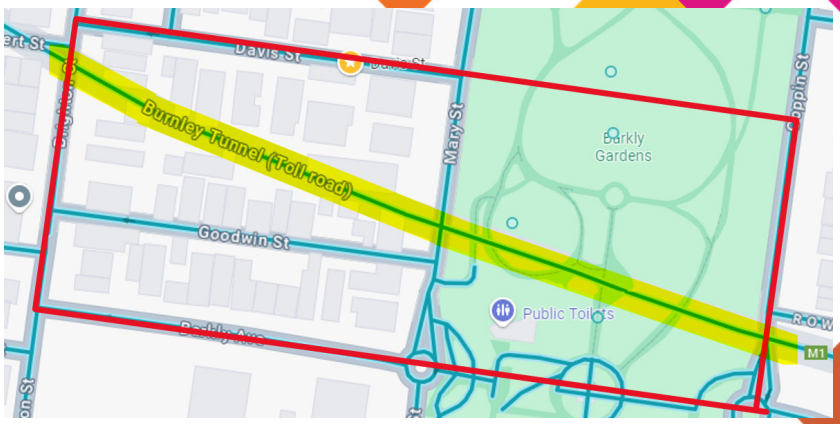
IFC entities	Description of relevant legal data
IfcSpace	It can be utilized to define the boundaries of legal spaces such as land parcels or rights of way. This entity can easement.
IfcPropertySet	Allows for the a LandUse, Legall
IfcZone	Multiple spaces components rep
IfcRelSpaceBoundary	Defines the rela boundaries of th
IfcRelAssignsToGroup	Links a group o example, a serie contract or legal



STEP 1: Requirements STEP 2: R

Prototyping

1) Infrastructure assets in the selected area – Victoria, Australia

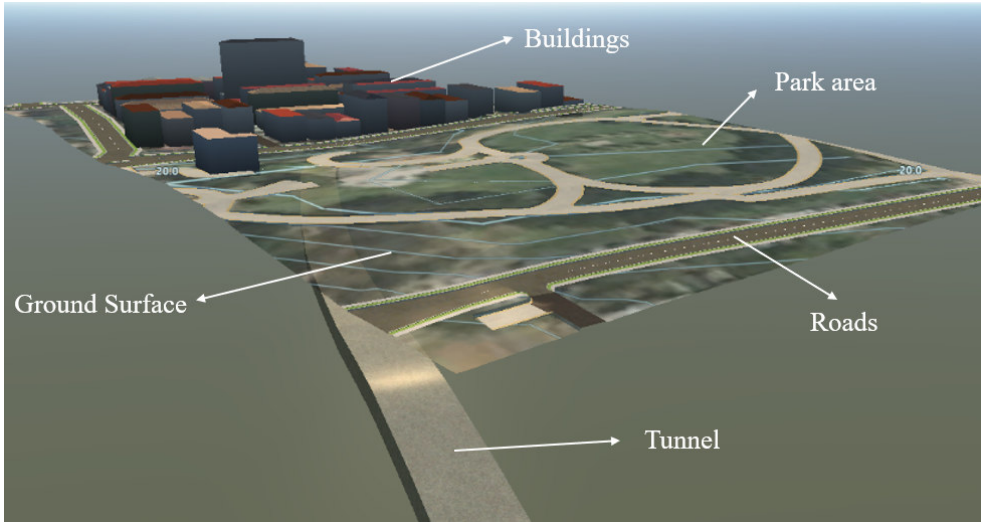


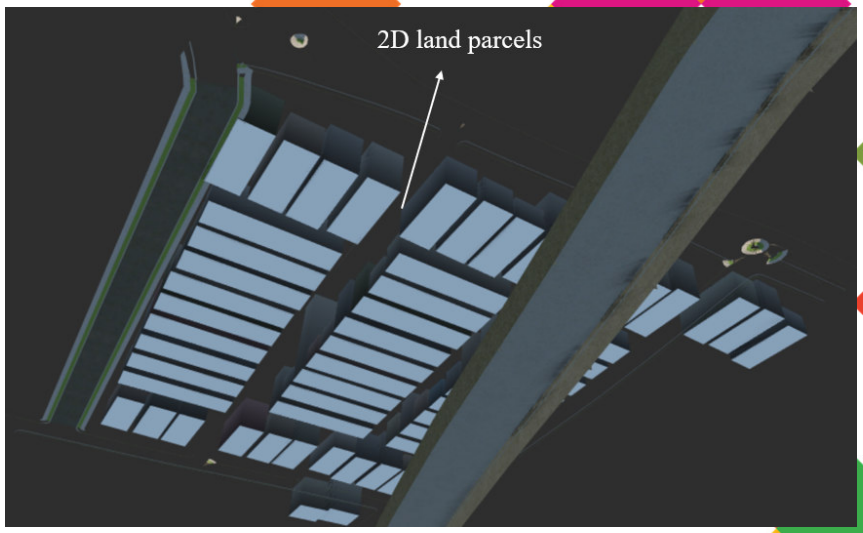
(Burnley Tunnel project, Melbourne)

STEP 1: Requirements | STEP 2: Relevant IFC entities | **STEP 3: Prototyping**

Prototyping

2) Physical 3D model creation

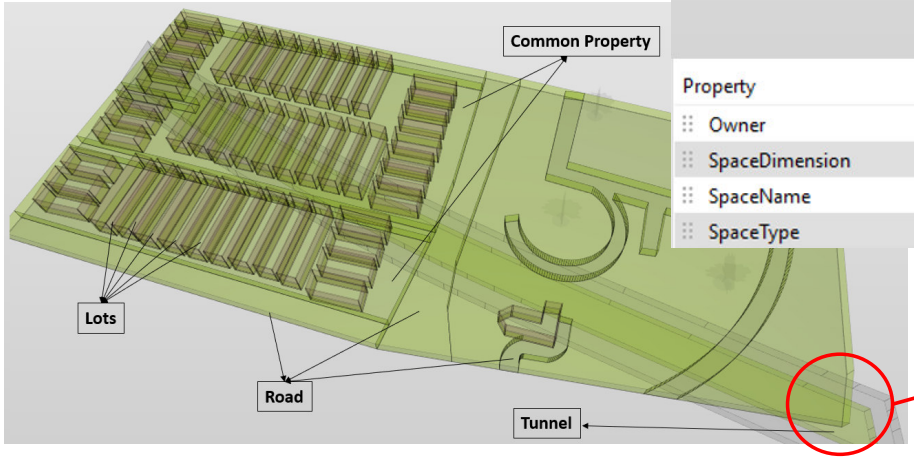


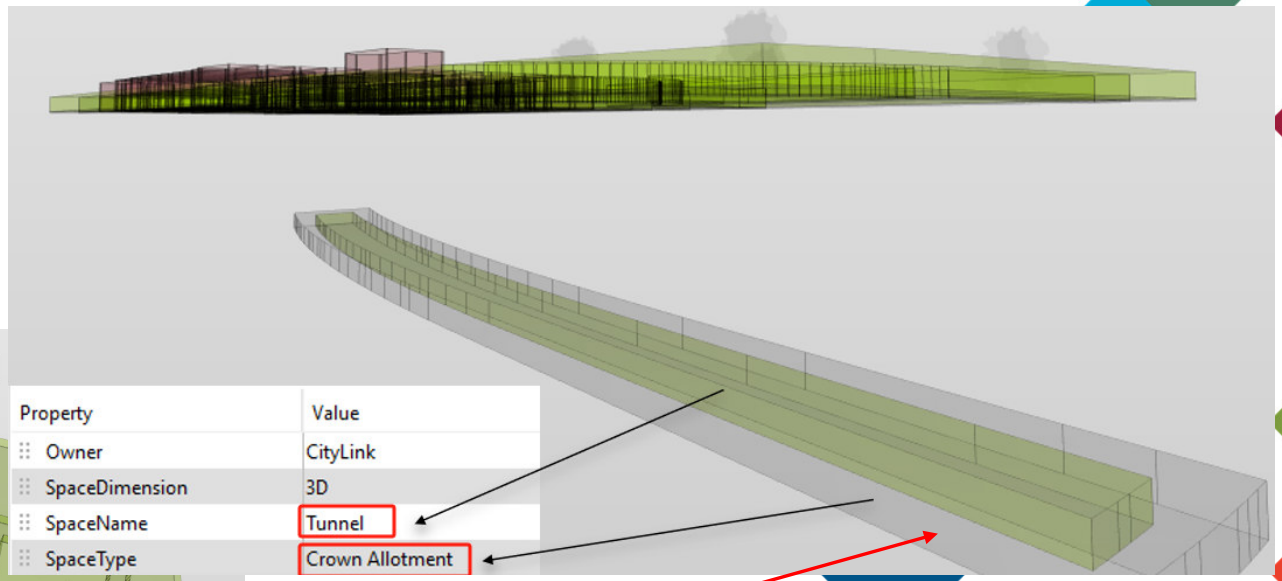


STEP 1: Requirements | STEP 2: Relevant IFC entities | STEP 3: Prototyping

Prototyping

3) Legal 3D model creation



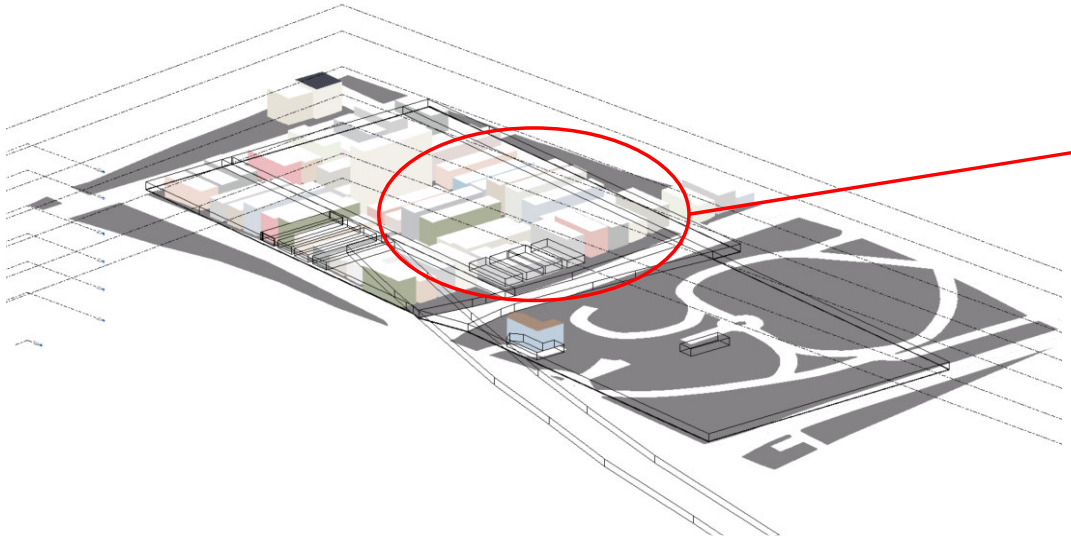


Property	Value
Owner	CityLink
SpaceDimension	3D
SpaceName	Tunnel
SpaceType	Crown Allotment

STEP 1: Requirements | STEP 2: Relevant IFC entities | STEP 3: Prototyping

Prototyping

4) Integration and visualization



STEP 1: Requirements | STEP 2: Relevant IFC entities | STEP 3: Prototyping

Discussion

Benefits:

- **Enhanced Data Integration –** with IFC framework, improving communication among surveyors, land registries, and other stakeholders
- **Support for Complex Infrastructure –** for legal spaces/boundaries in land and property data management
- **Foundation for Digital Cadastres –** contributes to the roadmap towards 3D cadastre development

Limitations:

- **IFC Capability Limitations –** current IFC standard does not fully support infrastructure-specific legal space modelling and lacks seamless integration with LADM
- **Data Requirement Validation Gaps –** the legal data requirements were primarily derived from literature and local sources, with limited industry consultation
- **National & International insight**

Future Works

- **Enhancing IFC for 3D Land Administration**
  - Investigate IFC4.3 capabilities for infrastructure-specific legal space modelling.
  - Develop an IFC-LADM integration framework for improved interoperability.
- **Refining Legal Data Requirements through Industry Engagement**
  - Conduct consultations with surveyors, land registries, and infrastructure planners to ensure the IFC-based framework aligns with real-world cadastral needs.
  - Address surveying workflows for accurately capturing and integrating 3D legal boundaries in infrastructure projects.
- **Expanding Case Studies & Global Applicability**
  - Apply the framework to different countries with varying land administration policies.
  - Explore how LADM-based extensions and ISO LADM Part 6 align with IFC-based solutions.

Thank you for listening!

Lanxuan Shen

PhD Candidate

lanxuan@student.unimelb.edu.au

The Centre for Spatial Data Infrastructures and Land Administration (CSDILA),

Department of Infrastructure Engineering,

The University of Melbourne

Question?

Suggestion?

The most relevant SDGs related to the presentation and theme of this session

1st relevant SDG

2nd relevant SDG

3rd relevant SDG

SUSTAINABLE DEVELOPMENT GOALS

International Federation of Surveyors supports the Sustainable Development Goals