# Reconstructing Land Tenure Maps of Australia in 3D

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DIGITAL TWIN & LAND TENURE ENGINEERING LAB @UNSW

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# Australian Research Council (ARC) Project No 3

## Reconstructing Land Tenure Maps of Australia in 3D

- Validation rules for back-captured 3D survey plans (strata, building, stratum)

## Partner

- ICSM

## Outcomes

- Two higher degree graduates to work for ICSM members

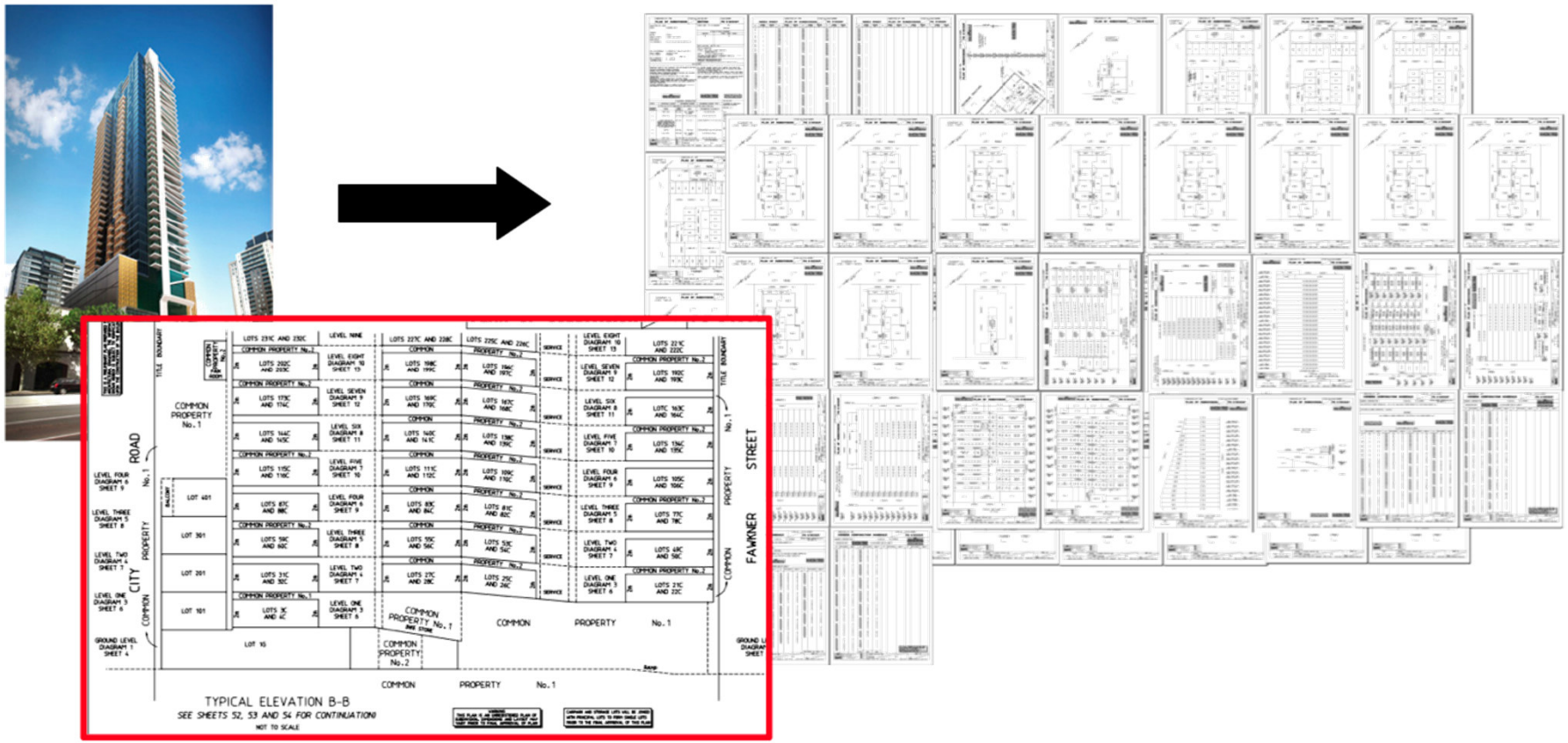
## Broader Impact

- New knowledge that benefits Australia and Beyond

Australian Government
Australian Research Council

ICSM
ANZLIC COMMITTEE ON SURVEYING & MAPPING

# 3D cadastre in practice (2012)



# ARC Linkage project – No 1

Australian Government
Australian Research Council

1. Where would the 3D data come from?
2. What elements need to be included in a 3D cadastral model and how?
3. How best can we visualise 3D cadastral data?

***Investigators***: Ian Williamson, Abbas Rajabifard, Mohsen Kalantari

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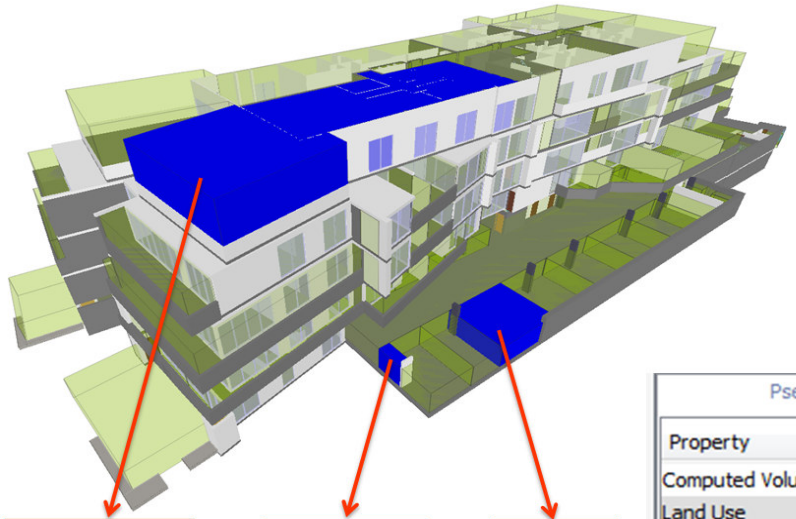
# Where would the 3D data come from?

## Design Stage (BIM)

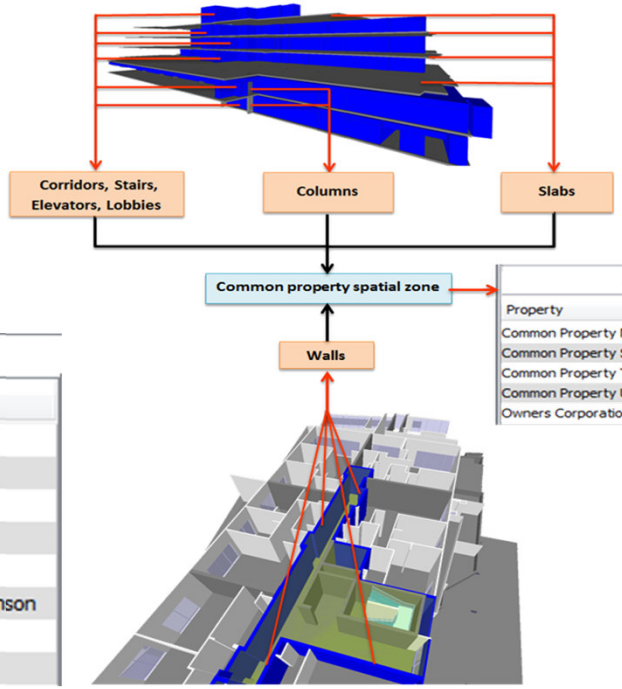

## Verification Stage (Laser Scanning)

# What elements need to be included in a 3D cadastral model and how?




Pset_PrivateProperty

| Property | Value |
|---|---|
| Computed Volume | 625.09 m3 |
| Land Use | Residential |
| Lot Entitlement | 40 |
| Lot Liability | 55 |
| Lot Name | LOT-303 |
| Lot Owner | Ms. Kate Johnson |
| Private Property State | Created |
| Private Property Unit | MultiPart |

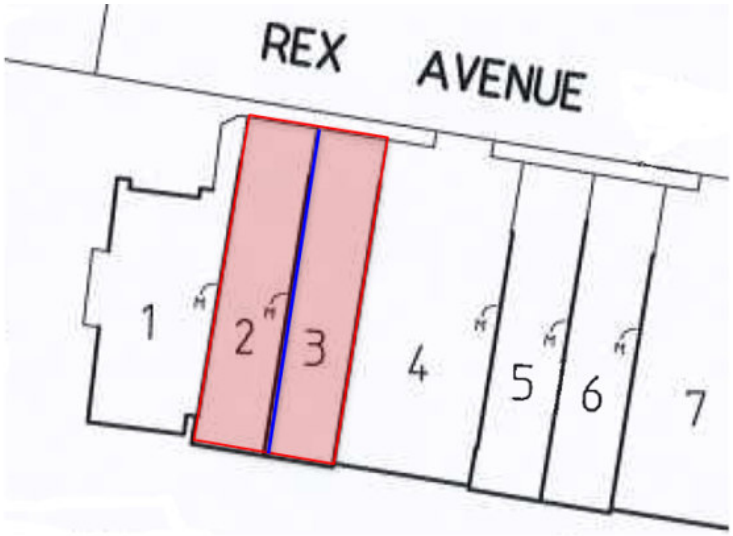


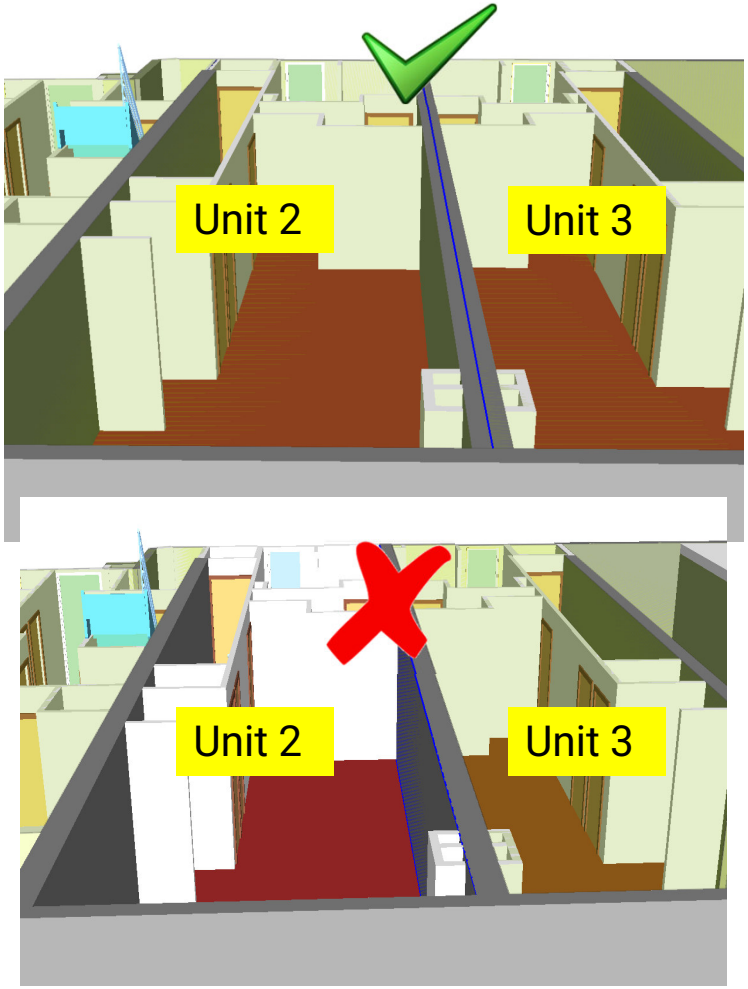

Pset_CommonProperty

| Property | Value |
|---|---|
| Common Property Name | Common Property No. 1 |
| Common Property State | Created |
| Common Property Type | Unlimited |
| Common Property Unit | MultiPart |
| Owners Corporation | Knight Alliance |

Courtesy of **Dr. Behnam Atazadeh**

# What elements need to be included in a 3D cadastral model and how?




Courtesy of **Dr. Behnam Atazadeh**

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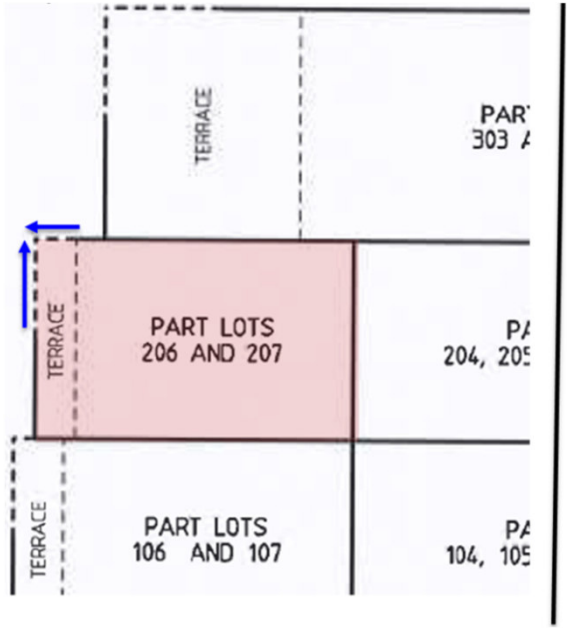
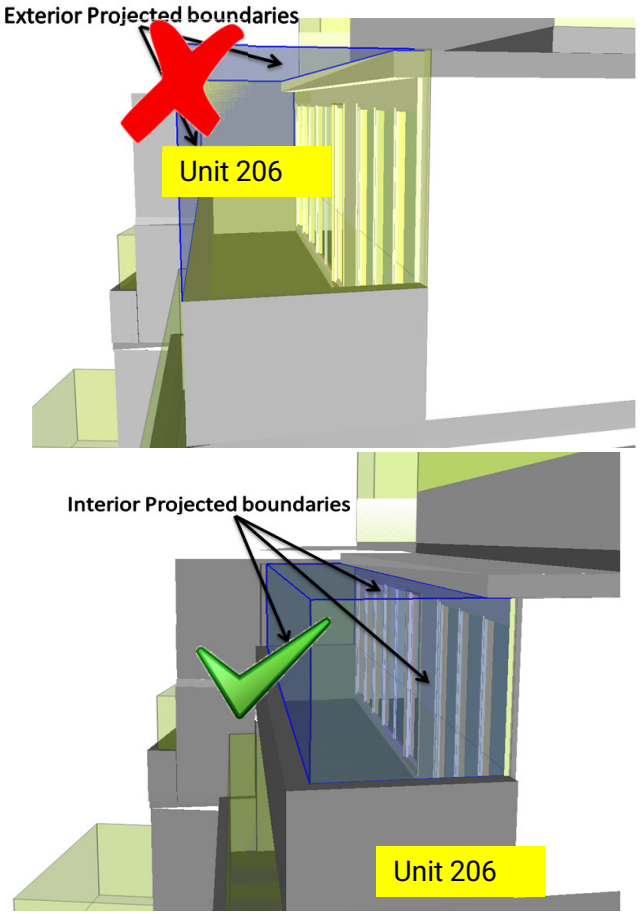
# What elements need to be included in a 3D cadastral model and how?




Courtesy of **Dr. Behnam Atazadeh**

# Where would the 3D data come from?

| Device | Data Collection | Data Processing | Data Accuracy | Data Completeness |
|---|---|---|---|---|
| **Device 1** | More efficient | Comparable | 19mm | More efficient |
| **Device 2** | More efficient | Comparable | 34mm | More efficient |
| **Device 3** | More elaborate | More elaborate | 7mm | More efficient |

Courtesy of Association of Land Surveyors Malaysia

# How best can we visualise 3D cadastral data?


Courtesy of
**Dr Davood Shoajei**

Source: https://www.spear.land.vic.gov.au/spear/pages/eplan/3d-digital-cadastre/3dprototype/prototype.html

# ARC Linkage – No 2

Australian Government
Australian Research Council

1. What elements need to be included in a city scale 3D cadastral model and how?

2. How do you ensure the validity of a 3D cadastral model?

VICTORIA State Government

CITY OF MELBOURNE

ICSM ANZLIC COMMITTEE ON SURVEYING & MAPPING

***Investigators***: Abbas Rajabifard, Mohsen Kalantari

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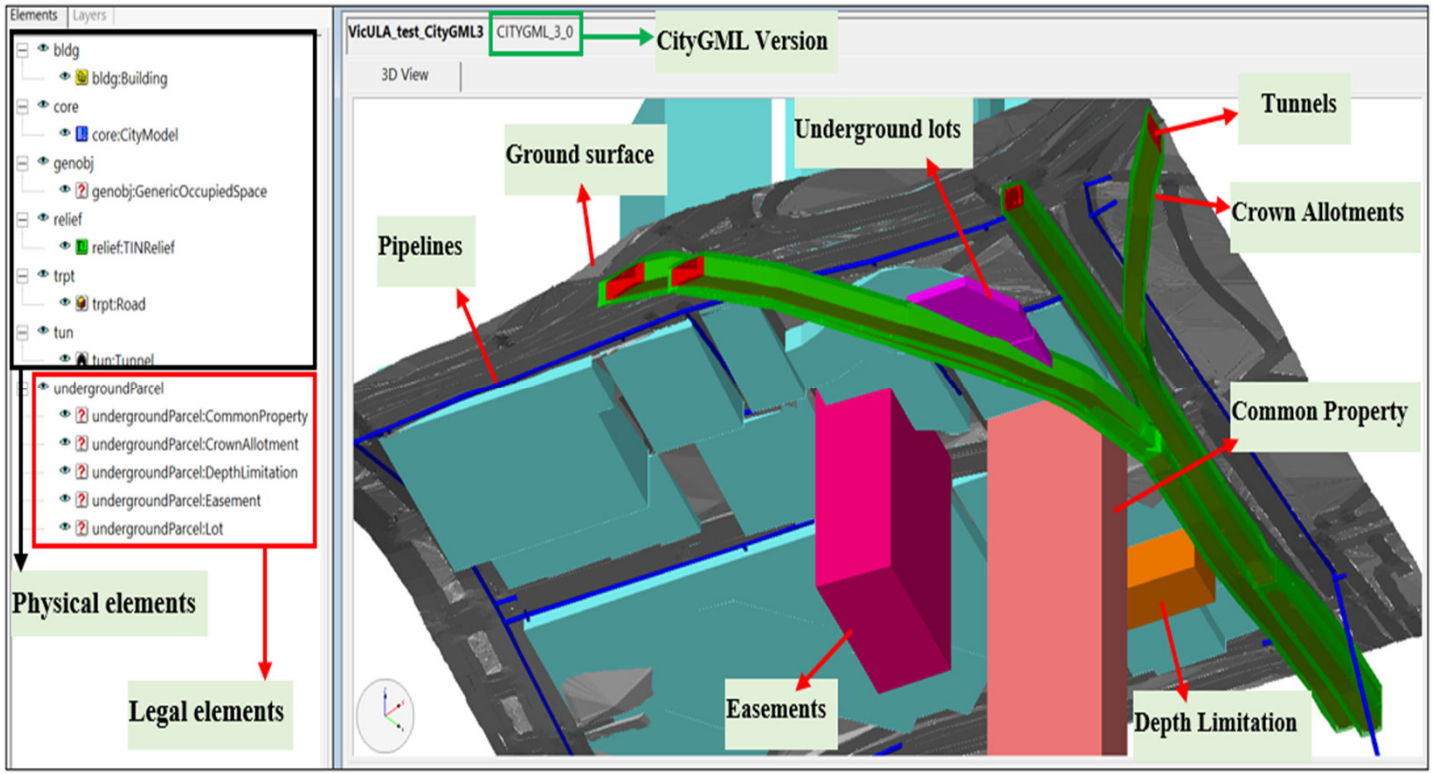
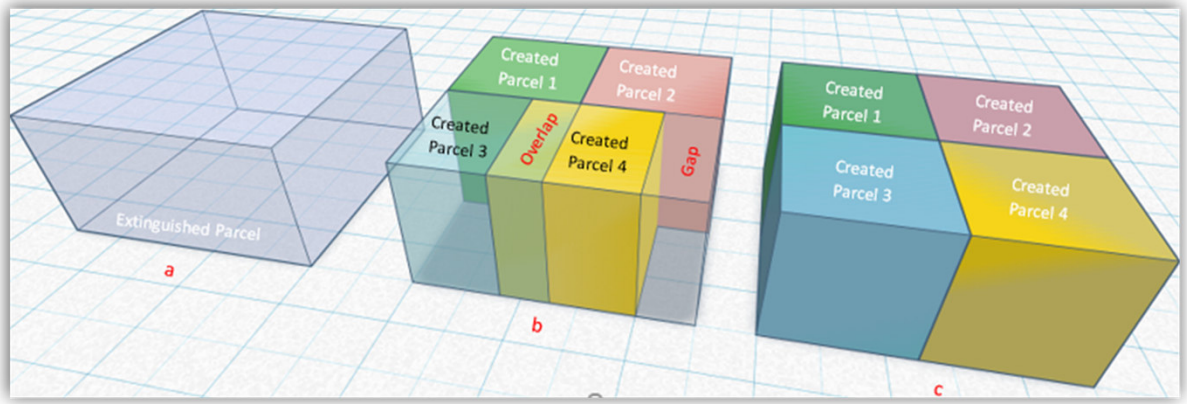
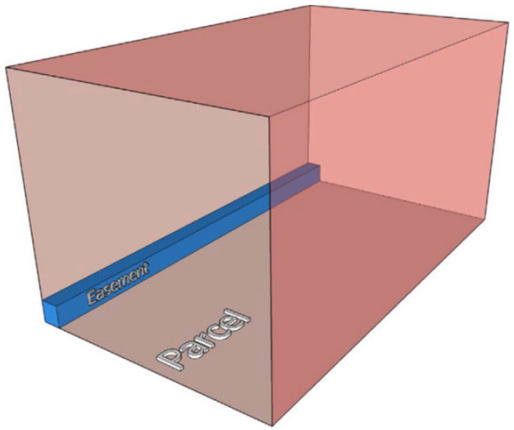
# What elements need to be included in a city scale 3D cadastral model and how?




Courtesy of **Dr. Bahram Saeidian**

# How do you ensure the validity of the model? Legal

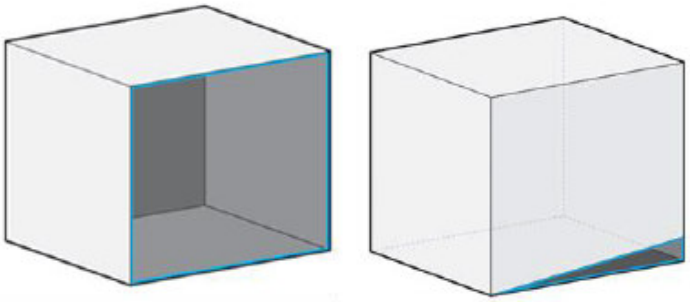


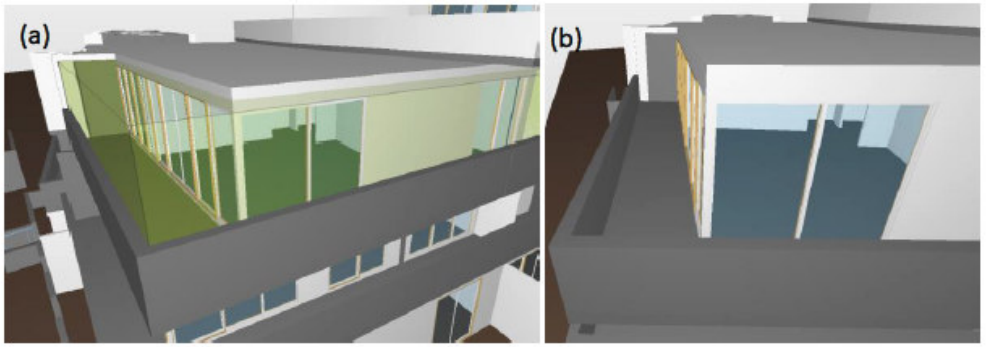

Courtesy of Dr **Ali Asghari**

# How do you ensure the validity of the model? Legal/Spatial

Watertightness



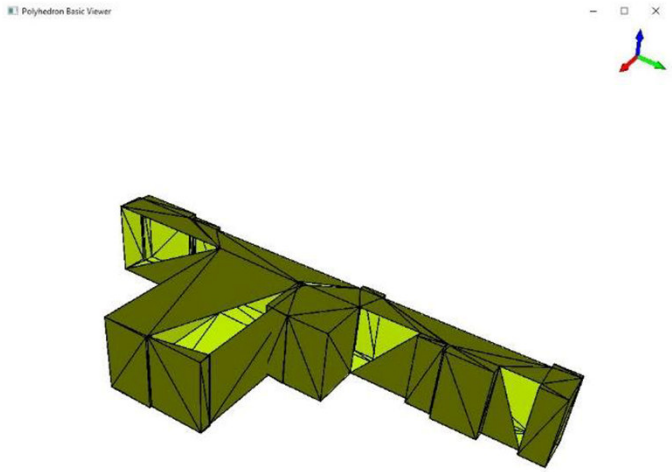
E.g. projected boundaries




Courtesy of Dr **Ali Asghari**

# How do you ensure the validity of the model? Spatial

## Validating spatial integrity




```
Internal Spatial Consistency Report...

Data Name: 4_self-intersected_Flipped_non-watertight.off
Data Type: 3D Polyhedral model consisted of triangles.

Checking vertices...
Number of vertices: 86
Minimum and Maximum vertex in-degree: (3,10)

Checking edges...
Number of edges and halfedges: (252,504)
Number of border edges: 12

Checking faces...
A total number of 164 faces including:
164 trinagle(s), 0 quadrat(s), and 0 arbitrary face(s).
Minimum and Maximum face degree: (3,3)

Primitive Checks...
Number of nonplanar faces: 0
Self-intersection status: The 3D object is self-intersected.
Pairs of faces intersected:11
Number of collinearity detected: 0
Orientation status: The 3D object is not correctly oriented.

Advanced Check...
Closure status: The 3D object is not Watertight!
Number of holes detected: 4
```

Courtesy of Dr **Ali Asghari**

# How do you ensure the validity of the model? Functional

The proportion of functional spaces (A1.1.1) for providing essential services* defined as part of unlimited CP (O1.2.3.1) to all functional spaces for providing the essential services

| Indicator | Importance | | |
|---|---|---|---|
| | Surveyor | OC expert | Total Avg. |
| I01.Structural building components as parts of unlimited common property (CP) | 4.17 | 5.00 | 4.55 |
| I02.Essential services as parts of unlimited CP | 4.42 | 5.00 | 4.82 |
| I03.Composition of limited CPs to support the use of all lots in limited OC | 4.50 | 5.00 | 4.82 |
| I04.Easement for services to secure lots' essential services | 4.29 | 4.55 | 3.45 |
| I05.Lots holding memberships of the OCs managing CPs that provide services for their beneficial use | 4.30 | 4.64 | 4.64 |
| I06.Occupiable lots delineated by building boundaries | 4.36 | 4.70 | 4.82 |
| I07.Physical building elements used as boundaries between occupiable lot and CP | 4.40 | 4.74 | 4.82 |
| I08.Physical building elements used as boundaries between unlimited and limited CP | 4.38 | 4.75 | 4.45 |
| I09.An appropriate number of limited OCs to represent different usage of lots | 4.33 | 4.73 | 4.27 |
| I10.Separate circulation in each CP solely used by each OC | 4.32 | 4.60 | 3.82 |
| I11.Separate entry in each CP solely used by associated OC | 4.27 | 4.47 | 3.55 |
| I12.Separate recreational and hygiene amenities in associated CP | 4.26 | 4.35 | 3.64 |
| I13.Fairly allocation of lot liability proportional to its area | 4.28 | 4.34 | 4.36 |
| I14.Fairly allocation of lot entitlement proportional to its area | 4.31 | 4.31 | 4.36 |
| I15.Consistency in boundary location delimiting all occupiable lots with the same usage | 4.32 | 4.33 | 4.55 |
| I16.Unobstructed paths from all occupiable lots to amenities of their CP | 4.31 | 4.38 | 4.55 |
| I17.Unobstructed paths from all occupiable lots to building service support areas of their CP | 4.30 | 4.41 | 4.55 |
| I18.Unobstructed paths from all occupiable lots to waste management areas of their CP | 4.30 | 4.44 | 4.55 |
| I19.Unobstructed paths from all occupiable lots to their part lots | 4.29 | 4.47 | 4.55 |
| I20.Easement of access to secure lots' unobstructed paths to their properties | 4.28 | 4.50 | 4.55 |
| I21.Lot with parking as a part lot | 4.21 | 4.38 | 2.45 |
| I22.Lot with storage as a part lot | 4.13 | 4.31 | 2.55 |

Courtesy of Dr **Jihye Shin**

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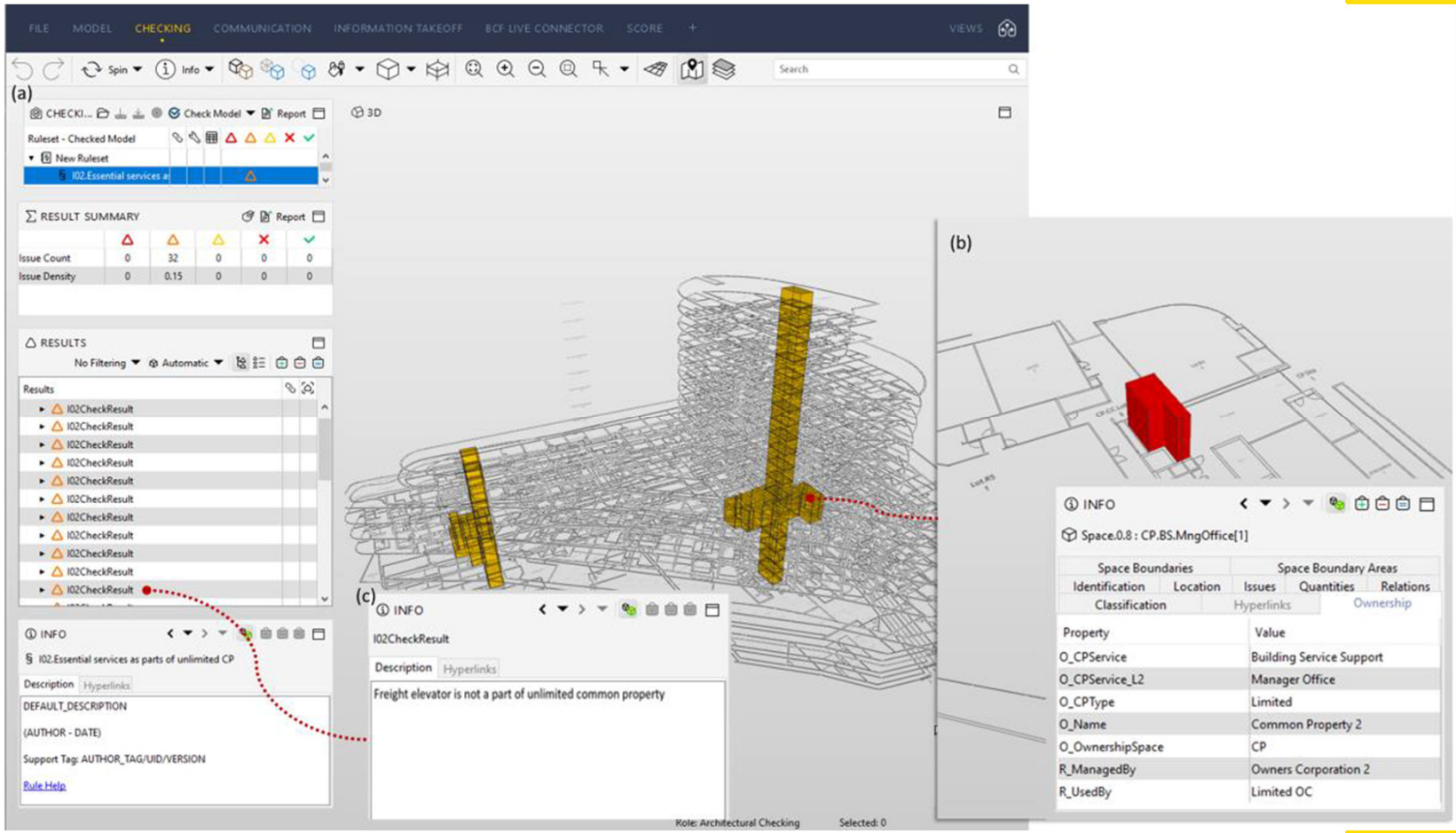
# How do you ensure the validity of the model? Functional




Courtesy of Dr **Jihye Shin**

# Progress in practice (2022)

Display options [show]

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## ICSM Conceptual Model for 3D Cadastral Survey Dataset Submissions

**Intergovernmental Committee on Surveying and Mapping**

Submission Date: 18/03/2022

Approval Date: <yyyy-mm-dd>

Publication Date: <yyyy-mm-dd>

External identifier of this document: **https://linked.data.gov.au/def/csdm/2022**

Internal reference number of this document: 21-CAD

Version: 1.0

Category: ICSM Implementation Specification

Editors: Rob Atkinson

Contributors: Andrew Hunter, Byron Cochrane, Jeff Needham, Adrian White, Murray Dolling, Roger Fraser, Nicholas J. Car, Matthew Purss & Simon Opper

**ICSM Conceptual Model for 3D Cadastral Survey Dataset Submissions**

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[TBD]

**Warning**

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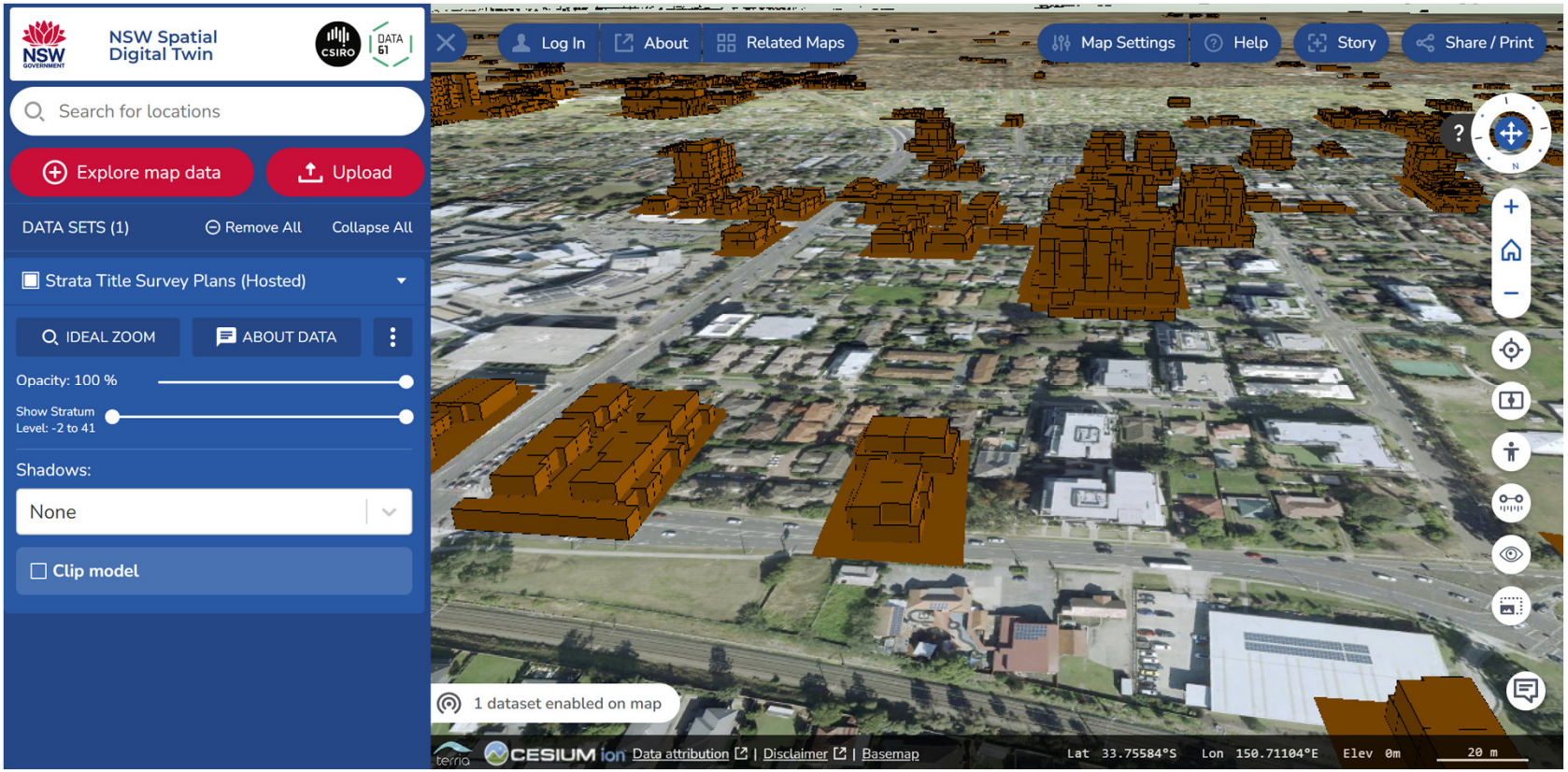
# Progress in practice (2024)



# ARC Project No 3

How do you ensure the validity of the 3D CSDM?
(georeferencing and alignment strata/stratum plans in NSW and building subdivisions in Victoria with digital twins and topographic features)

How do we ensure the interoperability of 3DCSDM with the design models? (IFC)

Australian Government
Australian Research Council

ICSM
ANZLIC COMMITTEE ON SURVEYING & MAPPING

***Investigators***: Mohsen Kalantari, Sisi Zlatanova

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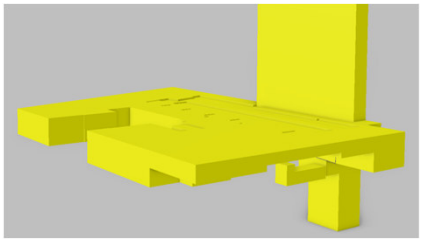
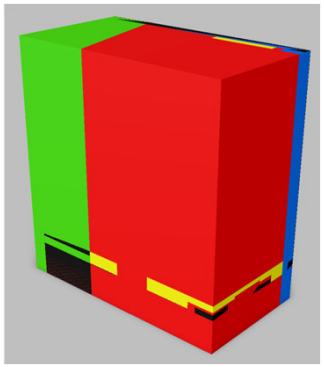
# Projects progress to date

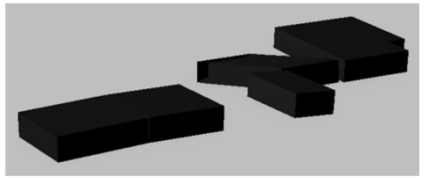
A 3D CSDM profile vocabulary for NSW





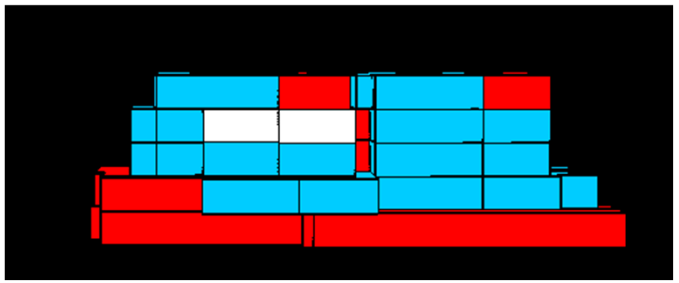
Peter Hales

Methodology for back - capturing stratum plans in NSW



Claire Warren

Colour, Transparency and Size in Visualising 3D Digital Cadastres



Jasmine Cheng

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# Relevant SDGs

SUSTAINABLE DEVELOPMENT GOALS | International Federation of Surveyors supports the Sustainable Development Goals

1st relevant SDG


2nd relevant SDG


3rd relevant SDG

# Thank You


Contact: mohsen.kalantari@unsw.edu.au