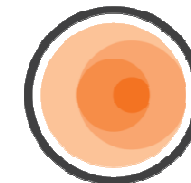


Comparing Three Types of BIM-based Models for Managing 3D Ownership Interests in Multi-level Buildings



Behnam ATAZADEH, Mohsen KALANTARI, Abbas RAJABIFARD



CSDILA
THE CENTRE FOR SPATIAL
DATA INFRASTRUCTURES
& LAND ADMINISTRATION



Land and Property
Information in 3D

Legal and Physical views



- Spatial extent of ownership interests can be defined in three approaches:
 - Pure legal modelling: Cognitive legal spaces (LADM)
 - Pure physical modelling: Physically existent elements (CityGML)
 - Integrated modelling: Appropriate composition of legal spaces and physical elements (Legal extension of IFC or CityGML)

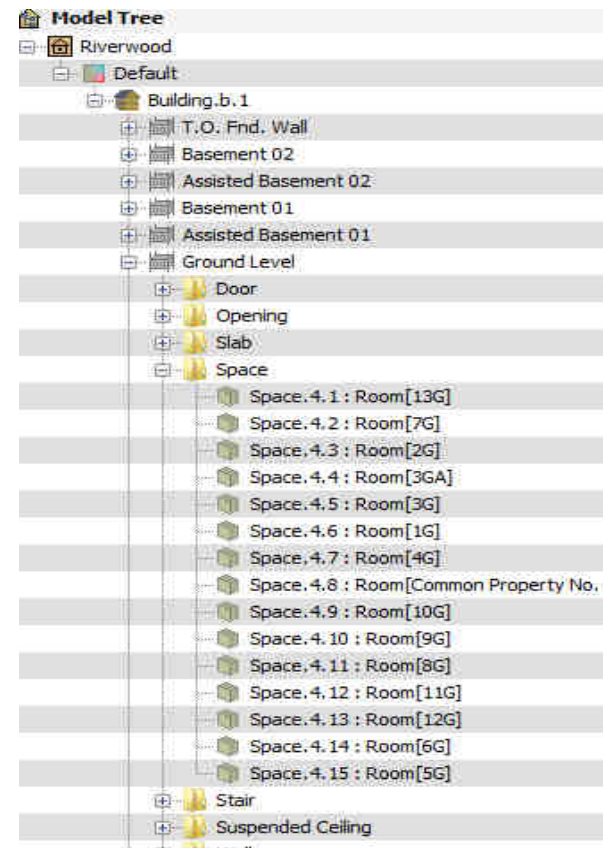
- BIM have the flexibility to represent spatial extent of 3D ownership interests by all the above approaches



BIM (Building Information Modelling)



- A rich data repository of information about physical and functional aspects of buildings.
- It can be enriched with legal objects (Atazadeh et al, 2016)
- IFC standard provides a hierarchical spatial structure to store building information:
 - site
 - building
 - stories
 - spaces and
 - building elements



Land and Property
Information in 3D



UNIVERSITY OF
MELBOURNE

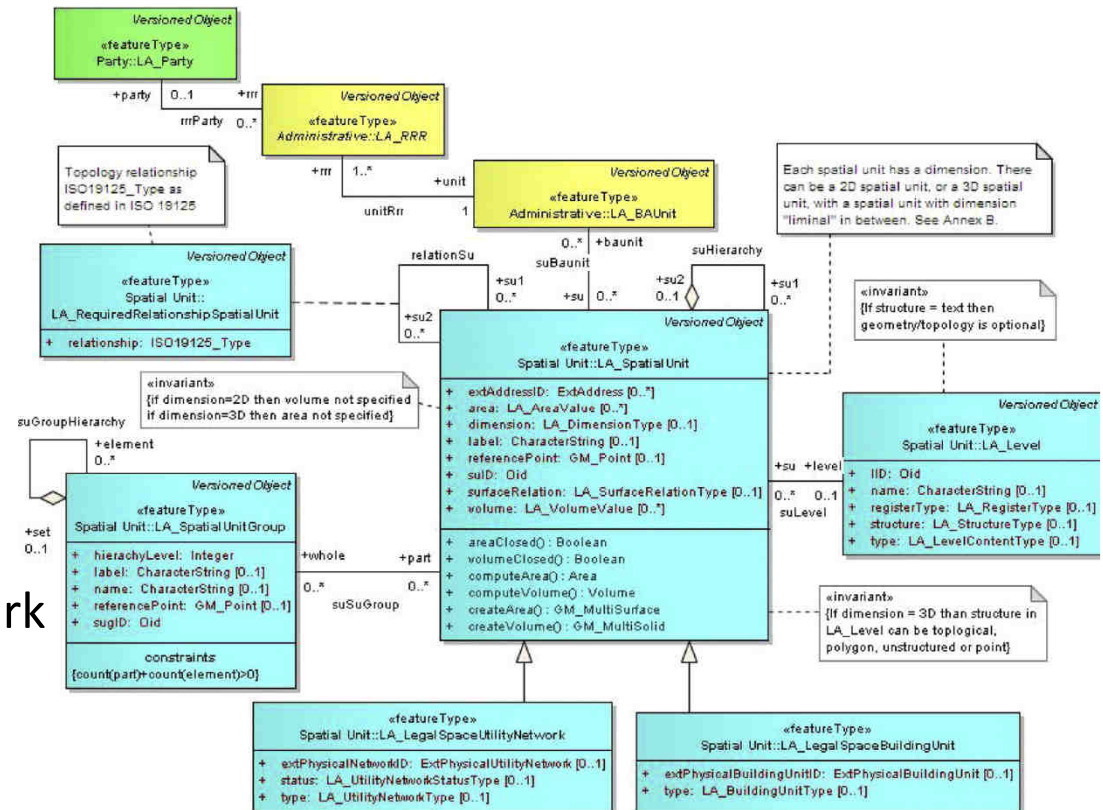
- Spatial Unit

- Spatial representation of ownership interests

- textual descriptions
- sketch maps
- Points
- unstructured set of lines
- areal and volumetric objects

- Basic Administrative Unit

- arrange and group a set of spatial units
- apartment unit, and its car park and storage area



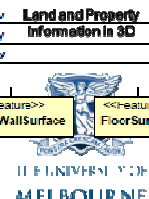
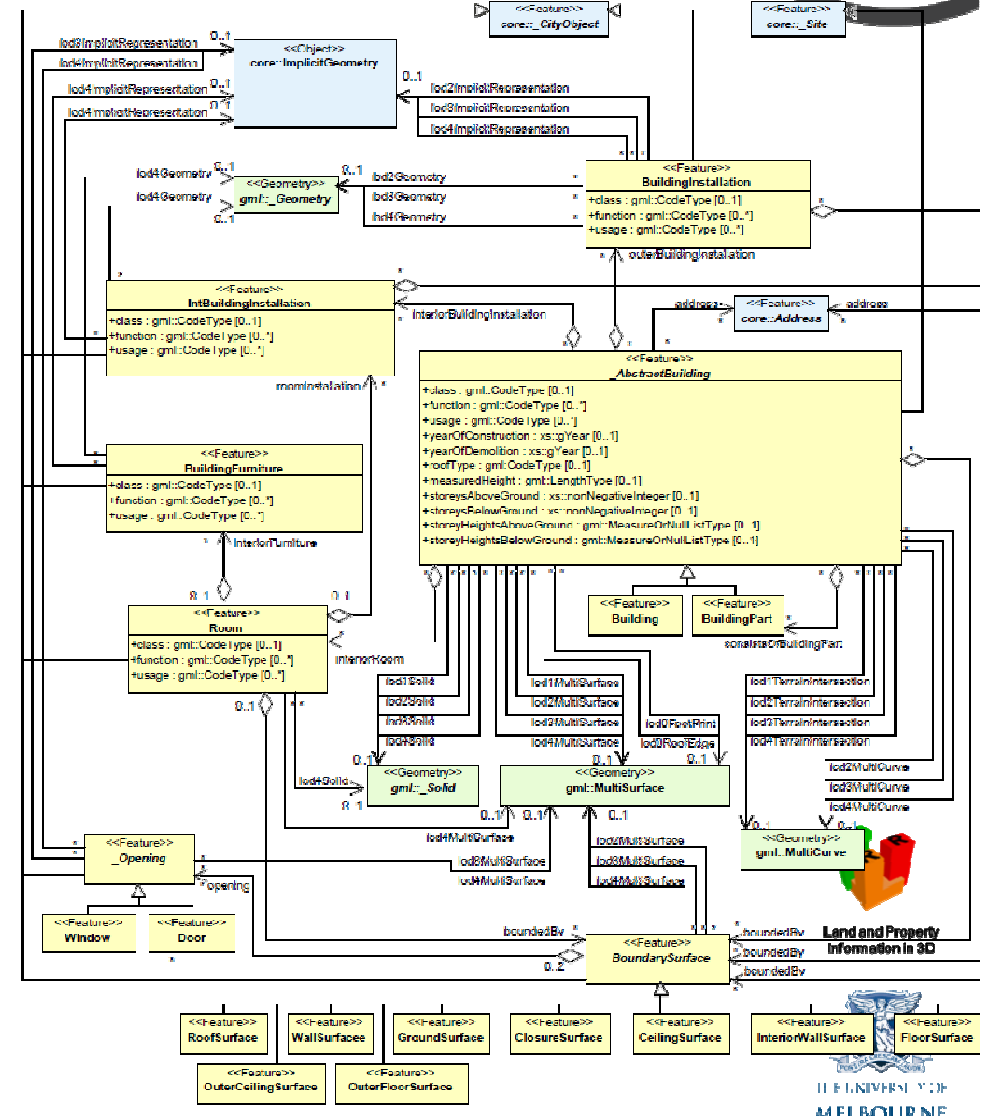
- Boundary Faces

- Boundaries of 3D spatial units

CityGML



- “_Room” class
 - for modelling ownership interests
- Physical boundaries
 - Subclasses of “_BoundarySurface” for modelling wall, ceiling, floor and roof boundaries.
- Virtual Boundaries
 - “ClosureSurface” subclass for boundaries without physical manifestation
 - those ones defined in balcony and terraced areas.



Integrated Spatial Data Models



- Some jurisdictions, such as those of Australia, define arrangements of ownership interests within multi-level buildings using both physical structures and legal spaces.
- Various integrated models proposed:
 - LADM-based ADE extensions of CityGML (Rönsdorff et al. 2014)
 - China (Li et al. 2016), Poland (Gózdź et al. 2014)
 - Other ADE extensions of CityGML
 - Preliminary ADE of CityGML for cadastral purposes (Dsilva 2009)
 - CityGML ADE for immovable property taxation (Çağdaş 2013)
 - Linking IndoorGML and LADM (Zlatanova et al. 2016)
 - Integration of CityGML and ePlan
 - 3DCDM (Aien 2013), LADM OWL (Soon et al. 2014)
 - Cadastral Extension of IFC (Atazadeh et al, 2016)



Methodology

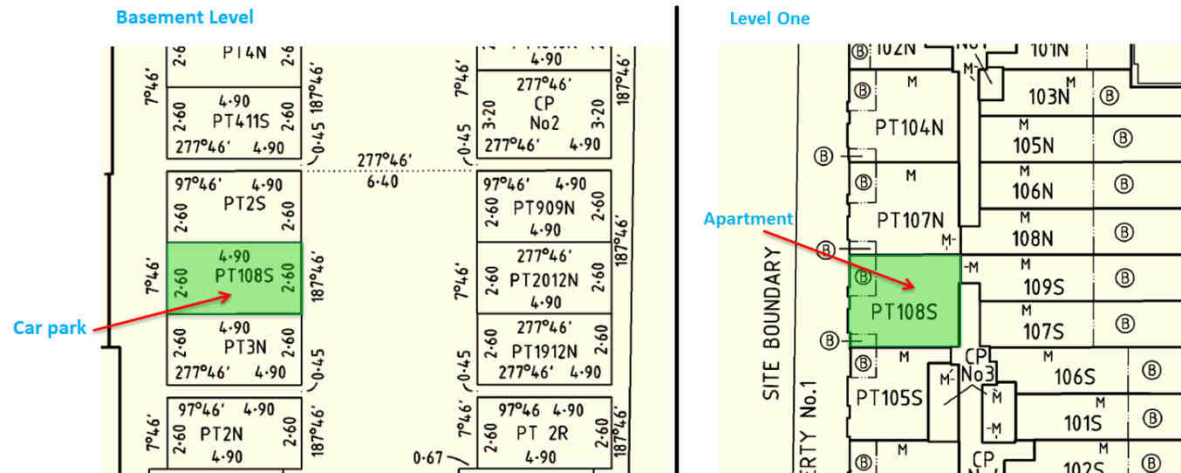


- Identify 3D ownership interests in Victoria, Australia.
- Select a relatively complex multi-level building and develop three types of BIM-based models
 - Legal model
 - Physical model
 - Integrated model
- Compare models by using some metrics.
 - number of objects
 - geometry batches
 - visualization speed
 - query speed
 - communication of structural boundaries

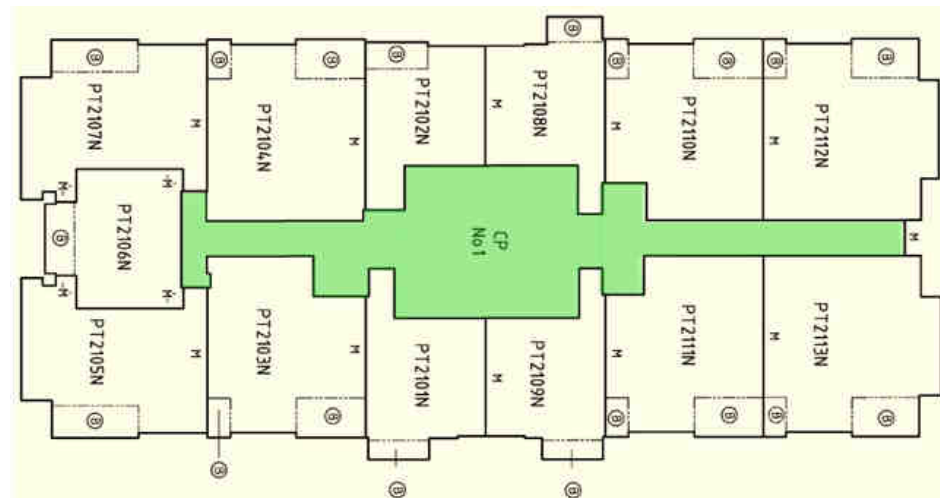


3D Ownership Interests In Victoria

- Strata Lots: Composed of a main lot (apartment unit) and accessory lots (carpark and storage area)



- Common Properties: Composed of various indoor and outdoor spaces as well as physically structures.



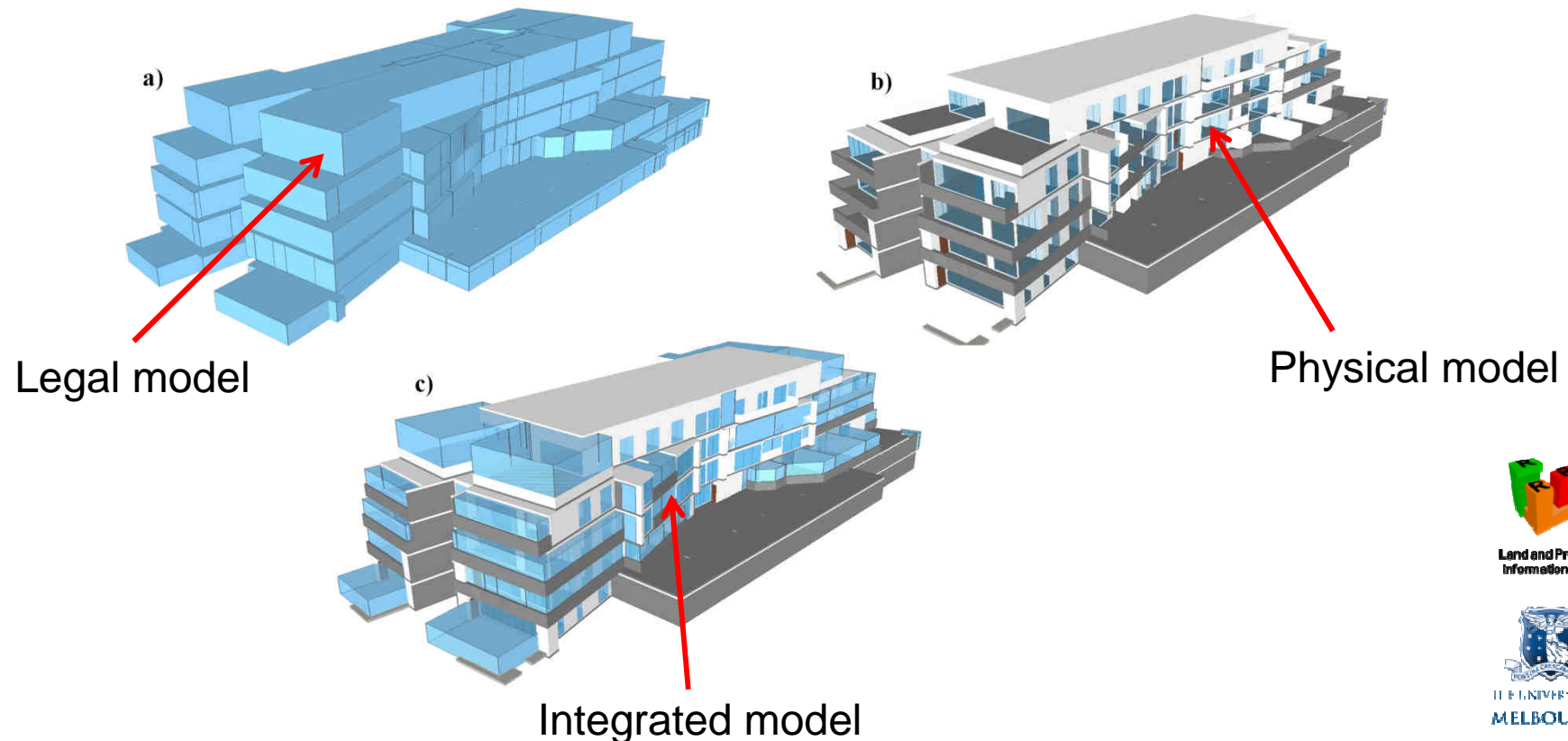
Land and Property
Information in 3D



THE UNIVERSITY OF
MELBOURNE

Implementation of BIM Models

- CAD plans used for creating physical model
- Subdivision plans used for creating legal model
- Both plans used for creating integrated model



Land and Property
Information in 3D



THE UNIVERSITY OF
MELBOURNE

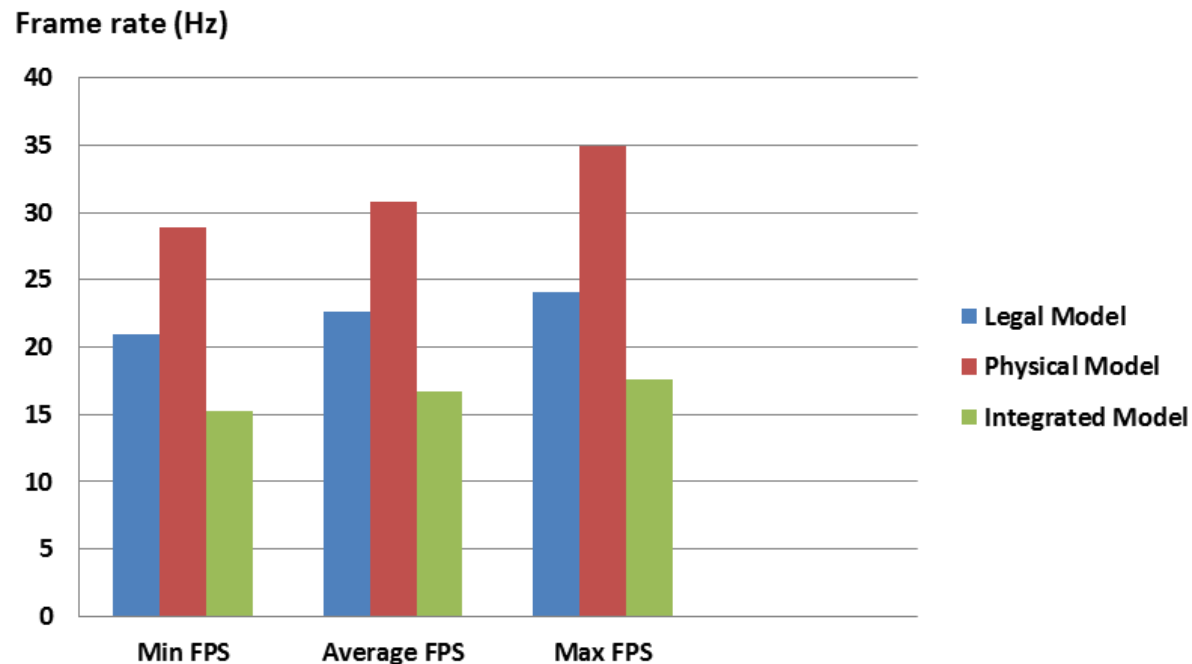
Results



- Number objects and geometry batches

| BIM Model | Number of objects | Number of geometry batches |
|------------------|-------------------|----------------------------|
| Legal model | 146 | 146 |
| Physical model | 962 | 1131 |
| Integrated model | 1108 | 1277 |

- Visualization speed



Land and Property Information in 3D

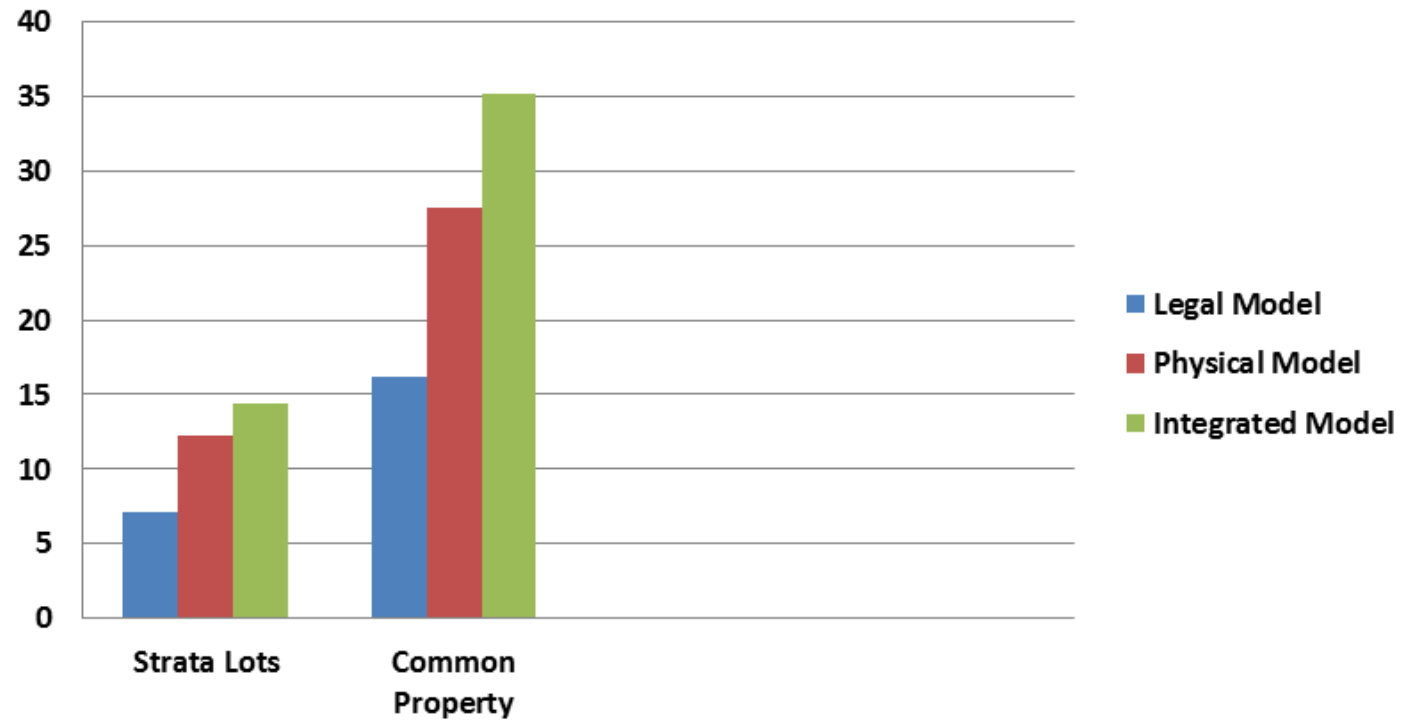


THE UNIVERSITY OF MELBOURNE

Results (Continued...)

- Query speed

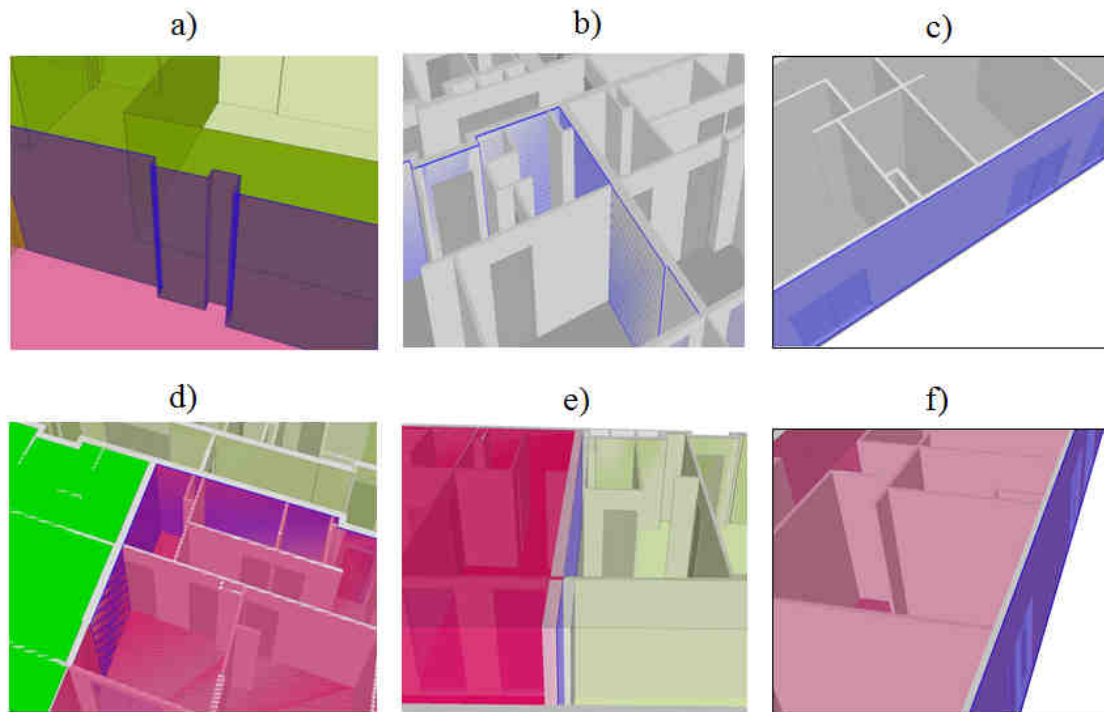
Query Speed (Milliseconds)



Results (Continued...)

- Communication of structural boundaries

| BIM model | Interior Boundaries | Median Boundaries | Exterior Boundaries |
|------------------|---------------------|-------------------|---------------------|
| Legal model | Incommunicable | Incommunicable | Incommunicable |
| Physical model | Communicable | Incommunicable | Communicable |
| Integrated model | Communicable | Communicable | Communicable |



Conclusions and Future work



- Findings
 - Pure legal or physical models can perform better in terms of visualizing and querying
 - Integrated models would provide more intuitive and visual communication of 3D ownership interests

- Recommendations for Future research
 - Using the adopted approaches for modelling ownership interests associated with urban infrastructure (tunnels, bridges, roads, ...)
 - Investigating the viability of BIM environment for managing lifecycle of cadastral information (nD modelling) in multi-level building





Thank You



Questions?

