Connecting LADM and IFC Standards: Pathways towards an Integrated Legal-Physical Model

Behnam Atazadeh, Abbas Rajabifard, Mohsen Kalantari

Centre for SDIs and Land Administration,
The University of Melbourne

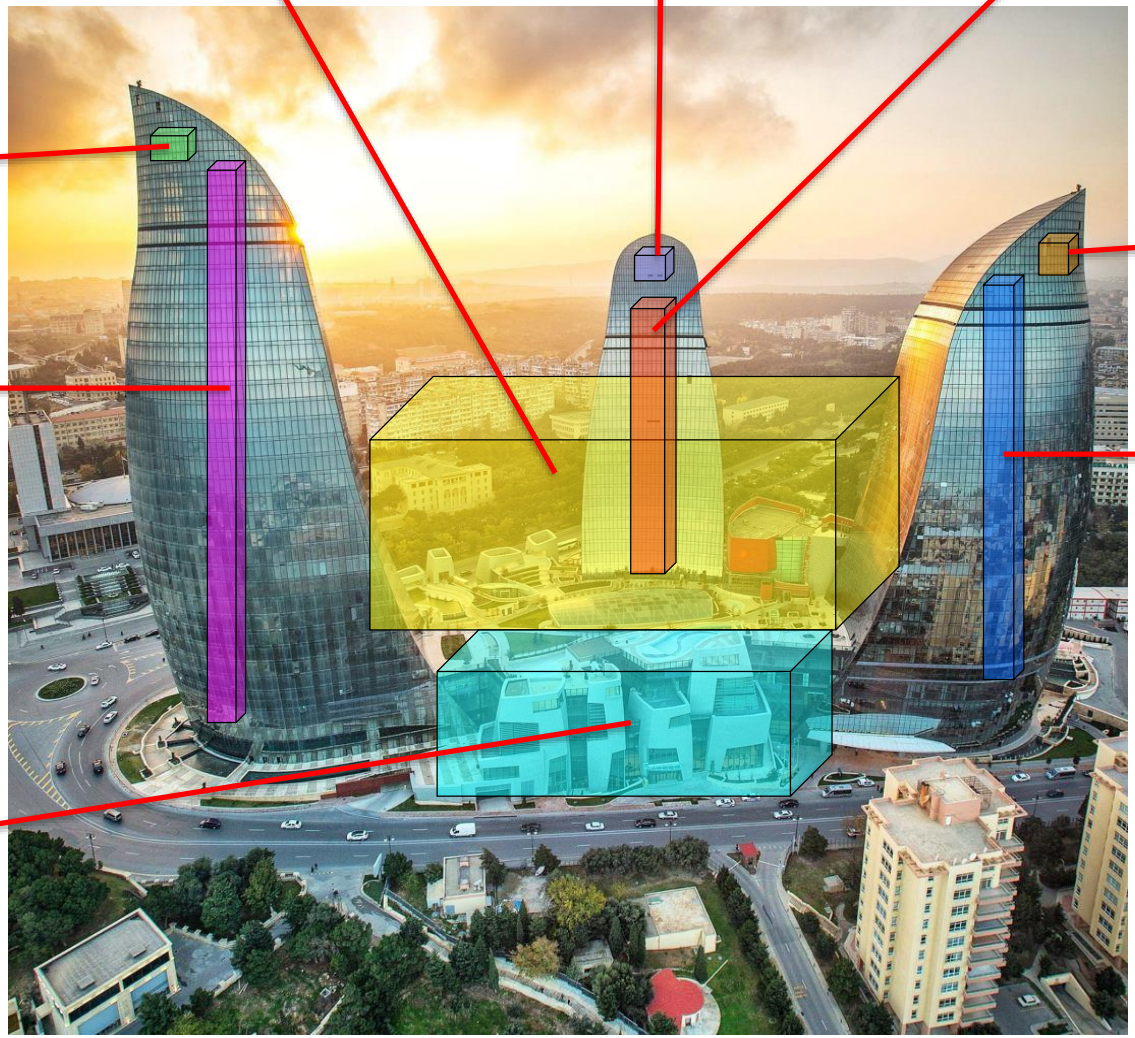
Australian Government
Australian Research Council

VICTORIA State Government | Environment, Land, Water and Planning
ICSM ANZLIC COMMITTEE ON SURVEYING & MAPPING
CITY OF MELBOURNE

Flame Towers in Baku, Azerbaijan

(Spatially and Functionally Complex Development)

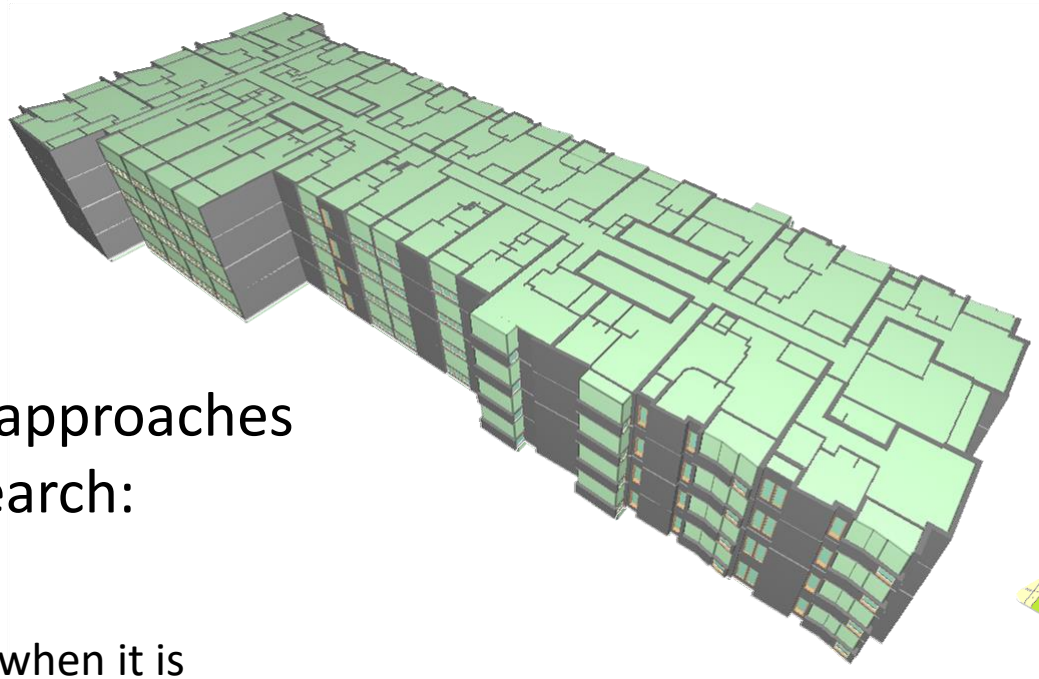
CSDILA
THE CENTRE FOR SPATIAL DATA INFRASTRUCTURES & LAND ADMINISTRATION



THE UNIVERSITY OF MELBOURNE

Legal View and Physical View of Buildings

- Legal spaces are adequate to subdivide and register ownership of land and properties.
- Physical spaces are ancillary to the communication of legal spaces with non-specialist.



Emergence of integrated approaches in 3D digital cadastre research:

- At visualisation level
- Defining specific relationships, when it is required, between legal and physical spaces

Review of Integrated Models

CSDILA
THE CENTRE FOR SPATIAL DATA INFRASTRUCTURES & LAND ADMINISTRATION

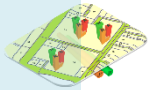
Integrated Model	Integration mechanism	Jurisdiction
CityGML and LADM	Incorporation of LADM-based legal concepts by developing an Application Domain Extension (ADE) for CityGML.	Jurisdiction Independent (Rönsdorff et al. 2014) Poland (Gózdz et al. 2014) China (Li et al. 2016)
Cadastral extensions of CityGML	The legal objects were defined as new entities within ADEs of CityGML.	The Netherlands (Dsilva 2009) Turkey (Çağdaş 2013)
CityGML and ePlan	Web ontology language (OWL) was used to semantically integrate physical components from CityGML with legal elements from ePlan model.	Singapore (Soon et al. 2014)
LandInfra	LADM and LandXML concepts were used for modelling legal objects while physical elements were considered based on IFC and CityGML standards	Jurisdiction Independent (Scarponcini et al. 2016)
IndoorGML and LADM	Two approaches are suggested: creating an extension module of IndoorGML based on LADM concepts, or connecting LADM and IndoorGML through external links	Jurisdiction Independent (Zlatanova, Li, et al. 2016, Zlatanova, Oosterom, et al. 2016)

THE UNIVERSITY OF MELBOURNE

Review of Integrated Models

CSDILA
THE CENTRE FOR SPATIAL DATA INFRASTRUCTURES & LAND ADMINISTRATION

Integrated Model	Integration mechanism	Jurisdiction
3D cadastral data model (3DCDM)	3DCDM is divided into two hierarchical structures, one for legal objects and another for physical objects.	Victoria, Australia (Aien 2013)
LADM-INTERLIS	INTERLIS language was adopted to integrate legal and physical objects by specifying constraints	Jurisdiction Independent (Kalogianni et al. 2017)
Cadastral Extension of IFC	Legal data elements was embedded into IFC standard with as minimum change as possible in the current data model of IFC.	Victoria, Australia (Atazadeh et al. 2017)
Cadastral extension of Unified Building Model (UBM)	Four types of legal boundaries were proposed in UBM, which is a physical model connecting IFC and CityGML.	Sweden (El-Mekawy and Östman 2015)
UrbanIT project	The core of the urbanIT project was a proposed extension to the IFC standard for managing cadastral data both inside buildings as well as land parcels on the site of buildings.	New South Wales, Australia (Barton et al. 2010)



THE UNIVERSITY OF MELBOURNE

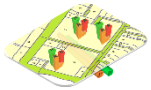
The One Relevant to This Study

CSDILA
THE CENTRE FOR SPATIAL DATA INFRASTRUCTURES & LAND ADMINISTRATION

Working with Open BIM Standards to Source Legal Spaces for a 3D Cadastre by Oldfield et al. (2017)

- Spatial unit → IfcSpace (indoor spaces) and IfcZone (zones)
- Boundary face → IfcConnectedFaceSet (a set of arc-wise connected faces)
- Boundary face string → IfcPolyLoop (a loop with straight edges bounding a planar surface)
- Point → IfcCartesianPoint (a point in either 2D or 3D space)

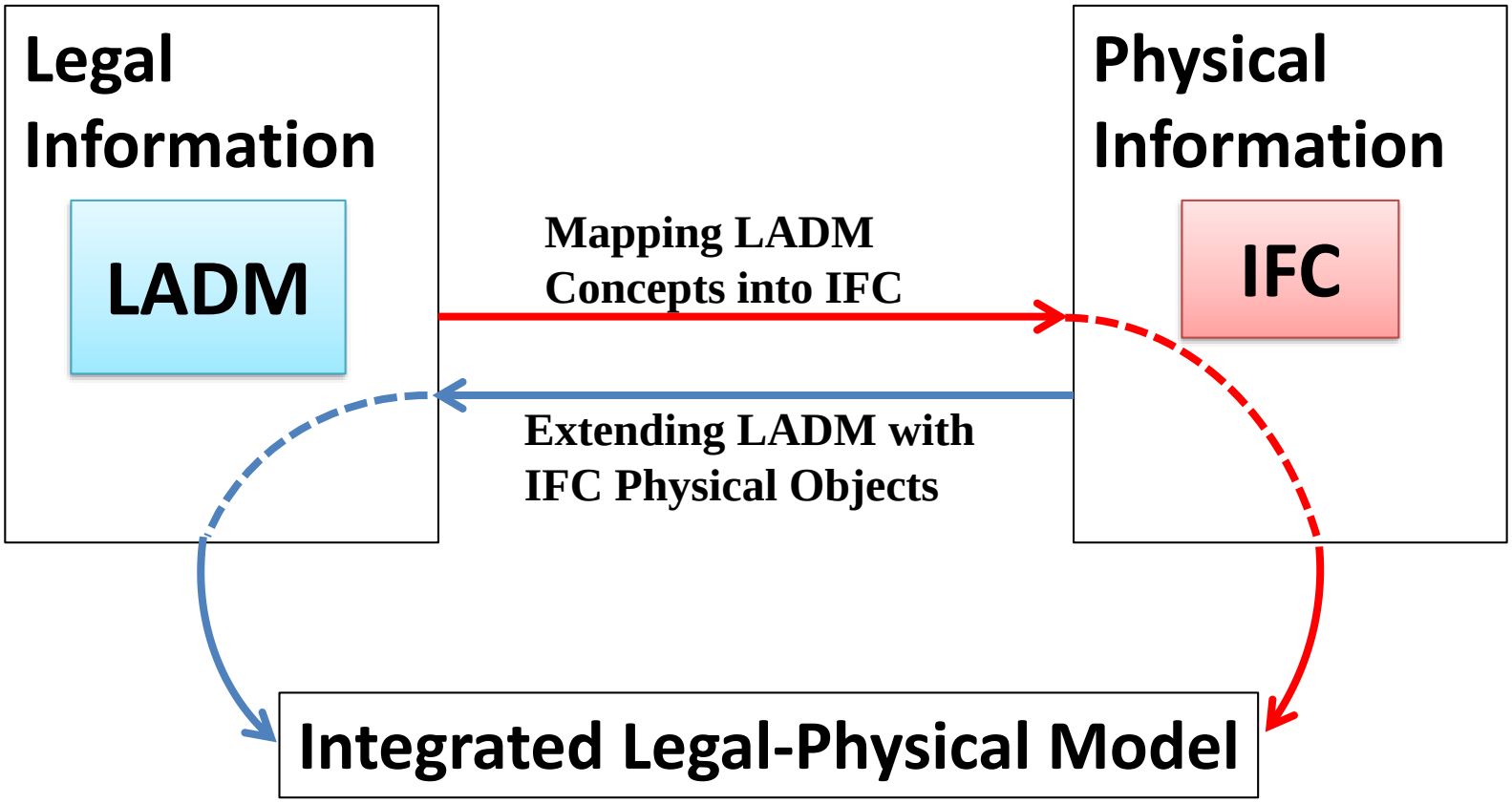
They recognized the use of property sets for managing legal attributes but did not propose how various property sets based on LADM can be applied to different IFC entities.



The concept of spatial units is more comprehensive and includes other spatial elements (e.g. external spaces around buildings)

THE UNIVERSITY OF MELBOURNE

Pathways Towards an Integrated Model



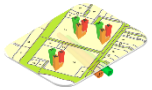
Mapping LADM Concepts into IFC

CSDILA
THE CENTRE FOR SPATIAL DATA INFRASTRUCTURES & LAND ADMINISTRATION

1. Identify suitable IFC entities for mapping each LADM concept itself.
2. Propose the attributes of each LADM concept to be modelled as property sets applied to their counterpart IFC entities.

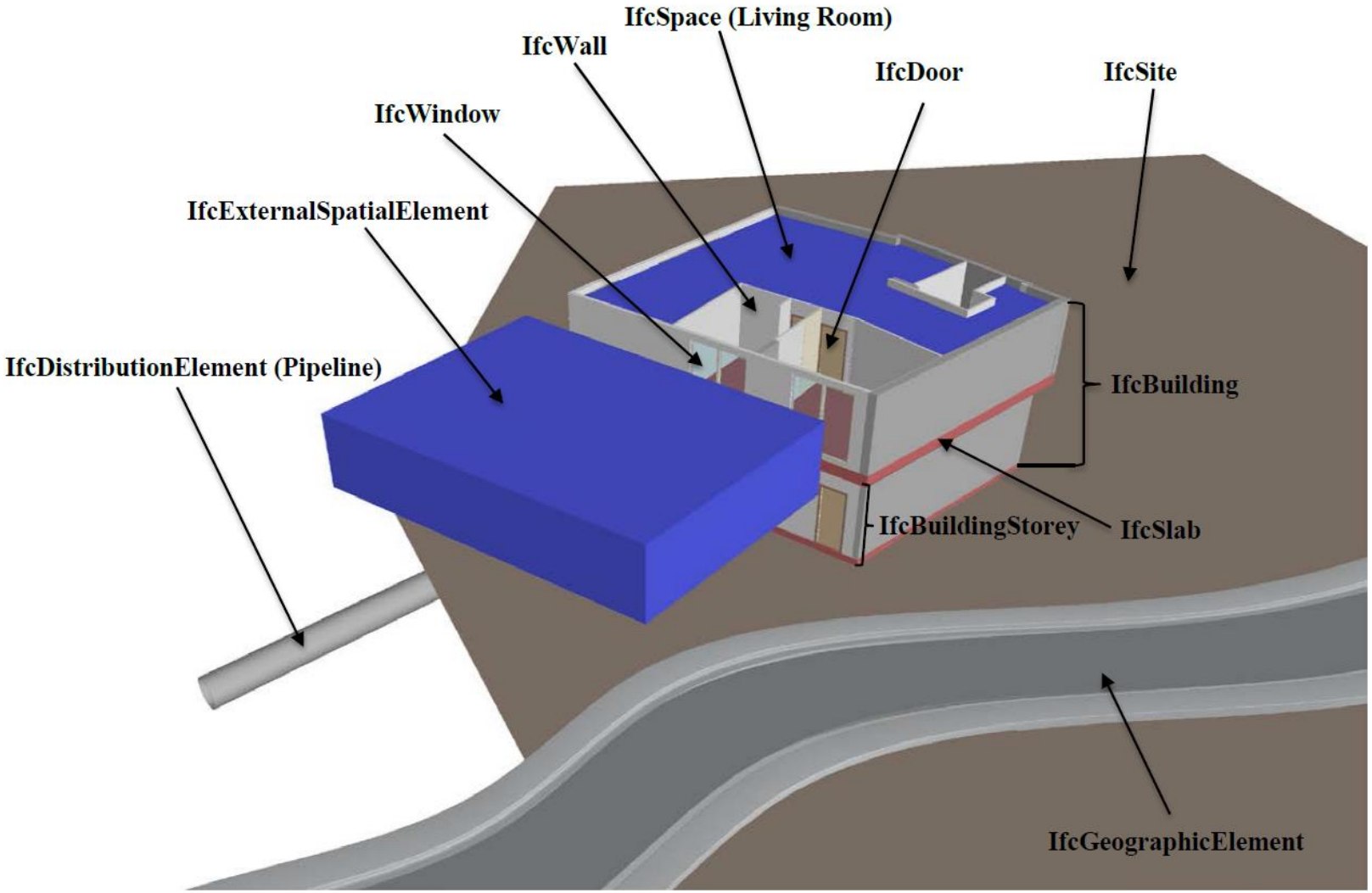
Spatial Units

Form of spatial unit		Suitable IFC entities
Land parcel	Individual	IfcSite
	Multiple	IfcSpatialZone
Indoor legal space	Individual	IfcSpace
	Multiple	IfcZone, IfcSpatialZone
Outdoor legal space	Individual	IfcExternalSpatialElement
	Multiple	IfcSpatialZone



THE UNIVERSITY OF MELBOURNE

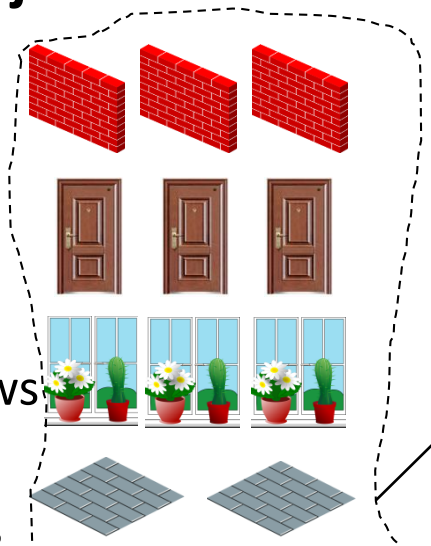
Physical and Spatial Elements in IFC

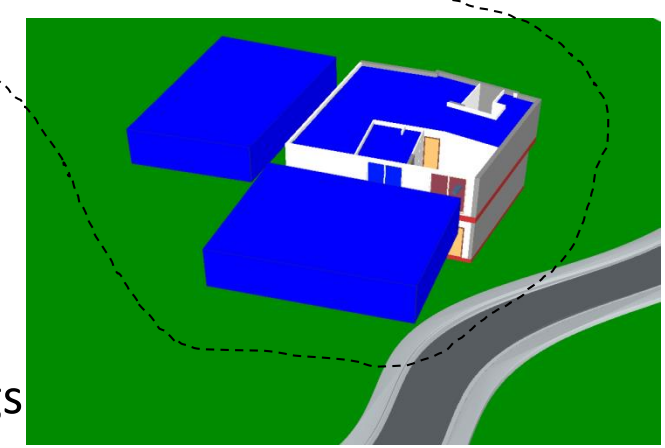


Concept of Spatial Zone

Composition of a Set of :

- **Visible Objects**
  - Walls
  - Doors
  - Windows
  - Ceilings





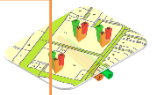
Spatial Zone

- **Non-visible Objects**
  - Spaces inside buildings
  - Spaces outside buildings

Attributes of Spatial Unit

CSDILA
THE CENTRE FOR SPATIAL DATA INFRASTRUCTURES & LAND ADMINISTRATION

Property Set Name	**Pset_LA_SpatialUnit**	
Attribute Name	**Property Type**	**Data Type**
area	IfcPropertySingleValue	IfcAreaMeasure
dimension	IfcPropertyEnumeratedValue	IfcLable
extAdressID	IfcPropertySingleValue	IfcIdentifier
lable	IfcPropertyEnumeratedValue	IfcLable
referencePoint	IfcPropertySingleValue	IfcCartesionPoint
suID	IfcPropertySingleValue	IfcIdentifier
surfaceRelation	IfcPropertyEnumeratedValue	IfcLable
volume	IfcPropertySingleValue	IfcSolidMeasure

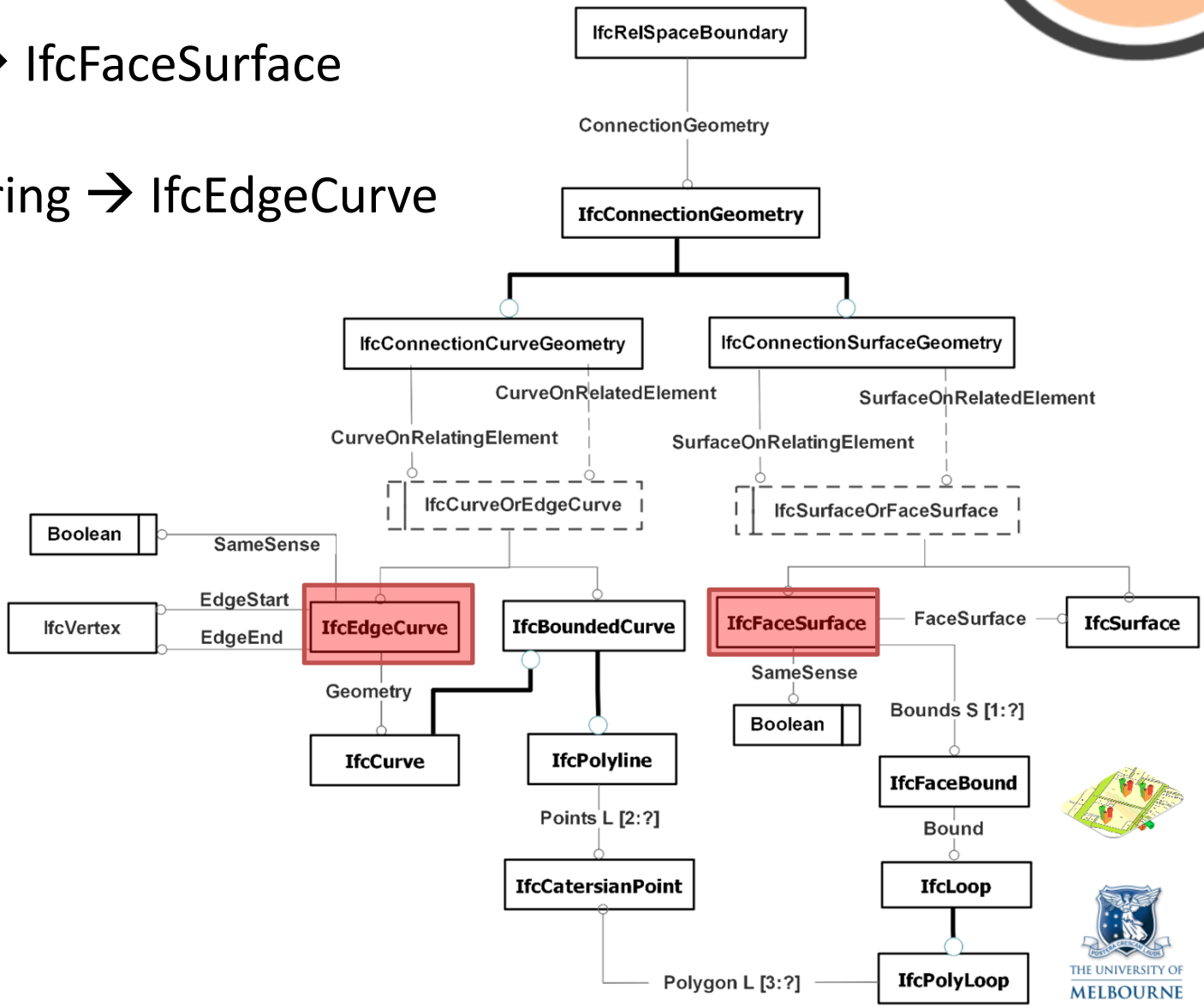


THE UNIVERSITY OF MELBOURNE

Boundaries

Boundary face → IfcFaceSurface

Boundary face string → IfcEdgeCurve



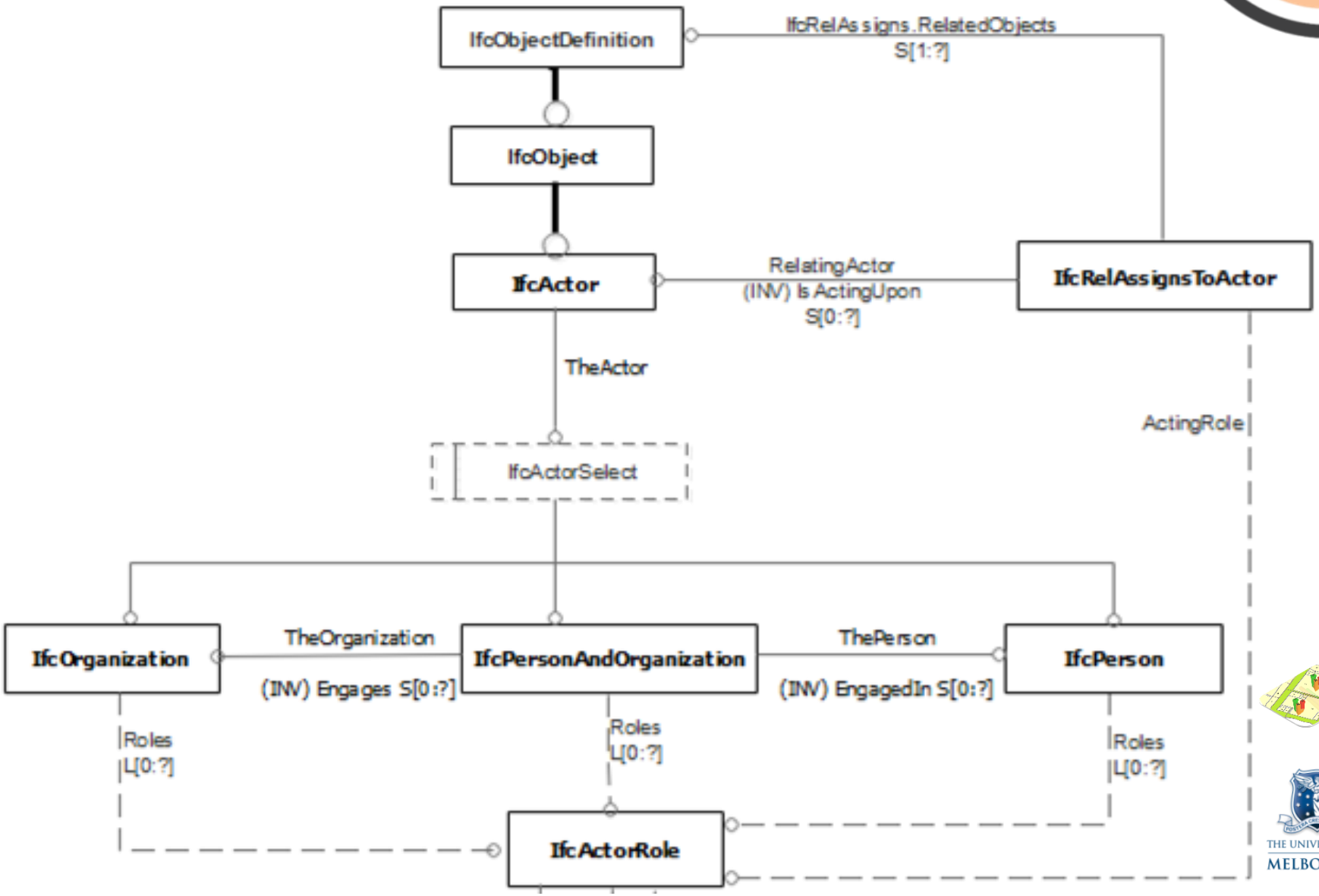
Basic Administrative Units and RRR

There is no equivalent IFC entity for modelling basic administrative units (LA_BAUnit) and RRR (LA_RRR and its subclasses).

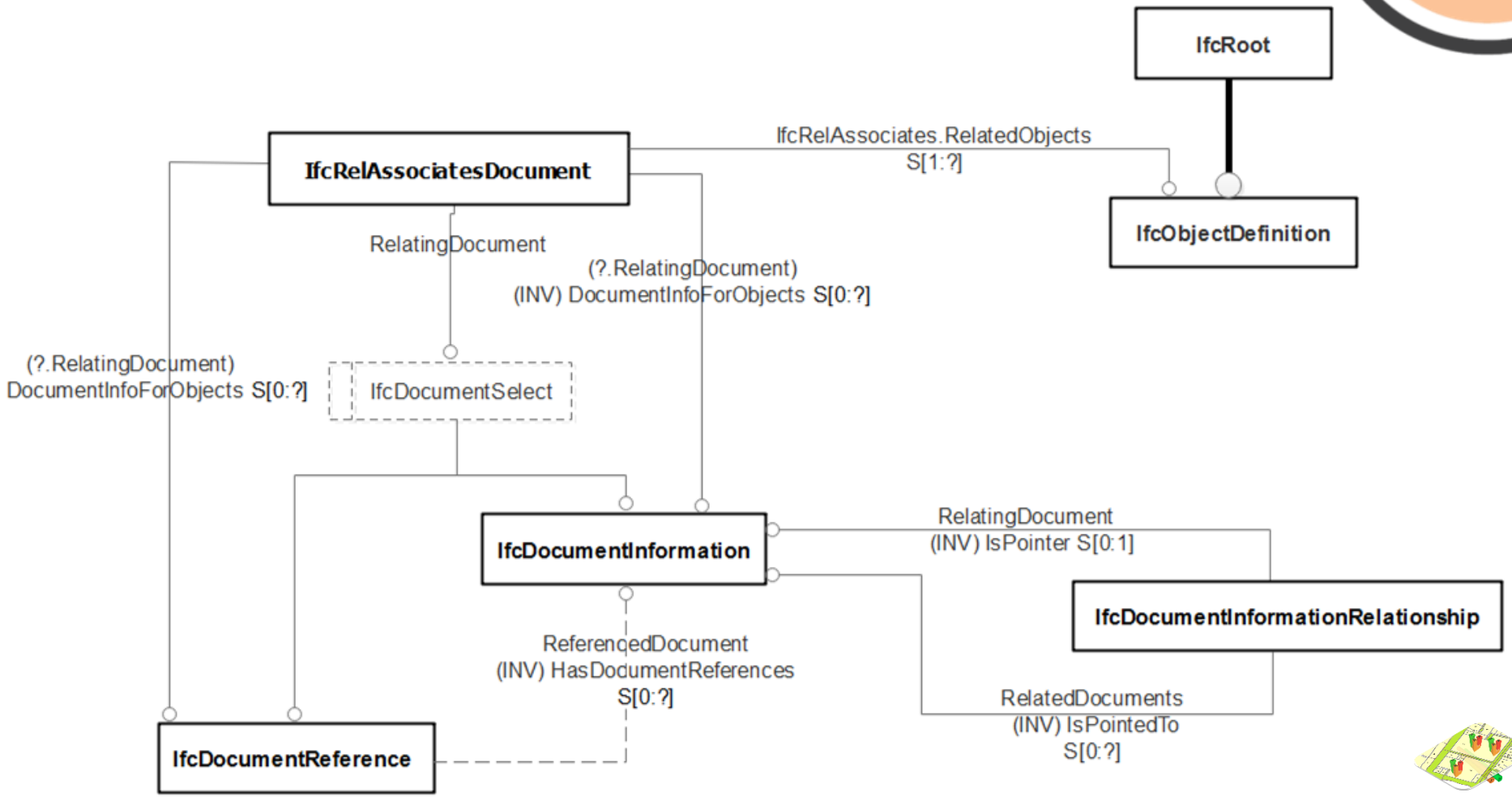
We could define attributes of this class as a property set which can be applied to “IfcSpatialZone” and “IfcZone” entities.

	Attribute Name	Property Type	Data Type
Pset_LA_BAUnit	name	IfcPropertySingleValue	IfcLable
	type	IfcPropertyEnumeratedValue	IfcLable
	uID	IfcPropertySingleValue	IfcIdentifier
Pset_LA_RRR	description	IfcPropertySingleValue	IfcText
	rID	IfcPropertySingleValue	IfcIdentifier
	share	IfcPropertySingleValue	IfcReal
	shareCheck	IfcPropertySingleValue	IfcBoolean
	timeSpec	IfcPropertySingleValue	IfcText
Pset_LA_Right	type	IfcPropertyEnumeratedValue	IfcLable
Pset_LA_Restriction	partyRequired	IfcPropertySingleValue	IfcBoolean
	type	IfcPropertyEnumeratedValue	IfcLable
Pset_LA_Responsibility	type	IfcPropertyEnumeratedValue	IfcLable

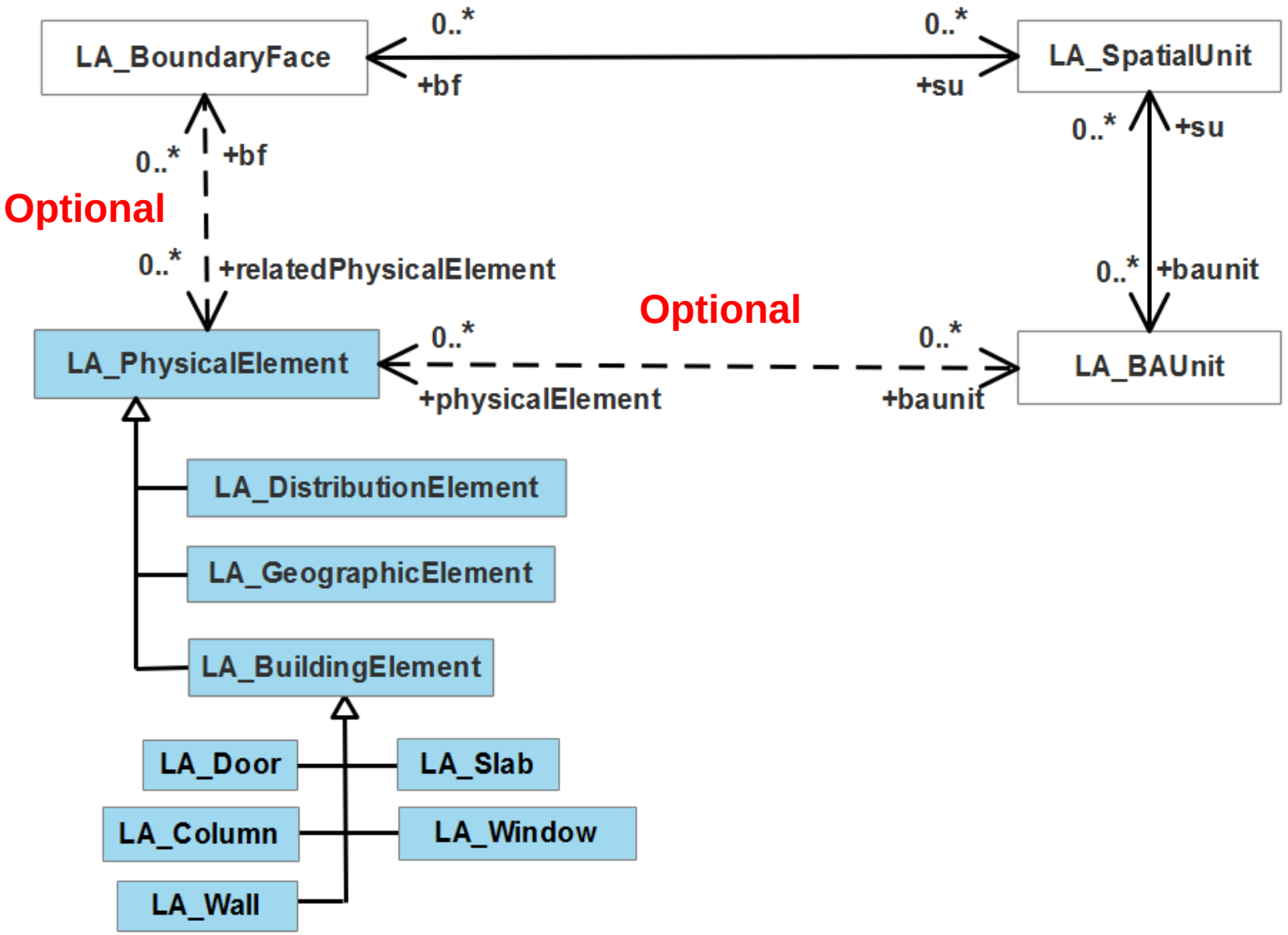
Parties


IfcObjectDefinition
IfcRelAssigns.RelatedObjects
S[1:?]
IfcObject
IfcActor
RelatingActor
(INV) Is ActingUpon
S[0:?]
IfcRelAssignsToActor
TheActor
ActingRole
IfcActorSelect
IfcOrganization
TheOrganization
(INV) Engages S[0:?]
IfcPersonAndOrganization
ThePerson
(INV) EngagedIn S[0:?]
IfcPerson
Roles
L[0:?]
Roles
L[0:?]
Roles
L[0:?]
IfcActorRole

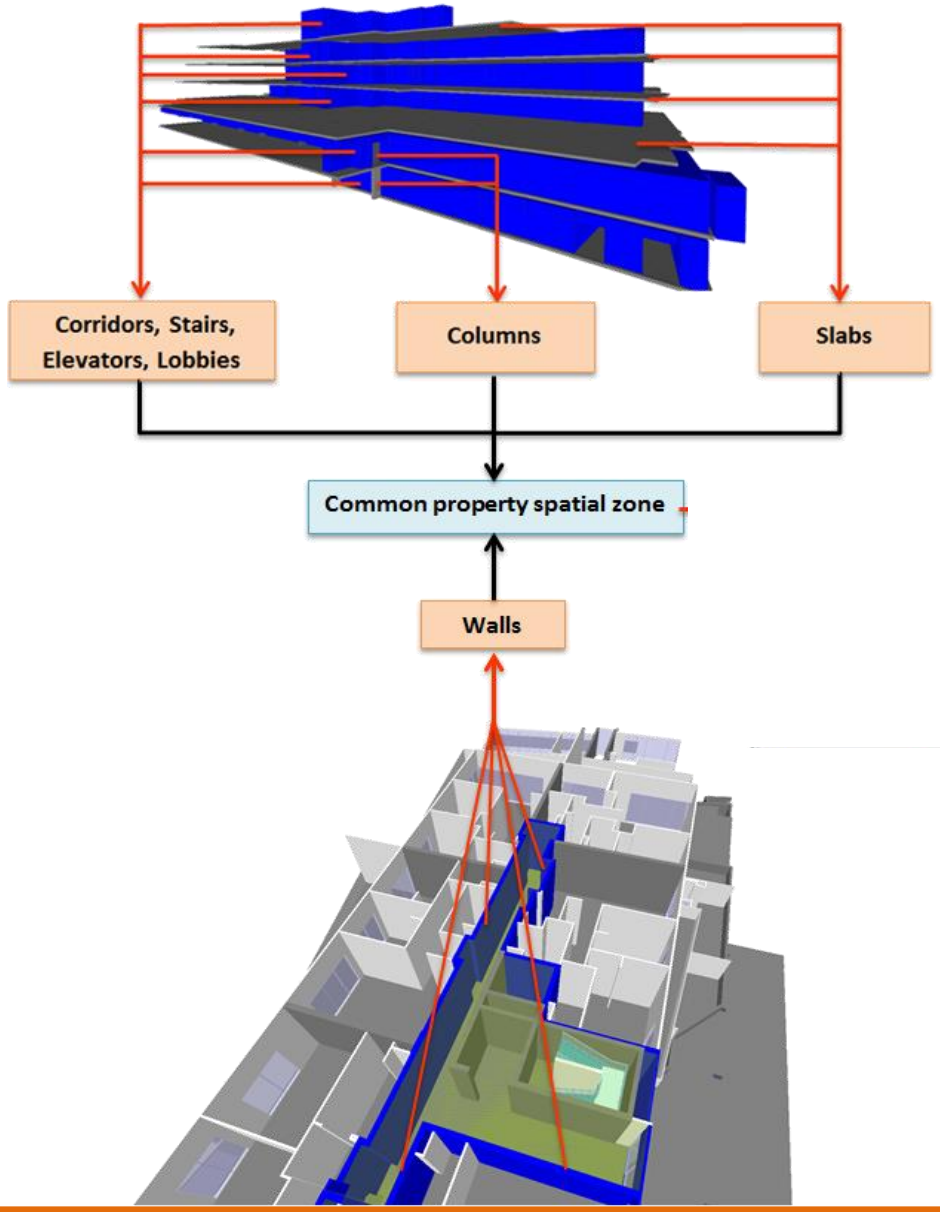
Administrative Sources



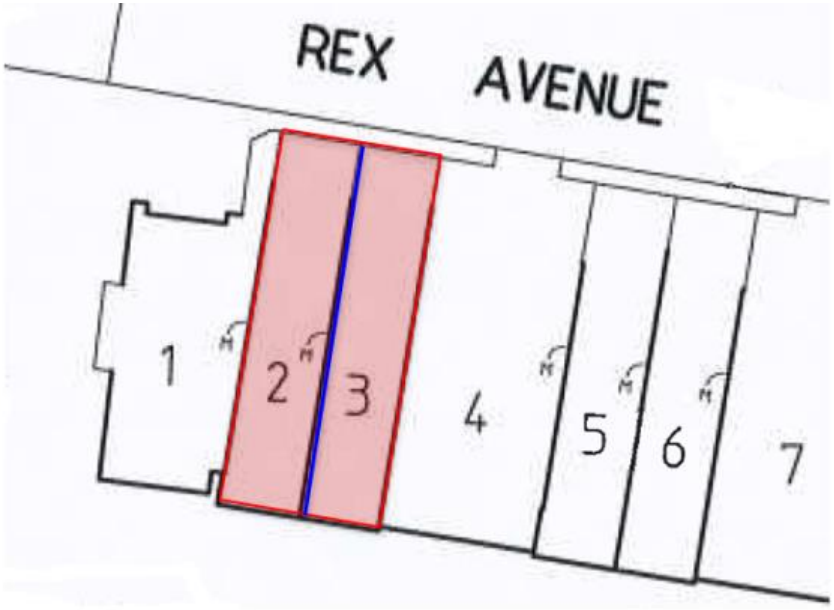
Extending LADM With IFC-based Physical Objects

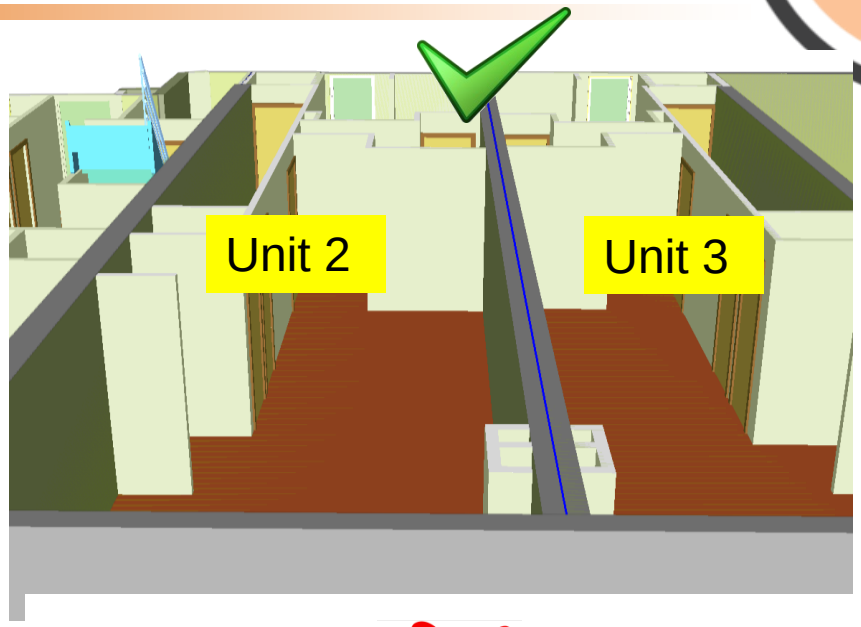


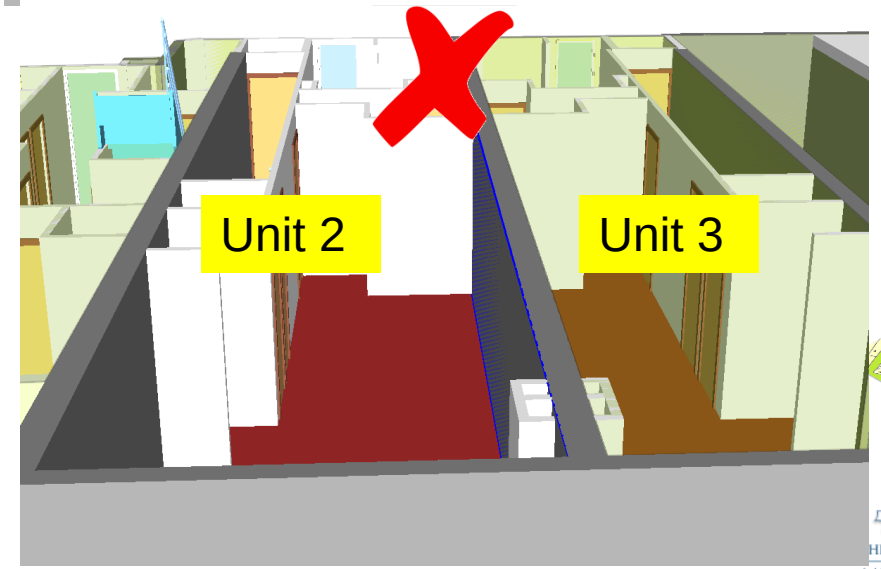
A Basic Administrative Unit



Location of boundary: Where? Why?



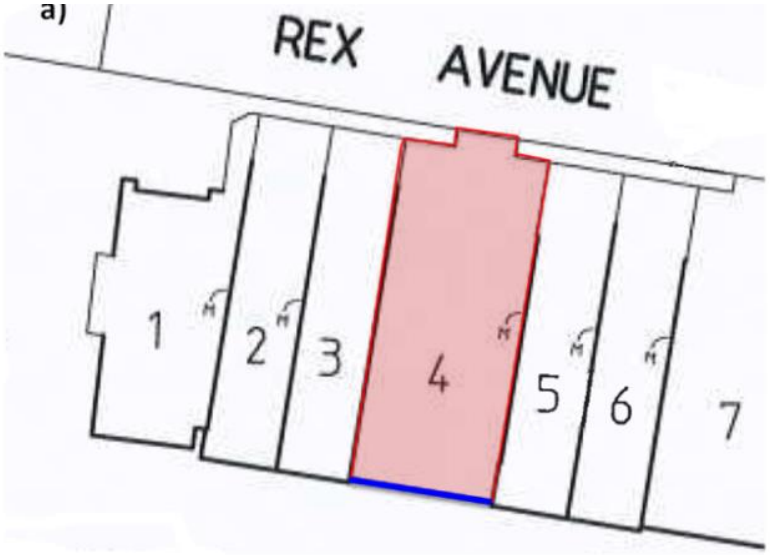


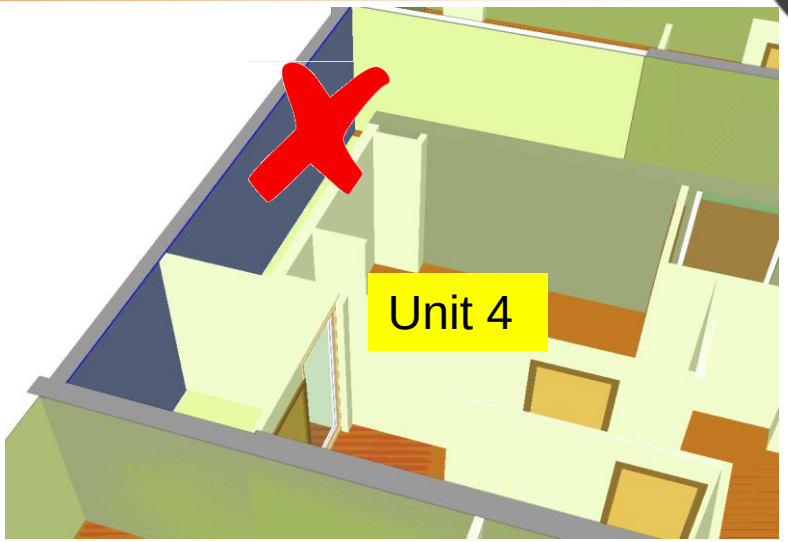


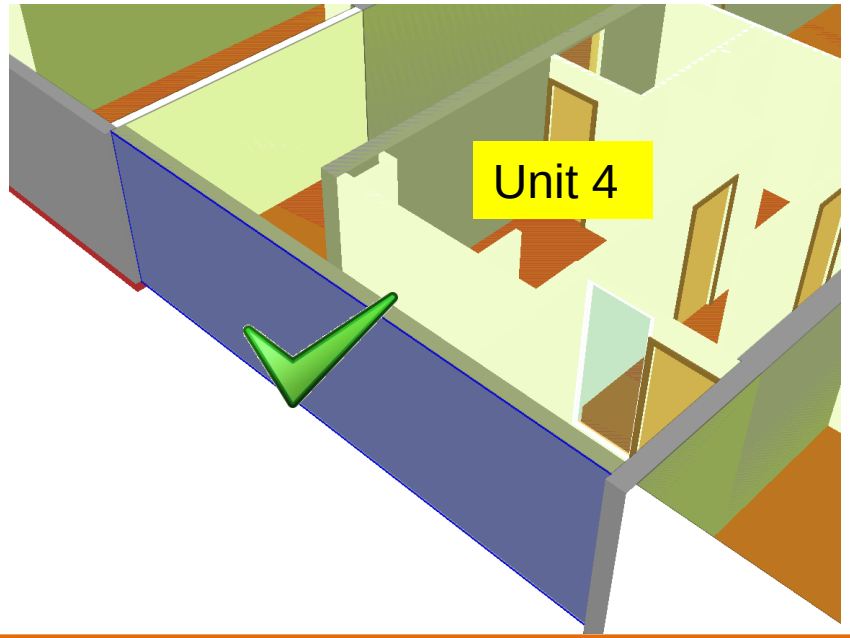
CSDILA
THE CENTRE FOR SPATIAL DATA INFRASTRUCTURES & LAND ADMINISTRATION

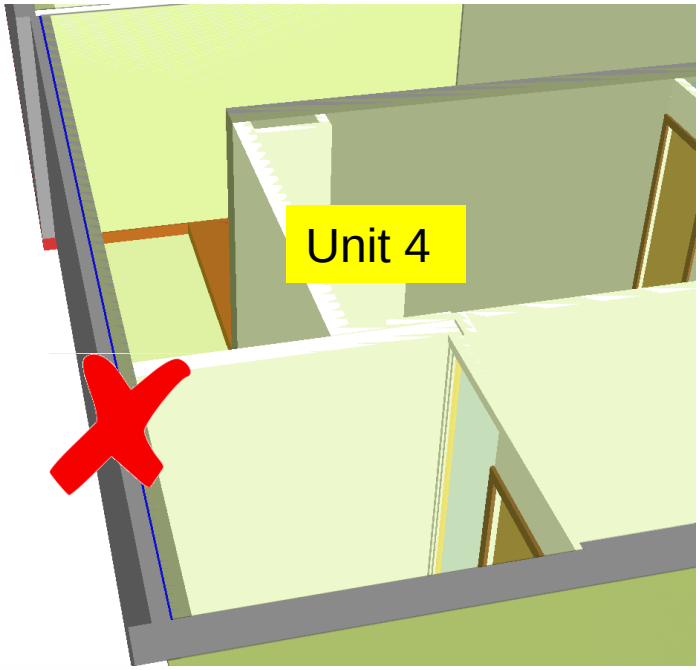
THE UNIVERSITY OF MELBOURNE

Location of boundary: Where? Why?

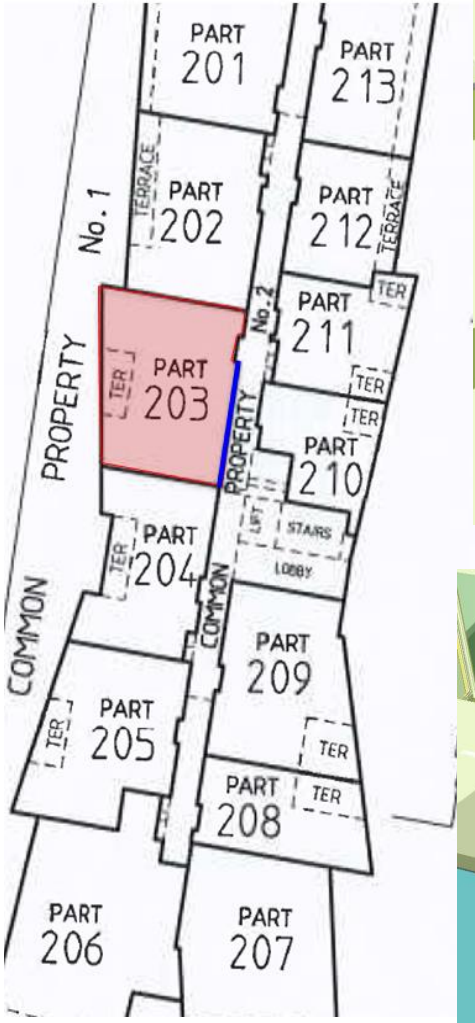


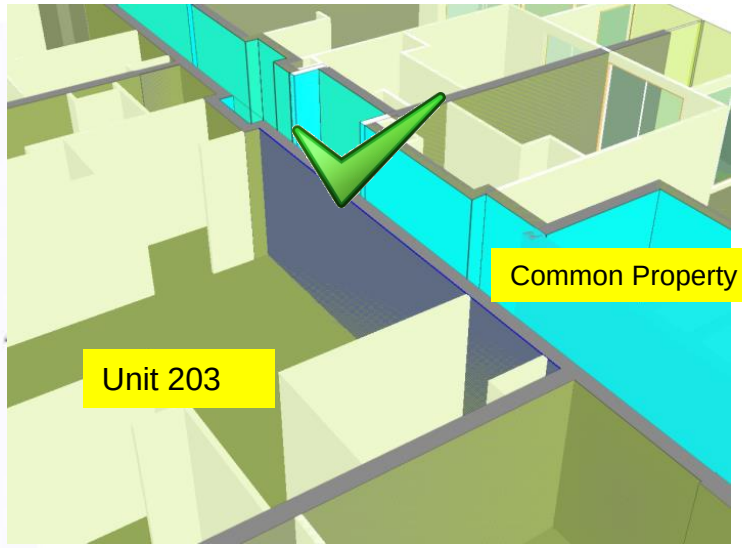


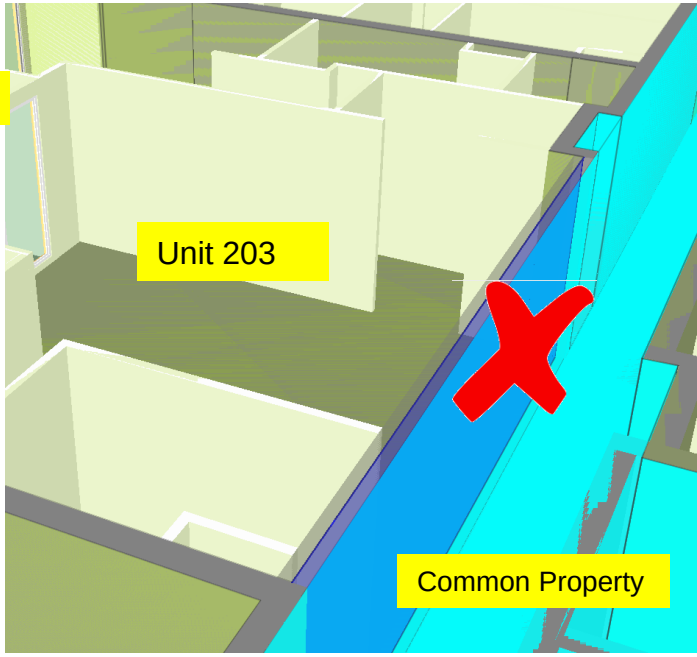


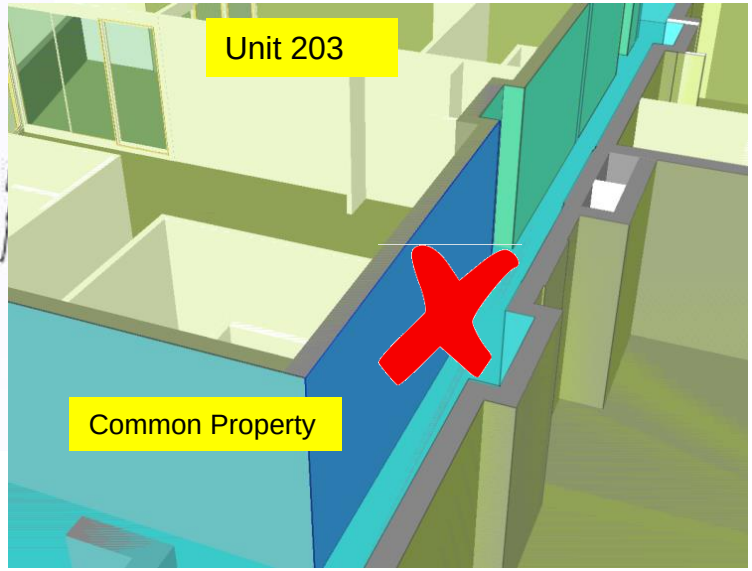


Location of boundary: Where? Why?

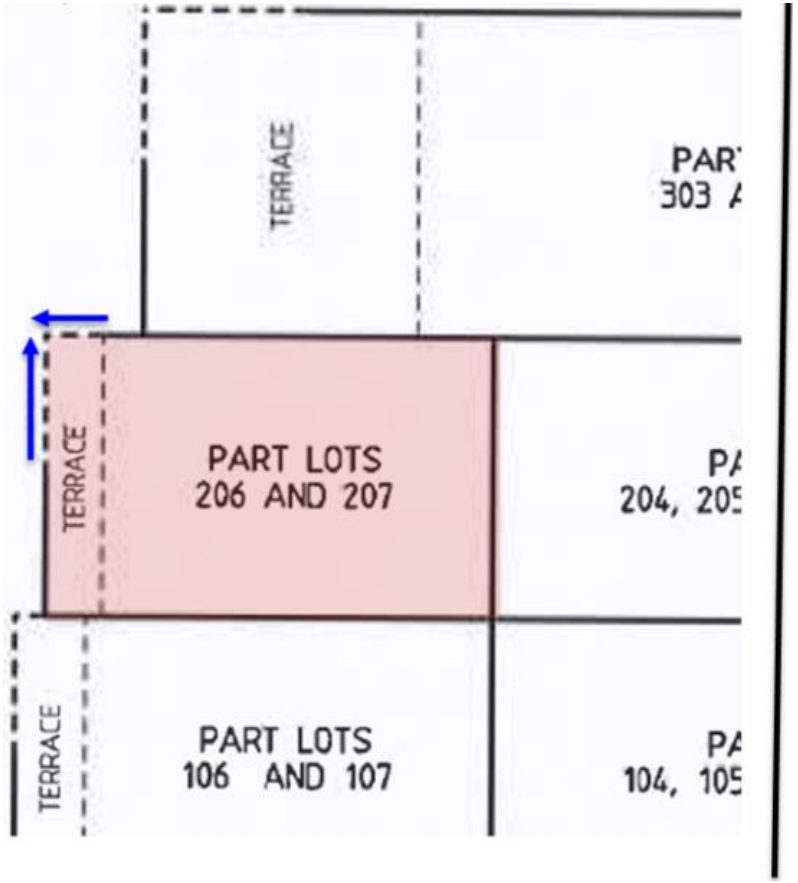


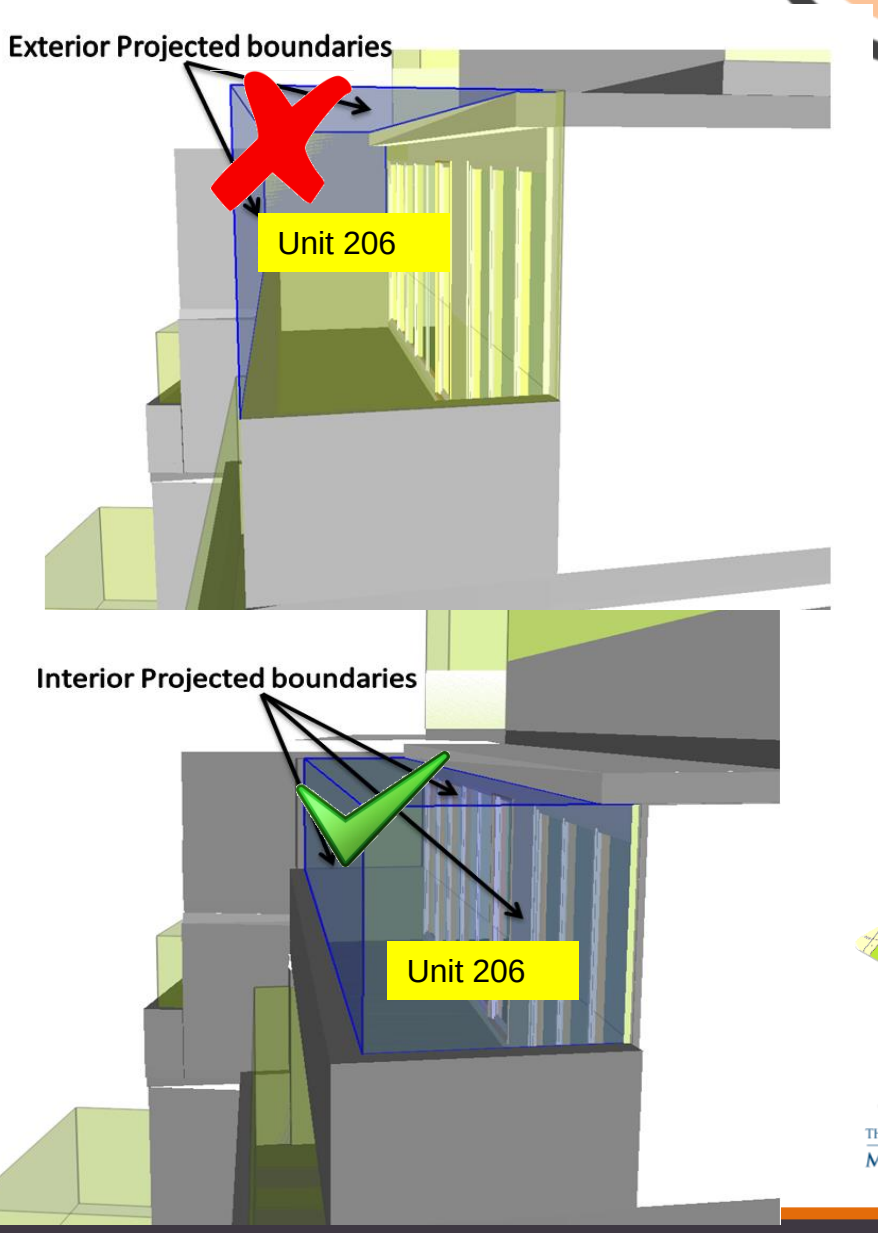






Location of boundary: Where? Why?



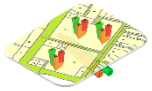


Discussion Points

CSDILA
THE CENTRE FOR SPATIAL DATA INFRASTRUCTURES & LAND ADMINISTRATION

- There is a limited investigation on the interaction between IFC and LADM standards to construct an integrated model

- Mapping LADM concepts into IFC
  - **Benefits:**
    - Link the legal information with other lifecycle information about buildings.
    - Unlock the value of legal information beyond the property registration
  - **Challenges:**
    - Establishing effective interactions between standardization experts in LADM and IFC standards. (e.g. LandInfra)
    - A good understanding of standards by both expert groups



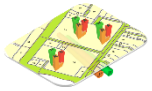
THE UNIVERSITY OF MELBOURNE

Discussion Points

- Extending LADM with IFC-based physical objects

  - **Benefits:**
    - Would motivate those jurisdictions which rely on physical elements, such as Victoria in Australia, to adopt LADM in implementing their 3D digital cadastral systems.
    - Broaden the scope of LADM standard in covering various jurisdictional approaches for 3D property registration

  - **Challenges**
    - Comprehensive understanding of property subdivision practices in jurisdictions which rely on physical elements to define legal boundaries and legal arrangements



THE UNIVERSITY OF MELBOURNE

International Symposium and Workshops

A SMART SUSTAINABLE FUTURE FOR ALL

Enhancing Resilience in a Changing Landscape

THE UNIVERSITY OF MELBOURNE

CDMPS
CENTRE FOR DISASTER MANAGEMENT AND PUBLIC SAFETY

CSDILA
THE CENTRE FOR SPATIAL DATA INFRASTRUCTURES & LAND ADMINISTRATION

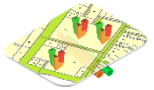
24-26 September 2018 at The University of Melbourne in Australia




www.ssf2018.com

Questions?

CSDILA
THE CENTRE FOR SPATIAL DATA INFRASTRUCTURES & LAND ADMINISTRATION



THE UNIVERSITY OF MELBOURNE