# The world is not all CityGML and IFC: other Geo/BIM standards
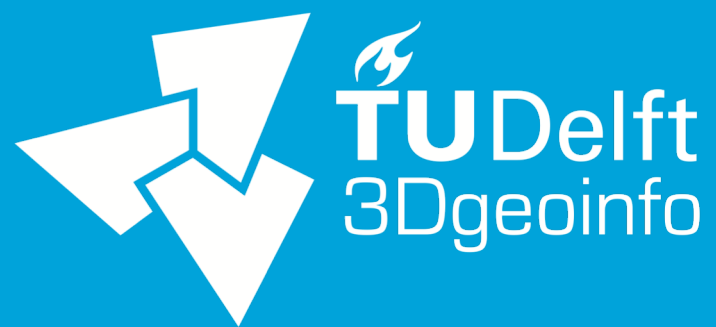
Anna Labetski

02/12/2019

# LandInfra / InfraGML

- OGC standard

- https://www.opengeospatial.org/standards/landinfra
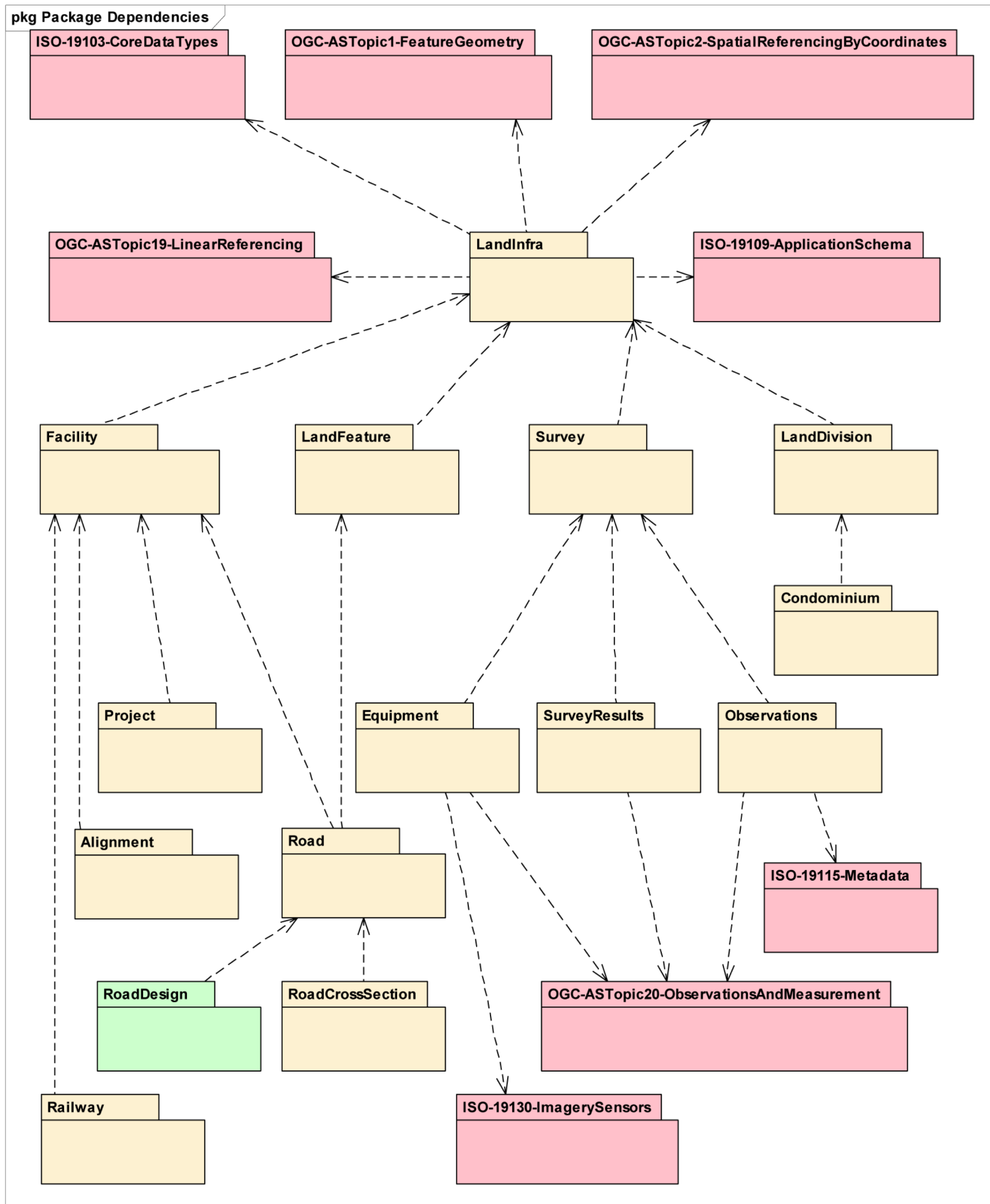
- Successor to LandXML

- based on a subset of LandXML functionality, but implemented with GML

- topography and subsurface information

- deals with the needs of surveying to locate infrastructure facilities on the terrain in compliance with interests in land

# LandInfra / InfraGML

- land and civil engineering infrastructure facilities, e.g. roads, buildings, railways, projects, alignment, survey, and land features

- division of land based on administration, i.e. jurisdictions and districts

- interests in land, e.g. land parcels, easements and condominiums

**pkg Package Dependencies**

- ISO-19103-CoreDataTypes
- OGC-ASTopic1-FeatureGeometry
- OGC-ASTopic2-SpatialReferencingByCoordinates
- OGC-ASTopic19-LinearReferencing
- LandInfra
- ISO-19109-ApplicationSchema
- Facility
- LandFeature
- Survey
- LandDivision
- Project
- Equipment
- SurveyResults
- Observations
- Condominium
- Alignment
- Road
- ISO-19115-Metadata
- RoadDesign
- RoadCrossSection
- OGC-ASTopic20-ObservationsAndMeasurement
- Railway
- ISO-19130-ImagerySensors

# LandInfra / InfraGML

- InfraGML → 7-part GML encoding

  - Land Features, Facilities and Projects, Alignments, Roads, Railways, Survey, and Land Division
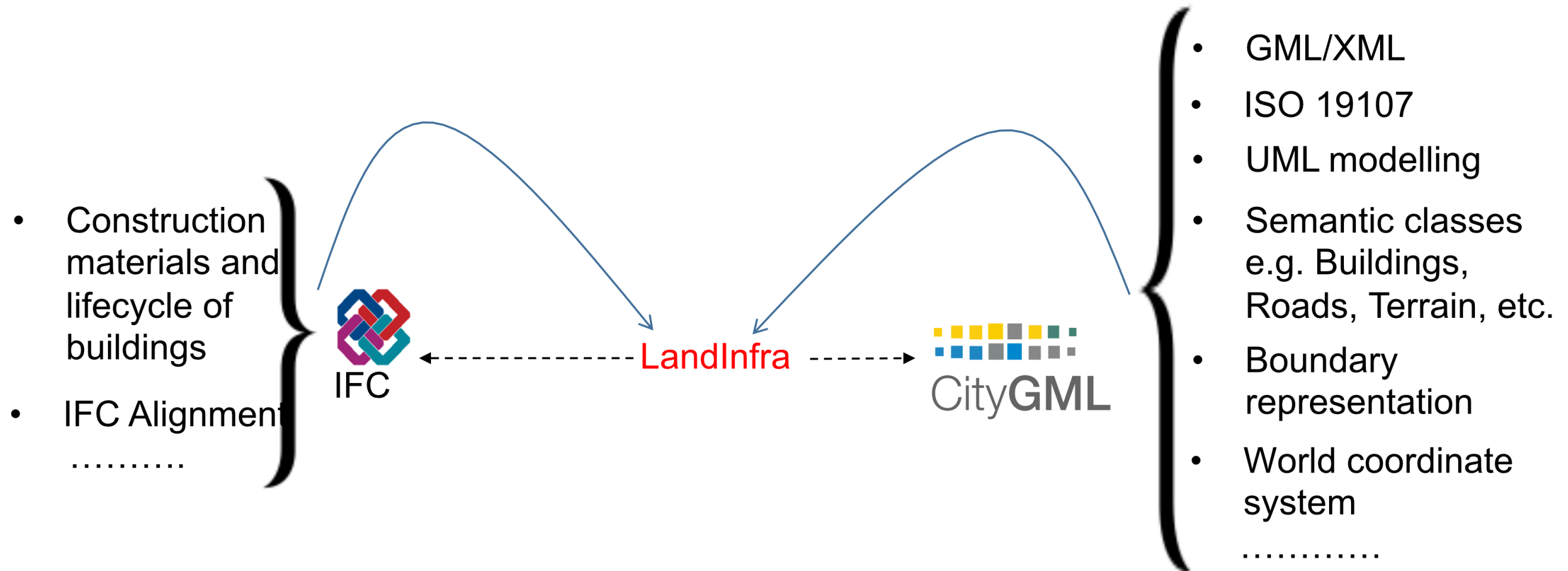
**Table 1.** Main LandInfra requirements classes

| # | Class | Summary | InfraGML part |
|---|---|---|---|
| 1 | LandInfra | Mandatory core with dataset information and common types | 0 |
| 2 | Facility | Collection of buildings, civil engineering works and their siteworks | 2 |
| 3 | Project | Activity related to the improvement of a facility | 2 |
| 4 | Alignment | Positioning element for locating physical elements | 3 |
| 5 | Road | Roads with 3D elements | 4 |
| 6 | Railway | 3D railway elements and track geometry | 5 |
| 7 | Survey | Information related to surveys, e.g. equipment, results, etc. | 6 |
| 8 | LandFeature | Whether natural or man-made, in the surface or subsurface | 1 |
| 9 | LandDivision | Public (political, judicial, or executive) or private land divisions | 7 |
| 10 | Condominium | Ownership of private and public units in a multi-unit building | 7 |

# LandInfra / InfraGML

No software support 😬

# Mapping between CityGML, LandInfra and IFC



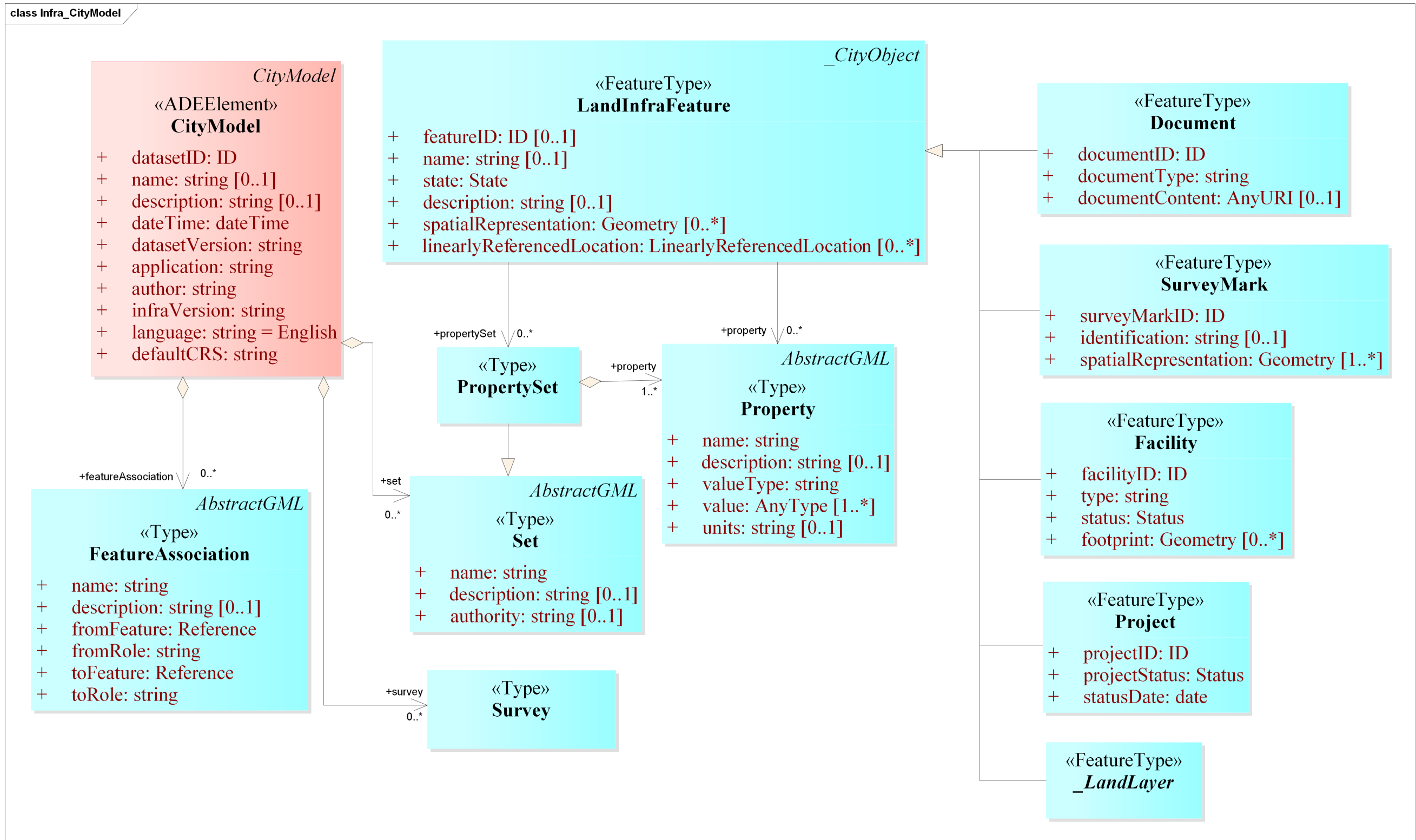- Construction materials and lifecycle of buildings
- IFC Alignment
  ……….

IFC

LandInfra

CityGML

- GML/XML
- ISO 19107
- UML modelling
- Semantic classes e.g. Buildings, Roads, Terrain, etc.
- Boundary representation
- World coordinate system
  …………

# Mapping between CityGML, LandInfra and IFC

**Table 1** A comparison of CityGML, IFC and LandInfra

| # | Criterion | CityGML | LandInfra | IFC |
|---|-----------|---------|-----------|-----|
| 1 | Body | OGC | OGC | buildingSMART |
| 2 | Version | 2.0.0 | 1.0.0 | IFC4 Addendum 2 |
| 3 | Users | 3D city modellers | Survey engineers & BIM | BIM & AEC (Architecture, Engineering & Construction) |
| 4 | Encoding | GML | GML | Mainly STEP (Standard for the Exchange of Product model data) |
| 5 | Focus | City objects | Land and infrastructure | BIM models |
| 6 | Geometry | Subset of ISO 19107 / GML 3.1.1 | ISO 19107 + more | ISO 10303 |
| 7 | Topology | Shared surfaces only | Between facility parts | Openings, coverings and other connections |
| 8 | Semantics | Detailed | Not so detailed | Detailed |
| 9 | Metadata | Basic | ISO 19115 compliant | Extensively but inconsistently used |
| 10 | LODs | 5 different LODs | Not supported | Not supported |
| 11 | Extensions | Generics or ADEs | Not supported | Supported |
| 12 | Appearance | Supported | Not supported | Supported |
| 13 | Software support | Low | Almost nonexistent | Medium |
| 14 | Codelists | Supported with ISO 19103 | Supported with ISO 19103 | Enumerations only |
| 15 | Land use | Simple types | Complex LADM types (ISO, 2012) | Not relevant |
| 16 | File size | Large (Kumar et al, 2016) | Large | Very large |

The LandInfra standard and its role in solving the BIM-GIS quagmire. Kavisha Kumar, Anna Labetski, Ken Arroyo Ohori, Hugo Ledoux and Jantien Stoter. Open Geospatial Data, Software and Standards 4(5), 2019.

# LandInfra and CityGML

class Infra_CityModel

**CityModel**

«ADEElement»
**CityModel**

+ datasetID: ID
+ name: string [0..1]
+ description: string [0..1]
+ dateTime: dateTime
+ datasetVersion: string
+ application: string
+ author: string
+ infraVersion: string
+ language: string = English
+ defaultCRS: string

_CityObject

«FeatureType»
**LandInfraFeature**

+ featureID: ID [0..1]
+ name: string [0..1]
+ state: State
+ description: string [0..1]
+ spatialRepresentation: Geometry [0..*]
+ linearlyReferencedLocation: LinearlyReferencedLocation [0..*]

«FeatureType»
**Document**

+ documentID: ID
+ documentType: string
+ documentContent: AnyURI [0..1]

«FeatureType»
**SurveyMark**

+ surveyMarkID: ID
+ identification: string [0..1]
+ spatialRepresentation: Geometry [1..*]

+propertySet 0..*

«Type»
**PropertySet**

+property

+property 1..*

+property 0..*

*AbstractGML*

«Type»
**Property**

+ name: string
+ description: string [0..1]
+ valueType: string
+ value: AnyType [1..*]
+ units: string [0..1]

«FeatureType»
**Facility**

+ facilityID: ID
+ type: string
+ status: Status
+ footprint: Geometry [0..*]

+featureAssociation 0..*

*AbstractGML*

«Type»
**FeatureAssociation**

+ name: string
+ description: string [0..1]
+ fromFeature: Reference
+ fromRole: string
+ toFeature: Reference
+ toRole: string

+set 0..*

*AbstractGML*

«Type»
**Set**

+ name: string
+ description: string [0..1]
+ authority: string [0..1]

«FeatureType»
**Project**

+ projectID: ID
+ projectStatus: Status
+ statusDate: date

+survey 0..*

«Type»
**Survey**

«FeatureType»
**_LandLayer**

# LandInfra and CityGML

city2InfraGML →

   https://github.com/tudelft3d/city2InfraGML

# INSPIRE

"The INSPIRE Directive aims to create a European Union spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment."

## INSPIRE Spatial Data Themes

Addresses
Administrative units
Agricultural and aquaculture facilities
Area management/restriction/regulation zones and reporting units
Atmospheric conditions
Bio-geographical regions
Buildings
Cadastral parcels
Coordinate reference systems
Elevation
Energy resources
Environmental monitoring facilities
Geographical grid systems
Geographical names
Geology
Habitats and biotopes
Human health and safety

Hydrography
Land cover
Land use
Meteorological geographical features
Mineral resources
Natural risk zones
Oceanographic geographical features
Orthoimagery
Population distribution — demography
Production and industrial facilities
Protected sites
Sea regions
Soil
Species distribution
Statistical units
Transport networks
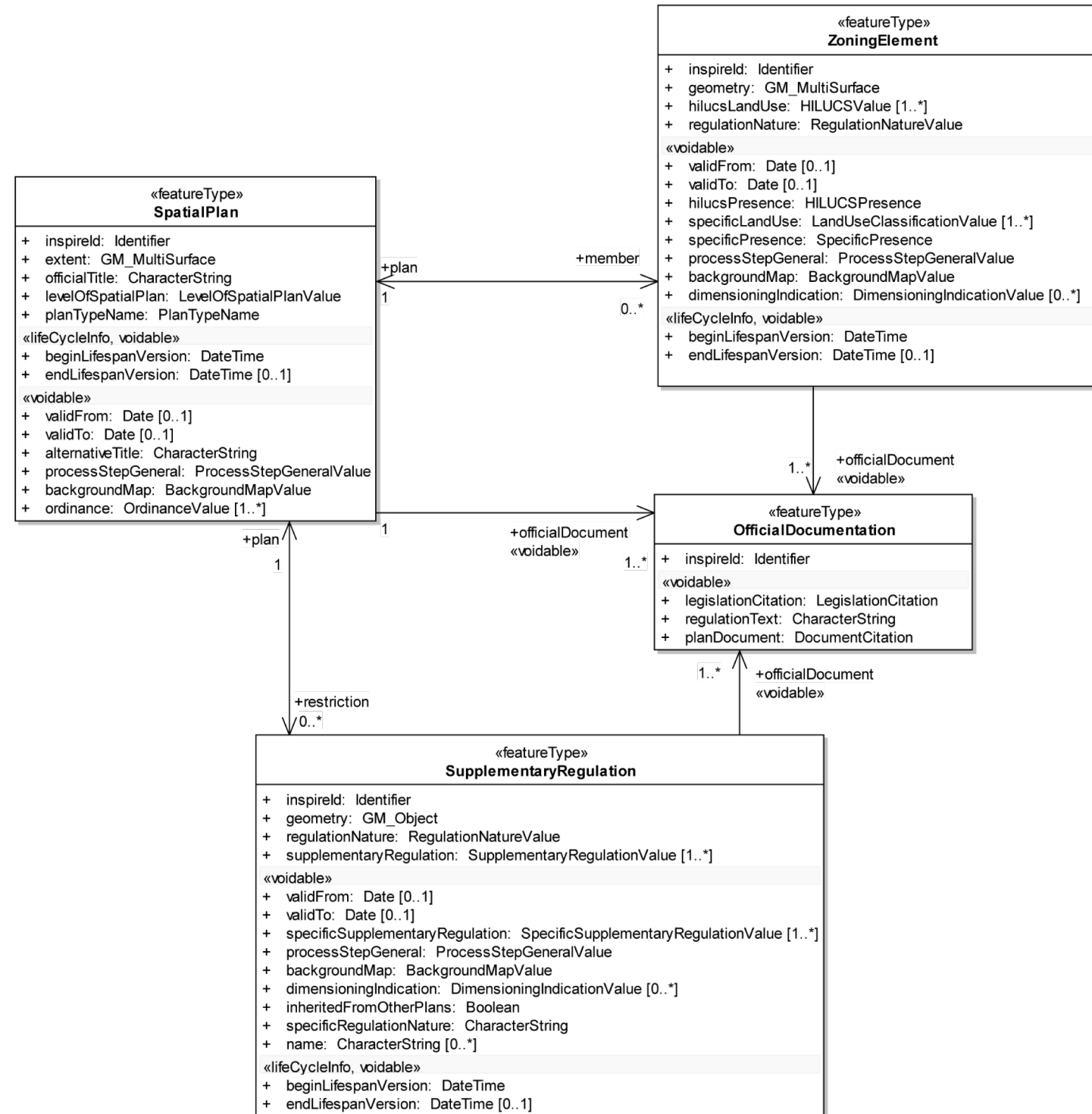Utility and governmental services

INSPIRE · Infrastructure for Spatial Information in Europe

# INSPIRE

«featureType»
**ZoningElement**

|  |  |
|---|---|
| + | inspireId: Identifier |
| + | geometry: GM_MultiSurface |
| + | hilucsLandUse: HILUCSValue [1..*] |
| + | regulationNature: RegulationNatureValue |

«voidable»

|  |  |
|---|---|
| + | validFrom: Date [0..1] |
| + | validTo: Date [0..1] |
| + | hilucsPresence: HILUCSPresence |
| + | specificLandUse: LandUseClassificationValue [1..*] |
| + | specificPresence: SpecificPresence |
| + | processStepGeneral: ProcessStepGeneralValue |
| + | backgroundMap: BackgroundMapValue |
| + | dimensioningIndication: DimensioningIndicationValue [0..*] |

«lifeCycleInfo, voidable»

|  |  |
|---|---|
| + | beginLifespanVersion: DateTime |
| + | endLifespanVersion: DateTime [0..1] |

«featureType»
**SpatialPlan**

|  |  |
|---|---|
| + | inspireId: Identifier |
| + | extent: GM_MultiSurface |
| + | officialTitle: CharacterString |
| + | levelOfSpatialPlan: LevelOfSpatialPlanValue |
| + | planTypeName: PlanTypeName |

«lifeCycleInfo, voidable»

|  |  |
|---|---|
| + | beginLifespanVersion: DateTime |
| + | endLifespanVersion: DateTime [0..1] |

«voidable»

|  |  |
|---|---|
| + | validFrom: Date [0..1] |
| + | validTo: Date [0..1] |
| + | alternativeTitle: CharacterString |
| + | processStepGeneral: ProcessStepGeneralValue |
| + | backgroundMap: BackgroundMapValue |
| + | ordinance: OrdinanceValue [1..*] |

+plan          +member
1              0..*

1      +officialDocument
       «voidable»
                1..*

1..*   +officialDocument
       «voidable»

«featureType»
**OfficialDocumentation**

|  |  |
|---|---|
| + | inspireId: Identifier |

«voidable»

|  |  |
|---|---|
| + | legislationCitation: LegislationCitation |
| + | regulationText: CharacterString |
| + | planDocument: DocumentCitation |

+plan
1

+restriction
0..*

1..*   +officialDocument
       «voidable»

«featureType»
**SupplementaryRegulation**

|  |  |
|---|---|
| + | inspireId: Identifier |
| + | geometry: GM_Object |
| + | regulationNature: RegulationNatureValue |
| + | supplementaryRegulation: SupplementaryRegulationValue [1..*] |

«voidable»

|  |  |
|---|---|
| + | validFrom: Date [0..1] |
| + | validTo: Date [0..1] |
| + | specificSupplementaryRegulation: SpecificSupplementaryRegulationValue [1..*] |
| + | processStepGeneral: ProcessStepGeneralValue |
| + | backgroundMap: BackgroundMapValue |
| + | dimensioningIndication: DimensioningIndicationValue [0..*] |
| + | inheritedFromOtherPlans: Boolean |
| + | specificRegulationNature: CharacterString |
| + | name: CharacterString [0..*] |

«lifeCycleInfo, voidable»

|  |  |
|---|---|
| + | beginLifespanVersion: DateTime |
| + | endLifespanVersion: DateTime [0..1] |

**Figure 22 – UML Overview of the Planned Land Use application schema**

# LADM

- Land Administration Domain Model

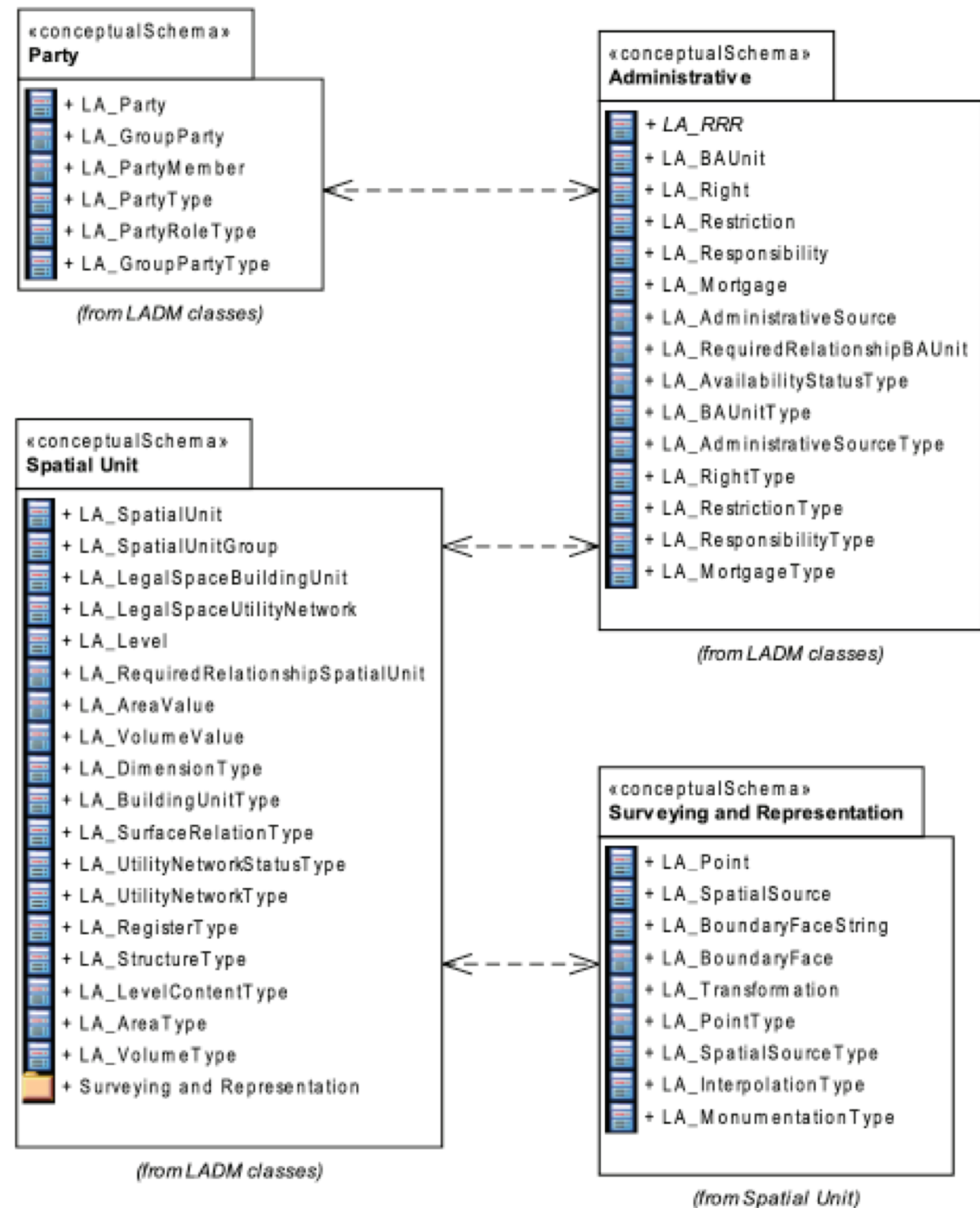- ISO standard - ISO 19152:2012

- LandInfra uses LADM for its land use class



«conceptualSchema»
**Party**

- + LA_Party
- + LA_GroupParty
- + LA_PartyMember
- + LA_PartyType
- + LA_PartyRoleType
- + LA_GroupPartyType

*(from LADM classes)*

«conceptualSchema»
**Administrative**

- + *LA_RRR*
- + LA_BAUnit
- + LA_Right
- + LA_Restriction
- + LA_Responsibility
- + LA_Mortgage
- + LA_AdministrativeSource
- + LA_RequiredRelationshipBAUnit
- + LA_AvailabilityStatusType
- + LA_BAUnitType
- + LA_AdministrativeSourceType
- + LA_RightType
- + LA_RestrictionType
- + LA_ResponsibilityType
- + LA_MortgageType

*(from LADM classes)*

«conceptualSchema»
**Spatial Unit**

- + LA_SpatialUnit
- + LA_SpatialUnitGroup
- + LA_LegalSpaceBuildingUnit
- + LA_LegalSpaceUtilityNetwork
- + LA_Level
- + LA_RequiredRelationshipSpatialUnit
- + LA_AreaValue
- + LA_VolumeValue
- + LA_DimensionType
- + LA_BuildingUnitType
- + LA_SurfaceRelationType
- + LA_UtilityNetworkStatusType
- + LA_UtilityNetworkType
- + LA_RegisterType
- + LA_StructureType
- + LA_LevelContentType
- + LA_AreaType
- + LA_VolumeType
- + Surveying and Representation

*(from LADM classes)*

«conceptualSchema»
**Surveying and Representation**

- + LA_Point
- + LA_SpatialSource
- + LA_BoundaryFaceString
- + LA_BoundaryFace
- + LA_Transformation
- + LA_PointType
- + LA_SpatialSourceType
- + LA_InterpolationType
- + LA_MonumentationType

*(from Spatial Unit)*

Figure 1 — The LADM overview of (sub)packages (with their respective classes)

# LADM

- defines a model covering basic components of land administration

- provides an abstract, conceptual model with four packages related to parties, ownership rights, spatial units, spatial sources, and spatial representations

- provides terminology for land administration, based on various national and international systems

- provides a basis for national and regional profiles

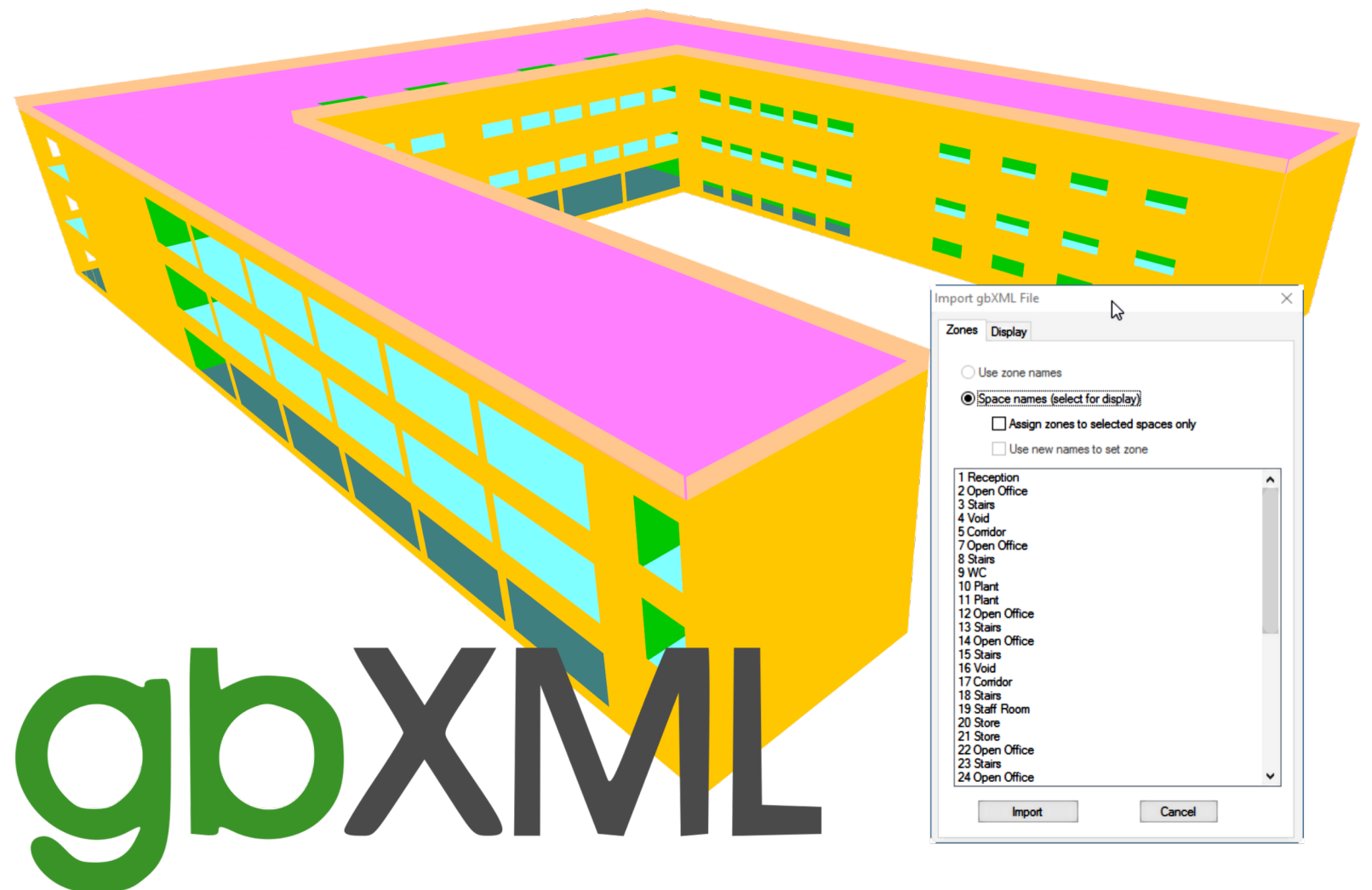- enables the combining of land administration information from different sources

# gbXML

- Green Building XML ➔ spun off from Green Building Studio

- [https://gbxml.org/](https://gbxml.org/)

- [https://github.com/greenbuildingxml/](https://github.com/greenbuildingxml/)

- designed to allow very different BIMs and architectural/engineering analysis software to share information with each other

- Heating, Ventilation, and Air Conditioning (HVAC)

- facilitates the transfer of building information stored in CAD-based building information models

gbXML

# gbXML

- there is software support: e.g. Revit ➜ Trane TRACE

- Autodesk, Trimble, Graphisoft, and Bentley + export and import capabilities in over 50 engineering and analysis modeling tools

- online viewer

# IndoorGML

- OGC standard

- [http://www.indoorgml.net/](http://www.indoorgml.net/)

- exchange of indoor spatial information

- main concepts: cellular space, semantic representation and geometric representation, topological representation and multi-layered representation

- there are viewers and some software to create data

# IndoorJSON

https://github.com/tudelft3d/indoorjson

# Standards...

- Slow to evolve

- Over-fit to a specific case

- Contribution is not transparent or easy

- UML prioritised over sample data and software

# thanks ☺

twitter - @tudelft3d
GitHub - tudelft3d
web - 3d.bk.tudelft.nl

**TU**Delft
3Dgeoinfo