# Utilizing 3D Building and 3D Cadastre Geometries for Better Valuation of Existing Real Estate

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## Overview

1. *Introduction*
2. Building and cadastral models
3. Valuation in sample countries
4. 2D/3D Information needs
5. Geometry for dissemination of valuation data
6. Conclusion

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## Introduction

- Valuation of the properties can be defined as all efforts to calculate the market value of a property

- Valuation of real estate/ properties is in many countries/ cities the basis for fair taxation

- Semantically rich 3D building models (e.g. BIM) and 3D Cadastral models are becoming more widely used day by day for different purposes.

- These models can be utilized as a basis for fair valuation and taxation

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## Aim & Summary

- In this context , this study focuses on…

  - Building and Cadastral Models

  - Relationship between physical real world objects and legal (virtual) objects

  - Information Requirements for Valuation in various countries around the globe

  - The use of geometric information for dissemination of valuation results

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## Building Models (Physical Objects), types

- 3D CAD
  - Geometry-only / Solid- or Non-Solid representations / No GeoReference / Single but Most Detailed
- GeoInformation Models (2,5D)
  - Geometry – Linked Semantics / Feature Model of GIS / Less detailed / GeoReferenced
- BIM (3D)
  - Geometry + Semantic Data Definition in an Object Data Model - ISO 10303 based exchange format / Single but Most Detailed / Rarely GeoReferenced
- CityGML (3D)
  - Geometry + Semantic Data Definition in an Object Data Model  - XML based exchange format / Medium detailed LOD 0-4 / GeoReferenced

## Land Administration (Legal/Virtual Objects)

- Land administrations systems (land registry, cadastre) have different origins in different countries.
  - The information was sometimes collected for taxation purposes and in other cases for legal security
  - In many countries the land administration systems more and more served both applications; e.g. in the area of spatial development or spatial planning
  - → Multi-purpose cadastre

- Based on the initiative of the FIG, ISO has developed the standard Land Administration Domain Model (LADM), ISO 19152:2012
  - Describes the relation between people and land
- The objects (parcels) are called legal or virtual objects, because they do not need to be visible in the real world.
  - Parcels can be in 3D→and mostly correspond to legal spaces (i.e. Tunnel, building part)
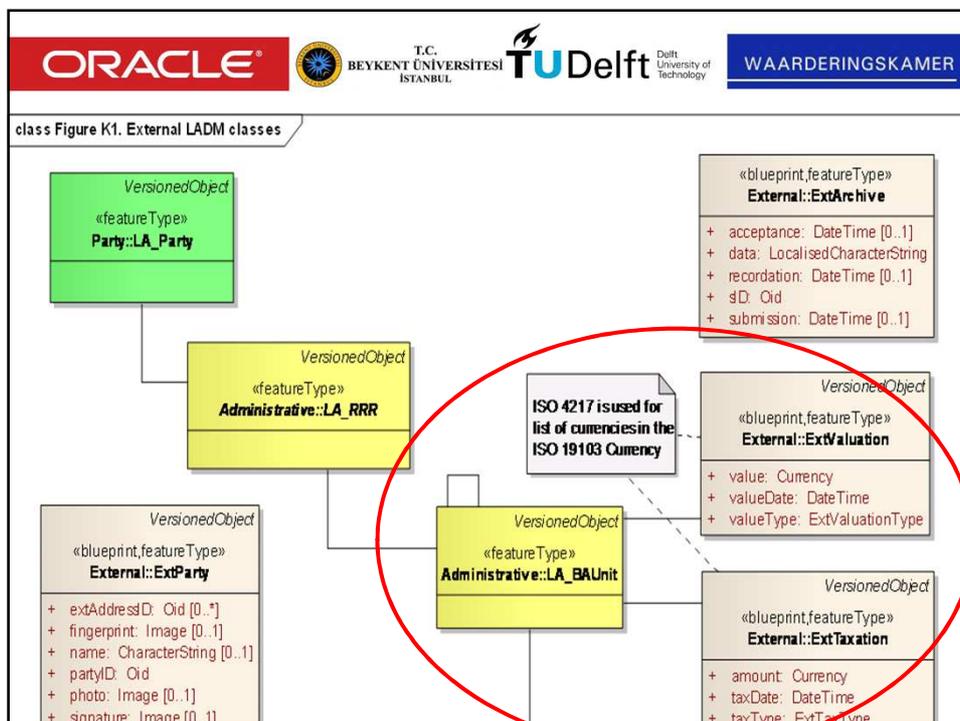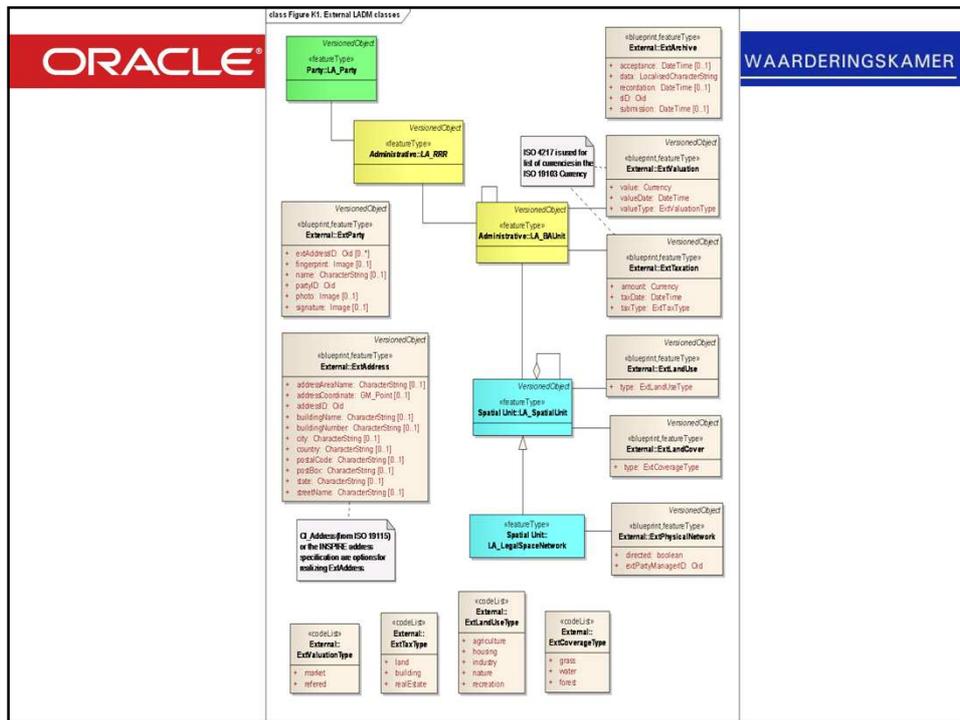
## Relationship Between Physical And Virtual Objects

- (3D) Cadastre is about the legal spaces. That is, spaces described by geometry (and topology) where certain rights, restrictions or responsibilities (RRRs) are attached to.
- Only when the RRRs are different then also a separate geometry is needed
- Most likely only a part of the indoor building modeling information may be relevant in 3D Cadastre context (and perhaps that geometry is even implicit; e.g. a 3D boundary defined by the 'middle of the wall').
- The geometries of the real world (physical) objects and the geometries of the legal objects should be consistent
- When one has the responsibility to pay certain amount of tax based on the function/ type of a room/ space in a building, then this would fall under the definition of a legal space.

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## Turkey

- Methods for determining the Market Value
  - Comparison with a reference sales price
  - Income approach; e.g. such as rent
  - Cost approach (Value of the land lot + Value of the building)

- Methods for determining the Taxation Value
  - Comparison – when there are similarities
  - Income approach; e.g. such as rent
  - Asset cost= Gross Floor Area x Unit Cost  (Unit Cost= Cost of 1 $m^2$. )

## United Kingdom

- Valuation for Taxation
- In UK taxation scheme a property is defined as "A separate unit of living accommodation, occupied by the same person(s) and within the same area of land, comprises a 'dwelling', together with any garden, yard, garage or other outbuildings attached to it.
- In tax calculations each property is allocated to one of the eight bands, A to H, ('A' being the lowest) according to its national value on 1 April 1991
- ….a house decreases in value because…
- ….a home gains a higher value because…

## USA

- Assessed value
  - Fair market value
  - Preferential treatment: farms, non-profits, large employers,..
  - Type, use, size, location, improvements, desirability, RRR, original/replacement cost, income
- Local variation
- Benefit of 3D models/cadastres
  - Documentation, communication
  - Streamlining of assessment, correction
  - Forecasting, policy planning (effects of assessment changes)
- Guaranteed by property, owner → next owner

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## Germany

- Assessed value
  - Value proxy
  - Type, use, size, location, *improvements*, *desirability*, RRR, *original/replacement cost*, income
- Local variation: Tax rate
- Benefit of 3D models/cadastres
  - Documentation, communication
  - Streamlining of assessment, *correction*
  - Forecasting, policy planning (effects of increasing density, RRR, …)
- Guaranteed by property, owner → next owner

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## Netherlands

- Valuation
  - Residential: Comparable sales, 0.1% – 0.2% tax rate
  - Non-residential: Income/cost approach, higher rate
  - Paid by owner & by user, once each
- Mass appraisal
  - Administrative data, street view, …
  - Determine comparable objects
  - Valuation by municipality
- Web-based viewer
  - Demonstrate reliable assessment
  - Transparent government

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## Summary of 2D Information Needs
## Land Lot/Parcel Valuation

- 2D land lot boundaries
- 2D permit boundaries (building, farming, other geographic RRRs, potentially implicit or explicit)
- Accessibility (roads), utilities
- Vegetation, particularly if protected (might represent restriction)
- Typical flow-off of rain water (might represent risk)

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## Summary of 3D Information Needs
## Land Lot/Parcel Valuation

- 3D land parcel (may yield additional information about quality, usability, value)
- 3D building permit boundary solid
    - Volume of the admissible bounding solid. Property tax can be significantly impacted by building permit, including that bounding shape, as opposed to merely the actual physical building, which may be much smaller or lower, or less deep into the ground.
- Some other geographic RRRs may also be 3D in nature, such as 3D boundaries of admissible trees, bushes, fences, etc.

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## Summary of 2D Information Needs Building Valuation

- 2D Floor Plans, *derive:*
    - Ground area
    - Total floor area
    - Floor area with certain increases for high ceilings

- Building orientation
    - e.g. broad side toward lake (can be more expensive)

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## Summary of 3D Information Needs Building Valuation

- 3D model for cost study or statistical value estimate, *derive:*
  - Volume with certain reductions for diagonal walls, roofs, etc, or with increases for higher floors (views)
  - Roof area consisting solar panels
  - Wall/window area to compute energy labels.
  - Check for total gross floor area, usable floor area
  - 3D model for *neighboring* houses can yield influence of sun, noise, visibility of landmarks, mountains, lakes, privacy,…
- Separate building parts by year built, likely longevity
- 3D model of building and surroundings with pictures to have faithful model of quality of building and quality of surroundings (virtual reality)

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Dissemination of Valuation Information in 2D

Cadastral Information is currently presented in 2D, but 3D representations will provide better visualization of information



Dissemination of Valuation Information in 3D

Augmented Reality helps the fusion of cadastral information and 3D

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## Analysis Of Findings

- Valuation is based on parameters such as the total square meters or the total cubic meters.

- …often considered as simple alphanumeric attributes, - obtained or estimated.

- more efficient to use actual square and cubic meters as these can be
  - Derived or at least
  - Checked against 3D building model geometries
    - from the building representation containing outer walls based on building footprint

## Conclusions

- 2D and 3D models are becoming more important for …
  - updating the information within the valuation models
  - presenting valuation results with the underlying data to for instance the owners of properties.
  - by adding "streetview" images to the 3D building models, models will also give information about quality of the building and quality of the environment of the property, which is also of great importance for the valuation.