6th International FIG Workshop on 3D Cadastres
2-4 October 2018, Delft, the Netherlands

National Technical University Of Athens
School of Rural and Surveying Engineering

LADM-based Crowdsourced 3D Cadastral Surveying – Potential and Perspectives

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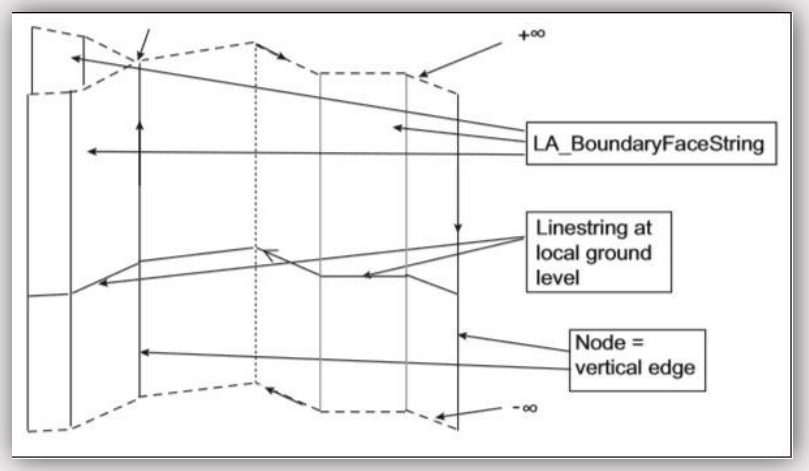
Introduction

- ***Current Situation:***
  - ✓ Vertically growing cities
  - ✓ Complex infrastructure
  - ✓ Subdivision of three-dimensional (3D) space
  - ✓ Overlapping property rights

→ *A modern land administration system (LAS) is needed*

- ***Land Administration Domain Model (LADM ISO 19152)***
  - ✓ Spatial domain standard
  - ✓ flexible conceptual schema for 2D/3D Cadastres
  - ✓ based on a Model Driven Architecture (MDA)



The identification of the acceptable 3D geometries and representations for the 3D cadastral objects is still challenging

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3D Aspect of LADM

- ***3D LADM-based country profiles:***
  - ✓ Russian Federation
  - ✓ Poland
  - ✓ Korea
  - ✓ Greece
  - ✓ Malaysia

→ ***Legislation***
→ ***Cadastral background***

High demand of required time and cost

- ***Linking LADM with physical models:***

Legal data model ↔ ***Physical data model***

↓

✓ ***Application schemas***
✓ ***Technical models***
(CityGML, IndoorGML, BIM/IFC, LandXML, InfraGML, etc.)

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The potential use of crowdsourcing for 3D cadastral surveys

❖ **Current research trends:**

- ✓ Low-cost equipment & IT tools
- ✓ Crowdsourcing techniques
- ✓ Mobile services (m-services) & Web services
- ✓ Open-source software (OSS)

Minimize cost and the time of the required surveys

2D Crowdsourcing cadastral surveys

❖ **Crowdsourcing in 3D cadastral surveys:**

✓ Parametric modelling methods (Model-driven) – ***Best Fitted Solution***

- *high robustness, maintenance of topology*
- *can be adopted by parties without specific photogrammetric skills*

A fit-for-purpose 3D crowdsourced cadastral surveying approach based on standardized data model as LADM, might be of significant value to speed up processes for establishing 3D cadastres

Proposed Framework

Proposed Framework

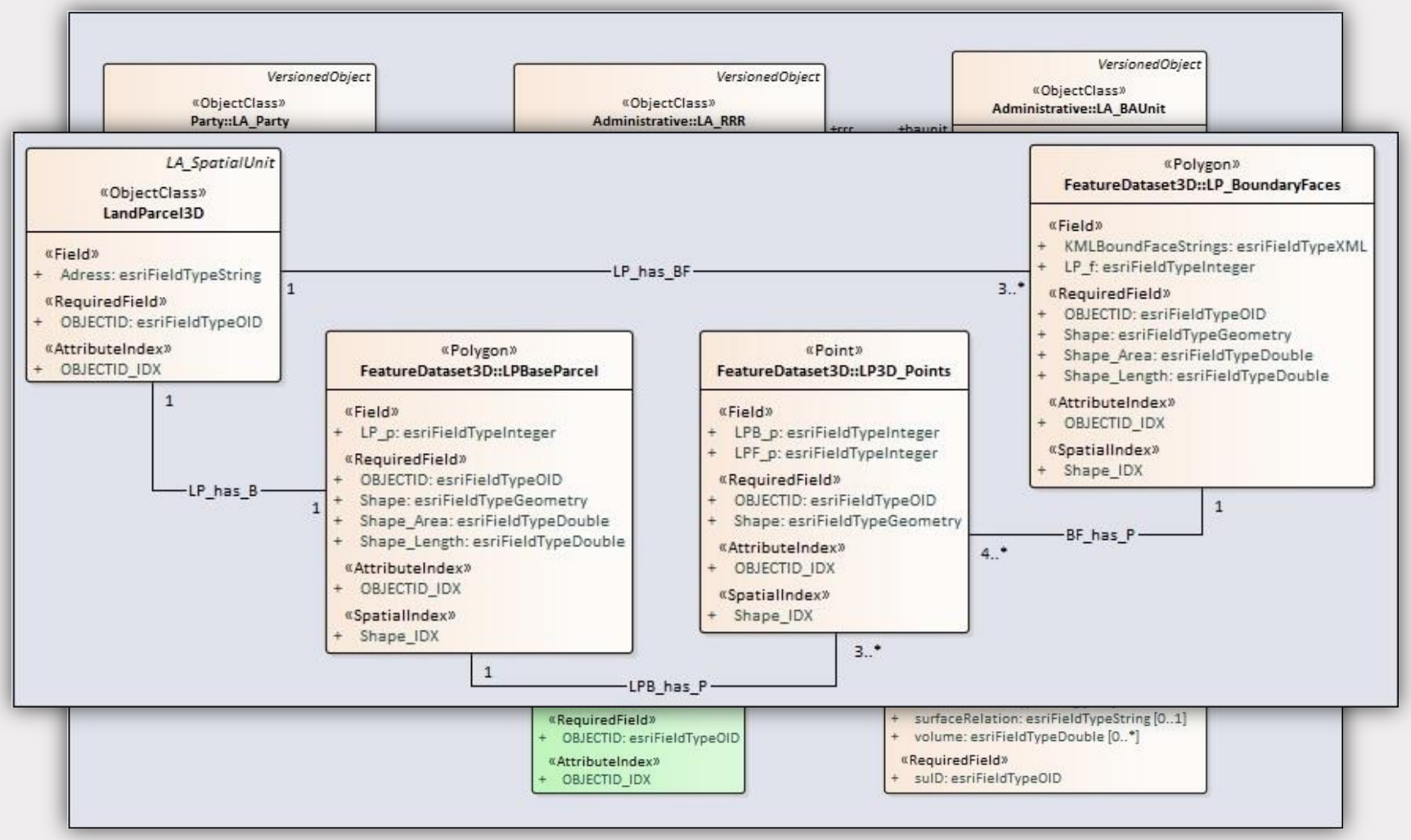
- **Technical Aspects**
  - **Server-side**
    - **LADM-based DBMS**
  - **Client-side**
    - **Open-sourced mobile application for Android**
- **Crowdsourcing Procedure**

❖ ***Cost-effective LADM-based technical solution***

- ✓ Acquisition
- ✓ Registration
- ✓ 3D modelling
- ✓ Visualization

Database Management System (DBMS) (1/2)

Enterprise Architect UML modeling tool – ArcGIS Geodatabase



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Database Management System (DBMS) (2/2)

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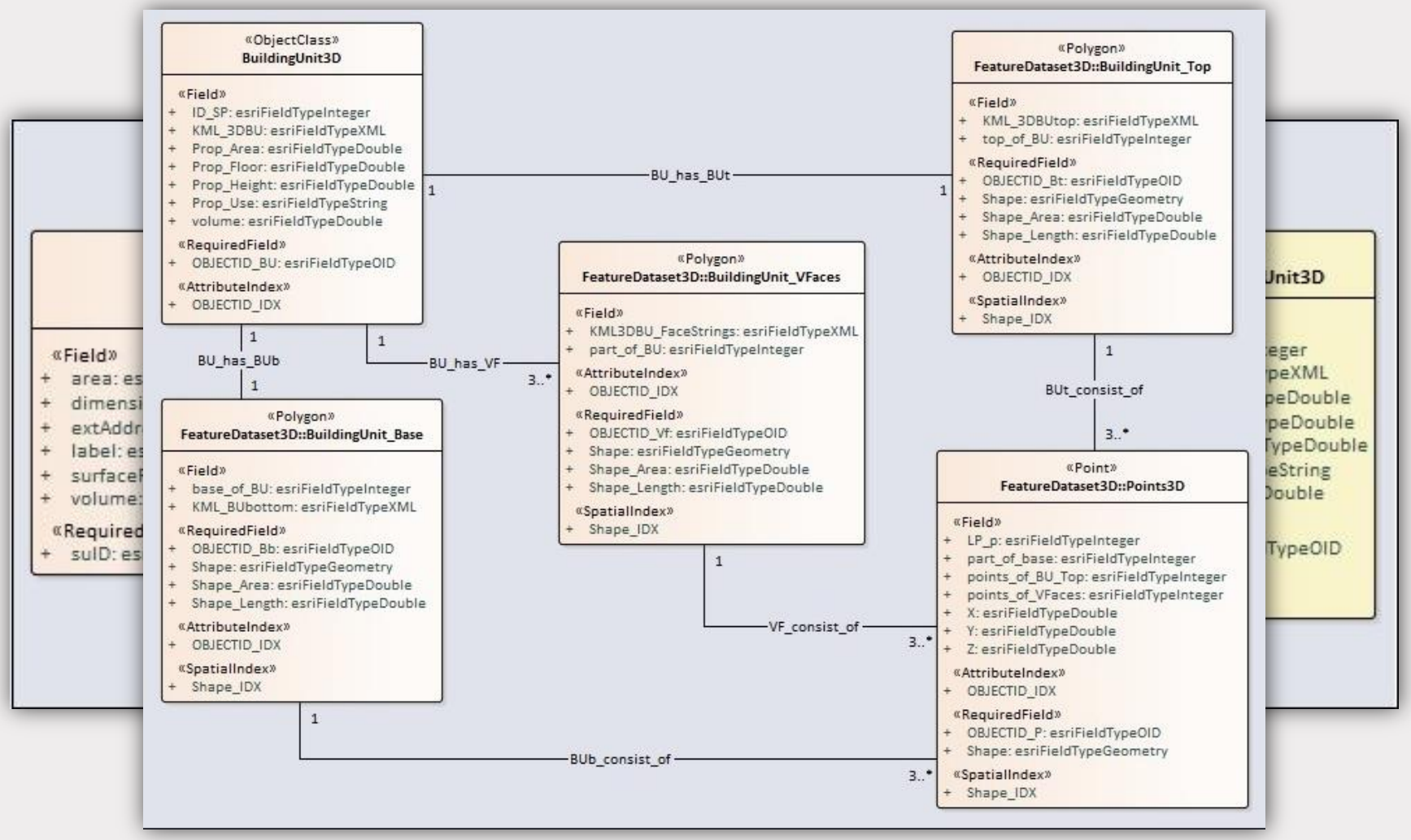

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3D – Crowdsourcing Self-developed Mobile Application (1/2)

- ***Self-developed open-sourced*** Mobile Application
  - ✓ 3D cadastral data acquisition
  - ✓ 3D modelling of real properties (LoD1)
    Land Parcel & Property Unit → Model-driven approach
  - ✓ 3D visualization above & below the terrain
- ***Software tools***:
  - ✓ Visual Studio 2013 (IDE)
  - ✓ Oracle JDK 8 (Java Development Kit)
  - ✓ Android SDK Manager (for API level 19),
  - ✓ add-in ArcGIS Runtime SDK for .NET (100.0.0) of ESRI
  - ✓ add-in Xamarin 4.5.0
  - ✓ the SharpKML library
  - ✓ the programming language of C#,
  - ✓ the Server of ArcGIS Online (Cloud of ESRI)

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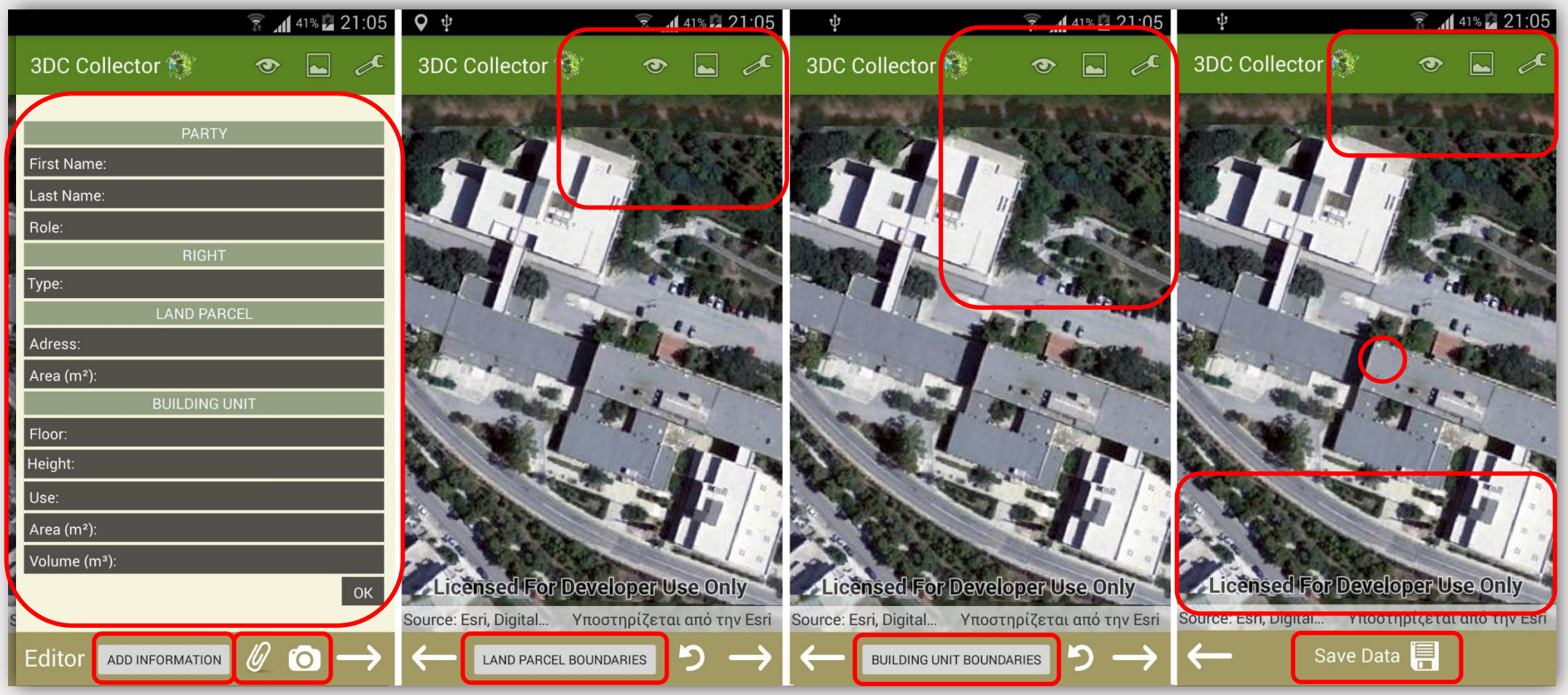
3D – Crowdsourcing Self-developed Mobile Application (2/2)



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Proposed Procedure for 3D Cadastral Surveys (1/2)

- Provision of the available **basemap** with the areas under cadastral survey
  - ✓ recent orthophoto overlaid with buildings floor plans → Higher geometric accuracy

  or

  - ✓ Orthophoto or aerial photo with the areas under cadastral survey → Lower geometric accuracy

- Crowdsourced 3D cadastral information/data acquisition

Cadastral Mobile Application

- ✓ Demarcation / digitization of the property boundaries
- ✓ Insertion of **additional geometric information**: building height, floor
- ✓ Insertion of **additional descriptive information**: rights holder's personal data, type of rights, etc.
- ✓ Verification **images** and **legal documents**
- ✓ **3D Parametric reconstruction** of the building

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Proposed Procedure for 3D Cadastral Surveys (2/2)

- Crowdsourced 3D cadastral information/data acquisition

Cadastral Mobile Application →

Help needed?

- ✓ Provided either by volunteers or by professionals
- ✓ Demonstration videos of the mobile/web applications by NCMA

- Data evaluation and control by the cadastral service

Incomplete Data?

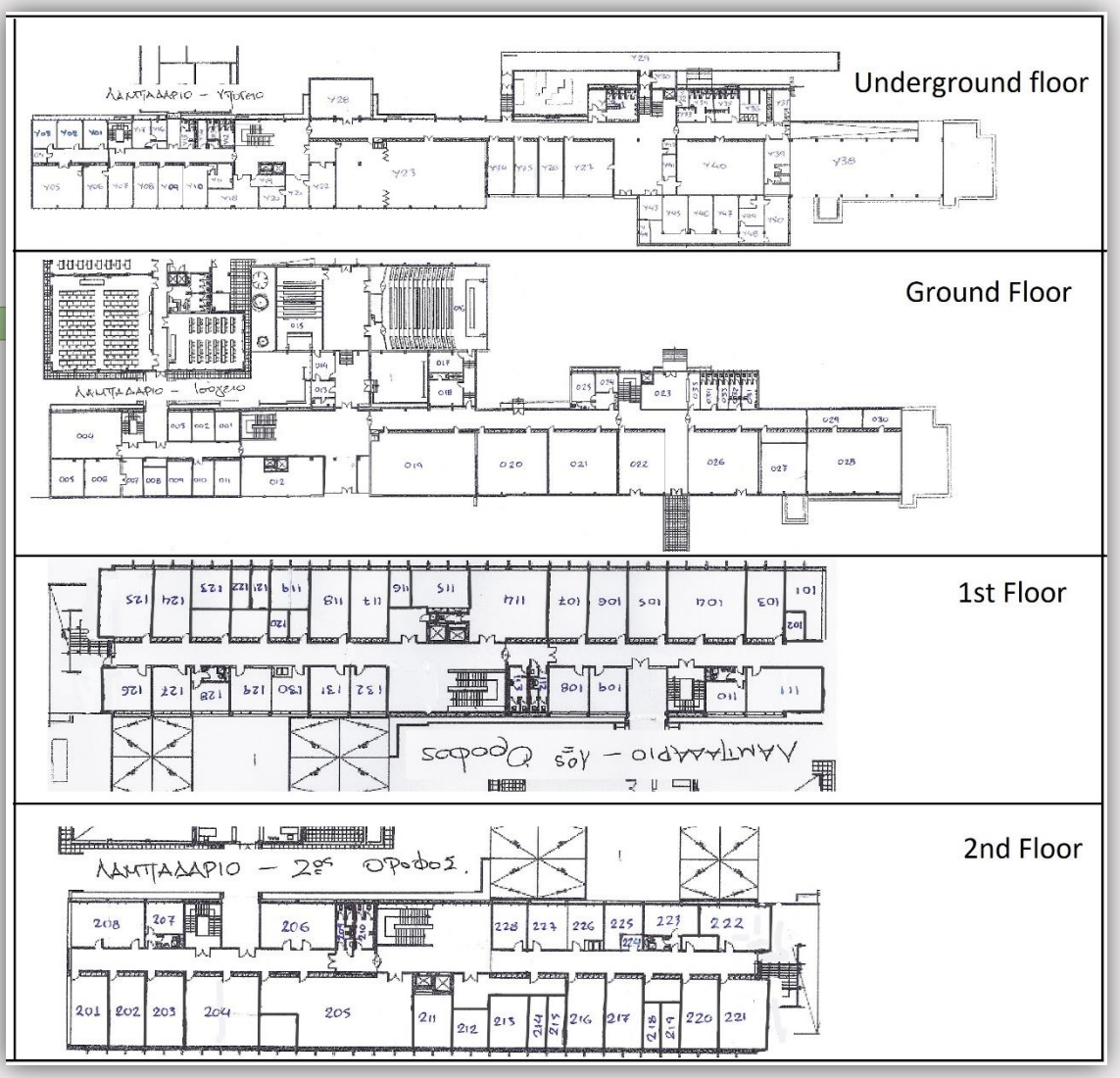
Submission of missing data by rights holders

- Compilation of **preliminary crowdsourced 3D building models** by right holders

Case Study (1/4)

- Acquisition of Crowdsourced 3D cadastral information/data:
  - ✓ The *room-outline* coordinates
  - ✓ The building *area code, address*
  - ✓ The room holder *name, role, type of rights*
  - ✓ The room *floor, height, use, area size, volume*

- Basemaps:
  - ✓ **Orthophoto** at the scale of **1:1000**
  - ✓ **Floor plans** of:
    - the underground floor
    - the ground floor
    - the first and
    - the second floor at a scale of **1:200**



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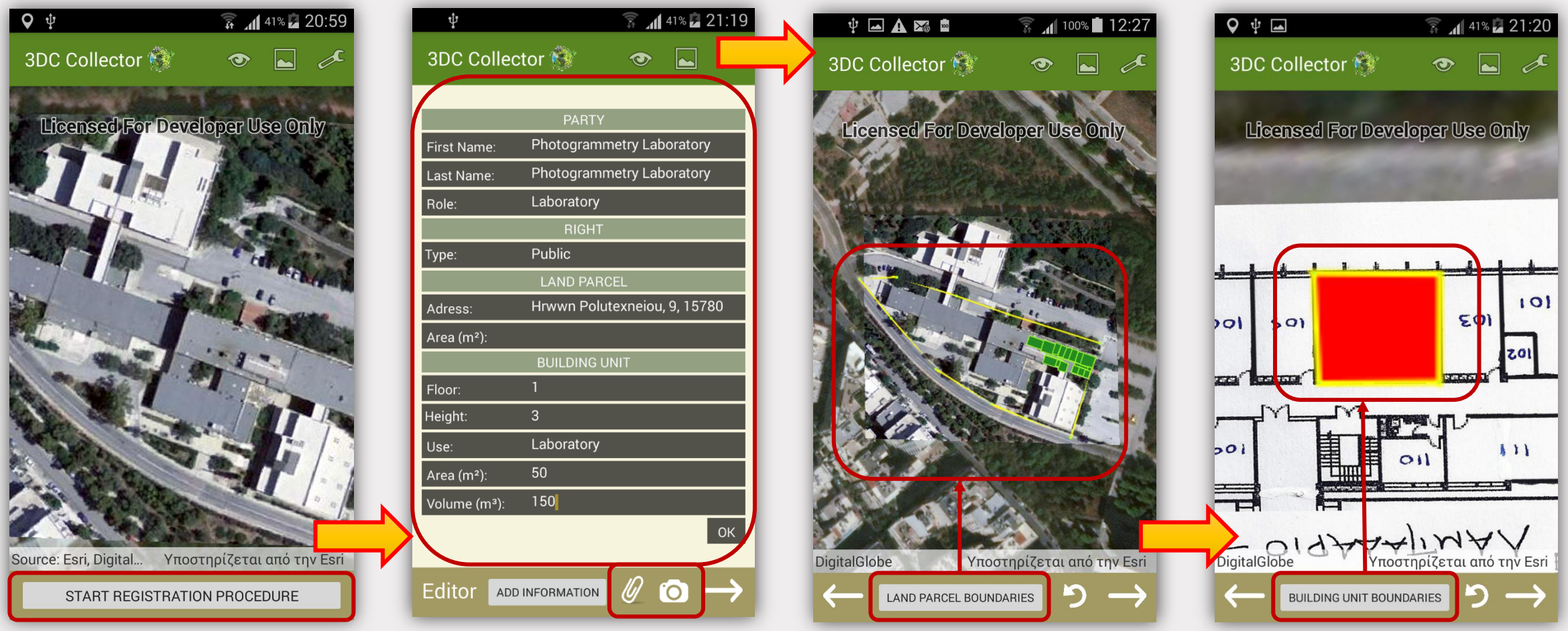
Case Study (2/4)

❖ Registration procedure:



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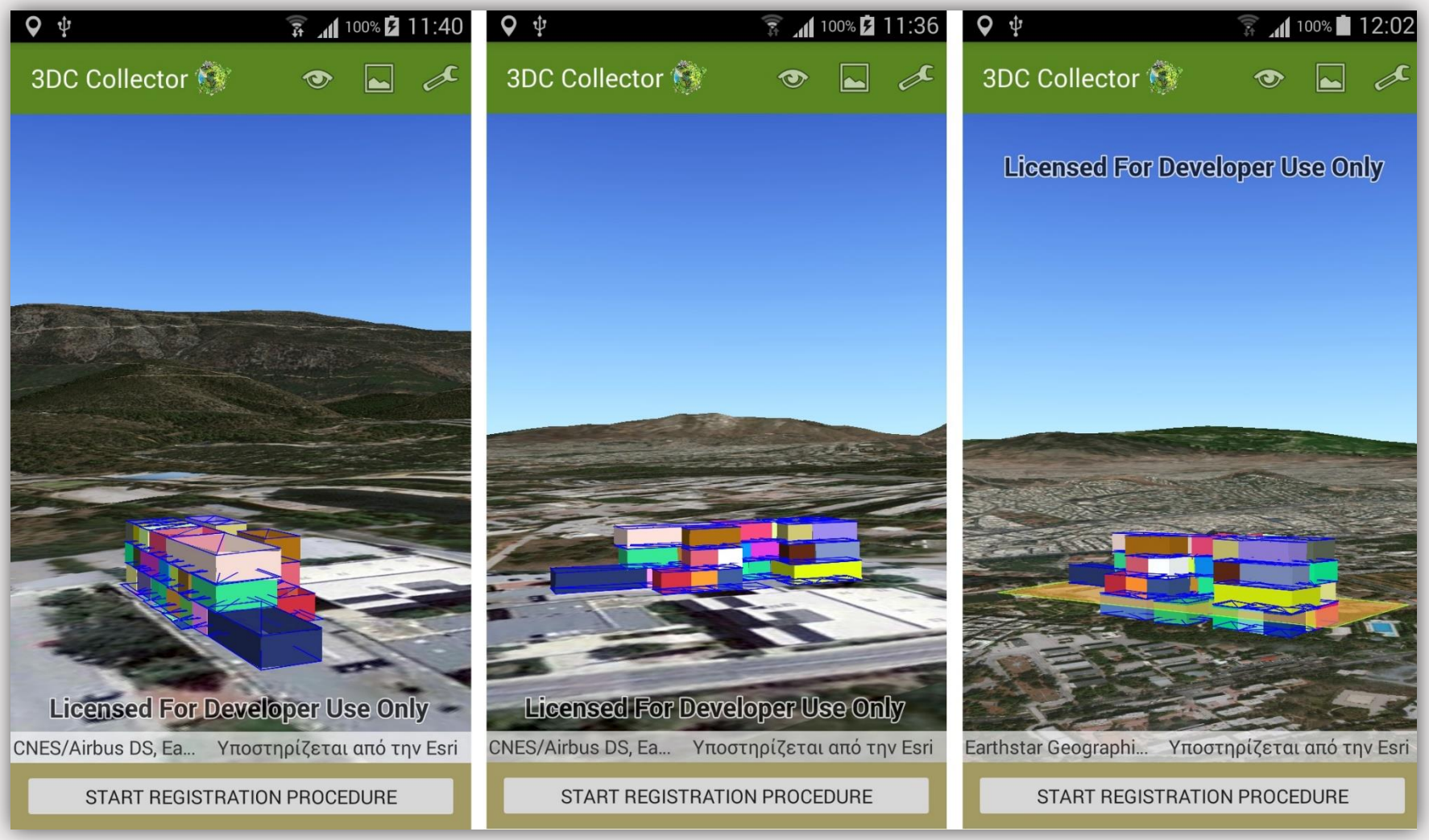
Case Study (3/4)

3D Visualization of the declared properties - *LoD1 (Parametric Modelling)*



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Case Study (4/4)

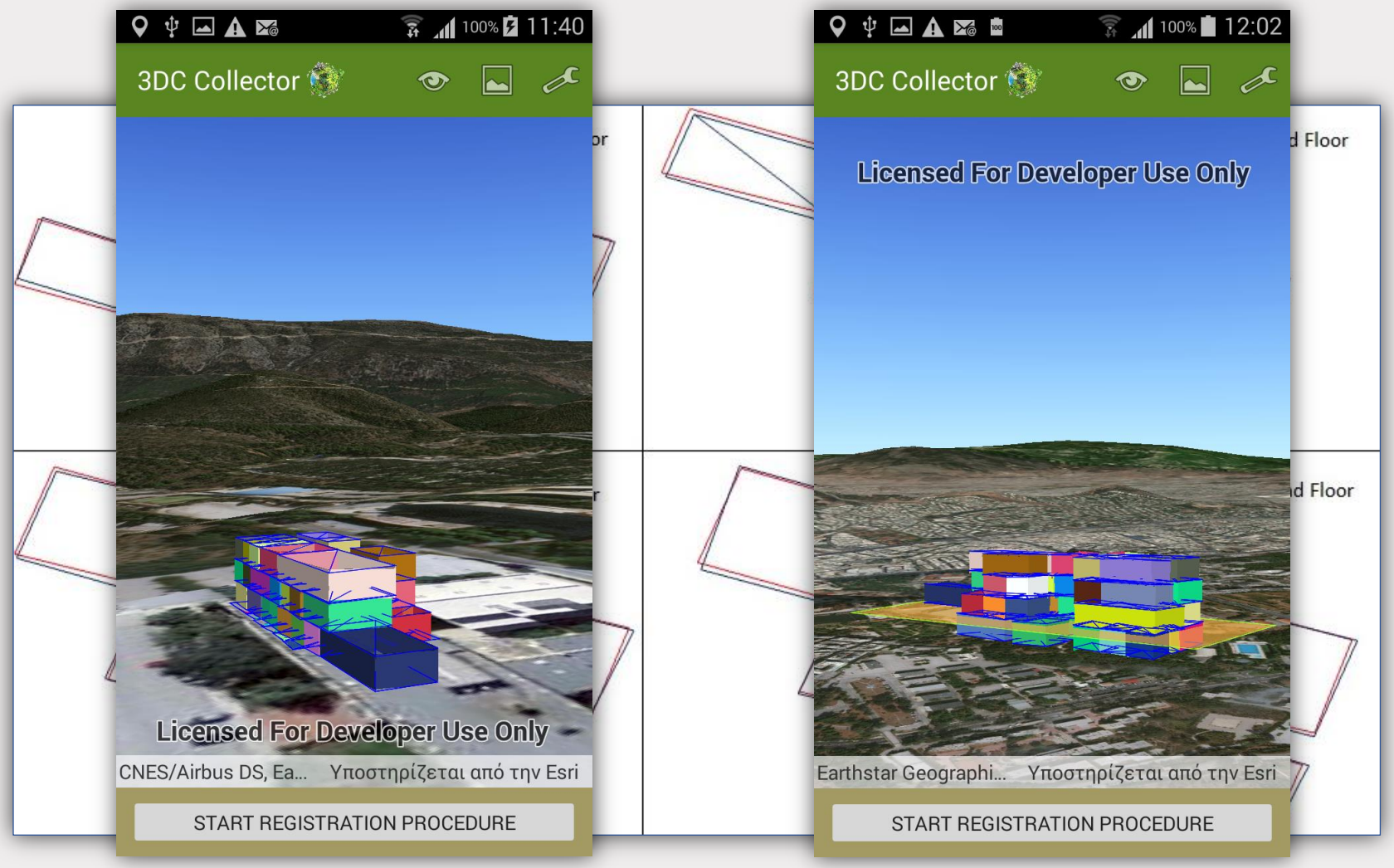
❖ **Result evaluation :**

✓ Comparison with the reference data:
- Maximum deviation: 0.49m
- Minimum deviation: 0.03m
- Average deviation: 0.17m

✓ Qualitative 3D models
- *correct 3D position*
- *small shape defects*

✓ Recording time per property:
- 5-7 min fast

✓ ***Easy-to-use***



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Conclusions

A **cost effective** solution is required for the initial implementation of a **EU** desired **3D Cadastre**

- ***Modern Approach - 3D Cadastral Surveys:***
  - ✓ ***3D Crowdsourcing Techniques*** - Citizens' participation – *errors minimization*
  - ✓ ***Cost effective and time consuming solution / automation***
    usage of modern ***low-cost IT tools, m-services, parametric modelling techniques***
  - ✓ ***Land Administration Domain Model (LADM ISO 19152)***
  - ✓ ***Available cartographic infrastructure***

Generalized technical framework for the initial registration of 3D crowdsourced cadastral data and the creation of a standardize cadastral database for both the developed and developing world

Thank you for your attention!

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