7th International FIG Workshop on 3D Cadastres
11-13 October 2021, New York, USA

National Technical University Of Athens
School of Rural and Surveying Engineering

Linking LADM with BIM/IFC standards for mobile-based 3D Crowdsourced Cadastral Surveys

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Introduction

Current Situation:

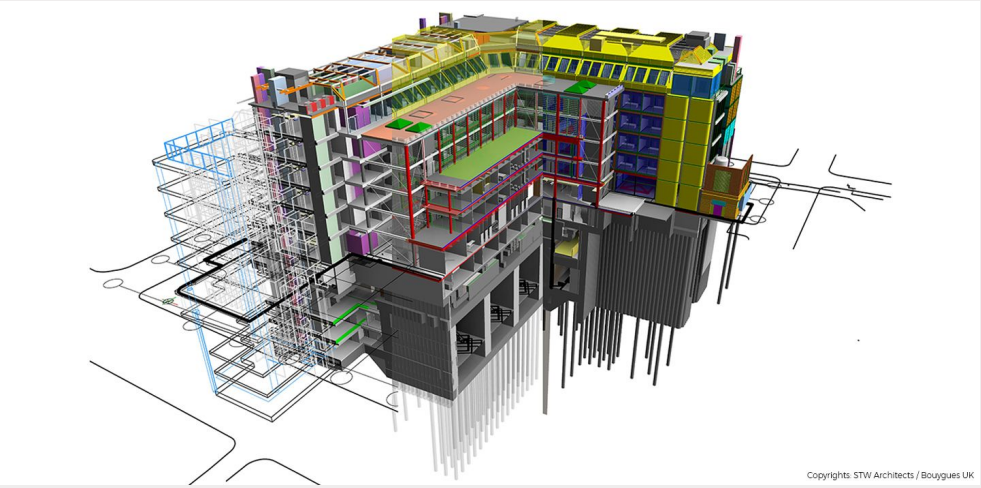
- ✓ Vertically growing cities
- ✓ Complex infrastructure
- ✓ Overlapping property rights

→

Traditional cadastral surveys

- ✓ *Delays*
- ✓ *Registration completion failure*

Building Information Modeling (BIM)



Research trends:

- ✓ *Low-cost equipment*
- ✓ *Crowdsourcing techniques*
- ✓ *Automated procedures*
- ✓ *Mobile services (m-services) & web services*
- ✓ *Open-source software (OSS)*

The immediate development of a reliable, qualitative and affordable solution for the initial implementation of a 3D cadastre, is feasible

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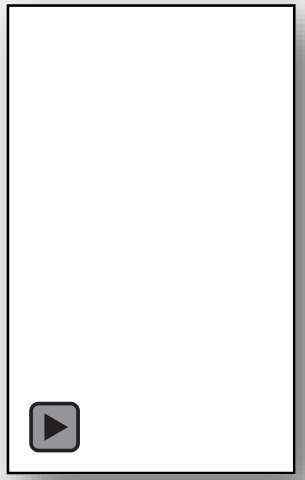
3D Cadastre - Current Research

- ✓ **LADM-based 3D Cadastres (LADM ISO 19152)**
  Flexible conceptual schema for 2D/3D Cadastres – based on a Model Driven Architecture (MDA)
- ✓ **Linking LADM with physical models**
  Application schemas & Technical models (CityGML, IndoorGML, BIM/IFC, LandXML etc.)
- ✓ ***2D/3D Crowdsourcing cadastral surveys***
  *Minimize **cost** and **time** of the required surveys*

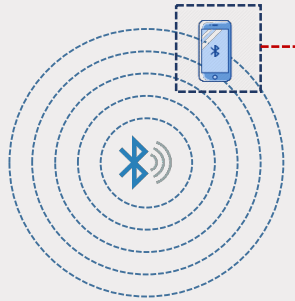
- ✓ 2D architectural floor plans
- ✓ Orthophotos
- ✓ 2D cadastral maps
- ✓ Aerial photos
- ✓ Maps

- ✓ GPS sensor - smartphone's GPS
- ✓ GNSS receiver device



Weak Indoor Positioning Accuracy

Indoor Positioning System (IPS)



Position Estimation

Machine Learning Algorithm

3D Cadastral Mobile Application

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BIM and 3D Cadastre

BIM

- ✓ ***able*** *to manage complex buildings structures*
- ✓ ***enable*** *communication between parties*
- ✓ ***provide*** *the geometry of the physical buildings' spaces for* ***3D Cadastre***

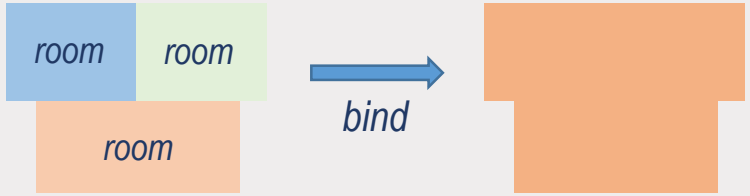
rooms, corridors, walls and floors

- ✓ ***Re-usage*** *of existing BIM*

time-effective - enable interoperability

Definition of ***Legal Spaces?***

Physical spaces → *Legal space*



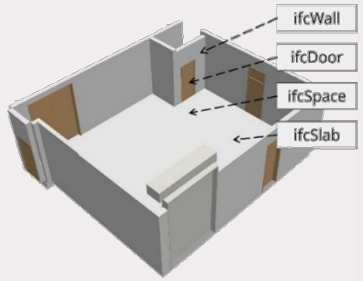
Large amount of mainly ***new constructions*** *are already mapped utilizing* ***BIM***

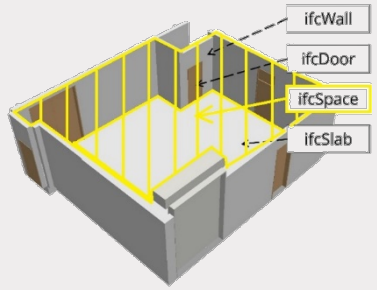
Representation ***Legal Spaces?***

- ✓ *Open BIM exchange models*

IFC *(Industry Foundation Classes)*

*** IfcSpace entity ****





BIM *along can provide a promising input to* ***3D Cadastre***

Update the cadastral database with:

- ✓ *Ownership status*
- ✓ *Uses changes*
- ✓ *etc.*

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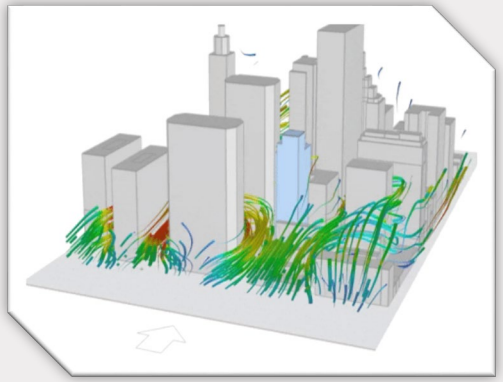
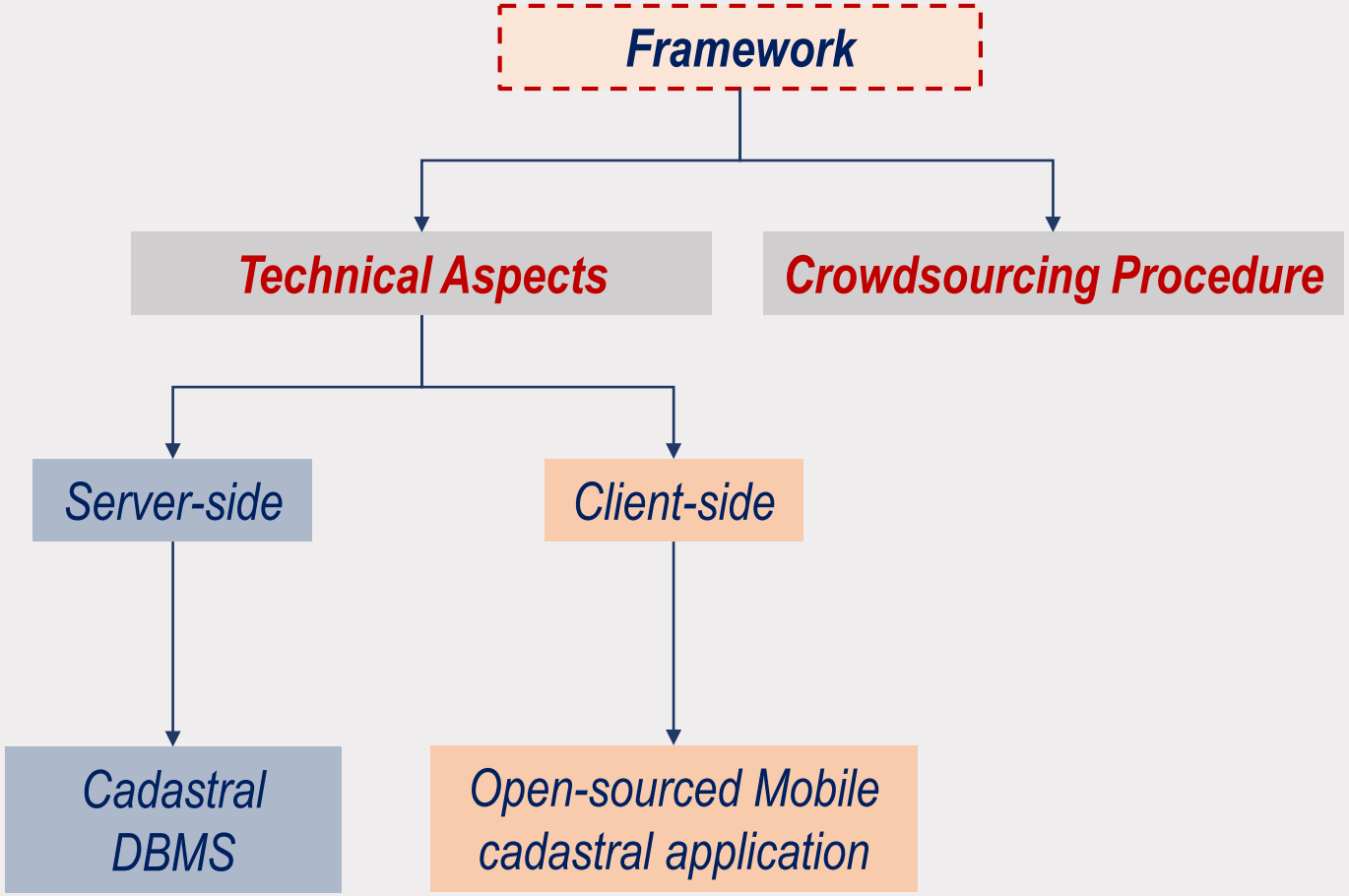
3D Crowdsourced Cadastral Mapping – Framework Overview

- ***Cost-effective technical solution***
  - ✓ Acquisition
  - ✓ Registration
  - ✓ Visualization





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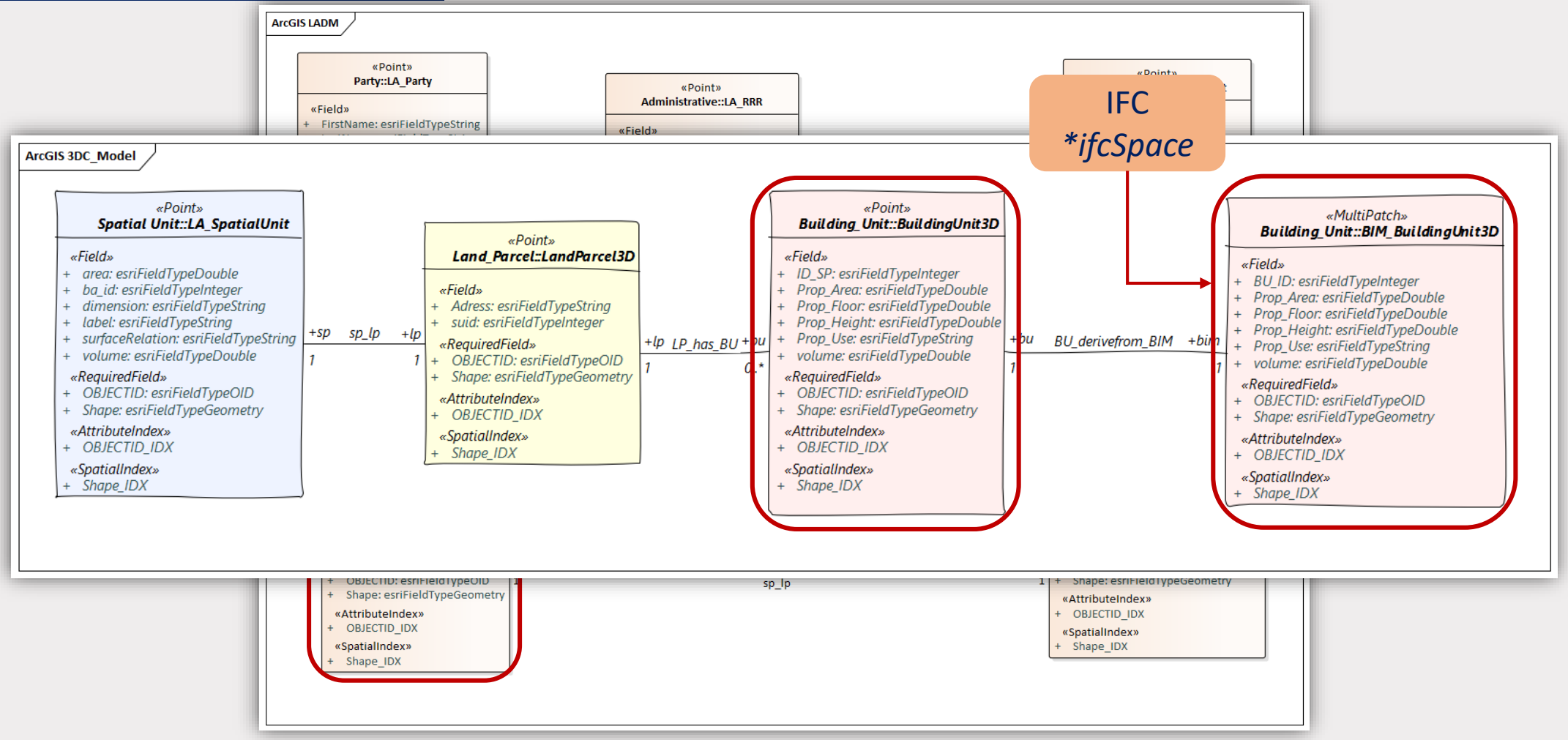
Database Management System (DBMS)

Enterprise Architect UML modeling tool – ArcGIS Geodatabase



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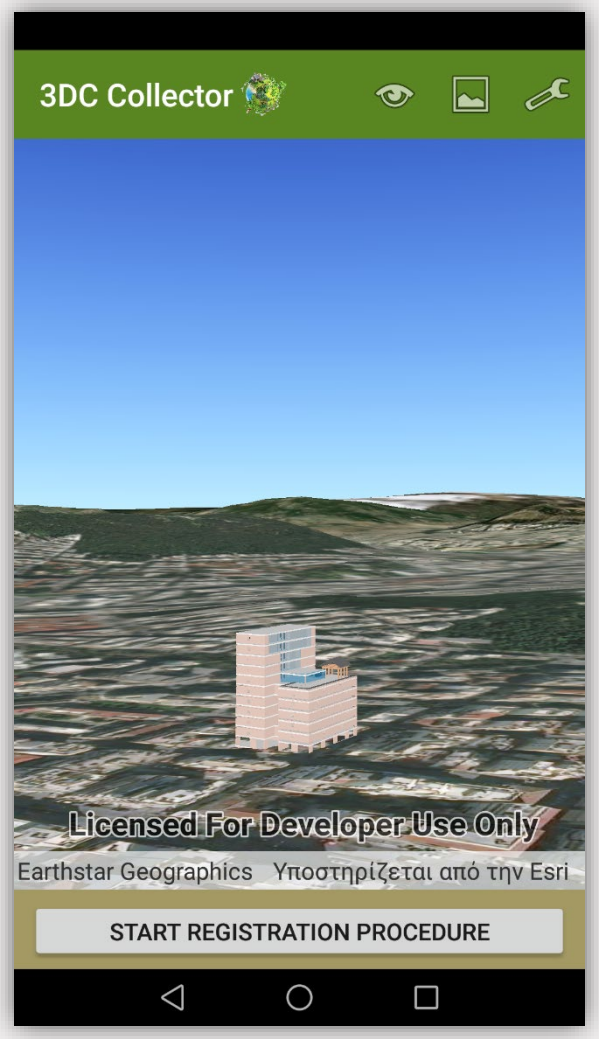
3D – Crowdsourcing Self-developed Mobile Application (1/2)

- ***Self-developed open-sourced*** Mobile Application
  - ✓ 3D cadastral data acquisition
  - ✓ registration of the cadastral data and their relationships within a LADM-based cadastral geodatabase
  - ✓ 3D visualization of BIM/IFC data

- ***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 programming language of C#,
  - ✓ the Server of ArcGIS Online (Cloud of ESRI)



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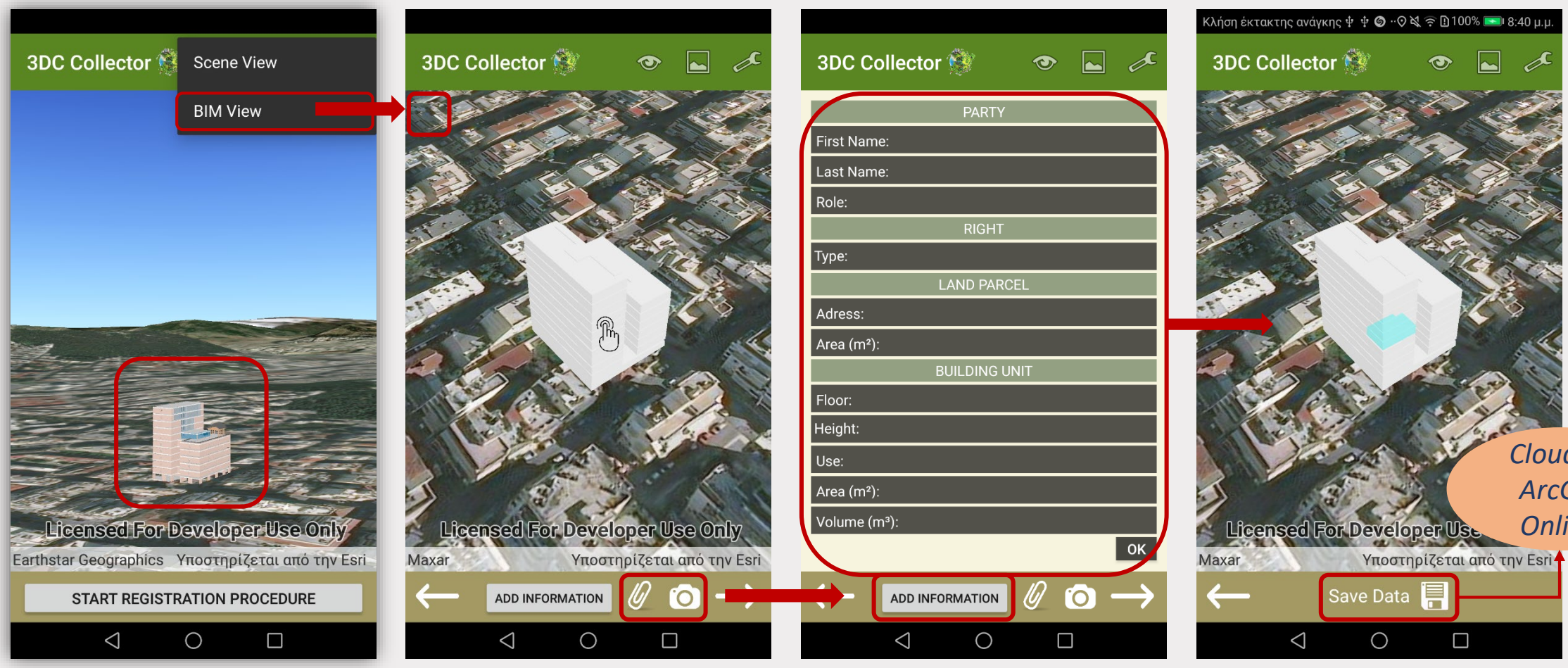
3D – Crowdsourcing Self-developed Mobile Application (2/2)



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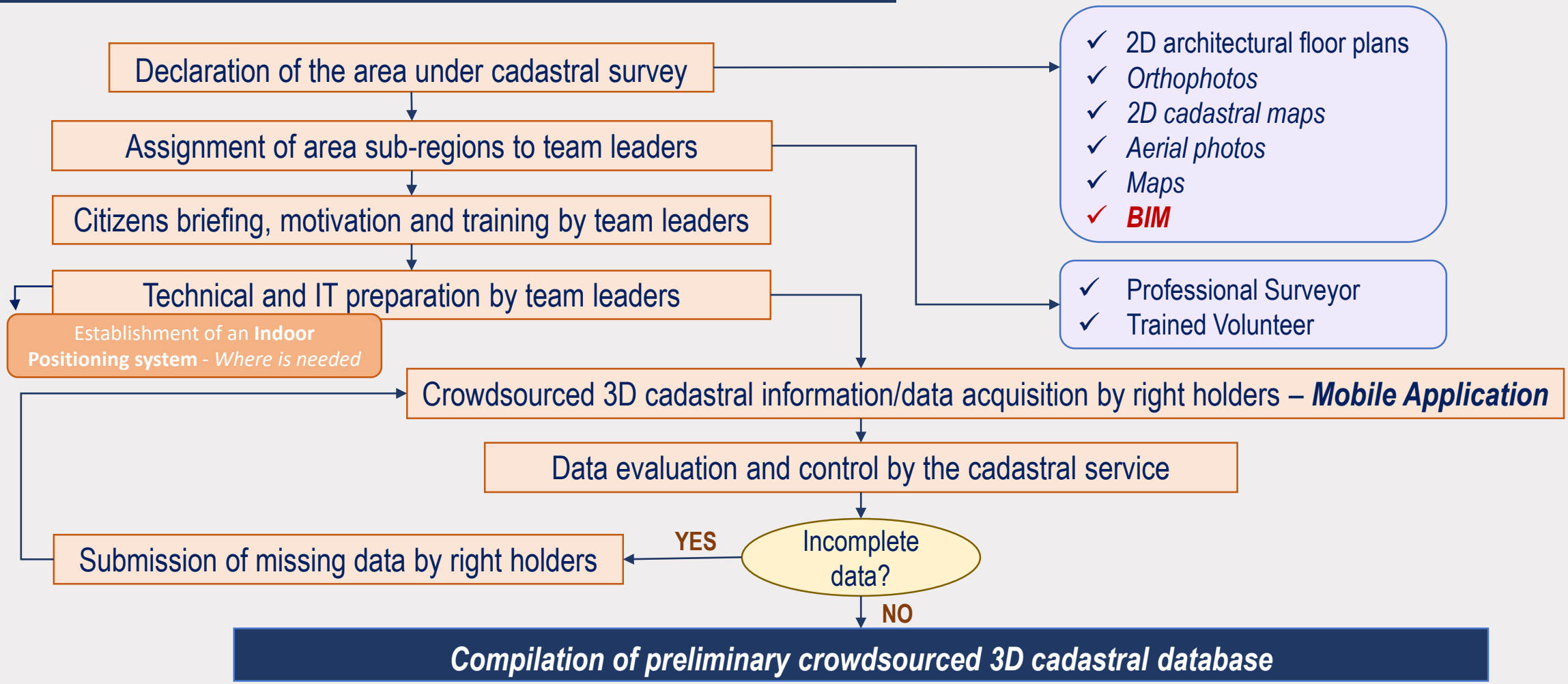
Proposed Crowdsourced Procedure for 3D Cadastral Surveys



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Test implementation (1/3)

Data preparation

BIM → IFC → Geodatabase

Cadastral spaces
IfcSpace

Assumption
legal boundaries are **correctly** sited

Attributes' enrichment
Descriptive (cadastral) information

Urban area – Athens, Greece

Cadastral information/data

- ✓ descriptive information about the building, the property unit address, area code, and use,
- ✓ and the right holder first name, last name, type of rights

Data collection:

- ✓ *Young students of NTUA with the role of right holders*

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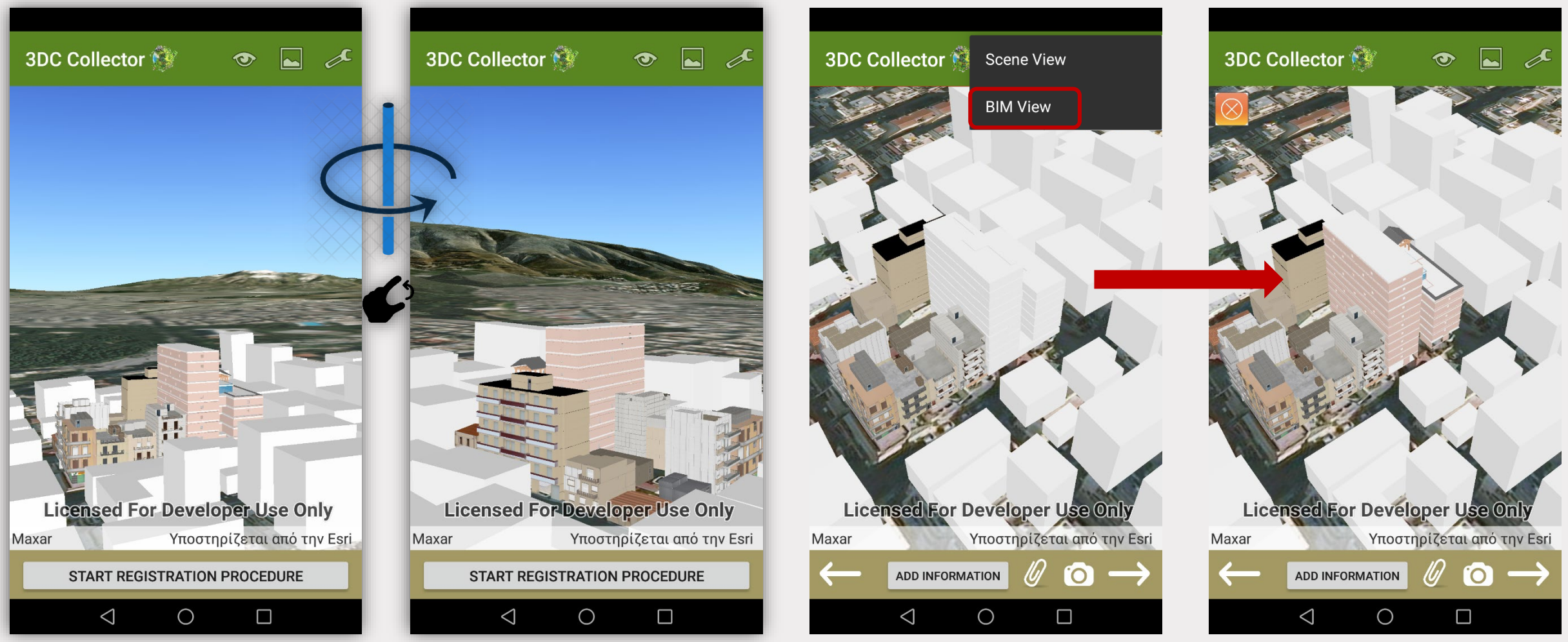
Test implementation (2/3)



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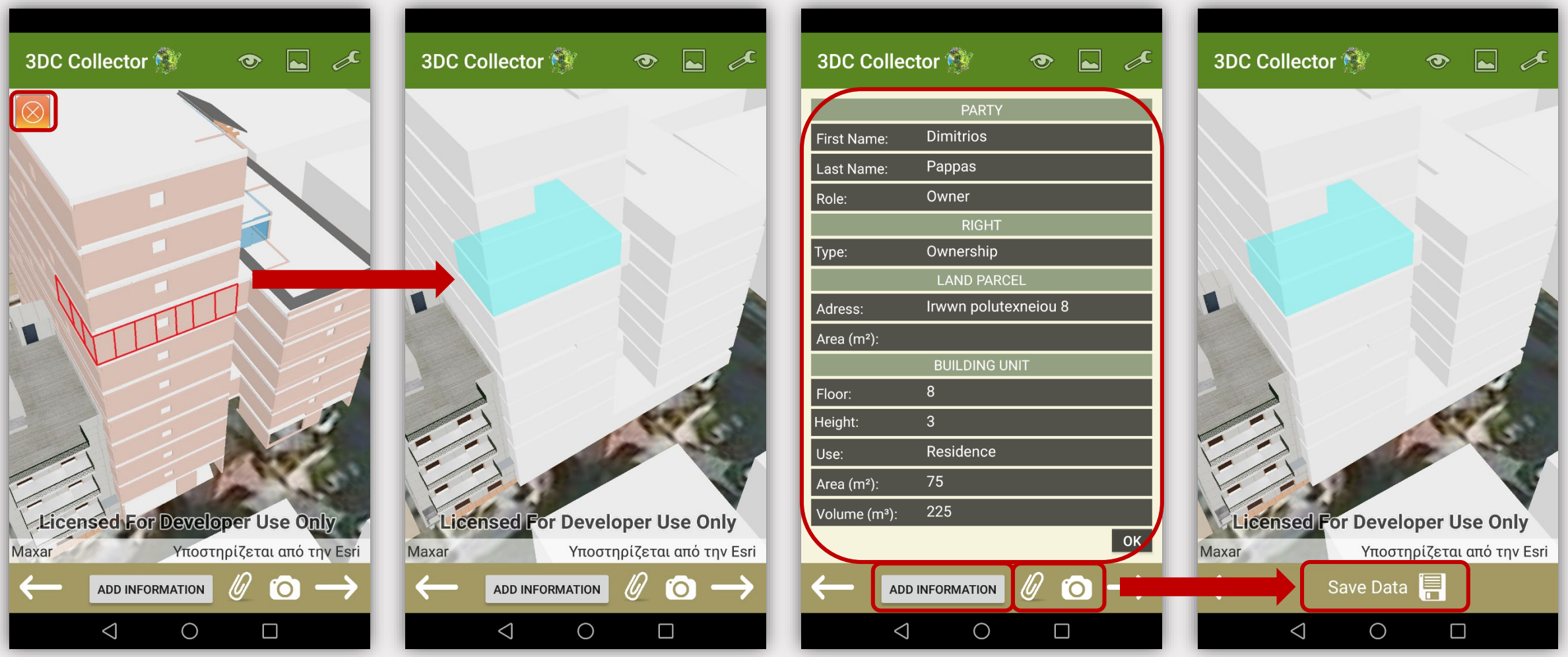
Test implementation (3/3)



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Results and Conclusions

Modern Approach - 3D Cadastral Surveys:

- ✓ *Easy-to-use Mobile Application*
- ✓ Recording time per property:
  - 7-15 min fast
- ✓ *3D Crowdsourcing Techniques* - Citizens' participation – *errors minimization*
- ✓ *Time-effective solution*
  (re-)use of powerful representational models - such as BIM
- ✓ Data interoperability *IFC standard*
- ✓ Transparency
- ✓ *Reliability*

Promising Solution

An **alternative** solution is required for the **fast** initial implementation of a **EU** desired **3D Cadastre**

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Thank you for your attention!

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