

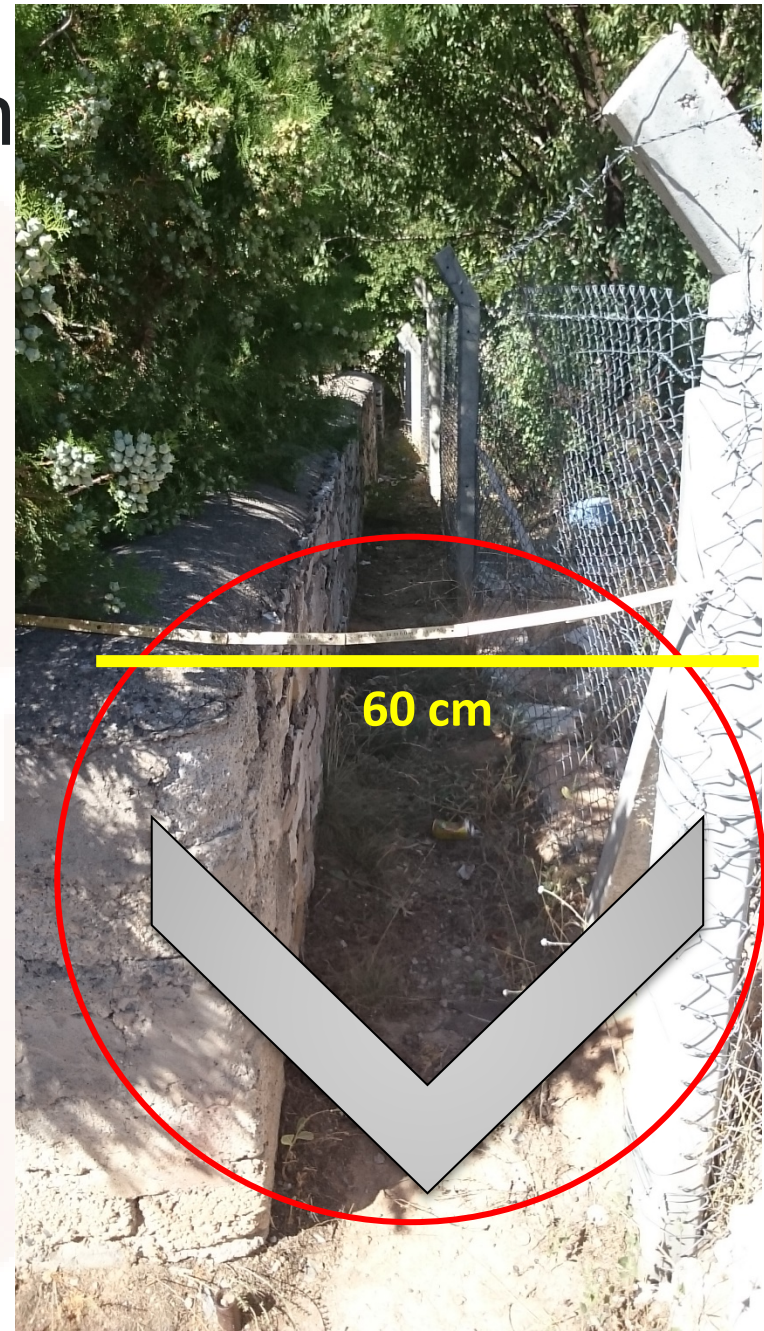
# Hierarchical Blockchain Architecture for Better Public Service Regarding the Transactions of Cadastral Surveys and Land Registration

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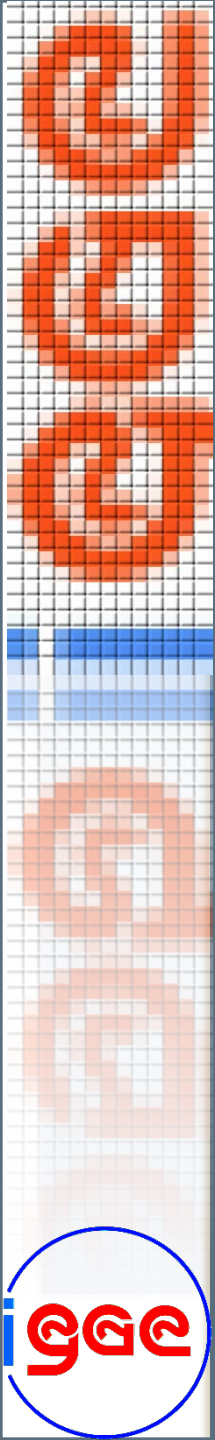
# Agenda

- Introducing the Problem
- Blockchain Technology
- Turkish Cadastre Surveys: Some Statistics
- A Use Case for Land Registry and Cadastre Process
- Proposed Model and Implementation
- Evaluation and Conclusions



# Introducing the Problem

- Parcels in a block
- First cadastral surveys in 1982.
- 'Base Cadastre' due to Law#3402: conducted in 2004
- Updating Cadastre Surveys (22-A): 2016 (planned)
- Area of the parcel 525 m<sup>2</sup>, the gap: 21 m<sup>2</sup>, the tolerance 9.6 m<sup>2</sup> ( = 0.00042 x scale x SQRT (area))



# Blockchain Technology

- Blockchain
  - facilitates a resilient and highly distributed ledger (registry) for recording transactions (blocks time-stamped in a time sequence)
  - By a network of nodes having equal rights
  - In a secure (encrypted) communication framework.
- Applications:
  - distributed currency, trust and contracts application,
  - distributed data management
  - without central authorities
- Related Work
  - Application: Georgia, Honduras, Ghana
  - Research: Lantmateriet-Sweden, Netherlands



# Blockchain Technology

- Blockchain Transactions;
  - supporting real-time transactions,
  - pushing relevant data to the interested parties for cooperated approval
  - within an encrypted network
- Why Blockchain is useful for cadastre and land registry works
  - Transactions are created by none/one or many participants
  - The types of transactions are 'create' and 'transfer'.
  - 'Deletion' is generally not applicable
  - The assets are attributed and defined as non-dissolved, non-divisible as well as divisible.
  - Transactions of an asset could be performed by mutual policy defined by the owners.
  - The authorization could consist cryptographically sign due to asset definition.
  - All the information related with an asset in a timeline and time trace are all preserved in the registry.



# Turkish Cadastre Surveys

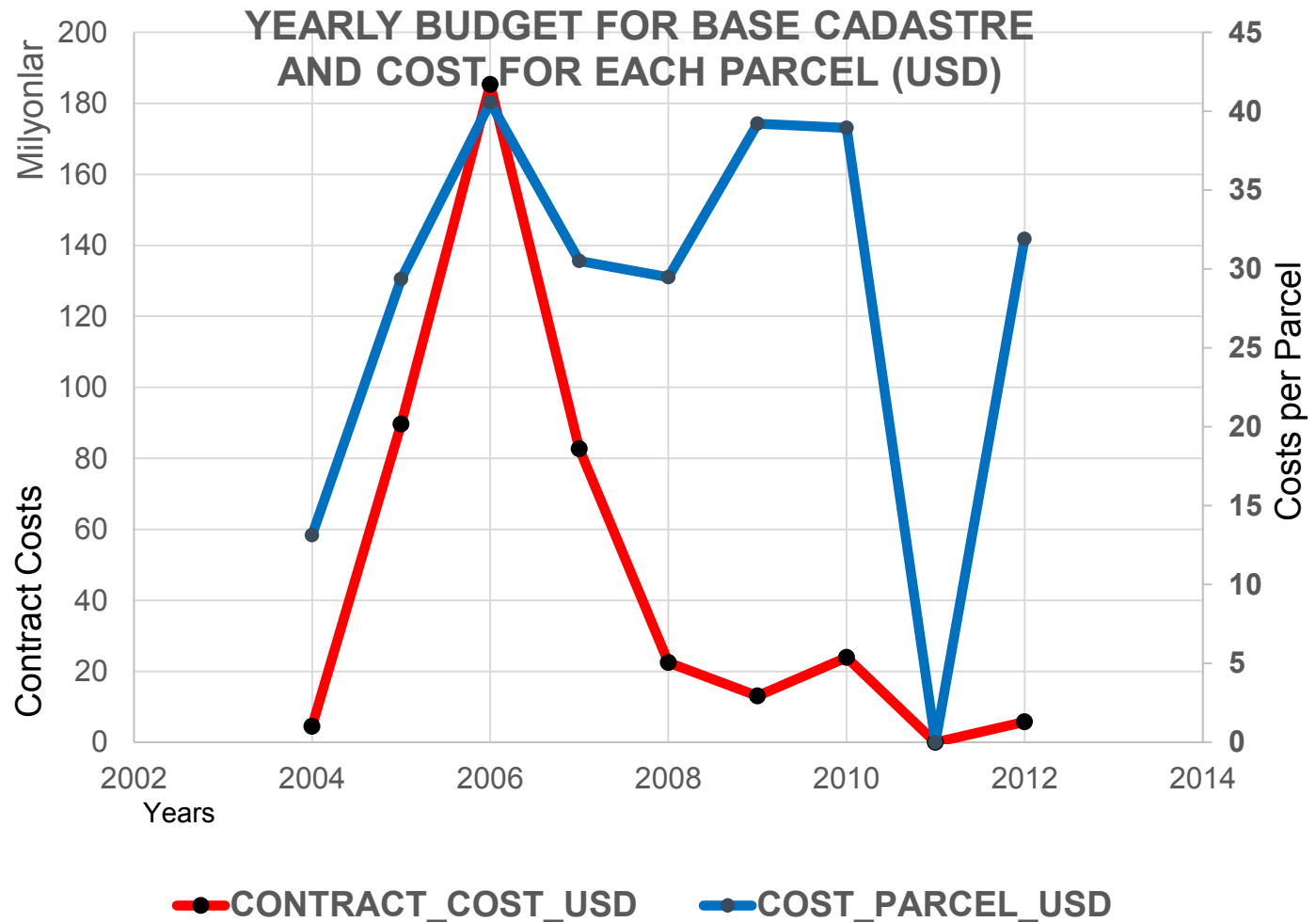
- Cadastre Legislation
  - 1847: first Land Registration Organization
  - 1924: General Directorate of Title Deed' (Law # 658)
  - 1934: Registry and Cadastre' (Law # 2613)
  - 1987: unique cadaster for urban and rural (Law # 3402)
- General Directorate of Land Registry and Cadastre-GDLRC
  - 'land registry' and 'cadastre' works
  - keeping 'land registry books – title deeds'
- Base Cadastre: 2005-2012: The impact of Law #3402
  - Digital, modern, survey based
  - Decreasing court cases, improving public service
  - Outsourcing private sector
  - Parcels; Total: 57.5 million, Last 10 years: 14.5 million
  - Total Cost: USD 427 million, USD 34 per parcel
- Updating (item 22-A)
  - Reason: Accuracy and incompleteness
  - Updating : USD 203 million
- Long Term World Bank Credits



# YEARLY BUDGET FOR BASE CADASTRE AND COST FOR EACH PARCEL (USD)

Total Cost of Latest Base Cadastre Campaign

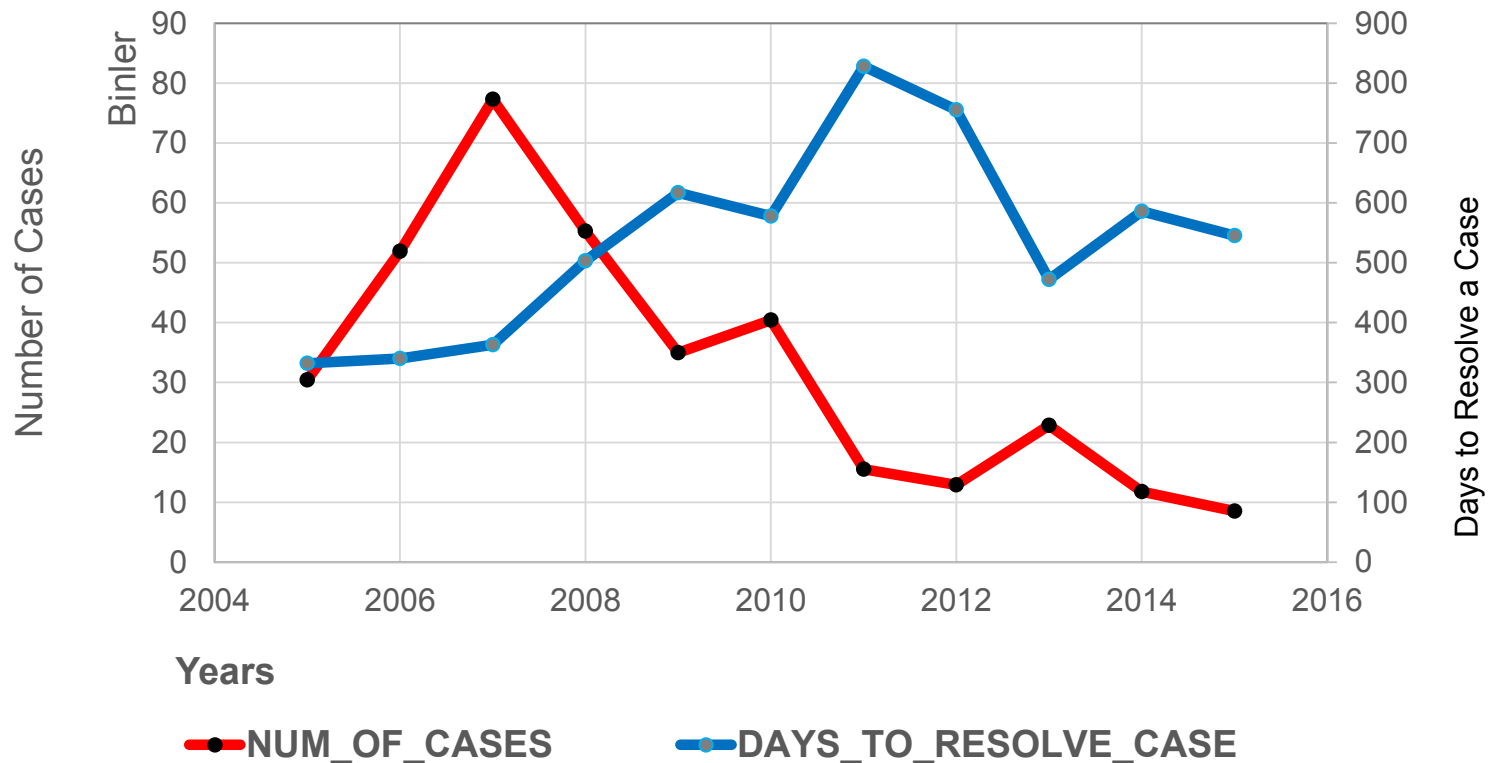
- USD 427 Million excluding the costs of GDLRC
- The Updating (22-A): USD 203 million



# YEARLY NUMBER OF COURT CASES AND DURATION TO RESOLVE A CASE

from 2005 to 2015, # of court cases 370 000

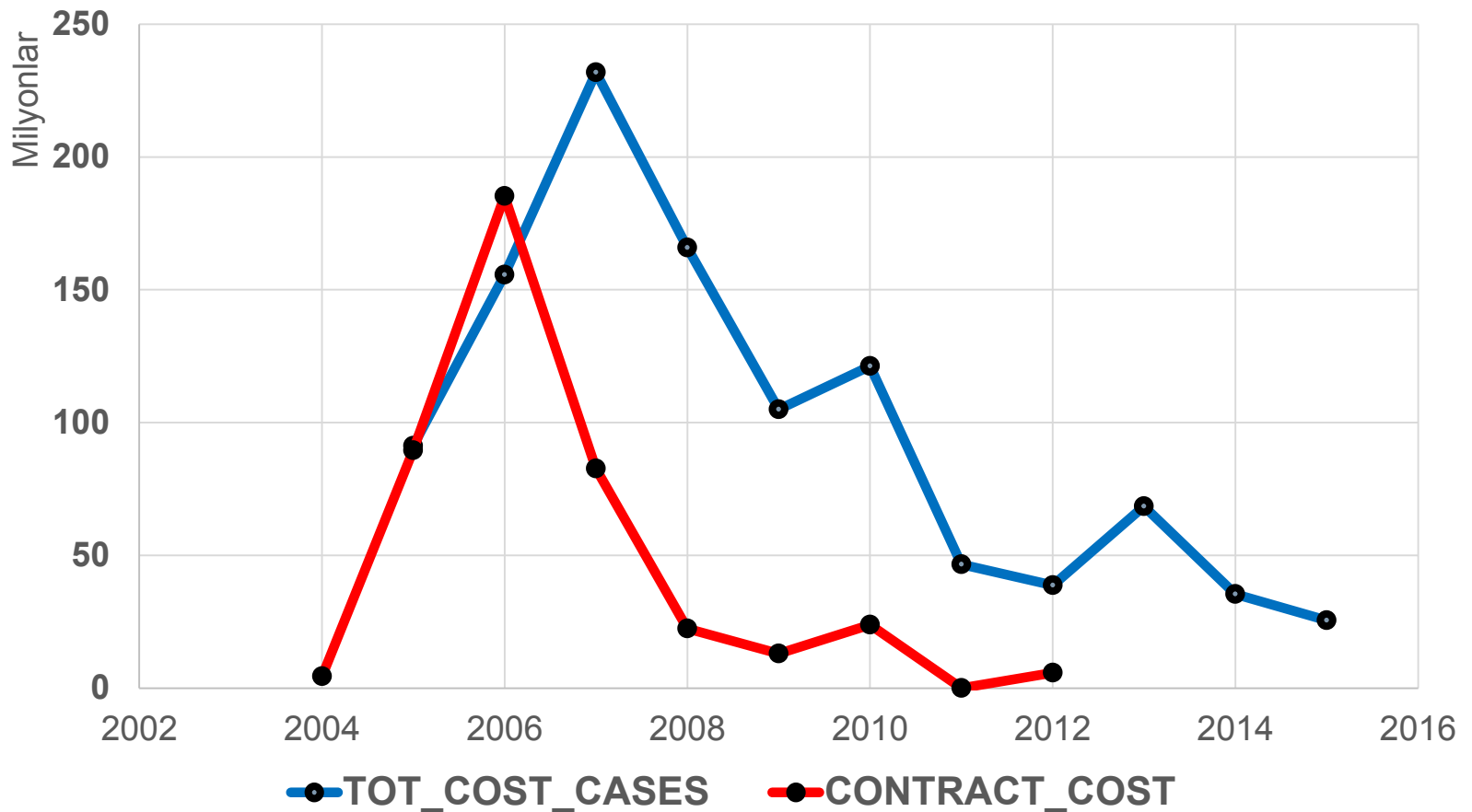
YEARLY NUMBER OF COURT CASES AND DURATION TO RESOLVE A CASE





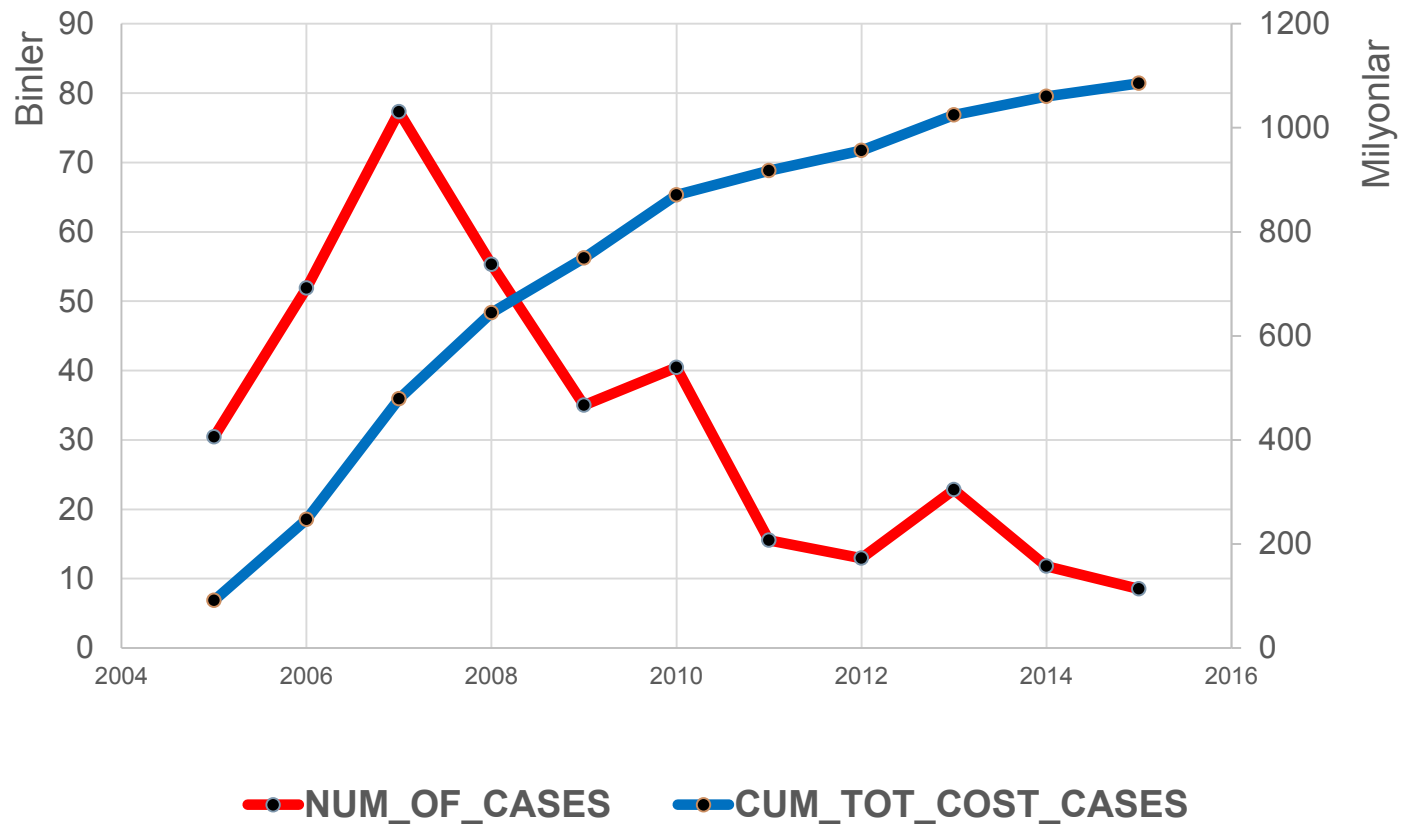
# YEARLY TOTAL CONTRACT COSTS AND COST OF COURT CASES (USD)

## YEARLY TOTAL CONTRACT COSTS AND COST OF COURT CASES

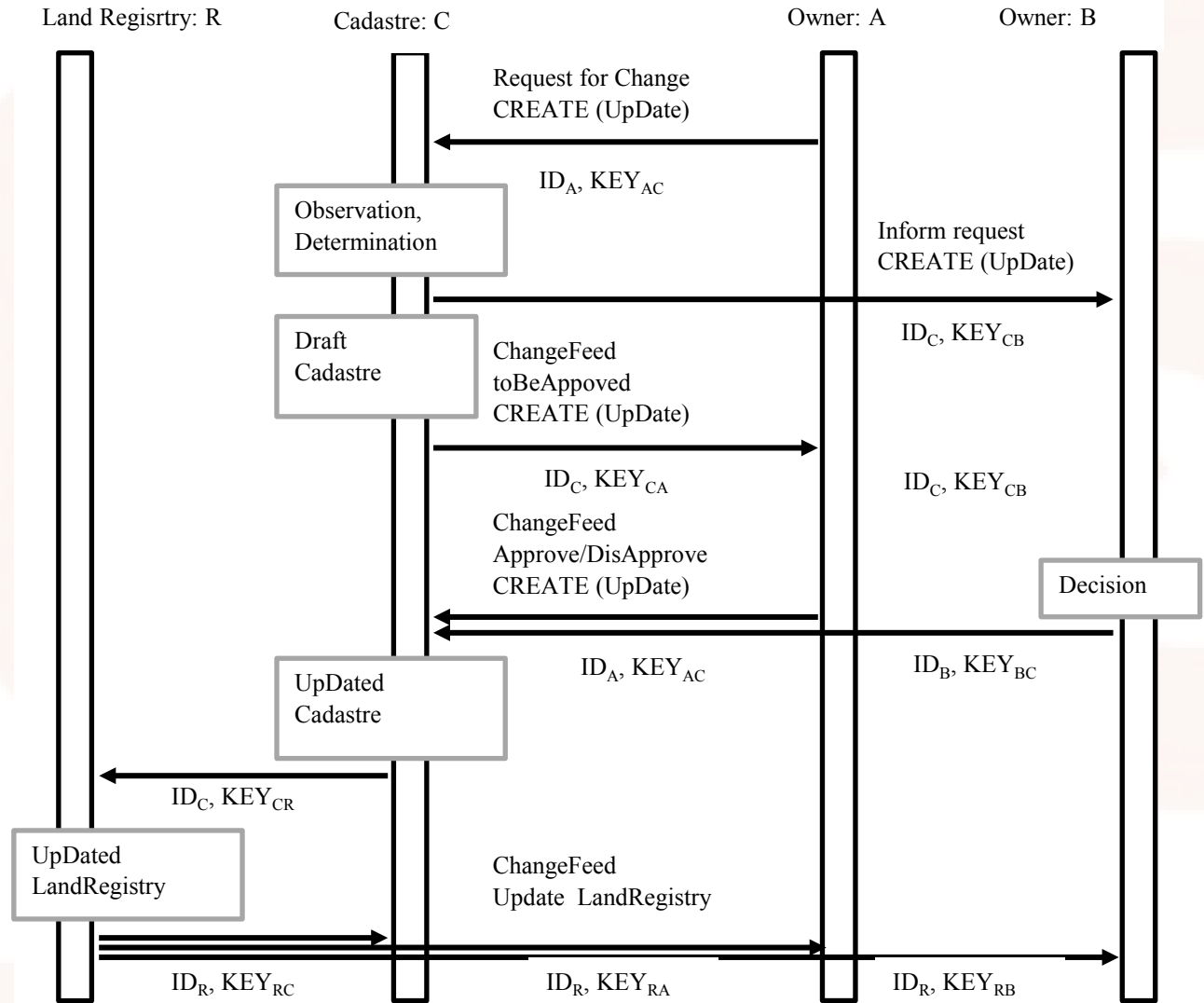


# YEARLY NUMBER OF COURT CASES AND CUMULATIVE COST OF COURT CASES

## YEARLY NUMBER OF COURT CASES AND CUMULATIVE COST OF COURT CASES (USD)



# Use Case for Land Registry and Cadastre Process



# Proposed Model: Architecture of Blockchain Cadastre Database and Data Processing

## LAND REGISTRY & CADASTRE (LR&C) BLOCKCHAIN (BC) NODE

### LR&C BC Database

LR&C BC APPLICATION (Python)

LEVEL 1 : Institutional (Region/Block)

LEVEL 2: Landowner (s) (Object/Parcel/)

LEVEL 3: Geometry (Part/Edge/Node)

LR&C BC TRANSACTION ENGINE MODEL (Python)

LR&C BC Engine

LR&C Data Model

Community Consensus

BC INFRASTRUCTURE

LAYERS

BigChain BD

ReThink DBMS

Ubuntu (+ Relevant Drivers)

### Loosly Coupled LR&C BC and GIS/CAD Middleware

LR&C Transactions Middleware (Python)

Synchronizes the 'LR&C BC DB' and 'Temporal GIS/CAD Engine for LR&C Transactions'

and

Maintains Common Registry (Ledger) (Specific to the 'Node LR and C')

### Spatio-temporal GIS/CAD Engine for LR&C BC Transactions

GIS ENGINE FOR CADASTRE DATA MANAGEMENT (ArcGIS)

GIS Data Management, Analysis and Monitoring

GIS/CAD Simultaneous Trans. Module

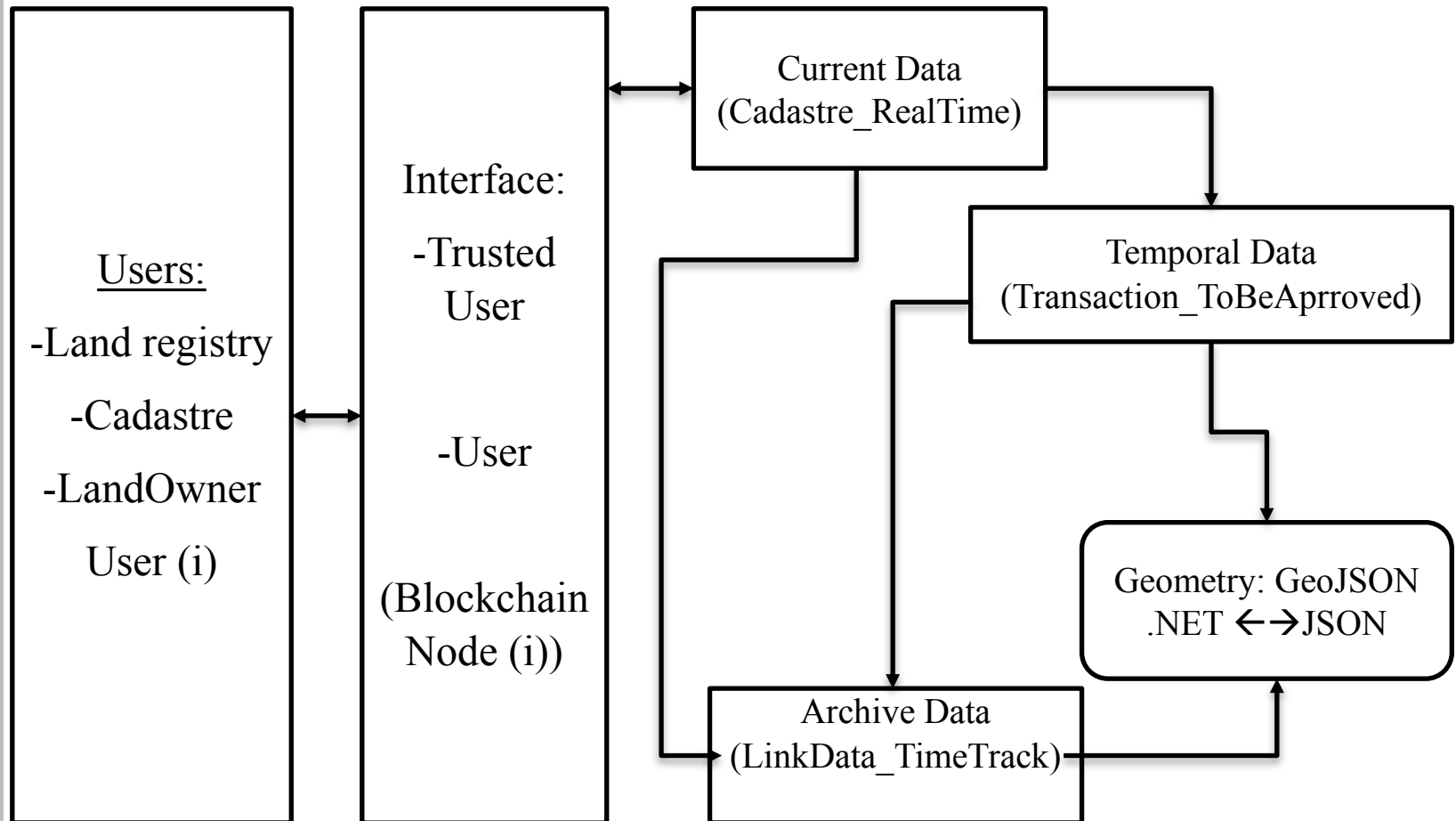
Temporal GIS/CAD Integration Module (Simplification&Generalization)

CAD ENGINE FOR CADASTRE DATA MANAGEMENT AND TRANSACTION (ArcGIS)

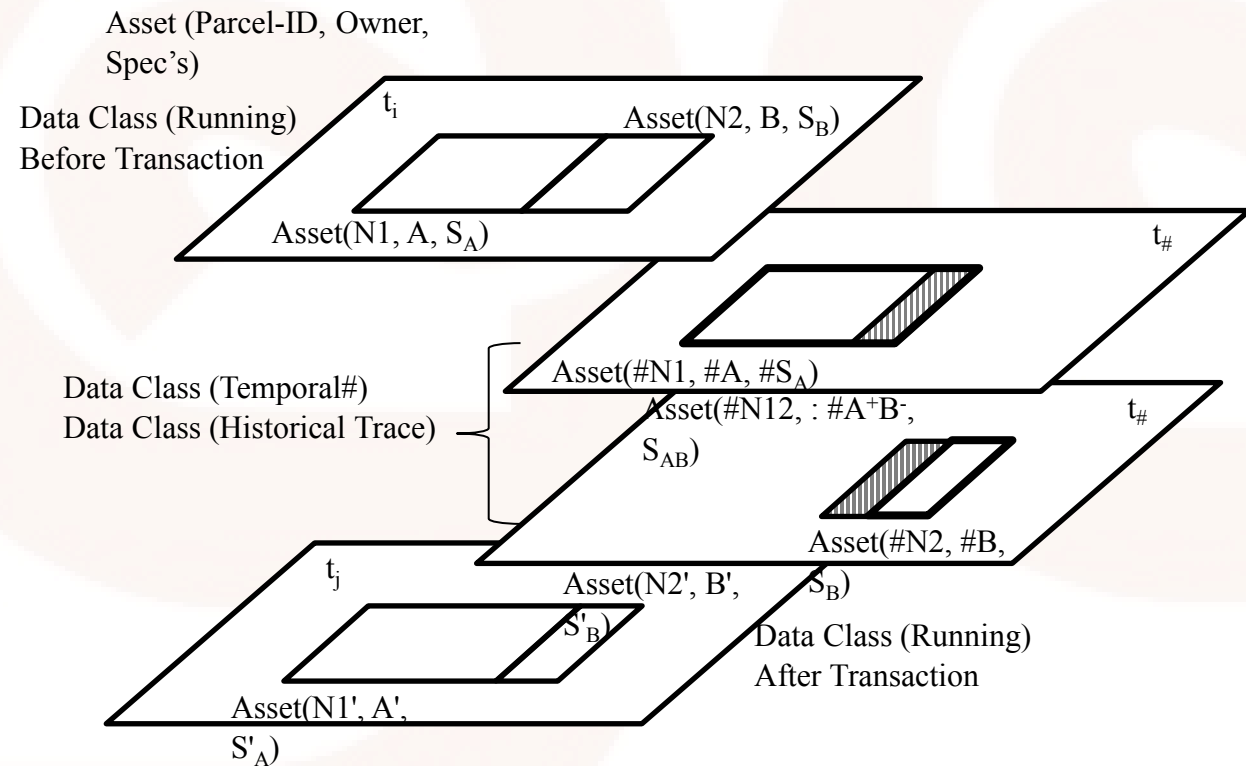
Temporal GIS/GIS Common Data Trans. Module



# Blockchain Cadastre Transaction System : The Process Workflow



# Geodata Transaction at Data Set (Database) Level in Blockchain



# YEARLY NUMBER OF COURT CASES AND CUMULATIVE COST OF COURT CASES

cadastre\_BC.mxd - ArcMap

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

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Editor Georeferencing

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olay

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Onay Bekleyen İşlemler

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Kadastro ID: 10

Tarih: 10/7/2017 12:38:59 PM

Alan	Değer
Tipi	1
Sahibi	
Ekleme Tarihi	
Degisme Tarihi	

Reddet Onayla Geri Dön

# Evaluation

- Economical: Cost per parcel (INCREASING)
  - Base USD 34, update USD 12
  - Registered Surveyor USD 200-250
  - Court USD 3000
  - Cost Base Campaign (2005-2012): USD 427 million
  - Cost Updating (22-A): USD 2013 million
- Legislation: Civil Code and Supreme Court Statements
  - Civil Code: booking and maintaining register is under guarantee of the State.
  - the Constitutional Court: consider the land registry and cadastre as separate tasks and any mistakes in cadastre survey is not under responsibility of the State.





# Evaluation

- Cadastre Survey
  - Need for new surveys, quality of surveys
  - Multiple physical boundaries
  - Data compilation by multiple institutions
- Cadastre System
  - Unnecessarily detailed the law of #3402
  - Tightly integrated Cadastre and Land Registry
- New User Requirements
  - Multiple versions (updates) already used in design, project and decision making
  - Smart cities and DIGITALIZED World
  - Decentralized and democratized data access and compilation



# Conclusions

- Introduced
  - an problem of two physical boundaries could be resolved in a court case
  - Blockchain technology from a cadastre survey perspective
- Proposed a Model of Blockchain Cadastre Database
  - Model of Land Registry & Cadastre (LR&C) Blockchain (BC) Node with three components
  - A Prototype of 'GIS Engine for Cadastre Data Management' part of the 'Spatio-temporal GIS/CAD Engine' component
  - Data flow and data model
- Realization of Physical Model
  - ESRI, ArcObjects SDK for .NET, C#
  - Multivalued item instances: serializing JSON, GeoJSON
- A prototype
  - GIS management on CAD frame: prototype
  - Analyses and initial trials: Management of registry on open source development platforms



# Conclusions

- New and Innovative
  - Use of Blockchain in Cadastre
  - Easing Errors and minimize dispute cases
  - Decentralizing and democratization of cadastre data
  - Decreasing hegemony of government on cadastre data
- To be Considered in International Society
  - Efforts of UN-GGIM, FIG, World Bank
  - Example for countries of weak legislation and limited cadastre survey



Who wants to be rich?  
The sooner...

There are slim  
'BITCOIN' land parcels  
with no owner.

Needs BIT-PARCEL  
mining effort...

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 **Bilgi Tekn. Dnş.**

