Enforcing Encrypted Dynamic Security Constraints in the Cloud

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UNIVERSITÀ DEGLI STUDI DI TRENTO

WHY CLOUD STORAGE

- Cost saving 
- Scalability 
- Efficiency 
- Availability 

APPLICATION

PROBLEM

Data in cleartext raises privacy issues

Write

Read

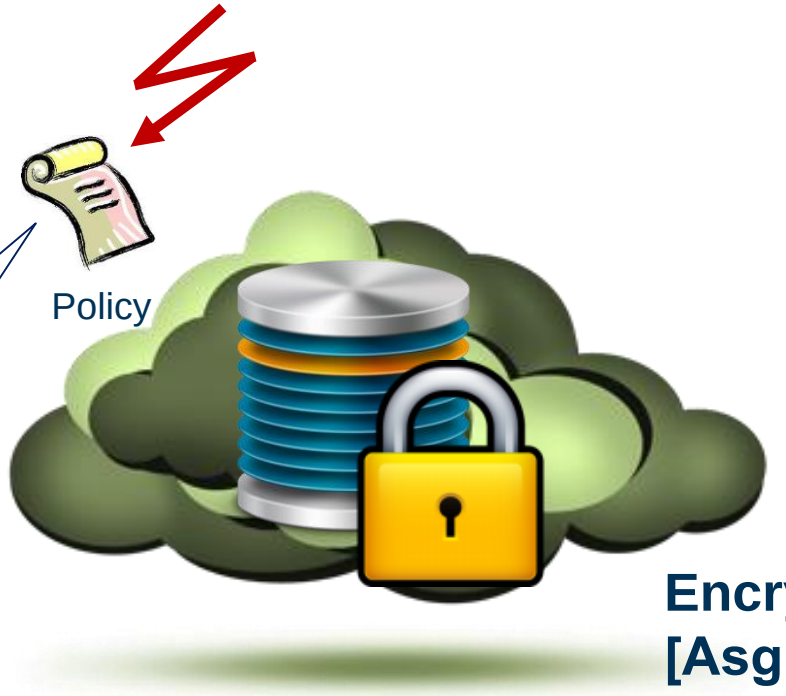
A POSSIBLE SOLUTION

Access policies specify who can gain access to the data

Encrypted databases [Asghar'13 CCSW]

A POSSIBLE SOLUTION, BUT

Access policies may leak sensitive information



Access policies specify who can gain access to the data

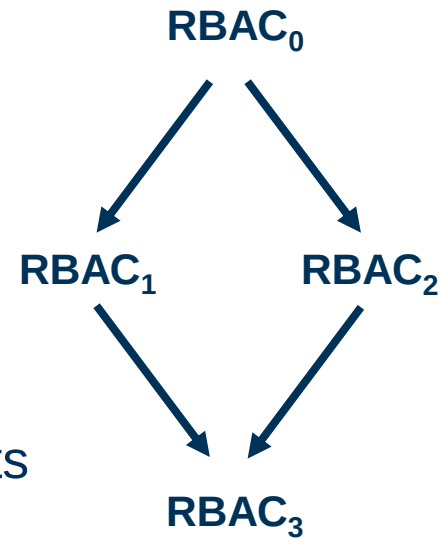
Encrypted databases [Asghar'13 CCSW]

OUR APPROACH

What kind of access policies?

ROLE-BASED ACCESS CONTROL (RBAC) POLICIES

- $RBAC_0$
  - Permissions are assigned to roles while roles are assigned to users
  - Encrypted $RBAC_0$ [Asghar'13 COSE]
- $RBAC_1$
  - Role hierarchies
  - Encrypted $RBAC_1$ [Asghar'13 COSE]
- $RBAC_2$
  - Separation of duties and Chinese wall constraints
  - **Focus of this work!**
- $RBAC_3 = RBAC_1 + RBAC_2$



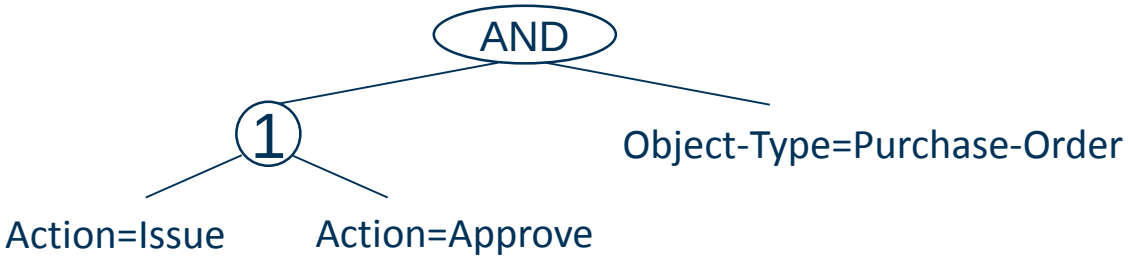
SEPARATION OF DUTIES

- Separation of Duties (SoD) constraints aim at providing multiuser control over the resources when there is any conflict-of-interest for completing a business process
- E.g., a clerk issues the purchase order while a manager approves it
- Types
  - Static SoD
    - A user cannot be active in two mutually exclusive roles
  - Dynamic SoD (DSoD)
    - A user can be active in two mutually exclusive roles but …
    - Simple DSoD (SDSoD) – not in the same session
    - Object-Based DSoD (ObDSoD) – not the same object
    - Operational DSoD (OpDSoD) – not all actions in a workflow
    - History-Based DSoD (HBDSoD) = ObDSoD + OpDSoD

HBDSoD

- HBDSoD is the most fine-grained category of DSoD

- A user active in both clerk and manager roles can either *issue* or *approve* a particular instance of the *purchase order*



CHINESE WALL

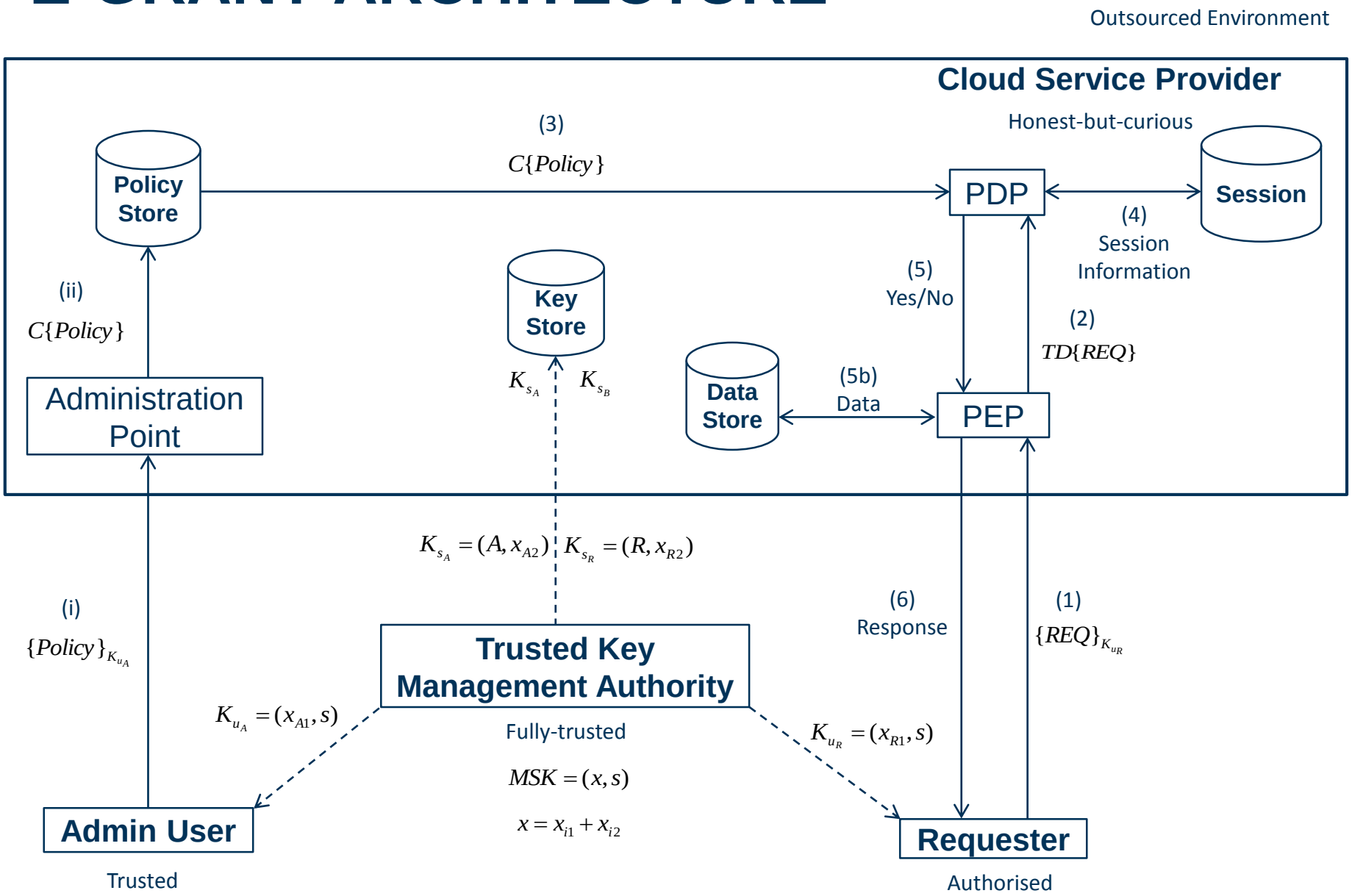
- It aims at providing confidentiality by preventing illegitimate information flow between domains that are in conflict-of-interest

- Imagine a consultant organisation that provides services to companies that are in conflict-of-interest, say Google and Microsoft

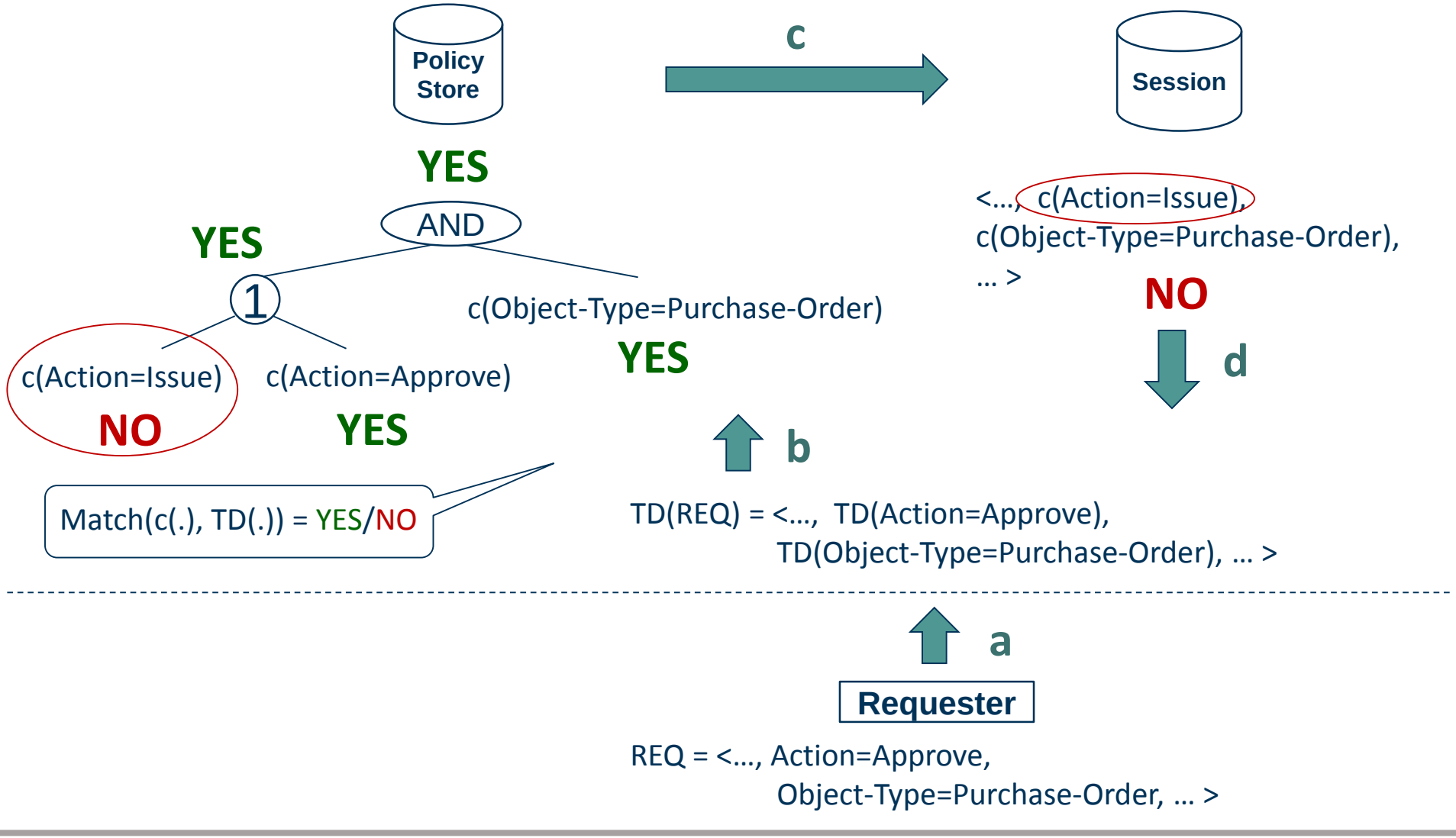
E-GRANT

- E-GRANT protects queries and policies stored in outsourced environments
- Our scheme is based on El-Gamal proxy encryption
- An encrypted session is maintained
- It is a multiuser scheme in which entities do not share any encryption keys
- A compromised user can be removed without requiring re-encryption of policies

E-GRANT ARCHITECTURE



HBDSoD EVALUATION

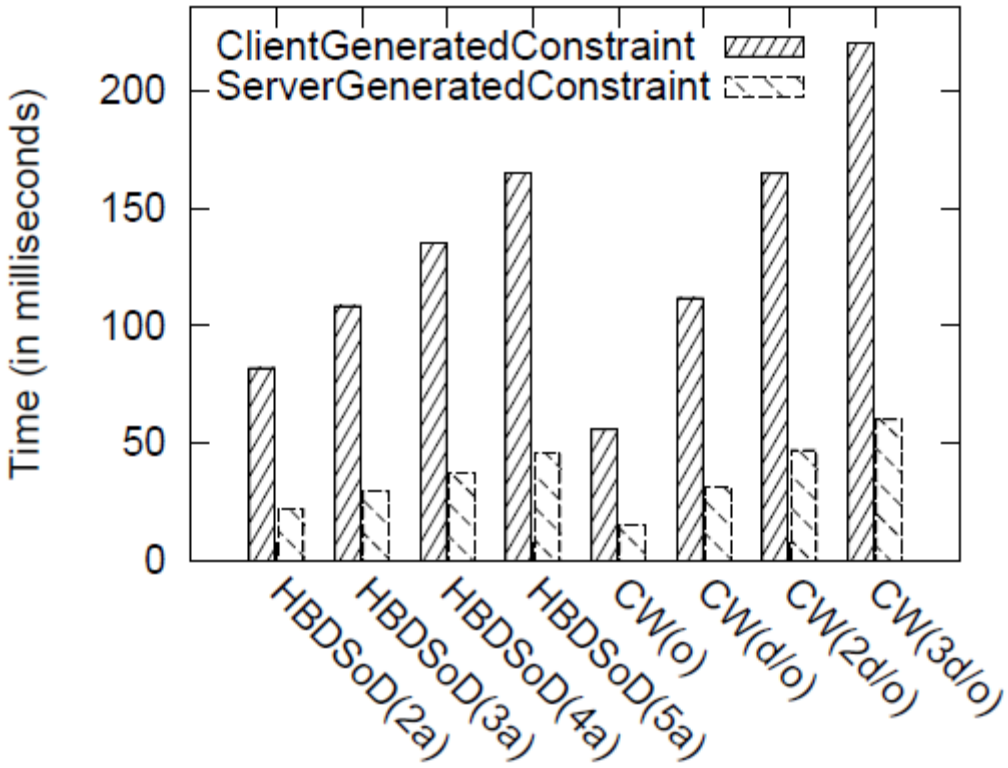


E-GRANT PROTOTYPE

- We developed a prototype of E-GRANT in Java

- We tested our prototype using a standard machine
  - Microsoft XP Professional version 2002 (SP3)
  - Intel Core2 Duo 2.2 GHz
  - 2 GB RAM

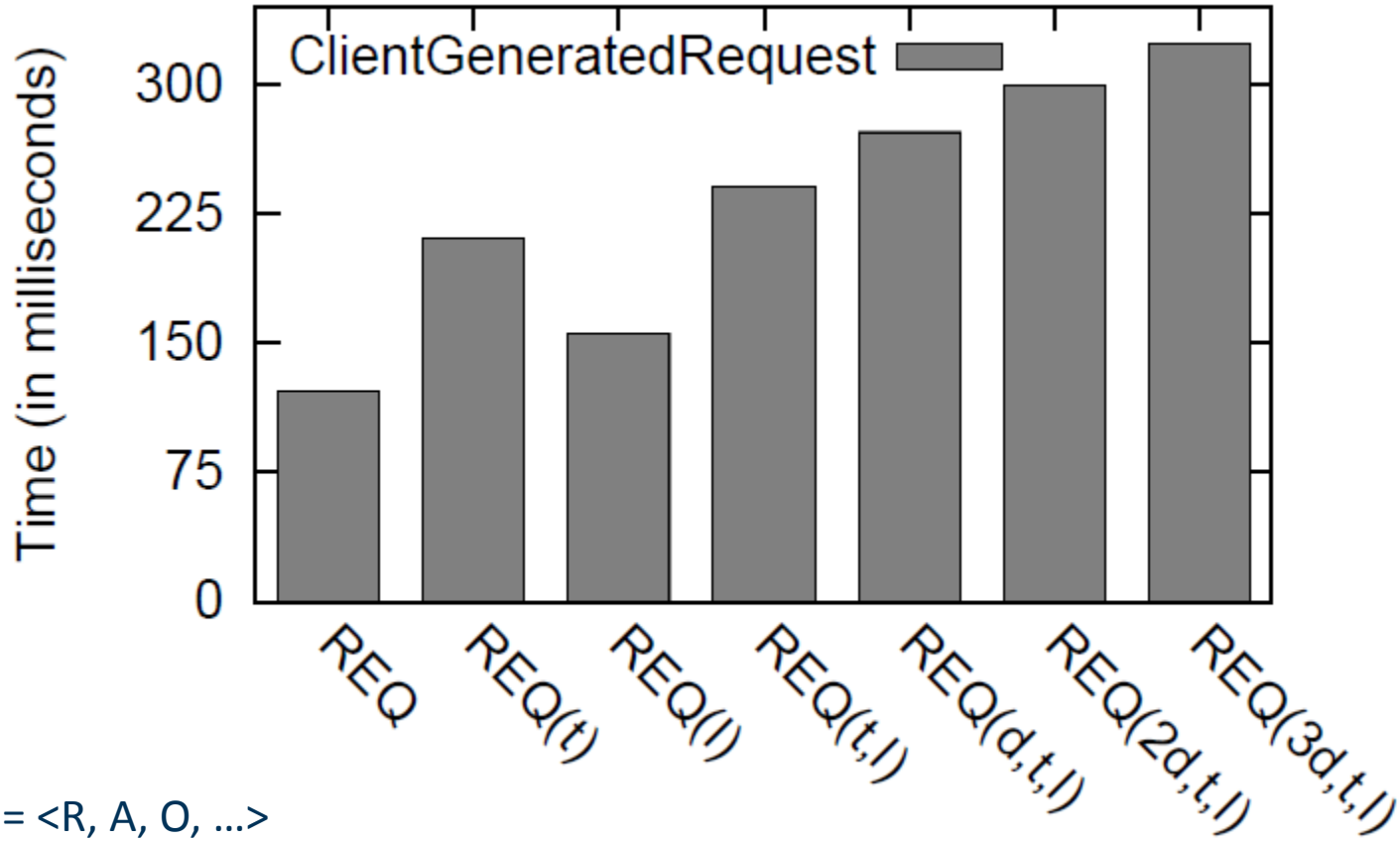
DEPLOYMENT OF CONSTRAINTS



a denotes actions:
Clerk or manager …

d denotes domains:
Google/Marketing/Project …
o represents object (or instance)

REQUEST GENERATION

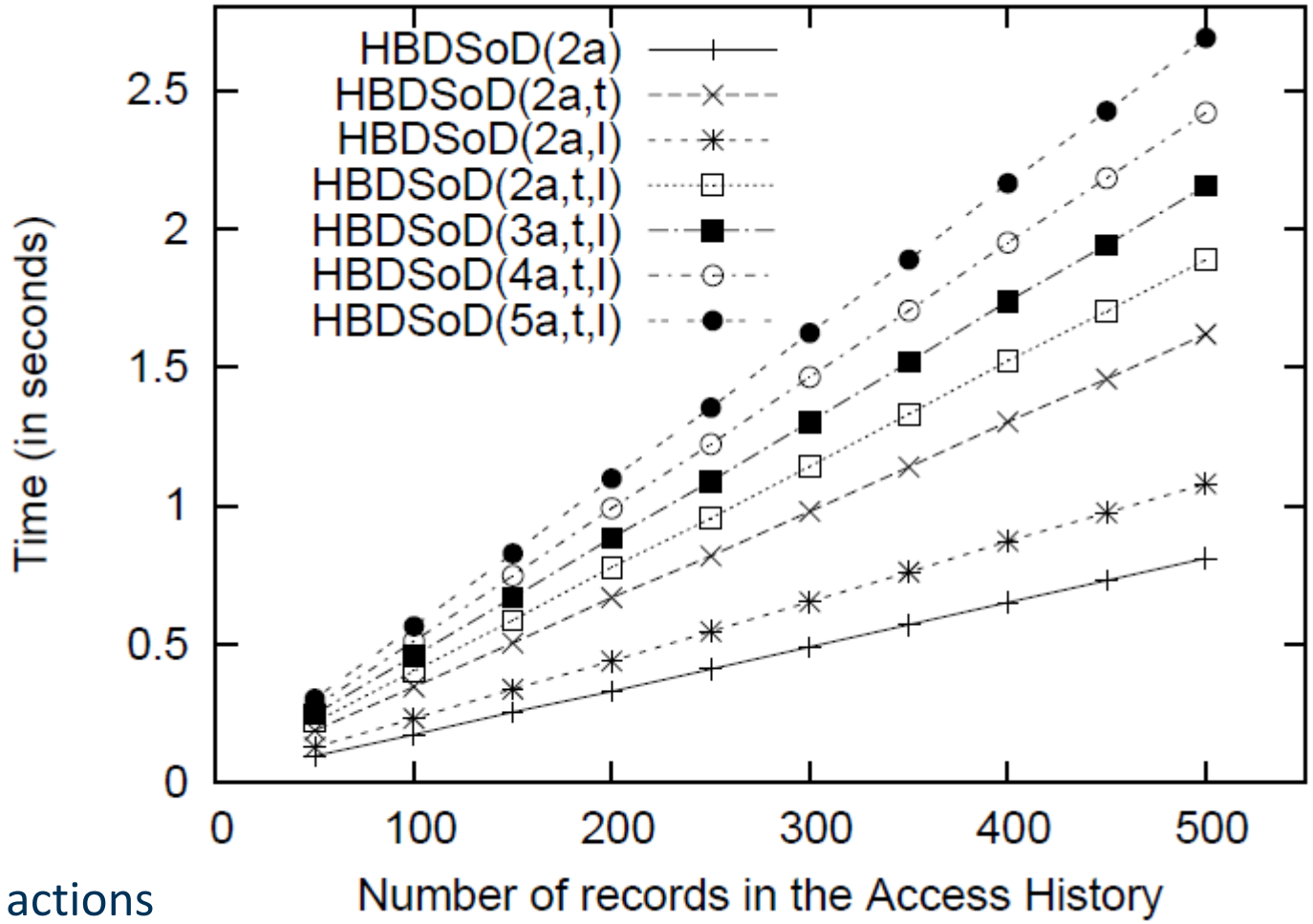


REQ = <R, A, O, …>
R is role
A is action
O is object

t is time
l is location

d denotes (an object with) domains

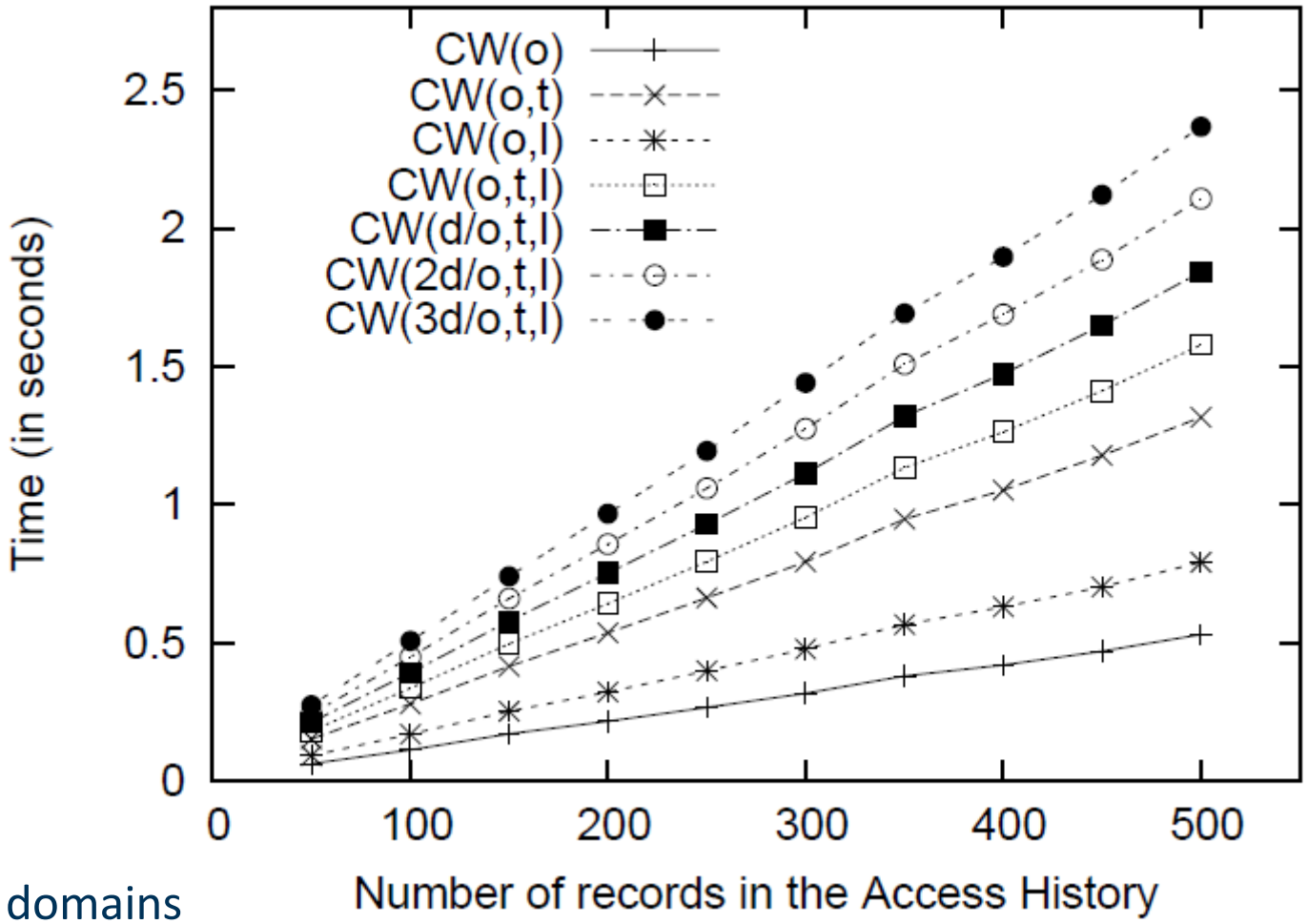
EVALUATION OF HBDSoD



a denotes actions

Time complexity per constraint: number of actions * number of records

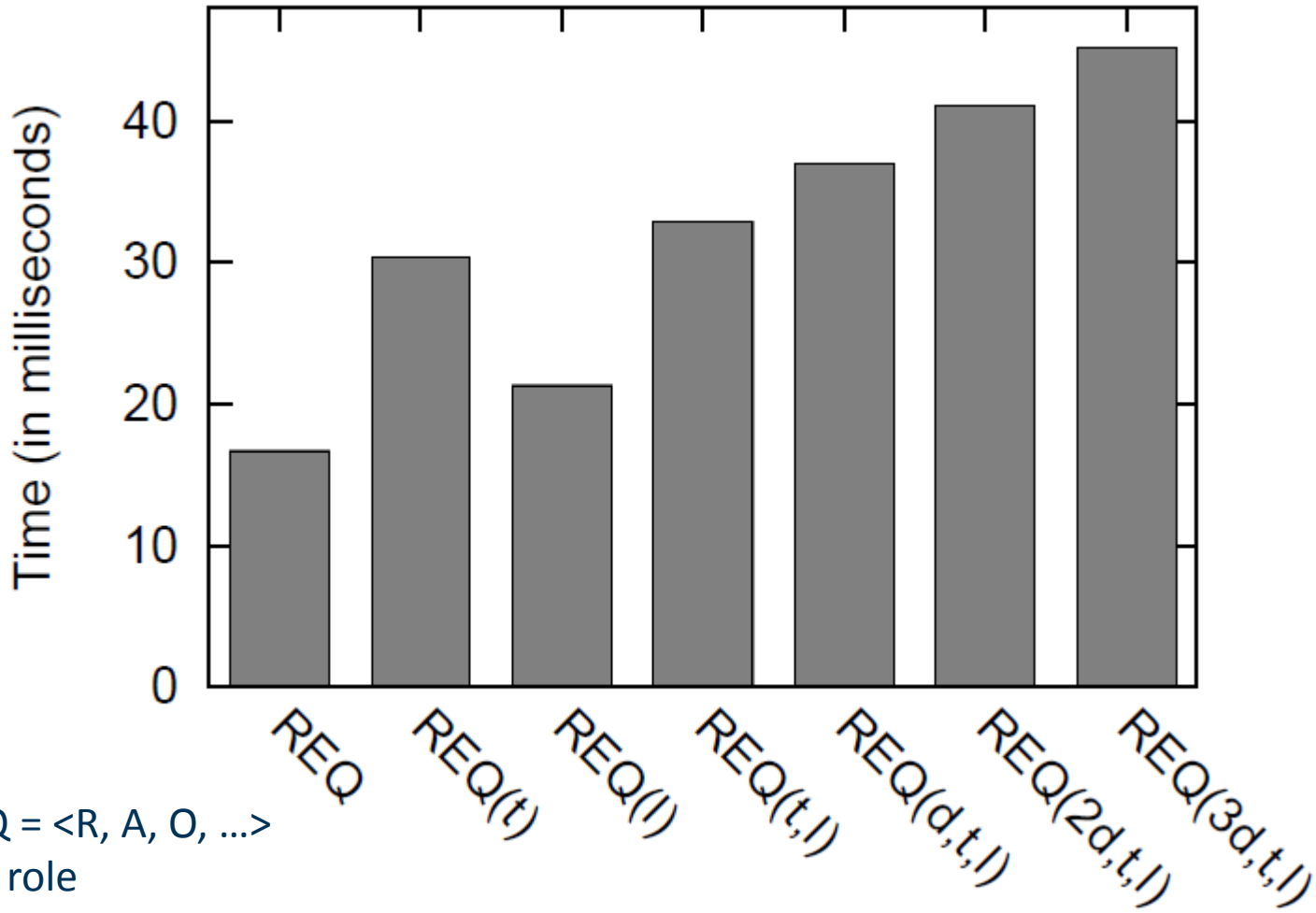
EVALUATION OF CHINESE WALL



d denotes domains

Time complexity per constraint: number of domains * number of records

COST OF UPDATING SESSION



REQ = <R, A, O, …>
R is role
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CONCLUSIONS AND FUTURE WORK

- E-GRANT enforces separation of duties and Chinese wall constraints in an encrypted manner
- **We are capable of providing full-fledged encrypted RBAC style of policies [Asghar'13 PhD-Thesis]**
- It is a multiuser scheme where each user has her own key, i.e., removing a user does not require re-encryption of stored policies
- As future work, exploring how encrypted RBAC could be made accountable would be an interesting direction

REFERENCE

- Muhammad Rizwan Asghar, Giovanni Russello, Bruno Crispo,
  E-GRANT: Enforcing Encrypted Dynamic Security Constraints in the Cloud,
  Pages 135-144,
  The 3rd International Conference on Future Internet of Things and Cloud (FiCloud) – Special Track on Security, Privacy and Trust,
  Rome, Italy, August 2015
  (Acceptance rate: 55/178≈**30%**).
  Best Paper Award!

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