Supporting Complex Queries and Access Policies for Multi-User Encrypted Databases

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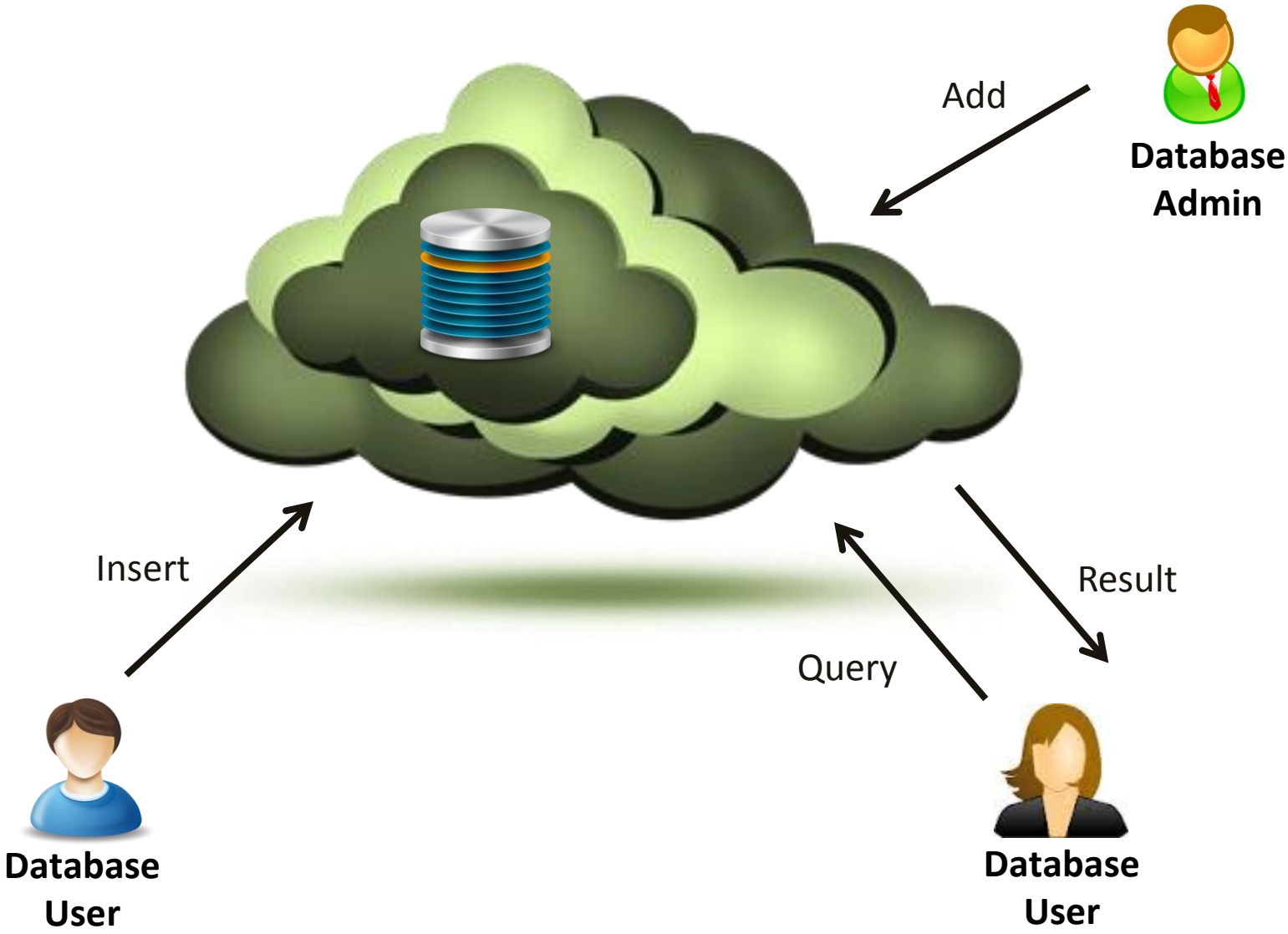
UNIVERSITÀ DEGLI STUDI DI TRENTO

Why Cloud Storage

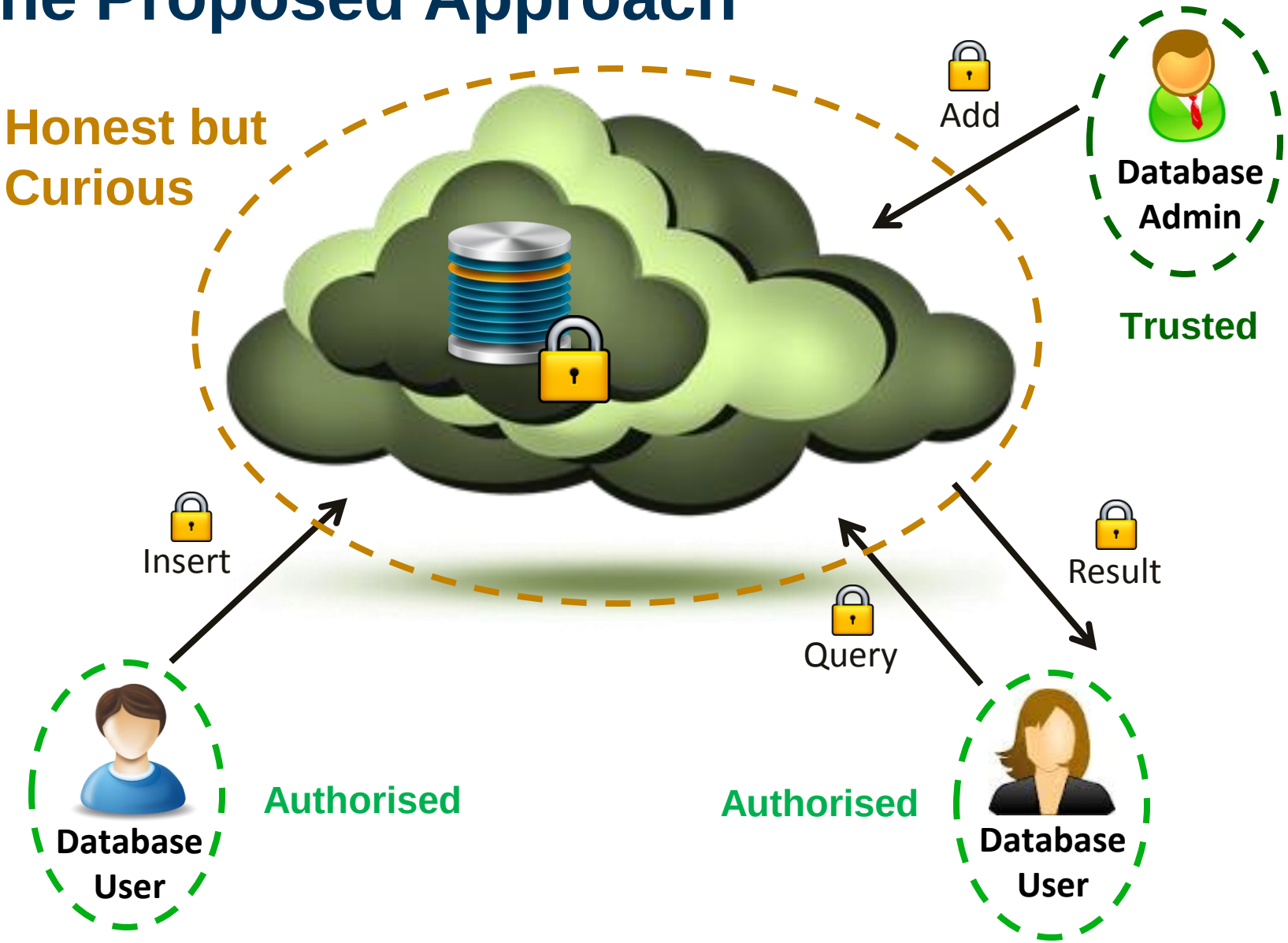
- Cost saving 
- Scalability 
- Efficiency 
- Availability 

Problem



End-to-end confidentiality/privacy

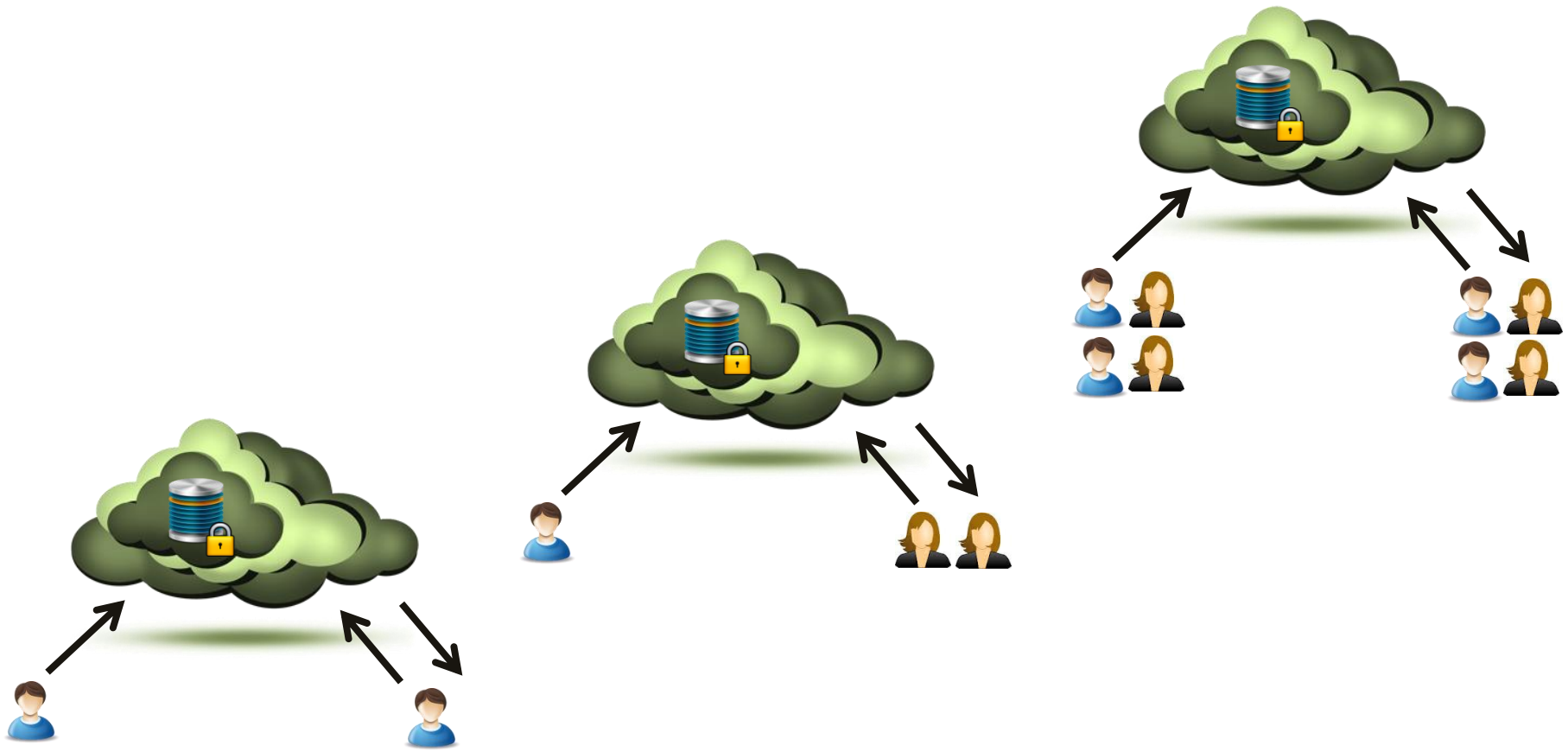
The Proposed Approach



Supported Queries

Keyword	**SELECT *name* FROM *Personnel* WHERE *position=manager***
Conjunction, Disjunction of Keywords	**SELECT *name* FROM *Personnel* WHERE *position=manager* AND *sex=female* OR *level=2***
Complex Queries (e.g., range queries)	**SELECT *name* FROM *Personnel* WHERE *position=manager* OR *age>30* AND *age<40***

State-of-the-Art Scheme Types



Single User	Semi-Fledged Multi-User	Full-Fledged Multi-User

State-of-the-Art

	Single User	Semi-Fledged Multi-User	Full-Fledged Multi-User
Keyword	Song et. al. (2000) Goh (2003) Chang and Mitzenmacher (2005) Hacigumus et. al. (2005)	Boneh et. al. (2004) Curtmola et. al. (2006) Zhu et. al. (2011)	Bao et. al. (2008) Dong et. al. (2008) Shao et. al. (2010)
Con/Dis-junction	Golle et. al. (2004) Bosh et al. (2011)	Baek et. al. (2008) Rhee et al. (2010) Cao et al. (2011)	Hwang et. al. (2007)
Complex	Hore et. al. (2004) Wang and Lakshmanan (2006) Popa et. al. (2011) Hore et. al. (2012)	Boneh and Waters (2007) Katz et. al. (2008) Yang et. al. (2011) Li et. al. (2011) Lu and Tsudik (2011)	**No Solution**

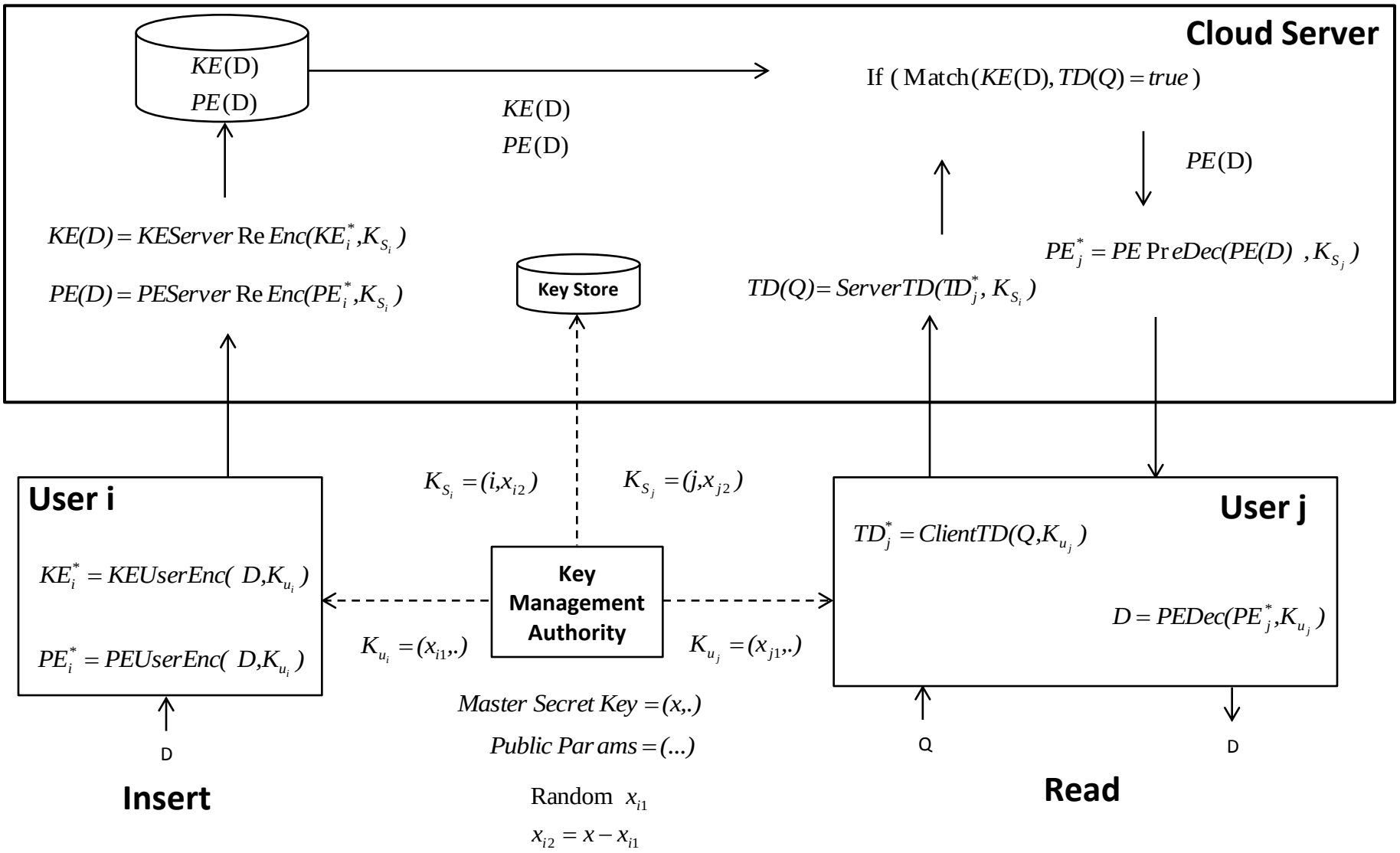
Our Proposed Solution

- We propose full-fledged multi-user scheme that supports complex queries
- Our proposed mechanism protects queries and data stored in the cloud
- We enable enforcement of access control policies
- Users do not share any keys and each user has her own key
- A user can be removed without requiring re-distribution of keys or re-encryption of stored data

Solution Overview

- For data insertion and ***retrieval***, we employ **Proxy Encryption (PE)**
  - Insert data → PE
  - Retrieve data → PE
- For making data ***searchable***, we use **Keyword Encryption (KE)**
  - Insert data → KE
  - Make query → Trapdoor (TD)
  - Perform matching → Match
- We protect access control policies using KE

Solution Details



Representation of Tables and Queries

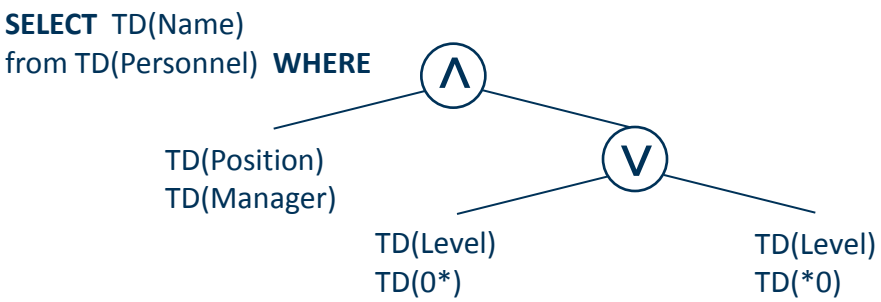
Personnel			
Name	***Gender***	***Position***	***Level***
Andy	Male	Manager	2

$\{Personnel\}_{KE}$			
$\{Name\}_{KE}$	$\{Gender\}_{KE}$	$\{Position\}_{KE}$	$\{Level\}_{KE}$
$\{Name\}_{PE}$	$\{Gender\}_{PE}$	$\{Position\}_{PE}$	$\{Level\}_{PE}$
$\{Andy\}_{KE}$	$\{Male\}_{KE}$	$\{Manager\}_{KE}$	$\{1^*\}_{KE}$, $\{^*0\}_{KE}$
$\{Andy\}_{PE}$	$\{Male\}_{PE}$	$\{Manager\}_{PE}$	$\{2\}_{PE}$

SELECT *name*

FROM *Personnel*

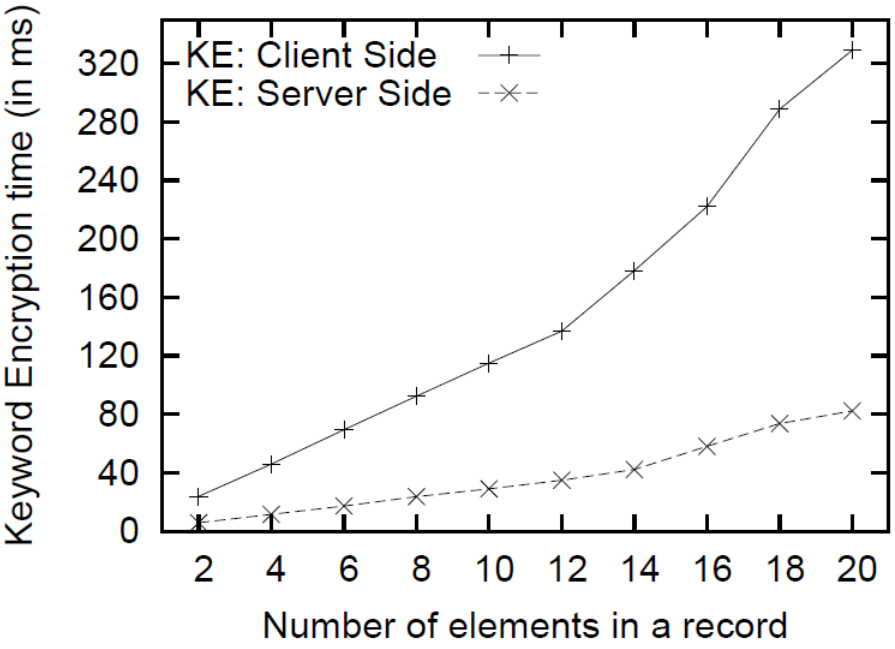
WHERE *position=manager* AND *level<3*

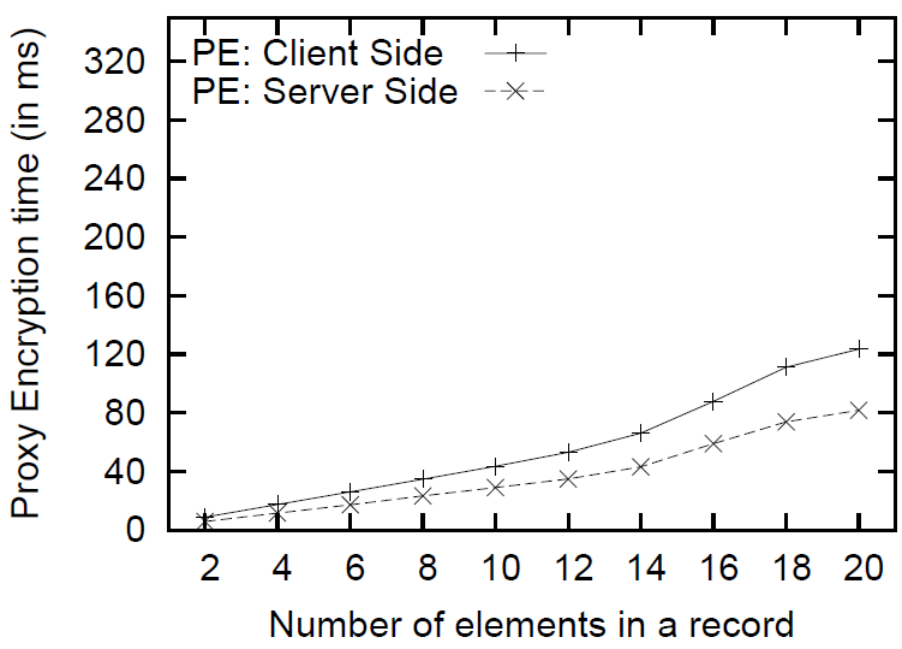


Performance Evaluation: Insert

A prototype implemented in Java

Tested on Intel 2.67 GHz with 4 GB RAM, Microsoft Windows 7

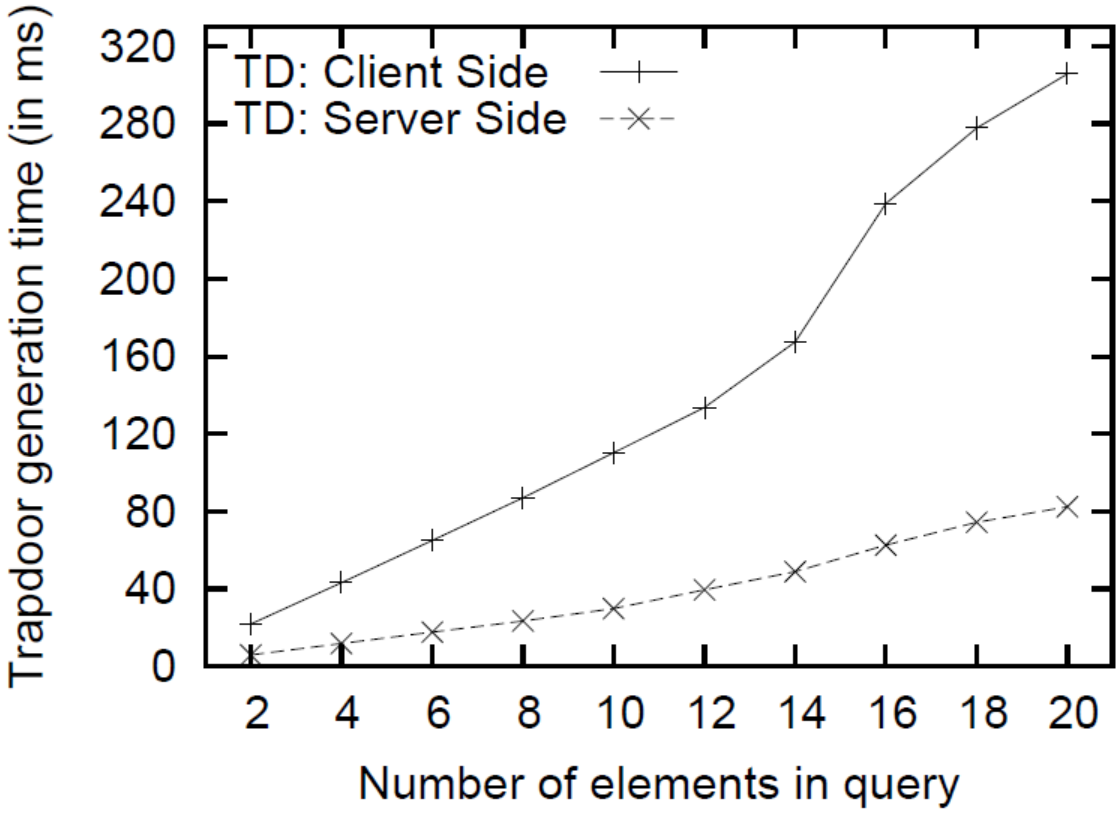




Complexity: $\Theta(n + ms)$

n is number of strings, m is number of integers, each of size s bits

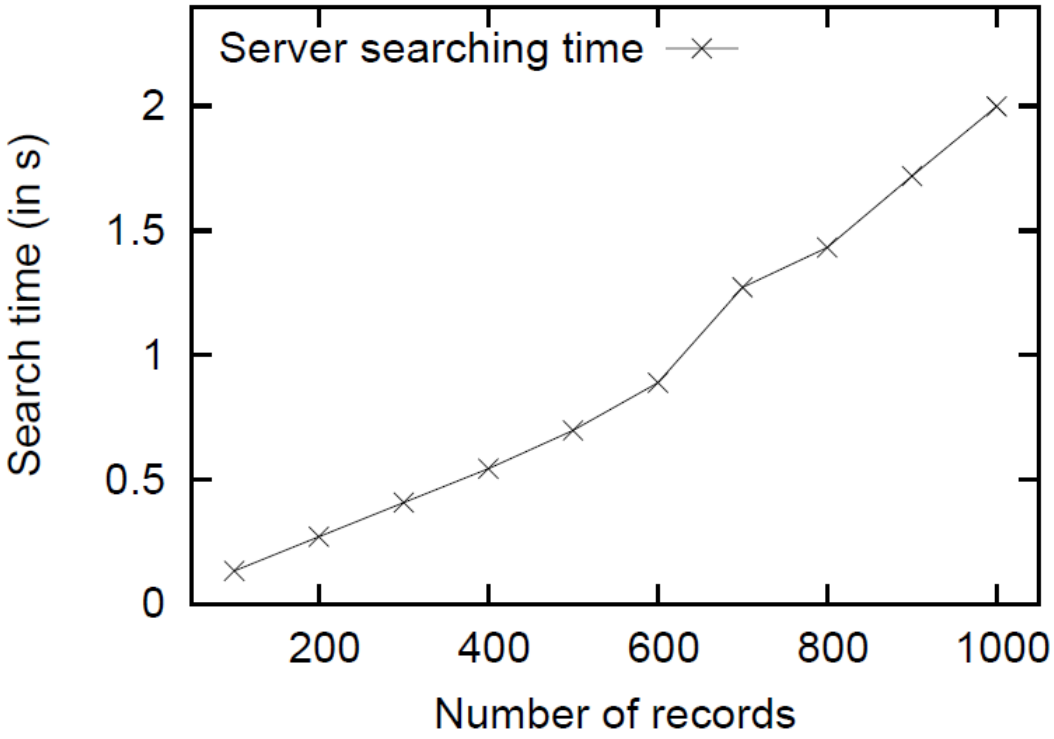
Performance Evaluation: Select (Query)



Complexity: $\Theta(n + ms)$

n is number of strings, m is number of integers, each of size s bits

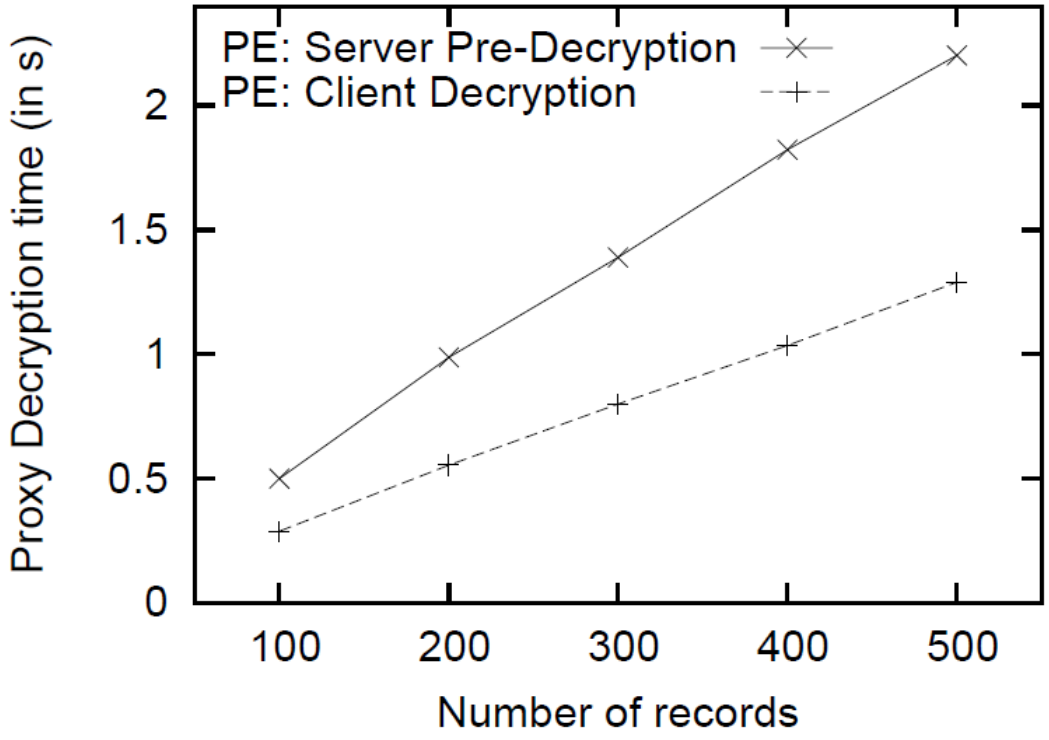
Performance Evaluation: Select (Server)



Complexity: $O(r*(n + ms^2))$

r is number of records, n is number of strings, m is number of integers, each of size s bits

Performance Evaluation: Select (Decryption)



Complexity: O(r*(n + m))

r is number of records, n is number of strings, m is number of integers

Summary

- We presented the first multi-user scheme that supports complex queries in the cloud
- Each user has her own key
- A compromised user is revoked without requiring re-distribution of keys or re-encryption of stored data
- In future, we would like to
  - make performance improvements
  - build indexes
  - apply the technique on very large database

Thank You!

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