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CERTIFICATION COURSES

CLOUD COMPUTING

CLOUD SECURITY IV

Security Issues in Collaborative SaaS Cloud

PROF. SOUMYA K. GHOSH

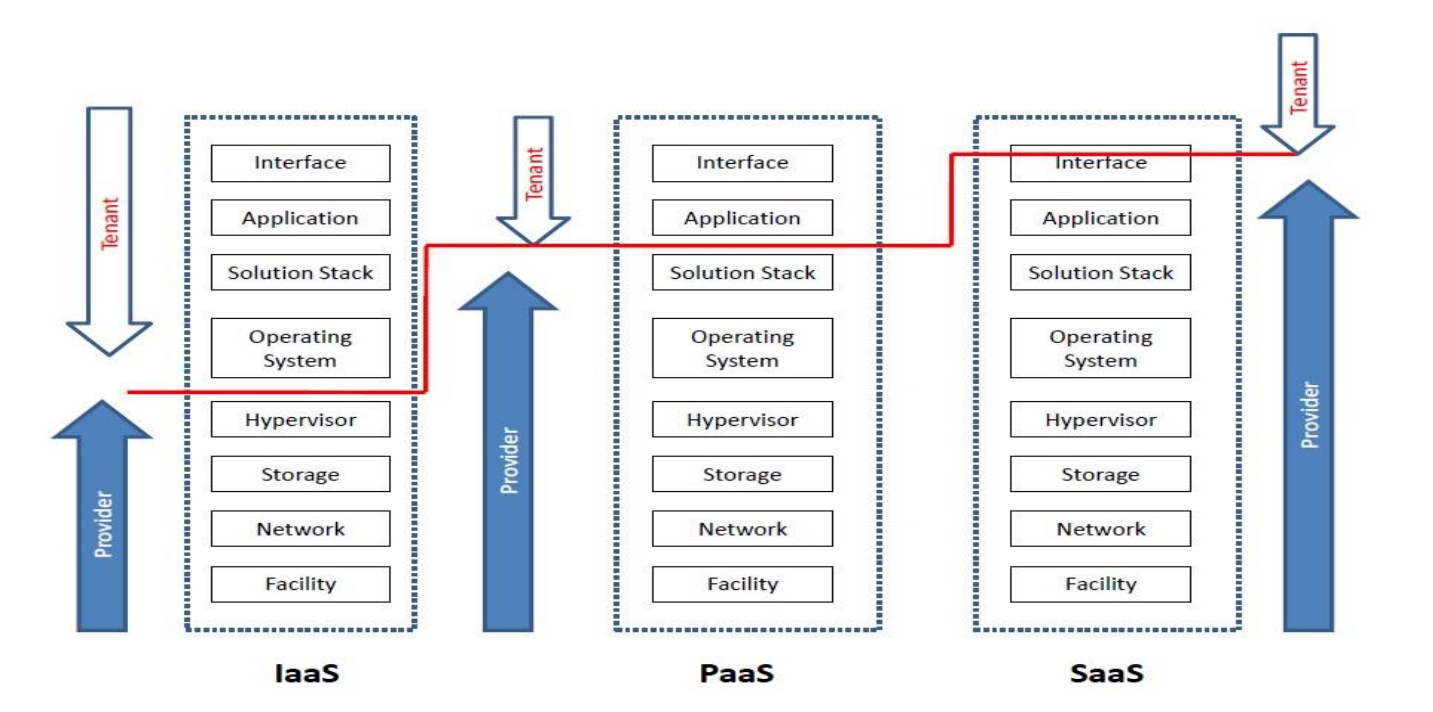
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

IIT KHARAGPUR

Security Issues in Cloud Computing

- Unique security features:
  - Co-tenancy
  - Lack of control on outsourced data and application
- General concerns among cloud customers [Liu'11]:
  - Inadequate policies and practices
  - Insufficient security controls
- Customers use cloud services to serve their clients
- Need to establish trust relationships
- Beneficial to both stakeholders

Security Responsibilities



SaaS Cloud-based Collaboration

- APIs for sharing resources/information
  - Service consumer(customers): human users, applications, organizations/domains, etc.
  - Service provider: SaaS cloud vendor
- SaaS cloud-centric collaboration: valuable and essential
  - Data sharing
  - Problems handled: inter-disciplinary approach
- Common concerns:
  - Integrity of data, shared across multiple users, may be compromised
  - Choosing an “ideal” vendor

SaaS Cloud-based Collaboration

- Types of collaboration in multi-domain/cloud systems:
  - Tightly-coupled or federated
  - Loosely-coupled
- Challenges: securing loosely-coupled collaborations in cloud environment
  - Security mechanisms: mainly proposed for tightly-coupled systems
  - Restrictions in the existing authentication/authorization mechanisms in clouds

Motivations and Challenges

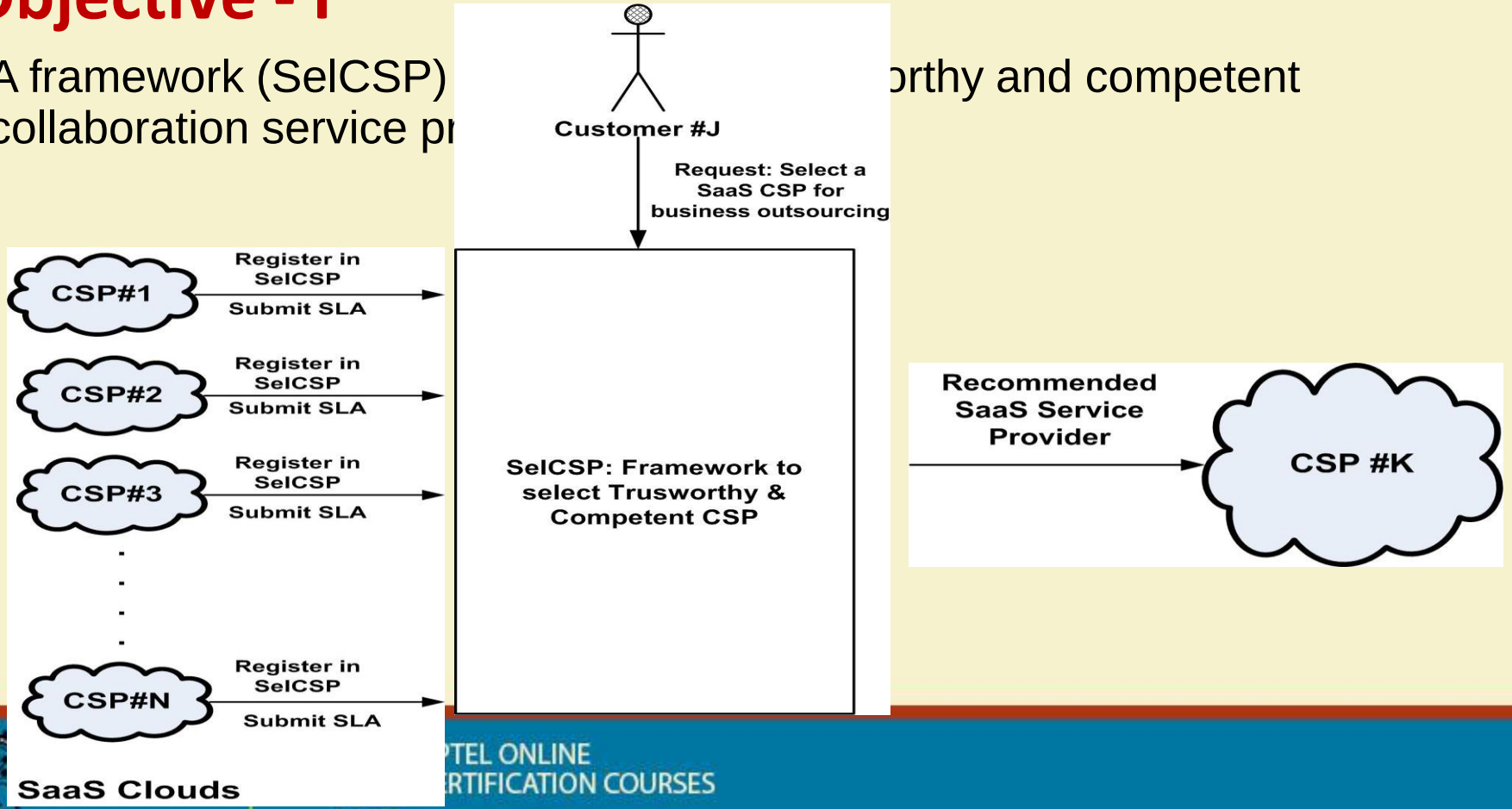
- SaaS cloud delivery model: maximum lack of control
- No active data streams/audit trails/outage report
  - **Security**: Major concern in the usage of cloud services
- Broad scope: *address security issues in SaaS clouds*
- Cloud marketplace: rapid growth due to recent advancements
- Availability of multiple service providers
  - Choosing SPs from SLA guarantees: not reliable
    - Inconsistency in service level guarantees
    - Non-standard clauses and technical specifications
- Focus: *selecting an "ideal" SaaS cloud provider and address the security issues*

Motivations and Challenges

- Online collaboration: popular
- Security issue: unauthorized disclosure of sensitive information
  - Focus: *selecting an ideal SaaS cloud provider and secure the collaboration service offered by it*
- Relevance in today's context: *loosely-coupled collaboration*
  - Dynamic data/information sharing
- Final goal (problem statement): *selecting an ideal SaaS cloud provider and securing the loosely-coupled collaboration in its environment*

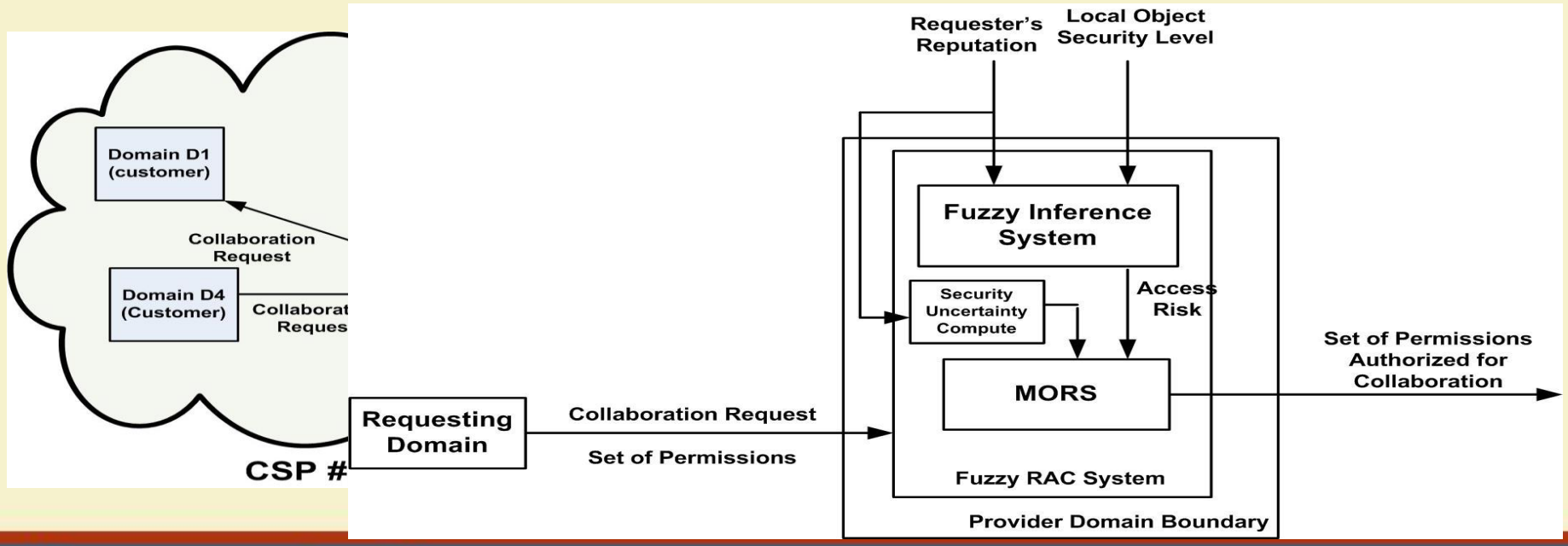
Objective - I

A framework (SelCSP) orthy and competent collaboration service pr



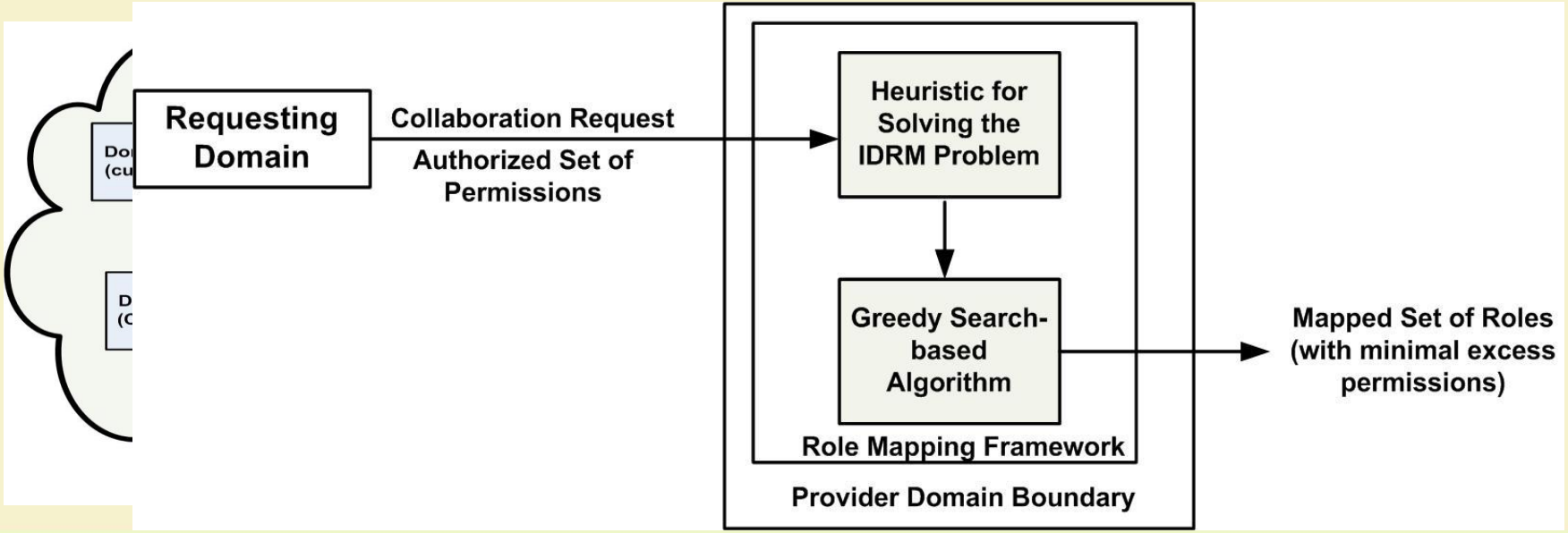
Objective - II

Select requests (for accessing local resources) from anonymous users, such that both access risk and security uncertainty due to information sharing are kept low.

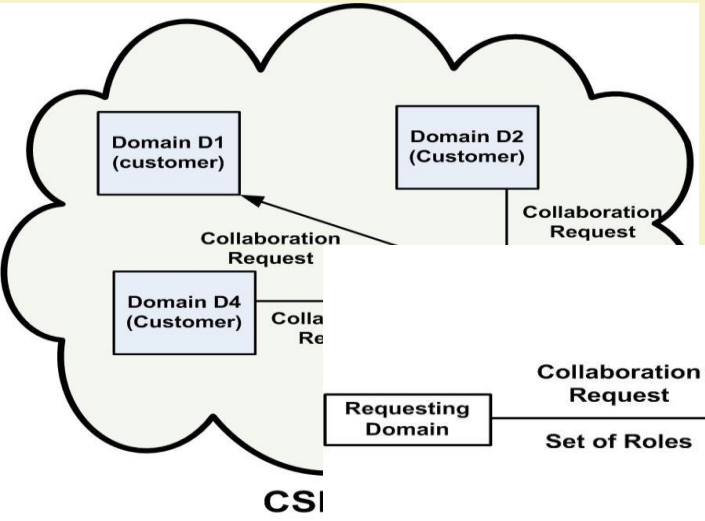


Objective - III

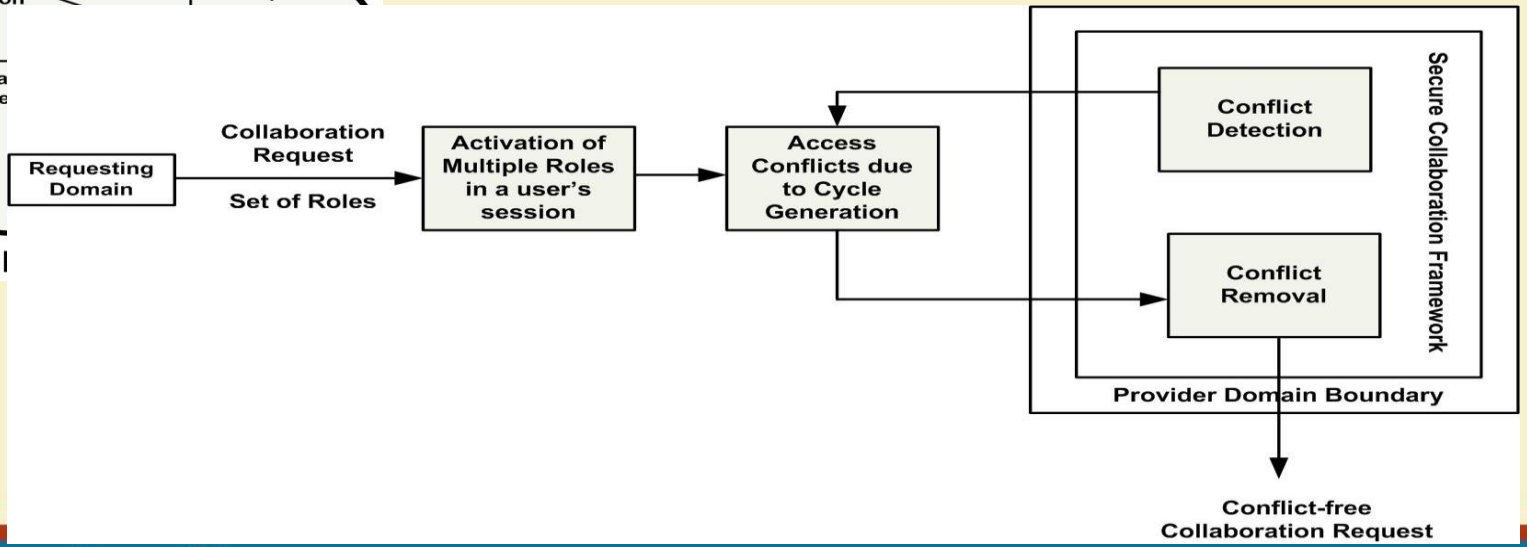
Formulate a heuristic for solving the IDRM problem, such that minimal excess privilege is granted



Objective - IV



A distributed secure collaboration framework, which uses only local information to dynamically detect and remove access conflicts.



Selection of Trustworthy and Competent SaaS Cloud Provider for Collaboration

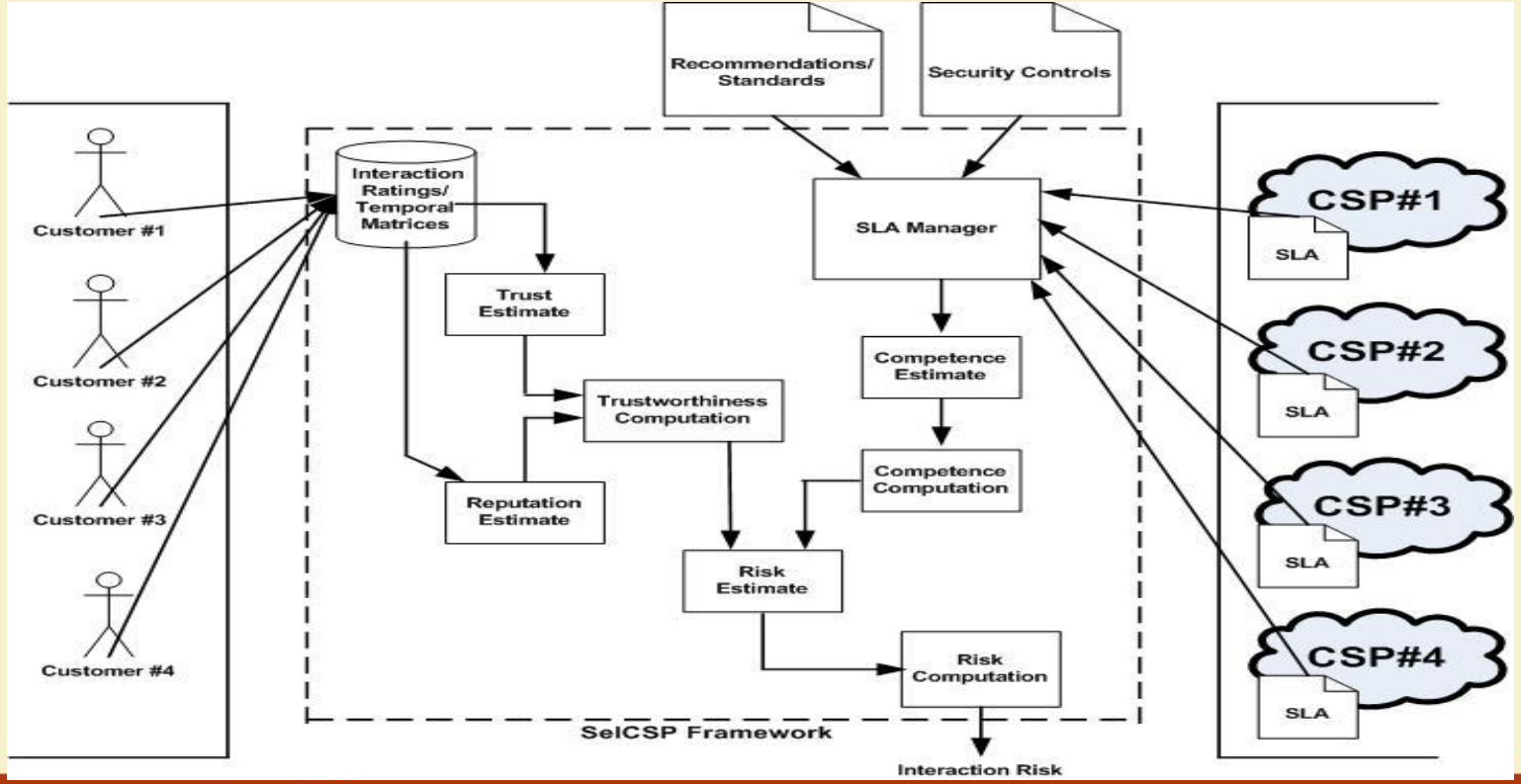
Trust Models in Cloud

- Challenges
  - Most of the reported works have not presented mathematical formulation or validation of their trust and risk models
  - Web service selection [Liu'04][Garg'13] based on QoS and trust are available
    - Select resources (e.g. services, products, etc.) by modeling their performance
- **Objective: Model trust/reputation/competence of service provider**

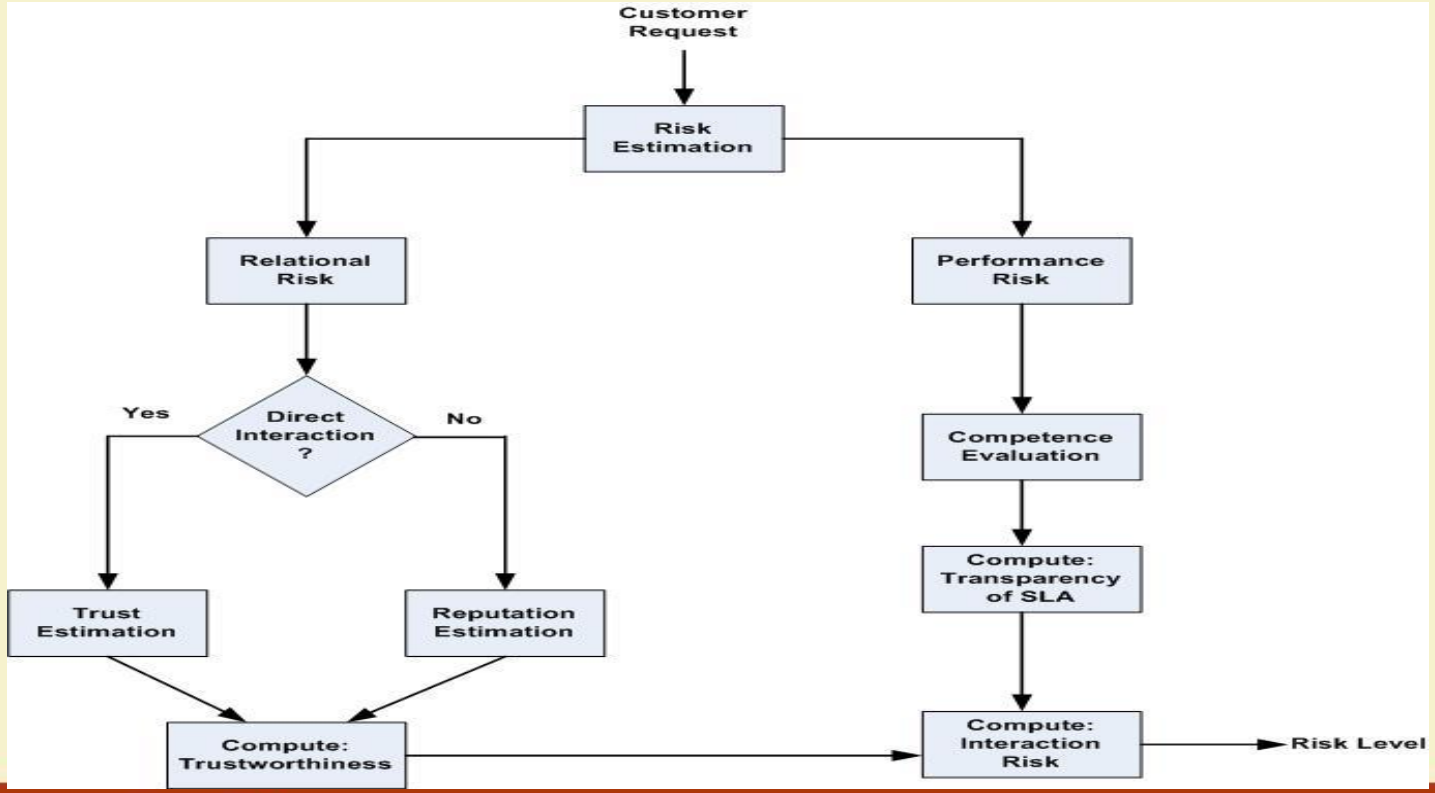
Service Level Agreement (SLA) for Clouds

- Challenges:
  - Majority of the cloud providers guarantee “availability” of services
  - Consumers not only demand availability guarantee but also other performance related assurances which are equally business critical
  - Present day cloud SLAs contain non-standard clauses regarding assurances and compensations following a violation[Habib’11]
- Objective: **Establish a standard set of parameters for cloud SLAs, since it reduces the perception of risk in outsourced services**

SelCSP Framework



SelCSP Framework - Overview

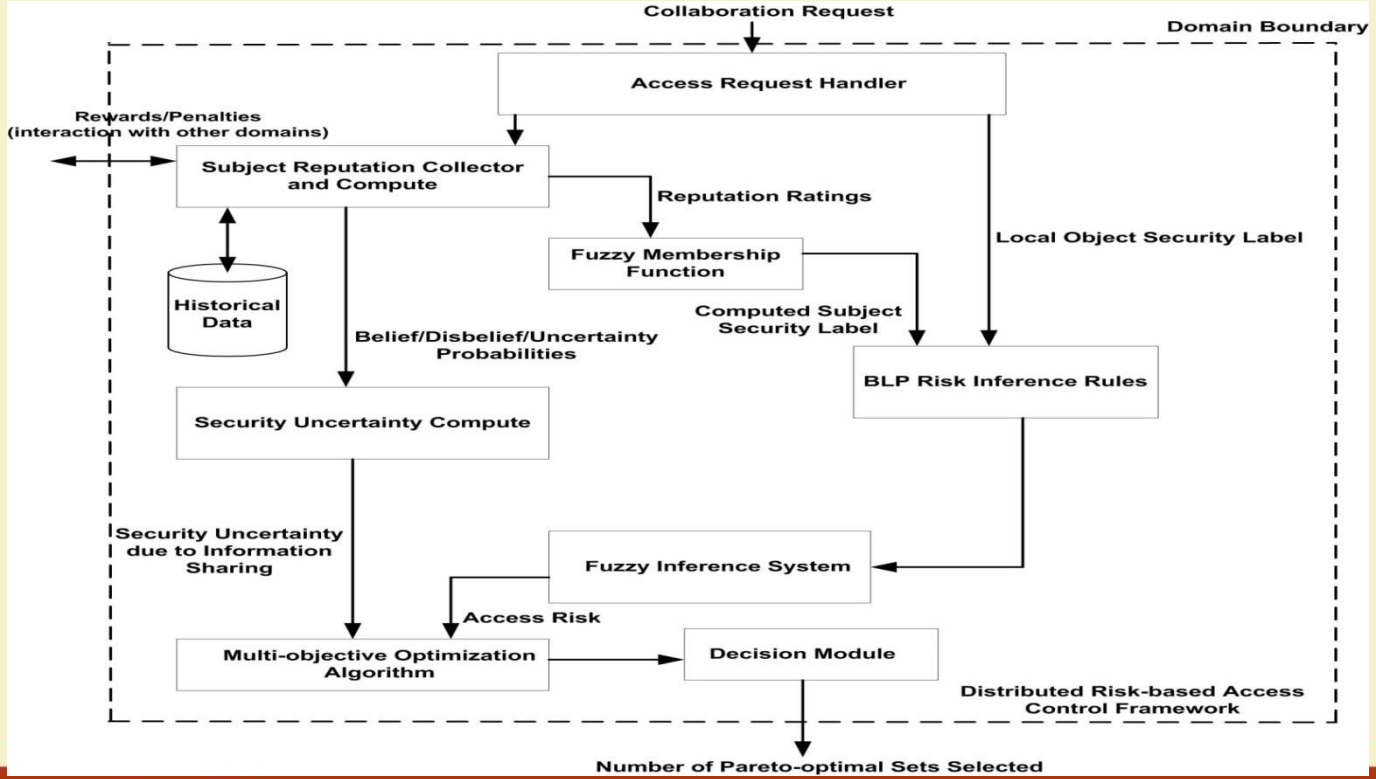


Recommending Access Requests from Anonymous Users for Authorization

Risk-based Access Control (RAC)

- RAC: Gives access to subjects even though they lack proper permissions
  - Goal: balance between *access risk* and *security uncertainty due to information sharing*
  - Flexible compared to binary MLS
- Challenges
  - Computing security uncertainty: not addressed
  - Authorization in existing RAC system: based on risk threshold and operational need.
    - Operational need: not quantified.
    - Discards many requests which potentially maximizes information sharing

Distributed RAC using Fuzzy Inference System

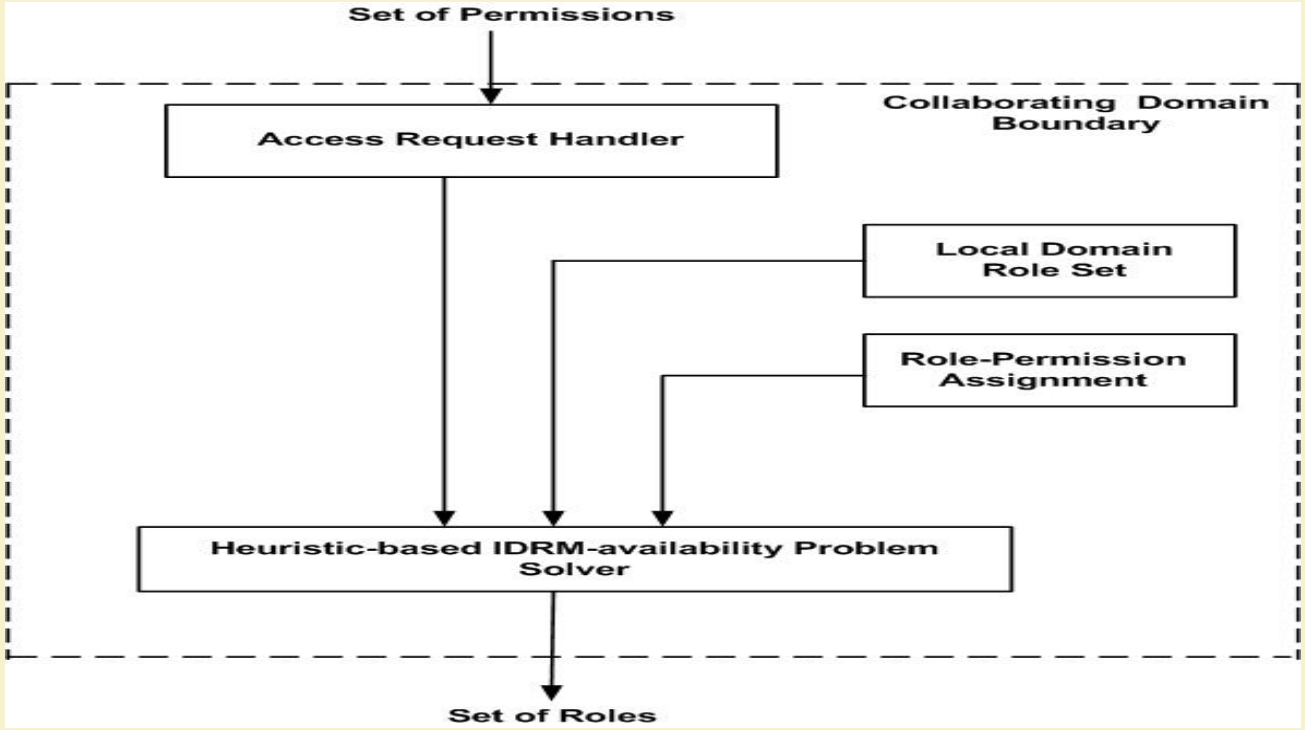


Mapping of Authorized Permissions into Local Roles

Inter-Domain Role Mapping (IDRM)

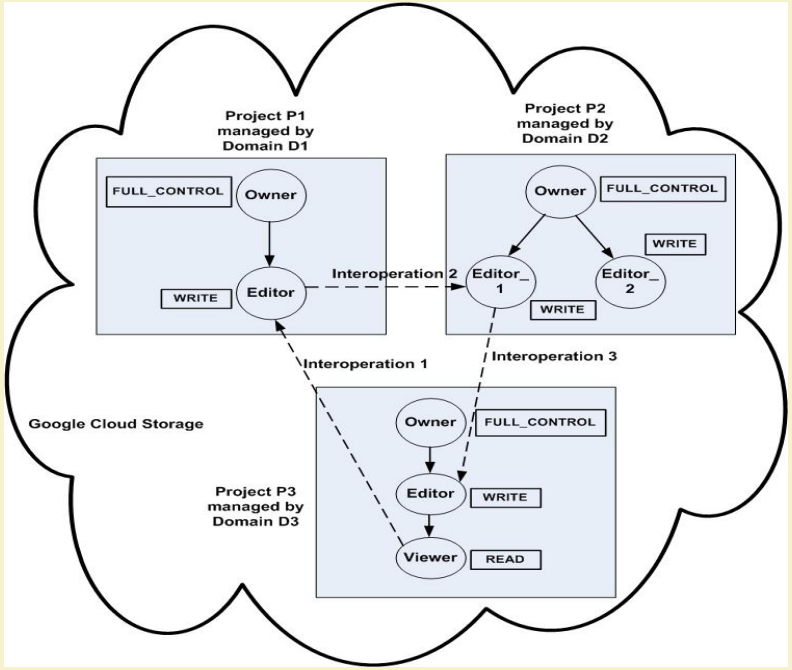
- Finds a minimal set of role which encompasses the requested permission set.
  - No polynomial time solution
  - Greedy search-based heuristics: suboptimal solutions
- Challenges:
  - There may exist multiple minimal role sets
  - There may not exist any role set which exactly maps all permissions
- Two variants of IDRM proposed: *IDRM-safety*, *IDRM-availability*
- Objective: formulate a novel heuristic to generate better solution for the IDRM-availability problem.
- Minimize the number of additional permissions

Distributed Role Mapping Framework

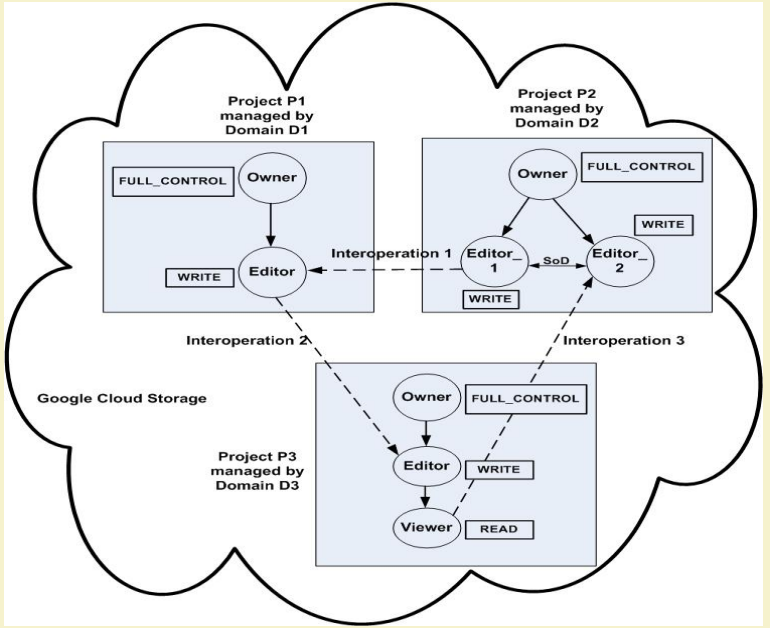


Dynamic Detection and Removal of Access Policy Conflicts

Access Conflicts



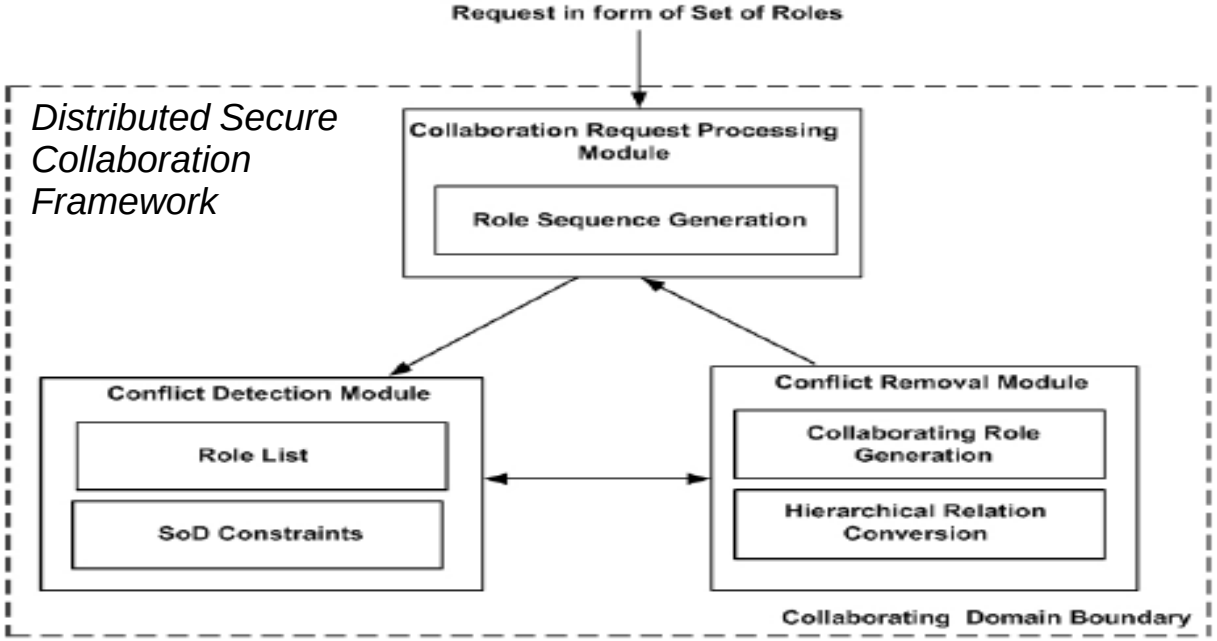
Cyclic Inheritance Conflict



Violation of SoD Constraint

Objective

- Dynamic detection of conflicts to address **security** issue
- Removal of conflicts to address **availability** issue
- Proposed: distributed secure collaboration framework



- Role Sequence Generation
  - Interoperation request: pair of *entry* (from requesting domain), *exit* (from providing domain) roles
  - Role sequence: ordered succession of entry and exit roles
  - Role cycle:
    - Safe role cycle
    - **Unsafe role cycle**

Conflict Detection

- Detection of inheritance conflict
  - Necessary condition: at least one exit role
  - Sufficient condition: current entry role is senior to at least one exit role
- Detection of SoD constraint violation
  - Necessary condition: at least one exit role
  - Sufficient condition: current entry role and at least one exit role forms *conflicting pair*

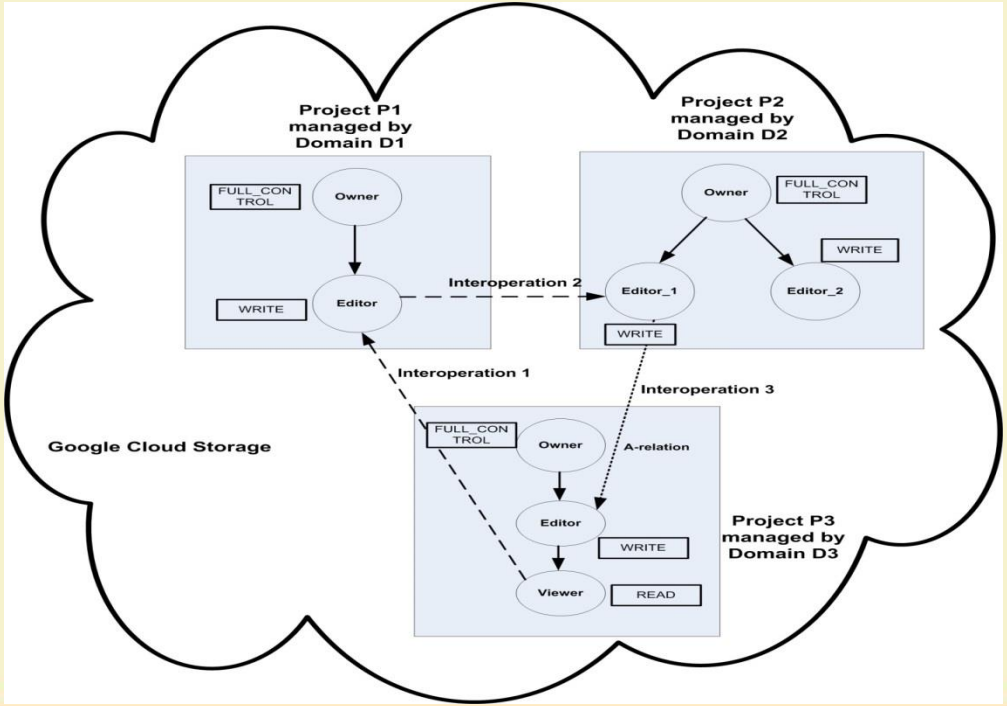
Conflict Removal

Cyclic Inheritance

- Two cases arise:
  - Exactly matched role set exists
    - RBAC hybrid hierarchy
      - *I-hierarchy, A-hierarchy, IA-hierarchy*
    - Replacing *IA-relation* with *A-relation* between exit role in previous domain and entry role in current domain
  - No-exactly matched role set exists
    - Introduce a virtual role

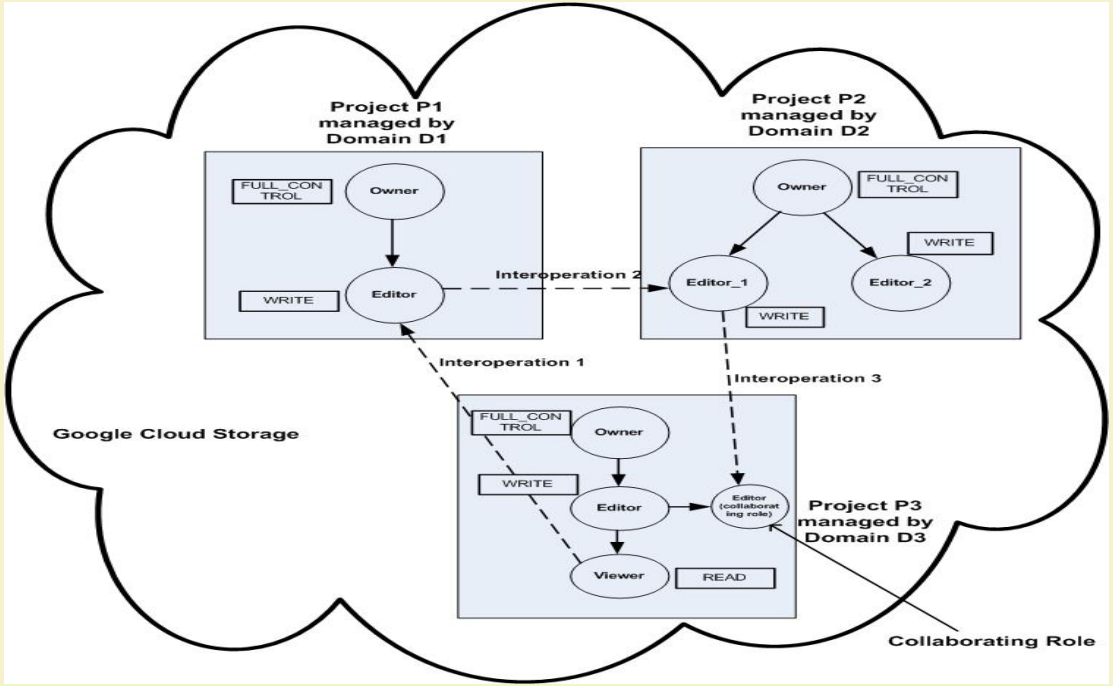
Conflict Removal

Cyclic Inheritance: Inheritance Conflict Removal Rule for Exactly Matched Role



Conflict Removal

Cyclic Inheritance: Inheritance Conflict Removal Rule for No-Exactly Matched Role



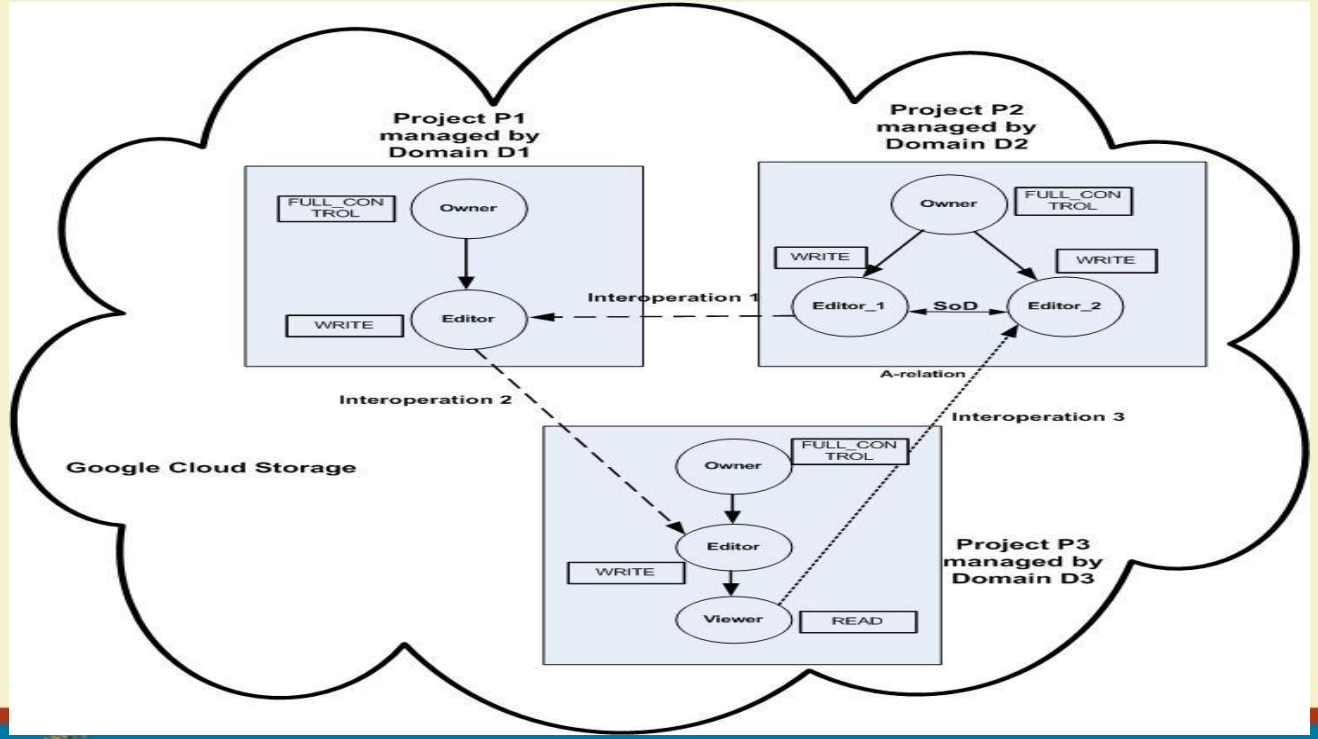
Conflict Removal

SoD Constraint Violation

- Two cases: similar to removal of inheritance conflict
  - Additional constraint: identifying *conflicting permission* between collaborating role and entry role in current domain
  - Conflicting permission
    - Objects are similar
    - Hierarchical relation exists between access modes
- Remove conflicting permission from permission set of collaborating role

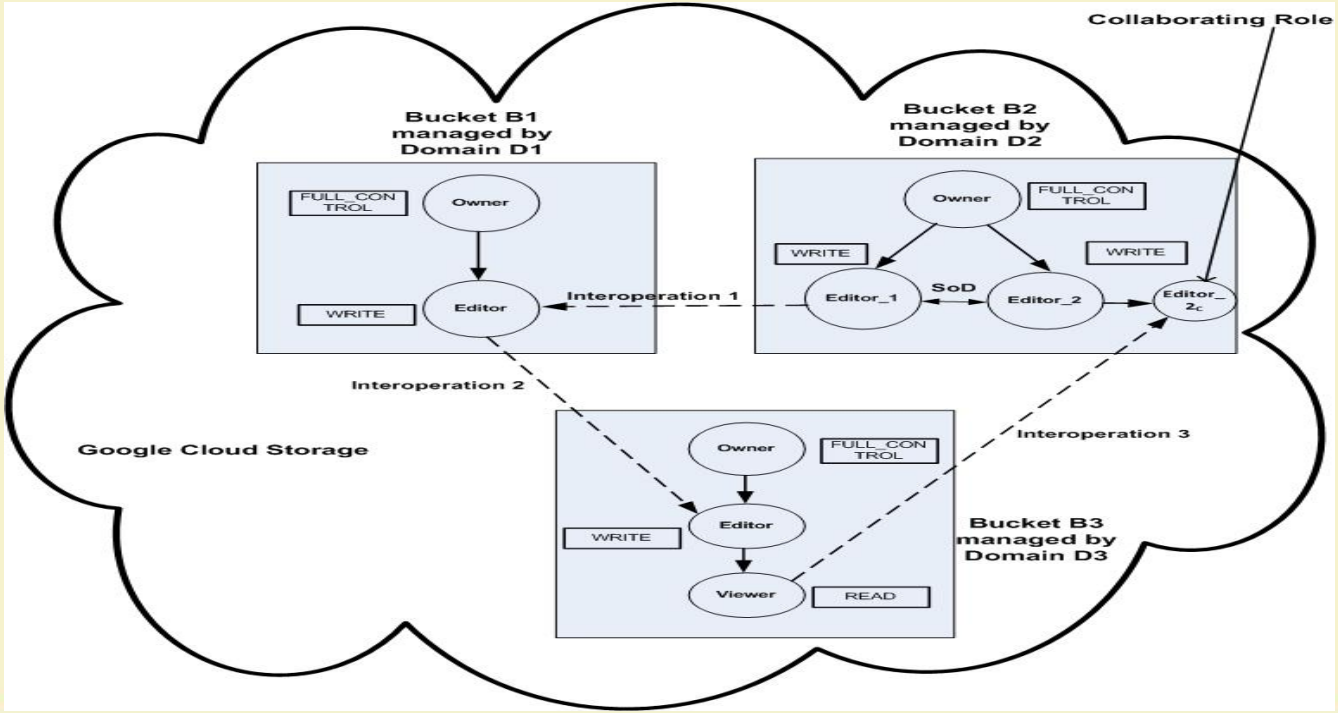
Conflict Removal

SoD Constraint Violation: SoD Conflict Removal Rule for Exactly Matched Role



Conflict Removal

SoD Constraint Violation: SoD Conflict Removal Rule for No-Exactly Matched Role



Summary

Secure Collaboration SaaS Clouds: A Typical Approach

- Selection of Trustworthy and Competent SaaS Cloud Provider for Collaboration
- Recommending Access Requests from Anonymous Users for Authorization
- Mapping of Authorized Permissions into Local Roles
- Dynamic Detection and Removal of Access Policy Conflicts

Thank You!