Unified Policy Management in Cloud

Hassan Takabi
December 4, 2012

University of Pittsburgh,
Pittsburgh, PA, USA

Outline

- Overview of Cloud
- Security Challenges in Cloud
- Motivation
- Use case scenario
- Semantic Based Policy Specification
- Semantic Based Policy Management Framework
- Conclusion & Future Work

Overview of Cloud and its features

- 5 Key Characteristics
  - On-demand self-service, ubiquitous network access, location independent recourse pooling, rapid elasticity, measured services
- 3 delivery models
  - IaaS, PaaS, SaaS
- Deployment models
  - Public cloud, private cloud, community cloud, hybrid cloud

Security Implications of Cloud Features

- Outsourcing
- Extensibility and Shared Responsibility
- Virtualization
- Multi-tenancy
- Service Level Agreement
- Heterogeneity

Security Challenges in Cloud

- Authentication and Identity Management
- Access Control
- Policy Integration
- Service Management
- Trust Management

Motivation

- No single authorization/ policy language
- Each CSP employs its own access
- Authorization is bound to CSP
- Policies composed in incompatible languages
- CSPs don’t understand each other
- Users must use diverse AC solutions

Challenge

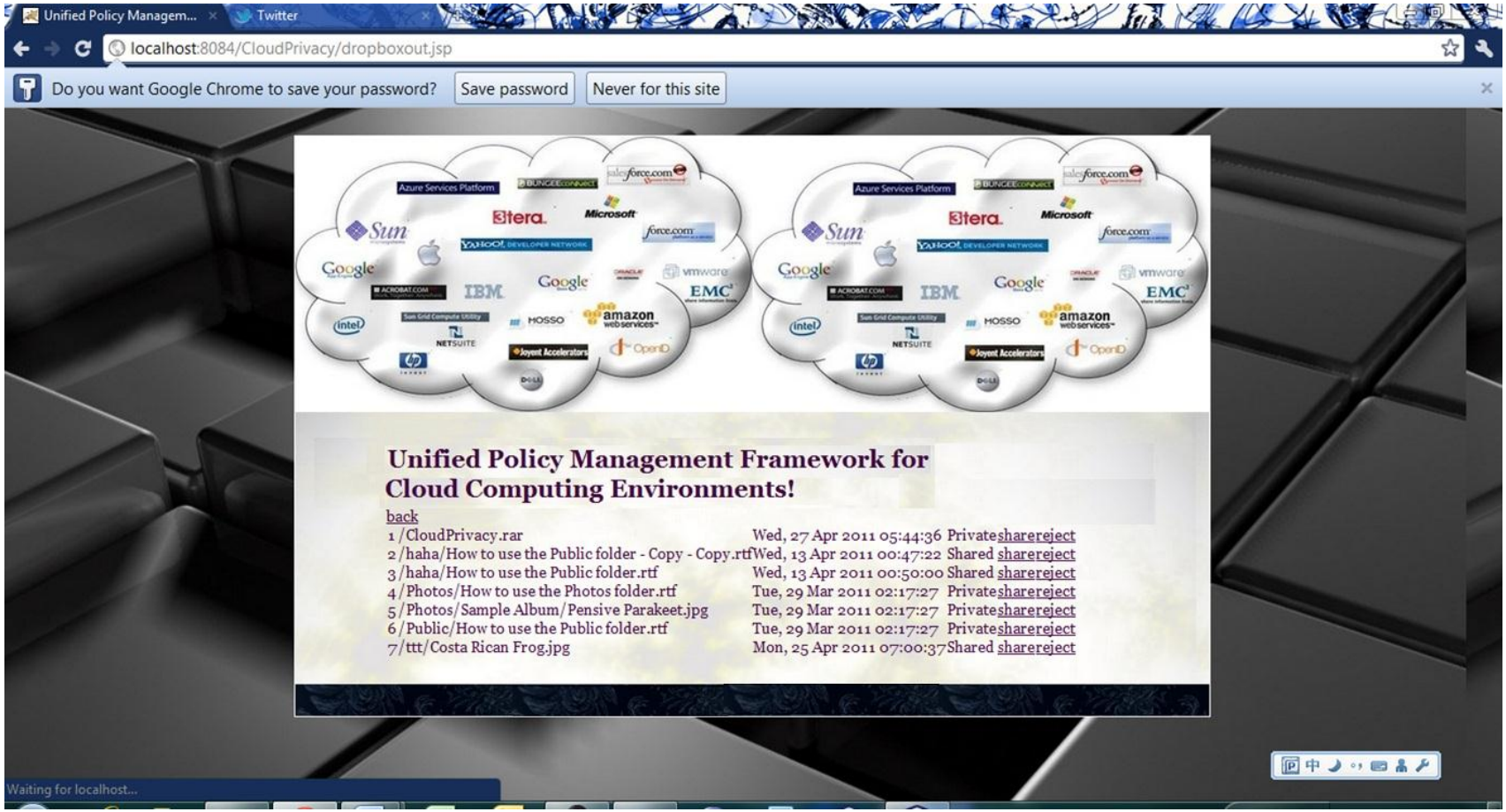
- Design an integrated access control system
  - work with all types of content
  - regardless of where they are stored
  - Manage from a central location.

Use Case Scenarios

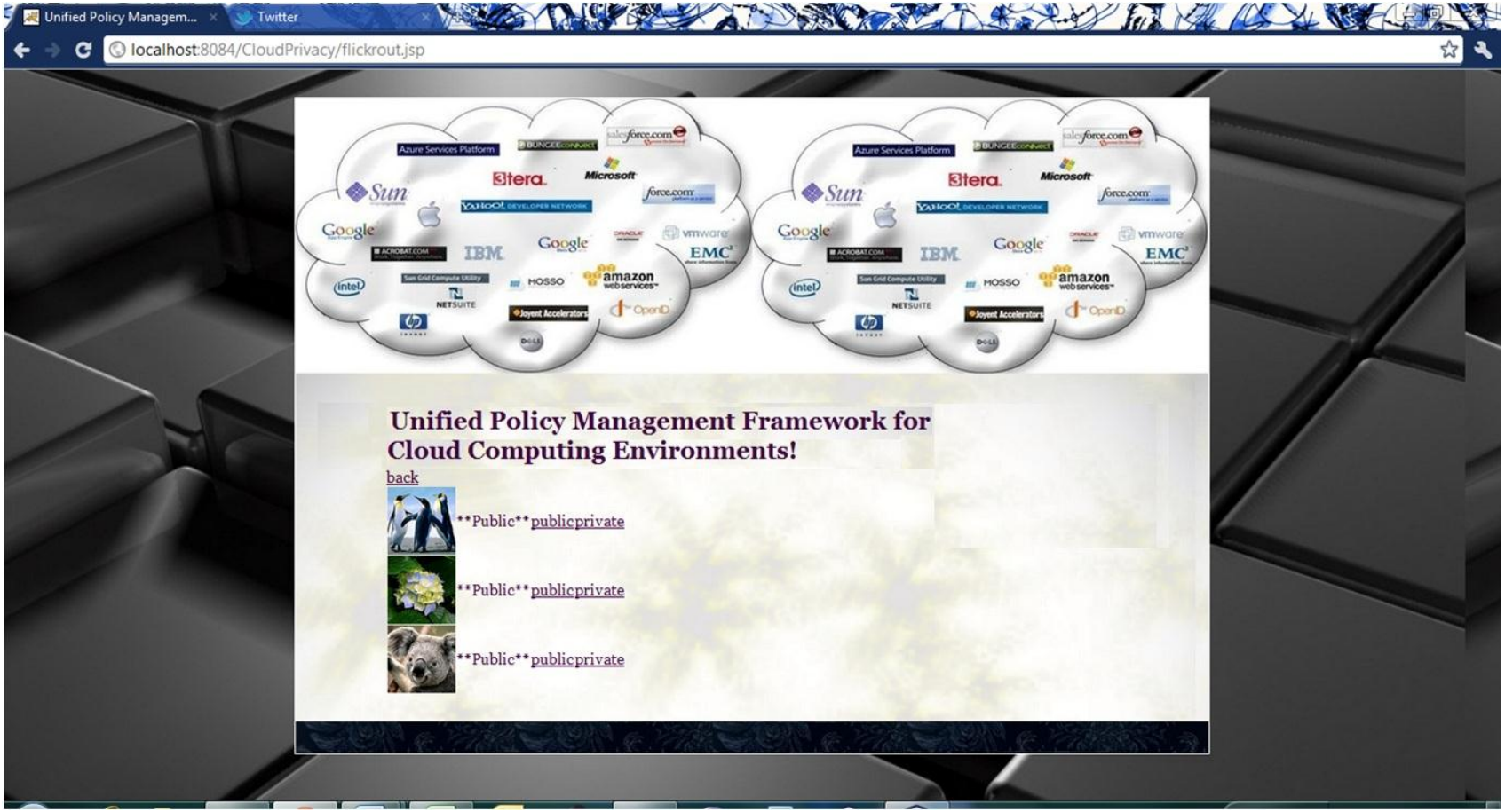
- Individual
  - Alice a PhD student
  - Dropbox, Google Docs, Amazon S3, Mint
- Small and Medium Businesses
  - IaaS: Amazon S3 and FlexiScale
  - PaaS: Google App Engine and LoadStorm
  - SaaS: Zoho, Zuora, Workday, Salesforce, …
- Collaboration & interoperation is impossible

Use Case Scenario (Cont.)

Use Case Scenario (Cont.)



Use Case Scenario (Cont.)



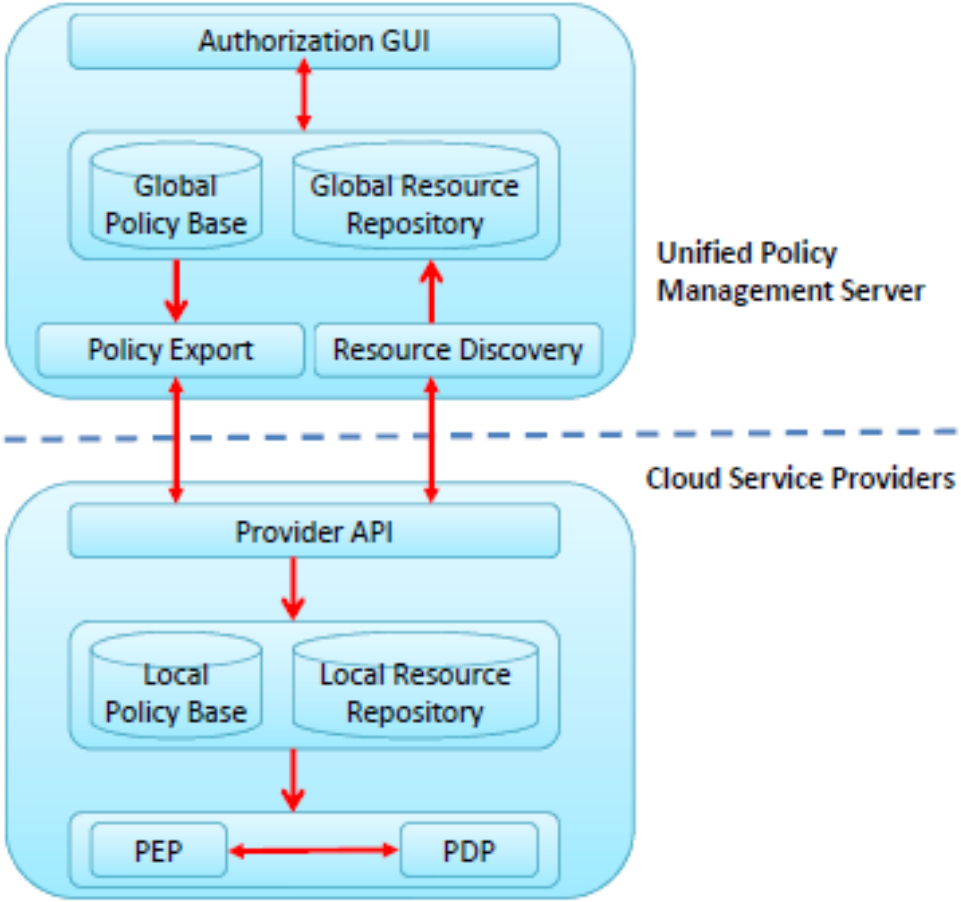
Limitations

- Application centric vs. user centric
- Unified policy management system
- Heterogeneity and interoperation
- Privacy preservation

Policy Management Framework

- Cloud-based framework that efficiently delivers policy management services
- Built on the concept of centrally expressing user’s security requirements
- Manage user’s resources scattered across the Cloud

Architecture: Unified Policy Management Framework

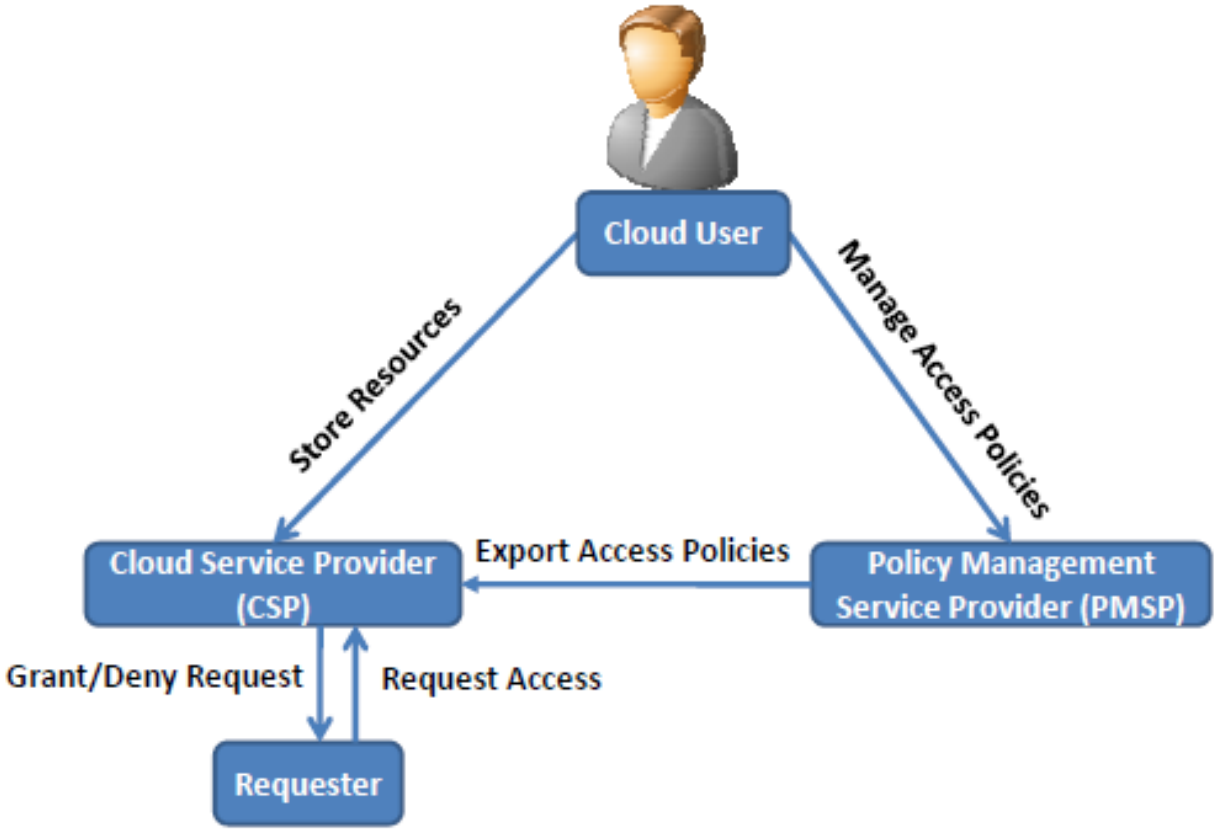


PMaaS

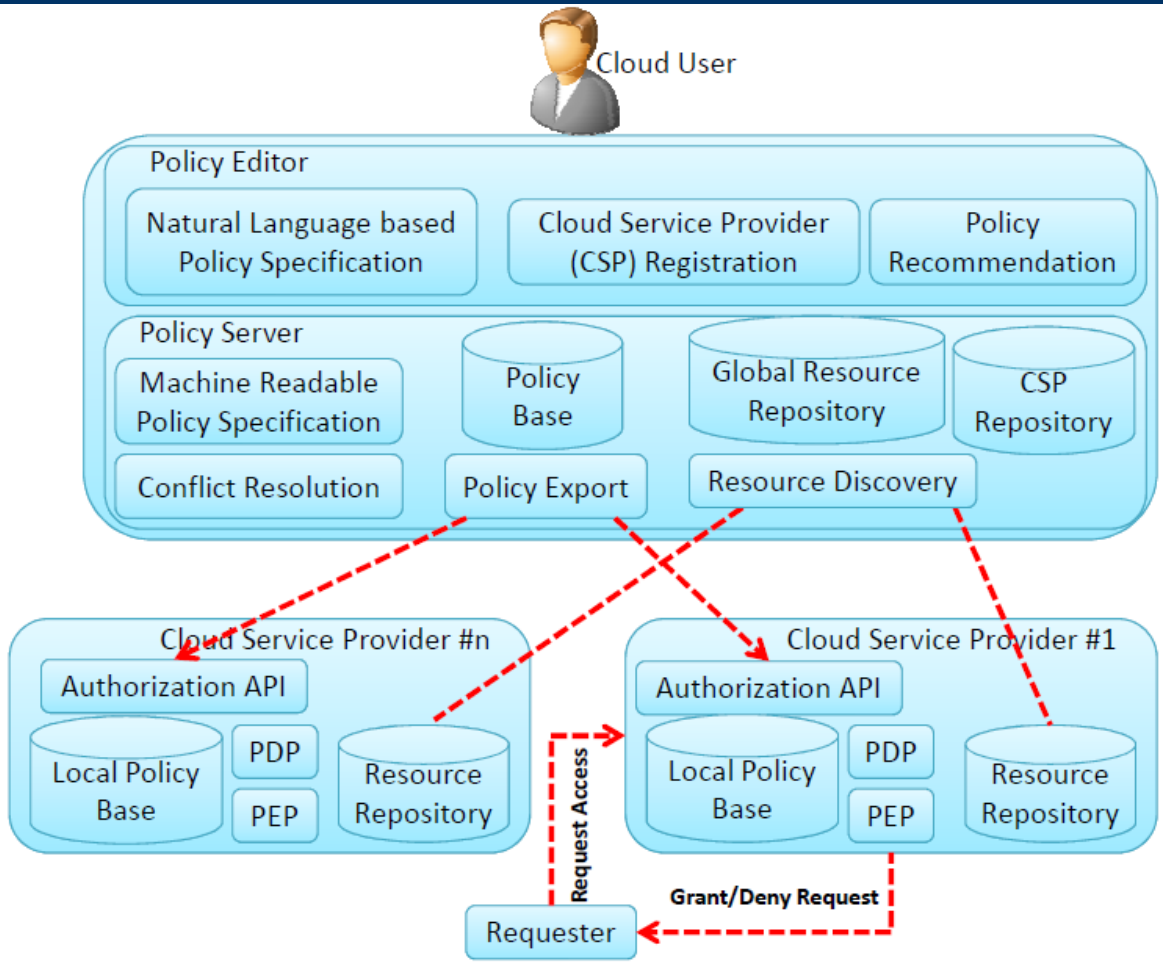
- capabilities provided to the customers to manage policies for services and products running on a cloud infrastructure which are accessible through usable interfaces.
- customers do not manage or control the underlying cloud infrastructure, network, servers, operating systems, storage, or even individual application capabilities.

PMaaS: High Level View

- Cloud user
- PMSP
- CSP
- requester



Policy Management as a Service (PMaaS) Framework



Policy Management Service Provider (PMSP)

- The Policy Editor
  - policy administration point (PAP)
- The Policy Server
  - policy information point (PIP)

Policy Management Process

- Registering cloud service providers
- resource discovery
- specifying policies
- exporting policies

The Framework Deployment

- PMSP should be able to exchange data with the CSPs.
- PMSP should generate policies in a format that the cloud service provider understands
- Changes
  - Push strategy
  - Pull strategy

PMaaS: Discussion

- Policy specification is external to CSP
- Unified policy management system
- Consolidated view of the access policies applied to their resources.
- Moving resources from one CSP to another
- Extend functionalities of the existing system
- Concerns

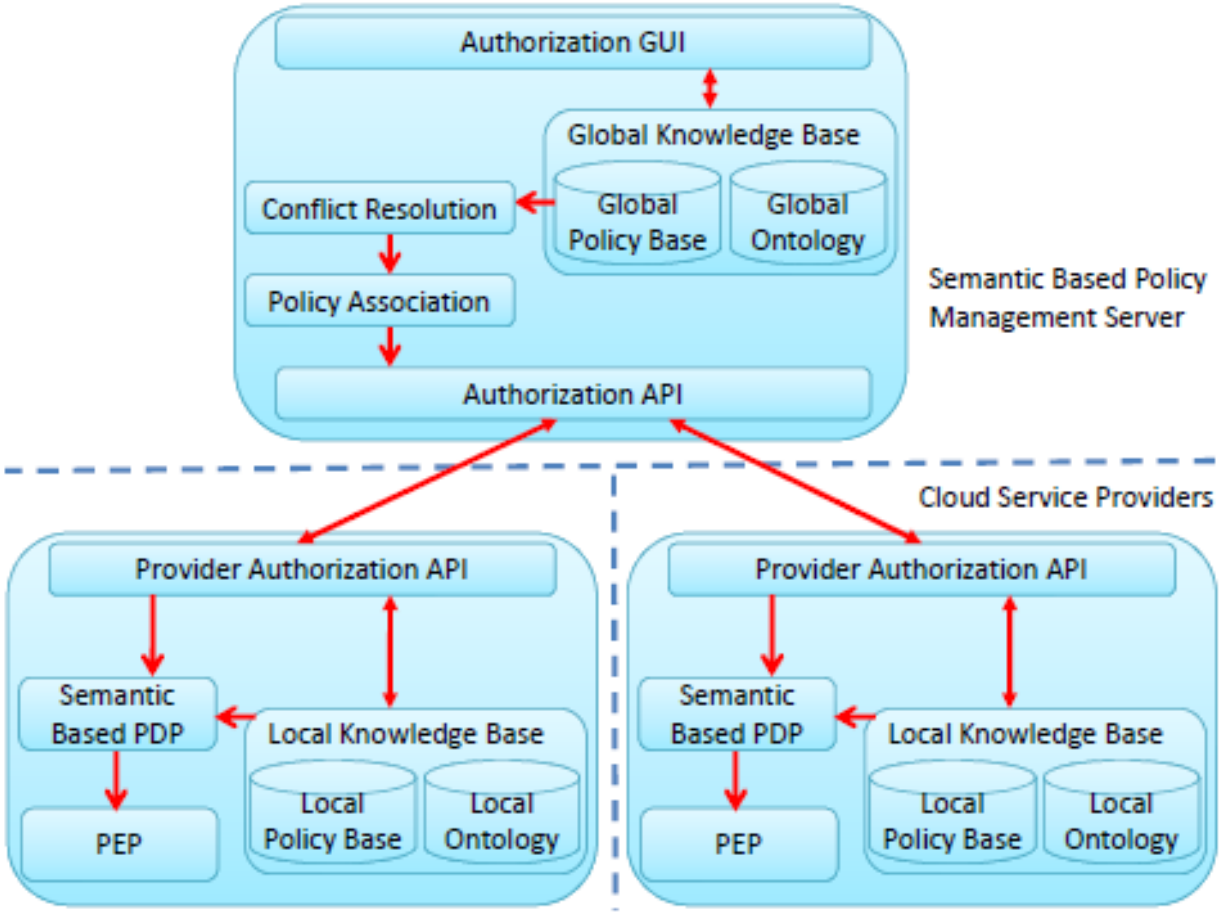
Semantic Based Policy Specification

- Semantic Web and Policy Management
- provide a common understandable semantic basis for policy specification
- semantic based policy specification language (SBPSL)
- Use OWL to model this specification language

Semantic Web and Policy Management

- combination of OWL 2 RL and SWRL with DL-Safe restriction,
  - high expressiveness
  - reasoning using rule-based engines which offer good performance
  - scalable reasoning without sacrificing too much expressive power
  - heterogeneity management and interoperability
  - separation between domain description and policy description

Semantic Based Policy Management Framework



Ontologies

- Subject rdfs:subClassOf owl:Thing
- Role rdfs:subClassOf owl:Thing
- Object rdfs:subClassOf owl:Thing
- Action rdfs:subClassOf owl:Thing
- Attribute rdfs:subClassOf owl:Thing
- Provider rdfs:subClassOf owl:Thing
- Service rdfs:subClassOf owl:Thing

Ontologies

- Subject Ontology
- Object Ontology
- Action Ontology
- Provider Ontology
- Service Ontology
- Attribute Ontology

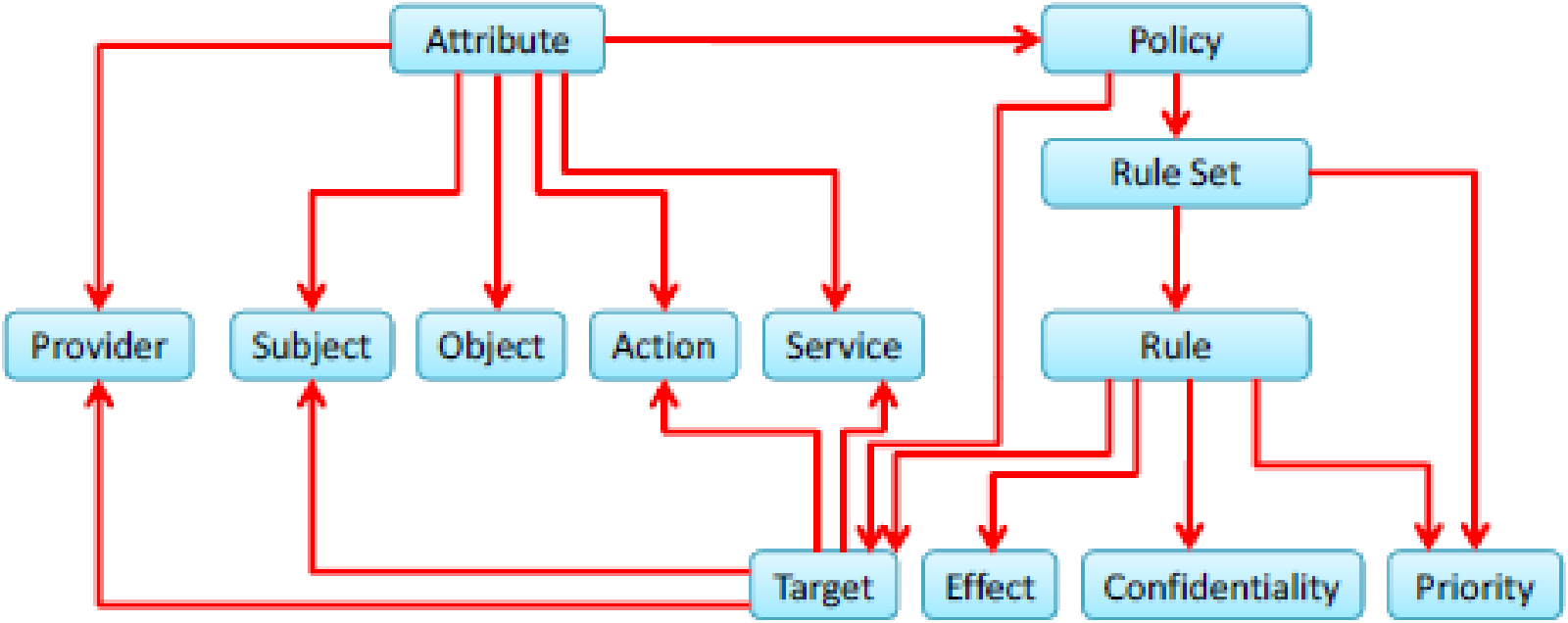
Subject Ontology

- Subject: a user, a user group, a role, a process, a service and so on.
- modeled as an OWL class Subject.
- The instances of this class represent the subjects on which the policies are defined.
- The object property and data property of OWL are used to describe attributes of a subject with hasSubjectAttribute and hasSubjectDataAttribute respectively.

Rule and Rule Set

- [Subject, Object, Action]
- [Provider, Subject, Object, Action, Service]

SBPSL


Attribute
Policy
Rule Set
Provider
Subject
Object
Action
Service
Rule
Target
Effect
Confidentiality
Priority

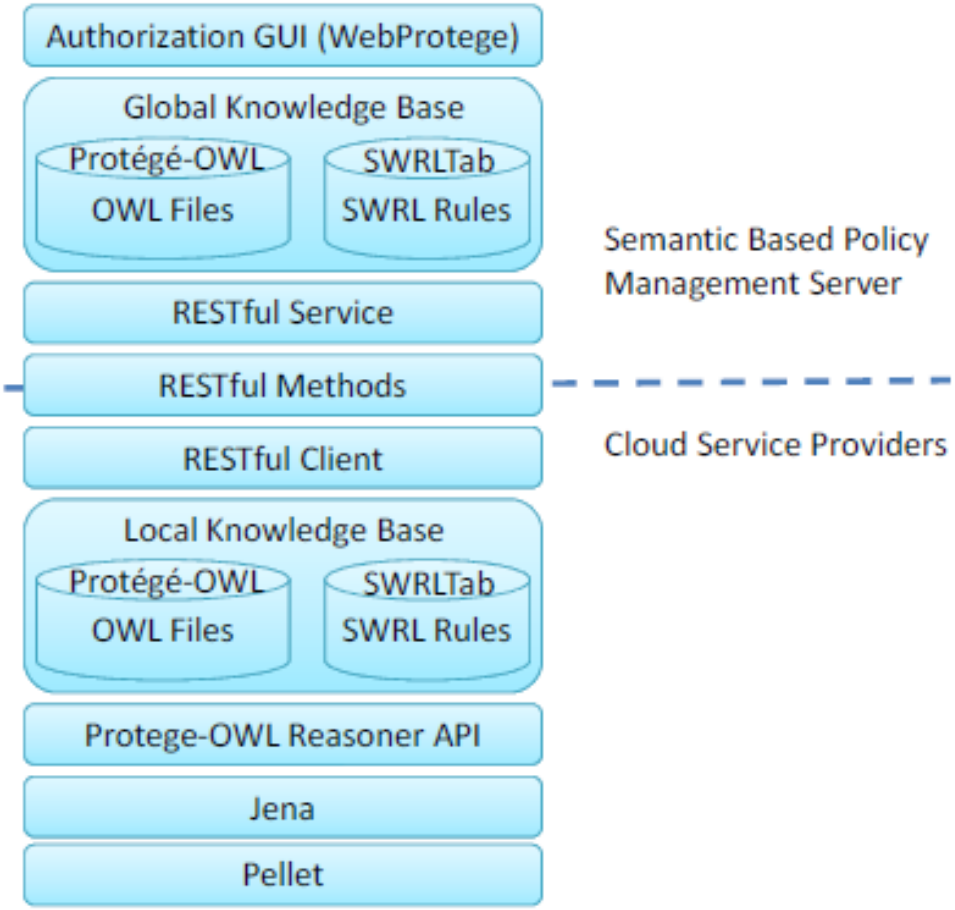
Knowledge Management

- Authorization knowledge management
- Access request processing

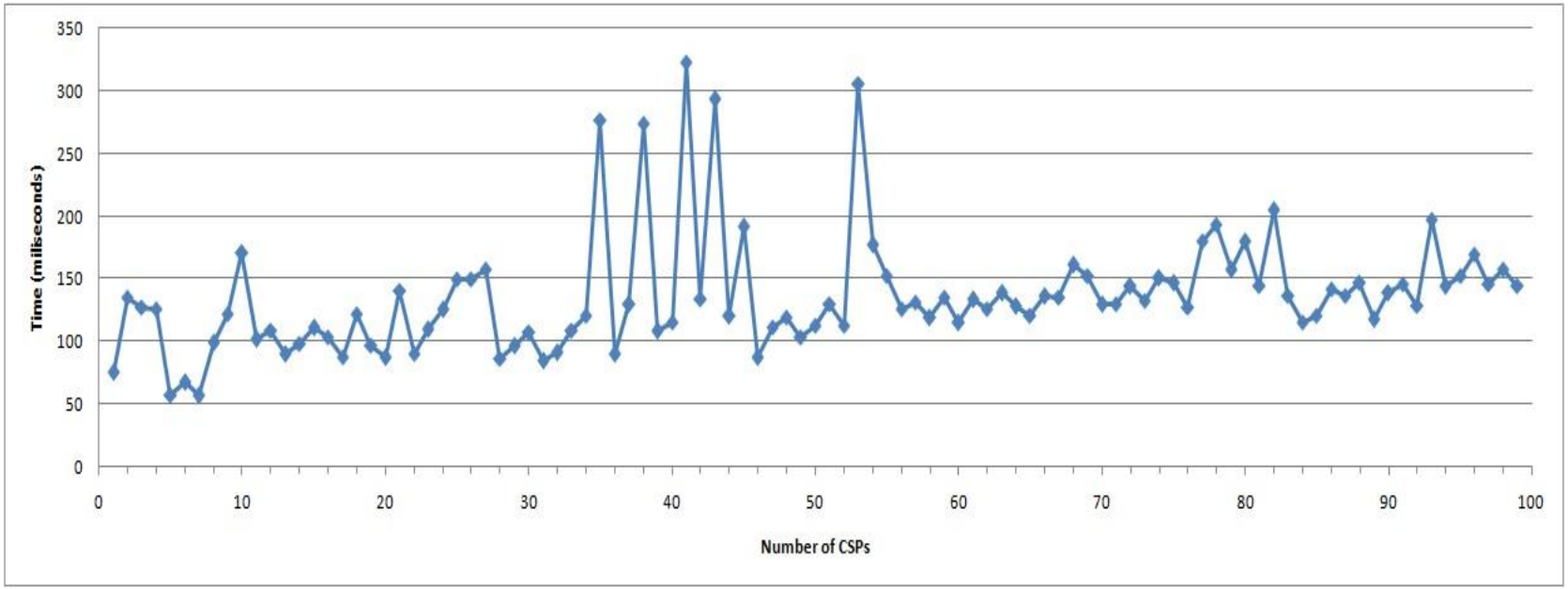
Reasoning & Conflict Analysis

- The Reasoning Process
  - Inference
  - Validation
  - Querying the ontology
- Policy Conflict
  - when two disjoint properties appear simultaneously
  - *unauthorizedSubject*

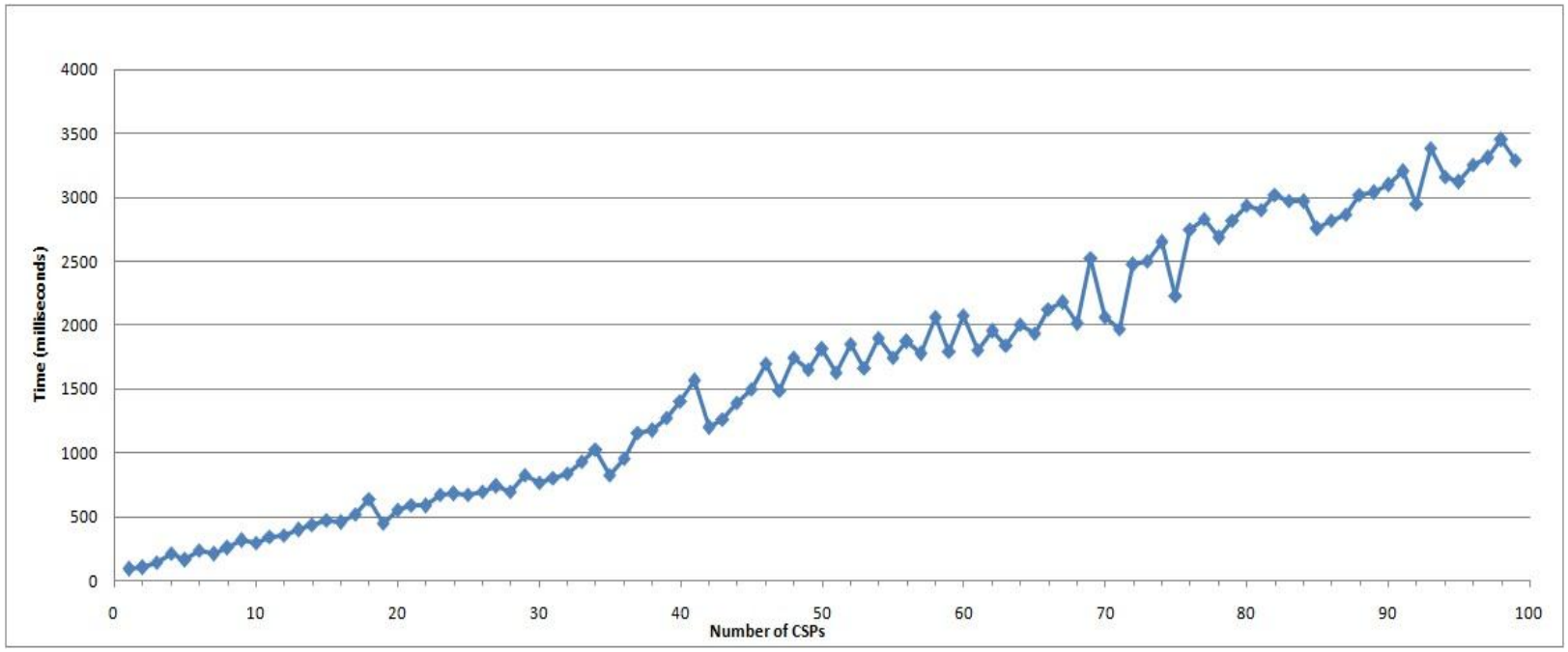
Implementation Architecture



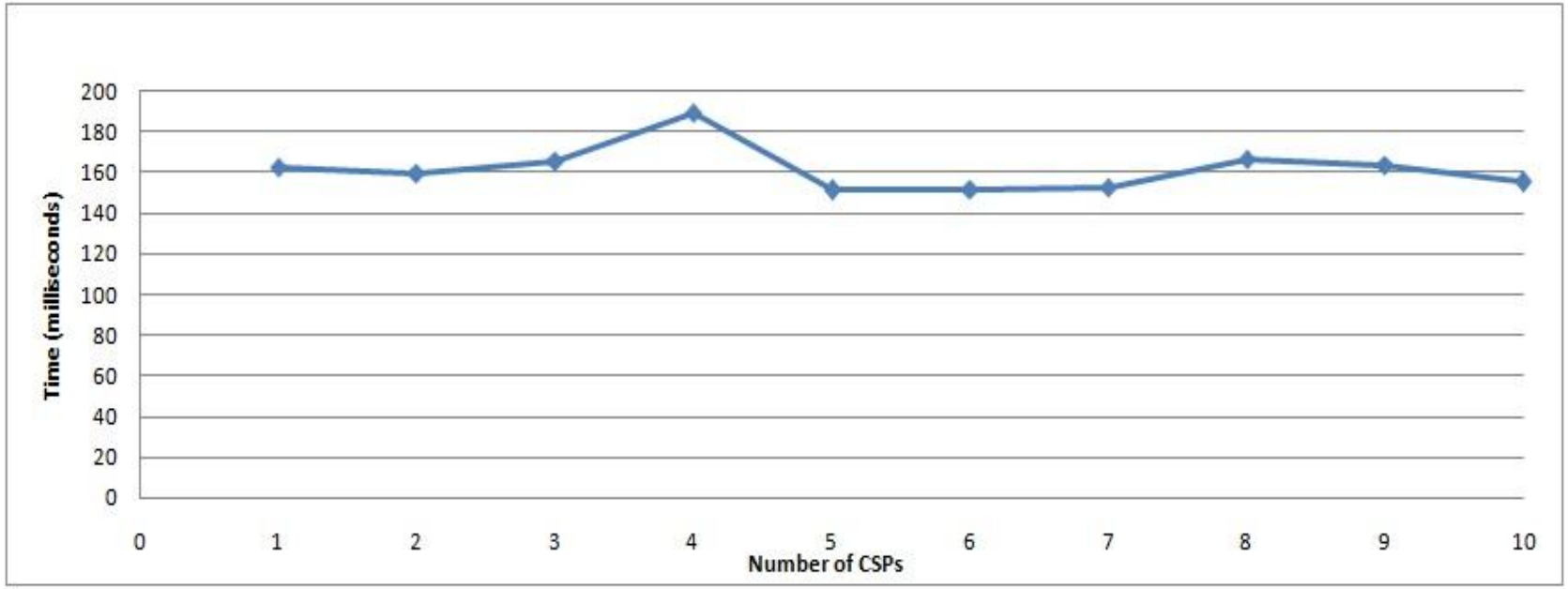
Performance evaluation



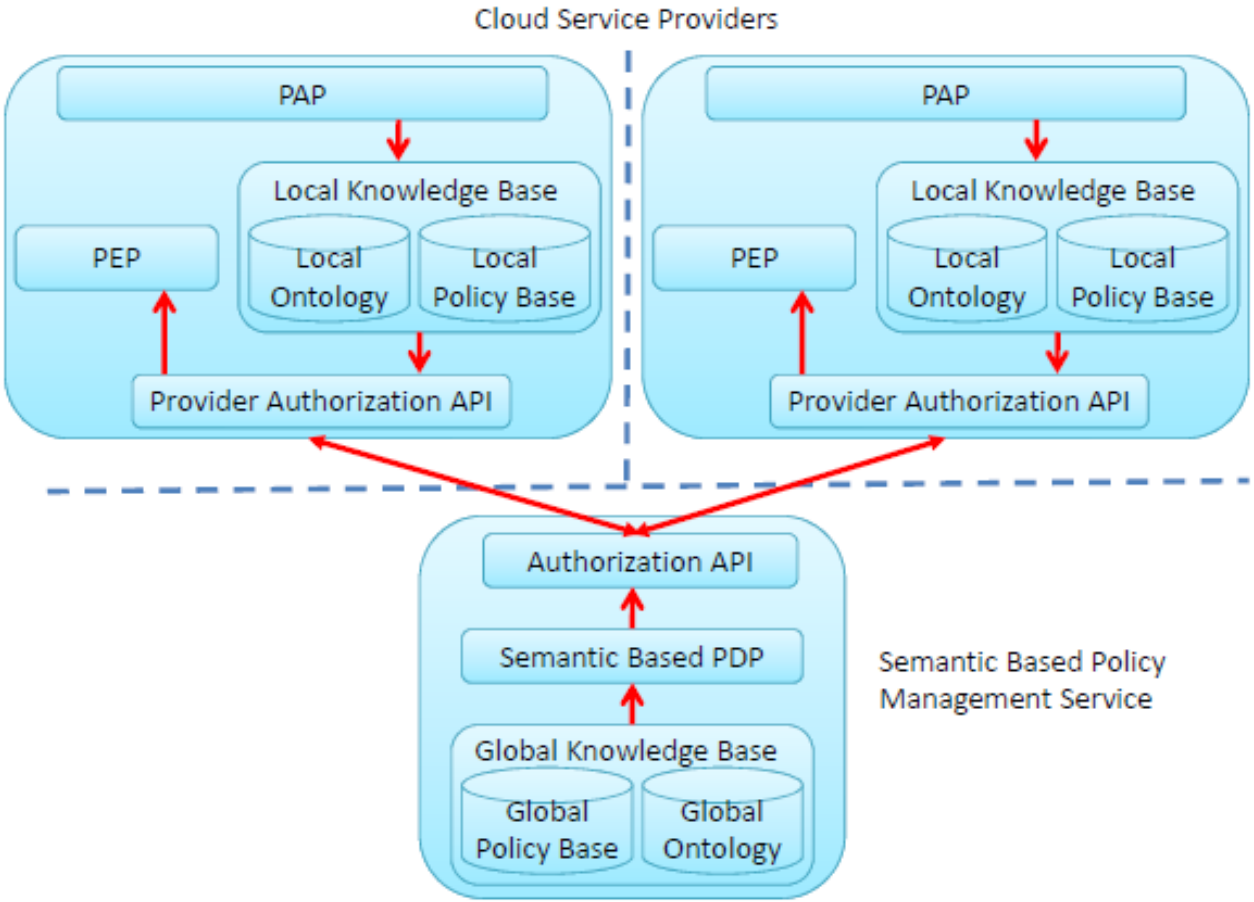
Performance evaluation



Performance evaluation



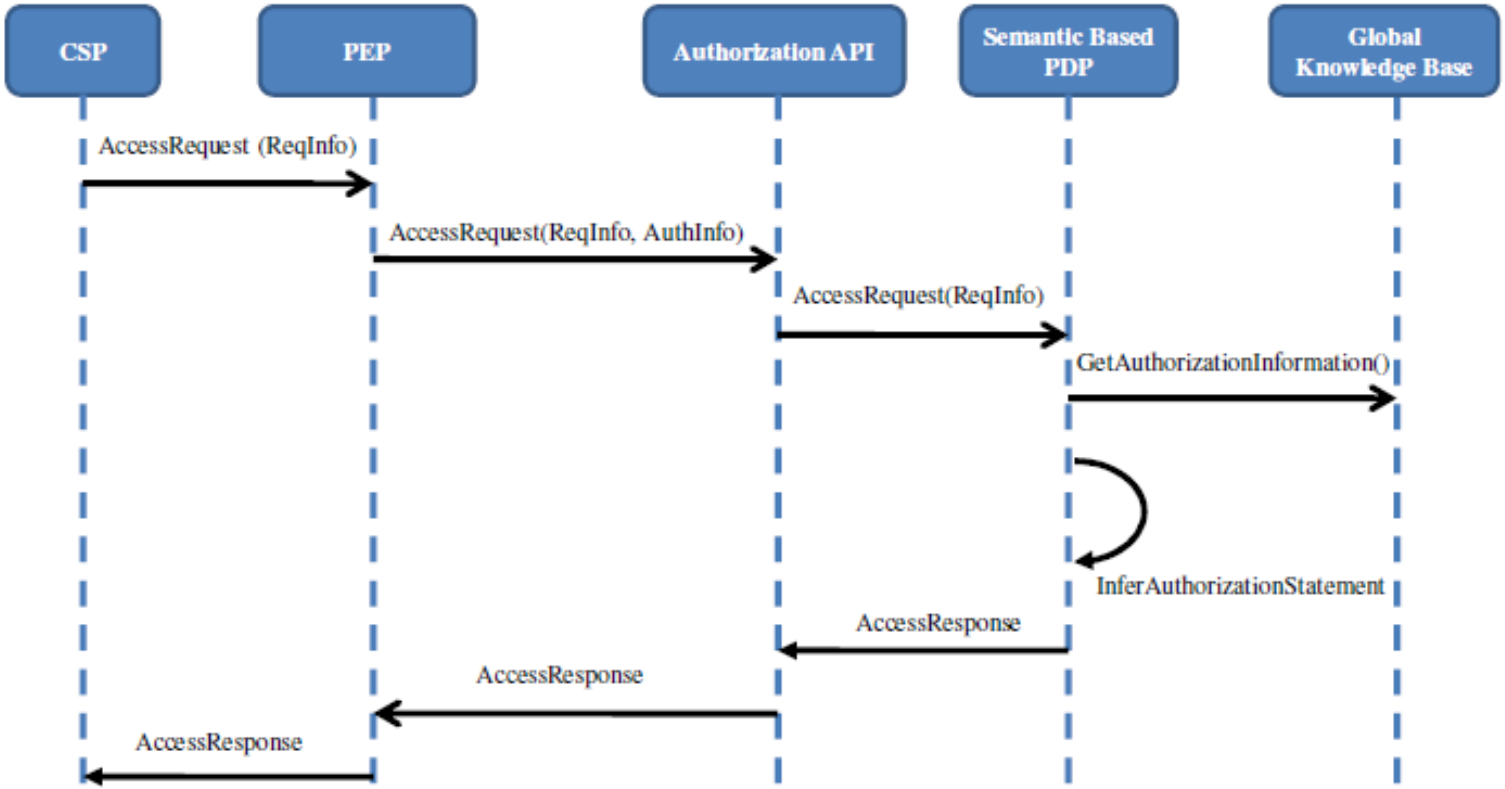
Cloud Interoperation



The Architecture

- cloud service provider
  - PAP
  - PEP
- semantic based policy management service
  - semantic based PDP

Access Request Processing



Conclusion and Future Work

- The access control issues particularly heterogeneity and interoperation
- proposed a semantic based policy management framework
- introduced semantic based policy specification language
- Privacy Preservation

Questions?