Inter-cloud Introduction

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Agenda

- Introduction
- Summer Updates
- Future Work

Introduction

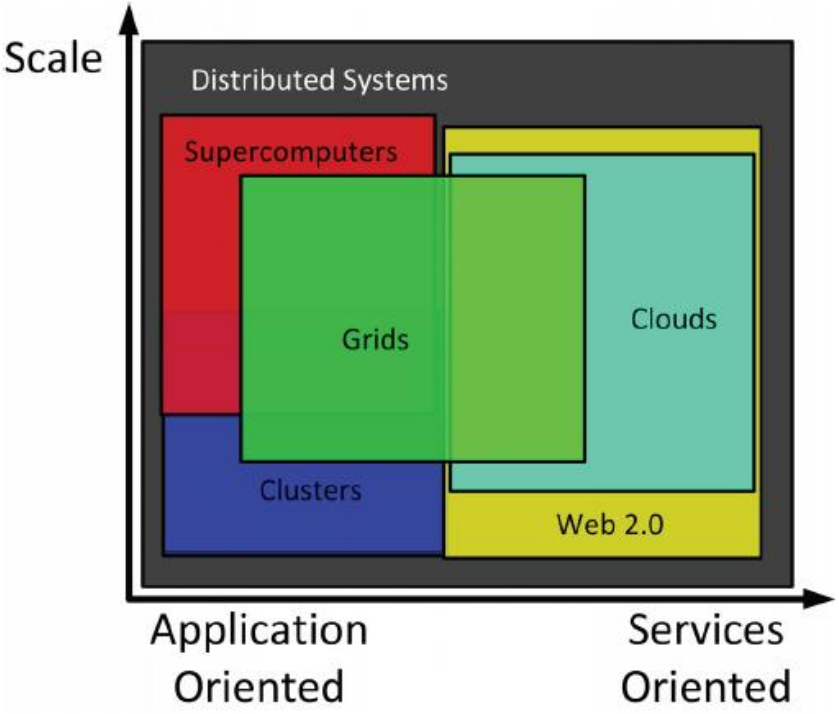
- Cloud Introduction
- Cloud Federation
- Researches on Cloud Federation
- Conclusion

Cloud Introduction

- Definition
  - A large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet.
    - In “Cloud Computing and Grid Computing 360-Degree Compared”

Cloud Introduction

- Comparisons & Service Mode



SaaS	Software-as-a-Service	Google Apps, Microsoft "Software+Services"
PaaS	Platform-as-a-Service	IBM IT Factory, Google AppEngine, Force.com
IaaS	Infrastructure-as-a-Service	Amazon EC2, IBM Blue Cloud, Sun Grid
dSaaS	data-Storage-as-a-Service	Nirvanix SDN, Amazon S3, Cleversafe dsNet

amazon web services

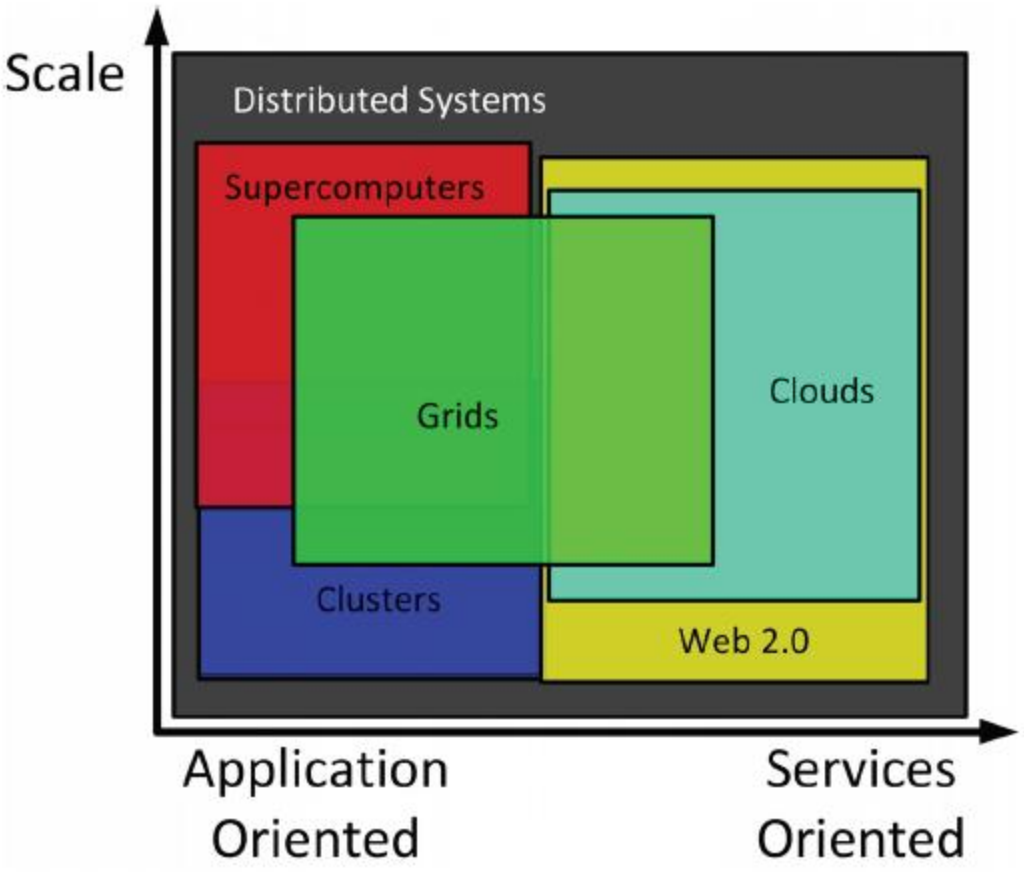
Windows Azure
Microsoft's Cloud Services Platform

salesforce

Google app engine

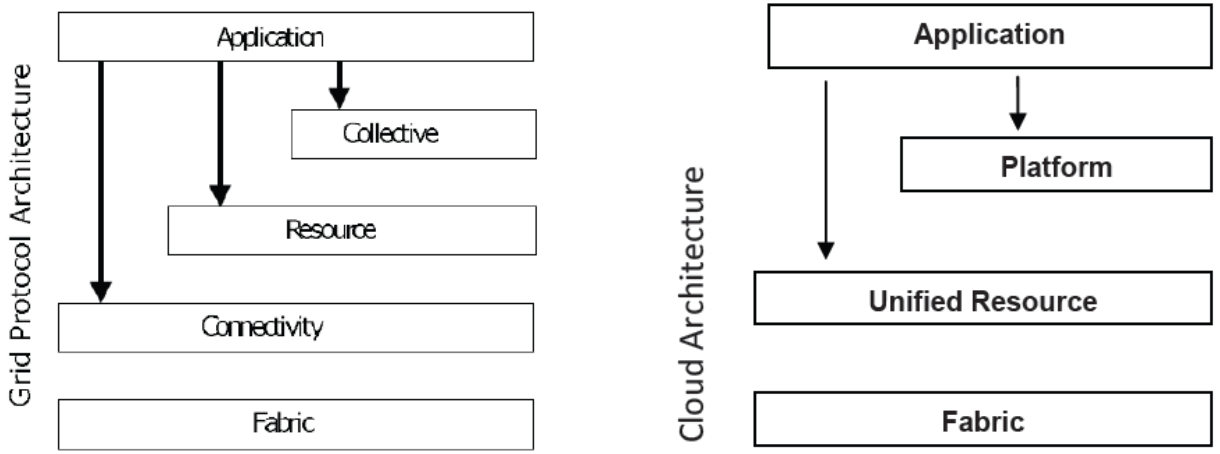
Cloud Introduction

- Cloud definition
  - Massively scalable
  - Can be encapsulated at different levels
  - Driven by economies of scale
  - Configurable
- Grid
  - Enable resource sharing and coordinated problem solving in dynamic, multi-institutional virtual organizations



Cloud Introduction

- Difference
  - Business Model (consumption basis / project-oriented)
  - Motivation (address internet-scale computing problem / integration)
  - Architecture



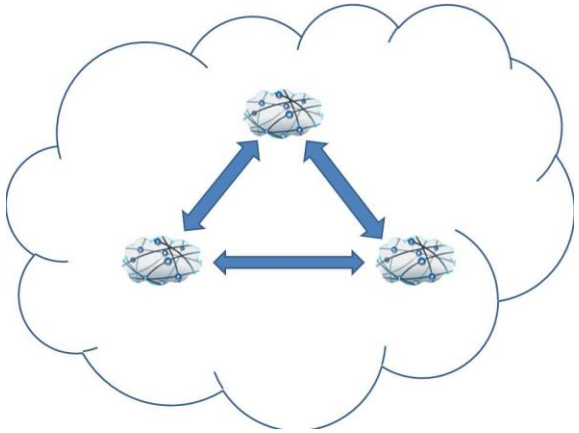
  - Resource Management (shared by all users at the same time / Queuing system)

Cloud Introduction

- Difference
  - Virtualization (abstract & encapsulate / doesn't rely on so much)
  - Programming Model (WS APIs / MPI / Mash-up & scripting)
  - Application Model (HPC & HTC)
  - Security Model (simple / mature)
- Challenge of Cloud
  - Provenance (reproducibility of science results)
  - Privileged user access
  - Regulatory compliance
  - Data location
  - Data segregation
  - Recovery
  - Investigative support
  - Long-term viability

Cloud Federation

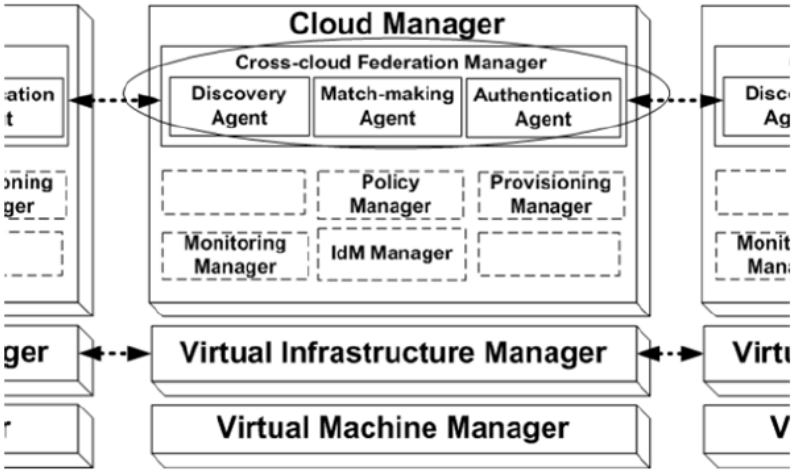
- Message transmission & collaboration among Clouds



- An ideal solution to
  - tasks overload for a single Cloud
  - user’s need to transplant their Cloud-apps
  - a new business model for Cloud providers

Researches on Cloud Federation

- Add an additional communication layer on the top of the existing architecture
  - Antonio Celesti
  - RESERVIOR model by IBM



- Contribution
  - Few changes are involved
  - Discovery -> Match-making -> Authentication

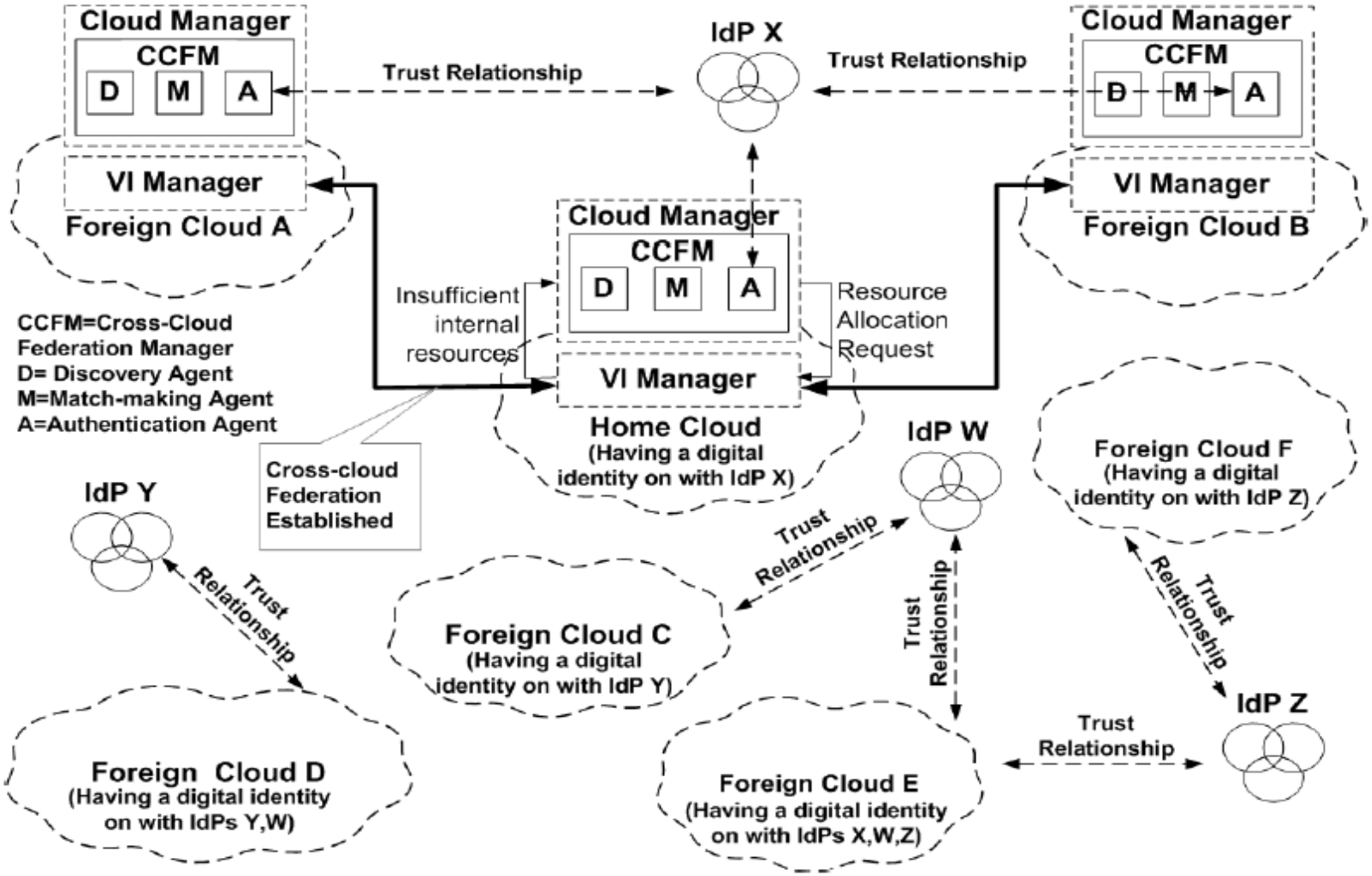
Celesti's Model

- How to Enhance Cloud Architectures to Enable Cross-Federation
  - Cloud Computing (CLOUD), 2010 IEEE 3rd International Conference on Digital Object Identifier
  - Monolithic -> Vertical Supply Chain -> Horizontal Federation
  - Discovery -> Match-making -> Authentication

Celesti's Model

- Discovery Agent
  - Publish-and subscribe software pattern
  - Act as a presence daemon to distribute info
- Match-making Agent
  - Find the best fit foreign cloud to build federation
- Authentication Agent
  - Create a security context between home and foreign cloud (cooperating with third-party trusted entities)
  - Identity Provider / Service Provider (log-in once)

Celesti's Model



Celesti's Model

- Implementation
  - Discovery - XMPP (Extensible Messaging and Presence Protocol)
    - Getting others' info through IM through a special XML tag <iq></iq>
  - Match-making – XACML
    - Analyzing unquantifiable and quantifiable info belonging to a certain range
    - Using matrix to list all quantifiable parameter and choose one with the smallest 'distance'.
  - Authentication – SAML (Security Assertion Markup Language)

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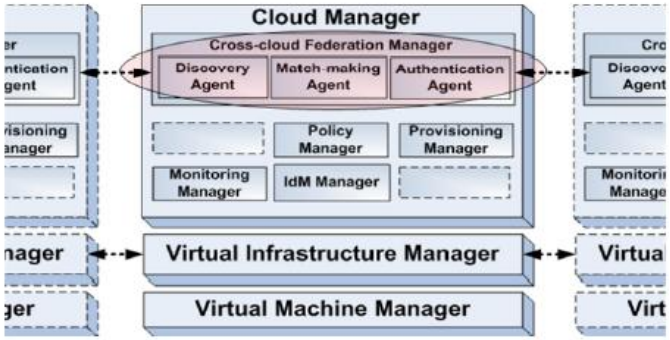
Celesti's Model

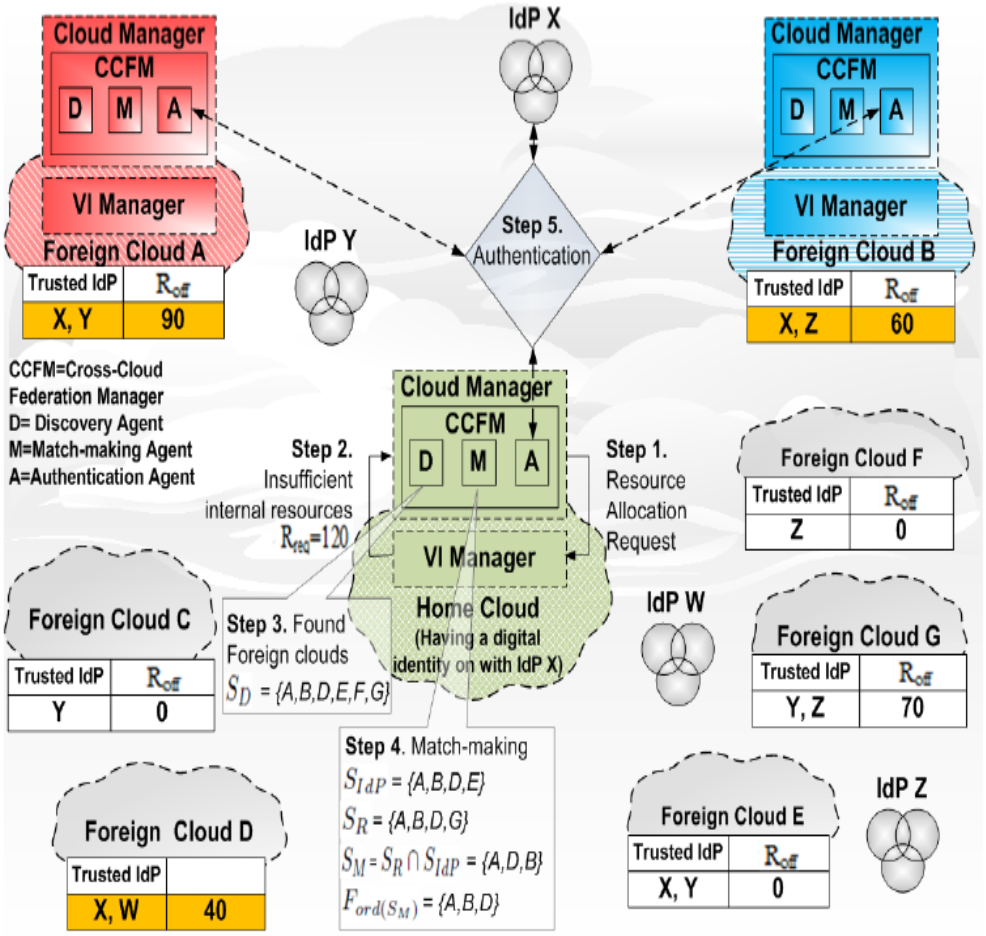
- Three-Phase Cross-Cloud Federation Model: The Cloud SSO Authentication
  - 2010 Second International Conference on Advances in Future Internet
  - Three-phase
    - Discovery, match-making, authentication
  - Authentication
    - Based on IdP/SP model along with SAML technology
    - Cloud Single-Sign On Authentication

Celesti's Model

- Architecture



- Example
  - Resource request
  - Lack of resource
  - Find foreign clouds
  - Match-making
  - Authentication

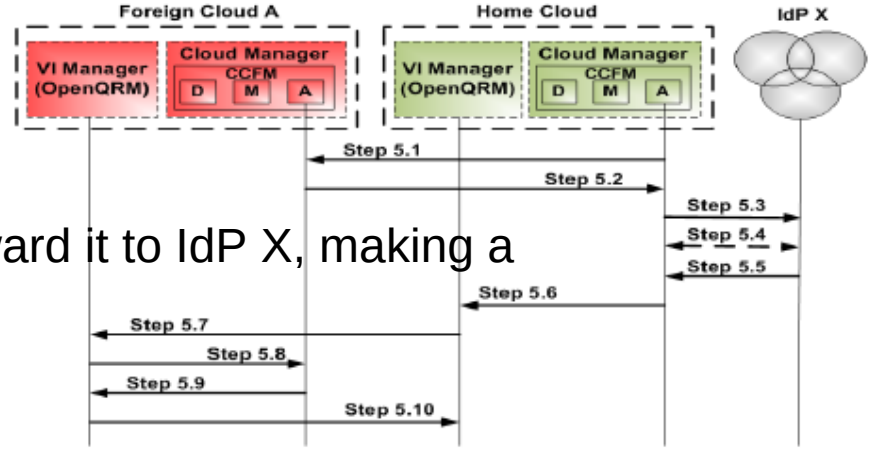


Celesti's Model

- Authentication phase
  - Single-Sign On is needed and no more authentication will be done with those clouds with same IdP
  - Through IdP, trust context can be built regardless of the internal security policies of Clouds
- SAML
  - Key concepts
    - Assertion, Binding, Protocol, Profile
  - CCAA-SSO
    - A customized developed SAML profile
    - An **assertion** including an authentication statement, a request-response **protocol**, and a SAML SOAP **Binding**

Celesti's Model

- Details in Step 5
  - Request for a set of virtual resources
  - Response an authentication query
  - Unpack authentication request and forward it to IdP X, making a SSO request
  - Authenticate home Cloud
  - Response to authentication request
  - Unpack authentication request and forward it to VI Manager
  - Send authentication assertion
  - Forward to Authentication Agent
  - Ask to allocate resources
  - Establish a secure communication channel



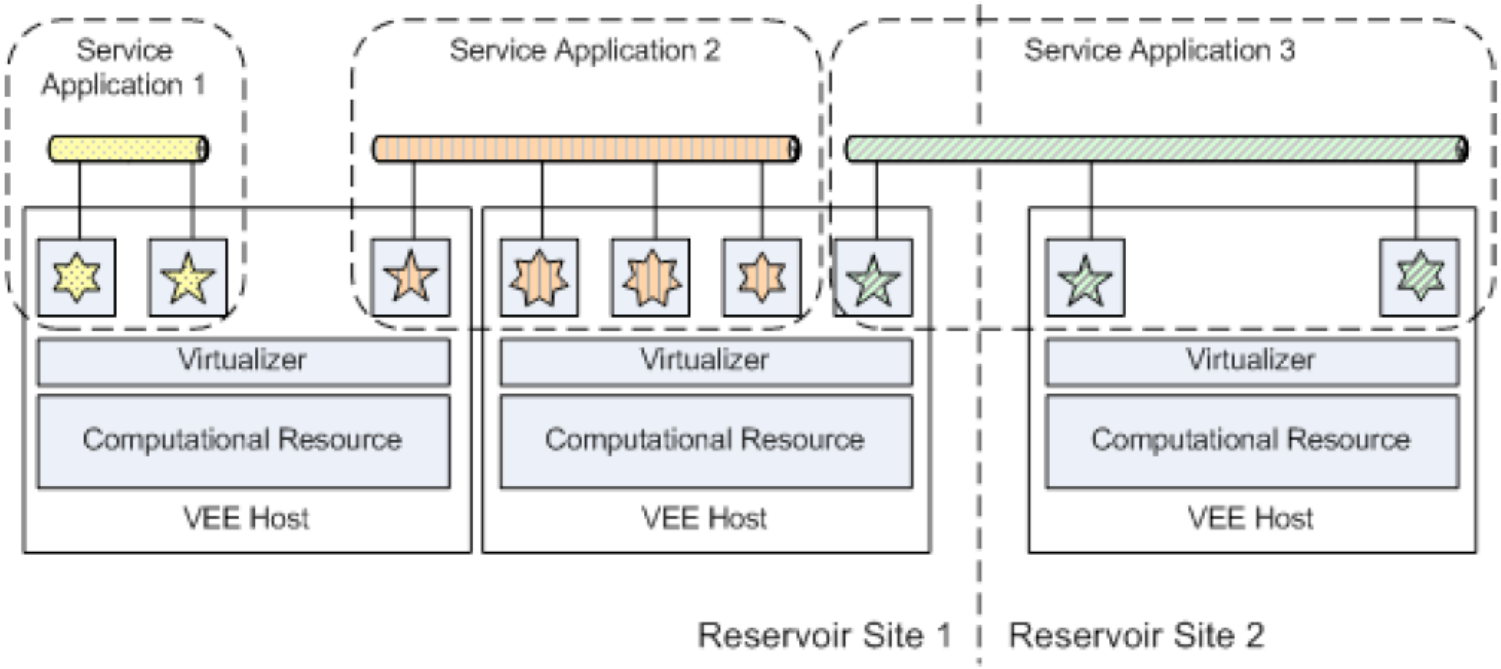
RESERVOIR Model

- The RESERVOIR Model and Architecture for Open Federated Cloud Computing
  - IBM Journal of Research & Development
  - Motivation

    Facilitate an online economy across clouds considering on-demand, costs, and QoS
  - Current Problem
    - Limited scalability of single-provider clouds
    - Current cloud are not designed to support BSM (Business Service Management)

RESERVOIR Model

- The RESERVOIR Model
  - Service provider (business logic)
  - Infrastructure provider (computational resources)
  - VEE (virtual execution environment)



RESERVOIR Model

- Service Mode
  - Explicit (fixed size, pay as you go)
  - Implicit (minimize over-provisioning)
- Service manifest
  - Formally defines the contract and SLA between service provider and infrastructure provider
    - size for explicit mode
    - # of CPUs, memory, network bandwidth…
    - # of VEEs
    - …..
  - Extend OVF (Open Virtual Format)

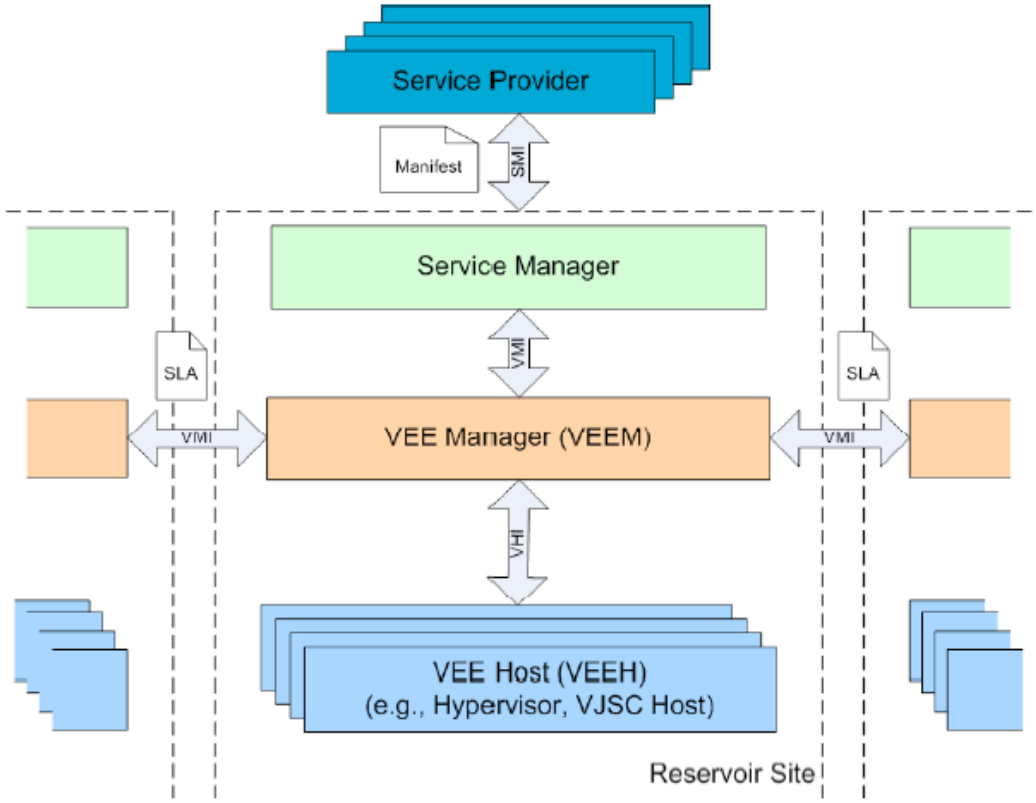
RESERVOIR Model

- Architecture

accounting
& billing →

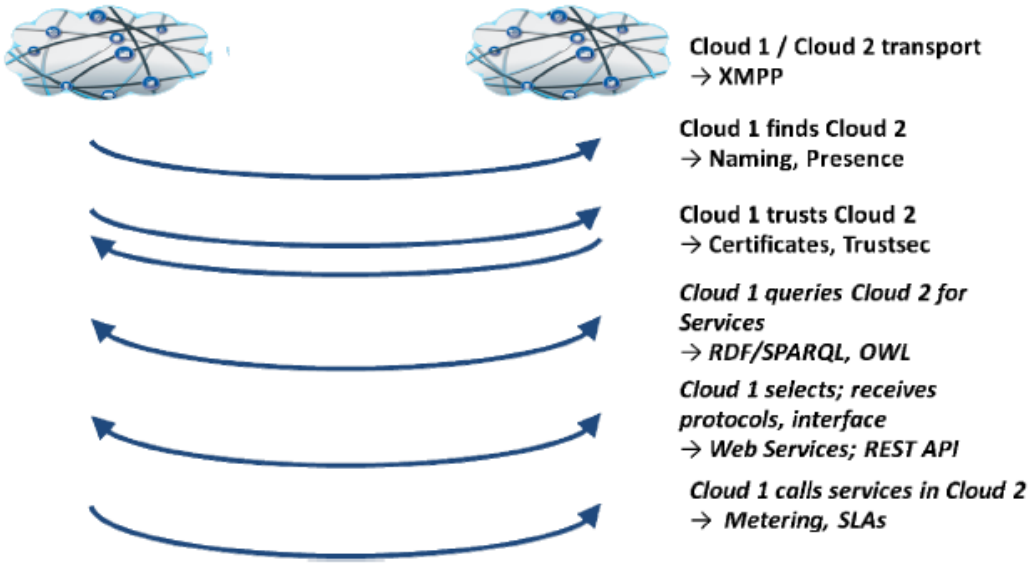
find optimized
VEE place →

create, migrate VEE,
allocate resources →



Researches on Cloud Federation

- Focus on underlying protocols among Clouds
  - David Bernstein
  - Erik Ludvigson



- Contribution
  - IP Addressing, Message Transmission, Ontology Match-making, Multicasting, Time Synchronization, Security
  - Prove the feasibility of Cloud Federation

Underlying Protocols

- Blueprint for the Intercloud – Protocols and Formats for Cloud Computing Interoperability
- Current Situation

  Codes run on one cloud and explicitly reference services on another cloud
- Inter-cloud Protocol
  - Find implicit ways to interoperate among clouds
  - Candidate base set of protocols and formats.

Underlying Protocols

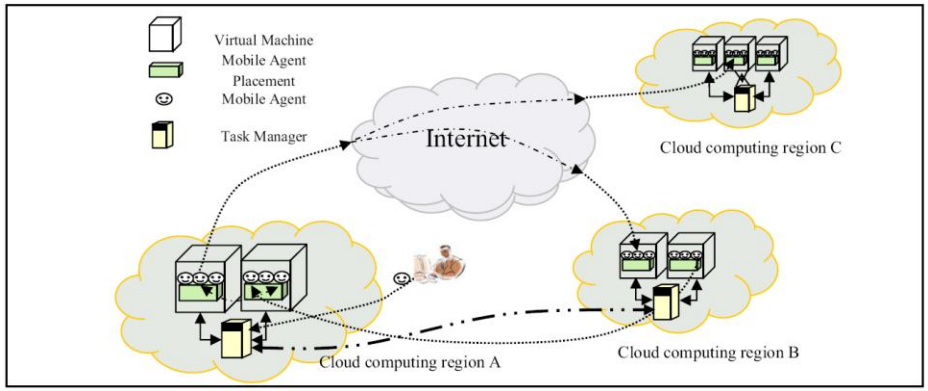
- VM Mobility and its limitation
  - Allow a running system to be moved from one VM to another VM.
  - Scope of applicability in network addressing – totally different network rather than only different subnet.
  - Target VM may not as fit as the original one.
- Storage Challenge
  - Storage failure and user's fault-dealing codes shouldn't be executed in inter-cloud environment.
- Addressing
  - Each VM has an IP address and each machine can has many VMs.
  - IPv4 and IPv6 are not interoperable. (LISP – Location Identity Separation Protocol)

Underlying Protocols

- Security
  - communicate over a non-secure network or supply trusted security certificates
  - IPA – Identity, Policy and Audit.
- Message protocol
  - XMPP (Extensible Messaging and Presence Protocol, same as last week)
- Virtual Machine (focus on image file info)
- Multicast
- Time Synchronization

Researches on Cloud Federation

- Others
  - MABOCCF (Zhang)
    - Based on mobile phone
    - “passive” federation (-)



  - Cloud & Grid (Casola)
    - Vertical combination
    - Performance (-)

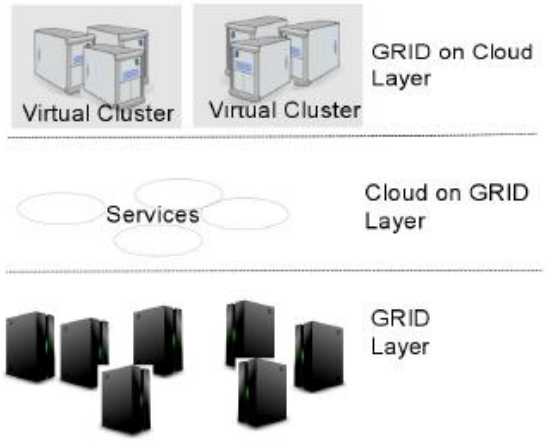


Figure 1. The *gridcloud* layers

Summer Updates

- InterCloud (by CLOUD)
- InterCloud (by GICTF)
- InterCloud Identity Management (by Celesti)
- Accounting & Billing in InterCloud (using RESERVOIR)

InterCloud (by CLOUD)

- InterCloud: Utility-Oriented Federation of Cloud Computing Environments for Scaling of Application Services
  - Proceedings of the 10th International Conference on Algorithms and Architectures for Parallel Processing, LNCS, Springer, Germany, 2010.
  - Motivation
    - Dynamically coordinating load distribution among different Cloud-based data centers. (**Location -> QoS**)
    - Load coordination must happen automatically, and distribution of services must **change in response to changes** in the load.

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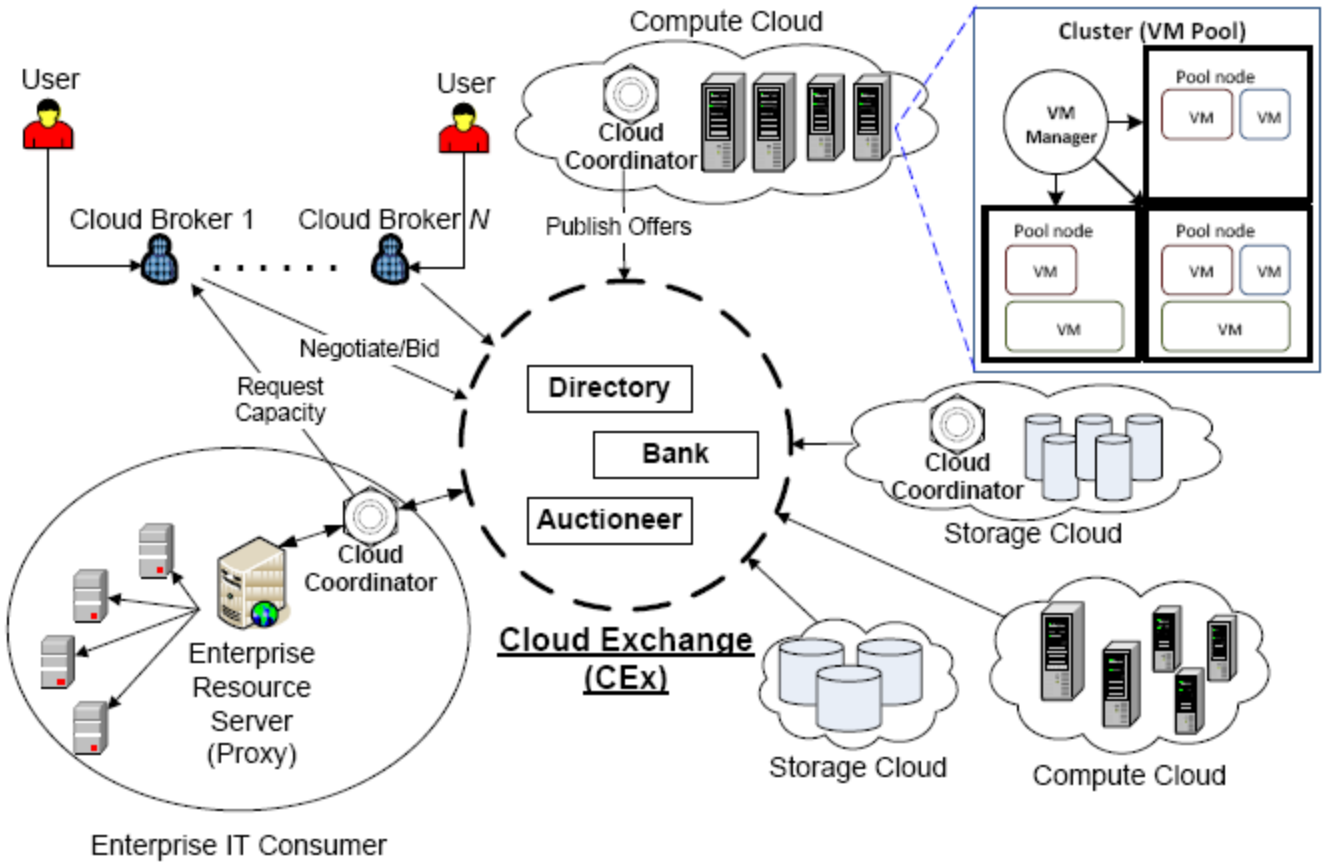
InterCloud (by CLOUD)

- Definition & Goal
  - Facilitates **just-in-time, opportunistic and scalable** provisioning of application services, **consistently** achieving QoS targets under variable workload, resources and network conditions.
  - Create a computing environment that supports **dynamic expansion or contraction of capabilities** for handling sudden variations in service demands.
- Intercloud Usage
  - It's impossible for a single Cloud Provider to put his data centers at all locations around the world, so he needs to construct Federated Cloud to meet **QoS needs for all users**.

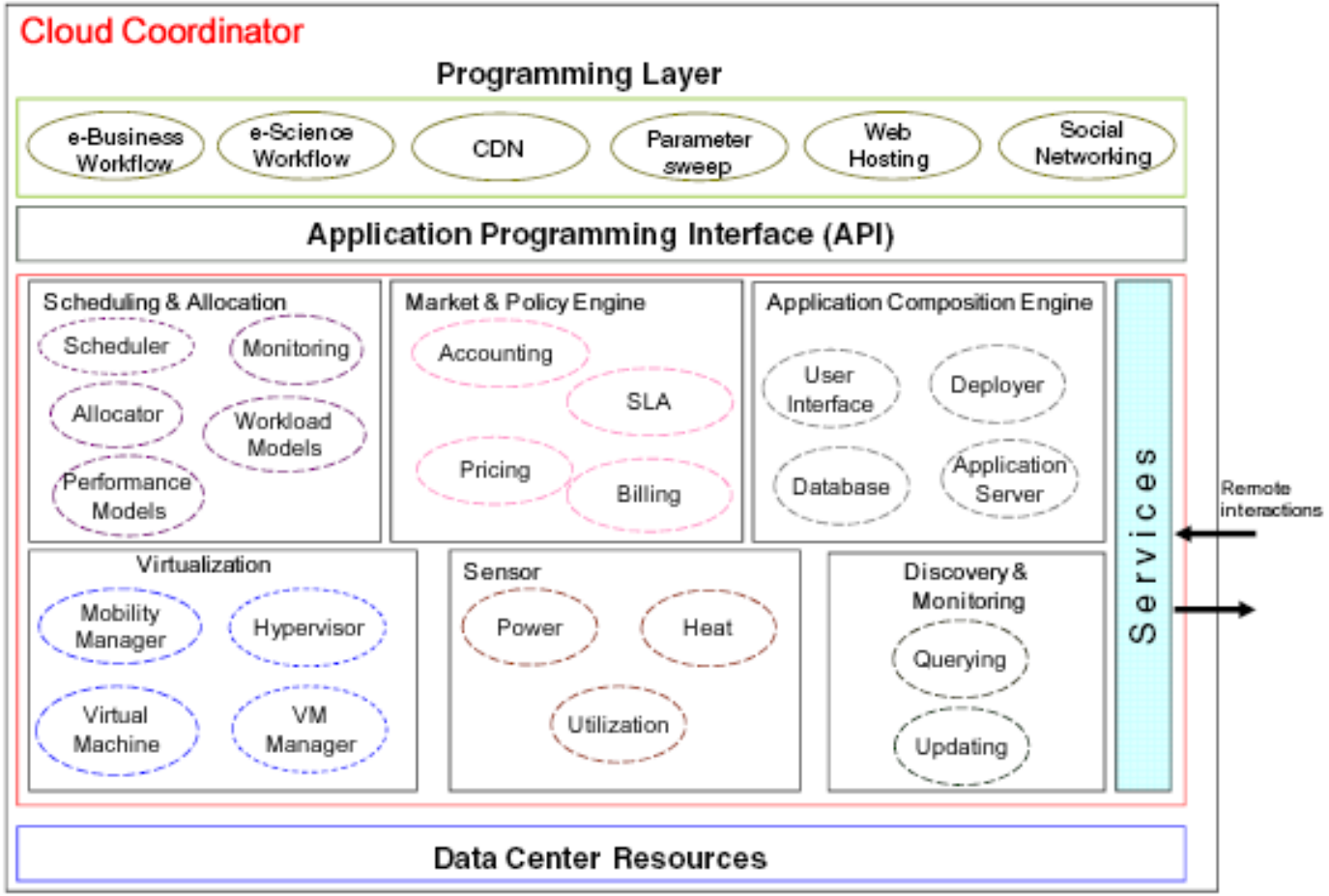
InterCloud (by CLOUD)

- High level architecture



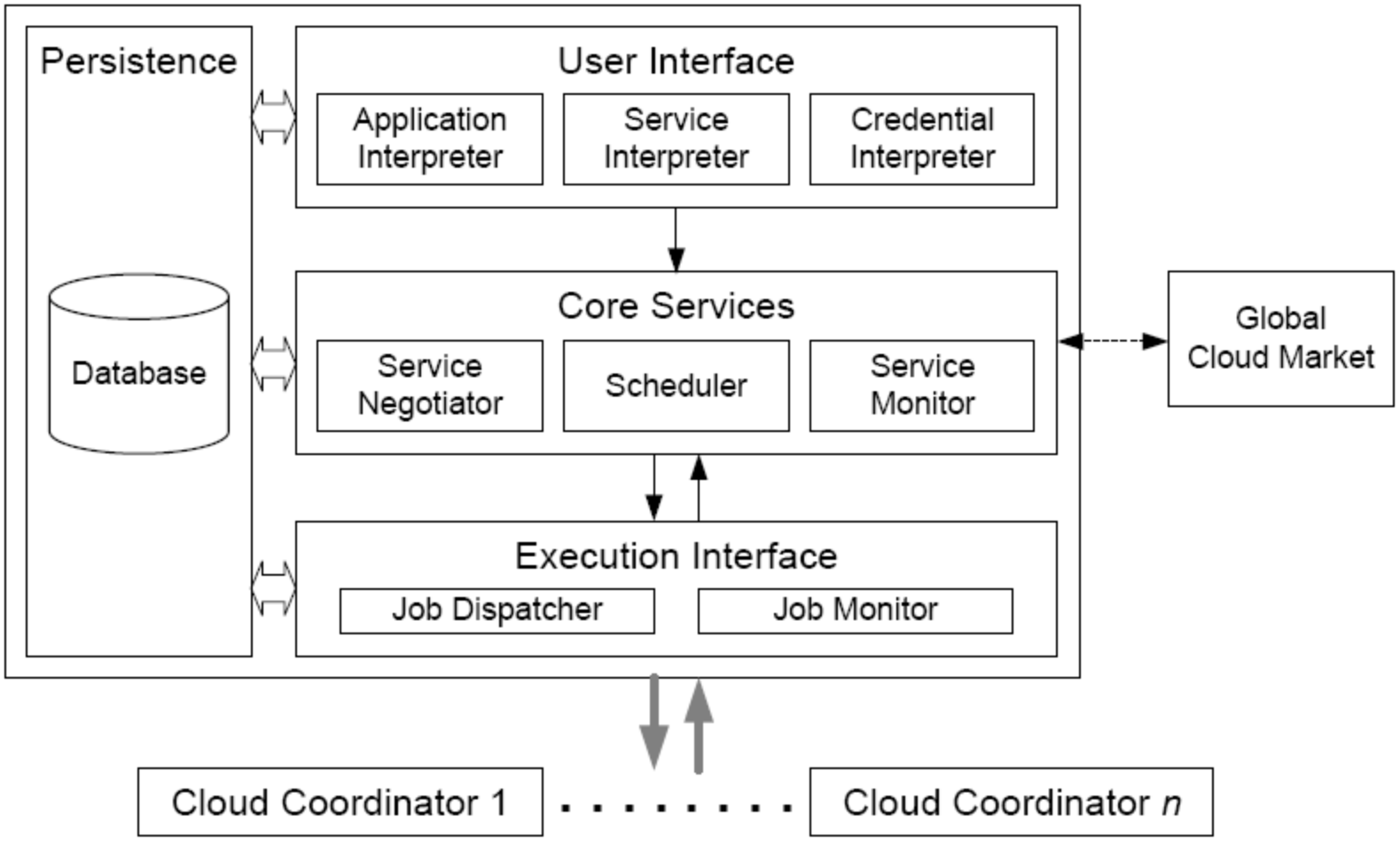
InterCloud (by CLOUD)

- Cloud Coordinator



InterCloud (by CLOUD)

- Cloud Broker

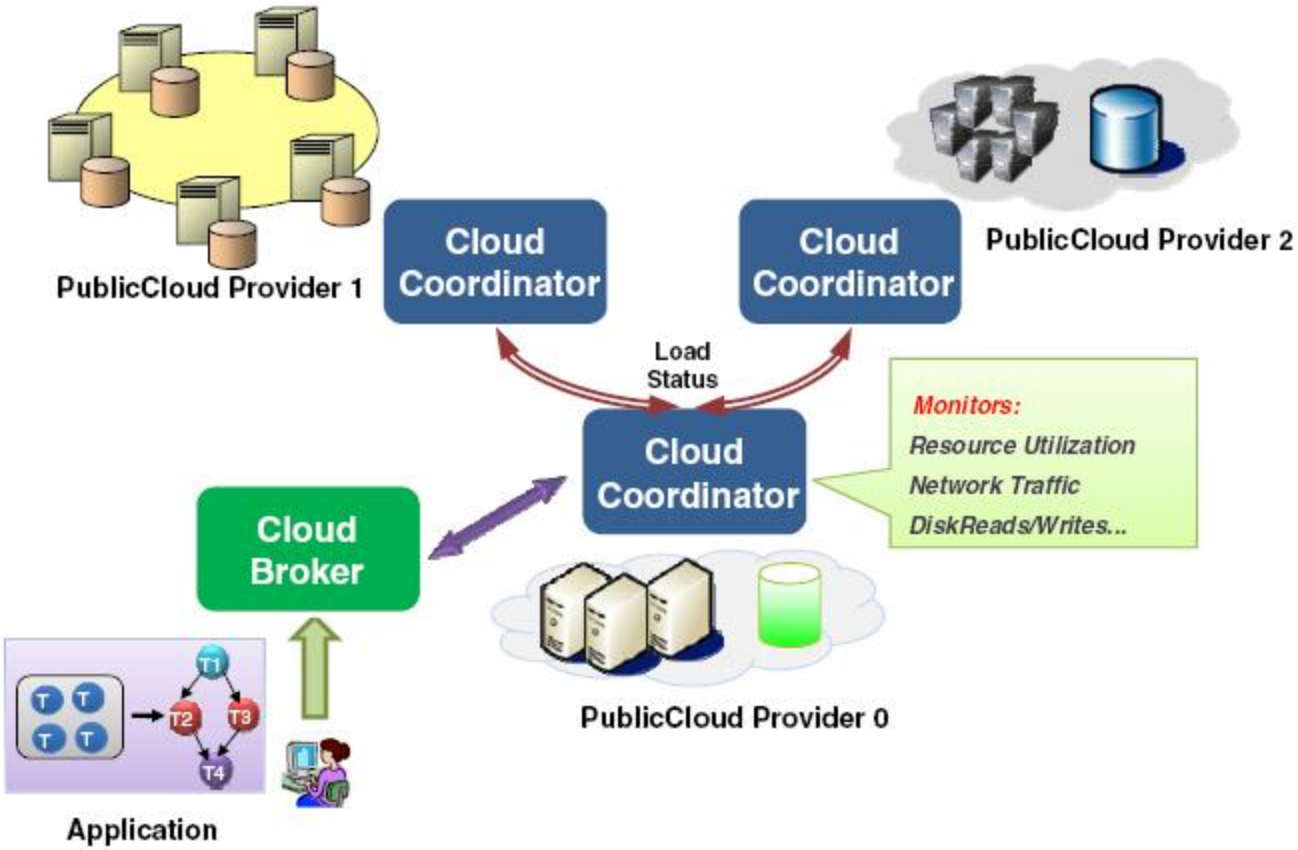


InterCloud (by CLOUD)

- Cloud Exchange
  - Act as an **information registry** that stores the Cloud's **current usage costs and demand patterns**
- Directory
  - Store available SLA levels and prices for query.
- Auctioneer
  - Periodically clear bids and asks received from global CEx participants
- Bank
  - Online payment management

InterCloud (by CLOUD)

- Performance experiment environment



InterCloud (by CLOUD)

- Financial experiment

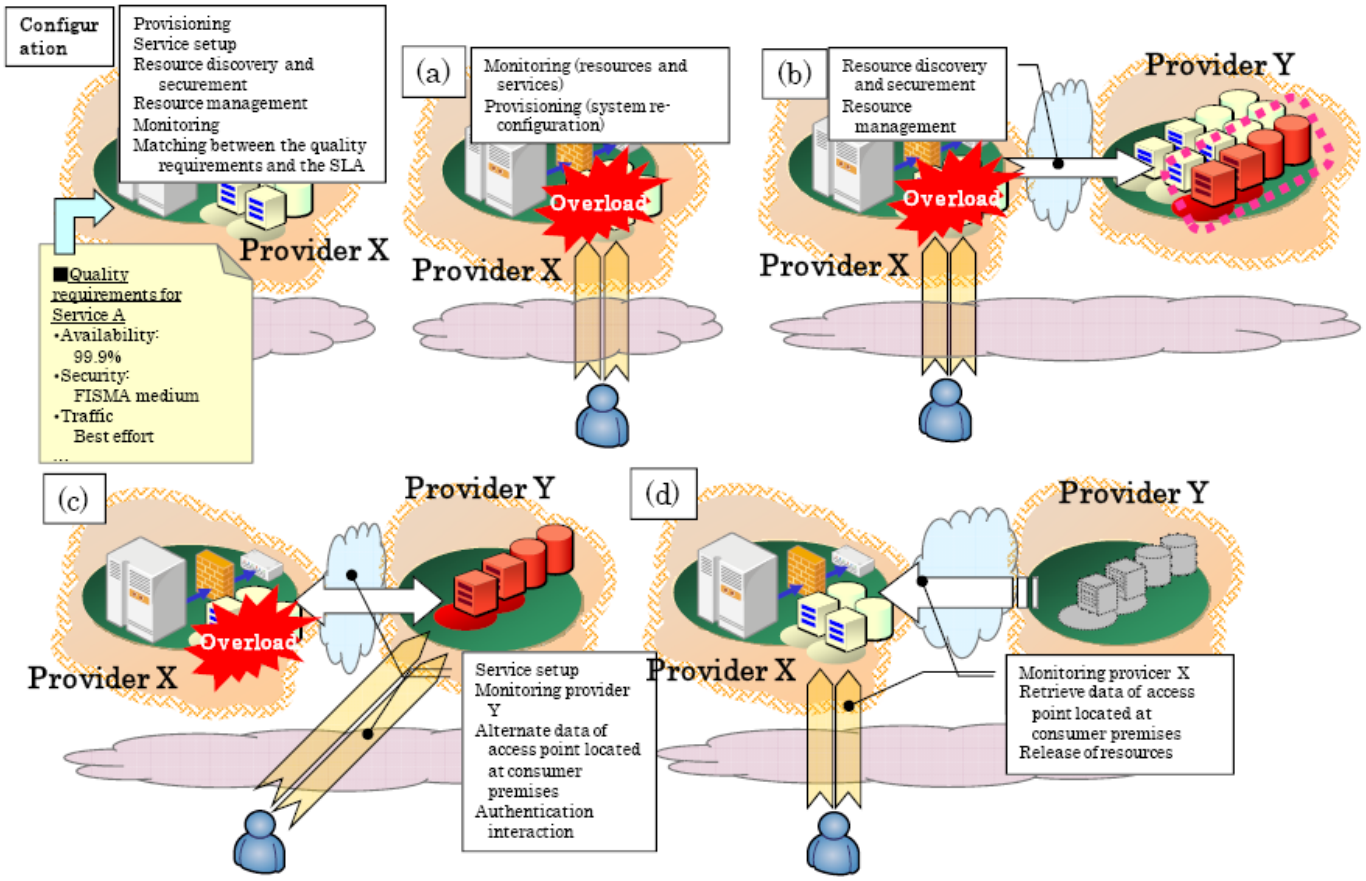
	Makespan (s)	Cloud Cost (U$)
Private only	127155.77	0.00
Public 10%	115902.34	32.60
Public 20%	106222.71	60.00
Public 30%	98195.57	83.30
Public 40%	91088.37	103.30
Public 50%	85136.78	120.00
Public 60%	79776.93	134.60
Public 70%	75195.84	147.00
Public 80%	70967.24	160.00
Public 90%	67238.07	171.00
Public 100%	64192.89	180.00

InterCloud (by GICTF)

- Use Cases and Functional Requirements for Inter-Cloud Computing
  - Global Inter-Cloud Technology Forum
  - Needs of inter-cloud
    - Unlimited resource extension
    - Cope with abrupt load fluctuation
    - Meet guaranteed qualities
    - High performance regardless of service node or physical location
    - Convenience by service cooperation

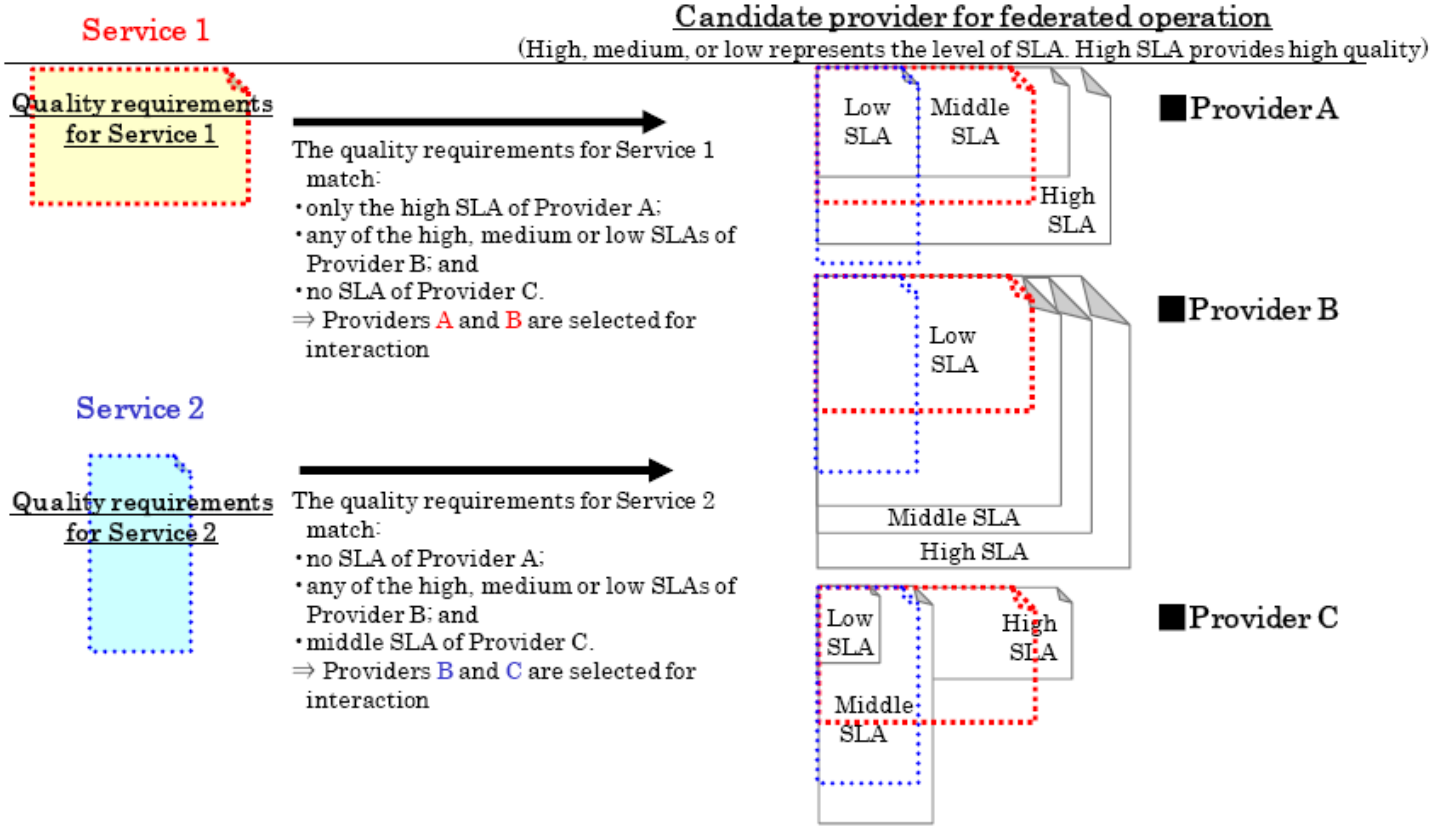
InterCloud (by GICTF)

- Procedures



InterCloud (by GICTF)

- Candidate provider selection



InterCloud (by GICTF)

- Functional requirements
  - Matching between service consumer's quality requirements and SLA
  - Monitoring
  - Provisioning
  - Resource discovery and securement
  - Resource management
  - Service setup
  - Authentication interworking
  - Network interworking
  - Alternation and Retrieval of data for access route from consumer
  - Releasing resource

InterCloud Identity Management

- Security and Cloud Computing: InterCloud Identity Management Infrastructure
  - Proceedings of The 19th IEEE International Workshops on Enabling Technologies: Infrastructures for Collaborative Enterprises (WETICE 2010) - ETNGRID, Tei of Larissa, Greece June 2010

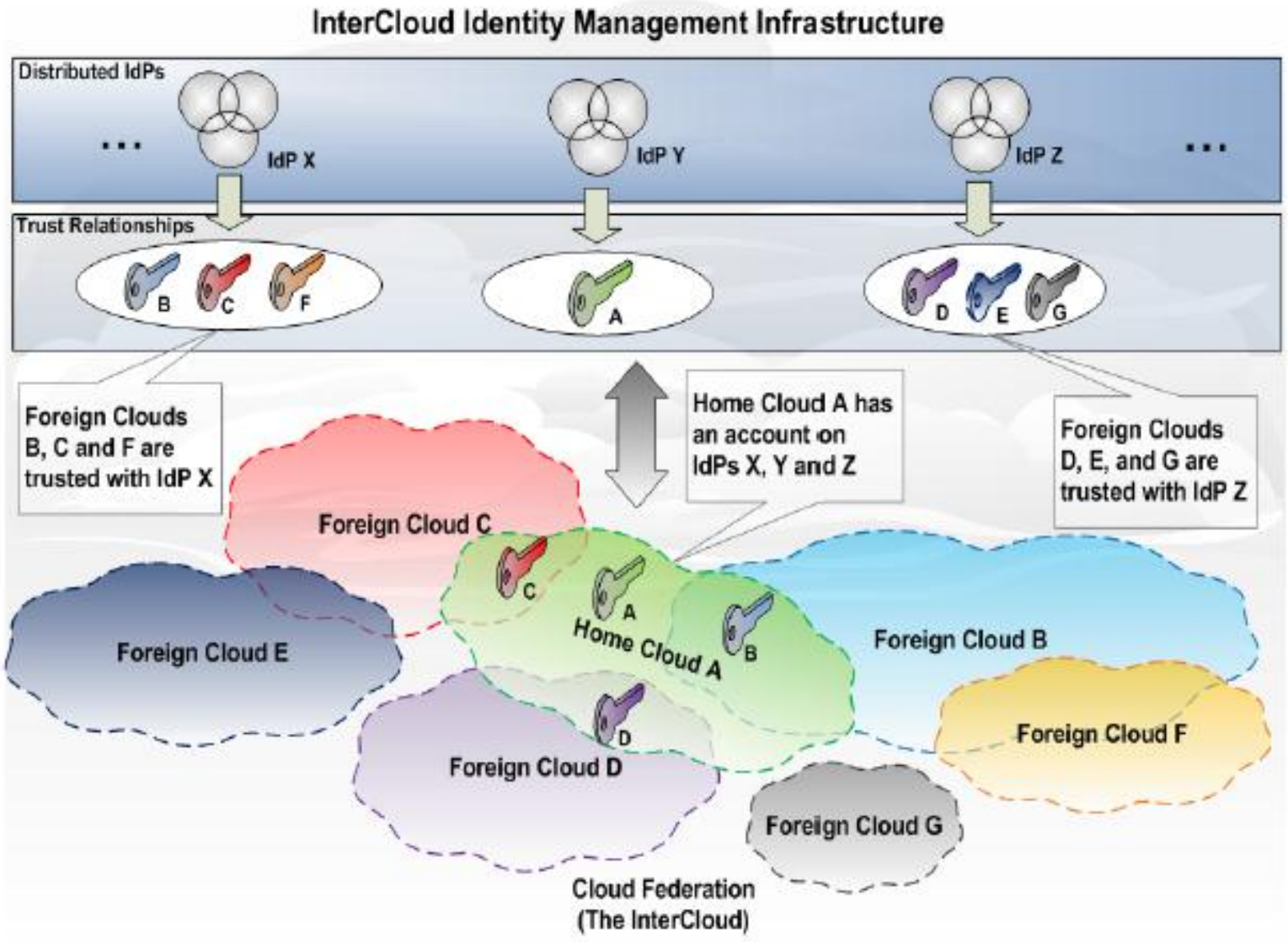
InterCloud Identity Management

- Cloud challenges
  - Privacy
  - Security
  - Federation
- Solution
  - Identity Management (IdM)
  - Set up a trusted third party responsible both for storing the access credentials and securing them
- Definition
  - Home Cloud
  - Foreign Cloud

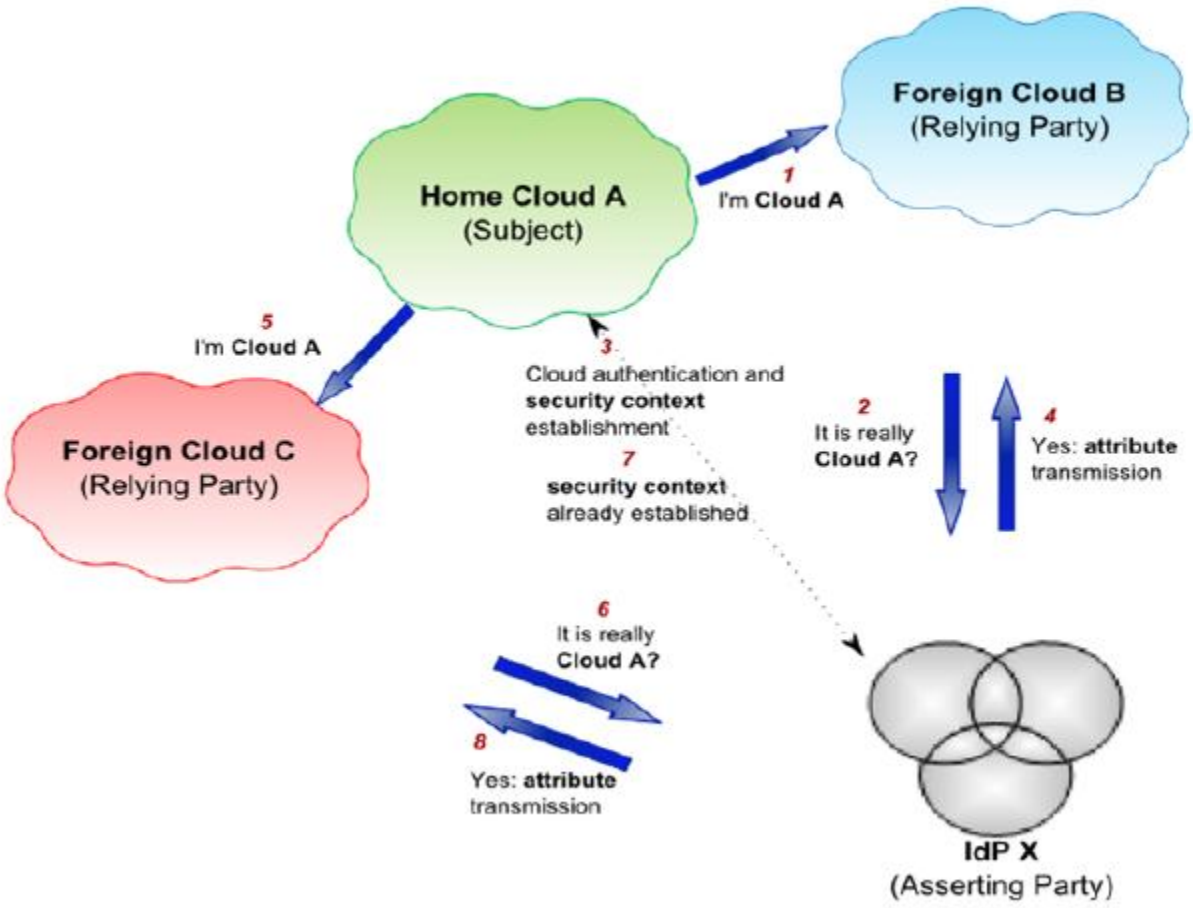
InterCloud Identity Management

- IdM/SP model
  - End-user
  - User agent
  - Service Provider (SP)
  - Identity Provider (IdP)
- SAML
  - It can establish trust relationship between entities with different security mechanisms
- ICIMI
  - InterCloud IdM Infrasture

InterCloud Identity Management



InterCloud Identity Management



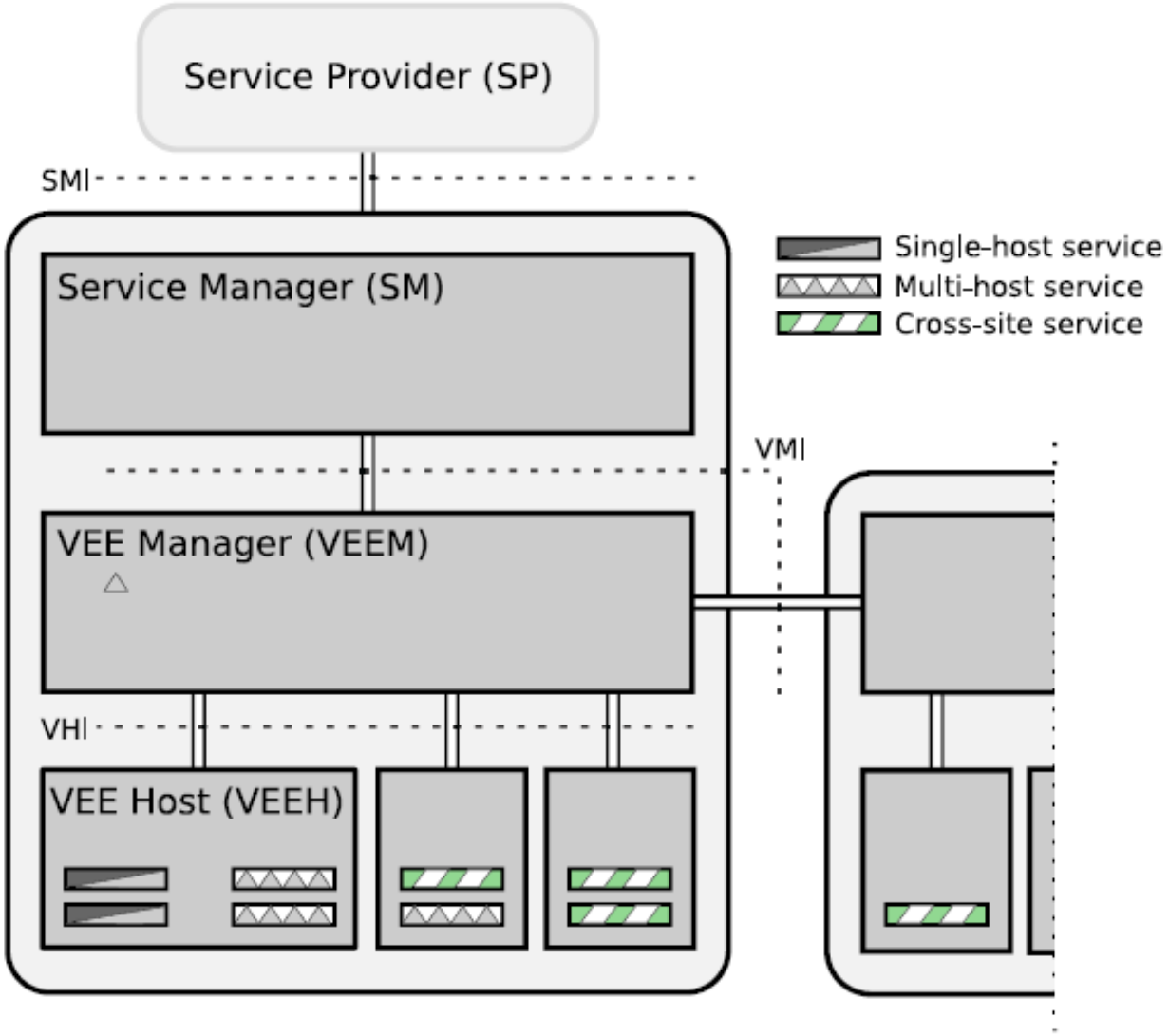
Accounting & Billing in IC

- Accounting and Billing for Federated Cloud Infrastructures
  - Grid and Cooperative Computing, 2009. GCC '09. Eighth International Conference
  - Contribution
    - Propose an accounting and billing architecture to be used within RESERVIOR
  - Main Challenge —— Carry out a fair and standardized way both
    - Between end-user and infrastructure owner. (*)
    - Between sites making up the federation.

Accounting & Billing in IC

- RESERVIOR
  - VEE
    - Virtual Execution Environment
    - The isolated environment where customer's apps are executed and maintained.
    - Includes VMs and VJSC. (stands for Virtual Java Service Containers)
  - IP
    - Infrastructure Provider, an organization operating one or more sites.
  - Three layers
    - Service Manager
    - VEE Manager
    - VEE Host

Accounting & Billing in IC



Accounting & Billing in IC

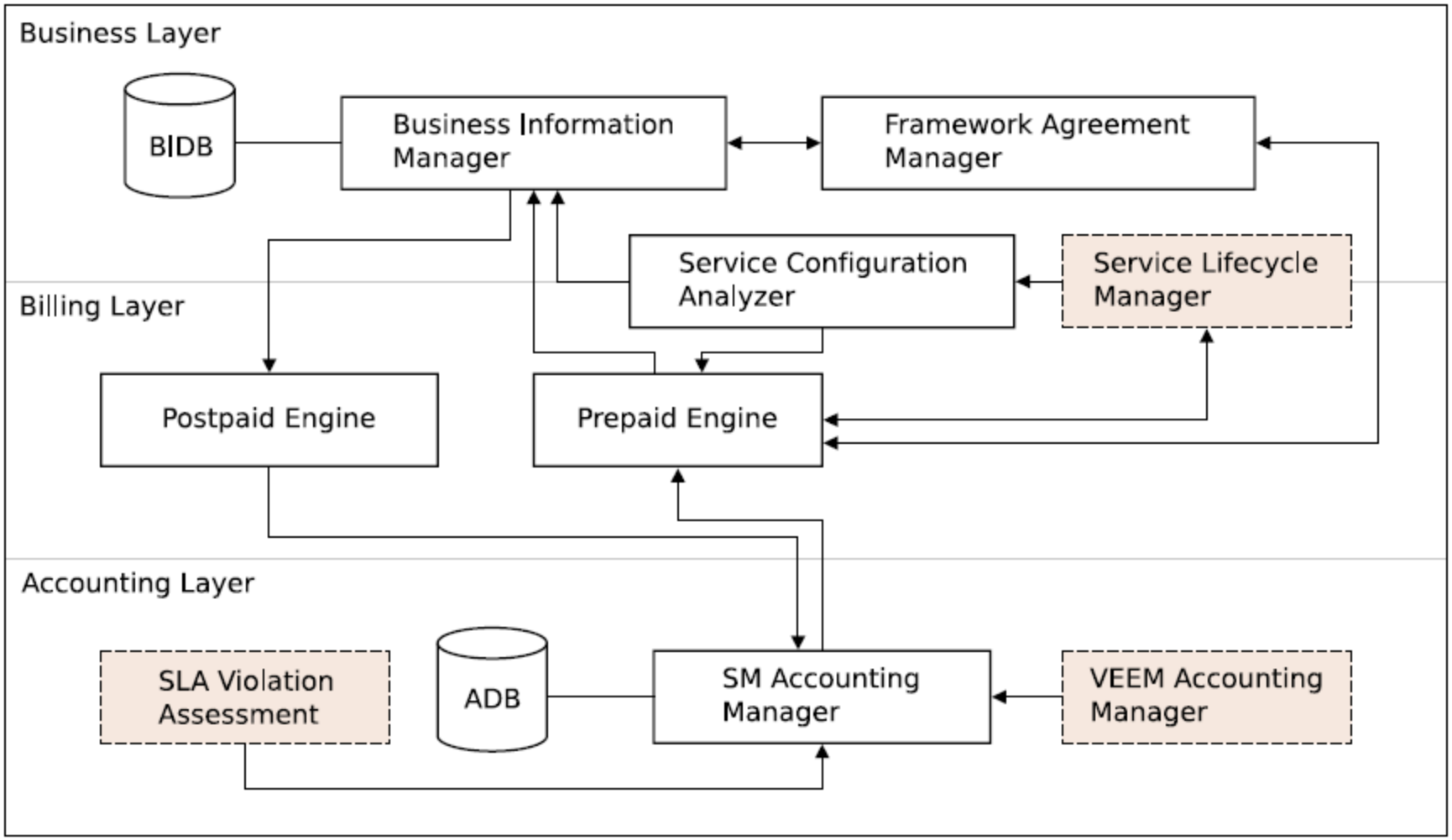
- Pay Mode
  - Postpaid
  - Prepaid
- Using Scenarios
  - Accounting for executing processes with unknown and dynamic placement
  - Accounting for services composed of an varying number of VEEs

Accounting & Billing in IC

- Some other requirements
  - Location unawareness
  - Service elasticity
  - Service billing
  - Complex pricing
  - Adaptable design
  - Flexible data format
  - Service accounting
  - Compensations

Accounting & Billing in IC

- Architecture



Accounting & Billing in IC

- Sample Procedure

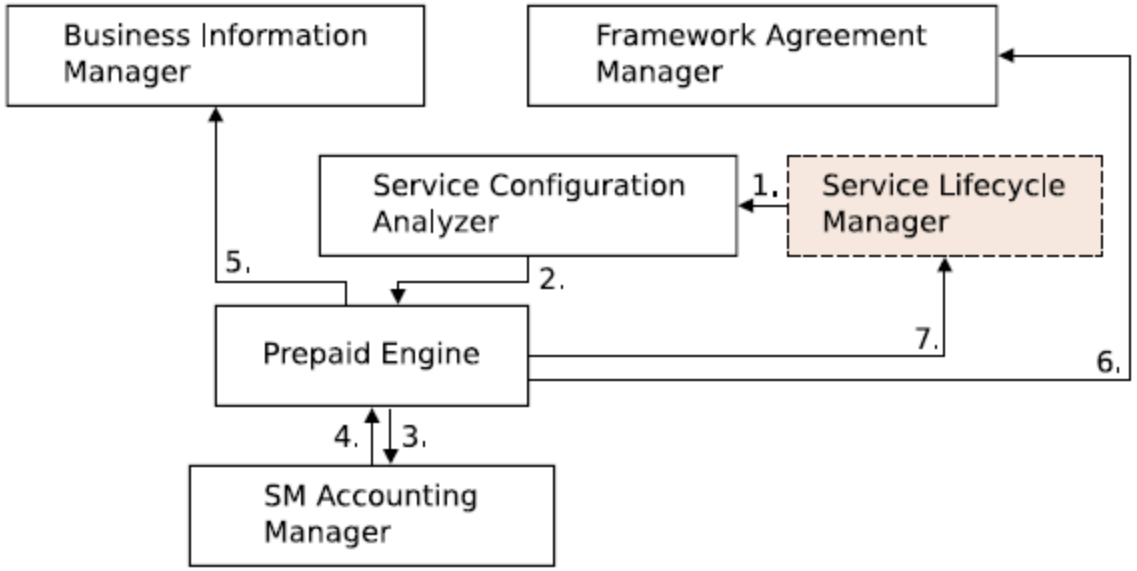


Fig. 3. The figure shows the procedure for the Prepaid Engine. The Prepaid Engine registers in the SM Accounting Manager to listen for updates when instructed to do so by the Service Configuration Analyzer. The Business Information Manager supplies the conversion from data concerning usage and violation to credits, and also makes decisions about what to do when the account runs low on credits.

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Thanks!