Creating and Managing Dynamic Cloud Federations

Taipei, ISGC 2015, March 19th

Giuseppe Andronico
Marco Fargetta
Maurizio Paone
Salvatore Monforte

INFN Division of Catania
Cloud federation

Definition of federation (from a common dictionary):

*Act of joining states or other groups with an agreement in common affairs they will be governed under one central authority.*
## Terminology

According with the NIST definitions

<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cloud Service Providers (CSPs)</strong></td>
<td>provision the physical processing, storage, networking, and other fundamental computing resources</td>
</tr>
<tr>
<td><strong>Service Providers (SPs)</strong></td>
<td>deploy, configure, maintain, and update the operation of the software applications on a cloud infrastructure at PaaS and SaaS levels.</td>
</tr>
<tr>
<td><strong>Cloud Brokers (CBs)</strong></td>
<td>manages the use, performance, and delivery of cloud services, as well as negotiates relationships between CSPs and SPs.</td>
</tr>
<tr>
<td><strong>Cloud Consumers (CCs)</strong></td>
<td>exploiting CSPs can accomplish services for both PaaS and SaaS layers.</td>
</tr>
</tbody>
</table>
Survey on cloud federation model

Reservoir architecture:

**Service Manager**: the highest level of abstraction, interacts with the service providers to receive their Service Manifests, negotiate pricing, and handle billing. Two tasks:
1. deploying and provisioning **virtual execution environments (VEEs)** based on the Service Manifest,
2. monitoring and enforcing SLA compliance by throttling a service application’s capacity.

**Virtual Execution Environment Manager (VEEM)**: responsible for the optimal placement of VEEs into VEE hosts subject to constraints determined by the Service Manager.

**Virtual Execution Environment Host (VEEH)**: responsible for the basic control and monitoring of VEEs and their resources (e.g., creating a VEE, allocating additional resources to a VEE, monitoring a VEE, migrating a VEE, creating a virtual network and storage pool, etc.)
Survey on cloud federation model

In the Reservoir model the architecture is “invasive”, so it is hard to make it coexists with the already existing Cloud Managers.

RESERVOIR leads up to FI-Ware, a recent EU initiative, and to XI-FI Federation, a federated framework based on FI-Ware. XI-FI federates homogeneous FI-Ware systems based on OpenStack

Cross-Cloud Federation Manager is an architectural design for federation, a software in charge of:
- Discovery
- Match-making
- Authentication

Openstack is focusing on Identity & Access Management federation
Federation model: Orchestrator

Focus on cloud interoperability:
- Mainly focused on protocols needed to access clouds based on different software systems (OpenStack, OpenNebula, EC2, …)
- Main effort to design communication protocols and resources dissemination policies

Approach focused on interoperability:
1. CC willing to access the federated cloud resources
2. Centralized entity receiving requests from CC
3. Translates them into requests to external CSPs.

This model, following the introductory definition, is not a cloud federation:
- Users (CCs) are aware of the different CSPs
- There is not cooperation among CSPs
Federation model: Orchestrator

Different software interfaces to access either their own internal resources or the external ones (“federated”). Users are divided in:

• **Internal users** that access cloud services through native APIs,
• **Federated users** that interact with the central entity through federation specific APIs.

Some issues that can be critical in specific scenarios.

• **Internal users** cannot extend their cloud resources by taking advantage of federated CSPs, because they need another external software system that, in turn, will access resources not related to their own cloud.
• Additionally, **internal users** may have applications developed on cloud manager specific APIs thus, in order to exploit the federated resources, such applications have to be rebuilt.

Nevertheless, each cloud may provide **different services or interfaces** (e.g. event notification or monitoring service), which cannot be available on the federation system.
Federation model: Federator

Focus based on definition allows to design a system able to transparently extend each cloud including external resources. Only cloud users:

- No distinction between internal and federated users
- Can access the resources offered by both their own CSP and external federated ones through cloud native interfaces

Most of the harmonization work among the federated CSPs is performed by FedGW, a software running on each site. The entity Federator will carry out operations like resource discovery, marketplace of image templates, and so on.
**Reference scenario**

A, B & C are small CPSs. D & E are CSPs big enough to internally address any request. CSP D is distributed around the world and its internal interconnection is depicted as a link between D and D’.

Cloud brokers act as third party intermediary agents, that make their business selecting the best solution satisfying both the CSPs and SPs’ requirements.

Our interest is to provide clouds A, B and C the same type of business opportunities as for clouds D and E, in which neither brokers nor SPs might be aware of the capabilities each cloud operator supply with.
Inside INFN the need for federation is present and evaluation is under go

Types of federation considered:
• Internal, to maintain a distributed cloud inside the organization
• External, to support cooperation:
  • Support to experimental collaborations
  • Participation to R&D activities on different levels
Distributed organisation

INFN is distributed in many sites and each site has its computing resources.

All sites contribute to big experiments but they also work on local/smaller experiments.

Sites need to maintain their local computing facilities for a better and more efficient work.

To support big experiments the resources should be aggregated.

Each site has to maintain the control of the resources.
Support external cooperation

Big experiments, like LHC, require huge amount of computing resources
Difficult for a single organisation to provide all the resources

Many applications require a different computing model than Grid
Resources available to the user access in order to perform the operations and/or create a virtual experiment cluster

Scientists should access all the experiment resources from the same location
INFN researchers should access their UI and the system behind has to collect the resources for the user

Partners should put the resources together but maintain the control locally
The administration of the resource remains responsibility of the owner
Designed Cloud Federation model

Cloud federation life cycle comprises of two distinct moments:

• **join/exit**
  • related to the activities performed by a CSP to create or destroy the environment needed by the federation members to communicate each others

• **resources access**
  • related to the discovery, negotiation and usage of federated resources.
Join/Exit

Federated resources:
- Are an upper bounds of the resources available, not exclusively for the federation members
- Its real usage depends on the actual request during federation life cycle.

Federation manager:
- Receives join request reception by the CSP
- checks whether the information provided about resources and policies matches with the federation rules

If yes the CSP can be considered as being federated and ready to fulfill requests from/to others federation members.

CSP can:
- Modify the amount of resources committed to the federation and the policy in any moment but the changes must be notified in advance to the federation manager, who will propagate the information to all members.
- Be rejected because it does not comply anymore with the rules
- Leave the federation, either for its or the federation manager decision
Discovery & Negotiate

The federation defines the technical aspects in order to access remote resources and maintains a list of CSPs providing resources with both qualitative and quantitative information. Nevertheless, in order to access member resources a new negotiation is requested between the two members, acting one as CC and the other as CSP, with the supervision of the federation manager acting as CFA.

Cloud manager to access federated resources:
1. Send a request to the federation manager
2. Federation Manager search for the required resources
   1. Cloud manager can reject offer and send a new request
3. In case of acceptance:
   1. Establish agreement and sign it
   2. Notify the Federation Manager
   3. Federation Manager can update resources usage
4. CC can start to use new resources
Request & Access

CC requires new resources to CSP

1. internal resources: request managed from CSP as usual

2. from the federation:
   i. cloud manager will become a CSC of the federation
   ii. start the negotiation procedure described above, internally managed by a federation agent.
   iii. Upon agreement establishment, the required resources made available
   iv. CC can access the services transparently as resources managed by the cloud itself

3. agreements could be defined in advance, before users request new resources.

4. Users might release requested resources before the actual expiration of the corresponding agreement
Conclusions and future work

The challenge: federation to overcome all the problems raising in merging clouds with heterogeneous administration domains.

Sensible argument in case of research institutions willing to cooperate sharing resources in a simple way for users.

E.g., INFN is owning distributed resources, managed differently from different cloud manager. In this way could be shared without the need to establish only one set of policies for all. Also this would be very useful in future collaborations with other institutions.

The high level model of cloud federation introduced is able to provide the scalability and flexibility needed by small clouds.

The added value: providing a high-level model not related to a specific technology which aims at federating different cloud infrastructures.

We are working on a concrete implementation:
- To test our model
- To provide new features
- To solve real problems that may occur in cloud federation accomplishments.
Thank you
Any question?