SDN for Inter Cloud Networking

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Objectives

- **Cloud networking**
  
  - Provide connectivity in a non-intrusive way of distributed resources (preserves the network configuration of cloud providers).
  
  - Establish dynamically and control end to end connectivity of distributed resources and services.
  
  - Cloud and network providers involved.
Summary

- Cloud Broker Framework
- Cloud Request Splitting
- Cloud Networking Gateway Manager description
- Performance Results
Contents

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Cloud Broker Framework

Cloud Broker Framework

Cloud Request → User

1. Cloud Request
2. Request Splitting
3. Resource Provisioning
4. CNG Manager
5. CNG
6. Cloud Manager

Cloud 1

VLAN

Cloud 2

VLAN

SDN for Inter Cloud Networking

November 18, 2013
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Cloud Request Splitting

**Objective:**

- Find optimal (minimum connectivity cost) request splitting across multiple cloud providers
- Splitting algorithm determines the sub-graphs to providers mapping
Cloud Request Splitting

- $x^j_i$: set to 1 if resource $i$ is associated with cloud provider $j$.

- $y^j_{ii'}$: set to 1 if a requested link between nodes $i, i' \in N_r$ involves cloud providers $j$ and $j'$.

- $P^j_i$: price (or cost) of requested node $i$ if provided by cloud provider cloud $j$.

- $P^j_{ii'}$: price (or cost) of link between, nodes $i, i' \in N_r$ when involving cloud providers $j$ and $j'$.

Quadratic program formulation:

$$
\begin{aligned}
\min & \sum_{i \in N_r} \sum_{j \in Pr} P^j_i x^j_i + \sum_{(i,i')} \sum_{(j,j')} P^j_{ii'} x^j_i x^j_{i'} \\
\text{s.t.} & \sum_{j \in Pr} x^j_i = 1; \quad \forall i \in N_r; \quad x^j_i \in \{0, 1\}
\end{aligned}
$$

Linear integer program formulation:

$$
\begin{aligned}
\min & \sum_{i \in N_r} \sum_{j \in Pr} P^j_i x^j_i + \sum_{(i,i')} \sum_{(j,j')} P^j_{ii'} y^j_{ii'} \\
& \sum_{j' \in Pr} y^j_{ii'} = x^j_i; \quad \forall i, i' \in N_r; \quad \forall j \in Pr \\
& x^j_i + x^j_{i'} - y^j_{ii'} \leq 1 \\
& \sum_{j \in Pr} x^j_i = 1; \quad \forall i \in N_r; \quad x^j_i \in \{0, 1\}; \quad y^j_{ii'} \in \{0, 1\}
\end{aligned}
$$
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The CNG-M in the proposed networking architecture can be seen as an SDN controller.

The networking architecture relies on two main components:

- SDN controller called Cloud Networking Gateway Manager (CNG Manager)
- A virtual and generic appliance (CNG)
  - acting as a gateway between user resources (named Cloud Networking Gateway, CNG).
  - the CNG provides a RESTful interface to enable the configuration and the programmability of its features by the CNG Manager.
Cloud Networking Gateway Manager

- Ensures connectivity between resources acquired from distributed and independent cloud providers.

- Gives partial or complete control of connectivity to the users so they network their applications.
The CNG Manager has:

- Northbound interface towards client requesting connectivity based on the OCCI specification and service model.

- The CNG Manager Core selects the appropriate drivers, in line with user expressed networking requirements.

- Southbound interface interacting with transport technologies through specific drivers.
CNG Manager relies on an OpenFlow driver to configure 2 CNGs acting as OpenFlow switches connected to a NOX controller.
Contents

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Performance Results (CNG Manager)

<table>
<thead>
<tr>
<th>Cloud Providers</th>
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<th>6</th>
<th>8</th>
<th>10</th>
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<td>Delay (s)</td>
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</table>

- Configuration delays of the network graphs composed through CNG nodes.

- Each node of the network graph represents a cloud provider.
**Performance Results (Splitting algorithm)**

<table>
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<th>Cloud Providers</th>
<th>Request Size</th>
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<tr>
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<td>2.38</td>
<td>4.05</td>
<td></td>
</tr>
</tbody>
</table>

- Delay required to split a Cloud request between multiple Cloud Providers: Exact method.
Performance Results (Splitting algorithm)

- Average cost generated by the graph splitting algorithm when multiple Cloud Providers are involved.
Conclusion

- Proposed an SDN controller (the CNG Manager) to achieve dynamic on demand inter cloud networking.

- Control of connectivity between distributed resources acquired from multiple cloud providers.

- The CNG Manager is available at:
  - https://github.com/MarouenMechtri/CNG-Manager

- Future work:
  - multi-objectives optimization as needed in the cloud context.
  - generalizing SDN principles to support distributed & connected clouds services.
Thank you for your attention

Questions?