Master Thesis
Design and Implementation of a Cloud-Federation Agent for Software Defined Networking

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Contents

1 Abstract

What is Cloud-Computing, Network Virtualization and Cloud-Federation about? (very short, details in Introduction and Overview Chapters)

2 Introduction

Give insight about the importance of the Cloud-Federation topic.

2.1 Research Aspects

- What kind of Research was already made by other parties? Which projects evolved from them? - Describe own research that could be done.

2.2 Development Aspects

- Where is the focus in the development part of the master thesis? - More implementation and technological overviews are given in the next chapter (technological Overview)

2.3 Economical Aspects

- Apart from research, is there a Economical benefit foreseeable from that topic? - Which econonomic aspects are already of interest in Cloud Computing / Virtualization in general?

2.3.1 Economies of Scale

- Cost advantages for Cloud-provider / Cloud user, based on small, unique Servers on the Company side

2.3.2 Energy Efficiency

- Current European Research Project on Federated Clouds and the idea to swap work, based on the presence of renewable energy - e.g. use Cloud in the north of Germany, if enough wind-energy is provided, swap to Cloud in the south of Spain, if energy from noon-sun could be used.

2.3.3 Service License Agreements in a Federation

- How could SLAs be handled autonomously on a pre-defined set of economic settings (price per MB/Bandwidth, price per Compute-Unit, priorization of users) - Interesting Economical Aspect: Provide many small clouds over different regions in the world - Offer federations, based on closest proximity to clients.

3 Technical Overview

- As the Introduction has given an overview on the topic itself, why it is important in research and why could be useful in practice, this chapter does focus on the technologies needed for a Cloud-Federation. Things to be answered:
- What were the enablers of Cloud Computing? (as a step before Cloud-Federation) - What has HW/Network/Storage virtualization to do with it? - What Service Models does Cloud-Computing offer as of today? - Which research projects are also / have also been following the idea of Cloud-federation? - What to learn from those research projects?

3.1 Enablers of Cloud Computing

- What allows us to build up a Cloud-Federation? - Before Cloud-Federation, go into detail about Cloud-Computing, and the technical enablers of this

3.1.1 Hardware Virtualization

- When has it emerged? - What were the milestones of it? - Today: CPU virtualization techniques (Intels VT-x, VT-d, VT-c and AMDs IOMMU, etc.)

Virtualization Types

- There are several types of Virtualization available. From Software to Hardware accelerated Virtualization.

- Full virtualization
- Partial virtualization
- Paravirtualization

KVM

- What is KVM? - Virtualization Type - How could machines be deployed, cloned, migrated - Storage pools - Remote management - OpenSource - The Development Part of this MA is using KVM, because...

XEN

- What is XEN? - Virtualization Type - XEN Domain Model - OpenSource XEN vs. paid XEN

3.1.2 Storage Virtualization

Distributed File Systems

- Tell about location transparency Examples:
- Old variant: FTP - Newer Variants:
- Hadoop Distributed File System (HDFS) - Amazon S3 File System - Google File System (GFS)

Migration

- Why is Migration important for Clouds? Especially for Cloud-Federation

3.1.3 Network Virtualization

Describe basics of Network Virtualization: - Virtualized Data-Layer - Virtualized Control-Layer

3.2 Cloud Computing - Deployment Models

- Describe Cloud Computing Deployment Models, as these are also of interest for a Cloud-Federation
- Private Clouds should not be able to enter a federation other than a federation that the private Cloud provider established himself (same Company, different locations, same federated Cloud).

3.2.1 Public Clouds

3.2.2 Hybrid Clouds

3.2.3 Private Clouds

3.3 Cloud Computing - Service Models

- Focus on Infrastructure as a Service, as the Cloud-Federation MA will be based on this, however also define the other two Service Models as well.

3.3.1 Infrastructure as a Service

3.3.2 Platform as a Service

3.3.3 Software as a Service

3.4 Research Projects on Cloud-Federation

- These projects were funded by the EU for at least 3 years and have issued Cloud-Federation in their proposals (covering several other topics as well).

3.4.1 Contrail

3.4.2 4Caast

3.4.3 Reservoir

4 Network-Federation

- This is the first chapter, referencing the implementation part of the MA. - The implementation part is divided into Network-Federation (federation on a basic level, using OpenFlow) and Cloud-Federation (in the upcoming chapter).

4.1 OpenFlow

- What is OpenFlow? - Why is it so useful for a Federated environment? - Architectural Description: OF-Controller / OF-Switches - Some flow descriptions (handover to controller, etc.) - Basics on OpenFlow Table entries - OpenFlow enabled Switches -¿ bridge passage to OpenVSwitch

4.2 OpenVSwitch

- OpenVSwitch as a OpenFlow enabled, virtual Switch - OpenVSwitch functionality with / without OFC

4.2.1 GRE-Tunnels

- GRE-Tunnels in general (what is Generic Routing Encapsulation? Small header description) - GRE-Tunnels in conjunction with OpenVSwitches -¿ Build up Gateway Switches

4.3 Mininet

- Mininet as a Network Simulator, using OpenVSwitches and OFC(s) - How could Mininets be federated? - Pros/Cons & Limitations of using Mininet as a replacement of a real network simulation, using physical devices.

5 Cloud-Federation

- Second chapter, caring about the implementation part of the MA. - The Cloud-Federation is seen as an enhancement of the pure Network federation, described in the previous chapter

5.1 Agent based Federation

- Autonomous execution of a generic network-federation - What aspects could be managed autonomously by agents in pre-federated envionments (pre-federated means: Clouds exist that want to be part of a federation)

5.1.1 Cloud Discovery

- How to discover Clouds that want to federate? - What data needs to be exchanged (only for federation information)?

5.1.2 Match Making

- If a Cloud was found that is a good federation partner (decided by the Cloud Discovery Agent), what has to be done prior the upcoming federation? - Synchronization of sliced OpenFlow Tables, maybe User-Pool synchronization, if Cloud-Federation is not only happening on the Network-Layer

5.1.3 Establishing a Federation

- After a Federation Match was established, go on with the real federation of both Cloud partners. - How could security be granted here? What data needs to be transmitted, while the federation is in place?

5.2 Cloud-Computing Environments

- As the Cloud-Federation should (at least in theory) be interoparable with the most used Cloud Environments out there, go a bit into detail about three different environments. - Where is the difference of each introduced solution? - Where could Agents be placed, to enhance the given solution with federation functionality?

5.2.1 OpenStack

- Focus on that one, as OpenStack is really an emerging Cloud Environment.

5.2.2 OpenNebula

5.2.3 Eucalyptus

6 Security-Aspects

6.1 Security Assertion Markup Language

Explain SAML:

- XML Format
- Assertions
- Statements (Authentication, Attribute, Authorization decision)

Why could SAML be of importance for a Cloud Federation?

6.1.1 Service Provider

6.1.2 Identity Provider

6.1.3 Attribute Authority

6.2 Authentication Agent

Explain a theoretical Approach for a SAML implementation in the Agent based Cloud-Federation.

7 Evaluation

- Evaluation of Implementation, as well as on Theoretical Aspects. - Is Cloud-Federation possible? Is it performant? What about Security?