Hybrid Clouds: Implementation and obstacles

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Spring 2016
Bachelor's thesis, 15 hp
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Bachelor's program in Computing Science, 180 hp
Abstract

Hybrid cloud is the approach companies want to adopt for its future in the cloud since hybrid cloud allows you to boost the capacity or the capability of a cloud service by aggregation, integration or customization with another cloud service. Those services can be both private or public. Implementing a hybrid cloud is a big process and companies have difficulties finding a good standard for it. In this thesis, the key points and obstacles in the implementation of the hybrid cloud are pinpointed. One obstacle, workflows are studied closer. Workflows are the result of cloud orchestration, arrangement and coordination of automated tasks. The thesis covers the implementation process of workflows. The result of the thesis is key findings and motivation for the implementation of hybrid cloud and how workflows should be implemented.
Acknowledgements

I would like to express my gratitude to my supervisor Pedher Johansson at the department of Computer Science, Umeå University. He gave me feedback and supported me through the work of this thesis. I would like to thank my supervisors Tomas and Jonas at Atea. Tomas Olsson for taking the time to discuss ideas and answering my questions. Jonas Emilsson for taking the time to answering my questions and coming up with the initial specification to the thesis. Finally, I would like to thank my family that supported me under this thesis.
Contents

1 Introduction 1

2 Cloud infrastructure 2
   2.1 Cloud computing and Virtualization 2
   2.2 Public cloud 3
   2.3 Private cloud 3
   2.4 Community cloud 4
   2.5 Hybrid cloud 4
   2.6 Cloud computing services 5
   2.7 Workflow 6
      2.7.1 Automation 6
      2.7.2 Orchestration 6

3 Implementation and obstacles for hybrid cloud 8
   3.1 Decision to automate 9

4 Workflow guidance 11

5 Discussion and summary 15
   5.1 Implementation of workflows 15
   5.2 Summary 16

References 16
1 Introduction

Cloud computing has evolved and we are now looking at the new era of hybrid cloud [24]. Gartner defines a hybrid cloud service as a cloud computing service that is composed of some combination of private, public and community cloud services from different service providers [8].

This thesis will show an implementation approach for the hybrid cloud. The implementation approach identifies the key points of the implementation process and gives an example of how a workflow should be implemented. This is done by a literature review that presents a result with the future of the hybrid cloud and the needed information for implementation of the hybrid cloud. The result is shown by a key point presentation and discussion around them to give the needed information for an enterprise to adopt a hybrid cloud. Obstacles for the hybrid cloud will be presented that halts the implementation and standardization of hybrid cloud. One of these obstacles identified is workflows and is studied closer. That to give the needed information to implement a workflow and is shown both by identifying the key points of the workflow implementation and also with an example of how it should be done. Workflow is decided orchestration that describes the arrangement and coordination of automated tasks. The cloud providers today can not present well-standardized workflows that allow a smooth adoption for a company. Therefore, this thesis shows how a company should think when a task should or should not be automated.

This thesis has been done in collaboration with company Atea, Atea is a supplier of IT infrastructure with approximately 6,800 employees.
2 Cloud infrastructure

Cloud computing as a concept emerged in the 1980’s [21]. In the 1990’s it became possible for users to connect with their PC’s and exchange information and data as well as usage of remote applications. But global sharing did not emerge before the introduction of Web 2.0 at the start of 2000’s [25]. Cloud came into the scene by showing an IT service model, which delivers a set of convenient, on-demand and configurable computing services and resources to clients over a network in a self-service fashion, independent of device and location service provider interaction [29].

2.1 Cloud computing and Virtualization

Cloud computing is a service often delivered from a cloud service provider (CSP) that makes it possible to use resources (servers, network, storage, services and applications) through a network instead of a local server. Cloud computing is based on virtualization. Virtualization can be described as a way to abstract applications and its components from the hardware and use resources like environment, OS, storage or network components virtual as shown in Figure 1. Which creates a picture of multiple computers that is shown as one resource or one machine.

![Figure 1: Traditional architecture and virtual architecture.](image)

National Institute of Standards and Technology (NIST) describes that cloud computing has five Characteristics [26].
**On-demand self-service:** A consumer can unilaterally provision computing capabilities, such as server time and network storage as needed, automatically without requiring human interaction with each service provider.

**Broad network access:** Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).

**Resource pooling:** The provider’s computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, and network bandwidth.

**Rapid elasticity:** Capabilities can be弹性ally provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

**Measured service:** Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

### 2.2 Public cloud

Public cloud is a form of cloud computing where a company relies on a third party cloud service provider for services such as data, servers, storage and application, which are delivered through a network. The public cloud can free companies from the need to purchase, manage and maintain on-premises hardware and software infrastructure.

Public cloud is often deployed with a big advantage to accessibility, speed and scalability than on-premises-infrastructure. This because of the cloud providers expertise and its infrastructure. Public cloud can be charge as pay-as-you-go fees that many companies think are a good way to save money and resources [15].

### 2.3 Private cloud

Private cloud is typically a cloud computing platform that is implemented within the corporate firewall, under the control of their IT department.

The private cloud is designed to offer the same benefits as the public cloud systems. But a private cloud implementation aims to avoid many objections regarding cloud security. Because of security has to be implemented on the system it is a big downside to scalability versus public cloud [14].
2.4 Community cloud

Community cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns, e.g., mission, security requirements, policy, and compliance considerations. It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises [26].

2.5 Hybrid cloud

Hybrid cloud allows you to boost the capacity or the capability of a cloud service by aggregation, integration or customization with another cloud service. There might be a private cloud service that needs to expand its capacity by extending temporarily into a public cloud service. Hybrid data centers allow companies to balance privacy needs with additional capacity and capability needs. Cloudbursting brings fast scalability [16] to a system and is often used to describe the benefit hybrid cloud brings to capacity [8].

But is every business that has an on-premises data center and uses a public cloud a business that uses a hybrid cloud? The book Hybrid for Dummies structures it like this [24]:

Cloud is hybrid:

• if a company uses a public development platform that sends data to a private cloud or a data center–based application,

• when a company leverages a number of SaaS (Software as a Service) applications and moves data between private or data center resources, and

• when a business process is designed as a service so that it can connect with environments as though they were a single environment.

Cloud is not hybrid:

• if a few developers in a company use a public cloud service to prototype a new application that is completely disconnected from the private cloud or the data center, and

• if a company is using a SaaS application for a project but there is no movement of data from that application into the company’s data center.

The ability to combine public clouds with private cloud services has a major impact on computing for companies so well as service providers and cloud application builders. The change to hybrid IT is in fact transforming the entire computing industry as well their needed resources and technology to be competitive. It does not matter what company you look at the need to have cloud services is always there. The cloud is the foundation for future of computing [13]. So a hybrid cloud is attractive because it enables cloud service customers to address their business needs by leveraging the wide-ranging capabilities of public cloud service providers in particular, the low cost and leading-edge functionality.
available and at the same time using private cloud deployment for more sensitive applications and data. Interlinking cloud-deployed applications and data with traditional non-cloud enterprise applications and data is also an important part of hybrid cloud deployments.

2.6 Cloud computing services

There are three different main types of cloud computing services, SaaS, PaaS and IaaS that separate responsibilities of the services. In the Figure 2 below you can see the differences between the three cloud services and on-premises. Hybrid cloud deployment can be mixed around, for example, can a deployment be an on-premise private IaaS with a publicly hosted SaaS application as you can see in Figure 3.

![Figure 2: Cloud computing services separation.](image)

What **Software as a Service (SaaS)** provides to the consumer is to use the provider’s applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (for example, web-based email) or a program interface. Spotify and Netflix are examples of SaaS services. It is made available to the customer over a network, typically the Internet [18].

**Platform as a Service (PaaS)** is a cloud service that provides a platform for the customers to develop, run and manage applications without the complexity of building and maintaining the infrastructure typically associated with developing and launching an application. So in PaaS, the consumer controls software deployment and configurations settings while the cloud provider provides network, servers, storage and other services to host the consumer’s application [12].

**Infrastructure as a Service (IaaS)** is a cloud service where a cloud provider provides hardware, servers, virtual machines (VMs) and storage on the behalf of its users [11]. This means that an IT company can create scalable IT solutions where the complexities and
expenses of managing the underlying hardware are outsourced to the cloud provider [10].

Figure 3: Hybrid cloud deployment possibilities, shows the different clouds placements with its services.

2.7 Workflow

Cloud automation describes a task or function accomplished without human intervention. Cloud orchestration describes the arrangement and coordination of automated tasks, ultimately resulting in a workflow.

2.7.1 Automation

Automation seeks to make all activities related to cloud computing as efficient, fast, and as hands off as possible through the use software automation tools which are installed directly on the virtualization platform or software and controlled via an intuitive interface [5].

The thing that makes automating a big thing in cloud computing is that if it is done correctly software developers and enterprises can focus on creating digital services and driving new businesses models with IT. Director of the cloud platform for the EMEA region at Google Barak Regev, describe cloud adoption as a way to go beyond simply replacing physical infrastructure with cloud services and virtualization. "As you automate everything, everything is fully managed and you deal only with software development. That is where cloud is evolving and focused," said Barak Regev at Cloud Expo London [2].

2.7.2 Orchestration

Automation tools must occur in a particular order, under certain security groups/tools, be granted permissions and given roles. In different words, even when the building blocks of that environment is automated the engineers must complete hundreds of manual tasks to
deliver the new environment. This is where cloud orchestration is the key [1].

Orchestration software enables automation and orchestration of virtual network services and virtual workloads. Orchestration links a variety of automated tasks together to supply a new service. That is performed using a set of tools and workflow templates that integrate management actions and multiple discrete tasks by providing a software-based workflow using standard interfaces [22].
3 Implementation and obstacles for hybrid cloud

The future of cloud is hard to foresee but if you study some surveys you may see some trends. Global data center traffic will grow at a compound annual growth rate (CAGR) of 25 percent from 2014 to 2019 [23]. By 2019, more than four-fifths (86 percent) of workloads will be processed by cloud data centers; 14 percent will be processed by traditional data centers [23]. Cloud workloads are expected to more than triple (grow 3.3-fold) from 2014 to 2019, whereas traditional data center workloads are expected to see a global decline, for the first time, at a negative 1 percent CAGR from 2014 to 2019 [23].

If we look at Interxion study [19] we can see that companies expect themselves to move to hybrid IT from 45 percent using hybrid IT in 2014 to 80 percent in 2016. Rigtscales [27] report the same, 77 percent of respondents are now adopting private cloud up from 63 percent last year. As a result, use of hybrid cloud environments has grown to 71 percent. In total, 95 percent of respondents are now using the cloud (up from 93 percent in 2015). That means that companies and organizations are working for ways to make their computing infrastructure best suitable for their needs through a hybrid cloud model. With hybrid data centers, new software systems are emerging that allows small businesses to take leverage of hybrid services. Small companies can then take a part of the latest technology and be a competitive part of the computing industry. Many companies have local offices that want to be able to have the same resources and access to the head office. The hybrid cloud offers that, which allows companies and organizations to work closer to their customers.

Many known people in the IT industry has spoken about the hybrid IT and its future.

“I start to think of a multi-cloud environment as a foundation for a next wave of applications,” says Ed Anderson, Gartner.

“Hybrid cloud is our foundation and focus,” says Steve Daheb, Oracle.

“We are leveraging hybrid cloud and we are actively increasing our adoption,” says Paul Stokes, CIO of the University of Victoria [4].

So companies have recognized that good things can be achieved with a hybrid development. However some things that need to be considered are examples that often halt the adoption of hybrid cloud [31]:

- the cost benefits provided by different providers,
- reliability and performance benefits,
- deployment speed,
• storage location (for example, the data protection laws governing the local jurisdiction), and

• security, risk, control concerns, and the availability of off-the-shelf, ready-to-use SaaS solutions.

Security is the biggest issue [31] to hybrid standardization. All organizations have to take a unique approach to their hybrid model considering their legacy and policies. Security was identified early as the biggest problem for adoption of the cloud but not much progress has been done to convince the companies that it can be done in a safe way. With encryption solutions of the data residing in the cloud and access management. Together with a secure interface to the CSPs and a secure data flow with different solutions (HTTP, SFTP, etc.) this can be solved. Solutions and approaches for that are not in this thesis but is well covered in Security Guidance for Critical Areas of Focus in Cloud Computing [17].

Investigate the different ways to go is necessary when you want a cloud solution. You can either choose private, public or just hybrid. When you choose it is important to note that if you have security needs the way to go is hybrid. Why you may ask, when security is in the picture, a part of the private cloud is needed and public cloud allows cloud bursting. Still, even if the hybrid is the best choice to go for many companies they choose to wait, which can be fully understood because of three big obstacles in the cloud industry. First, software-defined networking is a bit weak point for any private cloud technology [3]. Second, the talent gap of qualified candidates who are certified to configure, provision and manage the technologies to support private and hybrid workloads [3]. Third, the lack of good automated workflows, the lack of automation between on-premises and cloud environments makes hybrid cloud computing a cumbersome choice [7].

But if you choose to have an own hybrid cloud the implementation demands a lot, you would need to design, implement and manage a virtual network on top of your existing resources. To provide users with the same features found in commercial public clouds, private and hybrid clouds must perform a number of technically complex tasks. They must provide a uniform, homogeneous view of virtualized resources, regardless of the underlying virtualization platform. They must manage the full cycle of Virtual Machines, including dynamically establishing networks for groups of Virtual Machines and managing their storage requirements, such as deploying virtual machine disk images or creating software environments on-the-fly [21][32].

They must support configurable resource allocation policies to meet the organization’s specific goals. Finally, they must adapt to an organization’s changing resource needs, including peaks in which local resources are insufficient, and changing resources, including addition or failure of physical resources [30].

3.1 Decision to automate

The application automation and virtualization have been the savior for many cloud systems. Providers which host cloud environment which is hosted by providers brings an understanding of the dynamic nature of the platform. Everything can shift in a second. That can be a
server needs more resources or an application is getting pegged [6]. Provisioning services bring the capabilities of spinning up VMs within seconds and make it possible for users to use more/new resources. Just that self-service is central for the cloud. If you look back at Section 2.1 under NIST definition of cloud computing it says on-demand self-service and measured services which are enabled by automation. So you can say without automation it is not a fully functional cloud [20].

So for a seamless cloud service, it depends on cloud automation. Automation is a mechanism that enables customers to provision or decommission services through a self-service portal at any time, without any intervention by the cloud provider. Each service request would trigger multiple changes in the cloud provider’s environment, such as reconfigurations of networking devices, new virtual disks, backup configurations and new VMs. All of these changes must be coordinated and executed automatically and in the correct sequence, meaning it must be orchestrated.

The foremost requirement for delivering ITaaS is automation and it requires a business commitment to achieve. But still, companies do not take the word automation with joy. It is often that they think it is too small like ”it only take 4 minutes, why automate” or it is too big and they think it is impossible to automate. But if you look at the decision to automate from [9].

- Volume of the task,
- length and complexity of the end-to-end process,
- time sensitivity of the task (how valuable is immediate completion?),
- avoidable human error and improvement of traceability, and
- whether or not the service needs to be provided to a non-technical user, such as an end user.

Then the concepts bring some light on other things than just the importance of the time perspective these other things can be just as important. Human error is often overlooked with the benefit of automation. If you take away error possibilities in a process that is done many many times a month a company can save a lot of time and money in error searching and debugging. A little thing can be a big thing and companies need to look from different perspectives to find the necessity to automate their processes. Exception handling is important to keep in mind, a human brain is fast to adapt to changes and can think of a logical solution. That is a thing that the automation engine doesn’t bring, it does nothing without direct directions.
4 Workflow guidance

This chapter combines automation and orchestration to create a workflow. The chapter shows a simplified process for implementing a workflow to create a customized VM. Workflow is done by using VMwares products VMware vRealize Orchestrator (VRO) and VMware VShpere web client but the idea can be used in other products just as well. The script engine in VRO is JavaScript so the automation scripts are written in JavaScript. The workflow sets up a VM with SQL server 2012 installed on a Windows server 2012 R2. The delivered VM is customized by the user through the user input seen in Figure 8. There the user can customize the name, CPUs, ram and storage.

Template is a master image of a virtual machine that can be used to create a new virtual machine. The first step is to set up the VM that is cloned. This is done in VMware VShpere web client. So we start with an already finish template with Windows server 2012 R2 that has the specifications shown in Figure 4.

![Figure 4: Template win2012R2 specifications.](image)

Next step is to manually install the SQL server on the now created VM. When that is done with the chosen plugins we go the other way to create a template from a VM. Resulting in a template Figure 5, as you can see the same specification but now with SQL installed. The manual steps are done and it is time to start with the implementation of the workflow. Software changes from VSphere to VRO. Now it is time to plan how the workflow should look when it is finished. The tasks of the workflow should be separated and together deliver the finish workflow. This workflow is divided into six workflows that are orchestrated to one. The workflow is in the order CloneVM, ChangeRAM, addNumberOfCPUs, changeDiskspace, startVM and updateGuestOS seen in Figure 7. All of them has an own workflow that is created separately. CloneVM is the only one explained in this thesis to give an understanding of the attributes and parameter, shown in Figure 6. The in parameters
Figure 5: Template win2012R2 with SQL specifications.

has to be specified by the user and in attributes is already specified by the developer. So as you can see in the top left and bottom right, CloneVM workflow need a name for the new VM and returns the cloned new VM.

Figure 6: Workflow that clones the template.

When all the workflows work separately it’s time to create the workflow that together delivers a VM with customized specifications. The workflow looks like Figure 7. As you can see, the separation is in the six workflows named earlier. The in-parameters you can see at top left corner in the window in Figure 7 has to be specified by the user. That specification can be customized in VRO and in this case looks like Figure 8.
Pressing submit runs the hole workflows and delivers a VM with SQL installed on Windows server 2012 R2 with users VM hardware customization. The delivered VM is shown in Figure 9.
Figure 9: The delivered VM, shown as a started VM in the web client.
5 Discussion and summary

The future means the end of traditional data centers as you can see in Chapter 3. That is because migrating the workload to a cloud data center makes it possible to virtualize and it allows dynamic deployment. Which gives a company much better understanding of their environment and resources.

The most important factor for managing hybrid clouds is the management of virtual infrastructure, i.e., the dynamic orchestration of virtual machines to meet the requirements outlined in Chapter 3. Even if you have the expertise to do this in-house, you will to some degree need the support of an experienced hybrid cloud services vendor to manage this in order for you to obtain its full benefits [28][30]. So the future of hybrid cloud demands products that include support, automation, orchestration and gives virtualization of the system.

The last years have felt short of the expectations in the aspect of the implementation of hybrid cloud. But the interest of hybrid cloud is very high as you can see in this report. After the obstacles mention in this thesis are solved a more standardized implementation approach will able to be presented. But today this does not exist therefore the implementation and motivation aspects proposed in this thesis will help you adopt the hybrid cloud.

5.1 Implementation of workflows

This section discusses the implementation step and is biased on my thoughts together with some of the market thoughts. The implementation becomes the next step in the automation process after you decided to automate seen in Section 3.1. Some basic principles need to be considered [9]: Such as

- build only for need,
- break the process into small and manageable parts,
- consider the life cycle of the automated process, in addition to the associated decommissioning, and
- avoid over-engineering.

These principles may be have seen in other implementations/developments of IT-services. You probably have and can imagine why these principles are here as well. The first build for need, it is always there if no need no profit no success. Implementing a strong automation is not an easy task, consider and justify the investment is something you have to do. Break down the processes is a very important step when implementing a strong automation
process. If you look back at Chapter 4 you can see that the workflow is in small parts, orchestrated to run the whole workflow. That brings a more adaptive and manageable solution. When a well-written workflow has been published duplicate workflow can come handy. When using duplicate workflow it copies the workflow and can easily be changed to a similar task resulting in happy developers and earned time. Debugging and error handling also becomes easier and more manageable with small parts. So when implementing a new automation process, break it down into small parts and workflows and connect them together to a bigger and bigger workflow. That in the end becomes the workflow that delivers the whole automated process. Some phrases are very true and should be considered [9]:

- “A bad process is still a bad process after you have automated it.”
- “The more complex your infrastructure is, the more complex your automation is, and the more complex problem solving is.”

5.2 Summary

The implementation and future obstacles of the hybrid cloud have been described. This implementation process and obstacles identification strive to provide the needed information for a successful adoption of hybrid cloud. Implementation of workflows with automation is one of these obstacles mentioned and is explained deeper with an example of how it should be implemented.
References


