AALTO UNIVERSITY
SCHOOL OF ELECTRICAL ENGINEERING
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MARKET UNCERTAINTY ESTIMATION OF DESKTOP CLOUD SERVICES

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Technology

Stockholm, November 1st, 2011

Supervisor: Professor Heikki Hämmäinen
Instructor: Mikael Haglund, M.Sc. (Tech)

AALTO UNIVERSITY
SCHOOL OF ELECTRICAL ENGINEERING Abstract

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Cloud computing is a new way to consume and deliver IT solutions as services, transforming high CAPEX to a more manageable OPEX. Customers are able to buy IT services on-demand, from a provider hosting an infrastructure, which is automated, standardized, and virtualized, with great flexibility and economies of scale benefits. Alternatively, companies can buy the infrastructure pieces themselves and build private cloud solutions, delivering the same benefits to their users.
Cloud computing can deliver these capabilities, but what is the view among practitioners within different industries? What are the observed benefits, beliefs, and thoughts about cloud computing, and how will it help them in their business?

This thesis looks at the concept of cloud computing in general, but the main focus of the thesis is desktop cloud solutions. The thesis is completed as a multiple case study within two industries in Sweden, the mining and manufacturing industry, and security services and solutions industry. The objective of the thesis is to try to determine the market uncertainty around desktop cloud solutions, examine the possible management structures and what would trigger customers to implement a desktop cloud solution. To determine the research questions and to create a conceptual framework, the thesis relies on the theories presented by Mark Gaynor. The data collection is done as a qualitative multiple case studies. Data is collected by interviewing IT practitioners from the case industries, then analyzed and used to answer the research questions.

The key findings of the thesis show that there are clear market opportunities for desktop cloud solutions. Companies are facing challenges with their current desktop infrastructure and these problems could, at least partly, be solved by a desktop cloud solution. There are still both technical and business concerns, which providers have to solve before customers will implement desktop cloud solutions. For companies used to IT-outsourcing and that have an outsourcing strategy, outsourcing their desktops, is a possible next area in IT-outsourcing. Those companies will most probably choose a solution with a centralized management structure.

Companies are not yet ready to move business critical functions into the "cloud", but cloud solutions are considered, when new solutions are implemented. So at the moment noncritical business solutions are starting to get ready to be bought as a service and "moved into the cloud".

Keywords: cloud computing, desktop cloud, hosted desktop solutions, VDI, HVD, Mark Gaynor, market uncertainty, network solutions, management structures

AALTO UNIVERSITETET
HÖGSKOLAN FÖR ELEKTROTEKNIK Abstrakt

Författare:	Jonas Löfman	Sidantal
Rubrik:	Uppskattning av marknadsosäkerheten för arbetsstationer som en molntjänst	7 + 69+ 10
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Övervakare: Professor Heikki Hämmäinen

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Molntjänster ger användare och leverantörer nya möjligheter att konsumera och distribuera IT lösningar som tjänster. Höga investeringskostnader transformeras till mera hanterbara månadsavgifter, när användare köper lösningar som tjänster, vilket tillåter dem att köpa IT resurser enligt behov. Leverantörer kan skapa en flexibel IT infrastruktur, som är automatiserad, standardiserad och virtualiserad, vilket ger stordriftsfördelar.
Men vad är åsikten om molntjänster i företag inom olika industrier? Vad är de förväntade fördelarna, tankarna och hur förväntar sig dessa företag att molntjänster kommer stödja deras verksamhet?

Detta diplomarbete koncentreras sig delvis på konceptet molntjänster, men huvudfokus ligger på arbetsstationer som en molntjänst lösningar. Arbetet har gjorts som en mångfallsstudie inom två svenska industrier; säkerhetsbranschen samt tillverkning- och gruvindustrin. Målet med arbetet är att bestämma marknadsosäkerheten mot dessa lösningar och vad som möjligen skulle driva ett företag att implementera arbetsstationer som en molntjänst. Forskningsfrågorna har skapats med hjälp av teorier framlagda av Mark Gaynor.
Data samlas in genom en kvalitativ mångfallsstudie. Genom att intervjua IT-personal inom fallföretagen, har de insamlade data sedan analyserats, för att besvara forskningsfrågorna.

Resultaten visar tydligt att det finns en marknad för arbetsstationer som en molntjänst. Företag har idag problem med sin nuvarande PC infrastruktur och problem kunde, åtminstone delvis, lösas genom att implementera arbetsstationerna som en molntjänst. Lösningsmodellen är inte komplett och har ännu vissa tekniska brister, som måste lösas före företagen är mogna för en fullständig implementation.

För företag som redan idag har lagt ut sin IT-verksamhet hos en tjänsteleverantör, kan arbetsstationer som en molntjänst vara ett naturligt följande steg i företages outsourcingstrategi. Det är något som också tycks stämma mera generellt. Företag är inte mogna att lägga ut affärskritiskafunktioner i "molnet", men molntjänster som en lösningsmodell övervägs mera när nya lösningar sökes och implementeras. Så icke-affärskritiskafunktioner börjar vara färdiga för att köpas från leverantörer som en tjänst.

Keywords: molntjänster, arbetsstationer som en molntjänst, Mark Gaynor, marknadsosäkerhet, förvaltningsstrukturer

Acknowledgment

First I want to thank the companies who participated in the study. To those at **Assa Abloy Ab**, **Boliden Ab**, **Niscayah Ab**, **Polygon Sverige Ab**, and **Securitas Sverige Ab**, who participated in the interviews, I would like to express my sincere gratitude for taking the time to help a young researcher with his thesis. I felt the discussions we had, was mutually beneficial.

I also want to thank Stanley Ekberg at IBM for helping me come up with the subject and giving me thoughts and ideas how to tackle the problem. I want to thank my sponsor Mikael Haglund, who agreed to participate in the project. I also appreciate all the input and thoughts my colleagues at IBM, have given me during the writing process.

Thank you, Professor Heikki Hämmäinen for supervising my thesis. I appreciate the freedom I have been given around the subject, whilst you still firmly made sure, the thesis was completed properly.

The last, but probably most important acknowledgment goes to my family and friends, who supported me during the writing process and my overall studies at TKK, but also for the support I receive for the most of my choices.

Stockholm, November 1st, 2011

Jonas Löfman

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List of abbreviations

CAPEX	Capital Expenditure
CRM	Customer Relationship Management
ERP	Enterprise Resource Planning
GUI	Graphical User Interface
OPEX	Operational Expenditure
OS	Operating System
PoC	Proof of Concept
SLA	Service Level Agreement
SME	Small and Medium Enterprises
TCO	Total cost of ownership
VDI	Virtual desktop infrastructure

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1 Introduction

1.1 Motivation

There are different views on what exactly cloud computing is and there is no absolute definition. Cloud computing is a new delivery and consumption model for IT services. It enables providers to provision computing services, through a shared infrastructure, which is virtualized, standardized, and automated. This means IT solutions can be sold as a service. Cloud computing will lower customers IT capital expenditure, when computing becomes just an operational expenditure. Gartner [16] calls this shift from capital to operating expense a well-documented benefit [18]. Customers pay for computing power, network and storage resources, when they need it, and pay for the amount of computing and storage capacity they need, like paying for a utility. The term cloud computing is quite recent, according to Vouk[48] the term was made popular by IBM and Google in 2007, but the underlying technology builds on virtualization techniques, research in distributed computing and network services, which are much older topics than cloud computing.

Desktop cloud is one cloud computing solution. A desktop cloud solution refers to a delivery model, where end users connect to a virtual desktop, which runs in a data center. This means that instead of end-users having their own PCs, with its own processor, memory and hard drive, the end-users are given a so-called thin client. A thin client refers to a device that instead of processing data itself, it is connected to a server, which does the actual computing. The thin client just works as user interface, without real processing capabilities. A desktop cloud solution lowers the requirement for the desktop in use, but relies on the networks and servers, to be able to keep up the connection and provide the needed computing capability. The predicted benefits of a desktop cloud solution, is that a company can easier manage the workers desktops and tighten the security, as the actual computing power and stored data is in the data center, accessible over the internet or an intranet. Also most of the maintenance and support functions can be moved from help-desks, to the data centers.

The purpose of this thesis is to study the demand towards desktop cloud solution. What the market uncertainty is within Swedish companies and what desktop cloud service providers can do to lower a possible high market uncertainty.

1.2 Research question

This thesis will rely on the theories of network services presented by Mark Gaynor in his book ”Network Service Investment Guide” from 2003 [19]. According to the theory, a customer will outsource some function, if the market uncertainty of the service is low, as keeping the function in-house does not provide any additional value. By outsourcing a service, the customer can focus on its core business functions. But if the market uncertainty of a service is very high, the customer will keep the function in-house, as he is afraid to be locked in with some provider’s solution and wants to keep the flexibility and control of the function for himself.

Gaynor's theories, does not take in consideration any industry factors, so one must assume they are meant to hold true, in any industry i.e. they are universal and non-industry specific. In this thesis, these theories around a network service will be tested with two industries. These two industries have very little in common, but by choosing two industries that have very little in common, non-industry specific results can be presented, if clear similarities are found. If variation is found, this points towards industry specific results.

This thesis will focus on the network service solution, desktop cloud and the market for the solution, within two industries in Sweden, the security services and solutions industry and the manufacturing and mining industry. The thesis will examine what are the benefits customers feels they must receive, to be willing to implement a desktop cloud solution. And if there are some barriers preventing customers from implementing a desktop cloud solution with a centralized management structure. Besides that, the thesis will analyze the market uncertainty towards cloud computing solutions in general and if ”cloud”, is still a provider pushed technology or something that customers are ready to implement and already have a demand for the solutions.

The following research questions were formed:

1. Triggers for a Swedish company to implement a desktop cloud solution, why would these companies implement desktop cloud solutions?

2. What are the barriers for a Swedish company to implement a desktop cloud solution with a centralized management structure?

3. What actions can a provider take to lower the market uncertainty for the customer around a desktop cloud solution?

4. Market uncertainty for desktop cloud and other cloud computing solutions among companies in Sweden?

1.3 Methods

The research methods used in this thesis are listed below.

Literature study

Qualitative case study

First the theoretical framework presents the theories this thesis relies on. In the technology background section, the literature study's purpose is to gain a better understanding and present what desktop cloud solutions are, from a more technical standpoint. Examine what the claimed benefits are for implementing a desktop cloud solution, in an organization. As there are varying definitions of what exactly a desktop cloud solution is, the literature will help to form one definition for a desktop cloud solution, which will be used in this thesis. The technology background will not be a technological deep-dive, presenting all the protocols and techniques involved in the solutions.

The literature reviews are done to find existing knowledge about the subject and examine earlier research. The data will be collected from research articles, company press releases, industry newspapers, white papers, other publications and websites.

The qualitative case study is a multiple case study completed with two industries in Sweden, the security services and solutions industry, and the manufacturing and mining industry. Through a conceptual framework the research questions are created. To answer the actual research questions 1-on-1 interviews with companies representing one of the case industries will be completed.

1.4 Scope

This thesis focuses on desktop cloud solutions and the issues revolving around those solutions. What triggers customers to implement a desktop cloud solution in their organization, and what is stopping them? These questions are tightly linked to the market uncertainty, the customers and providers are facing towards desktop cloud solutions. Only one type of cloud computing solution is selected for natural reasons, trying to determine the market uncertainty for several solutions, requires several

studies. But by studying cloud computing solutions in general as well, some general market uncertainty towards cloud computing can also be determined.

The general overview of cloud computing is studied in the case industries in this thesis. What does the practitioners within the industry believe cloud computing will solve for them and what benefits are they receiving, or will receive in the future, from cloud computing?

The companies studied have a wide-spread presence in Sweden with several locations within the country. The companies are selected by a purposeful sampling strategy, and must meet certain set of criteria. Within the case companies, someone working within the organizations IT department is selected, preferably a CIO or someone close to the CIO. The case companies do not have IT as their core competence, IT's role is to support the general business.

Five interviews were completed and the findings show there is a clear market for desktop cloud solutions. The current PC infrastructures at these companies causes a lot of challenges and a desktop cloud solution would solve them. The market uncertainty towards the solutions are still quite high, as the companies feel there is not any trusted references yet, that would prove to them that the solutions works. This is also backed up by the findings and that are then linked back to Mark Gaynor's theories around market uncertainty. The management structure of a possible future solution seems to be directly linked with a company’s current IT-outsourcing strategy. For companies that have chosen to outsource most of their IT, desktops will probably be a natural next step to outsource to a provider. For a company accustomed to in-house IT, there is no motivation to just outsource the companies PCs.

1.5 Structure

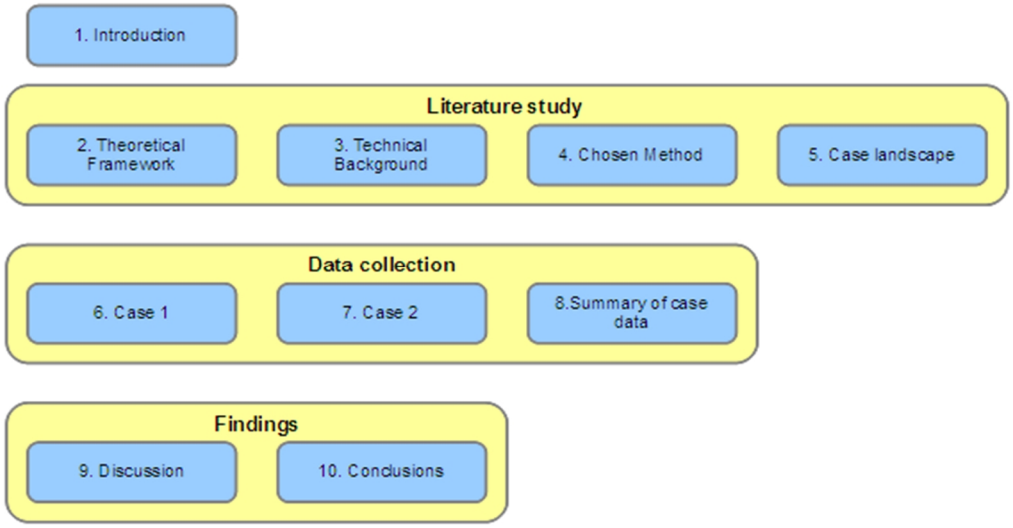


Figure 1: Structure of the thesis

The thesis is divided into three main parts: a literature study; a case study; and findings. First the literature study is completed, which purpose is to give a background to the actual thesis. First all the used theories are presented. After that a technical background is given, presenting the solutions and the technologies studied in the thesis. Chapter 4 presents the chosen method, which represents the used research tools in the study. The last part of the literature study is the case landscape, where the case country and industries are reviewed.

Chapter 6 and 7 are the case studies in the respective case industries. Those chapters objectives, is to present the collected case data, without linking the cases together. The collected data is presented, without focusing too much on actual analysis of the data. Chapter 8 is a short summary of the data and linking the data together.

Finally the thesis ends with the findings. First the collected data is discussed and the cases are linked together. After discussing the data collected in the thesis, the key findings are presented. Finally possible future research areas around the topic are suggested and what implications the thesis has.

2 Theoretical framework

This chapter will present the theories that this thesis relies on. Concepts and models needed for analysis will be presented in the sub-chapters.

2.1 Management structures in network based services

According to Gaynor [19] a user of network service can choose between two different management structures: centralized or distributed. A network service with a distributed management structure describes an architecture, where the user manages the service's infrastructure in-house. The term in-house is not bounded by geography or distance, it just describes how the user has full control of the service. The distributed management structure can also be called insourcing.

A centralized structure describes an outsourced model, where the user is a customer, buying the service from a provider. The provider manages the infrastructure and sells the service to its customers. Both management structures are depicted in figure 2 and figure 3, respectively.

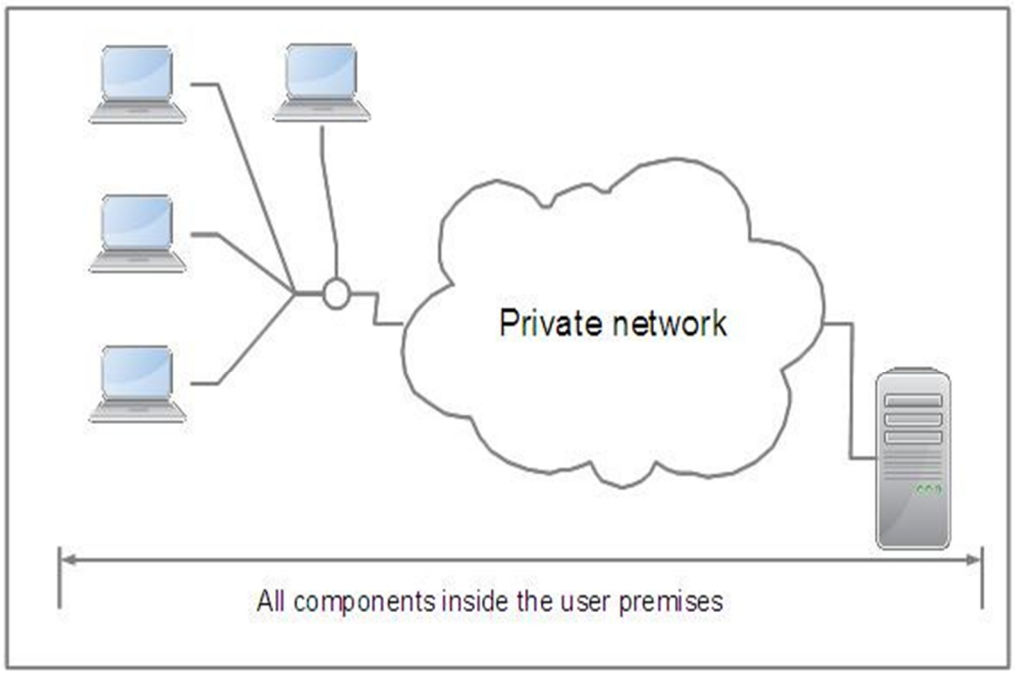


Figure 2: A network service with a distributed management structure

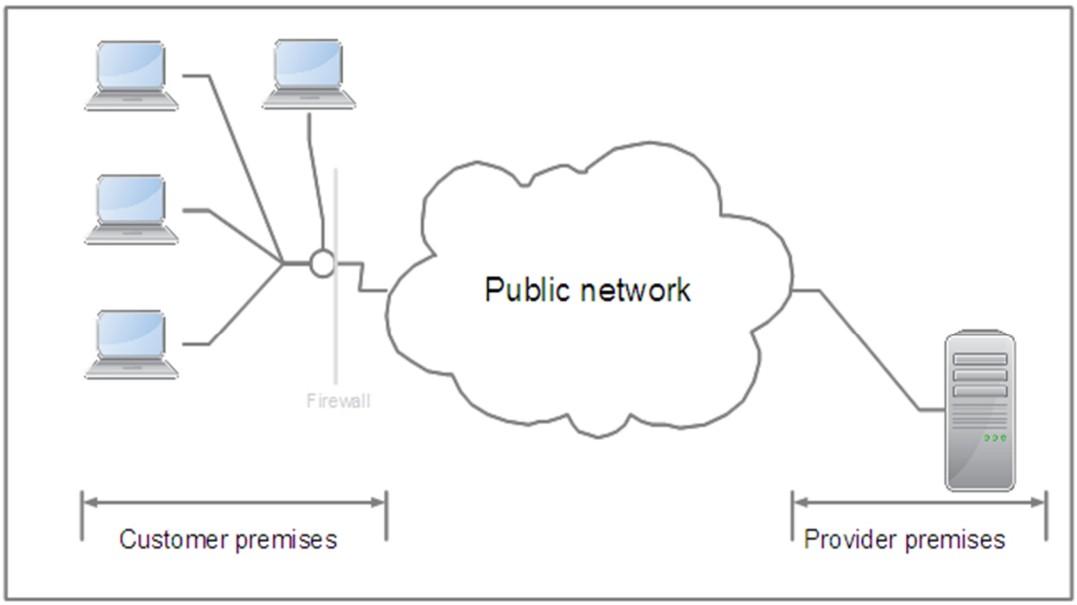


Figure 3: A network service with a centralized management structure

We can see in figure 2 that all the parts of the service are in-house, inside the company firewall, when we have a network service with a distributed management structure. The traffic between the users and the server hosting the service stays within the company premises and the traffic is secured and private. Figure 2 shows a server and clients of some sort, connected through a private network. The clients and server are chosen because they fit the desktop cloud theme of this thesis, but they could also be for example phones and a private exchange, like Gaynor uses as an example in his book. In Figure 3 we have a network service with a centralized management structure. Here we see the firewall protecting the customer premises from the public network. In this example the server hosting the service is located on the provider's premises and the customer buys the service from the provider and the functionality of the service is provided over a (public) network.

Typically both management structures have their own benefits and challenges for the user of a network service. These benefits and challenges, according to [19], for both management structures are presented in table 1 below.

Table 1: Benefits and challenges with different management structures

Networks services with a distributed management structure	
Benefits	Challenges
• Experimentation is easy, promotes innovation • User can customize and even improve the service for their preferences • Users control the upgrade and maintenance cycles	• Less efficient use of limited resources • More skilled people needed in-house, to manage the service • Experimentation might also be done by people without the proper skill level, which may cause disruptions in the service
Networks services with a centralized management structure	
Benefits	Challenges
• Economies of scale • Allows the user's organization to focus on its core competencies • Easier billing	• Inflexibility to change • Allowing a single point of failure • Changes impact a wide range of users

As one can see, a network service with a centralized management structure should be able to utilize its resources more efficiently. But it is not as flexible as a network service with a distributed management structure. The efficient usages of resources are important factors when discussing cloud computing. The economies of scale providers can reach, when offering a standardized service to several users, depends on the efficient usage of their resources. This is also the reason for the inflexibility with network services with centralized management structure. If service providers would offer tailored services for each customer, the provider will have challenges reaching economies of scale. With a distributed management structure, the users can customize the service to their liking, and receive a high level of flexibility, but reaching similar economies of scale that providers benefit from, is difficult.

2.2 Market uncertainty

Market uncertainty is the amount of uncertainty a new product or solution will face, when it is brought to the market. Market uncertainty for the users/customers is an issue, when they are offered several rivaling solutions, with technical differences. The solutions, might all serve the same purpose, but as the underlying technology may differ, the customer is uncertain about, which solution to choose. If the technology is the same and it is mainly the brand that differentiates the solution, then the customer's choice is relying on preferences and other subjective reasons. But when having to decide, which technology to select, the choice is far from trivial. This can lead to the customer postponing the buying decision. [19]

According to Kim Clark [9], market uncertainty for the developers of the solution, presents itself, when the developers do not know the customers preferences. Technological diversity for the same solution, occurs when different developers, selects different technologies. The developer chooses an underlying technology, because he believes the chosen technology will prevail and prove to be a successful route.

Market uncertainty from the provider's side can be seen, when the provider offers many versions of the same service. The provider can offer the service with a centralized management structure, so that the customer can outsource the service. But the same provider can also offer the same network service, with a distributed management structure. In that case, the provider usually offers the components needed to manage the service in-house. The reason for this is that when the provider does not know the customer preferences towards a new network service, the provider tries to enter the market from different angles and with different approaches. Also, if the service is something radically new, the users does not know exactly what they need, and can't articulate their needs, so with several options, they can choose the solution, they think will satisfy their needs. This type of versioning is also called network service experimentation. [19]

2.3 Measuring market uncertainty

Gaynor [19] explains how a precise measurement of market uncertainty is not possible, but one can estimate the market uncertainty for a network based service, to be low, medium, or high. Gaynor gives a few examples of scenarios that prove the market uncertainty is low for that set of network based services.

- ***Emergence of a dominant design*** - once a vendor's solution becomes a dominant design, the market uncertainty is already low or decreases when the dominant design of the solution, is determined. When a dominant design is present on the market, the choice for the customer should be quite easy.

- ***Agreement between providers in the industry*** - when there is little or no agreement between industry experts and providers, the market uncertainty must be high, as none of the providers are sure in what direction a solution should evolve. A sign of low market uncertainty is when there is agreement between vendors and a clear technology direction for the solution.

- ***Ability to forecast the market for the solution*** - if the market for a solution is predictable, it implies low market uncertainty.
- ***Products are becoming commodity*** - when vendors are no longer able to different their solutions by features, customers will start basing their buying decision on price, or because of e.g. "brand/vendor loyalty".

2.4 Gaynor's theories on network based services

Based on different assumptions, Gaynor presents three theories for network services that according to him are valid, under some assumptions. Two of these theories will be selected, as the assumptions should hold true for this thesis and this case. The assumptions and theories will be presented here, then the assumptions and theories, will be evaluated and adjusted to these cases and thesis, when creating the conceptual framework during the research design process. Both theories and all five assumptions are cited from Gaynor's book [19].

"**ASSUMPTION 1** - The market demand for network-based services has market uncertainty. This means that service providers (which includes enterprise users) are unable to accurately predict the value they will receive for providing a service"

"**ASSUMPTION 2** - Experimentation with services is possible, and a market exists to value the experiments. The value of a particular experiment is the success of its adoption. This experimentation is used to determine what service best matches the current market conditions in the context of what features will be the most popular"

"**THEORY 1**- The expected value of the best of n simultaneous attempts at providing a service is likely to exceed the expected value of any single experiment. As n increases, the possibility of a truly outstanding market match grows."

"**ASSUMPTION 3** - The payout to the service provider offering the best of n choices is nonlinear. More experimentation and greater uncertainty increase the expected

value. The service provider receives this value by providing the service that best matches the market."

"**ASSUMPTION 4** - The less disruptive and less expensive it is to develop and deploy a service, the more experiments there will be. Experiments in networks with infrastructure allowing applications with end-2-end architecture requiring no alteration to the network infrastructure are generally less expensive and less disruptive than environments where a more constraining centralized architecture requires infrastructure change and permission."

"**ASSUMPTION 5** - For some services there exist business and technical advantages (BTA) that push providers to offer services that are more centrally managed."

"**THEORY 2** - If high market uncertainty causes the difference between the expected value of the best of n experiments and the expected value of each individual experiment to exceed the business and technical advantages of the centralized management structure, then a service provider should consider providing this service with a more distributed managed architecture. When market uncertainty is low enough that the advantage of having n choices is less than the business and technical advantages of a more centrally managed service, then providing the service with centralized management architecture makes the most sense."

3 Technical background

The second part of the literature review, will present cloud computing, desktop cloud and issues relating to those concepts. This is not a technical deep-dive and the section does not offer a deep technical architecture models on cloud computing solutions. This chapter is used for getting a clearer and more precise definition of the technologies that are brought up in this thesis.

3.1 Cloud computing

3.1.1 Technologies enabling cloud computing

Even though the concept cloud computing is quite recent, and started popping up in 2007, when IBM and Google started talking about cloud computing, the technologies enabling cloud computing date further back in time. According to Vouk [48], cloud computing builds on virtualization, distributed computing and SOA.

Virtualization

Virtualization is a concept that dates back to the 1960s and the IBM mainframe. Virtualization of servers, allows multiple servers running different applications to be consolidated onto one server. Virtualization decouples hardware from software (OS), with a virtual layer between the hardware and the operating system. This virtual layer is called a hypervisor or virtual machine monitor. Basically a server is split into several server images, each image capable of running its own operating system (OS). Each OS can then run some applications. Server virtualization is shown in figure 4 below. Virtualization allows better utilization of servers, and instead of every single business application running on a dedicated server, the application runs on a server image. [40]

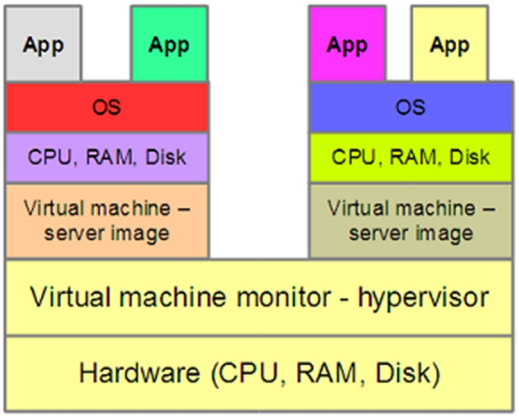


Figure 4: Server virtualization

It is quite common to see the virtual machine monitor or hypervisor, replaced by a VMware virtualization layer. This can be a bit misleading, as it then assumes the processor architecture is x86, where undoubtedly VMware is a very strong virtualization vendor [6]. Figure 4 is not tied to any specific hardware architecture and just shows a generic hypervisor. The different colors shows that several OS's and virtual hardware images can be run on the same physical infrastructure, this enables hosting several applications on different kind of platforms.

Virtualization is a key technology for cloud computing. A virtual infrastructure offers the flexibility and cost benefits, cloud computing infrastructure must have, to be able to reach economies of scale and ensure flexible IT delivery models.

Distributed computing (cluster and grid)

According to Pankaj et al [36], cloud computing is the next evolutionary stage in distributed computing, with it is roots in cluster and grid computing. Foster et. al. [12] argue that grid computing should not be confused with cloud computing. Cloud computing can be seen as a new model for grid computing, both solutions share a vision to lower IT costs, offer computing power on-demand and increase flexibility. But it is still not that the same, as the size of the "cloud" infrastructure, large companies are investing in, is so much bigger than the infrastructure of the grids. Ian Foster also has a grid checklist, in a paper where he defines grid computing [13]. The first criterion is coordination of computing resources that don't have centralized management.

So in this thesis, cloud computing will be seen as an evolution from grid computing, but bearing in mind, that they shall not be confused with each other. Grids get their

computing power, from different location, with resources that are not structured under one authority. Cloud computing again, gets it computing power from data centers, managed by one authority, be it then a public cloud, maintained by a vendor, or a smaller private cloud, managed in-house at the user's location. Also the target market varies, as grids are more focused towards scientific and academic use, whereas cloud computing is targeted towards the industry sector [36].

Service-Oriented Architecture (SOA)

Service-Oriented Architecture (SOA) defines how computer services interact with each other, how one service performs some logical task for another service. The main SOA components are service providers services that perform the logical task; service consumers, the service that needs a task performed by the service provider; and service repositories, where the services are registered. Under the architecture the services are loosely coupled, meaning that the service providers does not know why or does not care why it is performing a service for the service consumer. [37]

Loose coupling can also be seen as a black box architecture, where the parts in the system, are black boxes, where the content of the box, is actually irrelevant. This is done to "hide" complexity. SOA enables building business applications and reusing old existing software assets. The components are linked together through a business process to deliver a level of service, which easily defined. [20]

When SOA is being discussed, you hear some of the same themes coming up as with cloud computing. "In an SOA environment end-users request an IT service (or an integrated collection of such services) at the desired functional, quality and capacity level, and receive it either at the time requested or at a specified later time." [48] SOA has a similar flexibility that also comes up with cloud computing. As with cloud computing, in SOA components can be reused for different functions and the architecture supports large scaling. The difference is of course that SOA is just an architecture, a model how to create IT applications, by linking and reuse the needed components together to build a logical whole.

3.1.2 Cloud computing

The concept cloud computing describes a model where an application or functions is delivered over a network as a service, where underlying hardware and software is located in a data center, where the actual computing and processing is done. What

the purchased functions actually are, is not that important for the concept of cloud computing. The function can be a business application, it can be raw computing power or something else. The important factor is that it is delivered as a service, meaning you can not purchase it as a product or own the infrastructure. A term that comes up a lot when cloud computing is talked about, is XaaS, which stands for everything as a service. The X is then replaced with whatever is being sold as a service. The most common ones are IaaS, PaaS and SaaS: infrastructure as a service; platform as a service; and software as a service. The IaaS, PaaS and SaaS are also the layers of the cloud architecture and can be seen as a stack, which represents the main three layers of cloud services available. [39]

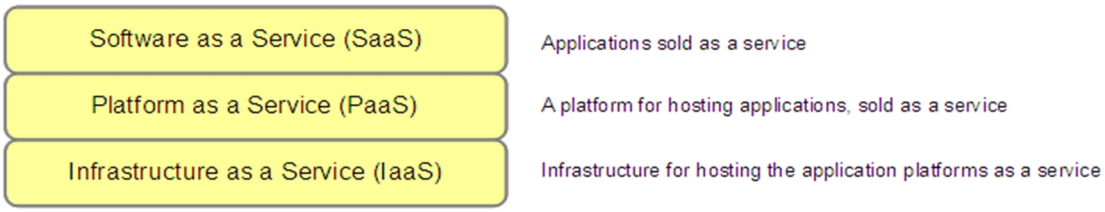


Figure 5: Cloud architecture layers

Cloud computing is enabling computing as a utility, you have a pay as you go model, where you pay for what you use or reserve. Cloud computing gives you flexibility, the user has the possibility to scale up or down the computing resources needed (this might be restricted by service level agreements (SLA)). The pricing models and flexibility gives the user's computing on-demand, meaning, the user buys the amount of power needed, for the time needed. For the user this means that most of the CAPEX needed to invest in infrastructure components are transferred to the cloud providers, who invests in a large data center, and then sells resources to the user according to some price model. For the user this means CAPEX becomes OPEX and the user pays for what he needs, when he needs it. Another point when discussing cost is the utilization of resources. Even if the price/performance-ration would be better with an application running on it is own server in the company's own data center, what happens to the price/performance-ratio, if the server is only utilized by 25%, or if the application is only needed 4 months during a year? If the server needed for the application is bought as a service, and only used when needed, the XaaS model might be more affordable. [1]

The discussion above is true for what is called public clouds, which will be defined in a separate chapter. Besides public clouds there are also private clouds and even the looser hybrid cloud definition. In private clouds, the model changes a bit and some of the statements made earlier might not hold true.

3.1.3 Cloud computing management structures

Public and private clouds are definitions that should come up when discussing cloud computing, besides public and private, also a hybrid model exists, which is a mix of public and private clouds. The public and private clouds come back to the discussion of management structures that came up in chapter 2.1. A public cloud computing solutions is clearly a network solution with a centralized management structure. In a public cloud you have a customer and a provider, the provider offers cloud solutions from their data centers, and the customer buys what he needs and in the quantities needed. The provider manages and is responsible for the infrastructure components, the customer just buys a standardized service from the provider. The term public cloud is used, because the provider offers a service over the public internet for customers and the service is publicly available for purchase according to some price model [14].

Private clouds are where an organization builds their own cloud infrastructure inside their own firewall, and offers the services to users within their own organization. Consolidation and virtualization will results in better utilization, so the organization can offer similar large-scale computing power as a service. But this changes a little the view on cloud computing, as the organization needs to invest in the infrastructure and will not benefit from the flexible pricing models a public cloud offering offers to its users. So the cost benefits from CAPEX to OPEX may not exist in a private cloud, if the cloud service is built in-house, but the resource pooling and higher utilization can still lead to economies of scale. [14]

As private and public cloud computing are clearly defined and have clear bounds, the third cloud model, is somewhere in between the two ends. Hybrid cloud is also emerging and is a mix of private and public clouds. In a hybrid cloud, some of the resources are secure behind a firewall, some parts are in the public domain. An easy

example would be a private cloud solution, which buys peak capacity from a public cloud computing vendor. [14]

3.2 Cloud security issues

Cloud is a network service and like many other web-based services, it has security issues, some known and some found on the way. Before discussing actual security issues with cloud solutions, a Gartner report will be discussed. The report present issues with selecting a cloud provider, and reminds customer of what to ask and ensure what the customer will receive, when selecting a cloud provider.

3.2.1 Security issues when selecting a cloud provider

The Gartner report "Assessing the Security Risks of Cloud Computing" seven points are presented and what the customer should remember when selecting a cloud provider. [7]

1. Privileged user access. As business data is moved into the cloud and a vendor's data center, is the security of the customer's data ensured? The customer must trust the provider and should have a clear view of who exactly is authenticated to view the customer's data.

2. Regulatory compliance. The customer is responsible for its own data and can be subjected to external audits and investigations. The customer must ensure the selected cloud provider is also ready to comply with regulatory issues and ensure the data can be audited, even if it is located on the vendor's premises.

3. Data location. Where is the data actually located, and will the cloud provider comply with customers local jurisdictions, even if the data is abroad?

4. Data segregation. Is the customer's data secured and encrypted, even though the data is located in a shared infrastructure?

5. Recovery. How does the cloud provider recover from disaster and how is your data protected and secured, in case of a disaster.

6. Investigative support. The provider must be able to show that data and activities can be accounted for later.

7. Long-term viability. What happens to the customer's data and how does the customer get it back, if the cloud provider goes broke or is acquired by another company.

The points from the Gartner report form a kind of checklist and shows that the selection of a cloud provider is certainly not trivial.

3.2.2 Some known security issues with cloud computing

As cloud computing is a web service, one form of attack against a cloud provider would be a Distributed Denial of Service (DDoS) attack, where a malicious instance would use a bot-net to perform a DDoS attack on a cloud providers premises and block the service. Armbust et al [1] argue that a DDoS attack against a cloud provider is not as easy as it sounds. Mainly because these cloud providers are large IT companies that have the size and resources to fight off an attack. Armbust et al also argue that for example a DDoS attack made, in the interest of blackmailing the provider for money, would be a large-scale attack and actually quite expensive to perform. In their example a made up attack on Amazon's cloud services, would have to go on for 32 hours, before the cost of defending off the attack would be larger than the actual cost of the attack.

One should note though, that if the attack is not done because of blackmailing nor to achieve some monetary gain, but to either cause harm, or driven by some other motive, the cost of the attack might not be important, and a cloud provider could well be a target.

As a side note, when writing this section, in the beginning of December of 2010, some large-scale DDoS attacks are performed because of Wikileaks [2]. According to the BBC [3], the attackers where planning an attack against Amazon and it is cloud services, but did not manage to crash their services, because Amazon was seen as too big. The attackers did manage to complete a DDoS attack against companies like PayPal, MasterCard and Visa [4].

Maggi & Zanero [29] talk about the new security challenges in the cloud. They argue that many of the security issues and vulnerabilities are caused by programming errors in the software, operating and running the cloud infrastructure. They also state that some of the security issues are not new, even though the cloud paradigm might

be, and so "classic" threats are still present in cloud computing. This also means that countermeasures used in the past, might well still be viable in the new cloud milieu. Similar findings and proposals are also presented by Armbust et al [1].

3.3 Desktop cloud

In essence, desktop cloud is virtualization of the desktop, where the hardware, OS, and applications are moved from the personal computer to a server. The screen of the computer still displays the desktop, but in reality, it is just a shell, depicting a picture of the desktop. The only thing actually done on the client is the representation of the graphical user interface (GUI) and the communication with the server, hosting the desktop. The applications and the actual processing are run on the server.

3.3.1 Background and definitions of desktop cloud

According to IBM, they, together with Citrix, Desktone, VMware and Wyse, launched the first public desktop cloud service during the autumn of 2009 [21]. Desktop virtualization offering have been on the market before autumn of 2009, but the interesting issue, is the public cloud part of the announcement, as it desktop virtualization was now offered as a public cloud computing solution, for enterprise customers.

Desktop cloud is an alternative desktop delivery model, a way of hosting desktops in the cloud and delivering desktops to users, as a service (desktop cloud is in some context called DaaS, desktop as a service, but will be referred to as desktop cloud in this thesis). Traditionally an organization has a large number of distributed PCs for their employees. Each PC has it is own hardware, software applications, and OS installed. Desktop cloud again, moves the processing power, applications, storage needs, and OS to a remote data center, giving the user a lightweight computer, which in extreme cases, is just a keyboard, mouse and monitor, or then an application for connecting to the data center, and not utilizing the PCs own resources. [5]

These lightweight computers can be called thin-client. The opposite for a thin-client, would be a thick-client. To avoid mixing thick and thin client concepts, they will be defined. In the IT world, a server has a client, the client is the one making requests from a server, which then sends a response back to the client. This means a client requires a network connection, to be considered a client. A thick-client has it is own

hardware, software and OS, but also needs a network connection. A thick-client, can operate without a network connection, but then it should be referred to as a workstation, to define the offline mode. A thin-client can not operate offline, as it lacks most of the components needed, and only works with a network connection established. A minimum requirement for a thin-client, would be, that it is able to establish a network connection. [45, 46, 47]

Before the concept desktop cloud was discussions, there were similar hosted virtual desktop solutions, but under the definition Virtual Desktop Infrastructure (VDI). In VDI, virtualization techniques are used to be able to run the desktop applications and hardware on a server in a remote data center, running on virtual machines [32]. Miller and Pegah [32] wrote a paper on VDI in 2007, during those times the cloud computing concept was just emerging, but virtualization was called a "mega-trend" and VDI would add to that trend and become increasingly important during the next years. In [32] many of the needed and possible network protocols needed for VDI are also mentioned.

3.3.2 Hosted desktops in the cloud

So what exactly does decoupling of the OS and hardware from the client mean, and how are they moved into the cloud? The basic components needed for a virtual desktop according to IETF can be found in e.g. [52]. It shows several different approaches to a desktop cloud solution by different vendors (these will be covered in the next chapter). Besides the virtual desktop client, which is the device for the end-user, a virtual desktop agent is also needed. The agent is control software installed on the virtual machine, residing in a data center. Then with a set of protocols connects together the client and the agent.

With resource management the virtual machine images and the physical hardware are managed. The applications are streamed, which means that the applications and the OS are broadcasted to the thin clients. This application streaming creates an application streaming layer, which ensures the users of the thin clients can use their regular business applications, emails, user data etc. This layer provides these applications to the clients, without having to consider what platform these applications are on. Linux and Windows application platforms are the most likely. A picture of these layers are drawn by Lai et al [27] and depicted in figure 6 below. [23, 27]

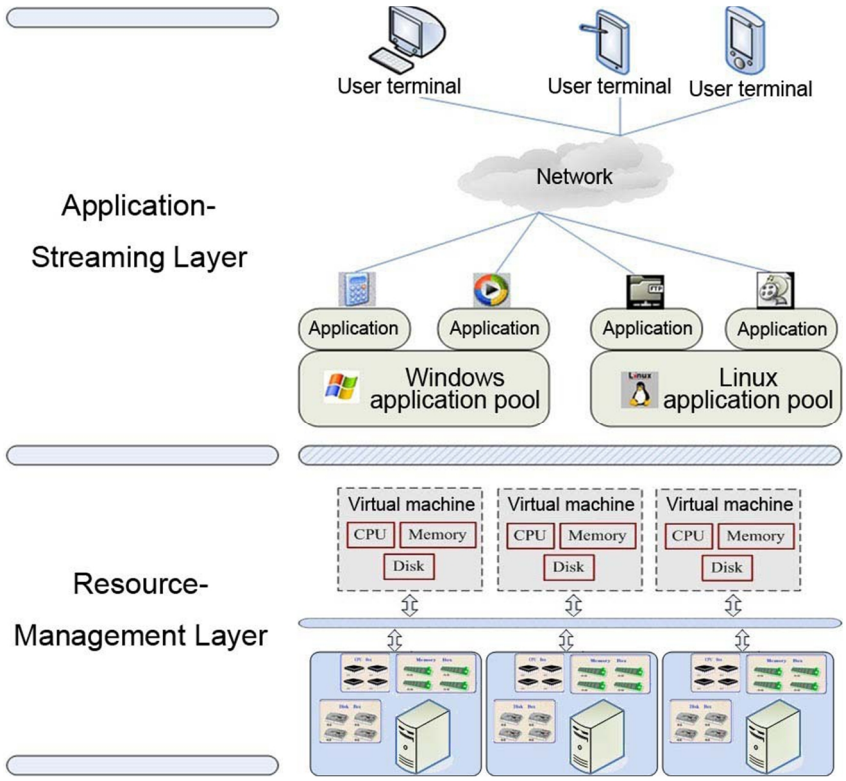


Figure 6: A proposed virtual client architecture. Picture from [27]

As one important benefit of desktop cloud solutions are that they can lower customers on-site help desk costs, the solution must be possible to implement also to companies with several, distributed, locations. The number of user can be in the thousands for each remote site, so they will need their own pool of virtual server images to be able to stream applications from them. This can be solved by choosing a primary site and install a core server in that location, that takes care of the distribution of the service. Figure 7 below, shows the core server and the remote sites. [23]

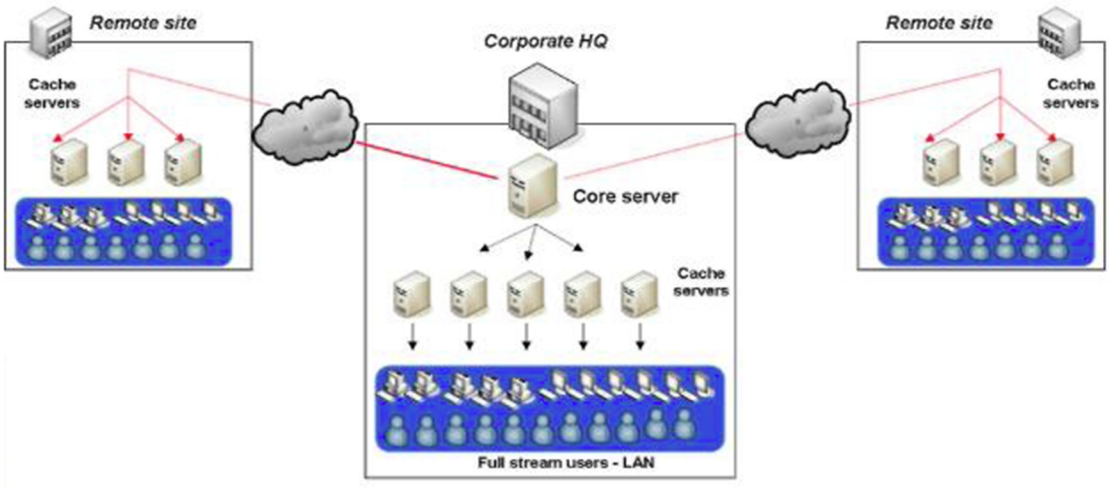


Figure 7: Desktop cloud with distributed sites. Picture from [23]

3.3.3 Examples of different vendors architecture for desktop cloud

This chapter presents different architectures by different virtualization middleware vendors, as they are presented in [52].

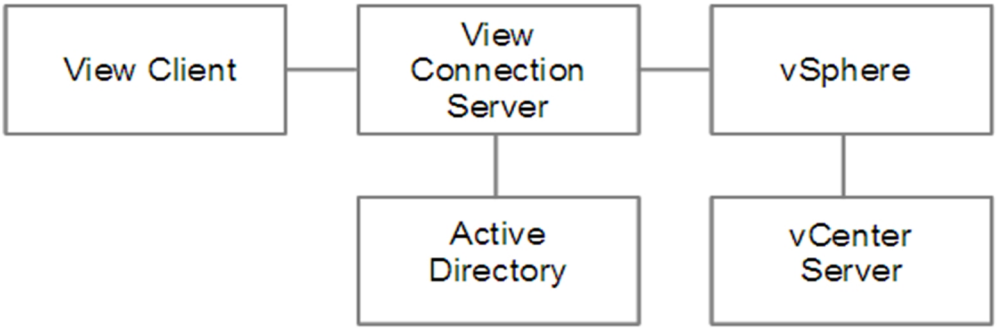


Figure 8: VMware View architecture. Picture from [52]

Figure 8 depicts VMware's VMware Viev architecture and the approach they have taken to deliver virtual clients in a desktop cloud solution. The View Client is software that runs the virtual PC machine on either a thin or thick client. The View Connection Server is a broker for the client connections. It is connected to the Active Directory that authenticates the user and then connects the client to available virtual machines. This also takes care of load balancing, ensuring that clients connect to available virtual servers. vSphere is the virtualization platform VMware uses and this gives the virtual machines for the View Connection Server to distribute to the client. vCenter Server is the management system for the infrastructure of virtual machines.

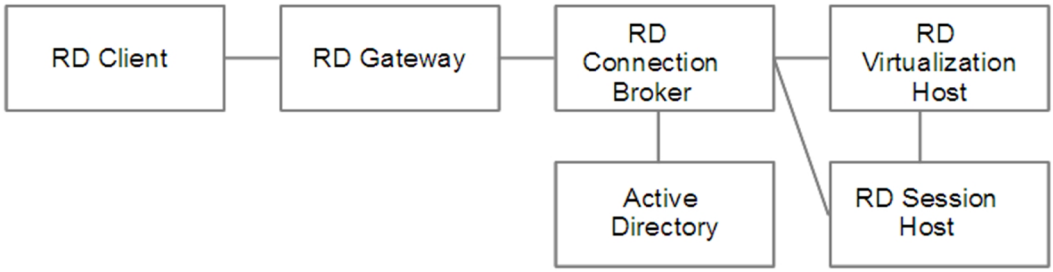


Figure 9: Microsoft RDS architecture. Picture from [52]

Figure 9 depicts Microsoft's RDS (Remote Desktop Service) architecture. The gateway authorizes external clients and secures the connection between the virtual client and server. The authentication is done by the Active Directory. The connection broker does load balancing and assigns correct resources for every client. The broker

selects a virtual machine from a virtual machine pool and gives access to each client. The RD Virtualization Host is integrated with Hyper-V (Microsofts virtualization hypervisor) for providing virtual machines for the virtual desktops. The RD Session Host is responsible for hosting windows-based programs and applications.

In [52] there are also other design and architectures. This shows that there is not one clear dominant design on the market yet.

3.3.4 Management structures in desktop cloud

Desktop cloud is a network service and like Gaynor defined [19], a network service can be implemented with a centralized and distributed management structure. This also holds true for desktop cloud. Desktop cloud is a solution that a company can implement with both a centralized management structure or with a distributed management structure. If a customer selects a centralized management structure, he chooses to connect to a provider's data center and buys the desktop hosting, purely as a service. In cases like this, the organization outsources its desktop's to a third-party, desktop cloud provider. This can be called a desktop as a service on a public cloud. If the customer chooses to insource desktop virtualization, the desktop cloud service runs in the organization's own data center and has a distributed management structure. The level of freedom the customer has over the service depends on the selected vendor. It is possible to buy the parts needed from separate vendors and the customer builds their own desktop cloud solution. By doing this, the customer has naturally, complete control over the service. But a customer can also buy a desktop cloud solution with a distributed management structure from a provider, and then the provider takes care of the infrastructure on the customer's premises. In this model, the infrastructure is on the customer's premises, but the customer shares the control of the service, with the provider.

A desktop cloud with a distributed management structure should always have more freedom and flexibility to adapt to the customers wishes and needs. With a desktop cloud solution with a centralized management structure, most of the control is in the providers hands. The provider surely listens to the customer's needs, but the customer should understand, that the provider, probably offers the same desktop cloud service for several customers, and the provider must try to suite every customers need and make compromises, to try to satisfy all its customers. A desktop cloud service with a centralized management structure is most likely very standardized, and all the

possibilities and restrictions, should be clear from the beginning when buying the service.

The management structure of the desktop cloud solution should make little to no, difference for the desktop user. The user only uses a thin client (or an application on his computer), which represents an actual desktop view, but the actual computing and processing is done in a server, in a data center. If then the data center is on the users companies premises, or a cloud providers public data center, the user will in practice, see no difference.

3.3.5 Claimed benefits of a desktop cloud solutions

The most common case for an enterprise is that most of the employees, have their own PC, laptop or dedicated workstation, a computer which its own software, hardware and OS. They are probably connected to different servers, which run business applications, external storage, or databases. But the workstation they use, are what can be called thick-clients, a client with it is own hardware and OS, and they can be used without the connection to servers.

According to Beaty and Shaikh [5], by moving most of the PC into the cloud, management costs for desktops decreases, as applications are no longer installed individually on every users PC. All updates are performed in the data center, so not only does the management costs decrease, also the manageability of companies desktop infrastructure increases and is more effective. This centralized updating is called patch management. The IT department can always be sure, that every user has the correct patch and version of the software, as the patches are installed into the server. The user does not have to worry about being on the correct patch, and does not need to go online to check that he has updated his software to the latest version. Also as most of the function is moved into a data center, on-site labor cost decreases. This on-site labor costs is help desk functions and on-site IT support staff. This cost can be cut by eliminating a large part of the supporting functions. All this cost savings mean desktop cloud should have a lower TCO than a traditional PC infrastructure. [5]

This should be very lucrative for a company with many locations and a distributed desktop infrastructure. To think there will not be any user detected problems after implementing a desktop cloud solution might be wishful thinking, but in theory,

most of the problems users face, are in the servers, hosting the desktop. So the risk of problems can be minimized, when the can be either proactively prevented by the maintenance staff in the data center, or then resolved fast by having personnel on-site with the knowledge to resolve most issues.

Besides these cost benefits, desktop cloud can also give other benefits to an organization. The security can be increased, as no confidential material is actually stored on the computer, but is all safely locked away in the server. This does not protect the company, if a malicious user gets access to the thin-client and can log into the servers, so the users are still responsible for not giving away the access and authorization rights. But a lost laptop does not cause that much harm, as it holds close to no value on its own.

Desktop cloud also offers flexibility for the users, as if given the right, the user can access his desktop from any computer with a network connection, assuming, the user has the right to create a VPN connection, to the cloud service. Besides this, older computers can also be used and there is no need to upgrade e.g. 3 year old laptops, as their own performance makes no difference, as long as these computers are able to establish a network connection.

3.3.6 Restrictions with desktop cloud and transformation

Even though the topic may be "hot" and there are clear claimed benefits with implementing a desktop cloud solution, one should not be confused and believe it is a "one size fits all" solution and that desktop cloud can be applied to anything and anywhere. There are some cases and workloads that users run on their desktops, which are not suited for a desktop cloud solution. Nothing is saying these problems would be impossible to overcome, but one should be aware of what suites the cloud computing model and what does not.

Martinez-Mateo et al [30] lists a few desktop usage scenarios, which are not well suited for a desktop cloud solution. If some workload e.g. requires heavy usage of graphic cards, the workload is not well suited for desktop cloud and to be hosted in a data center. Also latency-sensitive applications, where the time it takes an event to reach the client though a network is critical, are preferable to run on a classic desktop.

To ensure the transformation of the desktops into the cloud, Beaty and Shaikh [5] proposes a transformation planning process, a kind of assessment project. One of the first steps is user profiling, where during some predefined time period, the desktop usage in the organization is monitored. By doing this the statistics of interest are gathered, like size and utilization of memory and local disk. Number, speed, type and utilization of processors and utilization of network interfaces. Once the resources needed are clear from the user profiling, the next step is desktop benchmarking. This is done to figure out the scaling factors needed when moving into the cloud, as the mix of virtualization technologies and VDI technologies used, makes it difficult to assess the new hardware and software needed, based on purely the figures of what was used in the past. With the scaling factor from the benchmarking and the usage analysis, the capacity the organization needs in their desktop cloud solution can be planned. [5]

These transformation planning or assessment projects should be done, to ensure the right components are moved into the cloud. As stated earlier desktop cloud is not a "one size fits all" solution, so to ensure customer or user satisfaction, these issues should be noted, before subscribing/buying a desktop cloud solution.

Another issue with thin-clients in general, is of course that they per definition require a network connection. No matter which management structure model of desktop cloud is selected, a network connection is needed to run a virtual client. Personnel working in a dedicated workspace do not have to worry that much about faulty network connection. The network connection at an office should always work and there is probably always a network connection available, to access emails and other business applications. But the network might become an issue if the users are relying on public WLANs, 3G and/or GSM networks. The bandwidth needed for working with the thin-client varies between streamed application and solution models, but some bandwidth is always needed. As stated earlier, the thin-client must be capable of establishing and maintaining a network connection, but for desktop clouds solutions to work there must be a network to connect with.

3.3.7 Market uncertainty with desktop cloud based on literature

According to Gartner in [8], there were around half a million hosted virtual desktops in the world in 2009. Hosted virtual desktop (HVD) in this case, being an outsourced desktop virtualization service, which is equal to the term desktop cloud, used in this

thesis. According to Gartner the number of HVDs will be 49 million units worldwide in 2013. The revenue will increase from around $1,5 billion in 2009, to over $65 billion in 2013. They note that because of the economic recession the transformation from classic PCs to HVD units, will be delayed in the short-term, and a growing number of suppliers will not be seen before 2011 and 2012. [8]

So from these figures we can see that there is a supposed demand, but at least in 2009, the worldwide number of desktop cloud units was only 500 000. And if the adaptation is delayed by a few years, as a result of the economic recession, the number of desktop cloud units, might still not be that high, in the beginning of 2011. One should note, that these figures are not about terminals and thin clients used in organizations (e.g. Citrix solutions), but outsourced desktops, i.e. desktop cloud with a centralized management model.

This means that the market uncertainty seems to still be high towards desktop cloud solutions, as it is a relatively new solution with a low implementation rate. This is also supported by Mark Gaynor's theory. The market uncertainty is most probably high, when one can not forecast the market and the demand. We can see from Gartners predictions that they were not able to forecast the market correctly.

4 Chosen method

4.1 Qualitative case study

According to Yin [51] case studies should be used when trying to answer "why" or "how" research questions. A case study should also be used when the researcher wants to study general circumstances of the phenomenon in real-life context.

A multiple case study is selected to be able to compare the two cases and their industries. According to Yin when studying multiple cases, the objective is to identify and point out the differentiating factors. If differentiating results are found, they suggest that the results are industry specific.

According to Robson [10] (and summarized by Mäntylä in [33]) there are four things a researcher needs, to perform a case study:

- A conceptual framework
- A set of research question
- A sampling strategy
- Decide the methods and instruments for data collection

The purpose of the conceptual framework is to introduce the main features of the study and all the aspects, variables and dimensions of the case [33]. According to Yin [51] the conceptual framework works as a blueprint and preliminary theory for the case study. According to Miles & Huberman [31] a conceptual framework should be built based on literature, theories and the researchers own common sense and experiences.

According to Patton [38] purposeful sampling works better in qualitative inquiries and the sampling size can be much smaller, than in quantitative studies. When a smaller sample size is selected and not chosen randomly, the researcher can understand the phenomenon more in-depth. Patton describes how purposeful sampling drives to selection of information-rich cases to study.

The research questions can be made before the conceptual framework, but they have to reflect the conceptual framework. Also after the conceptual framework is done, the research questions have to be consistent with the framework. Case studies are not tightly dependent on the sampling strategy, but it should be selected based on the research questions and the conceptual framework. In a small case study, purposeful

sampling will answer the research questions better. The conceptual framework, research questions, and sampling strategy, decides the methods and instruments for the data collection. The case study does not rely that much on data collection techniques, as it emphasizes the trustworthiness of human instrument. [10, 33]

4.2 Research design

The unit of analysis, the case, in this thesis is an industry. There are two units of analysis in this thesis: Swedish security solutions and services industry and Swedish manufacturing and mining industry. Purposeful sampling is used to select the studied companies, and they are selected based on the sampling strategy presented later. The companies selected from the industries, are different organizations, but they all represent their own respective industry. The case is the decision-making of these companies and reason why they would or would not implement a desktop cloud solution. The context, Sweden, is chosen for keeping the scope reasonable.

A multiple-case study is selected for the replication-logic it gives the researcher. This thesis builds on theories presented by Mark Gaynor [19] and the conceptual framework that will be created from these theories. As these theories do not build on a specific industry, they should hold true for any industry. The industries selected have little in common. The purposeful sampling strategy ensures the studied companies are somewhat similar, but they represent their own specific industries. By studying two different industries the theories can be tested in different milieus. If similarities are found between the two contrasting cases, they will strengthen the reliability of the proposed theories and suggest that the theories can hold true for other industries as well.

4.2.1 Conceptual framework

First the theories and assumption made by Gaynor in [19] and presented during the chapter on theoretical frameworks will be discussed and adjusted to the subject of desktop cloud, this thesis and this case. Gaynors assumptions now becomes the writers assumptions, using common sense, knowledge about the subject, and general observations and thoughts that have been made while working in the IT sector. For the convenience of the reader, the assumptions and theories are given in table 2 below.

Table 2: Gaynor's assumption and theories about network services

ASSUMPTION 1 - The market demand for network-based services has market uncertainty. This means that service providers (which includes enterprise users) are unable to accurately predict the value they will receive for providing a service
ASSUMPTION 2 - Experimentation with services is possible, and a market exists to value the experiments. The value of a particular experiment is the success of its adoption. This experimentation is used to determine what service best matches the current market conditions in the context of what features will be the most popular
THEORY 1- The expected value of the best of n simultaneous attempts at providing a service is likely to exceed the expected value of any single experiment. As n increases, the possibility of a truly outstanding market match grows.
ASSUMPTION 3 - The payout to the service provider offering the best of n choices is nonlinear. More experimentation and greater uncertainty increase the expected value. The service provider receives this value by providing the service that best matches the market.
ASSUMPTION 4 - The less disruptive and less expensive it is to develop and deploy a service, the more experiments there will be. Experiments in networks with infrastructure allowing applications with end-2-end architecture requiring no alteration to the network infrastructure are generally less expensive and less disruptive than environments where a more constraining centralized architecture requires infrastructure change and permission.
ASSUMPTION 5 - For some services there exist business and technical advantages (BTA) that push providers to offer services that are more centrally managed.
THEORY 2 - If high market uncertainty causes the difference between the expected value of the best of n experiments and the expected value of each individual experiment to exceed the business and technical advantages of the centralized management structure, then a service provider should consider providing this service with a more distributed managed architecture. When market uncertainty is low enough that the advantage of having n choices is less than the business and technical advantages of a more centrally managed service, then providing the service with centralized management architecture makes the most sense.

Assumption 1, in seems to hold true. The evidence supporting that there is market uncertainty, from the provider side, for desktop cloud, is that there are desktop cloud solutions with both centralized and distributed management structures, offered on the market today. Some companies even offer both models (e.g. IBM [22]), which would

indicate that providers are not sure, which offer will generate more revenue, as the level of adoption gets higher, for them and value for the customer. There also seem to be market uncertainty from the customer side like discussed earlier in chapter 3.3.6. Assumption 1 and 2 are, in this case, quite tightly linked together. Experimentation is possible, like just discussed and there is a market to the value the experiments, as the value is the success of the experiments adoption. Theory 1 in this case, suggest that a provider should offer desktop cloud solutions with both centralized and distributed management structures, as there are different needs and some level of uncertainty on the market, so the provider will achieve best results by offering both models.

Assumption 3 assumes that the value the provider receives from offering a desktop cloud solution with either centralized or distributed management structure is not equal. The best result is made by offering the version that best matches the demand of the market. This assumption should hold true. One can assume that the vendor would rather offer one solution over the other, but the market demand probably drives the solution, that should be offered, to achieve best result. Assumption 4 holds true in one view-point, but might not apply to desktop cloud. Yes, the easier and cheaper it is to experiment, the more experiments there should be. But desktop cloud, and cloud solutions in general, is probably not the cheapest activity to undertake and build up for the provider. As discussed earlier, offering a cloud solution with a centralized management structure usually requires heavy investment in infrastructure, and that is especially true when talking about desktop cloud. A provider does not simply experiment with a public cloud solution, but has to believe he will receive results. The customer can experiment with public cloud solutions, by running pilots and test groups, and then expand later or end the subscription. Experimenting with a private desktop cloud solution, requires a little more resources, but if started small-scale and accepting the risk, the private desktop cloud model, should also allow experimentation for the customer. Here real options come into play. The provider does not have a real option, if he decides to invest in a desktop cloud offering he will sell to customers. After the investment in the infrastructure is made, there is no turning back. The same goes for the user, if he builds up a desktop cloud solution with a distributed management structure. But a customer for a desktop cloud solution with a centralized management structure has a real option. He can try out the service, and then later decide to either continue with the service or cancel it.

Assumption 5 assumes that there are some expectations to the earlier assumptions. There are probably times when the customer should or will select a desktop cloud solution with a centralized management structure, even if the market uncertainty is high and does not allow experimentation. A guess would be that for example, when the needed skill for insourcing a desktop cloud solution does not exist inside the organization, it is easier to outsource than to obtain the needed knowledge and skill (by recruiting or training). The customer might also already have outsourced their IT, so there is no reason to implement a desktop cloud solution in-house. Also if cost savings are wanted, it might be cheaper to subscribe the service, than starting creating it from scratch, also some employee resources could be cut down. From a provider's point of view, the value of economies of scale, gained from offering a public model might overcome the results that would be gained by offering a private or even both models.

Theory 2 then states, that with market uncertainty and depending on how the user values the freedom and flexibility of a distributed desktop cloud model, the provider should be ready to offer a desktop cloud solution with a distributed management structure. But there is some threshold, when the market uncertainty drops and value of experimentation, does not add enough value for the user, so the users are ready for a desktop cloud solution, with a centralized management structure.

Gaynor does not talk about any industry aspects, so one must assume these are universal and cross-industry theories, as long as the assumptions hold true. This is the reason two case industries were selected. If the hypothesis' hold true in both cases, it would seem that they are universally true for this network solution (desktop cloud). Any variation between the case industries, would suggest towards an industry-specific issue.

4.2.2 Research questions

The research questions for this thesis were stated earlier in the introduction. The four research questions for this study will be repeated here:

1. Triggers for a Swedish company to implement a desktop cloud solution, why would these companies implement desktop cloud solutions?

2. What are the barriers for Swedish companies to implement a desktop cloud solution with a centralized management structure?

3. What actions can a provider take to lower the market uncertainty for the customer around a desktop cloud solution?

4. Market uncertainty for desktop cloud and other cloud computing solutions among companies in Sweden?

Besides the market uncertainty pointing at which management structure should sell best, there must also be some market uncertainty towards the networks solution itself. The first research question of this thesis is to try to understand "what it takes", to get a customer to implement a desktop cloud solution at all, be it then based on either management structure model. After understanding those triggers, the second and third research questions focuses on the management structures. What would a customer require from the service to implement a desktop cloud solution with a centralized management structure? What can the providers do, to lower the market uncertainty and what are the experiments the user has to or wants to perform, before being ready to implement a solution with a centralized management structure?

The fourth and last question was formed, actually because the researcher will be given the chance to investigate a little around the thoughts around "cloud" in general, when interviewing practitioners within Sweden. What are their concerns about cloud computing, and what benefits do they believe they will receive in the future from cloud computing.

Another view on this "cloud" buzzword will also be examined. Cloud computing is a "hot" IT-trend and there is a lot of talk of cloud computing in the (IT) media. The promises of lower costs, more flexibility and efficiency should interest any manager, even if he is not in charge of IT and may even have lacking IT knowledge. Are these CIO's, interviewed feeling pressured to implement cloud computing solutions from their management?

The researcher believes there is pressure from the non-IT management on the IT departments, on implementing cloud computing solutions, as the promises made by the providers should be lucrative for any company's CEO or CFO. The researcher has no personal view on if cloud computing is the solution for everything, but believes CIO's are forced to explain to their managers what implications implementing cloud computing solutions will have. This hypothesis should be easy to test, as it is a matter of a yes or no question.

4.2.3 Sampling strategy

A purposive homogenous sampling strategy will be used, to gain more in-depth knowledge of the sub-group [38]. The selected companies should have a few things in common:

- Companies with strong presence in Sweden. The company does not have to be a Swedish company, but preferably have at least some management and control of their own organization in Sweden.
- Wide spread to many locations in Sweden. A company with several locations, might well have pains with managing their distributed desktops, and could benefit from some desktop cloud solution.
- Not a SME, but a large company (measured by employees and/or revenue)
- The companies should not have IT as their core business or have IT related core competence.

In the companies someone who has knowledge of the companies IT strategy and plans will be interviewed. This can be a manager, a strategist, or a business planner.

4.2.4 Methods for data collection

Data will be collected by qualitative interviews, which are open-ended and semi structured. A tight predefined structure is not selected, because if something new is thought of after an interview, the researcher wants to keep the possibility open, to use the new insight in the remaining interviews. Similar questions will be asked at each interview, but the discussion held with the interviewee, will dictate the order in which the questions will be asked. Also the interview question list is just a guideline for topics that should be covered.

4.3 Research process

Five to seven interviews were planned to be conducted for this thesis, during the first quarter of 2011. First a prospect list was created with 16 companies, which met the requirements made in the sampling strategy. The prospect list contained companies who met all the requirements set up in the sampling strategy, but did not fit into either of the case industries. The final prospect list that was used contained 11 companies, 3 in the security solutions and services industry and 8 from manufacturing and

mining companies. A few of the companies from the prospect list declined and did not want to participate, and some were unreachable. From five of the prospect companies, someone was found that agreed to participate in the study. 4 of the 5 interviews were completed in person, one had to be done as a teleconference.

The persons interviewed, did not wish to be mentioned by name or linked to their companies, so only their position, which case industry they represent and date of the interview, is presented in table 3 below.

Table 3: Participants of the study

Position	Case industry	Date of the interview
CIO	Security solutions and services industry	18.02.2011, over phone
Responsible for technical development	Security solutions and services industry	22.02.2011 in person
CIO	Manufacturing and mining industry	04.03.2011 in person
CIO	Manufacturing and mining industry	22.03.2011 in person
CIO	Manufacturing and mining industry	30-31.03.2011 in person

As this is in Sweden and the researcher speaks Swedish fluently, the interviews were completed in Swedish. The interview questions are presented in Swedish in appendix 1 and then a translated version is available in appendix 2. The answers and results from the interviews will be presented in English, the only Swedish in this thesis is in the appendices.

4.4 Research quality: validity and reliability

Before the interview a presentation of terminology, concepts, claimed benefits, and theories about desktop cloud, which are used in the thesis, will be sent to the interviewees. This is done to ensure that both the interviewer and the interviewed have a common understanding of desktop cloud and what is actually being studied. The slides that will be sent can be found in appendix 4. A definition of cloud computing in general will not be distributed, because of the varying definitions, the researcher wants to hear the case companies own definition of cloud computing, and does not want to risk influencing that definition by giving a personal definition beforehand.

Data triangulation is used, to validate the data. Separate interviews per case industry are performed, to validate the results and to ensure to get wide enough input and not get blinded by a single-source of data.

Transparency and replicability is important for validating the results. Transparency will be achieved by describing in detail the used methods and the research process. All material shown to the participants of the interviews will be published in the thesis, together with the used interview questions. All collected data from the interviews will also be available for further studying and analysis.

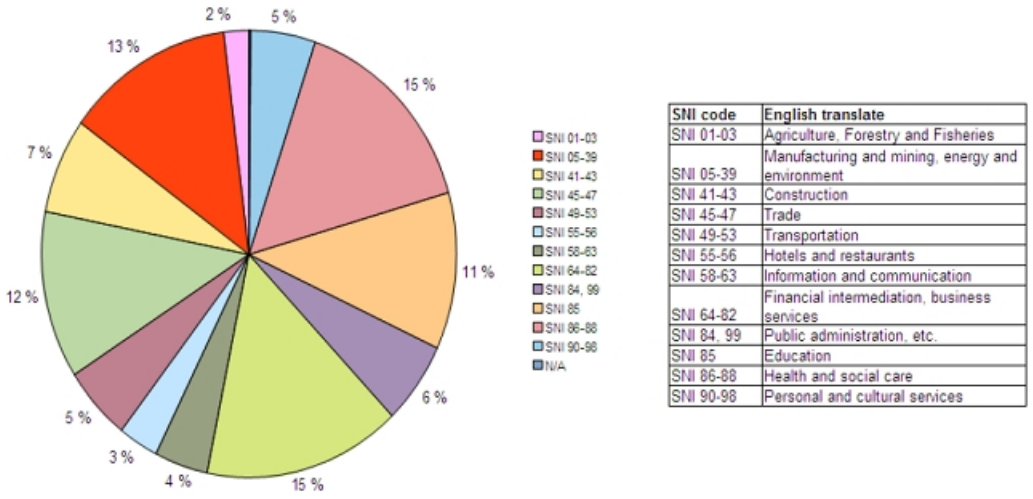
5 The case landscape

5.1 The case country

Sweden, the largest country in the Nordic, in Northeast Europe, is seen as a high developed technology country. This statement is backed up by the International Telecommunication Union's (ITU) [25] latest report from 2009 [26], which contains the ICT Development Index (IDI), where Sweden is ranked as the country with highest ICT development (all Nordic countries are in the top ten). Similar results are found by the World Economic Forum [49], in their latest Global Information Technology Report [50], where Sweden is awarded the highest scores on the Networked Readiness Index (NRI), measuring the effective use of ICT in the society. These reports show that Sweden is an information technology forerunner, globally, and has a very high technology development and readiness.

5.2 The case industries

According to SCB's [41] latest "Labour Force Survery November 2010" [42] there are 4 567 000 people employed in Sweden. SCB then divide these into 12 SNI categories that categorizes the different industries (SNI is the Swedish Standard Industrial Classification, more information and the categories are presented shortly in appendix 3). Figure 8 below shows how the Swedish work force in Sweden is divided by industry category.



SNI code	English translate
SNI 01-03	Agriculture, Forestry and Fisheries
SNI 05-39	Manufacturing and mining, energy and environment
SNI 41-43	Construction
SNI 45-47	Trade
SNI 49-53	Transportation
SNI 55-56	Hotels and restaurants
SNI 58-63	Information and communication
SNI 64-82	Financial intermediation, business services
SNI 84, 99	Public administration, etc.
SNI 85	Education
SNI 86-88	Health and social care
SNI 90-98	Personal and cultural services

Figure 10: Breakdown of the Swedish labor force by industry category

Also employee PC usage within companies in these industries is interesting. By estimating and understanding how many of the employees use computers in their work, one could size the opportunity desktop cloud solutions have within the industry. SCB has completed a study, "Use of ICT in Swedish enterprises 2010" [43], which estimates how many employees of a larger company uses PCs regularly in their work. A general result was that 2 out of 3 persons use PCs regularly with internet connection in their work. For example in manufacturing companies over 70% of the employees use a PC in their work regularly. Over 80% of those PCs have an internet connection. For services companies the PC usage per employee is a bit lower, around 70%, but of those PCs, around 95% have internet connectivity.

5.2.1 Swedish security services and solutions industry

The security services and solutions industry includes companies offering private security, surveillance services and solutions, secure transportation etc. The companies all include into the large light green part of the labor force in figure 8, SNI 64-82, financial business and business services. Financial business and business services employs over 700.000 people in Sweden, about 15% of the total workforce, the security services and solutions industry is naturally only a marginal part of that. According to SCB [41], the security industry employed 21.650 people in 2010. Of those, 16.325 were working for the 8 larger companies, employing over 500 people. The problem with the statistics is that the security companies themselves report higher employee numbers, but this is probably just a matter of varying definitions or old numbers. The largest employers in the industry are Securitas Ab with 9.000 employees, followed by G4S with 4.500 employees [44, 15]. Examples of a few other companies with over 1.000 employees in Sweden are Loomis (1.300), Paxia Security (1.200) and Niscayah (1.000) [28, 35, 34]. The companies in the industry vary from large multinational companies operating globally to smaller, local players.

5.2.2 Swedish manufacturing and mining companies

Manufacturing and mining companies are part of the SCBs SNI 05-39. They are in the same category as energy and utilities companies, so the 13% of the Swedish workforce, that are in this category are not all working in the manufacturing and mining industries, but a large part are. The industry relies heavily on export and is

dependent of the global economy. Among the industry, are the companies who got hit hard during the recent economic downturn.

This companies are naturally mostly in distant locations, away from larger cities. The mining companies are naturally close to the mines and mineral extraction sites. The manufacturing companies, at least the larger ones, have large factories also outside of major cities. Administrative staff and management can of course be located anywhere, and the well-known companies, have at least one office in one of the larger cities of Sweden.

6 Case: Swedish security services and solutions industry

6.1 General view on cloud computing solutions

One would not expect companies operating in the security services business, to be able to outsource their complete IT operation to a third-party IT-provider. But does that make implementing cloud computing solution altogether impossible? It became quite clear during the interviews that the answer is no. Operating in the security business, does not stop these companies from looking at cloud computing solution or even implementing them. The general view within these companies was that some of the information they are handling is too sensitive to be trusted to any other party and the data must be kept in-house. Some data is not even allowed to leave Sweden, even if the companies are operating internationally, and wanted to e.g. build a larger cloud solution with a distributed management structure, serving multiple international locations, it would not be possible because of legal issues.

Both of these companies had some public cloud computing solution implemented in their organization today. The view was that the solutions bought as a service, are not feasible to implement in-house, because of cost reasons, lack of skills or resources. It is more effective to buy them from a provider as a service. Example of solutions bought as a service, are email cleaning, CRM solutions and similar noncritical business functions.

One may note that for example a company's CRM system is probably critical for the line of business. But they are not applications with the highest availability requirements. So it can be defined as a noncritical function, as the business can still function, despite the CRM system being down on random occasions.

None of these companies have cloud computing solutions in any technology roadmap or IT strategy, and there are no general strive to implement more cloud computing solutions. When planning to implement new application or solutions, cloud computing solutions are objectively considered, if feasible, but not, according to the persons interviewed, actively prioritized. This would suggest that the market uncertainty towards cloud computing, in the Swedish security solutions industry, is not remarkably high and companies are willing to look at solutions with centralized management structure. But the market uncertainty is not so low yet, that a solution with centralized management structure would be preferred over other options. This

suggest that a cloud computing solution provider offering solutions with both centralized and decentralized management structures should be able to reach the best result. As the centralized solutions are not prioritized, the decision to out- or insource a functionality will be made case by case.

When discussing possible management pressure to implement cloud computing solutions, the views vary a bit between the interviewees and their respective companies. In one of the companies the view is that the IT department drives the private cloud discussions. They want to have a more automated, standardized and virtualized IT infrastructure, to have a flexible and managed infrastructure. They do not feel pressure from their upper management to implement more cloud computing solutions. The business side, doing applications development, does not care if the application platforms are cloud based or not. But in the other company, the interviewed person said, his managers are asking why they are not implementing more cloud computing solutions.

This points towards the fact that this seems to be related to the company culture and management culture. In one company the upper management and business side let the IT department take care of IT without interfering or getting involved with their decisions. In another company the upper management is more involved with the IT department's decisions and projects. There is probably an optimal, balanced mix of management involvement and IT department autonomy, for reaching the most productive results.

When considering that the companies in the security services and solutions industry have actually bought cloud computing solutions, it seems that for at least noncritical business functions, the business and technical advantages of these solutions favor a centralized management structure. So at least the market uncertainty toward cloud computing solutions is so low that companies in this industry are not afraid to buy and implement cloud computing for noncritical business applications. But as stated earlier, providers should still continue to offer solutions for both centralized and distributed management structure, because business critical functions are not yet planned to be "moved into the cloud".

6.2 Desktop cloud solutions

6.2.1 General view on desktop cloud solutions and perceived value

The studied companies have experience with thin clients or applications giving thin client control functionality. Thin client like functionality refers to a thick client, which uses an application window to get access to a specific desktop and OS lying on a server, which does the computing. While using the application, the thick client, does not use its own computing resources, so it operates like a thin client. There are a few hosted thin clients in the companies, but the number of users is small. The thin clients are hosted in the company's own data centers.

The IT departments at these studied security companies, all have similar challenges with their workstation infrastructure today. A lot of unmanaged desktops at several different locations that are outside of the control of the IT department. Making sure each employee's PC has the correct application patch is also a "headache" for the IT department. Updates are distributed, so that a user downloads the latest patch and then completes the update. The problem is, that workers can forget to check which patch they are on, or then they do not log onto the company intranet over a VPN, so the updated patch can not be pushed to the user. Being on the wrong patch causes security vulnerabilities and the IT department does not have the control they would like to have or need.

The scattered geographies these companies have, seems to cause them problems and "pain". There are thousands of laptops at several offices and customer sites, in- and outside of Sweden, with users needing varying kinds of on-site support. The distributed support needed, is expensive and cumbersome for the IT departments. The centralization of the support to the data centers is clearly something these companies would like to have.

The view among the interviewees from the security companies towards desktop cloud solutions can be called positive. A desktop cloud solution with a complete centralized management structure was not though, seen as a realistic solution.

6.2.2 Triggers that could lead to an implementation

One general concern when talking with these companies was the network part of the virtual desktop. No mater, which management structure of a desktop cloud solution

is selected, a network connection is needed to run the virtual client. Personnel working in a dedicated workspace do not have to worry that much about faulty network connection. The network connection at an office should always work and there is by default a connection, to access emails and other business applications. The view within these companies is that the network connection at the offices are good enough and the annoyance of temporarily losing the use of your terminal, would be worth it, if desktop cloud would solve the current PC caused "headaches".

The big issue is concerning the mobile workers working from remote sites that can not be called "offices" and where there is not a network connection available by default. The mobile workers seemed to be using 3G mobile modems when working on remote non-office sites, but the general experience with these mobile modems are not that satisfying that these companies would entrust the whole client to depend on that network connection. The problem seems to be that these remote sites can be so remote, that a 3G connection is not even available and then the speed of the connection drops so much, these companies do not see a desktop cloud solution for these remote workers, as a feasible solution.

From this, one clear trigger for a possible implementation can be seen, and it is solving the technical issues around the network requirements.

Then these companies also use equipment that are connected and operated by a PC, e.g. a card/finger print recognition device, connected to a PC. It would be cost-effective to replace these PCs with a thin client, but historically this equipment has not worked well with hosted PCs. The reason seems to be that ports used in the hosted PCs, are not recognizing the equipment and transferring the generated traffic correctly to the hosting servers. There must be proof that this technical equipment would work with a desktop cloud solution. The proof of concept would have to be done by the solution provider, there is no interest in these companies having to undertake and complete the study themselves. So a trigger would be, clearing all technical doubt by the provider.

6.2.3 Barriers against public desktop cloud solutions

None of the companies sees a desktop cloud solution with a completely centralized management structure bought from a third-party desktop cloud vendor, as a realistic solution. A hybrid solution might be possible, so that most of the management is

distributed, but some parts could be bought from a third-party vendor. One concern is the business area they are operating in. These companies core business is handling sensitive, private and possibly classified information. They are not willing to entrust that information to any outsider and some of the information even has to stay in-house because of legal issues.

Even if it would not be a legal issue per se, these companies store and maintain sensitive and highly private information, which they have promised their customers to keep safe and private. The loss of reputation would have an enormous impact on these companies, if some of the information would be leaked out by a third-party, they shared the information with.

When asking but-if questions and trying to find other barriers, and playing with the thought that there would not be any legal issues, another barrier also came up. Desktop cloud solutions with centralized management structures, are still so new, these companies are not interested in being among the first ones to implement these. One reason for not being among the first ones is the fear of possible hidden costs. Another is that they are not ready to trust a desktop cloud vendor with the control of their entire desktop infrastructure.

This means that within this case industry there are three distinct barriers towards a desktop cloud solution with a centralized management structure.

Table 4: Barriers against selecting a public desktop cloud solution

Business constrains	The company's core business is to handle private and sensitive information, even if they would not be legally bound to store some of the information within the company, they are not going to entrust the data to an outside vendor, with one reason being the fear of loss of reputation
Legal concerns	Companies within this industry have a legal obligation to ensure that some of the information they are handling, does not leave the country
Market uncertainty	The companies fear the hidden costs and unexpected problems that can present when being among the first ones to implement a new solution

6.2.4 Market uncertainty with desktop cloud solutions

As mentioned during the barriers discussion, these companies have no interest in implementing a desktop cloud solution with a centralized management structure as it is seen as a too young technology and they do not dare to be among the first one implementing these kinds of solutions. This is clearly a sign that the market uncertainty,

within the security solutions and services industry towards desktop cloud solutions, is high. All the studied companies see benefits with desktop cloud solutions, but are not prepared to be "pilot-customers". And this is assuming the legal issues would not be a problem. The industry they work in will probably dictate, at least for a foreseeable future, the solutions being handled in-house, with a distributed management structure.

Other signs that according to Mark Gaynor suggests a high market uncertainty is the lack of a dominant design. These companies can build a desktop cloud solution completely in-house. Hardware from different providers, software from someone else and then put it all together themselves. There are also different solutions offered by different desktop cloud service providers. This lack of a dominant design and general agreement between industry providers shows the market uncertainty is high. The solutions are not commodity-like, so features will most probably be the most important issue when deciding to implement a solution.

7 Case: Swedish manufacturing and mining companies

7.1 General view on cloud computing solutions

In the interviews with the manufacturing and mining companies, all the respondents said the same thing during different parts of their interview: cloud computing is not yet a mature solution model. They all think cloud computing will play a more important role in their industry in the future, but the solutions and/or the providers are not mature enough, at least yet. The view seems to be that cloud computing is getting a lot of attention, but not entirely without justification. But all three CIO's said that a lot of the attention and discussion is started by the providers, pushing their solutions, and the demand from the customer side, is not as high as e.g. the IT literature seems to suggest.

None of these companies had implemented solutions they considered to be cloud computing solutions, or had been sold by a vendor that would call the solution cloud. One of the companies had an ongoing case, where they were looking at a SaaS solution for a specific business application. But before buying anything the IT department will make sure that the security and stability of the solution is on par, with the companies own requirements. Another company stated that they consider cloud computing solutions each time they look at new solutions, but they have not been convinced to buy a solution yet. They do not prioritize cloud solutions, but they are at least looking at them in most cases. The last company said they are following the cloud discussion and that there are some plans to buy noncritical business applications as a service, but there are not any concrete cases at the moment.

These companies all have different IT roadmaps and IT action lists, but cloud computing is not mentioned in any of these lists. Cloud is discussed, but they are not ready yet to state in a roadmap that they will actually buy and implement more cloud computing solutions. One of the companies said that they are renewing their IT strategy and roadmap in the near future, and if the strategy becomes a five-year plan, cloud computing will most likely be mentioned.

When asked if any of these CIO's felt pressure from their upper management to implement more cloud computing solutions, the answer was no. They are not being pressured to implement cloud computing solutions per se. They all feel they are responsible for their own companies IT and their management has faith in them to

make the correct choices when it comes to IT. Naturally their management pressures them to solve different problems and issues, but if the solution is cloud computing, it is up to the IT department to decide. None of them feel they have ever had to defend for their management, why the IT department has not implemented cloud solutions.

These companies have not yet implemented any cloud computing solutions and according to the CIO's the solutions are not even mature enough for noncritical business applications or functions. They are looking at solutions and following the discussion, but the fact that nothing have yet been implemented, shows the market uncertainty for cloud computing solutions with centralized management structures, are still high within the Swedish manufacturing and mining industry.

7.2 Desktop cloud solutions

7.2.1 General view on desktop cloud solutions and perceived value

All three companies have some experience of thin clients and at least some PC users in the companies, uses a virtual client instead of a traditional physical PC. The current thin client usage is marginal, ranging from a few percent up to ten percent of their desktops being thin clients. When asked if they see any benefits from the thin client usage, answers were positive. The benefits they see from thin clients is the manageability the thin clients gives the IT department.

Two of the three companies have thin clients that are hosted by an outsourcing partner, the last one hosted the thin clients in-house. The reason the first two do not see their hosted virtual desktops as a cloud computing solution, is because the solution is not as flexible as a cloud computing solutions should be, the pricing model is not based on usage, and they do not feel they buy the solution as a service. But the two companies, who outsource the service, do trust the data to be handled by a third-party service provider. The last company who host the solution in-house, did not mention trust issues to be the reason, why they have not outsourced the function, it is more in line with their overall decision, to keep most of their IT, in-house.

The problems their current unmanaged desktops cause are pretty similar between the companies. The distributed support needed to maintain all the PCs on different sites, is ineffective and expensive. Patch management is also an issue, when the IT department is not sure if all the users are on the correct version and in some cases the

new versions even have to be installed manually into each and every computer used in the company. The patch management is tightly linked to security and a user on old versions of an application causes a security issue and a threat to the companies PC infrastructure. Also individual smaller issues were found in each company. One problem is backups. Even if there is an automated backup application installed on every PC, the users switch them off from time to time, and the IT department is never sure, if each user has completed a timely and proper backup of their computer.

7.2.2 Triggers that could lead to an implementation

All of these companies see the value of a desktop cloud solution and on some level they would like to implement the solution. But they all have one major concern, mobility and the network requirement. Exactly the same point was brought up during the interviews within this case, as it did in the first one. Mobile employers, working in non-office locations, where a broadband network connection is not guaranteed. The CIOs all said they can see some of the administrative personnel work with a thin client as they have a dedicated workspace, but the mobile workers, can not be dependent of a 3G network, that may or may not be accessible for them.

So as seen with the security services and solutions industry in case 1, one trigger for implementing a desktop cloud solution, is solving the technical issues revolving around the network requirements.

One of the companies has had a few hundred thin client users in one region for the last two years. There are now plans to start to implement more thin clients in the other region the company operates in. The users today are administrative personnel, so if the plans go through and there will be a broader implementation in the organization, the users will be administrative personnel as well. But here one can see the value of an "internal reference". After using successfully in one part of the company, there is a good chance the usage will increase in other parts as well. So a trigger for desktop cloud is "internal reference", and how a successful small-scale implementation, can give the IT department confidence in the solutions, leading to a broader implementation.

7.2.3 Barriers against public desktop cloud solutions

These companies did not have a real issue with solutions with a centralized management structure and as stated earlier, two of the companies had a selected outsourcing partner, who does IT operations for them. The last company has decided to keep their IT in-house, because they do not see IT outsourcing, being able to actually improve their overall efficiency; "*as long as we are efficient enough, there is no need for us to outsource our IT*" the CIO said. But he also said that if outsourcing in general would be more effective, they are not against it, but now, there is no need. It was also quite clear that if the two companies, with outsourcing partners, would implement a desktop cloud solution with a centralized management structure, the entity managing the service, would be their current outsourcing partners.

So these companies are not against solutions with centralized management structure, but the solution provider, must have the reputation and be able to prove, that they are able to deliver the service. These companies have to trust their outsourcing partner. So a possible barrier for choosing a desktop cloud solution with a centralized management structure is the third-party service provider itself, or the lack towards the provider, from the customer side.

Also two of the companies said they want to see reference cases or proof of concept, and not just with desktop cloud solutions, but with most of the solutions they buy. It was implied that a reference case shown by a provider, is not enough, the reference must come from someone they trust and be more than a "public" reference. So a possible barrier is the lack of a trusted reference.

7.2.4 Market uncertainty with desktop cloud solutions

One of the companies has plans to increase the numbers of thin clients in their organization. The plan is still in an early phase, but it is being rolled out from one location to several of the company's location. The number of PCs that will be thin clients, if they fulfill their current plans, is still marginal compared to thick clients.

The companies who have an outsourcing partner are not afraid of the centralized management structure, for them desktop cloud would be a natural next step in IT outsourcing. For the company with the insourced IT, there is no reason to outsource this function, so it would stay in-house. But there must still be quite some market

uncertainty towards the actual solution, because a larger implementation of hosted desktops in the cloud is not planned at the moment.

Here we can also see the same issues pointing towards high market uncertainty, as we saw in case 1. There is no agreement between industry desktop cloud providers or a dominant design. Based on Mark Gaynor's theories, the market uncertainty must be high towards desktop cloud in the Swedish manufacturing and mining industry. This is also supported that desktop cloud solutions are not seen as commodity. Price will not be the biggest issue if and when implementing a solution, the choice will be made based on the features offered to the customer.

8 Summary of case data

This chapter shortly summarizes the collected data found in the case studies.

8.1 View on cloud computing

Table 5: Statements about cloud computing

Statement	TRUE	FALSE
The term "Cloud" is in a IT or technology roadmap	-	IIIII
The company has implemented a solution viewed as cloud computing	II	III
Cloud computing solutions are considered whenever new solutions must be implemented	III	II
Cloud computing is something that will be more important in the future and customers will receive benefits from it	IIIII	-
Management pressure to implement cloud computing solutions	I	IIII
Ready to implement a business critical function as a cloud computing solution	-	IIIII
Currently a large part of IT is outsourced	II	III

Table 5 shows individual results from all the companies. Different statements have been made, which then are either true or false.

There are some clear trends that can be seen from these individual results. Cloud computing is not yet mentioned in any IT roadmaps or internal strategies, so it seems there is no strive to actually implement more cloud computing solutions. This mostly suggest that companies understand that cloud computing is not automatically a solution to everything, and the companies do not feel they have to implement cloud computing solutions just for the sake of implementing cloud solutions. This is something that could be seen in both case industries. But cloud computing solutions are already implemented in a few companies, and companies are starting to consider cloud computing as a solution model, when new solutions are implemented.

As mentioned already in the case chapters earlier, companies are not ready to buy business critical functions from a cloud provider. This is also something that is universal from case company to case company, and there is no difference between the case industries. This is also a matter of definition. Two of the companies have most of their IT outsourced today to an outsourcing provider. This is clearly a business critical function, but is seen as "trusted", when it has not been sold as cloud computing.

There is also clearly no pressure from the higher level management on the IT department, to implement more cloud computing solutions. Only one recipient mentioned that he feels some pressure from his management, asking why the company is not implementing more cloud computing solutions.

8.2 View on desktop cloud

Table 6: Individual company findings about desktop cloud

What problems faced today, would desktop cloud solve?	**- patch** management **- eliminate** local support **- improve** backup automation	**- eliminate** distributed support **- better** managed security with patch management, control of the update cycles	**- eliminate** distributed support **- improved** patch management **- better** control	**- better** lifespan of the equipment **- distribute** needed tools faster **- cost** savings, from patch management and centralized support	- **scattered** geographic, causes expensive support **- update** distribution would be easier **- PC** refresh cycles would be easier to handle
Issues needed to be solved?	- network dependency	- network dependency	**- network** dependency **- proven** availability **- technical** issues	- network dependency	**- successful** PoC **- functionality** with other equipment
Management structure of a possible future solution?	Centralized	Distributed	- Distributed - Hybrid solution could be possible	Centralized	Distributed
Barriers currently preventing buying a desktop cloud solution with a centralized management structure?	**- follows** closely what another company does, so if the other company would implement something like this, it would be a good enough reference **- must** be offered by a provider they trust	**- don't** see cost benefits with outsourcing, efficient enough on their own **- provider** with "correct" reputation could be chosen	**- business** constrains **- fear** of hidden costs with new solutions	**- lack** of trust towards a possible solution provider **- lack** of a "trusted" reference case, would stop them from buying a solution	**- business** constrains **- no** interest in being among the first ones to "test" a new solution

Table 6 present individual findings from the case companies concerning desktop cloud solutions. When reading the table one should note, the answers are not in a logical order and have been scrambled, to ensure the privacy of the individual answers. This has been done, because the interviewees were promised, that their answers would not be linked back to the company they represented.

From the answers two universal problems that a desktop cloud solution would solve, can be seen. Patch management is clearly an issue with the current PC infrastructure. Distributed support is also cumbersome and inefficient, and could be solved with a desktop cloud solution.

Also a universal issue can be seen. The network dependency is a concern for all of the case companies. The question about the selected management structure of a possible future implementation directly reflects the company's current IT outsourcing strategy. Companies that outsource their IT to a partner would also implement a desktop cloud solution with a centralized management structure, if they would at some point buy a desktop cloud solution. Companies with insourced IT would select a solution with a distributed management structure.

Lastly, common barriers can also be seen. When the solution is something new, these companies are not interested in being among the first ones to implement it. There is fear of hidden costs and unexpected problems. They have to see a trusted and valid reference case, before they would consider buying a solution from a vendor.

9 Discussion and findings

This chapter discusses and analyses the collected data from the case studies. First all the desktop cloud related findings are discussed and after that cloud computing in general. Finally the findings are linked to the theory and the created conceptual framework.

9.1 Desktop cloud

9.1.1 Possible future market for desktop cloud

Table 6 in chapter 8.2, highlights some of the individual results found in each company involving desktop cloud. One of the requirements made for the case companies, was that they are distributed to several locations, and the results clearly shows that it is a real issue for these companies. Each and every company says the distributed support needed to maintain and help the users with their PCs is ineffective, cumbersome, and/or expensive. The ease of handling all the support locally, by a few technicians taking care of the desktop-hosting servers, or all support being taken care of by a service provider, clearly tempts the CIOs and the IT department.

Patch management was also mentioned in some form in each company. There are quite different methods today used in these companies, to make ensure every user is on the correct patch and to distribute new patches to different applications. The methods are ranging from quite crude and simple, to more advanced pushing methods, where a new patch is pushed to each user. But none of these companies is satisfied with the way it is handled today. Users on wrong version of an application can cause security vulnerabilities, but just the lack of control and the time consumed to ensure, every user is on the correct version of an application, is a problem for the IT departments today.

Many saw the possibility to implement more hosted desktops in their organization today. This would mean e.g. giving the static workers a thin client instead of a thick client. Where this was discussed, the conclusion was that almost half of the current PC users in a company could be using a hosted desktop instead of full physical desktop.

There were also some individual answers, of what a desktop cloud solution would solve, some listed in table 6 and in the earlier chapters, some possible benefits are individual company problems, related to a specific unique issue, and these are not listed in the thesis. But it is quite clear that the current PC infrastructure's in these companies, cause problems today and some could be solved by a desktop cloud solution. This shows that a market for desktop cloud solutions exists, and it is really a solution in it is correct form, as there is a problem that needs to be solved.

The problem is that there are still clear issues, which have to be solved.

What can also be seen from the data is the preferred management structure a possible future implementation would have, which seems to be directly linked to the general outsourcing decisions made in the company. Those who would outsource the function have already outsourced large parts of their IT. So when desktop cloud solutions is proven to be a working solutions and the concerns towards it has been solved, desktops can well be a natural new area to outsource.

9.1.2 What is stopping an implementation

A non-industry specific barrier for implementing a desktop cloud solution is the issues with mobility and the required network connection. As a client, per definition, must be able to connect to a network, there is a lot of concern, how the mobile users would be able to work with their thin clients, if they would have to rely on an available network. The mobile network will improve, 3G and 4G network coverage is increasing. But at the moment, no one is going to trust their laptop availability of their workers into the hands of a network provider. A possible solution for these mobile workers would be a laptop, with a thin client application window, so when a network is not available, the workers could still use their PC.

This is only an issue for mobile workers, as mentioned earlier, close to 50% of the workers are working in an office at a dedicated workspace, so a hosted desktop would work well for them. This solution would solve some of the problems the IT departments are having with their current PC infrastructure.

9.1.3 Implementation triggering factors

There are clear benefits companies think they would receive from implementing hosted desktops, be they then hosted in a public or private cloud. These benefits are

also what the IT department desires. The network requirement is still an issue, and there are some technical details that would have to be solved, before a complete company-wide implementation is possible. But IT departments and CIOs understand the benefits of the solution; it is the technical concerns that must be solved. This leads to a clear trigger, if a provider shows how a user is supposed to overcome the concerns with desktop cloud, customers are open towards the solutions.

Another trigger would probably be the "internal reference" mentioned in one of the cases. As many of the respondents mentioned, more hosted desktops could be implemented in their organization, by the employees, which are static, working at a dedicated workstation. These workers could well use thin clients and work like a pilot-group. If hosted desktops succeed, the IT department should gain more confidence in the solution and a broader implementation within the organization can be possible.

One should also note that hosted desktops can be next in line for outsourcing, if a company has chosen to outsource most of their IT. Because if IT outsourcing is currently done, the plan is probably to outsource as much as possible, so desktop outsourcing can well be a natural next step. This of course requires that the current outsourcing partners should be able to provide desktop cloud solutions.

9.1.4 Barriers against centralized management structures

When trying to determine the barriers against a centralized management structure, one can look at the market uncertainty. As there are a limited amount of reference cases, no one is interested in being the first one to try out a solution with a centralized management structure. The reason is the fear of the hidden costs a new solutions model might bring. None of these case companies are really interested in being the reference case for a provider. The manufacturing and mining companies, who had outsourced their IT, do not have a problem with a desktop cloud solution with a centralized management structure, but it would have to be managed by one of their current outsourcing partner, who they trust.

When using the theories by Mark Gaynor on deciding the market uncertainty, we can see that the market uncertainty is high towards desktop cloud, and it is not industry specific. Desktop cloud service providers have different approaches how to set up a desktop cloud infrastructure. There is clearly no agreement between the providers.

There is also no dominant desktop cloud design. Also as mentioned earlier in the thesis, no one seems to be able to predict the market, so the market uncertainty must be high, if using the definitions given by Mark Gaynor's theories.

Desktop cloud is the focus of the thesis and is the only solution that is being studied, so there is no real data about other cloud computing solutions, if not taking into account the general cloud computing discussion. But the barrier against a desktop cloud solution with a centralized management structure might be applicable to other solutions as well. Many of the cloud computing solutions with centralized management structures are new ways to deliver a certain function as a service. As it is something new, just like seen with desktop cloud, customers are not interested being among the first ones to implement a new solution. This is not a fact that can be drawn from the collected data, but a hypothesis, which one can draw from the gathered information.

9.1.5 Actions provider can take to lower the market uncertainty

Actions providers can take to lower the market uncertainty for desktop cloud? Be sure the solution model is complete and all the questions around it are solved. As the results show, these companies do not want to be the first ones implementing a solution. They want to see a trusted reference, which shows that there are not any big surprises waiting for them, after an implementation. What counts as a surprise, is individually defined, but these surprises are probably expensive, and they cause future costs.

The provider must also have the "correct" reputation and a clean "track-record". The customers will believe a trusted provider, when the provider gives the reasons, why the customer’s desktops should be hosted in a cloud. This again underlines the importance of reference cases, the provider must be able to prove, they are capable of managing the service for the customer, or that the infrastructure they sell, gives the customer the promised solution.

Outsourcing partners can be able to influence the choice to implement desktop cloud solutions or not. Companies accustomed to IT outsourcing, see no reasons, why their desktops could not be outsourced as well. It just requires that one of their current outsourcing partners can offer desktop cloud solutions and show the customer, how the solution works, and how it should be implemented. A clear action IT outsourcing

companies should take is start to look at desktop cloud solutions and try to include them in to their offered solutions portfolio.

Something else desktop cloud providers can and should do, is sell an assessment project, like the one found in the literature study earlier. By doing a transformation planning study, the vendor would have evidence to support, which company desktops could be virtualized and hosted. A transformation plan would naturally have to be done, if a customer decides to buy a desktop cloud solution, but if done in advance, the results of the study, could well help in the sales process. This is not something that will lower the general market uncertainty towards desktop cloud solutions, but should help with individual cases.

9.2 Cloud computing

As seen in the cases, some companies have implemented cloud computing solutions today in their organization, for various noncritical business functions. Most of the cloud solutions implemented are based on SaaS models, where the customers are buying an application as a service, instead of having to manage a platform hosting the application. But none have yet gone so far, that they would state, even internally, that they will strive to implement more cloud computing solutions. This is seen from the fact that not one of these companies has any cloud solution in their technology roadmaps or IT action lists.

But the view is clearly that there is something beneficial with cloud computing solutions, and it is more than empty promises. Only one company said that they are not really looking at cloud solutions at all today, but even in that company the CIO said, they are actively following the discussions and believe cloud will be important in their industry. The CIOs in the manufacturing and mining companies, all said the solutions are not yet mature enough, but they all follow the discussion around cloud computing, and one company had an active case, and the last company said they look at the cloud computing version of a solution, when planning to implement new functions. The security services and solutions companies already implemented cloud computing in some parts of the organizations.

A possible course companies will take, like the security companies in this case have done, is first to start looking at outsourcing noncritical functions into the cloud. If getting positive effects and experience from these solutions, the companies will start

to trust the cloud computing model. This will lead to either the customer buying more solutions from the providers cloud offering portfolio, or then take the step to start looking at other providers as well. The possible first cloud computing solutions will probably be based on SaaS, buying applications as a service, instead of having a platform to host the application.

So customers have faith in the model and believe they will benefit from the solution model, but the market uncertainty is clearly still so high, that noncritical business functions are currently the only functions that are moved, or considered to be moved, into a cloud with centralized management structure.

The lack of management pressure to implement cloud computing solutions is unexpected. Not because the researcher believes cloud computing is a solution for everything and something all companies should implement, but as there is so much talk about the subject and the benefits providers claim everyone will receive, the assumption before the study, was that the CIO's would at least have to defend to their managers why they are not looking at more cloud computing solutions, and also explain to their managers why cloud computing is not the solution to all their challenges. The lack of management pressure towards cloud computing in this case, might of course just be a result of the non-IT management, having low expectations towards cloud computing, and don't believe in the claimed benefits.

9.3 Linking findings back to theory

Theory 1 stated that a provider will reach the best result by offering a solution with both centralized and distributed management structures, as there is market uncertainty towards desktop cloud. As found during the case studies, there is demand for a desktop cloud solution, as current PC infrastructure of these companies causes problems and there is at least a wish to make it more efficient. Already within this small sample size, which had hand-picked case companies, the findings shows that some companies wish to outsource the service, and some insource. Even though there are clear reasons why the security services and solutions companies will prefer a distributed model, there is also demand for an in-house solution in companies, which are not used to IT outsourcing. So a providers aiming at making the most revenue, will succeed, if they offer a desktop cloud solution with both a distributed and centralized management structure.

Theory 2 in this case covers more the whole cloud computing discussion, without taking into consideration what the actual solution is. As told by some of the interviewees, some solutions are not just worth designing and maintaining in-house, as IT is not in these companies core business. There are business and technical advantages that cause customers to look at solutions with centralized management structure, even though there is market uncertainty towards cloud computing.

10 Conclusions

The purpose of this thesis is to study the market uncertainty of cloud computing solutions in general, but especially the market uncertainty towards desktop cloud solutions and triggering factors leading to an implementation. The study has been completed as a multiple case study in Sweden, with two case industries, mining and manufacturing industry and security services and solutions industry. This last chapter summarizes the results of the thesis, evaluates the study and proposes possible future research areas around the subject of cloud computing solutions. After that, the implications of the thesis is presented and what recommendations the researcher wants to give, based on the findings of the study.

10.1 Key findings

There is a clear market for desktop cloud solutions, both with centralized and distributed management structures. Companies are facing challenges with their current PC infrastructure and desktop cloud would be a possible solution. A triggering factor for an implementation is showing customers a "trusted" reference, which shows where in the organization they should implement a desktop cloud solutions, what its current shortcomings are and how and when technical concerns will be solved. Mobile users and the network requirement is an issue, and must be solved before a full company-wide implementation is possible.

A barrier against implementing a desktop cloud solution with a centralized management structure is the lack of trust in a provider. There is no interest among these companies to be a provider's first customer, as there is fear in hidden costs and unexpected problems. Companies accustomed to IT outsourcing are willing to look at a desktop cloud solution with a centralized management structure, but it must be offered by one of their current IT outsourcing partners. So it seems desktops are becoming the next natural steps in IT outsourcing, at least for companies looking to outsource their IT.

At the moment cloud computing is seen as a concrete solution model among IT practitioners and customers are starting to become ready to also look at cloud computing solutions when implementing new business functions. Public cloud offerings are only trusted to handle noncritical business functions, any business critical functions are still handled in-house. For companies looking or accustomed to IT-outsourcing

the questions seems to be, what solution is next to be bought as a service and ready to be "moved into the cloud". Companies that have not chosen IT-outsourcing as their IT strategy are also looking at cloud computing solutions, for those functions that are not worth developing and hosting in-house.

10.2 Evaluation of the findings

As mentioned earlier in chapter 4, transparency and replicability is important for validating the findings and results. All material shown to the participants of the interviews, are published in the thesis, together with the used interview questions. All collected data from the interviews is also available for further studying and analysis. The interviewees were all aware of the company the researcher worked in, but it was made clear from the start, that the researcher was not there to promote any companies solutions or products, but to complete an academic study. This resulted in that the researcher employer was not mentioned in particular during any of the interviews.

This means that similar results should be achievable by any researcher, if the same methods would be used in either of the case industries. But as the technology cycle in the IT industry is very rapid and cloud computing is far from a mature solution, just the general cloud computing market uncertainty could be review in less than a year, and already new findings would be possible to make. A few years later, the cloud computing findings in this thesis could be obsolete, as cloud computing has either become a somewhat standardized solution model, which users have embraced, or the term cloud is forgotten, and IT as a utility has taken another form. The underlying technologies enabling cloud computing solutions will not be lost, but be a vital part of how customers consume IT solutions. For a service provider a virtualized, standardized, and automated IT infrastructure, delivering economies of scale benefits, will be as important as it is today, regardless if the service is called cloud or not. This thesis gives the methods and tools that can be used when investigating the market uncertainty and management structures with new network solutions.

As seen in the thesis, companies are becoming ready to buy noncritical business functions as a service. In this area a clear future research project can be proposed. If companies are becoming ready to move noncritical business function into the cloud, when will cloud computing solutions be mature enough, to host business critical

functions? And when will services with centralized management structures be secure enough, in the customer's eyes, to handle private and sensitive data?

For the desktop cloud part of this study, a certain replication logic could be used right away in new research projects. Either desktop cloud is studied in other industries, to test the finding made in this thesis, but also another replication logic is available. This thesis concentrated on one cloud computing solution. The same research questions could be made within the same industries, but changing the solution from desktop cloud to another cloud computing solution.

10.3 Implications

This thesis has a few implications. For desktop cloud providers, with either distributed or centralized management structures, this thesis shows there is a market for the solutions, as there are distinct problems with the current PC infrastructure within companies. But it also shows that the solutions are not yet seen as good enough, and either functionality needs to be improved or then, providers have not been successful communicating that these issues would have been solved. For providers offering other cloud computing solutions, this thesis can work as a frame, used to determine the usefulness of a solution in possible customer's eyes.

For academics, the thesis strengthens the reliability of available methods when studying new network based solutions. The thesis also contributes to the ongoing and growing amount of academic research performed around the subject cloud computing. For fellow researchers the thesis presents methods available for studying cloud computing solutions, or other network based solutions.

10.4 Recommendations

Cloud computing discussions will likely continue to grow for at least a few years into the future. Currently the whole concept is seen as a mega trend and there is a lot of discussion around it in the IT world. The problem with the current discussions is that without a proper definition, there is confusion on what exactly can be considered to be cloud computing, for some it seems to be just SaaS, for some there is more depth behind the concept. A recommendation this thesis will give, is for providers to try to decide themselves what of their offerings they consider to be cloud computing and what is not. This will help if and when the buzzword "cloud" starts to fade, and

customers are starting to look for an exact definition. Hopefully there will be at least some de facto standards, created by the IT industry, to define what can and what can not, be considered cloud computing.

Another recommendation can also be given based on the results of this thesis. Companies today outsourcing part of their IT, seem to be committed to that, and the message was, that as much as possible of their IT should be outsourced and not managed in-house. For these companies, desktop outsourcing can be a natural new area to outsource, but the solutions have to be ready and proven to work. So IT outsourcing providers should start including desktop cloud offerings in their solutions portfolio, and actively try to improve the offering and to start convincing their customers, that desktops can also be outsourced to a provider.

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12 Appendix 1 - Original interview questions

Bakgrund och introduktion

- Bakgrund till studien och om forskaren
- Information om den intervjuade
- nuvarande ansvarsområde och roll inom företaget?
- kort yrkesbakgrund och föregående ansvarsområden?

Allmänna frågor om molntjänster

- Det saknas idag en exakt defintion över vad cloud computing är. Vad betyder molntjänster/cloud för er?
- Mycket pratas om molntjänster och det känns som att t.ex. ComputerSweden har varje vecka flera artiklar/nyheter om cloud och molnlösningar. Hur intresserad är ni emot molntjänster i ert företag?
- Har ni implementerat någon molntjänst i ert företag? Vad i så fall?
- Gör ni konkret något för att försöka implementera molntjänster i ert företag och skulle vilja implementera någon lösning, eller är det mera så att ni följer med diskussionen och trenden, men håller det ännu klart i bakgrunden?
- Har ni molntjänster i någon technology roadmap? Om ja, har ni tänkt 2011-12, eller är det mera en del av en 5 års plan och kanske först 2013-14
- Enligt din personliga åsikt, eller ditt företags, tycker du att detta med molntjänster är mera hype, eller är det något ni tror att kan ge er, och andra företag i er bransch, konkret nytta?
- Känner du att det finns en press från din ledning att implementera mera molntjänster?
- Finns det någon lösning som skulle ge er klar nytta om det skulle erbjudas som en molntjänst? Något ni skulle villa se?

Allmänt of företagets IT idag

- Hur ser er IT infastruktur ut idag? Har ni många datacenter i flera olika lokationer?
- Försöker ni konsolidera er IT idag?
- Outsourcar ni er IT idag? Vilka delar i så fall?

Desktop cloud - virtuella skrivbord

- Hur bekanta är dessa teknologier och lösningar? Har ni prata om lösningar som dessa, internt eller med någon leverantör?
- Hur låter allt detta? Är idén och konceptet förståelig och låter lösningen vettig?
- Orsakar era anställdas datorer idag "huvudvärk" åt er IT-avdelning?
    - hurdana problem? Kan du nämna t.ex top 3?
    - Hur ser er PC infrastruktur ut idag?
- Tycker du att några (eller alla?) er problem idag skulle kunna lösas, med att ge användarna endast en tunn client och sedan sköts allt arbete i en server som sköts av anställda hos er, med rätt IT kunskap?
- Är det något som oroar dig med en lösning som denna?
- Skulle en implementation orsaka några nya problem?
- Vad tror ni att ert företag skulle ha för nytta av att implementera en desktop cloud lösning?
- Alla datorer skulle ju inte behöva flyttas till molnet, det kan ju bara vara en del av organisationens datorer som flyttas. Var tror du att det skulle finnas mest nytta i er organisation?
- Skulle det betyda några stora förändringar inom er IT, att personal datorernas infrastruktur är i er kontroll?
- Vad skulle du se, att ert företag skulle kräva att få se, före ni skulle kunna implementera en desktop cloud lösning?
- Om ni skulle implementera en sådan tjänst vid något skede, tror du att ni skulle välja en distribuerad eller centraliserad modell?
- Enligt en teori upplagd av Mark Gaynor (2003) i sin bok 'Network Service Investment Guide: Maximizing ROI in Uncertainty Times', påstår han att kunder kommer inte att implementera en centraliserad lösning, om osäkerheten i kunden ögon är för hög.
- Ser du att denna hypotes stämmer? När lösningen och tekniken är lite obekant och ny, skulle du hellre själv villa att ni har infrastrukturen hos er (vilket då skulle vara en private desktop cloud lösning). Eller anser du att det kan vara bättre att låta någon utomstående sköta om infrastrukturen?
- Anser du att det finns en osäkerhet mot just desktop cloud? Hur är det med molntjänster i allmänhet?

- Vad skulle du säga att just nu är orsaken att ni inte har en desktop cloud lösning i planerna implementerad? Finns några orsaker, subjektiva/objektiva, som klart gör att ni inte "kan" implementera en sådan lösning just nu?
- Vad borde en leverantör göra för att få er intresserad av en molnlösning eller t.o.m implementera en?
- Om det kommer fram att de har planer på en desktop cloud miljö, eller redan implementerat detta
- I vilket skede är planerna och hur långt har ni kommit?
- Vill ni nämna hurdan lösningsmodell ni valt och kanske av vem, eller på basen av vems teknik?
- [Om de inte vill säga av vem] (utan att nämna några namn) på vilka grunder valde ni er desktop cloud leverantör?
- Fanns det några konkreta vinnande argument?
- Var det en lång process att bestämma sig och fanns det någon osäkerhet från er sida, och i så fall, vad var osäkerheterna?

13 Appendix 2 - Interviews questions in English

Background and introduction

- Background of the study and the researcher
- Information about the interviewee
- current position and responsibilities within the company?
- short career background and previous responsibilities?

General questions around cloud computing

- Today there is not a definitive definition of what cloud computing is. What does cloud computing mean to you and your company?
- As you probably know there is a lot of discussion and writing about cloud computing today in Sweden and local IT journals. How interested is your company in cloud computing?
- Have you implemented any cloud solutions? What in that case?
- Are you attempting to implement cloud computing solutions in your company and are there functions, you would like to implement as cloud? Or are you just paying attention to the discussion, but keeping it in the background?
- Do you have cloud computing in any technology roadmaps? If yes, is it a e.g. 2011-12 roadmap or part of a e.g. 5 year plan, reaching to 2013-15?
- According to you, and/or your company, do you feel cloud computing is more hype, or is it something that will provide clear benefits to you and others in your industry?
- Do you feel pressured by your management to implement more cloud computing solutions?
- Is there some solution that would give you benefits it it was provided as a cloud computing solution? Something you would like to see?

General questions about the companies IT

- Could you tell me about your current IT infrastructure? Data centers?
- Are you attempting to consolidate your IT today?
- Do you outsource parts of your IT today? Which parts in that case?

Desktop cloud - virtuella skrivbord

- Are these technologies and solutions familiar to you? Have you spoken about these kinds of solutions, internally or with a provider?

- How does it all sound? Does the idea and concept sound reasonable?
- Does your workers PC's give your IT department any "headache"?
  - what kind of problems? Could you mention e.g. top 3?
  - could you tell me about your current PC infrastructure?
- Do you think some (or all) of the problems you are facing, could be solved by giving the users thin clients and all the workload is on a server, which is maintained and administrated by you?
- What benefits do you believe your company would gain if implementing a desktop cloud solution?
- Are there things that worry you, with solutions like these?
- Would an implementation cause new problems?
- All PCs would not necessarily have to be moved into a cloud, it could only be a part of them. Where in your organisation, would you receive the most benefits by implementing a desktop cloud solution?
- Would an implementation cause any larger changes in your IT department, when the personnel's PCs are in your control?
- What do you think, your company would require to see, before you could implement a desktop cloud solution?
- Would a possible future solution have a centralized or distributed management structure?
- According to a theory presented by Mark Gaynor (2003) in his book 'Network Service Investment Guide: Maximizing ROI in Uncertainty Times', he claims clients will not implement a solution with a centralized management structure if the market uncertainty is too high.
- Do you think this theory is correct? When a solution is new, would you rather have it in-house, or do you think it would be better to outsource the functionality?
- According to you, is there market uncertainty towards desktop cloud? How about towards cloud solutions in general?
- What would you say is the reason that you don't have a desktop cloud solution implemented today? Are there any clear reasons, subjective/objective, to why you can't implement such a solution today?
- What do you think a provider can do, to increase you interest towards cloud computing solutions or even get you to implement one?

If it were to turn out, that they have already implemented or planning to implement a desktop cloud solution

- What is the status of the plans and how far have you come?
- Are you willing to tell me what kind of solution model you have chosen and based on who's technology?
- On what bases did you choose your desktop cloud provider?
- Where there any concrete winning arguments?
- Was it a long process to choose the solution model and where there any uncertainties from your side? In that case, what?

14 Appendix 3 - SNI explanations

SNI - Svensk Näringsgrensindelning, Swedish Standard Industrial Classification, a model by SCB, based on EU's standard NACE (Nomenclature statistique des activités économiques dans la Communauté européenne, in english Statistical Classification of Economic Activities in the European Community). SNI divides and categorizes the industry activities in Sweden.

SNI code	SCB's Swedish definition	English translate
SNI 01-03	Jordbruk, skogsbruk och fiske	Agriculture, Forestry and Fisheries
SNI 05-39	Tillverkning och utvinning, energi och miljö	Manufacturing and mining, energy and environment
SNI 41-43	Byggverksamhet	Construction
SNI 45-47	Handel	Trade
SNI 49-53	Transport	Transportation
SNI 55-56	Hotell och restaurang	Hotels and restaurants
SNI 58-63	Information och kommunikation	Information and communication
SNI 64-82	Finansiell verksamhet, företagstjänster	Financial intermediation, business services
SNI 84, 99	Offentlig förvaltning m.m.	Public administration, etc.
SNI 85	Utbildning	Education
SNI 86-88	Vård och omsorg	Health and social care
SNI 90-98	Personliga och kulturella tjänster	Personal and cultural services

Sources:

- SCB Labour Force Survery November 2010 [42]
- Wikipedia article: Swedish Standard Industrial Classification http://en.wikipedia.org/wiki/Swedish_Standard_Industrial_Classification cited 21-12-2010
- Wikipedia article: Näringsgrensindelning

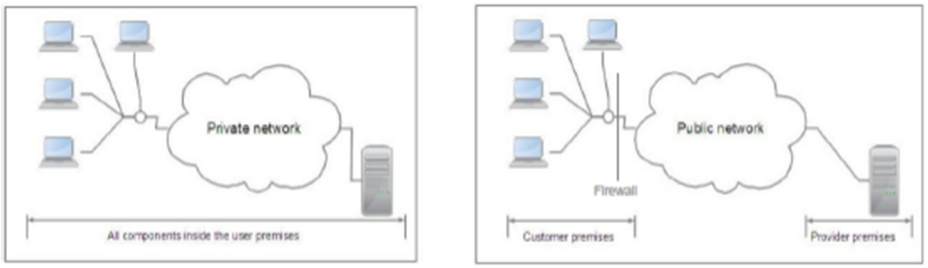
http://sv.wikipedia.org/wiki/Svensk_N%C3%A4ringsgrensindelning cited 21-12-2010

15 Appendix 4 - Presentation of concepts and terminology

This presentation was sent to all the interviewees before the interview.

Desktop Cloud

Del av Jonas Löfmans Master Thesis vid Aalto Universitetet



Jonas Löfman
Presentationen är gjord och ägs av Jonas Löfman, representerar endast definitioner och koncept som används i hans Master Thesis, skrivet för Aalto Universitetet i Finland

Bakgrund om examensarbetet

Arbetet är ett slutarbete för diplom-ingenjör examen vid Aalto Universitetet (före detta Tekniska Högskolan) i Finland. Examensarbetet är en fallstudie, som görs i Sverige.

"Working title":

"Management structures and market uncertainty towards a desktop cloud solution. A case study with Swedish companies"

Arbetet försöker besvara följande forskningfrågor

1) Triggers for a Swedish company to implement a desktop cloud solution with either a centralized or distributed management structure?

2) What are the barriers for a Swedish company to implement a desktop cloud solution with a centralized management structure?

3) What actions can a provider take to lower the market uncertainty for the customer around a desktop cloud solution?

4) Market uncertainty for desktop cloud and other cloud computing solutions among industrial companies in Sweden?

Jonas Löfman

Desktop cloud – virtualiserade skrivbord

Lösningsmodeller

- *"Virtual desktop on a private cloud"* infrastrukturen administreras i användarens datacenter och trafiken är inom företages brandvägg
- *"Virtual desktop on a public cloud"* infrastrukturen är hos en leverantör, och användaren köper lösningen som en tjänst

Fördelar

- Säkerhet: "patch management", alla användare på rätt version av mjukvara
- Centraliserad support, avskaffa decentraliserad support
- Administration och kontroll av företagets PC:n är på IT-avdelningen
- Lägre TCO med virtualiserade datorer, än med traditionella PC:n

Jonas Löfman

Koncept och terminologi

Desktop cloud = virtualiserade skrivbord

Hård- och mjukvaran flyttas från den fysiska datorn (bärbar, stationerad eller pekplatta) till en server. Användarens dator blir en tunn klient, som är kopplad till denna server över ett nätverk. Användargränssnittet är endast en replikerad bild, som överför användarens handlingar till servern.

Distribuerad och centraliserad administrationsmodell *(enligt Mark Gaynor)*

En nätverkslösning kan administreras antingen centralt eller distribuerat. Centraliserad administration betyder att användaren har outsourcat administrationen åt en leverantör. Distribuerad administration är fallet, då företaget själv administrerar lösningen.
(Termerna, publikt och privat används mycket, när man pratar om molntjänster)

Marknadsosäkerhet *(enligt Mark Gaynor)*

Osäkerheten i val av teknik och administrationsmodell i både användarens och leverantörens ögon

Experimentering *(enligt Mark Gaynor)*

När kunden och/eller leverantören prövar sig fram med olika modeller av samma lösning, för att hitta den administrationsmodellen och exakta lösningen, som ger mest nytta.

Jonas Löfman

Hypoteser och antaganden om nätverksbaserade lösningar

baserat på Mark Gaynors "Network Service Investment Guide" 2003

Antagande #1

Leverantörer är osäkra över vilken lösnings-modell de borde erbjuda; om lösning är ny och det är oklart vad exakt kunderna efterfrågar.

Antagande #2

Det går att experimentera mellan olika lösningsmodeller och en leverantör kan erbjuda flera modeller av samma lösning. Det finns en marknad för att utvärdera de olika lösnings-modellerna.

Hypotes #1

En leverantör kommer troligen att göra bättre resultat och ha större framgång genom att erbjuda olika lösningsmodeller samtidigt, istället för att erbjuda en lösningsmodell i taget.

Antagande #3

Desto enklare det är att att experimentera mellan olika lösningsmodeller, desto mera kommer kunder att pröva olika lösningsmodeller. Det är oftast lättare att experimentera med en lösning som har en distribuerad administrationsmodell.

Antagande #4

För vissa lösningar är affärs- och tekniknyttan så stor, att leverantörer kommer att erbjuda en lösning som de administrerar centraliserat, fastän det skulle finnas en mycket hög osäkerhet mot lösningen.

Hypotes #2

När osäkerheten är hög mot en lösning, kommer troligen en distribuerad förvaltningsmodell att ge bättre resultat för en leverantör. När osäkerheten mot lösningen är låg, kommer kunder troligen att få mera värde av lösning med centraliserad administration.

Jonas Löfman

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