Aalto University
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Financial Aspects of Cloud Computing Business Models

Information Systems Science

Master's thesis

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AALTO UNIVERSITY SCHOOL OF ECONOMICS **ABSTRACT**
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The purpose of the study was to explore financial aspects of cloud computing business models from information technology (IT) services provider's perspective. The financial aspects were divided into revenue model and related pricing mechanisms and cost structure and related cost accounting mechanisms according to business model ontology.

Cloud computing is a new computing paradigm and the latest megatrend in IT industry developed as a result of the convergence of numerous new and existing technologies. It is characterized by provision of rapidly scalable and measurable IT capabilities as a service on on-demand and self-service basis over the network from common resource pool.

The study was carried out as a single case study in a global company offering IT services for large enterprises and public organizations and currently preparing to introduce its own cloud services. Ten semi-structured interviews were conducted with managers of the case company for exploring the financial aspects of cloud services. Qualitative data analysis was employed for processing and summarizing the findings.

Findings of the study suggested that each cloud service should have a distinct business model. The business model is a mediating construct that translates the new technology to the service's value proposition. The business model also defines appropriate pricing and cost accounting mechanism for a service. The business models are based on services provider's position in cloud computing value chain. A cloud computing business logic framework was created to illustrate the interaction between the value chain, business models and its elements.

The key cost types of services do not necessarily change much with cloud computing. Cloud computing has still potential to significantly reduce services provider's costs through reengineering of production architecture. A cloud computing cost accounting model was created to illustrate how production costs should be aggregated and distributed.

Pricing of services changes with cloud computing and pay per use and subscription-based pricing mechanisms are most typical for cloud services. The pricing should be based on customer's perceived value instead of production costs of services. A generic cloud computing pricing mechanism that combines pay per use and subscription mechanisms was created to better balance risk sharing between services provider and customer.

The main contributions of the study were the establishment of services provider focus in cloud computing literature and discussion of financial aspects of cloud computing.

Keywords: cloud computing, business model, revenue model, pricing mechanism, cost structure, cost accounting mechanism

AALTO-YLIOPISTON KAUPPAKORKEAKOULU **TIIVISTELMÄ**
Liiketoiminnan teknologian laitos
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Tutkimuksen tavoitteena oli tarkastella pilvitietojenkäsittelypalveluiden liiketoimintamallien taloudellisia näkökohtia informaatioteknologian (IT) palveluiden tarjoajan näkökulmasta. Taloudelliset näkökohdat jaettiin liiketoimintamalliontologian mukaisesti tuottomalliin ja siihen liittyviin hinnoittelumekanismeihin sekä kustannusrakenteeseen sekä siihen liittyviin kustannuslaskentamekanismeihin.

Pilvitietojenkäsittely on uusi tietojenkäsittelyn paradigma, joka on kehittynyt lukuisten uusien ja olemassa olevien teknologioiden lähentymisen seurauksena. Sille on luonteenomaista nopeasti skaalautuvien ja mitattavien IT-voimavarojen toimittaminen palveluina yhteisestä kapasiteettireservistä verkon ylitse tarpeen mukaan ja itsepalvelupohjaisesti.

Tutkimus toteutettiin yksittäistapaustutkimuksena globaalissa yrityksessä, joka tarjoaa IT-palveluja suurille yrityksille ja julkiselle sektorille ja valmistelee tällä hetkellä omien pilvipalveluiden lanseeraamista. Kohdeyrityksen johtajien kanssa suoritettiin kymmenen teemahaastattelua tarkoituksena tarkastella taloudellisia näkökohtia pilvipalveluissa. Laadullinen aineiston analyysi suoritettiin tulosten käsittelemiseksi ja tiivistämiseksi.

Tutkimuksen tulokset viittasivat siihen, että jokaisella pilvipalvelulla tulee olla erillinen liiketoimintamalli. Liiketoimintamalli on sovitteleva rakennelma, joka muuntaa uuden teknologian palvelun arvolupaukseksi. Liiketoimintamalli myös määrittelee sopivan hinnoittelu- ja kustannuslaskentamekanismin palvelulle. Liiketoimintamallit pohjautuvat palveluntarjoajan asemalle pilvipalveluiden arvoketjussa. Pilvitietojenkäsittelyn liiketoimintalogiikan viitekehys luotiin arvoketjun, liiketoimintamallien ja niiden elementtien vuorovaikutuksen kuvaamiseksi.

Palveluiden pääkustannustyypit eivät välttämättä muutu paljon pilvitietojenkäsittelyn myötä. Pilvitietojenkäsittelyllä on kuitenkin mahdollisuus merkittävästi supistaa palveluntarjoajan kustannuksia tuotantoarkkitehtuurin uudenorganisoinnin kautta. Pilvitietojenkäsittelyn kustannuslaskennan malli luotiin tuotantokustannusten keräämisen ja jakamisen kuvaamiseksi.

Palveluiden hinnoittelu muuttuu pilvitietojenkäsittelyn myötä ja käytönmukaiset ja tilauspohjaiset hinnoittelumekanismit ovat tyypillisimpiä pilvipalveluille. Hinnoittelun tulisi pohjautua asiakkaan kokemalle arvolle palveluiden tuotantokustannusten sijaan. Yleinen pilvitietojenkäsittelyn hinnoittelumekanismi, joka yhdistää käytönmukaisen ja tilauspohjaisen mekanismin, luotiin, koska se tasapainottaa paremmin riskinjakoa palveluntarjoajan ja asiakkaan välillä.

Tutkimuksen pääkontribuutiot olivat palveluntarjoajan näkökulman tuominen pilvitietojenkäsittelytutkimukseen sekä pilvitietojenkäsittelyn taloudellisten näkökohtien tarkastelu.

Avainsanat: pilvitietojenkäsittely, liiketoimintamalli, tuottomalli, hinnoittelumekanismi, kustannusrakenne, kustannuslaskentamekanismi

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1 Introduction

Cloud computing is the latest megatrend in information technology (IT) industry. Although definitions still vary greatly, it could be loosely described as the delivery of software and hardware as services over the Internet. Cloud computing has been described as a technological change brought about by the convergence of a number of new and existing technologies (Skilton 2010). It is widely believed that cloud computing is a new disruptive computing paradigm[1]—however, defining what cloud computing actually means and understanding how it affects the industry remains still rather unclear because both industry and academia largely lack exact understanding and consensus of the nature and scope of this novel phenomenon (Armbrust et al. 2010, Lin et al. 2009).

Cloud computing is often seen as a part of larger development towards long-dreamed vision of society where computing is delivered as a utility (e.g., Zhang et al. 2010). Buyya et al. (2009) see 21st century where computing is being transformed to commoditized services and delivered as standard utilities such as electricity and telephony. Carr (2005, 2008) compares the shift to Internet-based computing to the rise of electric utilities in the early 20th century. Utility computing concept is not new[2] but cloud computing is seen as the realization of the paradigm (e.g., Armbrust et al. 2010). As computing as a utility is somewhat declamatory vision, some have also argued that cloud computing means just about commoditization of IT services (Harmon et al. 2009, Yeo et al. 2009).

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[1] Great majority of both popular and academic literature use concept of "computing paradigm" in context of Cloud Computing without further defining what it actually means. Computing paradigm presumably refers to the low-level foundation how the delivery and implementation of IT services are organized.

[2] Computer scientist and the Turing Award recipient John McCarthy was arguably the first to refer to utility computing in MIT Centennial 1961: "If computers of the kind I have advocated become the computers of the future, then computing may someday be organized as a public utility just as the telephone system is a public utility… The computer utility could become the basis of a new and important industry." (Qian et al. 2009).

If cloud computing is able to transform IT services something as prevalent as electricity—something that economists call as general-purpose technology (GPT) because it affects so powerfully the entire economy—the potential impact on society's welfare would be massive. For example, Etro (2009) has calculated that cloud computing has a significant contribution on the European Union's growth and wealth. According to Wyld (2009), it is likely that entirely new industries will be birthed over the next decade because of the shift towards cloud computing.

The expectations for cloud computing are currently sky-high. Paradoxically, albeit there is no agreement what cloud computing exactly is, there seems to be widespread consensus that it will greatly change the IT industry on all levels of the computational ecosystem. For example, special report of The Economist (Anon. 2008) believe that cloud computing "will undoubtedly transform the information technology (IT) industry, but it will also profoundly change the way people work and companies operate."

Despite of the high expectations, cloud computing has also many critics—the exaggerated hype, lack of clear definition, and general novelty of the concept makes it very controversial topic. First group of critics believe that cloud computing is nothing more than a new fancy name for old technologies and operating models that the industry has been using for decades. For example, in his famous address Oracle's chief executive officer Larry Ellison stated that "[t]he interesting thing about cloud computing is that we've redefined cloud computing to include everything that we [the IT industry] already do" (Farber 2008). Term "cloudwashing" has been introduced for referring to the marketing trick of selling old products and services under cloud brand (Adamov & Erguvan 2009, Staten 2009). The second group of critics does not believe in cloud computing paradigm itself. For example, Durkee (2010) do not believe that cloud computing in its current form could be growing and profitable business for IT services providers in the long term.

Whether cloud computing is "the next big thing" or not, it has gotten enormous attention in the industry (Tai 2009). The year 2009 has been called as the year of cloud computing (Lin et al. 2009) and every major IT vendor has presented their strategy to capitalize on cloud computing. For example, Microsoft has stated that company's vision "builds from this cloud base" (Gohring 2010).

The business opportunity in cloud computing is expected to be enormous. The leading IT research and advisory firm Gartner (2008) predicts cloud computing to become as influential as e-business. In Gartner's (2010) recent report, they forecast worldwide cloud services market's revenue to surpass $68.3 billion in 2010 and reach $148.8 billion by 2014. IDC (2009) predicts worldwide IT spending on cloud services to reach $42 billion by 2012. However, the impressive figures have been criticized to as greatly exaggerated.[3]

A vast number of cloud services have already emerged. For example, there exists Microsoft Windows Azure operating system, Google Docs productivity suite, and Salesforce's Force.com service development platform, all working on the cloud. A textbook example of cloud computing is Amazon Web Services that sells computing infrastructure such as storage, memory, and processor capacity as services via self-service web portal and bills customers according to pay per use pricing mechanism. However, as Buyya et al. (2009) and Zhang et al. (2010) remind, it should be borne in mind that cloud computing uptake has only just begun and many systems are still in the proof-of-concept stage.

Enterprises have quickly expressed their interest towards cloud computing.[4] In IDC's (2009) recent survey conducted with IT executives and chief information officers (CIO) across

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[3] Treadway (2010) has analyzed Gartner's figures and calls them "entirely useless" and "misleading" because of faulty accounting methodology. For example, out of $68.3 billion total cloud services spending forecasted for 2010, $32 billion (accounted under "Business Process Services") comes from online advertising, which should be also counted as cloud spending according to Gartner's methodology. Treadway feels that it is highly questionable to call online advertising as cloud computing.

[4] Interestingly, in Finland the adoption of cloud computing is above average. According to a recent survey (Avanade 2010) conducted with 502 executives and IT managers of large enterprises in 16 countries, 13%

Asia/Pacific (excluding Japan), they found that 41% of respondents are either evaluating cloud solutions for use in their businesses or already piloting cloud solutions. On the other hand, IDC also recently reported that nearly 60 percent of European chief information officers are already using cloud services—even if they do not realize it (Cooter 2010). The public sector also wants its share from cloud computing's expected benefits: United States and Japan has national cloud computing strategy (Qian et al. 2009) and United Kingdom announced in 2009 that all its future IT purchases must be "consistent with cloud computing" (Hunter 2009). However, according to Information Systems Audit and Control Association's (ISACA) IT Risk/Reward Barometer survey (Wade 2010), only 10% of organizations plan to use the cloud for mission-critical IT services, most likely due to security concerns as 45% of all IT professionals saying that the risks of cloud computing outweigh the benefits.

The key driver behind cloud computing adoption is potential cost savings with cloud-based services, as indicated by 50% of respondents in the study by IDC (2009). On one hand, cloud computing could dramatically lower the need for upfront investments in IT and ongoing maintenance. On the other hand, cloud services are billed according to pay per use pricing mechanism so that customer only pays for the capacity actually used (Wyld 2009). In a case study by Khajeh-Hosseini et al. (2010a), it was found that moving from in-house data center to cloud infrastructure would incur 37% cost saving over 5 years. However, Tai (2009) reminds that cloud computing research is still at a very early stage of modeling and understanding of costs and benefits.

The rapid increase in the number of cloud computing workshops, conferences, and papers indicates that the phenomenon has quickly captured also scholars' interest. However, the scope of the current literature is still fairly narrow. According to Khajeh-Hosseini et al. (2010b), existing works have mostly focused on technical problems and little has been written about the research challenges from an enterprise or organizational perspective. Li et al. (2009)

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of Finnish respondents used only cloud-based services compared to 4% globally. Also, according to a survey by CA (Karkimo 2010), only 3% of Finnish enterprises consider cloud computing as temporary trend.

note that only few approach cloud computing from the perspective of services provider and the lack of research makes it difficult to assess the economic risk of cloud services provider. Many scholars (e.g., Cai et al. 2009, Weinhardt et al. 2009b, and Wyld 2009) argue that more research on the business side of cloud computing need to be done to help services providers to create innovative cloud business models and to get cloud computing to grow and develop in sustainable manner and become financially viable operating model.

In particular, the implementation of adequate revenue models and pricing mechanisms for cloud services is often mentioned as a critical challenge because pricing is expected to be one of the key changes compared to current paradigm (Bhargava & Sundaresam 2004, Denne 2007, Klems et al. 2009, Weinhardt 2009b, Wyld 2009, Yeo et al. 2009). The costs of providing cloud computing services seem to be even less covered topic than the pricing. According to Li et al. (2009), there are currently no tools available for proper cost calculation and analysis in cloud computing environment. Analyzing the cost structure of cloud services is also critical because some critics (e.g., Durkee 2010) have claimed that revenue from cloud services is not able to support the costs of providing the services.

1.1 Review of Cloud Computing Literature

The current body of literature on cloud computing is still relatively small.[5] The search term "cloud computing" was looked from the abstracts of articles published in scholarly (i.e., peer reviewed) journals and at best about 250 articles was found (**Figure 1**). For comparison, a similar search conducted with term "web 2.0," which may be regarded as somewhat similar recent IT megatrend, resulted over 1,100 records in Scopus digital library that currently holds the greatest number of records on cloud computing articles.

[5] In Finland, the academia has barely addressed cloud computing. There exists only two Master's thesis level works by Kettunen (2009) and Ristola (2010).

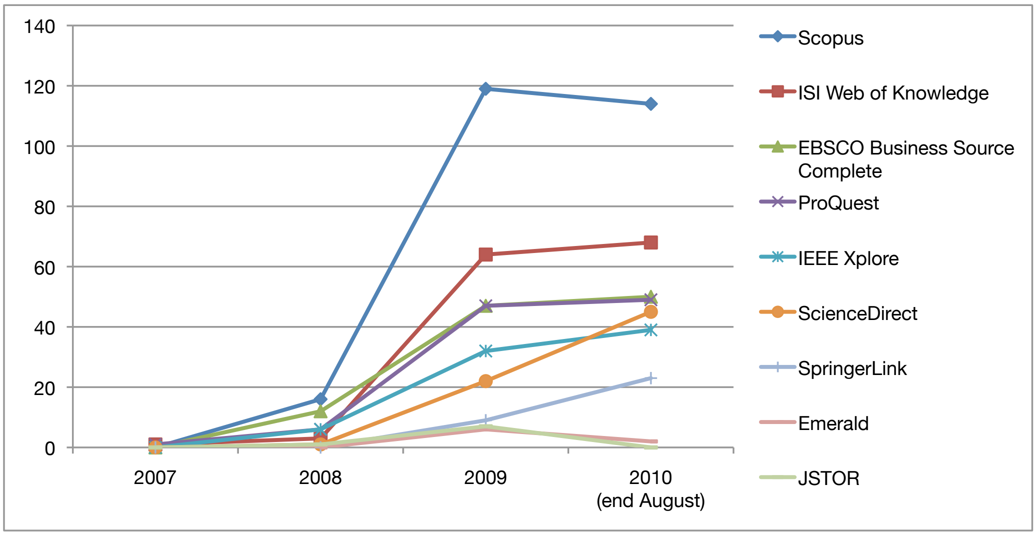

Figure 1. Number of scholarly cloud computing articles.

Arguably the earliest academic reference and attempt to formulate cloud computing dates back to 1997 to a paper at The Institute for Operations Research and the Management Sciences (INFORMS) conference. Chellappa (1997) used term cloud computing for a "computing paradigm where the boundaries of computing will be determined rationale rather than technical limits." The first scholarly papers actually addressing cloud computing date back to 2007 and the number then surges during 2008. The number of conference papers addressing cloud computing is currently over 700. White papers such as often-cited IBM's technical report on cloud computing (Boss et al. 2007) started to appear during 2007.

Sriram and Khajeh-Hosseini (2010) found in systematic literature review that academia appeared to be lagging behind the rapid developments in field of cloud computing. They also found that the research is split into two distinct viewpoints. One investigates the technical issues of clouds, and the other looks at implications of cloud computing on enterprises and users. It should be noted that enterprises here refer to customers of cloud services. The literature considering implications of cloud computing on cloud services providers (e.g., Buyya et al. 2009, Durkee 2010, Weinhardt et al. 2009a, b) still remains very limited. The articles addressing cloud computing from business or management perspective (e.g., Creeger 2009, Iyer & Henderson 2010) typically just introduce cloud computing paradigm and discuss the key benefits and issues of cloud services.

Figure 2 illustrates published cloud computing articles by subject areas as appeared in Scopus digital library. As easily noted, the amount of cloud computing literature in business and management context is very small.

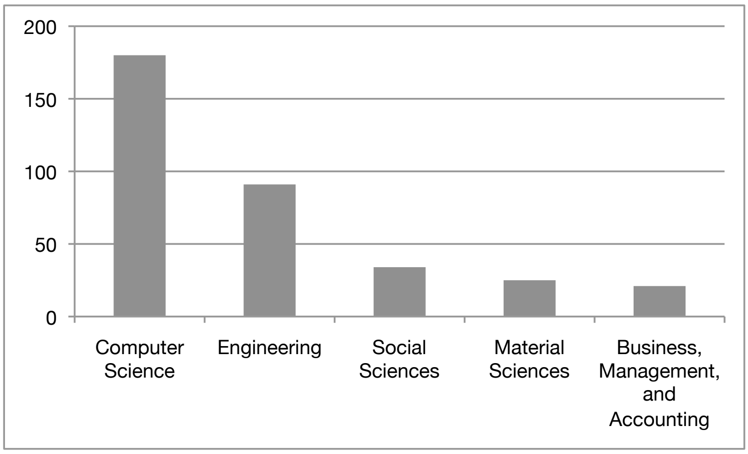

Figure 2. Cloud computing literature by subject areas.

Tai (2009) suggests naming the emerging field of research in cloud computing to "Cloud Service Engineering," which is defined as a "discipline that combines business and technology thinking for purposes of engineering Cloud services."

1.2 Purpose, Methodology and Scope of the Study

The purpose of this study was to explore financial aspects of cloud computing business models from IT services provider viewpoint. The financial aspects of business models are further divided to revenue model its pricing mechanism and cost structure and its cost accounting mechanism elements. The explorative approach was considered most suitable because cloud computing is still a novel phenomenon and the literature lacks of solid theoretical foundation to build on.

The primary research question of this study was what are the key considerations in financial aspects of cloud computing business models.

The study included an empirical part that was carried out as a single case study. The selected case company was a global IT, research and development, and consulting services provider, who is aiming to introduce a number of cloud computing services in near future. Number of interviews with selected managers from the case company was conducted to acquire information on the research topic.

There were some delimitations in the scope of the study. First, the study was limited to business-to-business market (including public organizations) because the case company does not operate on business-to-consumer market. Second, only financial aspects of business model were discussed although business models have many other elements as well. This delimitation was made to because financial issues were considered the most important at the moment and also to keep the length of the analysis reasonable. Third, the study was delimited to services provider's viewpoint and customer perspective was not extensively covered.

1.3 Structure of the Study

The rest of this study is organized as follows: *Section 2* introduces cloud computing in more detail by considering its definition, covering the essential concepts, and reviewing its development. *Section 3* discusses business model, revenue model, and cost structure concepts in cloud computing context. Sections 2 and 3 together form the theoretical background of the study. *Section 4* describes research design and methodology and introduces the case study. *Section 5* presents findings of the case study. *Section 6* assesses the findings of both theoretical and empirical parts and linkages between them and discusses both theoretical and managerial implications. *Section 7* concludes the study by summarizing key findings and contributions, assessing limitations, and giving suggestions for further research.

2 Cloud Computing Paradigm

This section introduces cloud computing paradigm in more detail. First chapter considers the definition of cloud computing. Second chapter outlines cloud computing by describing its essential characteristics, service models, and deployment models. Third chapter discusses the development of cloud computing.

2.1 Definition of Cloud Computing

Vaquero et al. (2009) argue that it is important to find a unified definition of cloud computing for delimiting the scope of research and emphasizing the potential business benefits. However, cloud computing still lacks a well-established definition in the literature and it is often confused with other related technologies such as grid computing (Smith 2009, Vaquero et al. 2009, Weinhardt et al. 2009a). Many definitions for cloud computing are clearly oversimplified and fail to capture the full nature of the phenomenon. For example, Buttell (2010) defines cloud computing by stating that it means "moving your computer applications and programs to the Internet rather than your desktop."

The term cloud in cloud computing is used as a metaphor for the Internet (e.g., Katzan 2010, Wyld 2009). It originates to telephone network diagrams, and later computer network diagrams, where cloud symbol was used to represent the underlying infrastructure of telephone network or the Internet. Computing in this context could be defined as activity of using computer technology, hardware, and software.[6]

[6] In Finland, a term "pilvilaskenta" is quickly gaining ground as the translation of cloud computing. However, this study suggests that term "pilvitietojenkäsittely" or "pilvitoimintamalli" should be adopted instead because they better depict the nature of the paradigm.

Vaquero et al. (2009) studied 22 definitions of cloud computing.[7] After the analysis of different definitions, they ended up to following new definition for cloud computing:

> *"Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized SLAs."*

The first widely cited definition of cloud computing, also known as UC Berkeley definition, was published by Armbrust et al. (2009, 2010):

> *"Cloud Computing refers to both the applications delivered as services over the Internet and the hardware and systems software in the data centers that provide those services."*

The most comprehensive, referred, and widely accepted definition of cloud computing currently is coined by Mell and Grance (2009b) from United States National Institute of Standards and Technology (NIST) Information Technology Laboratory (see **Appendix A** for full version of the definition):

> *"Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."*

All major research and consultancy firms have also rushed to publish their own definitions of cloud computing. For example, Gartner (2009), the leading IT research and advisory firm, has published following definition:

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[7] The content is partly based on the work by Geelan (2009), who collected experts' definitions of cloud computing.

> *"[Cloud computing is] a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service to external customers using Internet technologies."*

Formulating a comprehensive and unambiguous definition of cloud computing is challenging—if not impossible—task at the moment. Cloud computing paradigm is still at its early stages and develops continuously as the industry launches and enhances cloud services. Illustratively, the NIST definition of cloud computing is already going through its 15th revision and its authors "expect it to evolve over time as the cloud industry and cloud technology matures" (Mell & Grance 2009b). Similarly, Kim et al. (2009) argue that definition of cloud computing has already changed many times and will definitely undergo refinement also in future.

2.2 Key Concepts of Cloud Computing

The comprehensive and widely accepted work by Mell and Grance (2009b) from United States National Institute of Standards and Technology (NIST) Information Technology Laboratory outlines cloud computing from three viewpoints as follows: essential characteristics, service models, and deployment models.

Mell and Grance (2009b) summarize the essential characteristics of cloud computing to five key points:

1. *On-demand self-service*. Customers can provision computing capabilities (e.g., storage, memory, network bandwidth, user accounts) on-demand basis. Capabilities can be provided independently and automatically without human interaction with services providers.
2. *Broad network access*. Capabilities are available over the network. They can be accessed through standard mechanisms with different client platforms such as personal computers and mobile phones.

3. *Resource pooling*. Services provider pools capabilities to serve multiple consumers using multi-tenant model. Different customers (tenants) share the same underlying resources.
4. *Rapid elasticity*. Capabilities can be rapidly scaled in and out (i.e., provisioned and released) at any given time. The supply of capabilities from customer perspective appears to be infinite.
5. *Measured service*. Appropriate metering system is employed and customer's usage of capabilities can be transparently monitored, controlled, and reported.

Vaquero et al. (2009) analyzed 22 expert definitions of cloud computing and ended up to ten key characteristics of cloud computing:

1. User friendliness
2. Virtualization
3. Internet centric
4. Variety of resources
5. Automatic adaptation
6. Scalability
7. Resource optimization
8. Pay per use
9. Service SLAs[8]
10. Infrastructure SLAs

Iyer and Henderson (2010) analyzed the key capabilities afforded by cloud computing. They analyzed over 50 definitions of cloud computing from the websites key cloud services providers, blogs, and analyst reports. The seven key capabilities found in the analysis are following:

1. Controlled interface
2. Location independence

[8] Service Level Agreement (see **Table 1** for details).

3. Sourcing independence
4. Ubiquitous access
5. Virtual business environments
6. Addressability and traceability
7. Rapid elasticity

Youseff et al. (2008) argue that cloud computing ontology is important because it allows better understanding of the inter-relations between the different cloud components and thus enables composition of new systems as well as re-composition of current systems to optimize and affect cost-efficiency. It is currently widely accepted that cloud computing services could be categorized according to three primary service models (e.g., Creeger 2009, Durkee 2010, Lin et al. 2009, Mell & Grance 2009b, Viega 2009, Vaguero et al. 2009, Weinhardt et al. 2009a, b). These service models could be also described as different abstractions or interfaces of the cloud (Iyer & Henderson 2010, Nurmi et al. 2009). Architecturally, service models are cascading layers where services on higher layer build on the top of the lower layer's services, or as Weinhardt (2009a) describes: "those further to the top facilitate encapsulated functionality from the layers beneath by aggregating and extending service components via composition and mashup technologies."

The three cloud computing service models are the following:

1. *Cloud Infrastructure as a Service (IaaS).* Provides raw compute, memory, storage, and network transfer capabilities for custom solutions. The customer does not control the actual underlying hardware infrastructure but has possibly limited control over selected components. Capabilities are delivered as a single server or as part of a collection of servers integrated into a virtual private data center (Creeger 2009, Durkee 2010, Mell & Grance 2009b). Lin et al. (2009) suggest that target groups for IaaS are infrastructure providers and administrators. An example of this service model is Amazon Web Services (aws.amazon.com).

2. *Cloud Platform as a Service (PaaS).* Provides development environment for deploying new applications onto the cloud (i.e., top of bare-bones infrastructure). Platforms are

offered as application/solution stacks with programming languages and tools supported by the provider. The customer does not control the underlying infrastructure but has possibly limited control over deployed applications (Creeger 2009, Durkee 2010, Mell & Grance 2009b). Lin et al. (2009) suggest that target group for PaaS is Internet application developers. Examples of this service model are Google App Engine (code.google.com/appengine) and Force.com (force.com) application development platforms.

3. *Cloud Software as a Service (SaaS)*. Provides use of the working applications running on the provider's cloud infrastructure. Applications are accessed through a thin client interface such as web browser. The customer does not manage or control the underlying cloud infrastructure (Creeger 2009, Durkee 2010, Mell & Grance 2009b). Lenk et al. (2009) divides SaaS to applications and application services. Lin et al. (2009) suggest that target group for SaaS is application and IT users. Examples of this service model are Google Docs office suite (docs.google.com) and Salesforce.com customer relationship management (CRM) software (salesforce.com).

A more detailed cloud architecture, or cloud stack, proposed by Lenk et al. (2009) is presented in **Appendix B**. The three-layer architecture is often referred to as the SPI model, where SPI refers to SaaS, PaaS, and IaaS, respectively (Brunette & Mogul 2009). Although the SPI model is generally established, Armbrust et al. (2010) note that definitions for IaaS, PaaS, and SaaS still vary widely. The line between low-level infrastructure and a higher-level platform is not crisp, and that is why they should be possibly considered together rather than separate entities.

Cloud computing services could be set up according to different deployment models. Terms such as "cloud mode" (Rimal & Choi 2009) and "service boundary" (Qian et al. 2009) are also used. Most authors discuss public, private, and hybrid deployment models, but Mell and Grance (2009b) identify also community model.

The four cloud computing deployment models are the following:

1. *Public Cloud*. The traditional mainstream sense of cloud computing. The cloud is made available to the general public or a large industry group and is owned by an organization providing cloud services. Resources are provisioned from an off-site third-party provider who shares resources. (Mell & Grance 2009b, Rimal & Choi 2009, Qian et al. 2009, Zhang et al. 2010).

2. *Private Cloud*. The cloud is operated exclusively for an organization. It may be managed by the organization or a third party and may exist on premise or off premise. (Mell & Grance 2009b, Rimal & Choi 2009, Qian et al. 2009, Zhang et al. 2010).[9, 10]

3. *Hybrid Cloud*. The cloud infrastructure is a composition of two or more clouds that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability. The environment is consisting of multiple internal and/or external providers. (Mell & Grance 2009b, Rimal & Choi 2009, Qian et al. 2009, Zhang et al. 2010).

4. *Community Cloud*. The cloud infrastructure is shared by several organizations. It may be managed by the organizations or a third party and may exist on premise or off premise (Mell & Grance 2009b).[11]

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[9] There has been debate of omitting private clouds from cloud computing definition because conventional (i.e., small or medium-sized) data centers cannot employ same benefits (e.g., economics of scale) as public clouds comprised of hundreds of thousands of machines (Armbrust et al. 2010).

[10] Zhang et al. (2010) distinguish also virtual private cloud (VPC). A VPC is a private cloud within public cloud, which leverages virtual private network (VPN) technology. However, Qian et al. (2009) thinks VPC to be just a form of hybrid cloud.

[11] Gupta and Awasthi (2009) discuss "peer enterprises" referring to organizations, which share their under-utilized resources by participating in a mammoth peer-to-peer network, potentially offering the same computing power as the cloud.

2.3 Development of Cloud Computing

Cloud computing concept started to shape up in late 2000s. In August 2006, Google's chief executive officer and chairman Eric Schmidt was arguably the first to use the term cloud computing in context of doing business (Zhang et al. 2010, Qian et al. 2009). Amazon Cloud Computing, now Amazon Web Services, launched in October 2006 and IBM's Blue Cloud in November 2007 followed by numerous other companies.

However, cloud computing is not an innovation coming from nowhere. Instead, it is the result of evolutionary development in a long continuum of several different technologies and has characteristics of many preceding operating models and technologies (Iyer & Henderson 2010, Zhang et al. 2010, Zhu et al. 2009). Skilton (2010) describes cloud computing as "a technological change brought about by the convergence of a number of new and existing technologies." According to Louridas (2010), cloud computing "expresses technologies that are reaching maturity after many years of progress, aided by specific market forces." However, cloud computing is often regarded as a new disruptive computing paradigm. Voas and Zhang (2009) argue that cloud computing is the next paradigm that follows on from mainframes, personal computers (PC), networked computing, the Internet, and grid computing.

Table 1 summarizes key enablers of cloud computing as suggested by Armbrust et al. (2010), Mell and Grance (2009a), Randles et al. (2010), and Vouk (2008).

Table 1. Enablers of cloud computing.

Enabler	Description
Utility computing	Packaging of computing resources, such as computation, storage and services, as a metered service similar to a traditional public utility (e.g., electricity and water).
Distributed computing	Using multiple autonomous computers communicating through a computer network to achieve common goal such as solving a complex (i.e., computing-intensive) problem.
Cluster computing	Coupling number of computers to do parallel work so that they basically form a single computing unit with very high computing performance.
Grid computing	Making computer power as easy to access as an electric power grid by extending the idea of clusters to an e-infrastructure that offers multiple geographically dispersed computation, data, or service resources owned by different organizations.
Virtualization	Using computer resources to imitate other computer resources or whole computers by hiding the physical characteristics of a computing platform from users and instead showing another abstract computing platform.
Service-oriented architecture	Type of software architecture for creating and using business processes, packaged as services.
Free and open source software	Liberally licensing software to grant the right of users to use, study, change, and improve its design through the availability of its source code.
Service level agreements (SLA)	A part of a service contract where the level of service is formally defined. In practice, often used to refer to the contracted delivery time or performance of the service.
Broadband networks	High data rate Internet access.
Massively scaling large datacenters	Construction and operation of extremely large-scale, commodity-computer data centers at low-cost locations.
Application service provider (ASP)	Deploying, managing, and remotely hosting packaged software applications through centrally located servers and delivering them to companies on a rental or lease arrangement as customers pay for only what they use.
Software as a service (SaaS)	Deploying software over the Internet (i.e., running in user's web browser) and licensing it to customers as a service on demand, often through a subscription.
Web 2.0	Web applications that facilitate interactive information sharing, interoperability, user-centered design, and collaboration on the Internet.
Web services	Application programming interfaces that are accessed via Hypertext Transfer Protocol and executed on a remote system hosting the requested services.

It has been also argued (e.g., Creeger 2009, Tai 2009) that the most important driver for cloud computing is its business-driven nature. Transforming existing technologies as viable commercial practice has helped the adoption of cloud computing. Wyld (2009) believes that the late 2000s financial crisis and recessions may have had significant effect on the general interest towards cloud computing as companies have been forced to seek more cost-effective IT solutions.

IT research and advisory firm Gartner's hype cycle is a widely used analysis tool of the maturity, adoption, and business application of technologies. In Gartner's latest hype cycle analysis for emerging technologies (Fenn 2010), cloud computing is located just behind the vertex of expectations curve, or a phase called Peak of Inflated Expectations (**Figure 3**). In this phase, "a frenzy of publicity typically generates over-enthusiasm and unrealistic expectations" and "there may be some successful applications of a technology, but there are typically more failures" (Fenn & Raskino 2008). Gartner predicts that the mainstream adoption of cloud computing takes from 2 to 5 years.

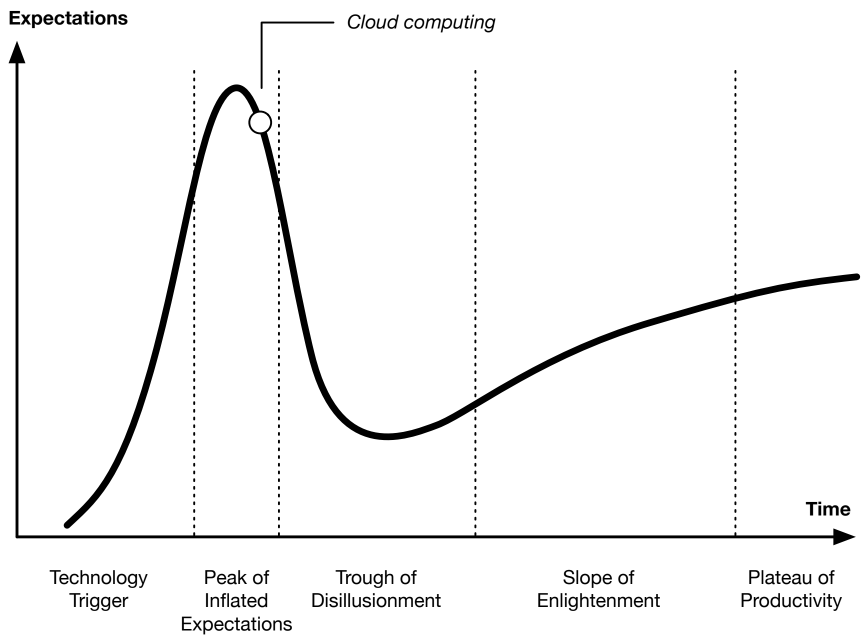

Figure 3. Cloud computing on Gartner hype cycle (Fenn 2010).

According to Gartner's analysis, cloud computing has passed the first phase, Technology Trigger, which is "a breakthrough, product launch or other event that generates significant press and interest" (Fenn & Raskino 2008). If cloud computing follows the hype cycle model, it should next enter into Trough of Disillusionment because it fails to meet expectations and becomes unfashionable. However, some businesses understand the benefits and practical application of the technology and continue to experiment with it during Slope of Enlightenment." The most important phase is though the final, Plateau of Productivity," which shows whether cloud computing is broadly applicable or benefits only a niche market. (Fenn & Raskino 2008.)

3 Financial Aspects of Business Models

This section discusses financial aspects of business models in cloud computing context. First chapter explores the concept of business model. Second chapter discusses revenue model and pricing mechanisms. Third chapter discusses cost structure and cost accounting mechanisms.

3.1 Business Model and Value Chain

The concept of business model is highly relevant in context of cloud computing. According to Iyer and Henderson (2010), cloud computing is an evolution of the dominant business model for delivering IT-based solutions. Similarly, Zhu et al. (2009) argue that cloud computing distinguishes itself from previous computing paradigms with its emerging business model, which creates remarkable commercial value in new use scenarios. The general importance of business model for a firm is demonstrated for example Malone et al. (2006), who find that some business models do have better financial performance than others in a study of over 10,000 US firms.

Business model is a concept nowadays widely used in academic and managerial literature as well as in popular discussion. It is used in various domains such as e-business, management, and strategy. The term business model is relatively young: it became popular only towards the end of the 1990s (Osterwalder et al. 2005). From the start, the concept of business model has closely related to IT industry; Osterwalder et al. (2005) have demonstrated with the stock market data that the surge of the business model term coincidences with the advent of the Internet in the business world.

The concept of business model is still relatively poorly understood and there is much confusion in the terminology (Osterwalder et al. 2005, Rajala & Westerlund 2007). Some authors use business model to simply refer the way a company does business whereas other authors emphasize the conceptual model aspect. Nevertheless, previous research agrees on business model's position as a conceptual and theoretical layer between business strategy and business processes (Rajala & Westerlund 2007). According to Osterwalder and Pigneur (2002) business logic triangle model, business model represents the architectural level between planning and implementation (**Figure 4**).

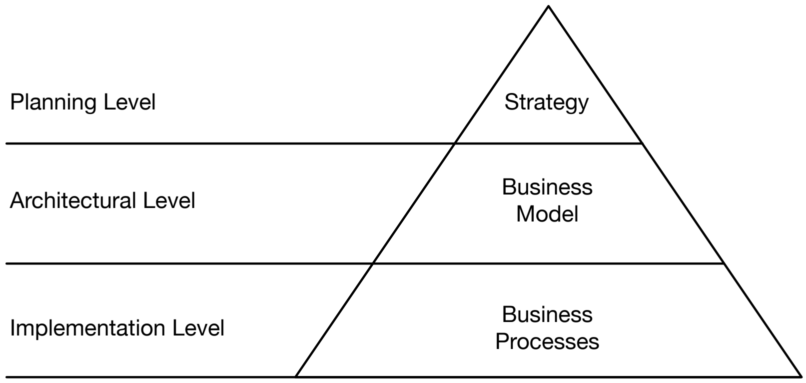

Figure 4. Business logic triangle (Osterwalder & Pigneur 2002).

Rajala and Westerlund (2007) define business model as ways to create value to customers:

> *"The concept of the business model in the literature on information systems and business refers to ways of creating value for customers, and to the way in which a business turns market opportunities into profit through sets of actors, activities and collaboration."*

Osterwalder et al. (2005) define business model as a tool for expressing business logic and describing customer value:

> *"A business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm. Therefore we must consider which concepts and relationships allow a simplified description and representation of what value is provided to customers, how this is done and with which financial consequences."*

Osterwalder (2004) proposes a single reference model based on the similarities of a wide range of business model conceptualizations. The model comprises nine "building blocks" categorized to four elements (**Figure 5**). The financial aspects element is composed of cost structure and revenue model building blocks and together they determine the business model's profit/loss-making logic.

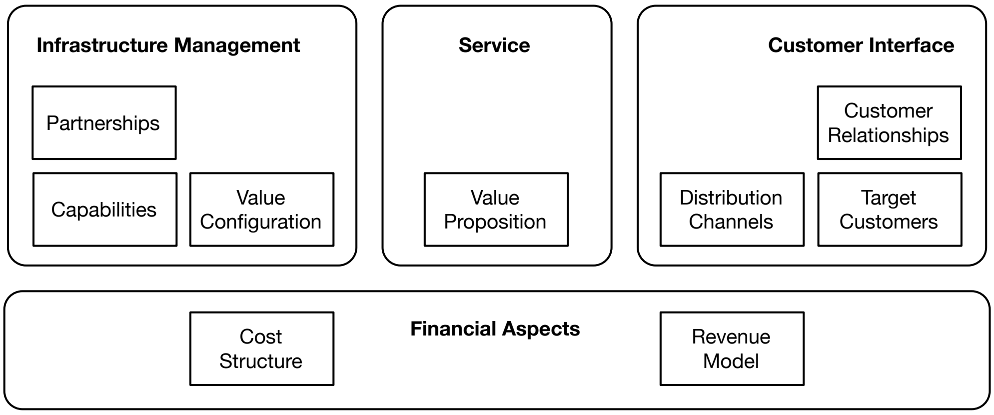

Figure 5. The business model ontology (Osterwalder 2004).

Chesbrough and Rosenbloom (2002) discuss the role of business model in capturing value from an innovation. Since cloud computing is generally regarded as some type of innovation, business model could serve as tool for capturing economic value from this new technology. Chesbrough and Rosenbloom (ibid.) define business model as a mediating construct between technology and economic value (**Figure 6**). The business model mediates technical inputs such as feasibility and performance to economic outputs such as value, price or profit. Authors argue that the function of the business model is to justify the financial capital needed to realize the model and to define a path to scale up the business.

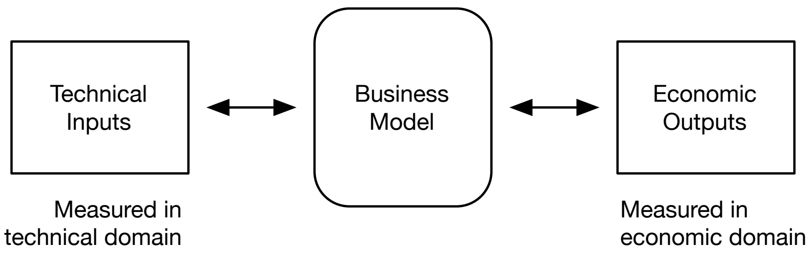

Figure 6. Business model as mediating structure (Chesbrough & Rosenbloom 2002).

Weinhardt et al. (2009a, b) connect business model concept to cloud computing by proposing cloud business model framework (**Figure 7**). The framework suggests that different business models could be derived from the different cloud service models as follows:

- *Infrastructure*. Focuses on enabling technologies.
    - *Storage*. Providing storage capabilities.
    - *Computing*. Supplying computing power.
- *Platform-as-a-service*. Solutions on top of a cloud infrastructure that provide value-added services.
    - *Business*. Development, deployment and management of tailored business applications on the cloud.
    - *Development*. Provide platforms for deploying and managing applications in the cloud.
- Applications. Delivers applications via the opaque platform and infrastructure layers.
    - *Software-as-a-service*. Applications that are entirely accessible through a web browser.
    - *On-demand web services*. Provisioning of rudimentary web services on demand.

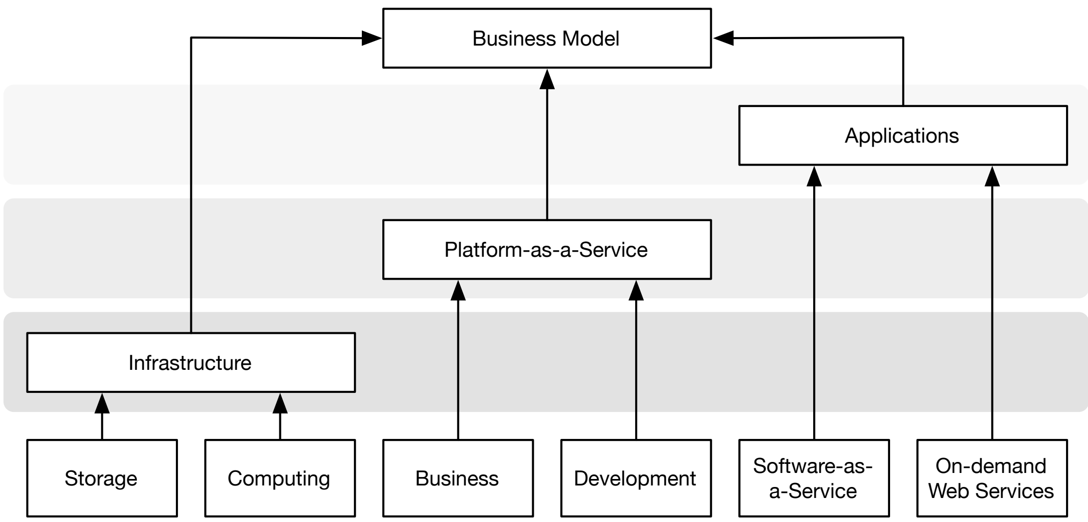

Figure 7. Cloud business model framework (Weinhardt 2009a, b).

Leimeister et al. (2010) also argue that each of cloud service should be based on a certain business model. However, Leimeister et al. (ibid.) argue that because of the dynamic and highly evolving nature of cloud services market, also the business models must be dynamic. They argue that conventional static models do not reflect the real world and lack substantial elements of changing market environments. Thereby, Leimeister et al. (ibid.) suggest that business models are constantly adjusted to the current hype cycle phase, technology changes, regulations, and market developments, which helps services provider to create stable business.

Some authors (e.g., Altmann et al. 2007, Zhang et al. 2010) equate business model in cloud computing context with the role of services provider. Leimeister et al. (2010) discuss cloud computing value network and identify five primary actor roles among customer:

- *Consulting*: Serves as a support for the selection and implementation of relevant services to create value for customer's business model.
- *Service providers*: Develop and operate services that are offered and deployed on the cloud computing platform and access hardware and infrastructure of the infrastructure providers. Offer value to the customer and an aggregate services provider respectively.
- *Aggregate services providers (aggregators)*: Might be regarded as a specialized form of the service provider, offering new services or solutions by combining pre-existing services or parts of services to form new services and offer them to customers.
    - *Data Integrators*: Focus more on the technical aspects necessary for data and system integration.
    - *Service Aggregators*: Also include the business aspects of merging services to offer new service bundles.
- *Platform provider*: Offers an environment within which cloud applications can be deployed. Acts as a kind of catalog in which different service providers offer services.
- *Infrastructure providers*: Supply the value network with all the computing and storage services needed to run applications within the cloud and provide the technical backbone.

Figure 8 illustrates cloud computing value chain based on works of Jaekel and Luhn (2009), Leimeister et al. (2010), and Zhang et al. (2010).

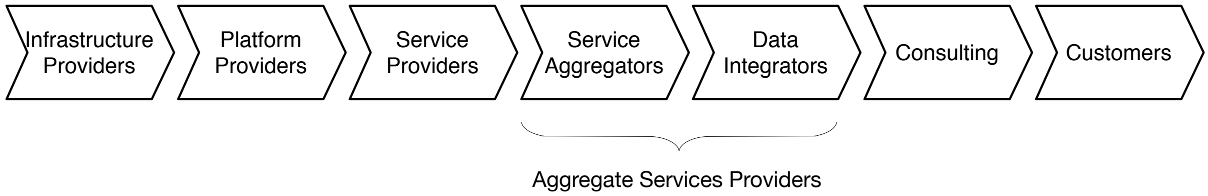

Figure 8. Cloud computing value chain.

The real-life cloud computing value network may be far more complex; Iyer and Henderson (2010) analyzed cloud services industry ecosystem and identified strategic relationships, technical alliances, reseller relationships, original equipment manufacturer (OEM) or independent software vendor (ISV) arrangements, and consortium memberships between different companies.

3.2 Revenue Model and Pricing Mechanism

Revenue model is the first building block of the financial aspects element in business model ontology. Although current cloud computing literature almost without exception considers pricing of cloud services, the discussion rarely covers more than a mention about usage of pay per use pricing mechanism. However, as Harmon et al. (2009) argue, pricing is one of the most critical decisions that a firm make whether planning the introduction of a new IT service or repositioning an existing IT service. Weinhardt et al. (2009b) argue that a commercial success with cloud services can only be achieved by developing adequate pricing mechanisms. Paleologo (2004) argues that traditional pricing mechanisms such as cost-plus pricing may be inadequate in on-demand services environment due to several changing factors such as shortened contract durations, reduced switching costs, weaker customer lock-in, uncertain demand, and shorter life cycles.

Osterwalder (2004) defines revenue model as an element that “measures the ability of a firm to translate the value it offers its customers into money and incoming revenue streams.” Also, a revenue model "can be composed of different revenue streams that can all have different pricing mechanisms." Sainio and Marjakoski (2009) argue that the traditional approaches to pricing have generally been quite operational but there should be also strategic planning level on pricing. Linking this to Osterwalder's ontology, it could be argued that revenue model refers to strategic planning and pricing mechanism to operational planning.

Osterwalder (2004) differentiates between three main categories of pricing mechanisms (**Table 2**). Fixed pricing mechanisms produce prices that do not differentiate in function of customer characteristics, are not volume dependant, and are not based on real-time market conditions. Differential pricing refers to pricing mechanisms that produce prices that are either based on customer or product characteristics, are volume dependant, or are linked to customer preferences, but not based on real-time market conditions. Market pricing stands for pricing mechanisms that produce prices based on real-time market conditions.

Table 2. Pricing mechanisms (Osterwalder 2004).

Category	Pricing Mechanism	Description
Fixed pricing	Pay per use	Customer pays in function of the time or quantity he consumes of a specific service.
	Subscription	Customer pays a flat fee in order to access the use of a product or to profit from a service.
	List price / menu price	A fixed price that is often found in a list or catalog.
Differential pricing	Service feature dependant	Price is set according to service configuration. Includes also bundling of different services.
	Customer characteristic dependant	Price is tailored to the characteristics of every single customer.
	Volume dependant	Differentiates prices on the basis of purchased volumes.
	Value-based	The final price will strongly depend on the customer's valuation of a value proposition.
Market pricing	Bargaining	The price outcome depends on the existing power relationships between the parties involved.
	Yield management	The best pricing policy for optimizing profits is calculated based on real-time modeling and forecasting of demand behavior.
	Auction	Price is set as buyers bid in increasing increments of price.
	Reverse auction	Price is set as sellers bid in decreasing decrements of price.
	Dynamic market	Price is the outcome of a large number of buyers and sellers that have indicated their price preference, but are not able to influence this price as individual sellers.

Cloud computing literature discusses some of the pricing mechanisms found above. Cai et al. (2009), Weinhardt et al. (2009), Yeo et al. (2009), and Youseff et al. (2008) discuss pay per use[12] mechanism, which is widely hyped to be one of the key changes that cloud computing brings to IT services business. With pay per use mechanism, capacity units such as number of transactions, gigabytes of storage or memory or units per time such gigabytes of memory per

[12] Also known as pay-as-you-use, pay-as-you-go, per-unit pricing, and resource-consumption-based pricing.

hour are associated with resources and assigned fixed price values and customer pays according to his metered usage of resources. The capacity unit may be also artificial as in the case of Amazon Web Services (2010) that sells "instances" of their capacity pool. Pay per use pricing is typically used with IaaS and PaaS services and its benefit is that it allows customization to specific application needs. Ouyang et al. (2007) note that quantification of resources and measurement of dynamic usage may be challenging task with cloud services. Denne (2007) discusses various advanced ways to implement pay per use pricing mechanism (**Table 3**).

Table 3. Pay per use mechanism implementations (Denne 2007).

Implementation	Description
Time-based pricing (Subscription pricing)	Pricing is based on consumed time units. The difference to the actual subscription pricing mechanisms discussed below is that customer does not sign a fixed contract.
Peak-level pricing	Pricing is based on peak consumption within a defined window.
User-based pricing	Pricing is based on the number of distinct users presenting themselves to the system.
Ticked-based pricing	Pricing is based on fixed price electronic tickets that services provider issues for use of the service (for a specific period of time).
Integral pricing ("under the curve")	Pricing is based on peak utilization of defined capacity unit divided by average utilization.
Overage charges	Pricing changes if customer exceeds the average consumption of the service.
Consumption commitments	Pricing is based on estimated average consumption and exceeding or undercutting the consumption commitment affects the price.

Among Denne (2007), also Prodan and Ostermann (2009) and Yeo et al. (2009) discuss advance pricing. In this pricing mechanism, customers prepay for a certain amount of capacity units that have to be consumed usually in a certain period of time and overcharging is applied if customer exceeds the quota of prepaid units.

Youseff et al. (2008) and Weinhardt et al. (2009b) discuss subscription pricing with cloud computing and Denne (2007) mentions pricing based on pre-purchase of services. With subscription mechanism, customer subscribes (i.e., signs a contract) for using a pre-selected combination of service units with a fixed price for fixed time period such as month. In subscription model, pricing is per unit of time and not per unit of consumption. Subscription pricing is most widely used with SaaS services and it allows prediction of customers' periodic expenses but lacks accuracy of charging users what they have used.

Youseff et al. (2008) discusses tiered pricing, which could be understood as service feature dependant pricing mechanism. With tiered pricing model, each tier offers fixed computing specifications (e.g., storage, memory allocation, CPU type and speed) and SLA at a specific price per unit time. For example, Amazon Web Services (2010) sells various different types of instances of capacity such as standard, high-memory, and high-CPU. Each different instance type packages resources such as storage and memory together differently. Tiered pricing comes very close to bundling, which is the sale of two or more products/services in a package with differentiating the unit prices according to contents of the package (Stremersch & Tellis 2002).

Weinhardt et al. (2009b) discuss "dynamic pricing" referring to mechanisms, in which the target service price is established as a result of dynamic supply and demand, for example by means of auctions. For example, Amazon Web Services has introduced so-called Amazon Spot Instances to allow customers to bid their unused capacity. Amazon runs the customer's instances as long as the bid price is higher than the spot price, which is set by Amazon based on their data center utilization (Amazon Web Services 2010).

Anandasivam et al. (2009) discuss revenue management, which is another name for yield management, for cloud computing. Yield management refers to allocating scarce resources and optimizing profits as a result of selling more with higher prices by influencing consumer behavior. For example, services provider can dynamically vary the price according to some variable such as time of the day to create incentives for customers to run their jobs during times of low utilization (Püschel et al. 2010).

Buyya et al. (2009) discuss dynamic market mechanism by suggesting federation of cloud by forming a global cloud exchange, where customers can bid resources same manner as other commodity exchanges. The cloud brokers acting on behalf of customers identify suitable cloud services providers through the cloud exchange and negotiate with cloud coordinators for allocation of resources. In other words, the cloud exchange would act as a market maker for bringing together services providers and customers. The benefit of this mechanism is that it aggregates the demand from the customers and evaluates it against the available supply, but obviously it is currently just a highbrow vision.

Weinhardt et al. (2009a) note that fixed pricing mechanisms, in particular pay per use and subscription, are currently most widely used in cloud services. They argue that although market pricing mechanisms could achieve more economically efficient allocations and prices, both users and providers still prefer simple, fixed mechanisms in which it is easy to predict payments. Yeo et al. (2009) argue that charging fixed prices based on metered usage is simple to understand and straightforward for users, but does not differentiate pricing to exploit different user requirements in order to maximize revenue. Khajeh-Hosseini et al. (2010b) say that market-based pricing mechanisms are starting to evolve but it is questionable whether they become popular in the end.

Cloud computing literature seldom sees any major issues with the new pricing mechanisms. Durkee (2010) takes opposing position by claiming that current cost-based pricing focus in cloud services makes the paradigm unsustainable in the long run. Durkee (ibid.) thinks that as a result of many providers competing to deliver very similar services in a highly price-competitive environment, the market soon approaches perfect competition situation, which encourages smaller prices. Durkee (ibid.) also sees many factors such as economies of scale, shared infrastructures, reduced deployment costs, and free and open source that foster decreasing prices. Similarly, Skilton (2010) discusses “race to bottom” phenomenon currently ongoing among major cloud vendors as they continuously lower their prices to work out the greatest cost savings for customers. However, Durkee (ibid.) argues that providing enterprise-class services—in terms of e.g., support and maintenance, SLAs, and performance—is just not possible with current prices. Thereby, Durkee (ibid.) argues that in order the services providers to secure their profits in future they must start providing value-adding solutions instead of bulk products. Services providers must establish long-term commitment that allows them to become familiar with the customer’s needs and create more value to customer.

Harmon et al. (2009) discuss revenue models, or what they call pricing strategies, for IT services and distinguish between cost-based pricing and value-based pricing. They argue that pricing of IT services has traditionally focused on covering costs, achieving desired margins, and meeting the competition. Similarly, Paleologo (2004) argues that pricing of IT services is still strongly similar to pricing in retail industry; hardware equipment is priced per-unit basis and IT services with fixed-price contract. In contrast to cost-based pricing, value-based pricing considers customer's perceived value from the service they receive rather than provider's costs and short-term value. The goal of value-based pricing is to set prices that facilitate the development of customer relationships and creation of long-term value for the customer, which, in turn, enables the achievement of the service provider's financial and strategic objectives. Value-based pricing takes account also other than economic customer value driver. **Table 4** describes the most common cost-based and value-based pricing mechanisms for IT services identified by Harmon et al. (idid.).

Table 4. Cost-based and value-based pricing mechanisms (Harmon et al. 2009).

Pricing Strategy	Pricing Mechanism	Description
Cost-Based	Flat pricing ("all you can eat")	Fixed price for unlimited use of service, typically without up-front fees.
	Tiered-pricing	Pricing is based on package of services.
	Performance-based pricing	Pricing based on theoretical throughput of the system such as MIPS (Million Instructions per Second).
	User-based pricing	Pricing is based on the number of users that utilize a collection of service capabilities over a given period of time. • Per-user pricing • High water mark pricing • Per-seat pricing
	Usage-based pricing ("pay-as-you-go")	Pricing is based on customers' actual usage on a transaction basis.
Value-Based	Penetration pricing	Market segments where buyers have high price sensitivity are targeted. • Low-price leader • Experience curve pricing • Bundling
	Skim-pricing	Market segments where buyers are relatively insensitive to price and have high search costs are targeted. • Price signaling • Reference pricing • Image/prestige pricing
	Hybrid pricing	Combines elements from penetration and skim-pricing. • Cost-plus pricing • Complementary pricing • Premium pricing • Random discounting • Periodic discounting • Second-market discounting

3.3 Cost Structure and Cost Accounting Mechanism

Cost structure is the second building block of the financial aspects element in business model ontology. Current literature on cost structure of cloud computing services is scarce. Li et al. (2009) state that there are no available tools proper for cost calculation and analysis in cloud computing environment. Similarly, Miller and Veiga (2009) argue that a cost per delivered service measure must be developed. Skilton (2010) reports that cloud computing providers are concerned of efficiencies of production and the cost to deploy and distribute services.

Osterwalder et al. (2005) defines cost structure as an element that "[s]ums up the monetary consequences of the means employed in the business model." Osterwalder and Pigneur (2009) suggest analyzing three cost elements when considering the cost structure of a business model:

1. The most important costs inherent in the business model
2. The most expensive key resources
3. The most expensive key activities

Osterwalder (2004) also suggests a subset element "account" that "defines a specific type of expenditures" and could be thus understood as an operational accounting mechanism for detailing the cost structure element. According to Osterwalder (ibid.), account can be detailed for example according to accountancy theory or an aggregate of expenditures. If the accounting theory is followed and structure of income statement is taken to basis, three primary cost aggregates could be distinguished (**Figure 9**):

- *Cost of Good Sold (COGS)*. The direct costs attributable to goods produced and sold.
- *Selling, General and Administrative (SG&A)*: Non-production related costs (in contrast to production costs such as direct labor).
    - *Sales & Marketing (S&M)*. Expenses needed to sell goods.
    - *General and Administrative (G&A)*. Expenses needed to manage the business.
- *Research and Development (R&D)*. Expenses included in research and development.

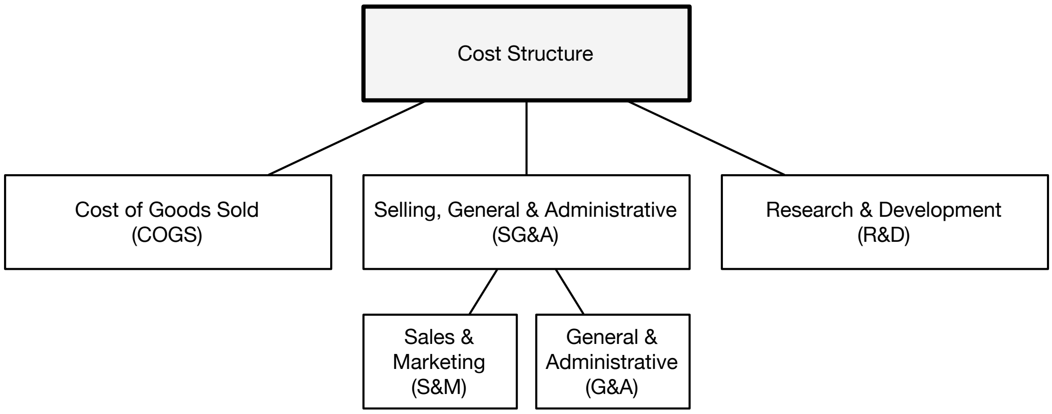

Figure 9. Cost structure according to income statement.

One widely used method to outline the cost structure of an IT service founds in The Information Technology Infrastructure Library (ITIL) version 2 Service Delivery book (Office of Government Commerce 2001). ITIL framework suggests six different cost types for formulating an IT cost model. In ITIL, cost type is the highest level of category to which costs are assigned in budgeting and accounting. Within each high level input cost type there will be a number of defined cost elements (**Table 5**).

Table 5. Cost types and cost elements according to ITIL (Office of Government Commerce 2001).

Cost Type	Cost Elements (examples)
Hardware	Central processing units, LANs, disk storage, peripherals, wide area network, PCs, portables, local servers
Software	Operating systems, scheduling tools, applications, databases, personal productivity tools, monitoring tools, analysis packages
People	Payroll costs, benefit cars, re-location costs, expenses, overtime, consultancy
Accommodation	Offices, storage, secure areas, utilities
External Service	Security services, disaster recovery services, outsourcing services, HR overhead
Transfer	Internal charges from other cost centers within the organization

Li et al. (2009) argue that elastic resource utilization and virtualization in cloud computing paradigm challenge existing cost analysis methods and therefore they have developed a new cost analysis method. They argue that two cost elements are required because only part of the resource pool, or the cloud, is used at a time according to users' dynamic demand. The first element is cloud total cost of ownership (TCO)[13] and it represents the foundational costs such as the investment to cloud infrastructure, which does not change much with the utilization of cloud by users. In other words, cloud TCO is the cost to build and operate the cloud. The second element is cloud utilization cost that refers to dynamic cost caused by the users. Cloud utilization cost is the cost of the used part of resources is the cloud, directly associating with the real resources locked up or committed to a particular user or application.

Contrary to traditional cost accounting methods, Li et al. (ibid.) adopt virtual machines (VM)[14] as the inputs of the utilization cost. They argue that because of the elasticity of the demand and pooled capacity, monitoring usage of resources is extremely troublesome, if not impossible. Thereby, they implement a three-layer derivation model without any dependency on monitoring or accounting (**Figure 10**). Li et al. (ibid.) also identifies eight categories of costs in the cloud. The cost categories apply to both cloud TCO and cloud utilization cost.

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[13] Total cost of ownership is originally a measure to assess the effectiveness of enterprise IT expenditures by considering the real costs (David et al. 2002). However, it is nowadays widely used as a general cost analysis tool to determine all costs—i.e., direct and indirect as well as cost of acquisition and operating costs—of a product or system for its entire lifetime.

[14] In hardware virtualization, a virtual machine (VM) is a software implementation of a machine (i.e., a computer) that executes programs like a physical machine. Virtual machines allow the sharing of the underlying physical machine resources between different virtual machines. Virtual machine density refers to the maximum number of virtual machines that can be deployed on a physical machine.

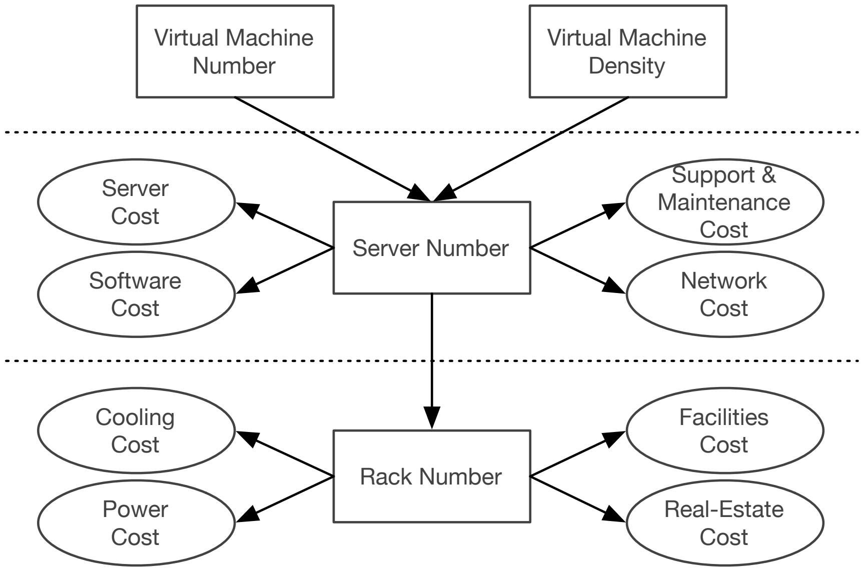

Figure 10. Cloud utilization cost model (Li et al. 2009).

The cost structure of services provider's data centers[15] that serve as the resource pool for producing different services has the key role in cloud computing cost model (e.g., Zhang et al. 2010). This is because in cloud computing paradigm customer does not anymore own the manufacturing equipment but instead just "rents" the capacity so services provider incur the costs of the infrastructure in the first place. In addition, it is often argued (e.g., Li et al. 2009) that maximum economies of scale are highly important the cloud services to be profitable.

Greenberg et al. (2009) have analyzed the cost structure of data centers considering a data center housing 50,000 servers using good quality, highly available equipment. They identify four cost categories as follows: servers, infrastructure, power, and network (**Table 6**). It is worthwhile to note that hardware (i.e., servers and network) forms only about half of the total cost. Barroso and Hölzle (2007) predict that in the future the costs of the data center facility,

[15] Data center refers to a facility used to house computer systems and associated components. A data center generally includes servers for providing services across a network, data communications connections, backup power supplies, and environmental controls such as air conditioning and fire suppression.

including energy usage, will become significantly larger than the actual server procurement costs.

Table 6. Data center cost structure (Greenberg et al. 2009).

Amortized Cost[16]	Component	Sub-Components
~45%	Servers	CPU, memory, storage systems
~25%	Infrastructure	Power distribution and cooling
~15%	Power draw	Electrical utility costs
~15%	Network	Links, transit, equipment

Interestingly, according to Greenberg et al. (2010) analysis, operational staff costs in massive data centers are under 5% due to automation and are thus not included in costs structure analysis at all; they mention that typical ratio of staff members to servers is 1:1000. However, this assumption may be biased towards an operating model where services provider utilizes massive datacenters with very high level of automation and sold services are such that staff is not constantly needed to do additional work such as configure operating systems, middleware, databases, and applications on the servers.

One key factor in data center cost-efficiency is server utilization rate. Currently, server utilization is often incredibly low; Armbrust et al. (2010) notes that several studies show that real world estimates of average server utilization in data centers range from 5% to 20%. It is often argued that in order the cloud services to be profitable, server utilization must be significantly higher. The key solution to higher utilization rates is virtualization, which allows hosting several servers inside one physical machine. At the same time, infrastructure costs such as power draw decreases. Soundarajan and Anderson (2010) believe that future data centers will be largely virtualized and virtualization has the potential to dramatically reduce the total cost of ownership.

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[16] One time purchases are amortized over reasonable lifetimes, assuming a 5% cost of money.

The overall systems architecture of a data center may also have significant effect on the total cost of ownership. Barroso and Hölzle (2009) has coined term warehouse-scale computer (WSC) to describe new type of data centers that for example Google uses. Instead of server racks filled with many specific configurations, warehouse-scale data center operates more like a single huge machine running many processes. This is contrast with traditional hosting facilities that could be understood more like a collection of co-located servers.

4 Research Design

This section describes the design of the study. First chapter explains the purpose, strategy, and methodology of the study. Second chapter describe the selection of the case and introduces the case company. Third chapter describes data collection process and analysis of the data. Fourth chapter discusses the reliability and validity of the study.

4.1 Research Strategy and Methodology

Empirical approach was selected for this study because it was necessary to obtain information on financial aspects of cloud computing from services provider viewpoint to fulfill the gap in current research. According to Uusitalo (1991), in an empirical study, the subject is a real world phenomenon and new information is acquired with some systematic method. According to Hirsjärvi et al. (2009) and Uusitalo (1991), the purpose of the study is most often either exploratory, descriptive, explanatory, or predictive. The explorative approach was selected because the subject of the study is still very novel and weakly known and there is no solid theoretical foundation to build on. According to Hirsjärvi et al. (2009), an exploratory study aims investigate poorly known phenomena, understand what is happening, find new phenomena and perspectives, or generate hypotheses. According to Uusitalo (1991), exploratory studies do not test theories.

The study was carried out as qualitative single case study. This methodology was selected because the research orientation of exploratory studies is typically qualitative instead of quantitative and research approach is either case study or field study (Hirsjärvi et al. 2009, Uusitalo 1991). Hirsjärvi et al. (2009) describe qualitative research with three key characteristics. First, qualitative methods such as interview are used. Second, inductive reasoning is employed, which means that diverse analysis of the data and revelation of unexpected things are essential instead of testing a theory or hypotheses. Third, judgment sampling is used in data collection, which means that the best suitable respondents are chosen in order to understand some activity or phenomenon better and discover new viewpoints instead of making statistical generalizations. According to Koskinen et al. (2005), the contribution of qualitative studies is normally based on its ability to present a new way to understand some phenomenon and thus the study requires more deepness than complex research design. Koskinen et al. (2005) argue that in business economics, the aim of qualitative research is to increase understanding on target company's activities for example by producing frameworks for management's situational analysis.

According to Hirsjärvi et al. (2009), case study is one of the three traditional research types of qualitative research among experimental and survey studies. Case study was selected because it is typical choice when the research problem is pioneering and profound in nature (Hirsjärvi & Hurme 2009). Also, as Uusitalo (1991) argues, case studies may reveal information that do may not come up in for example survey studies. Case study means acquisition of detailed and intensive information on single case or small group of interrelated cases aiming to profoundly describe a phenomenon (Hirsjärvi et al. 2009, Koskinen et al. 2005, Metsämuuronen 2006). According to Hirsjärvi et al. (2009), case studies are typically functional and operational and create descriptive material from which interpretations can be made to apply to practical situations.

Interview was selected as the information acquisition method because as Hirsjärvi et al. (2009) and Hirsjärvi and Hurme (2008) argue, it is good method when working with unknown or less explored topic and when predicting answers beforehand is difficult. They also argue that interview is good method because it makes possible to expand the information, clarify desired answers, and get illustrative examples. According to Hirsjärvi and Hurme (2009), the problem with the survey method is that it seldom reaches the essential thinking of the subjects.

Hirsjärvi and Hurme (2008) define interview by suggesting that interviewer's task is to mediate picture of respondent's thoughts, opinions, experiences, and feelings. In particular, the thematic, or semi-structure, interview type was selected for this study because it was most suitable considering the nature of the subject. In thematic interview, the researcher decides certain key themes representing specified sub-concepts or classes of broader theoretical main concepts beforehand, but the interview situation is still more like a conversation than a question-and-answer session (Hirsjärvi & Hurme 2009). The interview template is in presented in **Appendix B**.

4.2 Case Selection and Introduction

A single company was selected as the target for the case study. Company X[17] is a global company providing IT, research and development, and consulting services. Company X is a listed company and has several decades of history in the IT industry. Company X has currently more than 10,000 employees and its revenue was over one billion euros in financial year 2009. Company X's primary customer segments are large enterprises and public organizations.

Company X was considered as a suitable target for the case study because cloud computing has a significant role in its strategy. Company X is introducing number of cloud services in near future but has not yet officially published its cloud offering to customers or stakeholders. Company X was considered as a suitable target also because it was interested in supporting the study and allowing data collection in-house.

The key objective of the study for Company X was to support development of cloud computing services. As described in initial briefing with company representatives, the key challenges in developing cloud computing services in Company X are related to business model development. In particular, the representatives of Company felt that financial aspects such as revenue models and cost structure of cloud services need to be analyzed.

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[17] Due to the sensitive nature of the information that is disclosed in the study, the case company asked to stay unidentified. Thereby, an alias "Company X" is used through the study to refer the case company.

4.3 Data Collection and Analysis

Ten persons from Company X were selected as interviewees of the case study. The selection was made by the research project manager who also is an employee in the case company. All of the interviewees held some kind of managerial position (see **Appendix C** for details). The criteria for selecting interviewees were their position of authority with cloud computing services; according to Hirsjärvi et al. (2009), a person may have position of authority due to formal position or expertise and knowledge in some specific area. However, they also warn that authorities may deliver unreliable or wrong information as well.

The data collection was carried out between May 28 and July 8, 2010. Selected interviewees were invited to participate in the research by the research project manager. The objectives of the study were briefly explained in the invitation e-mail message sent to interviewees but interview questions were not included. Each informant was interviewed individually by the researcher except one interview that was carried out simultaneously with two interviewees for scheduling reasons. The interviews lasted from 40 minutes to 1 hour and 45 minutes and the average length was 1 hour and 10 minutes. The interviews were carried out in Company X's premises and were recorded for annotation purposes.

After interviewing all selected informants, the collected data was analyzed and summarized for presenting the findings. According to Hirsjärvi and Hurme (2008), there founds only few standardized analysis techniques for qualitative research. However, typically the researcher interprets the data and the analysis includes description, classification, and/or combining of the data. The results can be presented in many ways, for example as a text, which then represents researcher's description on the subject. Also, quotations from interviewees' speech may be presented to better illustrate the data and strengthen argumentation.[18] Representation of

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[18] All interviews except one were carried out in mother tongue of the interviewees and quotations presented in reporting findings were translated into English. According to Hirsjärvi and Hurme (2008), quotations may be edited if the meaning is not changed.

findings follows the themes of the interview template. The interviews were not completely transcribed during the analysis because the discourse itself was not the subject of the study.

4.4 Reliability and Validity

Quality control is a concept also applicable to scientific research (Hirsjärvi and Hurme 2008) because research should always aim to good accuracy (Koskinen et al. 2005). The quality of a research refers to its reliability and validity. In quantitative research, reliability refers to repeatability of a study, i.e., ability to deliver non-random results. Validity refers to research method's ability to meter what it is supposed to meter (Hirsjärvi et al. 2009, Uusitalo 1991).

However, according to Koskinen et al. (2005), concepts of reliability and validity suit weakly to qualitative research. It is suggested that they are not meaningful at all in context of qualitative research. According to Hirsjärvi et al. (2009) and Uusitalo (1991), the usage of validity and reliability are avoided in qualitative research. Nevertheless, Hirsjärvi et al. (2009) remind that reliability and validity should be somehow measured regardless of the type of research. Similarly, Uusitalo (1991) argues that same validity requirements relate also to qualitative research.

Uusitalo (1991) suggest that in context of qualitative research validity means that theoretical and empirical definitions should be connected together. Hirsjärvi et al. (2009) suggest that validity means consistency of description and its explanation and interpretation. According to Uusitalo (1991), in context of qualitative research and case study reliability should be understood as requirement of repeatability of the analysis. Researcher should follow unambiguous classification and interpretation rules when analyzing the data. Hirsjärvi et al. (2009) argue that the reliability of a qualitative study could be increased with detailed reporting of how the study was carried out. Koskinen et al. (2005) argues that concentration to small number of observations as in the case study also increases the reliability of the study.

The above requirements of reliability and validity were tried to apply to the appropriate extend in this study. In the interviews, it was assured that interviewees understand all the concepts to be discussed. The number of interviewees was limited to small enough. Consistent practices were applied to the interpretation and explanation of findings. Also, the execution of the study was reported in detail.

5 Findings of the Case Study

This section describes the findings of the case study. First chapter discusses cloud computing paradigm in general. Second chapter discusses general level implications of cloud computing on the case company and the IT industry. Third chapter discusses implications on the case company's business strategy and explores cloud computing business models. Fourth chapter discusses cost structure and cost accounting mechanisms. Fifth chapter discusses revenue models and pricing mechanisms. Sixth chapter analyzes implications on sales and marketing.

5.1 Cloud Computing Paradigm

All interviewees had some opinion on what cloud computing is but their views varied a lot and were based more on some key characteristics than clear definition. The interviewees agreed that is not currently clear definition for cloud computing and everyone tend to have own view on it. They also found cloud computing hard to define clearly because it seem to mean different things in different contexts. For example, cloud computing perceived in software as a service context differs from infrastructure as service. It was repeatedly mentioned that most likely there would be many different style cloud services instead of only one cloud service.

The interviewees regarded cloud computing with modest criticality. All interviewees thought that cloud computing is still greatly surrounded by hype. The amount of hype was considered even little comical taking into account that the true usefulness of cloud computing in enterprise environment is still mostly unknown. Some interviewees were also bit concerned about cloud computing's ability to deliver on its high expectations.

> *"It [cloud computing] is a lot of hype at the moment, definitely there is plenty of hype in it. What the real cloud services are going to be, what kind they form, I do not dare to [guess]… Anyone of us does not necessarily know yet what kind they will be."*

> *"Every now and then this [business] is much that kind of hype that we attach [some] prefix [such as] 'cloud' to some service and then it is it."*

"But what happens then if the hype does not reach it what it hypes up?"

One interviewee also questioned whether the demand for cloud computing services is truly market oriented or just driven by services providers themselves.

"This is always kind of the chicken or the egg thing that which one drives this, is it genuinely demand or our marketing and who guides the development, is it genuinely the efficiency of production or then this demand."

Many interviewees argued that cloud computing is not a totally new phenomenon. It was even stated that it is just a new name for old services that have been already used long time.

"I do not see nothing new in these cloud services as such."

"I think no [there is not any big change]. I think we have had basically the same concept for long time, [cloud computing is] just a new term, so I do not see a big difference."

"These cloud systems have been tried to sell with different names also before and they have either succeed or then not."

"I see that this [cloud computing] is more a market trend, a little same like SOA[19], EAI[20], ERP[21], and all others previously. These hype things come between year or two, different trends, and then they force each company to answer these things."

Interviewees suggested several different key characteristics or features for cloud computing:

- Multitenant environment

[19] Service-oriented architecture

[20] Enterprise application integration

[21] Enterprise resource planning

- Virtualization
- Automation
- Decreased bureaucracy
- Extended self-service
- Strictly standardized services
- Fast provisioning/time-to-market
- Ubiquitous services
- Decreased complexity
- Easy-to-use online provisioning
- Pay per use pricing mechanism
- Services delivered over the Internet
- Elasticity
- Minimum capital investment for customer
- Centralized service production
- Shorter contracts
- Optimal use of resources
- Flexibility
- Location and device independency
- Servicization

Although many interviewees mentioned also some technological qualities such as virtualization or multi-tenancy as key characteristics of cloud computing, it was agreed that cloud computing is more a new way to produce, develop, and deliver IT services than a technology-driven phenomenon. As the list above suggest, many interviewees saw cloud computing as an easier, faster, cheaper and more flexible way to sell and buy IT services.

All interviewees recognized the SPI model, or the three cloud computing service models. However, there was some uncertainty about the nature of the platform as a service model. Also, few interviewees questioned whether Company X has any significant demand for infrastructure as a service and platform as a service arguing that they are more like internal building blocks for higher level services such as web applications.

All interviewees recognized the different cloud deployment models except the community cloud model that was more unfamiliar and seemed to be somewhat irrelevant in business context. Interviewees suggested that hybrid and private deployment models have bigger role in enterprise market, at least in case of Company X's customers. Many interviewees were confident that enterprise and public sector customers would not be willing to locate their highly sensitive data on public cloud. This led to discussion what is the difference of especially private cloud compared to current practice.

It was unveiled that although Company X has published internally an official cloud computing strategy, employees are still rather uncertain about it and their attitudes quite skeptic.

> *"Yes, there is a lot of discussion in the intranet in Company X for example all of this [official cloud computing strategy], but then on person level when you discuss in corridors and coffee lounge or elsewhere, it is still this kind of a pipe-dream. Quite sarcastic comments."*

> *"Google and others have first introduced these services and after that started to call them as cloud services. Maybe it works better this direction than like 'now we have this beta one which is a cloud service, so please try it out, except this is not working yet.'"*

> *"As soon as somebody mentions cloud services to me, two adjectives come to my mind: one is possibilities and [another is] challenges… [or] actually problems."*

One interviewee explained that the critical attitude is related to concerns about the quality of cloud services. It was believed that Company X is pushing new cloud services with unrealistic marketing promises to customers so fast that production is going to have troubles keep up.

5.2 General Level Implications

All interviewees agreed that Company X must react to cloud computing because it in some way change the industry and the business of Company X. However, the magnitude and nature of implications were still highly uncertain.

“I truly believe that it [cloud computing] brings something new. It has very much potential.”

“There is something new and something old in it [cloud computing].”

“These next five to ten years are going to be interesting.”

“…for Company X as whole it [cloud computing] will be shocking.”

“It [cloud computing] will be one of the primary platforms to produce services to customers.”

The interviewees were more certain about that how cloud computing changes customers’ behavior. It was argued that customers’ adoption of cloud computing will happen slowly and they are not ready to change all of their IT systems to cloud-based at once. Instead, it was predicted that there would be a long period when cloud services and current services new lives side by side. One practical for this is that some current platforms have even over ten year life spans.

“World changes and we will go to cloud services but it does not happen this year, hardly fully next year either. Two, three years maybe.”

“I personally believe that it takes many, many years before there are truly flexible cloud services that you can buy on as-you-need basis.”

“In enterprise world there is this thing that there are some bank systems and others and they are such that they are just not replaced in five years. Now when the change begins, it takes five years that it is seriously considered what could be done to them, then it takes five years to ‘ok, we have decisions’, then it takes five years that it is started to thought what they [the current systems] should be done. The era of overlaps [between current systems and cloud services] will be quite long.”

"We have large customers and their decision-makers are… let's put it this way that they have seen quite a lot life and they are maybe not those who first go after every new craze. So, they are maybe not at first place moving their whole company's platform or system base as cloud-based. I am absolutely sure about that. They might experience with some small part but these are always long processes before any customer is accessed largely with any of these kind of new services. This is the way it has always been and this is how it always will be."

One of the most emphasized implications of cloud computing for Company X was that it forces to rationalize service production. All interviewees stressed that the foundation for cloud computing is a single common resource pool that allows efficient deployment of platforms and services on top of it. Although in practice there will be in many physically distributed data centers, they should still constitute one logical and coherent entity that enables effortless mobilization of the underlying resources.

It was also pointed out that cloud computing should bring rationalization in service development in form of modularization and reuse so that interaction between different platforms and services would be greater. As one interviewee explained, Company X has long had shared processes in service development but cloud computing enables managing them with one common administration model. Due to lack of consistent management framework, the provisioning of capacity and ramping up services are currently often slow, inflexible, and problematic, or briefly inefficient.

"The current model of how infra services are produced is at the end of its road, so to speak."

"We must have efficiently managed and efficiently produced services that are based on common infrastructure and common services. It is our life-blood; we do not otherwise manage in this competition of our customers. That we must had to have done anyway."

"We must get our internal processes, internal operating model work so that it do not take us half a year that we get capacity for a customer."

All interviewees also suggested that cloud computing should bring rationalization to service offering. First, interviewees believed that Company X should decrease the proportion of customer-specific solutions and offer more standardized services from limited and consistent portfolio. Second, there should happen servicization, or resources should be offered as a service. As one interviewee explained, customers are not foundationally interested in hardware specifications or other details of IT but instead want to buy resources as a service as easy as possible.

Some interviewees were concerned about how cloud computing changes risk sharing between services provider and customer. Traditionally, customers have owned the production equipment and its capacity. In cloud computing paradigm, customers only buy capacity without equipment and pay according to their actual usage. Thereby, in cloud computing customer's commitment and thus risk is significantly smaller than before. Interviewees felt that this may set unsustainable risk for services provider. It was suggested that customers should guarantee certain usage volume in contract but on the other hand this would negate the pay per use ideology, which is essential in cloud computing. Another suggestion was employ exclusivity clauses in contracts, so that customer is allowed to use pay per use pricing mechanisms if he commits himself to one service provider.

All interviewees believed that cloud computing opens new opportunities but also sets great challenges. It was pointed out that putting some individual service on the cloud is quite easy but as a whole cloud computing will be a big challenge to Company X. As one interviewee explained, cloud computing requires very much reforming in many parts of the organization at the same time and this scale change is impossible to carry out in short time. Another interviewee explained that although the new technological solutions develop fast, other related elements such as pricing mechanisms, sales and marketing, contracts, licensing, and SLAs could not develop as fast.

> *"Those things [non-technology related] are not wanted to talk about because they are difficult and hideous and it is going to take a lot more time to solve them as solve technologies."*

"That pricing thing and earnings logic is going to be a big thing [change] to us. … The earnings logic is probably going to flip somehow and it will have huge effect on customers' contracts and I feel that it has not been yet fully understood how do you do an offer of something like that."

Some interviewees were somewhat unsatisfied with the development of cloud computing services in Company X. It was argued that Company X is late in developing its own cloud computing offering. However, some interviewees pointed out that the competitors might also be in somewhat same situation.

"It is not wised up now how much thoughts and time should be sacrificed to it [the earnings side of cloud computing]."

"In my opinion [Company X has prepared for cost and pricing issues in cloud computing] unreasonably poorly."

"Well, we are little late. The point where we are now, we should have been in the end of last year."

"If Company X has not something ready to offer, then we are late. There are needs."

"We have quite little anything concrete yet."

5.3 Business Models and Value Chain

All interviewees confirmed that there are many different roles on cloud computing services market. It was remarked that Company X must carefully decide its position on cloud computing value chain and there are many positions that not suit to company's current capabilities.

"I can see three major competitor groups, which are the pure infrastructure players like Google and Amazon, and so forth, then [companies offering] the combination of infrastructure and services … and then the consultancy companies … [and] these kind of companies."

"You must find the own place and must be ready to change… or change the strategy and focus so that you do things where is business available. … must be awake."

However, it was also pointed out that cloud services market is still very unstructured, different actors are searching their places and nobody knows for sure what kind of roles and business models there will be as the paradigm evolves.

"There are so damn much roles and damn much different 'as-a-services' that outlining the wholeness … may be quite challenging."

"This is very complex world but in my opinion there are no any easy quick wins."

All interviewees were highly confident that Company X should not start competing on business models based on bulk services from public cloud because that space is already largely dominated by heavyweight cloud innovators such as Microsoft, Google, and Amazon Web Services. It was stated that competing for example against Google would be "madness" and "that game is already lost."

"I personally think so that in the end in this [business] those will win out who are genuinely global companies, who has customers over the globe, who can 24/7 get everything out from the [production] system. All the capacity must on always in use but if we are only in Europe this will become challenging to us price."

Instead of volume-based business models, it was suggested that Company X's position should me more at the other end of the value chain, where high-value services such as systems integration and consulting are in key role. Many interviewees mentioned that Company X's role would be a "cloud integrator," though referring to somewhat different things. Some meant that Company X could offer integration of 3rd party cloud services. One interviewee thought that Company X should have own cloud platforms that would act as hubs to selected external clouds. Yet another view was deployment of own cloud services on top of 3rd party cloud services. Interviewees found that demand for integration services will be high in future because customers will operate in multiple-provider environment and there is need to connect different systems. In general, interviewees were confident that despite of cloud computing there is demand for somebody capable of managing large entities also in future. As argued by one interviewee, it is already clear in future revenues do not come from the capacity, which was still the situation in past.

However, it was suggested that along with the integrator role Company X should have also own cloud services. One interviewee doubted that positioning only as a cloud integrator would not be wise because own services are more efficient way to get access to customers and create long-term customer relationships. In general, it was believed that despite of cloud computing Company X's strategy is based on strong customer relationships.

> *"It is maybe little hard for us to go the market and tout and seek presence by saying we are cloud services integrator … we cannot manage there alone with that [because] there is then our beloved competitors … whose technological presence in these kind of things, or a kind of a mindset, is much more powerful than ours."*

> *"My opinion is that earnings logic will be always and in all situations that we have existing customer account, who we offer these new services or current services delivered with this new way."*

> *"Our business model has been, and probably will be in future, that are as close as possible the customer."*

As indicated above, many interviewees argued that Company X must continue leveraging its existing customer base, which is consisted of large enterprises and public organizations. It was, though, suggested that if the production costs of services could be decreased significantly in cloud environment, also little smaller customers could be approached. Regardless, the main target group would be still large enterprises and Company X should progressively push them to adopt cloud services.

Historically, one of Company X's core competencies has been the production and implementation of custom solutions for customers' specific needs. Although there is currently official service catalog, in almost all cases the service is somehow tailored for customer's specific needs as explained by one interviewee. Many interviewees hoped that cloud computing could bring change towards more standardized and unified services with less customer-specific solutions. One interviewee suggested that customers' buying behavior should be guided to that direction with increasing their price awareness; this suggestion was obviously based on assumption that standardized services would cost less than customized solutions. Another interviewee suggested that cloud services portfolio should be developed very carefully to ensure that there is only limited number of services and their production costs could be kept on desired level.

Although it was generally accepted that Company X should employ business models based on small number of large customers instead of high volume, some interviewees argued that current customer number must be increased because with cloud computing business models revenues could be smaller. The main reason for this was introduction of pay per use mechanism in cloud services.

> *"Probably we, Company X, must have customers outside X[22] too, the growth is probably seen on the part of these countries, because if we have XX% of Finland's market, I do not see that we could grow quite many percents [more] from it."*

> *"But our whole business is the same … we must all the time live with the fact that customers' cost per unit decreases. We have lived with it years already. In a way, we eat our own leg all the time. Through a new service, whether it is cloud or something else, we look after new volume all the time [and] hide the [effect of] decreasing unit costs. If we stay still, our revenue starts decreasing because price erosion eats the profits."*

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[22] Details of the quote were removed in order to preserve case company's anonymity.

Although revenues might be smaller in cloud computing business models, it was pointed out that it could be possibly to some extent compensated with new business opportunities cloud computing creates. For example, one interviewee thought that cloud computing makes possible to offer customers totally new kind of services that have not been available before. Likewise, some interviewees argued that cloud services might have new features such as faster time-to-market, from which customer are willing to pay more.

Most interviewees suggested that cloud computing business models should bundle different services together as functional offerings instead of selling isolated services components for customer's building blocks. Interviewees felt that the price of a bundled service package should include basic level services such as support and backup but for non-standard options or customization there should be an additional price. It was also pointed out that customers assume that the price include development of the service such as periodical software updates and hardware upgrades. However, complex start-up, implementation, systems integration projects should be separate entities with own price.

> *"Customers do not want to build services from LEGO blocks."*

> *"You do not want to buy a car without the tires."*

Some interviewees emphasized that Company X should differentiate from its competitors by leveraging its strong image and reputation as a trusted domestic services provider. It was argued that this is very relevant aspect because security issues are currently among top factors blocking cloud services adoption. Especially when dealing with public organizations who are under strict legal regulation, issues such as the geographical location of customers data are critical.

> *"You do not sell with price only … actually the biggest determination for me is the emotional one, it is not necessarily a reasonable price."*

Some interviewees emphasized that business models of cloud services must very carefully analyzed before introducing them. In particular, if the pricing mechanism for a cloud service is pay per use -based, a realistic business case including the estimation of user base and their usage must be first developed.

5.4 Cost Structure and Cost Accounting Mechanism

Interviewees believed that cloud computing does not significantly change the cost elements in the cost structures of services. It was argued that cost of producing for example a storage capacity service does not depend much on whether it is cloud-based or not. It was also reminded that Company X has already years had services that could be to some extent regard as cloud services, so there is not necessarily change in cost elements itself. Interviewees agreed that classification of costs for example according to ITIL framework works equally for cloud services. It was suggested that at its most basic, the cost structure for a cloud computing consist of hardware platform, application layer, licenses, and human resources such as basic maintenance and support. However, interviewees were confident that there will be no unified cost structure for all cloud services because there will be so different services under cloud name. If there would be any consistency, it would be limited to service model level so that for example the cost structure of all IaaS services would be somewhat similar.

All interviewees confirmed that software licenses are likely to be the biggest cost component in cloud services. One interviewee estimated that licenses could form even 70 percent of the total cost of a service. It was noted that because of the recent popularity of virtualization technologies, the major software vendors are currently changing their pricing mechanisms to protect their revenue. In addition, with some major software vendors there is a clear seller's market where buyers can merely do nothing else than follow vendors pricing and terms.

> *"To the cost structure it [cloud computing] does not bring so much changes in my opinion— except, the keyword, the licenses, they are always dramatically more when they are in multitenant environment."*

"One wrong move from Microsoft can destroy a good product."

"There [at Microsoft] is also people who know how to calculate..."

Many interviewees believed that cloud computing could affect the cost structure of services by decreasing production costs. First suggested driver for cost reductions was virtualization, which has significant role in cloud computing technology. Virtualization increases the utilization rate of available capacity, which means that it is possible to serve more customers without increasing the number of production equipment. It was also mentioned that with virtualization the need for physical servers is smaller, which reduces the electric draw significantly.

"You do not waste resources when for example with ten customers everyone should have little reserve, the spare resource should be ten times, but now [in shared resource pool] it is only one time, or maybe two. … everyone definitely do not use hundred percent of their own resources at the same time."

"It is the whole idea of virtualization that same resource is used only when it is needed and it is then on loan somewhere else at other times."

"Virtualized environment is always cheaper."

Second key driver for cost reductions was single common capacity pool, which enables more efficient use of resources. Some interviewees also believed that a common capacity pool enables economies of scale and thus reduces costs in production.

"Everybody get as good service as before but because it is driven with bigger mass the price drops dramatically."

Third key driver for cost reductions was rationalization of production processes. It was suggested that producing services by using the single common capacity pool and interoperable modular cloud services increases efficiency and decreases costs. It was also often mentioned that the rate of automation in production processes should increase with cloud services.

Fourth, it was also suggested that cloud computing should bring rationalization to end-user services. It was argued that proportion of customer-specific solutions should be reduced and services portfolio should be smaller and more unified. Interviewees believed that more streamlined and standardized services portfolio would reduce costs. However, it was pointed out customization possibilities in services depend in the end on costs; if it is possible to effectively mass-customize services then there probably will be more choices for customers.

> *"In cloud world the tailoring possibility of a service will probably be close to zero. Either you have the one option, take it or leave it, or then you have one stack and there is three options what you want, SLA 1, 2, 3 or capacity 1, 2, 3, or something like this, or quantity class 10,000 or 100,000."*

Finally, some interviewees believed that self-service increases with cloud computing. For example, it was hoped that in future customers could provision services themselves via simple web portals. Although this might work with some services, many interviewees were sure that self-service would not become as the generic model for provisioning services. It was suggested that most probably there will be some self-service elements in Company X's cloud services but it is not the key element.

> *"Due to our history we have strong faith and ideology that we are going towards self-services. We make it like in electronic banking: you can do whatever you want there and it incurs no costs to us."*

> *"I deeply hope that in couple of years everything works … [so that] when customer has changed couple of parameters and he presses button … they have always server ready, it takes couple of minutes or couple of hours."*

> *"Another side what is in IT, troublesome and sad side, is that support is still needed much and it is relatively expensive."*

Although it was suggested that cloud computing should generally decrease costs, some interviewees pointed out that requirement of rapid elasticity in cloud computing may has inverse effect. Elasticity in cloud services means that customers must be able to scale resources up and down according to their needs and pay only for the resources they actually use. One interviewee explained that in enterprise environment capacity demand fluctuates so that there are common peak (e.g., end of quartile) and nonpeak (e.g., summer holiday season) times. The investment to capacity pool must be done according to peak demand but underutilized capacity during nonpeak periods may incur significant loss of revenue compared to old model where customer buys fixed amount of capacity according to peak demand.

Interviewees agreed that a cost accounting mechanism is needed for tracking the financial performance of cloud services. All interviewees agreed that it would be the best solution if there would be only one common cost accounting mechanism but it was doubted whether that is possible taking heterogeneity of cloud services into account. One interviewee remarked that cloud services set challenges to cost accounting system also in general. In Company X, internal transfer prices are employed as capacity is sold internally between different organizational units. With cloud services the usage of capacity fluctuates rapidly, which makes accounting more complicated compared to situation where fixed amounts of capacity is bought. Furthermore, it was noted that additional challenges in distribution of costs arise if services built on top often other services as suggested by SPI model.

5.5 Revenue Model and Pricing Mechanisms

Interviewees believed that cloud computing will change the pricing of IT services. One interviewee explained that cloud computing is a response to the fact that business environment has changed more dynamic and customers do not want anymore to bind themselves to fixed IT costs. In other words, customers want to decrease the proportion of capital expenditures (CAPEX) and increase the proportion of operational expenditures (OPEX) in IT. That is why pay per use pricing mechanism has gained a lot of interest among customers. However, interviewees were still very uncertain about the actual pricing mechanisms and their implementations with cloud services. Few also argued that services providers are not willing to sell services cheaper than before in order to protect their revenues.

> *"It [pricing] changes, I am sure for it, there is not even a question about it."*

> *"I do not believe that anybody has the philosopher's stone yet [regarding the pricing]."*

> *"[I have] concern about [customer's] costs. Quite many have spoken about the cost savings but I do not see, to tell you the truth, that cloud services bring cost savings, at least during couple of first years."*

All interviewees were highly doubtful that single common pricing mechanism would suit all Company X's cloud services because there are so many different type services. It was suggested that common pricing mechanism could be possible in case of services related to same service model. One interviewee argued that rationalization production of services towards single common capacity pool would make also pricing more coherent. All interviewees thought that unified pricing mechanism would be very valuable for Company X. However, few interviewees pointed out that in practice generic pricing mechanisms will not work with large enterprise customers.

> *"I do not believe that any company is ready to buy anything with so called list price from some public portal on the web."*

> *"I deeply hope that there will be one and common [revenue model] for simplicity but I am afraid that there will be at least two. … Regardless of [there would be one model] some salesperson will sell it differently and there are two [models]… because it was just large enough customer or then it was some chief information officer … [who said] they want it like this and do it and this is not discussed anymore."*

Although it was doubted that one pricing mechanism would suit for all cloud services, it was generally accepted that most cloud services should employ some kind of pay per use pricing mechanism because it is an essential feature of cloud computing. However, many interviewees remarked that there are several issues in pay per use pricing mechanism still to be solved. First, with pay per use model services provider must invest in capacity according to customer's expected demand but revenues are incurred only from customer's real usage. In addition, service's provider must incur the costs of maintaining and developing services. It was suggested that the price of cloud services must include some fixed overhead or base fee part to better cover all services provider's costs and increase controllability of resources. One interviewee suggested that this fixed part could be based on reserved maximum capacity. However, it was pointed out that this kind of hybrid model with different pricing components could be too complex for customers.

> *"I do not fully believe in this pay-as-you-use model. It is not possible because somebody will pay the buffer [in capacity] that stands there."*

> *"It is just [all the time] spoken about this … pay-as-you-use but it just cannot go like that, even common sense says that it cannot go like that, even the electricity bill does not go like that."*

One interviewee suggested that the unit price for capacity in a cloud service could vary according to customer's advance commitment.

> *"If a customer says 'Good, I want that service to use for a year' versus that that 'I will take it for the next hour,' so we but to the background different unit price how we calculate because the year is guaranteed money. You take it for an hour so I have to estimate how many hours I get sold from this environment during that year."*

Second, some interviewees pointed out that real-time metering of customer's usage is not yet possible and thus some kind of allocation method must be still employed. In addition, real-time provisioning of resources is also problematic. Thereby, it was suggested that if the capacity unit for a service is for example a user who uses an application, capacity could be sold in blocks of 1,000 concurrent users per certain time period such as month or financial quarter.

> *"It is not quite like this week 1,000 and tomorrow 1 [billed unit], we cannot go there."*

Third, it was noted that pay per use mechanism makes it impossible to estimate customer's bill beforehand if the usage fluctuates. Interviewees were sure that enterprise customers never want to take the risk that costs become unmanageable. However, some interviewees suggested that this issue could be solved by using some kind of cost limit mechanisms. It was also argued that enterprises probably know their demand at least roughly beforehand and in general do not buy capacity for business critical systems in ad-hoc style. However, all interviewees agreed that there must always be some mechanisms to reliably estimate customer's final bill.

> *"I do not believe that customer wants a surprise bill of their usage at the end of the month. They must still budget, whether there is cloud or not. This [business] will not change to budget free zone. I do not see at the moment that we would have any customers who would wants to get 'Surprise, surprise!' at the end of the month."*

> *"I will never believe in it that customer wants to get a surprise bill. Customer must know beforehand how much he consumes money when he makes some choice."*

> *"I may, again, be miserably wrong, but I never believe that this kind of thing go through. I have seen so much these different large customer enterprises of ours who live in half economizing and controlling costs… So, if it cannot be guaranteed in a way or another that TCO [total cost of ownership] decreases, that never goes through. If we can have some cutters, price ceilings or something else, maybe then."*

Interviewees understood that with pay per use pricing mechanism, the service must have some quantifiable capacity unit used for pricing. Several pricing units such as licenses, users or concurrent users, e-mail inbox size in megabytes, storage and memory in gigabytes, and virtual machines were suggested according to the nature of the cloud service. One interviewee pointed out that if a suitable capacity unit could not be found, then time should be used as the unit.

"In our wildest dreams we could have this application store portal. There you could for example buy or lease some [application such as] MS Visio for a day."

"If I have an icon here so I pay from it an euro per month, I drag the icon to trash so billing stops."

Some interviewees disclosed that there are a lot of people in Company X who strongly resist the pay per use pricing mechanism. First, it is feared that pay per use pricing leads to smaller revenues, which might be linked to managers' bonuses as well. Second, changing pricing mechanism would in some cases require changing existing contracts. Third, opening existing contracts would lead to smaller revenue because market prices had fallen since making the contract.

In addition to pay per use, some other pricing mechanisms were also discussed. Subscription pricing was mentioned to be the other primary pricing mechanism for cloud services. Subscription pricing was regarded most suitable for SaaS services. Most of the interviewees were quite unfamiliar with yield management pricing mechanism. However, after familiarizing themselves with the concept, they felt that it could be suitable for some cloud services. For example, the price of capacity could vary according to time of day. However, it was pointed out that at the moment there are not adequate systems to support yield management pricing.

"I do not consider it utopist that for example in the end of the month the capacity is for example more expensive."

Many interviewees emphasized that whatever the cloud computing pricing mechanisms are, they must be simple and easily understandable by customers and salespersons. The pricing unit should be some measure that relates closely to customer's own business and that customer considers fair. It was pointed out that more sophisticated pricing mechanisms could be more valuable in terms of internal processes or financial benefit but they might be also too complex for customers and salespersons.

"I somehow believe in that 'Keep It Simple, Keep It Stupid'. [The pricing mechanism must be] easily understandable, easily predictable, budgetable, so I believe more in that [simple mechanism] than in these fancy contraptions, with which apparent freedom is created to use as much as possible but then anyway different forecasting, budgeting, cost control [mechanisms and] regulations of corporations prevents the use of them in practice because they change things unmanageable."

Although it was emphasized that customers typically want to buy everything in as big package as possible and with one cost and one bill, it was also pointed out that customers want preserve transparency in order to know what are the contents of the bill. It was suggested that customers of a cloud service should get single bill with one final sum but the bill should also include breakdown of costs as an attachment.

"The human mind is such … that it wants to know what are the components inside the price."

Interviewees disagreed that service level agreement (SLA) would be an important component in pricing of cloud services. One interviewee noted that SLA is not an effective tool for differentiation because customers always want to have a properly functioning service anyway. Ironically, one interviewee noted that although Company X currently markets itself as a trusted enterprise vendor with premium SLAs, in real-life the service levels might be sometimes worse than compared to for example Google's free services. Thereby, it was thought that expected performance is not a good pricing component. Instead, recovery from a failure could be possibly used as a pricing component in cloud services.

"Customers always want to buy a working service. Hardly anyone wants to buy a service with twenty grands cheaper price if it is also twenty percents more unreliable."

5.6 Sales and Marketing

All interviewees believed that financial aspects of cloud computing business models have some effects on sales and marketing of services in Company X. It was argued that probably the biggest change would be the transition to pay per use pricing mechanism with new cloud based services. However, one interviewee pointed out that there might be many customers who do not want to use pay per use pricing although they are otherwise interested in cloud services.

All interviewees found that economics are the key driver for cloud computing adoption among customers. It was argued that there founds two primary ways to get customers to replace their current services with new cloud based services. First, a cloud service could be same price as the current service but it must offer better features than found in the current service. For example, the time-to-market with a cloud service might be shorter than with current service. However, it was pointed out that salespersons must be able get customer to understand the economic value of the implicitly monetary factors.

The second option is that a cloud service must be cheaper than the current service in use. However, it was pointed out that depending on calculation model, cloud services might not be cheaper than current services and thereby total cost of ownership (TCO) model should be employed to demonstrate the financial benefits of cloud services in the long run. It was argued that if customer can be guaranteed that their TCO decreases, it is highly effective sales argument for cloud services. However, it was remarked that TCO calculations must be very carefully planned in order to be plausible and pay per use pricing brings additional challenge to the model.

> *"You go to one of these big customers of ours … the first questions there is how much we save with this per year. You must have a plausible story how this usage based billing in real is going to decrease your TCO [and] how is it proved. [It should not be] like 'let's see after a year how it went'."*

> *"It [cloud computing] must bring some changes [to TCO] because cloud service is not necessarily that most cheapest service at the moment. The profitability must be brought out through the TCO."*

> *"This [TCO] is the marketing message and a lot of time must be devoted to [developing] that, I say."*

"Probably most [cloud service selling] cases start from comparison to old services. … With a fairly similar service [as compared to old service] … you must find the right price point at which the customer confirms: 'Yes, this is good. This better than the traditional as a service and we got better price to us and we get value for money.'"

All interviewees emphasized that customers must be able to compare TCO calculations of cloud and non-cloud version of a service. However, it was pointed out that calculating additional TCO model means a lot more work for salespersons and it was thought that sales process is already fairly burdensome.

Most interviewees believed that cloud computing services could decrease customer's IT costs when measured with TCO model. It was argued that implementation is the single most important cost component, which should decrease with cloud services. Other significant areas of cost reductions mentioned were service development, maintenance, and on-site services. However, few interviewees expressed their concerns about expecting and marketing too large cost reductions. One interviewee reminded that the fact still is that Company X has no experience of cloud services' impact on customers' business in practice.

"[I have] concern about costs. Quite many have spoken about the cost savings but I do not see, to tell you the truth, that cloud services bring cost savings, at least during couple of first years."

"I would test them [cloud computing services] damn strictly internally. I would not first go to sell those to new customer, do large outsourcing cases or any this type of cases for customer. [I would not] give promises on a thing from which we self do not have concrete understanding."

"It depends on marketing [function] whether the services are let to built well before they are started to sold."

Few interviewees believed that the amount of self-service increases significantly with cloud services and this would obviously have several implications for sales function. However, as discussed before, self-service probably will not be the generic model of provisioning services. Interviewees argued that although provisioning services as self-service is a nice concept, in practice customers in large enterprise context are not ready for it. Another interviewee argued that self-service model would mean that enterprises would again need own IT offices to have enough experience to provision services themselves and that is something that they do not want as the past outsourcing trend has already shown.

Some interviewees mentioned that new pricing mechanisms with cloud computing services are definitely going to set challenges to salespersons. For example, one interviewee explained that it is hard to salespersons to understand that capacity such as computing power is not necessarily measured and prices on per machine basis as before.

6 Discussion and Implications

This section assesses the findings of both theoretical and empirical sections and the linkages between them and discusses theoretical and managerial implications. First chapter discusses cloud computing business models. Second chapter discusses cost structure and cost accounting mechanism. Third chapter discusses revenue model and pricing mechanisms. This section also proposes new conceptual frameworks and models to address the key issues found in the study.

6.1 Cloud Computing Business Logic Framework

Findings of the study suggested that it is highly important to analyze cloud computing business models. The concept of business model is relevant especially with cloud computing because business model is a tool for translating the new technology to customer value and thus financial income for the services provider.

Based on the findings of the study, a cloud computing business logic framework (**Figure 11**) was created as a conceptual tool for illustrating the structure of business logic of a firm offering cloud computing services. The top level of the three-layer framework is business strategy and it depicts the role of the firm in the cloud computing value chain. Two strategic dimensions are attached to value chain to further define the different possible positions and strategic approaches. First, the nature of firm's customer relationship may be more transaction-oriented or relationship-oriented (Grönroos 1994). Second, firm's core competence may be low cost or uniqueness of services, which leads to either simpler bulk services with lower margins or more complex value-adding services with higher margins (Porter 1980). However, it should be noted that these dimensions are rather continuums than either-or decisions.

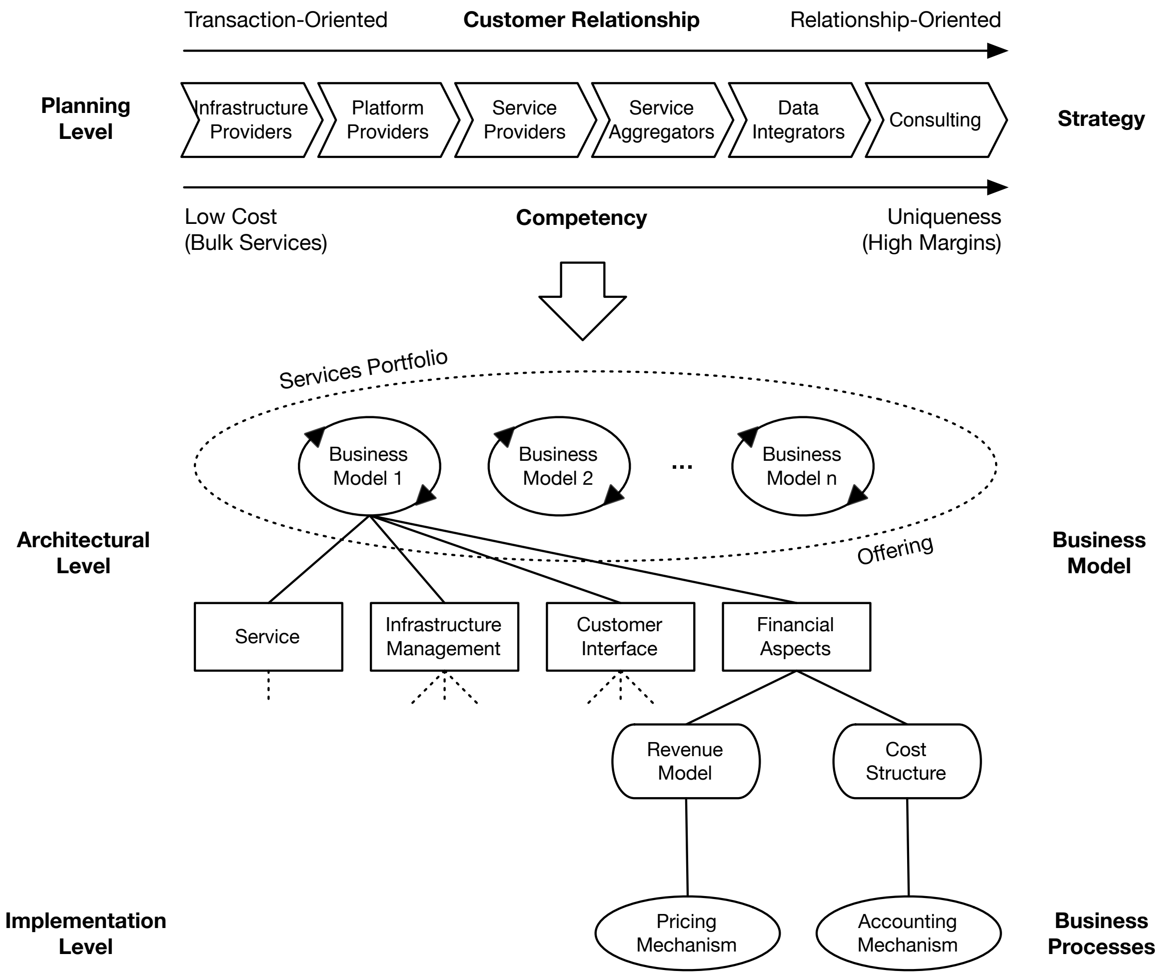

Figure 11. Cloud computing business logic framework.

The second stage of the framework is architectural level and it contains all business models of the firm derived from the selected position or positions on the value chain. The business model literature often assumes that a firm has only one business model and it covers all activities the firm does. Although this may be true with small and medium-size enterprises with single offering, it is more reasonable to think that large enterprises such as the case company have many separate business models as also the findings suggested. For example, two different services may have different type target segments, revenue model, and value proposition.

The business models of a firm together constitute the services portfolio, which depicts the internal perspective to business models and works as a basis for example for portfolio analysis techniques. From external viewpoint, business models form the offering of the firm. The framework also suggests that the business models are dynamic constructions that adapts to the changes of business environment such as cloud computing paradigms position on hype cycle.

The lowest stage of the framework is implementation and it refers to operational level business processes that put the business models in practice. In context of financial aspects business model element, pricing mechanism and accounting mechanism for a business model are designed on this level. Also, the prices and cost meters of the services belong to this level. Each business model element has its own building blocks but due to the scope of this study only financial aspects element is illustrated in the framework.

One severe shortcoming in current literature is that the SPI model is not sufficiently taken into account. Although the three service models are often introduced, their practical implications on business model formulation and thus revenue model and cost structure is not addressed. In many cases the financial aspects of cloud computing are discussed as if there would be only one cloud with single business model. The key question here is whether it is possible to define generic revenue model and cost structure in accordance with each service model or should there be separate models for each business model. The findings of the case study supported more the view that the uniqueness of services requires independent models customized to needs of each service. Thereby, the framework also suggests that revenue model and cost structure must be set individually for each business model.

The findings of the case study strongly supported the view that services providers working with medium size and large enterprises must position themselves more to the right-hand end of the value chain especially in terms of customer relationship. The current cloud literature is slightly too much based on assumption that cloud computing paradigm reduces the interaction between IT services provider and customer, and thus the value-adding services and value-based pricing approach are not discussed enough. However, based on the findings of the case study, it seems to be undoubted that the basic nature of providing IT services to enterprises would change. Related, it was also found in the case study that private and hybrid clouds are going to have significant role on the enterprise environment. As discussed by many authors, there are still several issues that prevent enterprises from adopting the public cloud offerings.

6.2 Cloud Computing Cost Accounting Model

Findings of the study suggested that it would be most beneficial for a services provider with many different cloud business models based on different service models to adopt hierarchical service production architecture according to SPI model so that modular services are build on top of other services. However, it was found that this change would induce critical changes to current cost accounting conventions. The key issue is how costs are measured, accounted, and distributed between different service layers and organizational units responsible of them.

A cloud computing cost accounting model (**Figure 12**) is proposed as a conceptual tool to address cost accounting issues in production of cloud services. The foundational assumption of the model is that the services provider has single common capacity pool, or an infrastructure cloud, which enables building platforms and services on top of it. The infrastructure layer sells capacity to platform layer, which builds pre-configured solution stacks for service developers on top of the infrastructure.

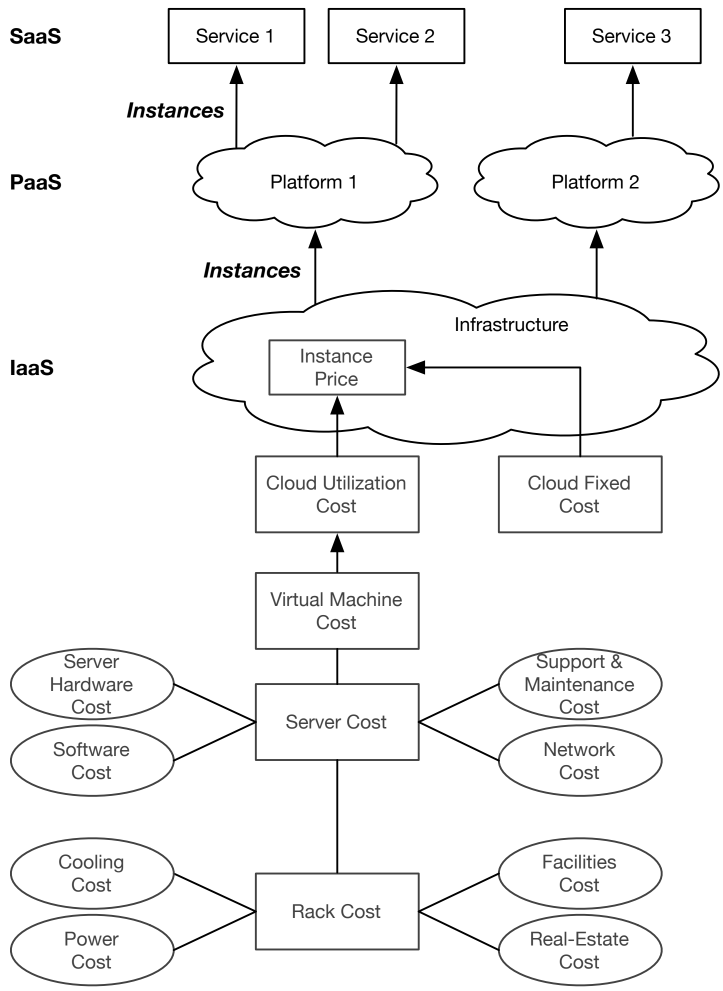

Figure 12. Cloud computing cost accounting model.

Capacity from the infrastructure cloud is sold with pay per use mechanism and it is measured in instances. The instance is a tiny share of computing capacity, which has pre-defined qualities such as amount of storage, memory, and computing power measured for example in virtual cores[23] of certain type processor. Thereby, instance is also a cost aggregate for the utilization of different resources from the cloud.

[23] The core is the part of the computer's processor that actually performs the reading and executing of the instructions. Virtual core refers to artificially splitting the processor into several cores instead it is physically just single-core.

Finally, the end user services are built on top of the platforms. Service developers buy capacity from the platform layer, also measured in instances. Platform level instances might have additional qualities such as type and amount of software, databases, and so forth. It is also possible that infrastructure and platform layers sell their capacity directly to customers as a service if the services provider is positioned more at the beginning of the cloud computing value chain.

The unit price of an instance is calculated by using a derivation model. The derivation model calculates the cost of utilizing a single virtual machine from the cloud, which is then linked to instance price. Since maintaining the cloud infrastructure incurs costs even if the cloud is not utilized, it is also possible to add some overhead to instance price depending on services provider's general accounting principles. The cost accounting model also identifies the eight cost categories that should cover the cost incurred by providing cloud services.

The findings suggested that cloud computing is a major opportunity to increase the efficiency of IT services provider's business processes and thus generate significant reductions in general cost structure. By leveraging single common capacity pool, shared and modular infrastructures and platforms, and common management framework, it is possible to increase agility of service development, production, and provisioning. The reorganization of production system after cloud computing paradigm could be understood as business process reengineering. Hammer & Champy (1993) defines business process reengineering as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service, and speed."

However, it should be noted that because of existing long contracts, it might not be possible to transform all services to be accordant with cloud infrastructure. It should be addressed what are the implications of maintaining two distinct cost accounting mechanisms.

6.3 Generic Cloud Computing Pricing Mechanism

Cloud computing literature strongly endorses pay per use pricing mechanism and it is often regarded as a key characteristic of cloud computing paradigm. However, findings of the case study suggested that pay per use mechanism as such might not be the optimal pricing solution at least from services provider viewpoint. It was found that pay per use pricing significantly changes the risk-sharing model between the services provider and customer as customer's commitment decreases. In addition, it was found that pay per use mechanism could have decreasing effect on services provider's incoming cash flows.

Based on the findings of the study, a generic cloud computing pricing mechanism is proposed (**Figure 13**). The model suggests that a typical cloud service has three primary price components. First, there is a price for starting-up the service but it is charged only once. There may be also additional one-time charges if the service has some attributes that customer is able to change after the service is implemented and bring additional work to the services provider.

Second, there is an availability cost that incurs even if the customer does not use the service. For example, in case of an e-mail service, availability is the cost that incurs from having the mailbox and ability to send e-mail even if the user does not actually send any e-mail. The pricing mechanism for availability component is subscription, which means that customer signs a contract for using the service for certain time period such as a month, quarter, and so forth.

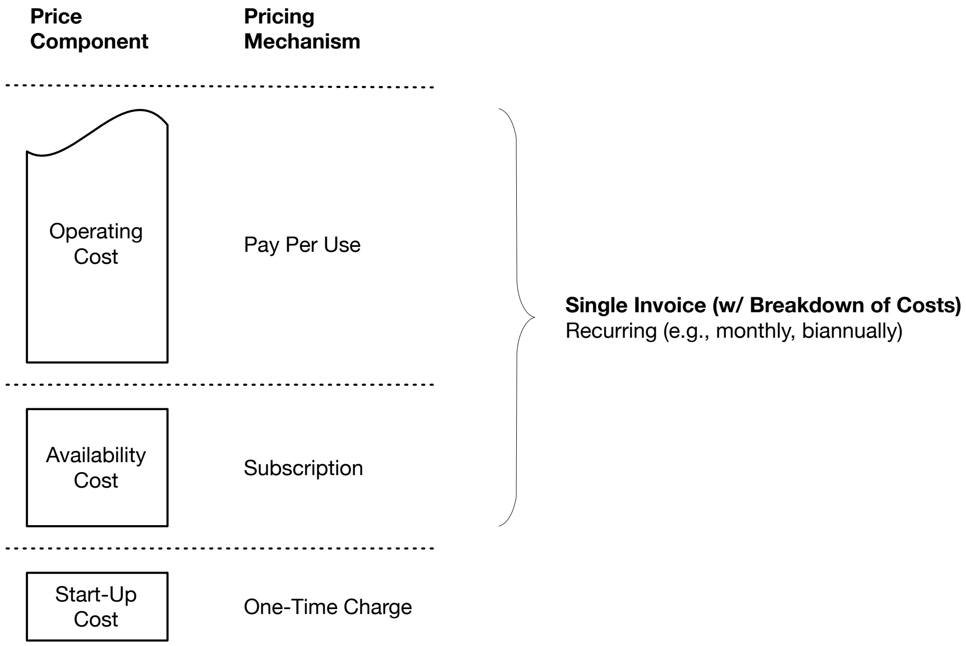

Figure 13. Generic cloud computing pricing mechanism.

Third price component is the actual operating cost of the service and it is the biggest element. The use of the cloud service is priced with pay per use pricing mechanism. There is some predefined capacity unit to be measured and customer pays in relation to his actual usage of capacity. Hence, the operating cost price component is variable whereas availability and start-up components are fixed. However, also the capacity units have fixed unit price. It is possible that the unit price of capacity units is set according to customer commitment. For example, the price could be cheaper if the customer contracts to use the service for a longer period such as one year.

For sake of simplicity and clarity, it is suggested that customer gets only single invoice that combines availability and operating cost. Though, there should be also breakdown of costs attached. It would be also beneficial to customer to be able to follow the development of the operating cost in real-time via web portal, but findings of the study suggested that this is not yet possible with current systems.

The benefit of the pricing model proposed is that it balances the commitment between services provider and customer. This is because customer's commitment is greater than compared to raw pay per use pricing mechanism. The proposed pricing model is good from service's provider viewpoint also because it has fixed-term subscription component that increases customer's lock-in and possibly stimulates closer relationship between customer and services provider.

Although the proposed model may be suitable for many cloud computing services, the findings of the case study also strongly suggested that formulating a generic pricing mechanism may be impossible in many cases. Thereby, the proposed generic pricing mechanism might better serve as a basis for service-specific pricing mechanisms.

7 Conclusion

This section concludes the study. First chapter summarizes the study and presents its key contributions. Second chapter assesses the limitations of the study. Finally, suggestions for further research are given.

7.1 Research Summary and Contributions

The purpose of this study was to explore financial aspects of cloud computing business models from services provider viewpoint. An international IT services provider preparing to launch number of cloud services was selected as a case company and several managers were interviewed for acquiring information on the subject.

It was found that cloud computing is regarded as a new computing paradigm but it is not so much technologically driven phenomenon as a new model to produce, develop, sell, buy, and provision IT services. At the moment cloud computing is still much about hype and there are only different predictions how it will change business processes of services providers and customers. However, it seems very likely that the change in enterprise market is more moderate and evolutionary than truly revolutionary. Services providers must be able justify the adoption of cloud services to customers by showing how customer's total cost of IT ownership decreases and/or how cloud computing enables new capabilities such as faster time-to-market of services.

It was found that each different cloud service should have distinct business model. The business model is a tool for translating cloud computing technology to customer value. The business models are derived from the services provider position on cloud computing value chain starting from bulk infrastructure services and ending to complex value-adding services such as integration and consulting. Public cloud deployment model is more typical at the beginning of the value chain whereas hybrid and private clouds are more relevant at the end of the value chain where also the customer relationship becomes more intimate. The cloud computing business has financial aspects element that is defined by revenue model and its pricing mechanism and cost structure and its cost accounting mechanism elements. A cloud computing business logic framework was formulated to illustrate the linkage between value chain and business models.

It was found that key cost types do not necessarily change much with cloud services but cloud computing has still potential to significantly reduce services provider's costs through reengineering of production architecture. The key drivers for cost reductions are single common capacity pool, shared and modular services, and common management framework, which increase the utilization of resources and boosts efficiency in deploying new services and provisioning services to customers. In addition, technological advancements, in particular virtualization, have decreasing effect on costs. A cloud computing cost accounting model was formulated to illustrate how production costs should be aggregated into a cost of virtual machine, which should be linked to capacity instances provisioned for upper layer platforms and services.

It was found that pricing of services change in cloud environment. The most typical pricing mechanisms for cloud services are pay per use and subscription. Dynamic pricing mechanisms such as yield management could be profitable but their complexity probably outweigh the benefits. The basis for price setting should be customer's perceived value instead of production cost of a service. A generic cloud computing pricing mechanism that combines pay per use and subscription mechanisms was formulated to better balance risk sharing between services provider and customer.

The main contribution of the study is the establishment of services provider focus in cloud computing literature. The study also contributes by providing rich empirical data collected from a prominent IT services provider preparing to launch number of cloud services. The findings of the case study highlights number of pragmatic issues that IT services providers must address. This study also contributes by linking cloud computing to business model literature and exploring financial aspects in cloud services context. Three conceptual frameworks were created for theoretical and managerial purposes. In addition, the study covers essential concepts, architectural designs, main characteristics, and key technologies of cloud computing thus providing a better understanding of the emerging phenomenon.

7.2 Limitations of the Study

This study has some limitations that should be noticed. The qualitative methodology and single-case approach together with one-sided services provider viewpoint made the scope of the study rather narrow. It should be also noticed that because of the methodology the study is not suitable for making any generalizations even inside the case company. The number of interviewees was fairly small and the persons interviewed were selected by one person alone. It is possible that expanding the number of the interviewees as well as the scope of selection to cover broader part of the case company would have helped to better answer the research problem.

In general, the findings of the empirical study did not contribute the research as much as expected. The information acquired was partly too vague, shallow or abstract that it would genuinely help to solve complex managerial problems. Also, the opinions of the interviewees were often somewhat uncertain; the interviewees themselves also admitted that it is very hard to predict what are the implications of cloud computing on different areas of business and many opinions had to left just as educated guesses. However, this was caused more by the nature of the subject than the research design.

7.3 Suggestions for Further Research

Cloud computing literature is still in its infancy. The scope of current literature is fairly narrow and thereby future research should consider cloud computing from less charted and novel perspectives. In particular, future studies should address the importance of services provider's perspective and start more profoundly discuss the numerous issues in that area. As this study revealed, cloud computing paradigm has still many aspects that should be understood better before it can evolve to the mainstream of enterprise IT. Some suggestions are presented next.

Future studies should continue exploring business models of cloud computing services. This study covered only two building blocks of out of the nine in the business model. A study assessing the most common cloud business models and their differences according to business model ontology would be highly useful. In particular, it should be analyzed what different capabilities different business models require from the services provider.

Research within the area of business model's financial aspects, or revenue model and cost structure, should be continued as economics of clouds are the key driving factor for both services providers and customers. This study proposed new conceptual frameworks and models to outline the essential financial aspects of cloud computing. However, the models are just preliminary sketches of somewhat uncharted territory and thus future studies should continue to expand and refine them.

In future work, private and hybrid cloud deployment models should be covered in more detail. Currently, literature discusses mostly public clouds offered by heavyweights such as Google and Amazon Web Services. However, as found in this study, private and hybrid clouds will most probably be the main form of cloud adoption in enterprise environment.

Future work should also address the changes in risk sharing model between services provider and customer that cloud computing paradigm necessarily inflicts. The implications of changing customer on pricing should be carefully reviewed in order to ensure cloud computing's viability from services provider viewpoint.

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Appendices

Appendix A: The NIST Definition of Cloud Computing

The NIST Definition of Cloud Computing

Authors: Peter Mell and Tim Grance

Version 15, 10-7-09

National Institute of Standards and Technology, Information Technology Laboratory

Note 1: Cloud computing is still an evolving paradigm. Its definitions, use cases, underlying technologies, issues, risks, and benefits will be refined in a spirited debate by the public and private sectors. These definitions, attributes, and characteristics will evolve and change over time.

Note 2: The cloud computing industry represents a large ecosystem of many models, vendors, and market niches. This definition attempts to encompass all of the various cloud approaches.

Definition of Cloud Computing:

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models.

Essential Characteristics:

On-demand self-service. A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider.

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

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

Rapid elasticity. Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.

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

Service Models:

Cloud Software as a Service (SaaS). The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a web browser (e.g., web-based email). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

Cloud Platform as a Service (PaaS). The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.

Cloud Infrastructure as a Service (IaaS). The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).

Deployment Models:

Private cloud. The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.

Community cloud. The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.

Public cloud. The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.

Hybrid cloud. The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).

Note: Cloud software takes full advantage of the cloud paradigm by being service oriented with a focus on statelessness, low coupling, modularity, and semantic interoperability.

Appendix B: Cloud Stack

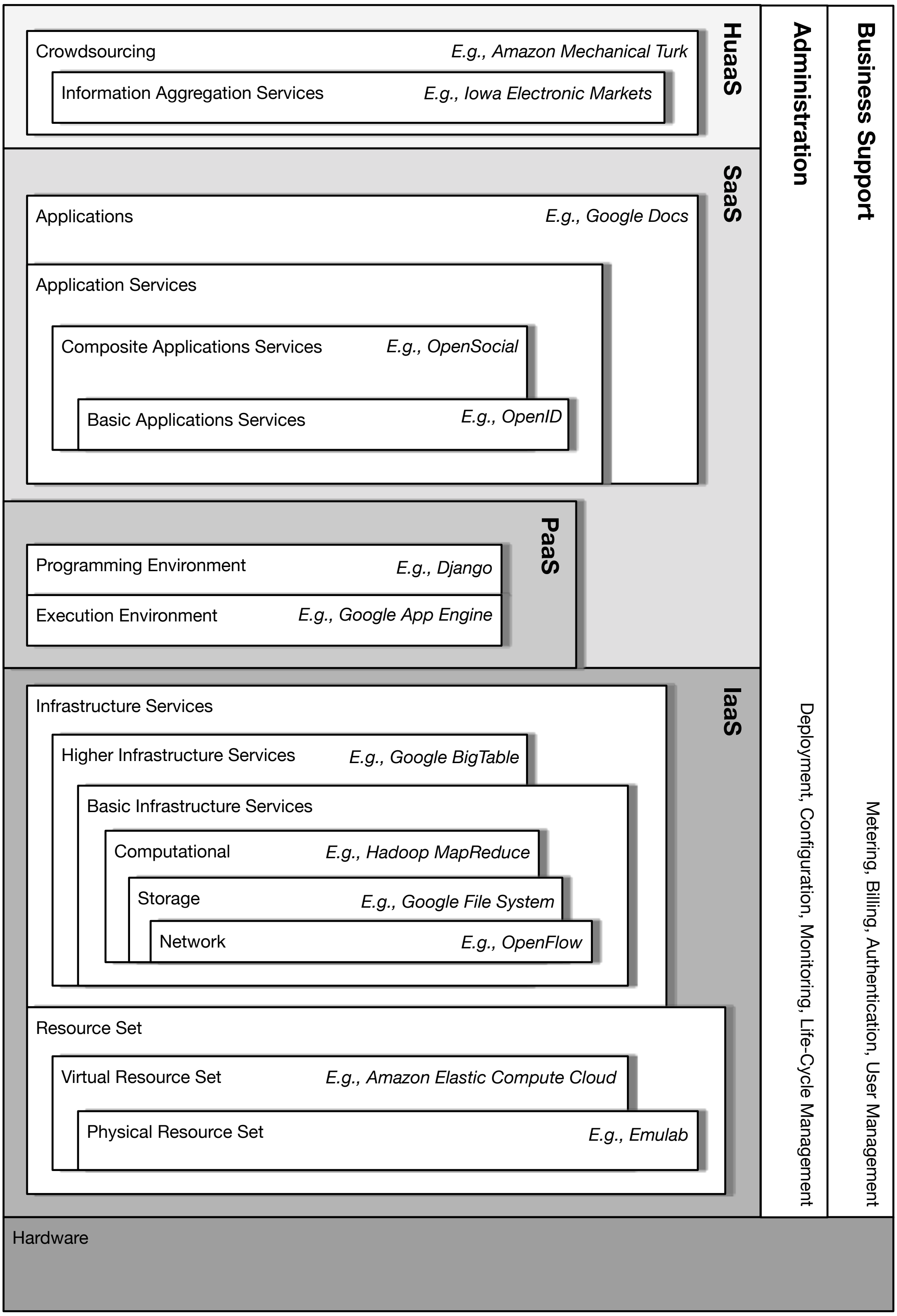

Figure 14. Cloud stack (Lenk et al. 2009).

Appendix C: Interview Template

The topics of this interview template roughly represent the progression of the interviews.

Theme 1: Cloud Computing Paradigm

- Definition of cloud computing
- Essential characteristics

Theme 2: General Level Implications

- Implications on Company X
- Implications on IT industry

Theme 3: Business Models

- Business strategy
- Cloud computing value chain
- Cloud computing business models

Theme 4: Cost Structures and Cost Accounting Mechanisms

- Cost structures and cost accounting mechanisms for cloud computing services
- Differences compared to existing structures and mechanisms

Theme 5: Revenue Models and Pricing Mechanisms

- Revenue model and pricing mechanisms for cloud computing servicess
- Differences compared to existing models and mechanisms

Theme 6: Sales and Marketing

- Cloud computing and total cost of ownership (TCO) model
- Implications of changing pricing mechanisms

Appendix D: Interviewees

The list of interviewees of the case study.

Interviewee A	Lead Service Architect, Virtual Capacity Services
Interviewee B	Service Owner, Capacity Services and Server Operations
Interviewee C	Senior Sales Executive, Public Sector Sales
Interviewee D	Offering Owner, End User Services
Interviewee E	Director, Internal IT
Interviewee F	Offering Owner, Capacity Services
Interviewee G	Service Owner, Desktop as a Service
Interviewee H	Lead Enterprise Architect, ERP System
Interviewee I	Line Manager, Test as a Service
Interviewee J	Concept Owner, Test as a Service