MASTER

Clearing the sky in cloud computing
a framework for SLA elements in the cloud

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Clearing the Sky in Cloud Computing:
a Framework for SLA Elements in the Cloud.

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"A cloud does not know why it moves in just such a direction and at such a speed...It feels an impulsion...this is the place to go now. But the sky knows the reasons and the patterns behind all clouds, and you will know, too, when you lift yourself high enough to see beyond horizons." ***(Richard Bach, 1936)***

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Summary

Since its birthday in 1969, internet has come a far way. It started with a successful transfer of the letters L and O before making the entire system braking down under the strain. Today, Facebook alone connects 750 million of active users over the internet. Another feature internet has to offer is Cloud Computing. The birth-year of commercial Cloud Computing is 2009 with Cloud vendors introducing browser based enterprise applications. Forrester research forecasts that the global market for Cloud Computing will grow from $40.7 billion in 2011 to more than $241 billion in 2020. The uncertainties surrounding Cloud Computing, however, hinder this development. Issues with security, interoperability, vendor lock-in and compliance are considered to be inhibitors to the adoption of the Cloud. Traditionally these topics are treated in contracts between the involved parties; Service Level Agreements (SLAs). The forces at work in Cloud Computing are expected to change the relationship specifics that are documented SLAs. The research scope is narrowed to two deployment models (Public and Private Cloud) and 3 service models (SaaS, PaaS, IaaS). The point of view from the service recipient (e.g., customer) is adopted. To investigate this the following research questions are formulated:

"(1) To what extent are traditional IT outsourcing SLA elements applicable in Cloud Computing and do they need to be complemented with Cloud Computing specific SLA elements?

(2) What is the consequence of the differences between the deployment models (Public Cloud, Private Cloud) for Cloud Computing SLA elements?"

First, a literature review is conducted to provide an insight into the extent to which SLAs in Cloud Computing is covered. Based on the reviewed literature it becomes apparent that there is a lack of a structured overview of what should be included in SLAs that can be applied in Cloud Computing. For SLAs in traditional ITO, however, such a structured framework exists. This framework provides an overview of eleven elements divided among 3 categories and contains all relevant topics that should be included in IT outsourcing SLAs. The framework is used as point of departure for the research method that attempts to answer the research questions.

The research project is divided into two stages: designing (1) and validating (2) the conceptual framework and SLAs. To answer the research questions, stage 1 has the objective to answer whether the SLA framework for traditional ITO is applicable in Cloud Computing and whether the forces at work in Cloud Computing result in additional and/or changed SLA elements. For the first stage of the study a qualitative research method is used: semi-structured interviews. They are used to investigate, on the one hand, the applicability of the existing framework and on the other hand to discover new elements, specific to Cloud Computing. The interviews, furthermore, should reveal differences between the Cloud deployment models. The interviewees are member of the PwC taskforce for Cloud Computing or are selected based on their knowledge about Cloud Computing. During the face-to-face interviews an interview guide is used to ensure that all important subjects are treated.

The second stage of the research project entails the validation of the framework and SLAs that are developed in stage 1. To achieve this, a second round of interviews is conducted among a different group of interviewees. This group consists of members from the Dutch CIO platform and an advisor from PwC. The framework and SLAs that are developed in stage 1 of the research project serves as guiding documents. The interviewee is asked to assess whether the content of the framework and SLAs is complete, usable and clear. Through this process the validity (e.g., credibility) of the framework and SLAs was assessed.

The analysis of the interview transcriptions of stage 1 leads to a conceptual framework that depicts the aspects that are of importance for companies to consider when investigating Cloud solutions. A clear distinction between the Public and Private Cloud is visible. The Public Cloud provides services that are standard, based on a 'take it or leave it' mechanism for which the governance is managed unilateral by the service provider and the visibility of the service is opaque (i.e., non-transparent). The Private Cloud provides a customizable service, based on a negotiable agreement for which the governance is managed bilateral by both parties and the visibility of the service is more transparent than Public Cloud services.

The application of SLAs in the Public Cloud and Private Cloud differs. The SLA in the Public Cloud, the (Unilateral)SLA, becomes a document that is drafted by the service recipient only and is used for creating the necessary internal awareness, provide service providers based on the extent to which they can support the requirements and to set the parameters by which the performance can be measured. The SLA in the Private Cloud, the (B)SLA, remains a document that is drafted by both involved parties and is used for, in addition to the uses for a (U)SLA, structuring the relationship and the negotiation of specifics for the service to be delivered.

The answer to the first part of the research question regarding the applicability of the traditional ITO SLA elements and whether they need to be complemented with Cloud Computing specific SLA elements is: yes. The extent, however, depends on the deployment model under consideration. In the case of (U)SLAs there are two redundant elements: Innovation Plan and Anticipated Change Plan. One element, Enforcement Plan, is partial redundant. For (B)SLAs all traditional ITO SLA elements remain relevant in Cloud Computing. Furthermore are there two elements that are added to both the (U)SLA and (B)SLA: Data Code of Conduct and Exit Strategy Plan.

The second part of the research question regards the consequences of the difference between the deployment models for the SLA elements. The main difference and contributor to the difference between the (U)SLA and (B)SLA is the nature of the relationship. In Public Clouds, the service recipient has no influence on the service and the (U)SLA is drafted as a document that can be used as a 'checklist' to avoid ambiguities when engaging into a Public Cloud service. The SLA that is drafted by the service provider is implicitly agreed upon when the service recipient decides to use the service. In Private Clouds, the service recipient is able to negotiate the specifics of a service and will document the negotiated and mutual agreed to service specifics in the (B)SLA.

As validation, four interviews are conducted to investigate whether the developed framework and SLAs are usable in practice, complete and if they are clear (i.e., understandable). The answers during the interviews resulted in two types of comments: conceptual and substantive. The conceptual comments regard the usability in practice and completeness and are considered most important for further improvement of the framework. The substantive comments regard comments that consider the clarity of the framework and SLAs. Among the interviewees there is a general consensus that the framework and SLAs are useful in practice and are applicable in Cloud Computing.

The validation interviews resulted furthermore in scientific and practitioners' recommendations. To improve the applicability of the framework, extended research on the influence of the deployment models (i.e., include Hybrid and Community), service models (i.e., include SaaS, PaaS and IaaS) and the influence of branch specific characteristics on the content of the SLAs can be conducted with the methods presented in the research as point of departure.

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List of Abbreviations

Amazon S3:	Amazon Simple Storage Service
(B)SLA:	Bilateral Service Level Agreement
BTA:	Business & Technology Assurance
CAGR:	Compounded Annual Growth Rate
CEO:	Chief Executive Officer
CIG:	CIO Interest Group
CIO:	Chief Information Officer
CSP:	Cloud Service Provider
CSR:	Cloud Service Recipient
EU:	European Union
FS:	Financial Systems
FY11:	Financial Year 2011
HRS:	Human Resource Services
IaaS:	Infrastructure as a Service
IasS	Infrastructure as Service
IT:	Information Technology
ITO:	Information Technology Outsourcing
NFAS:	Non-Financial Assurance Services
NFR:	Non Functional Requirement
NIST:	National Institute of Standards and Technology
o/s:	Outside of scope
PaaS:	Platform as a Service
PasS:	Platform as Service
PC:	Private Company
PDA:	Personal Digital Assistant
PS:	Public Sector
PwC:	PricewaterhouseCoopers
SaaS:	Software as a Service
SasS:	Software as Service
SLA:	Service Level Agreement
SLO:	Service Level Objective
SR:	Service Recipient
SP:	Service Provider
SPA:	System and Process Assurance
TICE:	Technology, Information, Communication and Entertainment
UCLA:	University of California, Los Angeles
US:	United States
(U)SLA:	Unilateral Service Level Agreement
UK:	United Kingdom
GM:	General Manager

1. Introduction

There is some discussion in the IT-world about what the true birthday is of the internet. Some say it is September 2, 1969. On that date, the world's first router (or Interface Message Processor at it was called at the time) employing packet switching technology connected two computers. However, potential and actual communication are two very different things. Therefore, other computer history enthusiasts have suggested an alternative date for the internet's birthday; October 20, 1969. On that date the refrigerator-sized Interface Message Processor communicated with a computer at UCLA, seven weeks after they were first connected. On that Monday the UCLA computer managed to send exactly two characters across the connection to a second computer at Stanford before the entire system crashed under the strain. The two successfully transmitted characters were the letters L and O. Since then Internet has come a long way. From the first spam message in 1978 to the Facebook announcement of 2011 that they reached an astonishing amount of 750 million active members (more than the population of the US and UK combined).

The birth-year of commercial Cloud Computing is 2009 with cloud vendors introducing browser-based enterprise applications (Pallis 2010). Forrester Research (2011) forecasts that the global market for Cloud Computing will grow from $40.7 billion in 2011 to more than $241 billion in 2020

1.1 Company Description

This research project is executed with the support of PwC. In this section an overview of PwC's history, activities and structure is given.

PwC (officially PricewaterhouseCoopers) is a global professional services firm headquartered in London, United Kingdom. It is the world's largest professional services firm measured by revenues and one of the "Big Four" accountancy firms next to Deloitte, Ernst & Young and KPMG. The history of PwC starts in 1849 when Samuel Lowell Price founded an accountancy practice in London later to be accompanied by Edwin Waterhouse to form Price, Waterhouse & Co in 1874 (the comma was dropped much later). In 1854 William Coopers founded his accountancy practice in London, which became Coopers & Lybrand in 1973. In 1998 Price Waterhouse merged with Coopers & Lybrand to form PricewaterhouseCoopers in an attempt to gain a scale that would put the new firm in a different league.

Today, PwC has offices in 757 cities across 154 countries and employs over 175,000 people. It had total revenues of $29.2 billion in FY11, of which $14.14 billion was generated by its Assurance practice, $7.63 billion by its Tax practice and $7.46 billion by its Advisory practice. The trading name was shortened to PwC in September 2010 a part of a major rebranding exercise.

Figure 2 PwC logo from 1998 to 2010

Figure 1 PwC logo from 2010 to the present

The Dutch part of PwC includes fourteen offices in which 4.900 professionals are active in three different perpsectives:

- Assurance
- Advisory
- Tax & HRS

A section of the Assurance perspective is the Business Assurance Services department. This department is divided in two sub-departments: Non-Financial Assurance Services (NFAS), and System and Process Assurance (SPA). The activities of these two sub-departments are shown in Figure 3. The members of the SPA department supported the research by facilitating the necessary resources for the project.

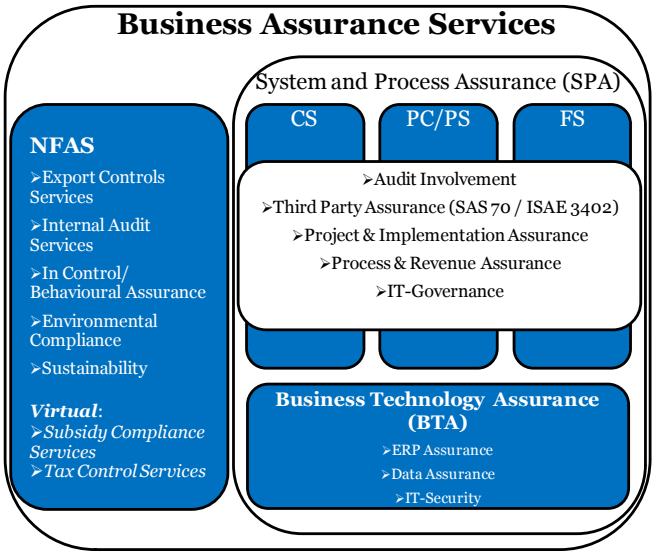


Figure 3 BAS department

1.2 Problem Statement

Cloud Computing is increasingly becoming a part of organizations. Numbers in a recent survey show that 24% of the customers are using Cloud Computing and another 61% is experimenting or waiting for Cloud Computing to mature (North Bridge 2011). Forrester Research (2011) forecasts that the global market for Cloud Computing will grow from $40.7 billion in 2011 to more than $241 billion in 2020. The uncertainties surrounding Cloud Computing, however, hinder this development. Issues as security, interoperability, vendor lock-in and compliance are considered to be inhibitors to the adoption of the Cloud (North Bridge 2011). Traditionally, topics regarding these issues are treated in contracts between parties in IT outsourcing engagements. Theory states that "outsourcing relationships require, next to relational governance (i.e., unwritten, practice based mechanisms), formal controls (i.e., contracts) in which the relationship is specified (Goo 2010). The early work of Jaworski (1988) defines the role of a formal contract as: "Contracts serve as mechanisms of formal control since they articulate acceptable behavior toward desired outcomes in the written rules and regulations". In IT outsourcing, the formal contract is drafted in the form of a Service Level Agreement (SLA) and describes the specifics of service(s) to be delivered and the expectations of the service recipient and service provider from the engagement; the relationship specifics. But do the characteristics of Cloud Computing change these relationship specifics?

In Cloud Computing, the basics of the relationship remain the same compared to traditional IT Outsourcing (ITO); party A requests a service and party B can provide this. The properties that Cloud

Computing features, however, form the base for differences that are observed in practice. The features that Cloud Computing has to offer are beneficial for companies (e.g., rapid scaling, pay-per-use, lower IT costs) but also cause situations to occur that did not occur in traditional ITO relatsionships. A few issues that arose with Cloud providers in the past are presented hereafter:

"In a period of less than 60 days, Apple MobilMe, Google Gmail, Citrix, and Amazon S3 all reported outages or periods of unavailability from 2 to 14 hours; in March 2009, Microsoft Windows Azure was down for 22 hours" (Paquette, Jaeger and Wilson 2010), "A cell phone provider that stored customer data in a Microsoft subsidiairy-provided cloud became unavailable when the provider lost that data. Customers had to wait for days to be informed that a possibility (but no guarantee) existed that their data may be able to be restored. However, the extent of data recovery, the level of data integrity, and the timeline to restore remain to be seen" (Paquette, Jaeger and Wilson 2010)

The unilateral nature of the relationship in Cloud Computing, especially in Public Clouds, results in the service recipient being more dependent on the service provider as in traditional ITO. When outsourcing services in the Cloud it is unclear what will happen to the data when outages occur or when data is lost. This are aspects that are important to consider when investigating Cloud opportunities.

When, a suited service provider is found and 'all is good', unforeseen events can cause a service recipient to subtract the service from one service provider and transfer them to another service provider. This transfer of data can have its own issues that were less relevant for traditional ITO: "As cloud offerings spread, there will be ongoing challenges with interoperability, portability, and migration. […] Cloud users can face severe constraints in moving their data from one cloud to another and find themselves locked in" (Hofmann and Woods 2010).

Next to the herefore described new situations a service recipient can encounter, the differences are also caused by the content of the relationship a service provider has with the service recipient. In Cloud Computing the relationship ranges from a one-to-many 'anonymous' relationship in case of a *Public Cloud* to a one-to-one 'close' relationship in a *Private Cloud* (Figure 4).

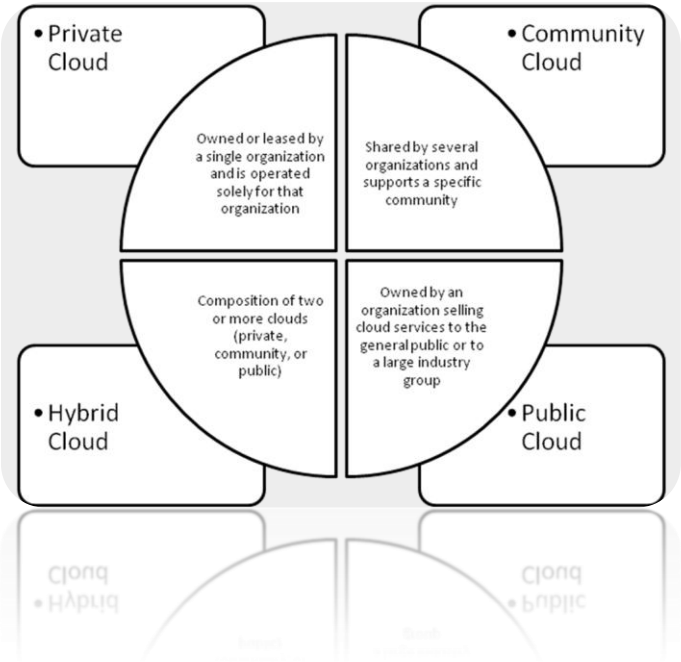


Figure 4 Cloud Computing Deployment Models (C4C 2011)

To counter the issues that result from the unknowns in an ITO engagment in the Cloud, adaptions have to be made to existing SLAs. There is a lack of published work on SLAs in Cloud Computing that describes which SLA elements to include and the differences for the deployment models. To fill the gap in this domain, this research project will answer the following research questions in the form of a framework that can be used by academics as a foundation for future research on the specifics of SLAs in Cloud Computing and by practitioners (service recipients) as a guide (checklist) for the development of company specific SLAs.

Research Questions

"(1) To what extent are traditional IT outsourcing SLA elements applicable in Cloud Computing and do they need to be complemented with Cloud Computing specific SLA elements?

(2) What is the consequence of the differences between the deployment models (Public Cloud, Private Cloud) for Cloud Computing SLA elements?"

1.3 Research Objectives and Contributions

This research aims to provide a framework that includes relevant SLA elements, in the context of professional service organizations from a Cloud Service Recipient point of view. The four Deployment models that are provided in Figure 4 include two models (Community and Hybrid) that are in between of the Public and Private Cloud. The scope for the research is bounded to the Private and Public Cloud Deployment Models. These are considered the two extremes in Cloud Computing Deployment models.

This research has two goals; 1) contribution to scientific research in the domain of Cloud Computing as well as to 2) the practitioner's field. First, this research will provide an overview of relevant SLA elements for Cloud Computing that has not yet been covered by scientific literature. This research aims at providing a framework that can be utilized by other researchers as reference in expanding the context and/or detail of the framework in future work. Second, this research provides a management tool for the preparation of Cloud Computing SLAs by consultancy oriented organizations.

1.4 Report Structure

This report is structured as follows. Chapter 1 provides the introduction for the company, the background of the research area and objectives of this research. Chapter 2 discusses the literature that has been published on SLAs and Cloud Computing. The research, interview, validation and conceptual framework design are given in chapter 3. Chapter 4 provides the results and analysis of the research. Chapter 5 treats the conclusions of the research and the recommendations from a practitioner and scientific perspective.

2. Literature Review

In section 1.2, the ambiguities among practitioners and lack of literature on SLAs in Cloud Computing is described. This chapter describes the literature review. First, Cloud Computing is treated to form a clear understanding of what is meant by the term Cloud Computing and what the new characteristics are compared to traditional ITO. Second, SLAs in ITO are discussed and this results in a framework which is used to structure the third section. This section treats the available literature on SLAs in Cloud Computing. Fourth, the gaps that are identified in the literature review are discussed.

2.1 Cloud Computing

To fully understand the forces at work in Cloud Computing it is important to come with a working definition. From this section it will be clear that there currently is no consensus on the leading definition for Cloud Computing. This section summarizes the attempts made to provide a general agreed upon definition and provides a definition that is accepted as a working definition by a broad spectrum of authors. After this the discussion about the novelty of Cloud Computing compared to techniques already in place is summarized and the main differences between traditional ITO and Cloud Computing are provided.

2.1.1 Definition

The author was lost in definitions when attempting to find a leading definition for cloud computing and had to come to the conclusion that there was no leading definition present. Attempts have been made to come to a solid definition for cloud computing by: feature matching from previous article definitions (Vaquero, et al. 2009, D. Truong 2010); performing a survey among 250 companies with at least 2.500 employees (F5 2009); asking 21 experts from the field (Geelan 2009); deriving definitions from world leading analyst firms (Stanoevska-Slabeva, Wozniak and Ristol 2010); an attempt to formalize the definition (Grandison, et al. 2010); and to structure the definition (Mell and Grance 2011).

The definition of Mell and Grance (2011) provides the most elaborate definition set out in 1) Definition description, 2) Cloud Computing Essential Characteristics, 3) Service models and 4) Deployment models. A large amount of articles[1] uses this definition and is therefore used in this research project. The definition is subject to rules and regulations from the US government and therefore assumed to be sound and valid. Nevertheless, NIST[2] recognizes that the definition will evolve over time as Cloud Computing is still in an evolving phase. Cloud Computing is defined by NIST as follows:

Definition

"Cloud Computing is a model for enabling ubiquitous, 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(On-demand self-service, Broad network access, Resource pooling, rapid elasticity , and Measured service), three service models(Software as a Service, Platform as a Service, and Infrastructure

[1] (Spring 2011), (Denny 2010), (Truong and Schahram 2011), (Triglav, Petrovic and Stopar 2011), (Pauley 2010) (Bala and Henderson 2010) (Robison 2010) (Chakraborty, et al. 2010) (Katzan(1) 2010) (Katzan(2) 2010) (Katzan(3) 2010) (Lin, et al. 2009) (Lombardi and Di Pietro 2010) (Miller and Veiga 2009) (Rimal, Jukan and Katsaros 2011) (Vaquero, et al. 2009) (Zhang, Cheng and Boutaba 2010) (Zissis and Lekkas 2011)
[2] National Institute of Standards and Technology.

as a Service), and four deployment models (Private Cloud, Community Cloud, Public Cloud, and Hybrid Cloud)."

The definition is complemented with an elaborate description of the *essential characteristics, service models* and *deployment models*. This elaboration is presented in Appendix I.

2.1.2 What's New??

From the definition provided in the previous section it can be derived that the domain of cloud computing is a broad one[3]. It appears to be an accumulation of technologies and ideas (dating back as far as the 60's (Parkhill 1966)) that were present in the past and are forged into a new term: Cloud Computing. So: What's new??

Infinite computing power

The illusion of infinite computing resources on demand is created, thereby eliminating the need to plan far ahead for provisioning (Armbrust, et al. 2009). This illusion is created by Cloud Computing through leveraging virtualization technologies at multiple levels (hardware and application platform (Vaquero, et al. 2009)) to realize resource sharing and dynamic provisioning (Zhang, Cheng and Boutaba 2010).

Scalability

Cloud Computing makes it easier to scale services according to client demand (Marston, et al. 2011), anyone who wishes to access the Cloud services can combine and recombine resources among which the underlying hardware assets (Sharif 2010). The Cloud being able to scale down and/or up on demand requires dynamic reconfiguration: as the system scales it needs to be reconfigured in an automated manner (Vaquero, et al. 2009).

Low entry requirements

It dramatically lowers the cost of entry for smaller firms trying to benefit from compute-intensive business analytics that were up till now available only to the larger corporations (Marston, et al. 2011). Cloud Computing operates on a pay-per-use base: processors by the hour and storage by the day (Armbrust, et al. 2009). This enables smaller firms to jump into the Cloud when necessary but also to leave it when the necessity for the service disappears.

All cited authors in this section recognize that the technologies and ideologies behind Cloud Computing are not revolutionary but have an evolutionary foundation. The growing capabilities of internet and affiliated services combined with known technologies result in the notion of Cloud Computing: a new, evolutionary way to apply known techniques.

2.2 SLAs in ITO

According to Goo (2010), ITO relationships have developed two vendor governance mechanisms reflecting formal and informal control modes: contracts and relational governance. Contracts serve as mechanisms of formal control since they articulate acceptable behavior toward desired outcomes in the written rules and regulations (Jaworski 1988), whereas relational governance are mechanisms to influence interorganizational behavior through social enforcement (Macneil 1980). Goo (2010) argues that most interorganizational relationships adopt a formal contract as a control mechanism. Contracts serve to place realistically enforceable limits on the actions of each party to extract additional rents from the other by failing to perform as agreed. As role for SLAs in ITO engagements he states that: "a SLA

[3] For a very elaborate taxonomy on Cloud Computing as a Everything as a Service model see (Esteves 2011)

describes the products or services to be delivered, sets Service Provider's (SP)[4] and Service Recipient's (SR) expectations, identifies contacts for end-user problems, and specifies the metrics by which the effectiveness of various contracted services and lower-level activities, functions, and processes will be measured, examined, changed and controlled". In many cases, however, IT organizations lack well-developed SLAs that can be used to effectively measure and manage relationships and activities associated with ITO. (Karten 2004)

In the work of Jin, Vijay and Akhil (2002) ten components are provided that a SLA can include. The ten compontens are: *purpose, parties, validity period, scope, restrictions, service-level objectives, penalties, optional services* and administration. The ten components, however, are elaborated in the work of Goo (2010). This work uses eleven elements that include the content of the ten components and extends the work to match the development of general IT.

The work of Goo (2010) provides an overview of eleven contractual elements that appear necessary in a comprehensive SLA for ITO. The elements are derived from early work in the field of relation dimensions (Macneil, 1978) and hierarchical elements (Ang and Beath 1993). The set of eleven elements are intended to dramatize the multidimensionality of exchange, in a real situation more (or less) than eleven elements are considered depending on the properties of exchange. The research identifies three categories in which the elements are divided[5]:

- *Foundation Characteristics:*
    - Service Level Objectives
    - Process Ownership Plan
    - Service Level Contents
- *Change Management Characteristics*
    - Future Demand Management Plan
    - Anticipated Change Plan
    - Feedback Plan
    - Innovation Plan
- *Governance Characteristics*
    - Communication Plan
    - Measurement Charter
    - Conflict Arbitration Plan
    - Enforcement Plan

The eleven elements that are provided by Goo (2010) are used as an evaluation tool of published literature for the next section of this review: the application of SLAs in Cloud Computing. The three categories (Foundation Characteristics, Change Management Characteristics, and Governance Characteristics) form the analysis subsections of the literature for SLAs in Cloud Computing. This was actually one of the intended outcomes of Goo's paper: "The study creates a conceptual framework by focusing on the general factor structure of the SLA in ITO […] This work would introduce IS researchers to a new avenue that seems promising for future studies of relationship management in ITO". (Goo 2010)

[4] SP and CSP are used interchangeably but represent the same
[5] See Appendix II for a detailed overview of the 11 elements

2.3 SLAs in Cloud Computing

This section is structured based on the three categories of Goo's (2010) SLA framework: Foundation Characteristics, Change Management Characteristics and Governance Characteristics. For each of the categories it is described what literature is published and when possible, expert opinions are added. Each subsection starts with a short description (in the text box) about the information that Goo (2010) suggests to be included in the concerned category. This information is put in a text box to make a clear distinction between literature reviewed for SLAs in Cloud Computing and the information provided by Goo (2010). The framework of Goo (2010) is to the best of the author's knowledge not yet researched for applicability in Cloud Computing. One possible result of this is that not all contractual elements can be mapped one-to-one to literature published on SLAs in Cloud Computing. This framework, however, provides an elaborate description of essential SLA categories and is therefore used for structuring this section of the literature review.

2.3.1 Foundation Characteristics

The relationship foundation between SR and SP is created in this category. Contractual elements included are: *Service Level Objectives, Process Ownership Plan* and *Service Level Contents*. These elements should ensure that SR and SP share a set of common goals. To clarify what is intended in this category Goo (2010) uses the term *Clan Control*: "Clan control is implemented through mechanisms that minimize the differences between controller's and controlee's preferences by issuing common values, beliefs, and philosophy within a group of individuals who are dependent on one another and who share a set of common goals" (Cloudhury and Sabherwal 2003, Eisenhardt 1985, Kirsch 1997)

The relationship between SR and SP in traditional ITO is different from the relationship in Cloud Computing. Depending on the service model, the relationship is a more one-way relationship in which a SP is less depending on SR than vice versa. A SP provides standardized solutions applicable to a general public (*community, public and hybrid cloud*) that will not fit all SR requirements. SRs that engage in Priavte Cloud services do not experience this. As an expert from KPMG states:

"The services offered by Public Cloud SPs are highly standardized; there is little room for deviations and specific wishes cannot be fulfilled" **M. Chung, manager IT Advisory, KPMG**[6]

Therefore to compare CSPs on what services they provide and to what extent they match the service level objectives of a SR, Alhamad, et al. (2010-1) present a novel trust model that uses SLA metrics from their previous work (Alhamad, Dillon and Chang, Conceptual SLA Framework for Cloud Computing 2010-1) and first hand experiences of users as main input. The model enables SRs that want to compare the available CSPs with the help of a central Cloud Services Directory. There is one evident drawback that Alhamad, et al. (2010-2) did not take into account: the lack of a standard for definitions used by CSPs and SRs. A result of this could be that a comparison between SR's SLO[7] and CSP offerings have little meaning due to the different content of the metric (e.g., availability as a measure of accessability %/time-unit or operationality %/time-unit. Comparing these two metrics for availability would not come up with a reasonable/usable comparison the same as comparing apples with pears).

A factor that determines the suitability for a business to transfer its services to the Cloud, and the content of the service level objectives, is the criticality of the services (Misra and Mondal 2011). The

[6] http://www.kpmg.com/nl/en/Pages/default.aspx
[7] Service Level Objectives

criticality of the services that may or may not be suitable for Cloud can be divided into four categories: *Highly critical* (may not be suitable for the Cloud), *Critical* (may be suitable if company is large), *Less critical* (suitable) and *Standard* (easily suitable) (Misra and Mondal 2011). The higher the criticality gets the more stringent SLAs are required. It is important that the SP recognizes the criticality of the services and treats them accordingly. A shared consciousness (building of SR trust in SP capabilities) for the content of services has to be developed.

When a match is found between a SR and SP there are more factors to consider in the SLA. Among them are the implications of multiple SRs in a SP domain: the multitenancy model. A drawback of this model can be that a SP can behave unfaithful towards a SR regarding their outsourced data and services. The possession of the data is shifted from internal at the SR to external at the SP. SR data is treated anonymously by a SP and a SP can reclaim storage by discarding data that has not been or is rarely accessed and/or hide data loss incidents to maintain a reputation (Wang and Ren 2010). Although data is treated anonymously by a SP, the philosophy, values and beliefs of SR and SP should be shared by all parties. In the case of a relationship that ceases to exist or termination of activities on the SP side, the custody, safety and availability of the data stored may be in question. (Paquette, Jaeger and Wilson 2010) According to CEO Steve Iverson after LinkUp shut down in on 8 August 2008, "at least 55% of the data was safe. How much of the remaining 45% was saved is not clear" (Scholes 2011) There are also legal obligations shared by SP and SR. Schnjakin, Alnemr and Meinel (2010) point out that legal practice in the US and the EU hold organizations liable for the activities of their subcontractors such as a CSP.

A SP can call for other SP's to assist when he cannot satisfy requirements of SRs in burst periods. The Process Ownership Plan requires a description of the number of companies that take part in the outsourced IS portfolio. (Goo 2010) For example when SP 1 calls in the help of SP2 when under capacity. But what service does a SR receive when SP 1 offers SLA A and SP 2 offers SLA B? (Hofmann and Woods 2010) In order to manage the multiple domains with possible different SLAs, literature describes an architecture that uses contracts based on SLAs to share selective management information across administrative boundaries (Bhoj, Singhal and Chutani 2001). Another architecture incorporates adaptations of existing protocols that enable agreements to renegotiate terms during service provision (dynamic negotiation) (Di Modica, Tomarchio and Vita 2009; Alhamad, Dillon and Chang, 2010-2). An expert from ETC has the following to say about the multi tenancy nature of Cloud solutions:

"It is almost impossible to describe all aspects of web-based ict-services with traditional SLAs: What are the consequences for Cloud Consumers when other fellow-Cloud Consumers place to heavy burdons on the web-infrastructure supporting the Cloud Services? And how many sessions can a Cloud Consumer use guaranteed/simultaneously without 'overloading' the total available sessions?" **K. de Jong, solution consultant, ETC**[8]

[8] http://www.etcdistribution.nl/beststore/bw-site.nsf

2.3.2 Change Management Characteristics

In this section an agreement is formalized to manage future changes by specifying the desired levels of behavior so that the SP's performance continues to meet the changing business needs of the SR. Contractual elements included are: *Future Demand Management Plan, Anticipated Change Plan, Innovation Plan* and *Feedback Plan.* To clarify what is intended in this category Goo (2010) uses the early work of Williamson (1996) on governance: "Because IT environment evolves rapidly and business conditions often require fast response from the SP to modify current services or deliver new services, parties in an IT outsourcing relationship are recommended to incorporate mechanisms that facilitate joint adaption to problems raised from unforeseeable changes into the contract" (Williamson 1996).

Change management characteristics require a different interpretation in Cloud Computing then they did in traditional ITO. The characteristics of Cloud Computing (*rapid elasticity, resource pooling*) create an environment where scaling up in high requirement bursts and scaling down in low requirement periods is no longer an issue. An issue that will receive more importance in Cloud Computing is that of priority determination in high requirement periods. When services are highly utilized, priorities need to be determined for the continuity of critical processes. The growing interest in Cloud Computing services can result in these situations happening more frequently than they did previously.

When services are transferred to the Cloud it is logical that the SR requires the upmost priority of the SP for himself. It can be possible, however, that the services of a SP become exhausted and a priority protocol becomes active. If the capacity of a SP begins to approach its treshold and compromising some services or performance is necessary, the SP will most likely protect their own service and pass degradation in service to their cusomers (Paquette, Jaeger and Wilson 2010). The need to understand the capacity of the cloud and how the account of the SR is managed is obvious, but not an easy task. The Cloud's reserve capacity is opaque and data on this subject is not made public by major SP due to competitive reasons. Changes in the required service density and/or priorities of services of the SR may vary and these changes have to be applied to the protocols of the SP. This dynamic way of working is not supported by current SLAs.

2.3.3 Governance Characteristics

The contractual elements underlying this category aim to set and continually assess the value that the relationship is generating for the various stakeholders to ensure that the relationship remains on course (Ouchi 1979). Contractual elements included are: *Communication Plan, Measurement Charter, Conflict Arbitration Plan* and *Enforcement Plan*. The governance characteristics entails mechanisms that specify desired outcomes (e.g., performance targets for particular activities or specific project goals) and those that help measure the controlee's performance with respect to the specified outcomes (e.g., measurement methodology) (Kirsch 1997).

It is important for SRs to monitor the performance of a SP because critical processes and/or data is relying on a SP outside control of the SR. Therefore strict monitoring policies have to be included in the SLAs to enforce the SP to act according to specified performance metrics. In the *Measurement Charter*, statements on what needs to be measured and how this should be done are included. Non-Functional Requirements (NFR) form the base for these statements. The traditional NFRs that are included in SLAs may not include all metrics that are relevant for Cloud Computing and others may be obsolete. Villegas and Masoud Sadjadi (2011) recognize the need for additional non-functional requirements such as *fault-*

tolerance, execution cost and *security* for Cloud SLAs. In total they identify six most salient NFRs that should be included in Cloud SLAs: *Response time, Uptime, Requests per unit of time, Fault tolerance, Security* and *Operational cost*. Although the paper investigates what NFR are important in Cloud Computing they do not elaborate on how to measure these NFR and how they should be mapped to low-level metrics. Comparable work is delivered by Alhamad, et al. (2010-1), they provide five basic NFRs to be included: *Availability, Scalability, A clear method for cost calculation, The configuration of service* and *Security and privacy*. The discrepancy in used terminology by both papers indicates that a standard for Cloud SLA metrics terminology is lacking. Alhamad, et al. (2010-1) acknowledge this and state: "To the best of our knowledge, scientific research in the area of SLAs and trust management does not investigate the new paradigm of outsourcing services in a pay-as-you-use framework, which is called Cloud Computing". Although it is still a work in progress Alhamad, et al. (2010-1) provide the most elaborate outline of SLA metrics categorized by Cloud Service model. Although this review recognizes three Cloud service model categories (SaaS, PaaS, IaaS), Alhamad, et al. (2010-1) uses four: Infastructure as Service (IasS), Platform as Service (PasS), Software as Service (SasS) and Storage as a Service. The metrics provided by Alhamad, et al. (2010-1) create a general overview of relevant metrics but are not an attempt to create a standard in definitions.

Mechanisms for measuring the determined metrics require a more dynamic support as parameters change constantly due to Cloud characteristics (e.g., *On-demand self-service, broad network access, resource pooling, rapid elasticity*). In their work Emeakaroha, et al. (2010) suggest a novel framework for managing the mapping of low-level resource metrics to high-level SLAs (LoM2HiS framework). Traditional monitoring technologies for single machines or clusters are restricted to locality and homogenity of monitored objects and therefore cannot be applied to Cloud Computing. A hampering factor in the measuring of SLA metrics and functioning of Cloud services (e.g., availability) is the fact that the Cloud services have to be accessible from anywhere with a device of own choice (i.e., ubiquity).When software and data reside on the end user's device the unavailibility of a network connection may be inconvenient but does not terminate the productivity. When the software and data reside in the Cloud, however, the absence of a network connection has more serious consequences. As a result, SRs regard ubiquitous access to network connections as critical (Yoo 2011).

Part of the governance characteristics are the penalty/reward definitions and formula. In Cloud Computing SLAs (e.g., Amazon S3, Windows Azure) a clause is included that treats the penalty for when a service is unavailable (down). The service credit that is provided consists of 10% or 25% (depending on magnitude of outage) of the amount paid by the SR. This is (normally) not sufficient to cover the expenses made by a SR that loses data/process continuity due to a Cloud service failure but is more of a goodwill structure by the SP; the SP promises a compensation in prospect. An expert from NetApp has the following to say about penalties in Cloud Computing:

"In tradtitional SLAs, a penalty clause is centrally positioned as a 'leverage tool'. This looks powerful, but in practice this results in fines reimbursing the cost price. It is better to incorporate into the SLA that the CSP, after missing its SLA obligations X-times, is required to support migration to another CSP." **F. van der Lecq, bid manager, NetApp**[9]

But as literature describes (Misra and Mondal 2011, Yoo 2011) the risks of data or continuity loss is mitigated by the use of multiple data centers and/or virtualization techniques. Misra and Mondal (2011) provide numbers for distaster recovery in traditional IT environments. Large companies spend between 2-4% of their budget and small te medium enterprises spend up to 25% of their IT budget on disaster recovery planning. Of companies that had a major loss of business data, 43% never reopen, 51% close

[9] http://www.netapp.com/us/

within two years, and only 6% survive long-term. But this fear is very much reduced in Cloud Computing as data in the Cloud is replicated thrice and stored in servers which are geographically scattered.Yoo (2011) illustrates this with an example of *n* data centers with a failure rate of $(1-r)^n$ with *r* being the reliability and (1-*r*) the failure rate of a single data center. If individual data centers have a reliability of 99%, storing the same data across two data centers increases reliability to 99.99%. Mirrorring the data in a third data center increases reliability to 99.9999%. Theoretically this looks like a pretty good assurance that the data is safe at a SP but a director at PwC states: "Nothing is sure as long as it is not proven that data is actually replicated. SP promise a lot, but a SLA is merely seen as a document on the side and less as an assurance document nothing is certain".

Next to metrics for Uptime the only other metric included in the SLA for Windows Azure is "Failed Storage Transactions". This includes request types for certain actions regarding storage services and their maximum processing times. The sheer lack of metrics in the current SLAs used by Window indicates the difficulties that are experienced in monitoring of and agreeing upon metrics included in Cloud services.

2.4 Concluding Remarks

The literature review provides an insight into the work that has been published on SLA in Cloud Computing. First, the definition of Cloud Computing is determined to provide an overview of the features it has to offer. Second, SLAs in traditional ITO were discussed. After that, literature was examined on what was published on SLAs in Cloud Computing.

Based on the beforementioned literature it can be concluded that theory about SLAs in Cloud Computing is still in development. In traditional ITO, frameworks and structured overviews of SLA elements are available. Such structured overviews and frameworks are not available for SLAs in Cloud Computing. In the literature review it is attempted to discuss the elements provided by Goo (2010) in the context of Cloud Computing, but this is not possible for all elements. For Cloud Computing, only parts of the SLA are treated in literature (e.g., Non-Functional Requirements (Villegas and Masoud Sadjadi 2011, Alhamad, Dillon and Chang, Conceptual SLA Framework for Cloud Computing 2010-1), low-level resource metrics to high-level SLA mapping (Emeakaroha, et al. 2010), SLA negotiation protocols (Di Modica, Tomarchio and Vita 2009, Alhamad, Dillon and Chang 2010-2)). This leaves a gap in literature on Cloud Computing and specifically in literature on SLAs in Cloud Computing.

Taking into account the identified gap in existing literature, this research project aims at developing a framework that includes the SLA elements relevant for Cloud Computing. The next chapter provides the mehodology for developing and validating the framework.

3. Research Methodology

The research method that is used to answer the research questions formulated in chapter 1 is described in this chapter. First, the general research design is describes the argumentation for the used mechanisms in the study. Second, the design of the interview describes the method of interviewing and the characteristics of the interviewees. Third, the design for the validation stage of the study describes the method for the validation of the deliverables of stage 1.

3.1 Research Design

Researchers generally choose from among three different research designs: *exploratory, descriptive,* or *causal design*. *Exploratory research* is used to develop a better understanding of a business problem or opportunity. It is meant to discover new relationships, patterns, themes, ideas, and so on. Thus, not intended to test specific research hypotheses. *Descriptive research* describes a situation by providing measures of an event or activity. *Descriptive research* is designed to obtain data that describes the characteristics of the topic of interest in the research. Hypotheses, derived from theory, usually serve to guide the process and provide a list of what needs to be measured. *Causal research designs* are designed to test whether one event causes another. Does *x* cause y? There are four conditions researchers look for in *causal research*: time sequence, covariance, nonspurious association, and theoretical support. (Hair jr., et al. 2011). The aim of this research is to develop a better understanding of SLAs in Cloud Computing, rather than testing or confirming hypotheses or to test whether one event causes another. Therefore, *exploratory research* is best suited for this study.

There are two categories of data that can be used by researchers: secondary and primary data. Data used for research that was not gathered directly and purposefully for the project under consideration is termed *secondary data*. Sources of secondary data include the researcher's company as well as various external agencies such as data collection companies, municipal or other governmental agencies, nongovernmental organizations, and trade or consumer associations (Hair jr., et al. 2011). There is no source for *secondary data* available for this study; therefore the study utilizes *primary data collection* methods to obtain data. Because of the exploratory nature of the study, the researcher collects narrative data through the use of focus groups, personal interviews, or by observing behavior or events. This type of data is referred to as qualitative. When the study is descriptive or causal, the researcher is likely to require a relatively large amount of quantitative data obtained through large-scale surveys or by accessing electronic databases.

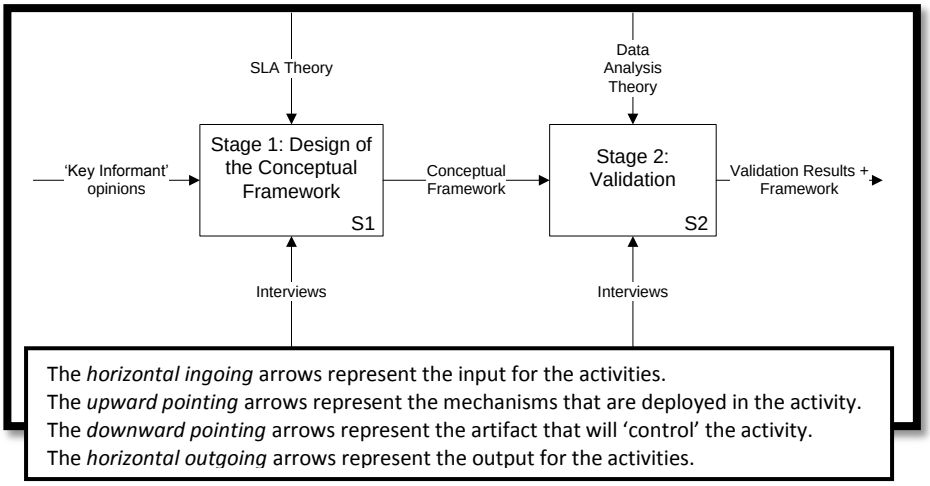


Figure 5 Research Design

The first stage of the study, S1 in Figure 5, utilizes a qualitative data collection method. There are two broad approaches to qualitative data collection – observation and interviews. The aim of the first stage of the study is to understand which SLA elements are required in Cloud Computing compared to traditional ITO and why, rather than to examine the behavior of people or events. Therefore, the qualitative method *interviews* is utilized in stage 1 to acquire the input, next to existing ITO SLA theory, for developing the conceptual framework.

Using interviews in stage 1 requires a certain degree of judgment (subjectivity) by the researcher. Therefore, the findings of qualitative approaches can be more difficult to replicate. But this does not make qualitative research unscientific and less useful compared to quantitative research. Perhaps the most important concept in establishing credibility in qualitative research is triangulation. There are four types of triangulation in qualitative research: researcher-, data-, method-, and theory triangulation. *Researcher triangulation* involves the analysis and interpretation of multiple researchers on the same team. *Data triangulation* requires collecting data from several different sources or at different times. *Method triangulation* involves conducting the research project using several different methods and comparing the findings, including sometimes findings from both qualitative and quantitative approaches. *Theory triangulation* is using multiple theories and perspectives to interpret and explain the data (Hair jr., et al. 2011). Data and method triangulation are applied in the follow up on the interviews. The interviewees will be asked to assess the individual and relative importance of the SLA elements that are included, based on the interviews. For this, a form is used that enables the interviewee to rate the importance and to include argumentation. This can be seen as a form of participant review. In p*articipant reviews,* the researcher asks participants to review researcher's synthesis of interviews with person for accuracy of representation (Bashir, Tanveer Afzal and Azeem 2008). The participant review is executed through a quantitative approach using a survey that enables the participant to rate the individual and relative importance. This is a different time and method and can therefore be classified as data and method triangulation.

To establish credibility (i.e., trustworthiness, validity) the study will incorporate a validation step in stage 2. A semistructured interview is used to test the findings of stage 1 among a different group of respondents than that was interviewed in stage 1. In this way data triangulation is used to establish credibility. The semistructured interview will be a face-to-face meeting with the respondent to enable clarification of possible ambiguities in their responses. Stage 2 will test the completeness, usability and clarity of the conceptual framework that is developed in stage 1. *Usability* is important to be validated to indicate that the deliverable (Cloud Computing SLA framework) is of practical use. *Completeness* is important to validate and indicates that the research project has been exhaustive (within resource limits available) and that it provides a comprehensive overview of Cloud Computing SLA elements. *Clarity* is important to validate and indicates whether the framework is self containing. Therefore stage 2 (S2 in Figure 5) involves the validation of the work delivered from stage 1 through validation of usability, completeness and clarity.

3.2 Interview

The first section of this chapter treats the theory selection for the input of the interviews. The second section discusses the interview design. The third section provides the method through which the interview transcriptions are analyzed.

3.2.1 Interview – Theory Selection

The conceptual framework for the SLA elements in Cloud Computing is composed from the interviews integrated with the available theory on SLAs in ITO and Cloud Computing. This section provides the theoretical framework that is used in the interviews as point of departure.

SLAs in IT outsourcing

Literature on traditional ITO forms the base for the development of the conceptual framework. In their work Lacity, Khan, & Willcocks (2009) review the ITO literature concerning the determinants of ITO success; *the ITO decision*, *contractual governance* and *relational governance*. These are very broad categories of determinants meant to capture the practices associated with ITO decisions, the practices associated with contracts, and the practices associated with managing supplier relationships (Lacity, Khan and Willcocks 2009). For the research project the formal/contractual aspects of the relationship are interesting, therefore the determinant *contractual governance* is of importance. According to Goo (2010) the role of a contract in ITO is fulfilled by the SLA: "The SLA describes the products or services to be delivered, sets SP's and SR's expectations, identifies contacts for end-user problems, and specifies the metrics by which the effectiveness of various contracted services and lower-level activities, functions, and processes will be measured, examined, changed and conrolled".

Next to the information gathered by the interviews a theoretical framework is selected as input for the conceptual framework. The available literature regarding SLAs in ITO is limited and treats SLAs only partial in the majority of the work (e.g., (Hofmann and Woods 2010, Alhamad, Dillon and Chang 2010-1, Alhamad, Dillon and Chang 2010-2, Emeakaroha, et al. 2010, Misra and Mondal 2011, Patel, Ranabahu and Amit 2009, Marques, et al. 2009)).

The input for the conceptual framework should consist of all relevant, high level, elements that should be considered when IT is outsourced. In their work, Jin, Vijay, & Akhil (2002) provide an overview of ten components that a SLA should have: *Purpose, Parties, Validity period, Scope, Service-level objectives, penalties, optional services, exclusions* and *administration.* Although this is already a quite elaborate exposition of SLA components, Goo (2010) provides a more elaborate overview of eleven elements that should be included in a SLA divided among three categories. The elements are supported by theories concerning *Relational Exchange, SLA templates, Transaction Cost Economic* and *Control Theory* (see Appendix II for a detailed overview of the eleven elements). Figure 6 shows the mapping of the ten components of Jin, Vijay and Akhil (2002), to the eleven elements of Goo (2010).

From the mapping it can be concluded that all the ten components are covered by the eleven elements. There are slight differences in terminology but the objective of the components are achieved by the linked element(s). There are two elements that receive no attention by the ten components: *Feedback Plan* and *Communication Plan*. Both are related to the interaction between the SR and SP after the outsourcing relation has been established. The eleven elements are considered superior to the 10 components because they cover all of the aspects and have two additional elements that take care of the 'after service' when the outsourcing relationship has been established. Therefore, the eleven elements of Goo (2010) are selected as theoretical foundation for the conceptual framework. The elements are reviewed, tuned and complemented based on te information of the interviews to come to the design of the conceptual framework.

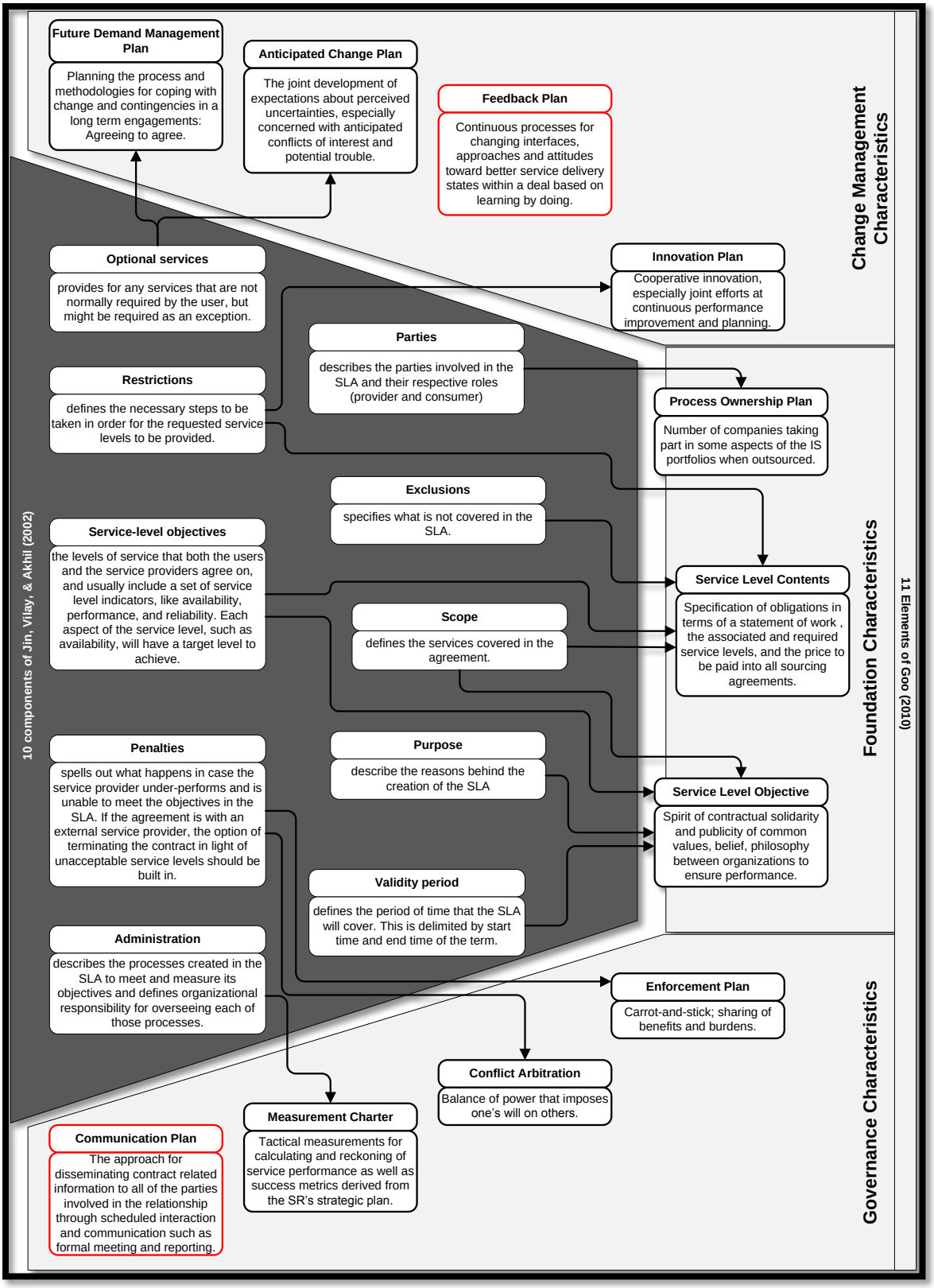


Figure 6 Mapping Jin, Vijay, & Akhil (2002) to Goo (2010)

3.2.2 Interview – Design

Interviews can vary from being highly unstructured to highly structured. Unstructured interviews are generally conducted using a flexible approach. In contrast, the interviewer controls structured interviews in a consistent and orderly manner. Whether structured or unstructured, interviewing can take a variety of forms, such as face-to-face or via telephone (Hair jr., et al. 2011). For this research (stage 1) in-depth interviews are used. An *in-depth interview* is an unstructured one-to-one discussion session between a trained interviewer and a respondent (Hair jr., et al. 2011). The semi-structured nature of the interview resides in the fact that open questions will be asked and that probing questions will be asked when more detailed information is required. *Probing* means that a researcher delves deeply into a response to identify possible hidden reasons for a particular behavior. The why, why, why technique (asking why several times) is a popular probing technique (Hair jr., et al. 2011).

The potential interviewees were selected from the taskforce Cloud Computing that has been created within the department of BAS at PwC. The leader of each group within BAS was asked to provide a representative that possesses knowledge, experience and an interest into Cloud Computing. This request yielded seven members from the taskforce. Next to the members of the taskforce, the leader of the taskforce was contacted to make sure that no knowledgeable persons outside of the taskforce were missed. The result of this was a group of eleven individuals; seven members from the taskforce and four persons from outside the taskforce. Table 1 shows the group that eventually was interviewed (all member of the Cloud Computing taskforce).

Table 1 Interviewee Characteristics

Name	Function	Department (within BAS)	Professional Experience
Mark Tesselaar	Director	SPA PC&PS	13 years
Bram van Tiel	Senior Manager	SPA TICE	9 years
Adri Briene	Partner	SPA BTA	24 years
Casper Lötgerink	Manager	SPA FS	7 years
Damiën Meijer	Manager	SPA BTA	9 years
Angel Fernández Causi	Senior Manager	SPA TICE	20 years

People that work at BAS investigate at companies to what extent they are in control of their processes and IT infrastructure. BAS provides a detailed assessment of the processes and IT infrastructure (e.g., access to data and programs, IT environment, computer operations, program changes). BAS activities are not to provide advice to a customer, but an assessment of their current systems and processes. Therefore, BAS is able to provide a clear view on what is required for a company to be in control of their IT systems and processes. From this point of departure, they can provide abstract and clear requirements for Cloud Computing to support a company's business process and what the requirements are for SLAs.

The potential interviewees were invited to participate by email. This initial email (see Appendix III) included a short introduction of the researcher and characteristics that the potential respondent should posses to be considered as a 'key informant'. The email was followed by a telephone call to arrange a convenient time and location for the interview. Prior to the interview a second email was sent to the interviewees, that included a reminder (date and time) and a document with the interview outline and theoretical background on SLAs in traditional ITO (see Appendix IV) as preparation for the interview. During the interview a guiding document, containing the basic information about the Service and Deployment models was provided (see Appendix V).

The interviews had a duration between 45 and 60 minutes and were conducted through face-to-face contact and by phone[10]. An outline interview schedule was used for the first two sections of the interview. The third section of the interview was more structured to ensure that all of the identified elements from traditional ITO theory were discussed in the context of Cloud Computing. The fourth section again used an outline interview schedule to probe for possible untouched topics related to the characteristics of Cloud Computing. Details of the four interview sections are presented in Appendix VI. The interviews were recorded by a digital device (smartphone). Based on the recordings, detailed transcriptions were created.

As a follow up on the interviews, a form presenting the elements that are included in the SLA was provided. In this form the interviewees were required to rate the individual elements and to rank the elements per category. Appendix VII shows the form that was used. Through this method the relative importance of the elements could be retrieved. Moreover, this enabled to test whether the information retrieved from the interviews was processed correctly. The form explicitly provided room for comments when there were ambiguities.

3.2.3 Interview – Data Analysis

To analyze the transcriptions of the interviews, grounded theory is used. This qualitative research method and its application in this research project is explained below.

Grounded Theory

The foundation for the data analysis lies in grounded theory. *Grounded theory* is a qualitative research method that seeks to develop theory that is grounded in data systematically gathered and analyzed. (Urquhart, Lehmann and Myers 2010). From their definition, Urquhart et al., (2010) discern four distinctive characteristics of the grounded theory method of which three[11] are relevant for this research:

1. The main purpose of the grounded theory method is theory building;
2. As a general rule, the researcher should make sure that their prior – often expert – knowledge of the field does not lead them to pre-formulated hypotheses that their research then seeks to verify – or otherwise. Such preconceived theoretical ideas could hinder the emergence of ideas that should be firmly rooted in the data in the first instance;
3. Analysis and conceptualization are engendered through the core process of joint data collection and constant comparison, where every slice of data is compared with all existing concepts and constructs to see if it enriches an existing category (i.e., by adding/enhancing its properties), forms a new one or points to a new relation.

The elaboration on the second characteristic states that: if the researcher starts with an existing theory, then the aim of the grounded theory method is to enhance the theory, widen its scope or n other ways improve it – but not to verify or falsify it. This is consistent with the objective of the research questions; to widen the scope of current SLA theory by integrating Cloud Computing. The third characteristic treats the processes of data collection and analysis. The used data collection method is conducting interviews (section 3.2.2) and the analysis is done by constant comparison, which will be explained in the remainder of this section.

[10] Two interviews are conducted by a telephone call due to difficulties in scheduling a face-to-face meeting.

[11] The fourth characteristic ('Slices of data' of all kinds are selected by a process of theoretical sampling, where the researcher decides on analytical grounds where to sample from next) is considered not relevant due to the nature of the selected group to be interviewed and the scope of the research.

Constant Comparison

The interviews where all recorded using a voice recording device (smartphone) and detailed transcriptions were produced to grasp the interview content accurately. The texts that resulted from the transcription of the interviews provided the input for the analysis. The objective of the analysis is to make sense of the data and to reconstruct the perspectives of the group being studied. The analysis consisted of two activities, namely fragmenting and connecting (Dey 1993). Both activities are necessary and keep each other in equilibrium. The former emphasizes the separate themes which emerge during the interview and focuses on an individual ordering process which is relevant to the research questions. The process of fragmenting lifts the coded pieces out of the context of the interview as a whole. The latter activity (connecting) accentuates the context and richness of the data as the interview parts were interpreted as a whole and the pieces of one case were connected (Siveskind 1999). This research, however, has a different point of departure. Siveskind (1999) does not work with a pre-determined set of codes from theory; only codes that are derived from the interviews. In this research, however, the interviews are analyzed by pre-determined codes from theory (section 3.2.1) and codes derived from the interview content. This method is called directed content analysis. The goal of a directed approach to content analysis is to validate or extend conceptually a theoretical framework or theory. (Hsieh and Shannon 2005)

3.3 Validation

This section will treat the method that is used for the validation of the developed conceptual framework in stage 1. The validation method consists of multiple semi-structured interviews. From these interviews, a qualitative validation is achieved on the aspects of completeness, usability and clarity.

3.3.1 Validation – Design

The objective of the validation interview is to test the framework and (U)SLA and (B)SLA on completeness, usability and clarity to achieve credibility. Semi-structured interviews are used as method for the validation interviews. An interview guide is developed that serves as a time guard and ensures that all relevant issues are touched in the interview. The interviewees were asked to answer as concise as possible and to be cautious not to wander off from the subject.

The first interviewee was selected from the Advisory department at PwC. The validation of the framework was not carried out among members of the BAS department. The daily work of BAS consists of assessments of live IT environments. Therefore, this group of interviewees is less applicable to validate a conceptual framework on its usability (i.e., completeness, usability, clarity). The interviewee that is selected for validating (PwC Advisory) has the expertise to assess whether the framework is usable in practice. It is in the nature of people at Advisory to 'think outside of the box' instead of purely assessing what is presented to them. From their experience with sourcing projects they can assess whether a SLA covers the elements of interest (completeness). Furthermore, they can assess whether the SLA is useful in sourcing projects (usability, clarity). From their experiences in these projects and experiences with traditional ITO they possess the knowledge to assess whether the SLA covers the elements of interest and if it could be used in practice.

The interviewee at PwC Advisory was selected based on the inquiry with the global sourcing leader of PwC NL. The global souring leader is considered to be knowledgeable about who in his department has the knowledge required.

After numerous (face-to-face, telephone, email) contacts, Örjan Leuvenink was selected as 'key informant' for the validation. His specialties (e.g., CIO advisory, business transformation, emerging technologies) made him the best candidate for the validation interview. After the selection, Örjan was contacted by phone to provide some basic information about the research project and the objectives for the validation interview. Before the actual interview an email (Appendix VIII) was sent with additional information and to recap the information provided in the telephone call.

Another group of interest for the validation is that of the Dutch CIO platform[12]. This platform consists of an independent group of CIOs and IT Directors from Dutch private and public organizations. The platform has the objective, among others, to develop knowledge on emerging technologies and to represent the ICT demand side in structural cooperation's with science, education and ICT providers. The initial contact with the platform was achieved through an appointment with Mr. Kees Jan, the CIO of Schiphol and secretary of the platform. Jans indicated that the platform recently founded a CIO Interest Group (CIG) that focuses on the Cloud; CIG Cloud. He initiated the contact with the CIG Cloud from where the interviewees were selected.

Next to PwC Advisory and the CIO platform a client of PwC (USG People) was asked to cooperate in a validation interview. USG People is investigating Cloud solutions for their business processes. They assembled a focus group that I spoke in one interview. Table 2 shows the interviewees that eventually were interviewed. The use of key informed senior respondents has been applied to previous research studies (e.g., Abdulwahed and Abdulridha, 2003; Mao, Lee and Deng, 2008) in the ITO domain and illustrates the applicability of the chosen interviewees for this study.

Table 2 Validation Interviewee Characteristics

Name	Function	Company	Professional Experience
Örjan Leuvenink	Principal Manager	PwC	11 years
Rene Bos	Director IT Services	USG People	24 years
Simon Moerkerken	GM Supply & Delivery		14 years
Toine van Eerden	GM ICT Strategy & Architecture		20 years
Marco van Westerlaak	Security Analist		4 years
Rob de Weerd	ICT Manager Operations	LUMC	19 years
Anand Sheombar	License Manager	SURFdiensten	12 years

The interviews had a duration between 60 and 90 minutes and were conducted through face-to-face contact. An interview guide was used to keep the interview structured and to ensure that all content was covered during the available time window. Next to the interview guide, the framework, (U)SLA and (B)SLA were provided in hard-copy during the interview. The following questions were used to treat the documents in detail.

Framework:

When you as a company want to investigate the possibilities of outsourcing services in the Cloud, this can serve as a high level view of important aspects.

- Is it clear what is presented in the framework?;
- Are there aspects/sections missing?;
- Would you like to add something?;
- Are there redundant sections?

[12] CIO Platform Nederland – www.cio-platform.nl

(U)SLA and *(B)SLA:*

When you as a company have decided to outsource a service in the Public/Private Cloud:

- Does the (U)SLA/(B)SLA contain all elements of interest?;
- Is it clear what is presented in the (U)SLA/(B)SLA?;
- Would you like to add something?;
- Would you like to change something?

3.3.2 Validation – Data Analysis

Comparable to the interviews conducted in the previous stage of the study, the interviews were recorded using a voice recording device (smartphone). From the recordings, detailed transcriptions were produced to document the comments accurately. The transcriptions were studied to identify sections of the framework that caused interviewees to question the completeness, usability and/or clarity of the framework. The interviewees were studied individually and cross-interview to identify common issues across interviewees. Before regarding the comment as valid and including it in section 4.2, the argumentation was studied in detail to determine the justification. This method is comparable to the method used for analyzing the interviews for the development of the framework and SLAs. Comments that only received support by an individual interviewee were investigated on soundness and their impact on the framework and SLAs. When the comment was sound and the impact was significant it was included.

4. Results and Analysis

This chapter provides the results and analysis of the interviews that are described in the previous chapter; the interviews of stage 1 (design) in the first section and the interviews of stage 2 (validation) in the second section.

4.1 Stage 1: The Conceptual Framework

In developing the conceptual framework and SLAs, codes were used to analyze the content of the interview transcriptions. The source for the codes is twofold: coding SLA theory (see section 3.2.1) and coding the interview content. The application of codes on the transcriptions enables the structural comparison of interview content. Section 4.1.1 provides the used codes. Section 4.1.2 discusses the interview findings that resulted from analyzing the interviews with the codes. It is recognized that codes derived from interviews actually are findings. They, however, are treated in a separate section because the codes are considered to be part of the methodology that is applied to come up with the substantive findings. The last section, 4.1.3, treats the results of the interview follow up in which the interviewees of stage 1 was asked to rate the individual and relative importance of the SLA elements.

4.1.1 Coding

There are two sources for the codes used to analyze the interviews. The selected SLA theory discussed in section 3.2.1, on which part of the interviews are based, forms the first source for the codes. Part of the research question is to investigate the applicability of the framework that is developed by Goo in Cloud Computing. Therefore, the elements are used for coding the interview content to enable this investigation. The code categories, abbreviations, theme that is represented by the code and an example from the interviews are presented in the table below.

Table 3 Codes from SLA theory

Category	Abbreviation	Theme	Example quote
Service Level Objectives	*SLO*	High level relational aspects (goals, objectives)	*"I think you have to describe your relationship goals, whether it still is an actual cooperation in the Public Cloud is questionable though"* Casper Lötgerink
Service Level Contents	*SLC*	Service characteristics (service levels, service descriptions)	*"The average business will say: My email has to work always. The 99,5% that is offered by the provider is something that could not be guaranteed in traditional SLAs"* Mark Tesselaar
Process Ownership	*PO*	Process owners and their roles and responsibilities	*"Ownership could be a topic of dispute, or at least something to look at"* Damiën Meijer
Future Demand Management	*FDM*	Management of changes in future demand (capacity, licenses)	*"Scalability becomes more an issue of the provider and less of the recipient. The provider has to provide numbers on what is possible and what is not"* Bram van Tiel
Anticipated Change	*AC*	Unforeseeable changes (conflicts of interest)	*"It is nearly impossible to estimate who is involved and after that it is the question to understand what issues can arise"* Mark Tesselaar
Innovation	*Inno*	Structure and processes for innovation	*"In a Private Cloud you can influence innovation development and implementation. In Public Clouds, however, I wouldn't know how to do this"* Adri Briene
Feedback	*Feed*	Feedback processes	*"If you look at Office 365 for example, this is not a topic of interest"* Bram van Tiel
Communication	*Comm*	Communication flow	*"You have to make the right agreements and if these are not met you should speak to him about it"* Bram van Tiel
Measurement	*Meas*	Measurement of the relationship	*"KPIs are important to include otherwise there is no way to measure the performance of the provider"* Angel Fernández-Causi

Conflict Arbitration	*CA*	Involvement of third parties in conflicts	*"The arbitration of third parties in conflicts is comparable to traditional ITO. This will be the same in Cloud Computing SLAs as traditional ITO SLAs"* Damiën Meijer
Enforcement	*Enf*	Penalties and incentives	*"You arrive at the attributable character of the Cloud. In the case of a Public Cloud this will be more difficult"* Casper Lötgerink

The second source for the codes is the interview transcriptions. This second set of codes, combined with the first set of codes from theory, makes it possible to answer the remaining part of the research question regarding the completeness of the existing theory and the consequences of the service and deployment models of Cloud Computing on the content of the SLAs. The table below shows the codes from the interview transcriptions.

Table 4 Codes from the interviews

Category	Abbreviation	Theme	Example quote
Data Location	*DL*	Data storage location specifics	*"When you are active in a market that prohibits the storage in certain countries you should include in the SLA that these countries are excluded from possible storage locations"* Angel Fernández-Causi
Compliance	*Comp*	Law and legislation requirements	*"Several instances require you to keep data in your records for up to 7 years. I can understand that a vendor after 3 year of inactivity thinks that he can delete it because the data became redundant"* Casper Lötgerink
Public vs Private Cloud	*PuPri*	Similarities/differences between Private and Public Cloud	*"There are differences between Public and Private Cloud in the sense that a Public Cloud will have a standard SLA"* Mark Tesselaar
Negotiation	*Neg*	Power to negotiate SLA terms	*"In the Public Cloud the service provider will work from the principle: Take it or leave it"* Adri Briene
ITO vs Cloud Computing	*ITOCC*	Similarities/differences between traditional ITO and Cloud Computing	*"In traditional ITO you have a reasonable insight into the whereabouts of the outsourced services. In Cloud Computing, however, you are faced with custom-build Cloud software that inhibits this"*Damiën Meijer
Risk Assessment	*Risk*	Assessment of risk that determines scope for outsourced services	*"You first have to make a risk assessment about the extent to which it is permitted by law and to what extent the data is sensitive to privacy"* Bram van Tiel
Customizability	*Cust*	Customizability of a outsourced service	*"The question arises whether it is at all possible to personalize or customize a service for your organisation"* Damiën Meijer
Perception	*Perc*	Perception of delivered service	*"The current economy is all about 'perception'. Perception is actually what it is all about. And factually a SLA is this perception in written form"* Mark Tesselaar
Transparency	*Trans*	Transparency of delivered services and provider	*"The transparency disappears for a large part in Cloud Computing"* Angel Fernández-Causi
Exit Strategy	*EX*	Protocols/procedures for exit from vendor	*"Actually, the most important element of a SLA is how get out of the relationship when necessary"* Casper Lötgerink

4.1.2 Substantive Findings

The substantive findings that are accumulated in a SLA for the Public and the Private Cloud and a conceptual framework are discussed in this section. The first part treats the aspects that are presented in the conceptual framework depicted in Figure 7. The conceptual framework does not provide an answer to the research question. The framework, however, does provide an insight in the forces at work in Cloud Computing. The aspects represented in the conceptual framework contribute to the eventual characteristics of the SLAs. The second part provides an answer to the research question by discussing the applicability of the traditional ITO SLA elements for Cloud Computing and the consequences of the deployment and service models. The last part discusses the importance of the included SLA elements.

Conceptual Framework

Before the answer to the research questions is provided, aspects of Cloud Computing that are relevant for SLAs are considered. These aspects are accumulated in the conceptual framework depicted in Figure 7. The conceptual framework shows the decision process and characteristics that lead to the drafting of a Public or Private Cloud SLA. In this section, the textbox with a number corresponding with the conceptual framework indicates to which part of the framework it is related. Part 5 of the conceptual framework is treated in the next section by answering the research questions.

Companies that are investigating outsourcing possibilities for their IT have to consider the specifics of its processes and data. 1 Compared to traditional ITO decisions this is not a new phenomenon. However, in Cloud Computing this assessment requires a higher maturity level. This is especially the case for Public Cloud services. The drawback of these services is that they are developed for the masses and do not allow service recipients to customize features; they provide a standard service. Private Cloud services are similar to traditional ITO in that they are customizable, to a certain extent, based on the recipient's requirements. When a company decides that its processes, or a section of its processes, are suitable to be outsourced in the Cloud they explicitly accept the Cloud characteristics. 2 In the Public Cloud these include: A standard service based on a 'take it or leave it' mechanism for which the governance is managed unilateral by the service provider and the visibility of the service is opaque (i.e., non-transparent). In the Private Cloud these include: A customizable service based on a negotiable agreement for which the governance is managed bilateral by both parties and the visibility of the service is more transparent than Public Cloud services. 3

The Cloud characteristics lead to a reconsideration of the application of SLAs in Public Cloud services. In traditional ITO the SLA is drafted by the involved parties and signed when consensus is reached on its content. In Public Cloud services, however, the provider drafts a standard SLA that is downloadable from its website. There is no active role for the service recipient else than agreeing to the SLA. The term SLA is extended for the Public Cloud to Unilateral Service Level Agreement ((U)SLA) to underline the unilateral nature of the SLA. The bilaterally drafted SLA in the Private Cloud is renamed to (B)SLA to underline that this remains a negotiable document. The applications for the (U)SLA and (B)SLA are enumerated below. 4

(U)SLA applications include:

- *Creating internal awareness:* Through a systematic review of the company's processes based on the elements included in the (U)SLA the level of internal awareness can be achieved that is required to be ready for Cloud adoption.
- *Service Provider comparison:* Based on the business requirements that are translated into the content of the elements in the (U)SLA, the available service providers can be compared on the extent to which they can support these requirements. When a gap (i.e., delta) remains after

comparing the Cloud service specifics with the business requirements, the service recipient is required to make arrangements to cover the delta (e.g., a local backup).

- *Performance monitoring:* The desired performance metrics that are formulated in the (U)SLA can be used to monitor the performance of the service provider. This can range from metrics that represent the specifics of a service (e.g., uptime, availability, latency) to desired procedures for resolving issues or providing feedback.

The applications of the (B)SLA are comparable to the application of SLAs in traditional ITO but are different from the (U)SLA. The difference with the (U)SLA is less on the application subjects but resides in the bilateral nature of the relationship between service recipient and provider. In the case of Private Cloud services it is possible to negotiate about the characteristics of the service and therefore the content of the)B)SLA. This results in the following applications for the (B)SLA.

(B)SLA applications include:

- *Creating internal awareness:* Through a systematic review of the company's processes based on the elements included in the (U)SLA the level of internal awareness can be achieved that is required to be ready for Cloud adoption.
- *Structuring the relationship:* The relationship is formally structured through formulating and agreeing upon the expectations and responsibilities of both parties for the outsourcing engagement. This underlines the bilateral nature that is not present in the case of a Public Cloud.
- *Service Provider comparison:* Based on the business requirements that are translated into the content of the elements in the (U)SLA, the available service providers can be compared on the extent to which they can support these requirements. When a gap (i.e., delta) remains after comparing the Cloud service specifics with the business requirements, arrangements to cover the delta are made between the service recipient and provider.
- *Negotiation:* The (B)SLA enables the service recipient and provider to negotiate the desired service specifics that are important to the service recipient. The service provider can customize its service to support these specifics.
- *Performance monitoring:* The performance metrics that are formulated in the (B)SLA are the result of an agreement between the service recipient and provider. This can range from metrics that represent the specifics of a service (e.g., uptime, availability, latency) to procedures for resolving issues or providing feedback.

The abovementioned findings of the interviews are presented in Figure 7; the conceptual framework. The aspects that are presented in the conceptual framework lead to the detailed content of the (U)SLA and (B)SLA. The next section will treat the alterations that have been made to the existing SLA for traditional ITO to make it applicable for the Cloud and to answer the research questions presented in section 1.2. 5

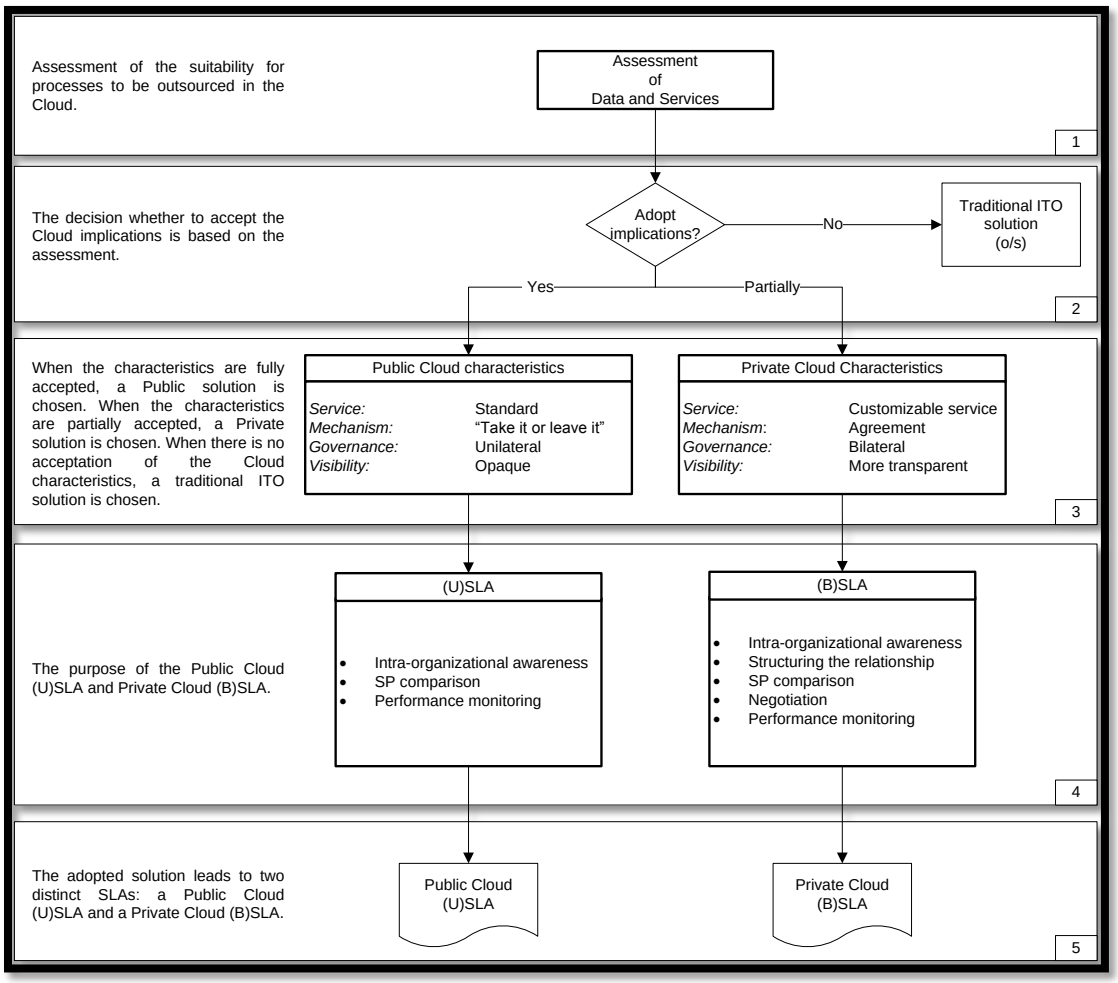


Figure 7 Conceptual Framework

Answer to the Research Question

This section attempts to answer the research questions that form the foundation for this research. The first part of the research question is answered by stating which contractual elements are removed from, or added to, the traditional ITO SLA to make it applicable in Cloud Computing. The second part of the research question is answered through a discussion of the differences that are present between the deployment models.

1) *To what extent are traditional IT outsourcing SLA elements applicable in Cloud Computing and do they need to be complemented with Cloud Computing specific SLA elements?*

Are they applicable in Cloud Computing: Yes, on a high level they are. The extent ,however, is dependent on the deployment model under consideration. For (B)SLAs the contractual elements of a traditional ITO SLA are applicable. In the case of (U)SLAs there are two redundant elements and one that is partly redundant. The two contractual elements and the argumentation for their redundancy is presented hereafter.

- *Innovation Plan:* There are two possible scenarios for innovations in the Public Cloud: incrementally innovations that are rolled out in the background or innovations that are announced and rolled out at a certain moment. The service recipient has no influence at all in

both scenarios; number and nature of innovations are determined by the service provider. Therefore there is no relevance for the Innovation Plan to be present in a (U)SLA.

- *Anticipated Change Plan:* Unforeseen changes in the contract that are caused by drivers (e.g., branch, law and legislation) at the service provider side and result in a changed service have to be accepted unconditionally. Therefore the procedures for unforeseen changes to the relationship are not part of the (U)SLA. When changes occur that are unacceptable for the service recipient (e.g., service does not support the business process sufficiently) the Exit Strategy Plan will be invoked.

The element that is partly adopted in the (U)SLA is the Enforcement Plan.

- *Enforcement Plan:* The Enforcement Plan includes the exit strategy and reward/penalty specifics. In Public Cloud services the penalty/reward specifics are downloadable from the providers website. Therefore this part of the contractual element is not part of the (U)SLA. The exit strategy, however, is very important in Public Cloud servicers and therefore is included as new contractual element in the (U)SLA.

Do the (U)SLA and (B)SLA need to complemented with Cloud Specific SLA elements: Yes. The characteristics of the Cloud require that there are two new contractual element added. The contractual elements and the argumentation for their added value are provided hereafter.

- *Data Code of Conduct:* The Cloud inherently causes processes to become opaque (Public Clouds to a larger extent than Private Clouds) due to the used technologies. Service providers are not or to some extent able to state the specifics of data policies. Compared to traditional ITO, where this was clear and did not require a separate contractual element, this must receive close attention. The Data Code of Conduct element includes the specification of boundaries for data storage locations (e.g., Europe only, exception for USA), and the identification of data access, change and deletion authorizatons.
- *Exit Strategy Plan:* The exit strategy receives more attention than it does in traditional ITO SLAs. In the Cloud it is paramount to ensure a fluent subtraction of your data from the provider to be able to restore it at a different location/provider. The increased importance lies in the fact that data in Clouds is almost always intertwined with other customers of the Cloud provider and often the exact location is unknown. This can cause issues when the service recipient wants to terminate the relationship. The element Exit Strategy Plan includes the specification of roles and responsibilities for the involved parties, time schedules for exit strategy activities and conditions that cause the exit strategy plan to be invoked.

2) What is the consequence of the differences between the deployment models (Public Cloud, Private Cloud) for Cloud Computing SLA elements?"

The consequence of the difference between the Deployment models is clearly present. The main difference and contributor to the difference between the (U)SLA and (B)SLA is the nature of the relationship. In Public Clouds, the service recipient has no influence on the service and the (U)SLA is drafted as a document that can be used as a 'checklist' to avoid ambiguities when engaging into a Public Cloud service. The SLA that is drafted by the service provider is implicitly agreed upon when the service recipient decides to use the service. In Private Clouds, the service recipient is able to negotiate the specifics of a service and will document the negotiated and mutual agreed to service specifics in the (B)SLA. The differences in content between the (U)SLA and (B)SLA are manifested in two additional contractual elements for the (B)SLA (Innovation Plan and Anticipated Change Plan). Furthermore, are there subtle differences between the (U)SLA and (B)SLA in the contractual issues and clauses in practice

that are a result of the negotiability of a (B)SLA. The main differences between the (U)SLA and (B)SLA are explained in the table below for each element they have in common.

Table 5 Shared Elements

Element	(U)SLA	(B)SLA
Service Level Objectives	The objectives for the SR and its expectations of the SP	The objectives for both the SR and SP
Service Level Contents	Service specification determined by business requirements of the SR	Service specification and obligations for involved parties
Process Ownership Plan	The SR's internal process owners and their roles and responsibilities	Process owners of involved parties and their roles and responsibilities
Future Demand Management Plan	Procedures for changes in demand	Procedures for changes in demand in agreement between the SR and SP
Feedback Plan	Desired feedback procedures on performance	Feedback procedures and how to act on them through implementation of changes
Communication Plan	Internal communication initiative owners	Organizational reporting structure and agreed interaction schedules
Measurement Charter	What is to be measured and the definition of the process to measure defined categories	What is to be measured, the processes to achieve this and the methodologies
Conflict Arbitration Plan	Desired timetables for resolving issues	Characteristics for third party involvement in case of issues

The detailed (U)SLA and (B)SLA are provided in Appendix IX and X.

4.1.3 Importance

The testing of the importance did not have the objective to change the content of the (U)SLA and (B)SLA. The objective was to give more substance to the SLAs through feedback from the interviewees. This can also provide an insight into the extent of which the information of the interviews was processed. The comments that were included, if any, were only to elaborate on a choice. No ambiguities were pointed out by the interviewees.

To investigate the importance of the included elements in the (U)SLA and (B)SLA the interviewees of stage 1 were asked to rate the elements individually and relative to each other on importance. The individual elements could be rated on a 5 point scale from 1: "Do not include" to 5: "Elaborate description". The relative importance was investigated by ranking the elements in a category from most important (1) to least important (2, 4 and 5[13]). Table 8 and Table 9 in appendix XI show the results from the investigation among 4 respondents, from the other three interviewees no response was received.

(U)SLA Importance

The individual elements are all regarded important to include. This is indicated by an average score of 3 or higher for the individual importance. The standard deviations, however, show that there is some disagreement between the interviewees. The major cause for this is the general tendency of one interviewee to rate elements lower. The average interviewee rating is relatively low (2,60) for one of the interviewees compared to the other 3 (4,50 – 3,70 – 4,20). We cannot say anything about significance due to the low amount of measurements. The relative high difference in average interviewee rating does, however, explain the standard deviations.

The relative importance shows the ranking of the elements per category. Below the ranking is provided that is determined by the relative importance test.

- Foundation Characteristics:
    1. Service Level Contents
    2. Data Code of Conduct

[13] Depending on the number of elements present in a category.

    3. Process Ownership Plan
    4. Service Level Objectives
- Change Management Characteristics:
    1. Future Demand Management Plan
    2. Feedback Plan
- Governance Characteristics:
    1. Measurement Charter
    2. Exit Strategy Plan
    3. Conflict Arbitration Plan
    4. Communication Plan

(B)SLA Importance

The individual elements are all regarded important to include. This is indicated by an average score of 3 or higher for the individual importance. The standard deviations, however, again show that there is some disagreement between the interviewees. The major cause for this is the general tendency of one interviewee to rate elements lower. The average interviewee rating is relatively low (3,15) for one of the interviewees compared to the other three (4,46 – 4,54 – 3,92).). We cannot say anything about significance due to the low amount of measurements. The relative high difference in average interviewee rating does, however, explain the standard deviations.

The relative importance shows the ranking of the elements per category. Below the ranking is provided that is determined by the relative importance test. There is disagreement on what should be the most important element in the category Change Management Characteristics and on the second most important in the category Governance Characteristics. This disagreement, however, does not influence the content of the framework.

- Foundation Characteristics:
    1. Service Level Contents
    2. Data Code of Conduct
    3. Process Ownership Plan
    4. Service Level Objectives
- Change Management Characteristics:
    1. Future Demand Management Plan
    1. Anticipated Change Plan
    2. Feedback Plan
    3. Innovation Plan
- Governance Characteristics:
    1. Measurement Charter
    2. Exit Strategy Plan
    2. Enforcement Plan
    3. Communication Plan
    4. Conflict Arbitration Plan

4.2 Stage 2: Validation

This section describes the validation of the framework and SLAs. The main objective of the validation interviews was to assess the credibility of the framework and SLAs. Except from the comments that are treated in the remainder of this section, the framework and SLAs were considered to be interesting and relevant. Four interviews are conducted to investigate whether the developed

framework and SLAs are usable in practice, complete and if they are clear (i.e., understandable). Each interview was concluded by asking the interviewee to summarize the general opinion about the framework and SLAs on its usability, completeness and clarity. The answers during the interviews furthermore resulted in two types of comments: conceptual and substantive. The conceptual comments regard the usability in practice and completeness and are considered most important for further improvement of the framework. The substantive comments regard comments that consider the clarity of the framework and SLAs. Apart from the comments regarding the framework and SLAs, there were also other suggestions and comments regarding Cloud Computing in general. These are incorporated into the practitioner's recommendations in section 5.2. The three validation topics (usability, completeness and clarity) are treated separately hereafter.

Usability

The members of the CIO platform acknowledge that they, as a platform, are working towards a checklist that assists companies in taking the necessary steps to be ready for the Cloud. The framework and SLAs can provide a valuable input or even point of departure for such a checklist. They furthermore indicate that companies currently are struggling with the exact characteristics of services in the Cloud and what the implications are for SLAs and contracts in general. The framework and SLAs can provide more insight into this issue. The companies that cooperated in the interviews explicitly mentioned that they will distribute the framework and SLAs to their departments.

Completeness

Initially there were comments on the completeness of the framework. The information that the interviewees received prior to the interview meeting did not include the scope definition of the research project. Therefore the interviewees identified missing aspects in the framework regarding the deployment (community and hybrid) and service models (SaaS, PaaS, IaaS) that are part of Cloud Computing according to its definition. In the interview it became clear that the research scope included only two deployment models (Public and Private)and did not explicitly take the service models into consideration. With this in mind they responded that within the scope the framework is complete with two exceptions: branch specific aspects and the decision moment.

The comments regarding the usability and completeness of the framework and SLAs, the conceptual comments, are provided in the table below.

Table 6 Conceptual Interview Comments

	Source	*Comment*	*Reaction*
1	***PwC*** ***LUMC*** ***SURFdiensten*** ***USG People***	The framework only treats the Public and Private Cloud although other deployment models exist. Why aren't these included?	The research project is scoped to the Public and Private Cloud only. These deployment models represent the 'extreme' scenarios in the Cloud. To improve the framework the other deployment models could be investigated in future research.
2	***PwC*** ***LUMC*** ***USG People***	The service models of Cloud Computing (SaaS, PaaS, IaaS) are not included in the framework. Why is that?	These were outside of the research scope for this project. To improve the framework the influence of the service models could be investigated in future research.
3	***PwC*** ***LUMC*** ***SURFdiensten*** ***USG People***	The SLAs do provide an overview of the relevant elements. But it can be expected that the branch an company is active in will influence the content of the SLA.	The research project had as objective to provide a general overview of SLA elements to be included without being branch specific. However, this could be a valuable extension to increase the practical applicability

4	***SURFdiensten***	The decision for a Private/Public solution sometimes occurs at a later stage of the flow, just before drafting the SLA.	Interviews showed that, based on the data and process assessment a Public, Private or traditional solution is chosen. The exact criteria for this choice is branch and maybe even organization specific. Theory on vendor selection could be consulted to gain a deeper insight in this decision.
5	***USG People***	We are especially interested in what will be the criteria that determine the choice for a Public or Private Cloud. In your framework this is only abstractly presented by a decision point.	

Clarity

During the inquisition of the framework and SLA's clarity, three substantive comments were identified that point out ways to improve the readability. The exclusion of abbreviations (6) and technical jargon (7) causes the framework and SLAs to be better understandable by other stakeholders than IT employees. Adding a description (8) to the SLA's categories (foundation-, change management- and governance characteristics) improves the understandability and therefore readability of the SLAs.

Table 7 Substantive Interview Comments

	Source	*Comment*	*Reaction*
6	***PwC***	Unclear what is meant by the abbreviations SR, SP and o/s.	The abbreviations are introduced in the report but not in the framework or SLAs, which causes confusion for the reader. The abbreviations could be replaced by the full expression or a legend could be included.
7	***SURFdiensten***	The use of the terms Unilateral and Bilateral is technical jargon. This could cause confusion for non-IT readers.	This terminology is extensively treated in the report that accompanies the framework and SLAs. A legend could be added to the framework to increase its readability.
8	***PwC***	What do the category headings in the SLA mean?	The meanings of the categories are treated in the report. To increase the completeness and clarity of the SLA however, they should be included. A brief description of the categories should be added.

5. Conclusions and Recommendations

This project covers the design of a framework for SLAs in Cloud Computing. The research aims to answer the research questions formulated in chapter 1. A result of this is a framework for SLA elements in Cloud Computing that includes an SLA for the Public Cloud and the Private Cloud. The framework and SLAs are formulated based on interviews at PwC and validated by an expertise panel. In this chapter conclusions are drawn and recommendations are made for both researchers and practitioners.

5.1 Conclusions

Based on the results of the interviews, it can be concluded that the SLA elements from traditional ITO are applicable in Cloud Computing to a certain extent. The nature of the relationship in Cloud Computing, however, requires a different mindset in establishing relationships. This mindset includes more trust building of the SP towards the SR and the acceptance of the SR that less topics can be covered in SLAs.

The Public Cloud results in the largest change for SLAs compared to traditional ITO. In Public Cloud solutions it is (nearly) impossible to change characteristics of the service, the providers work from a 'take it or leave it' principle. The services are standard and the corresponding SLAs are fixed and only to be agreed upon by the SR; it is not possible to negotiate them. Therefore, the purpose of SLAs drafted by the SR changes in the case of Public Clouds. The Public Cloud SLA becomes a unilateral document, an (U)SLA, which is used as a tool for:

- Creating intra-organizational awareness of the SR's processes and data;
- Comparing the available providers on the extent they can support business demands;
- The monitoring of the provider's performance based on desired requirements included in the (U)SLA.

The Private Cloud does not require significant changes for SLAs compared to traditional ITO. In Private Cloud solutions it is possible to customize services based on SR's requirements. The providers work from an 'agreement' principle in which the SR and SP discuss the specifics of the services and corresponding SLAs and both parties can negotiate requirements of the included services. The purpose of the SLAs drafted in collaboration between SR and SP remains unchanged in the case of Private Clouds. The Private Cloud SLA remains a bilateral document, a (B)SLA, which ,in addition to the usages of the (U)SLA, is used as a tool for:

- Structuring the relationship between SR and SP;
- Negotiating the specifics of the services described in the SLA.

Cloud Computing inherently causes processes to become opaque (Public Clouds to a larger extent than Private Clouds) due to the used technologies (e.g., virtualization) and characteristics (e.g., resource pooling). SPs can provide no or limited guarantee to where the data is stored and next to whom your data is stored. Therefore, an important addition to the traditional ITO SLA elements is the element regarding the treatment of data; Data Code of Conduct (DCC). This element treats the specification of boundaries for data storage locations and the identification of data access, change and deletion authorizations.

Furthermore, the traditional element 'Enforcement Plan' treats the exit strategy plan in its contractual clauses. From the interviews it became apparent that this topic requires more attention that in traditional ITO. For a SR it is paramount to be able to discontinue the relationship with his SP without this threatening business continuity or the loss of (critical) data. Therefore, an important addition to the traditional ITO SLA elements is the element regarding the exit strategy; Exit Strategy Plan (ESP). This

element treats the specification of exit roles and responsibilities for the involved parties and includes time schedules and conditions under which the exit strategy may be invoked.

From the validation interviews, suggestions for future work are identified. Future work will look at the influence of the Cloud Computing service models (SaaS, PaaS, IaaS) on the framework, the implications of the two other deployment models (Community and Hybrid Cloud) for the framework and the possibilities to make the framework branch-specific.

5.2 Recommendations

Scientific Recommendations

This research did not explicitly take the influence of service models (e.g., SaaS, PaaS, IaaS) in Cloud Computing into account. There are however indications from the interviews that the different service models will influence the characteristics of SLAs. The exact influence of the service models could be part of future work on Cloud Computing SLAs. The (U)SLA and (B)SLA that are developed in this research could be used as point of departure for the extended research. This would result in an increased knowledge of Cloud Computing service models and their influence on Cloud Computing SLAs.

The scope of the research is restricted to the Public and Private Cloud deployment models. The interviews ,however, have revealed that there is a practical need for the inclusion of the Community and Hybrid deployment models. The methods that are utilized in this research can be applied to investigate the impact on the framework and SLAs that is caused by these two deployment models.

The decision moment included in the framework is presented at the beginning of the flow and is based on the data and process assessment. The comments in the validation interviews suggest that the decision moment can occur at other times than is presented by the framework. Furthermore is there a specific interest in what the criteria are that determine the choice for a certain Cloud solution. This does not cause the framework to be inapplicable. However, extending the framework with vendor selection / management theory would enhance the completeness.

Practitioner Recommendations

The framework and SLAs provide an insight in the aspects that play a role in the determination of possible Cloud solutions for a company and the corresponding elements to be covered in an SLA. Currently, companies do not have a clear view on what these aspects and elements are. It is therefore recommended that companies use the framework and SLAs as a tool for investigating Cloud solutions and for the drafting of SLAs.

The framework and SLAs provide a general overview of what the relevant aspects of Cloud Computing are for a SLA and which elements should be included in a Public or Private Cloud SLA. Companies, moreover, should be critical towards the branch they are active in and the implications this might have for the SLA. Certain branches (e.g., financial, healthcare) require more attention to aspects as privacy or security. The SLA elements should therefore be considered in the context of the branch.

Recent developments on sustainability (e.g., less paper use, decreasing car usage) and the support of the new way of working (e.g., flexible working times, working at home, bring your own device) results in an increased relevance of Cloud Computing for a large number of companies. The general tendency of companies, however, is to be scared of Cloud Computing. By providing companies with the framework and SLAs developed in this research, they gain insight in the forces at work in Cloud Computing and required knowledge for the SLAs.

Appendices

Appendix I NIST Cloud Computing Components

1. Definition

"Cloud computing is a model for enabling ubiquitous, 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(On-demand self-service, Broad network access, Resource pooling, rapid elasticity , and Measured service), three service models(Software as a Service, Platform as a Service, and Infrastructure as a Service), and four deployment models (Private Cloud, Community Cloud, Public Cloud, and Hybrid Cloud)."

2. Cloud Computing 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 PDA's).

Resource pooling. The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Example 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 (typically through a pay-per-use business model) 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.

3. **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).

4. **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 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).

Appendix II The Contractual Elements of SLA in IT outsourcing

Characteristics	Contractual elements of SLA	Contractual issues of SLA in IT outsourcing	Clauses in practice	Theories (supporting references)
Foundation characteristics				
Publicizing common values, belief, philosophy within a clan	Service Level Objective	Spirit of contractual solidarity and publicity of common values, belief, philosophy between organizations to ensure performance	A statement of both SR's and SP's business objectives from the engagement A statement of overall objectives from the contract A statement of expectations and capabilities of the SP	Relational Exchange, SLA templates (Fitzgerald and Willcocks 1994, Heide 1994, Cloudhury and Sabherwal 2003, Ring and Ven 1994)
Resulting in sharing a common ideology, internalizing a set of values, and committing to a clan	Process Ownership Plan	Number of companies taking part in some aspect of the IS portfolios when outsourced	Statement of processes that are delivered via the agreement Statement of processes directly affected by the service included in the agreement Statement of processes that are required to manage the agreement between SR and SP Statement of process ownership roles, authorities and responsibilities	Relational exchange, SLA templates (Scardino 2001, Singleton, McLean and Altman 1988, Ring and Ven 1994)
Providing means to create a general commitment between partners from which desirable actions evolve	Service Level Contents	Specification of obligations in terms of a statement of work, the associated and required service levels, and the price to be paid into all sourcing agreements	A general description of the services required, major categories of services and specific service elements A compilation of the most common service levels completed for each service level Service-level target, time frame definition, quality statement, etc.	Relational Exchange, SLA templates (Anderson and Narus 1990, Mohr and Spekman 1994, Ambrose, Maurer and Stone 2001, Fitzgerald and Willcocks 1994, Kern and Blois 2002)
Change management characteristics				
Specific rules and procedures, which would lead to desired outcomes if followed	Future Demand Management Plan	Planning the process and methodologies for coping with change and contingencies in a long term engagement: Agreeing to agree	Join (SR/SP) demand forecasting process Assumptions made and process for updating the key assumptions that affect demand Prioritization methodology for current and future demands Process for scheduling, costing and modifying agreements	Relational Exchange, TCE, SLA templates (Grover, Cheon and Teng 1996, Willcocks and Kern 2002, Heide 1994, Scardino. 2002, Williamson. 1985, Williamson.. 1991, Williamson 1996)
Mechanisms that facilitate joint adaption to problems raised from unforeseeable changes into the contract	Anticipated Change Plan	The joint development of expectations about perceived uncertainties, especially concerned with anticipated conflicts of interest and potential trouble	Clear definitions of the key categories of change Roles, responsibilities and decision-making procedures for the SR and SP for each category of change Top drivers for change – reviewed regularly	Relational Exchange, SLA templates (Bendor-Samuel 1999, Fontenot and Wilson 1997, Lee and Kim 1999)

Methodology aligned to match known exchange hazards, particularly those associated with uncertainty	Feedback Plan	Continuous processes for changing interfaces, approaches and attitudes toward better service delivery states within a deal based on learning by doing	Statement of how changes will be implemented based on measurement results The road map for an efficient feedback on the identified drawbacks Prioritization methodology for current tasks and feedbacks	Relation Exchange, SLA templates (Singleton, McLean and Altman 1988, Willcocks and Kern 2002, Marcolin 2002)
	Innovation Plan	Cooperative innovation, especially joint efforts at continuous performance improvement and planning	Process for innovation, including implementation and prioritization Process for technology advancements (scope improvement and technology refreshes/upgrades) Business-measured innovation (business process improvement)	Control Theory, SLA templates (Matlus and Brittain 2002, Kirsch 1997, Cloudhury and Sabherwal 2003)

Governance characteristics				
Mechanisms that mitigate disruptions	Communication Plan	The approach for disseminating contract related information to all of the parties involved in the relationship through scheduled interaction and communication such as formal meeting and reporting	Organizational reporting structure Identified communication initiative(s) owner(s) Identified recipients for various communication initiatives Communication schedules and media	SLA templates (Grover, Cheon and Teng 1996, Lee and Kim 1999, Willcocks and Kern 2002, Singleton, McLean and Altman 1988)
Rewards or sanctions for meeting or missing the targets	Measurement Charter	Tactical measurements for calculating and reckoning of service performance as well as success metrics derived from the SR's strategic plan	Statement of measurement methodology Definition of what is to be measured Definition of processes to periodically measure the defined categories Interfaces with feedback plan	Control Theory, SLA templates (Maurer 2001, Singleton, McLean and Altman 1988, Ouchi 1979, Kirsch 1997, Cloudhury and Sabherwal 2003)
Setting and checking performance targets, interim milestones to ensure that the relationship remains on course	Conflict Arbitration Plan	Balance of power that imposes one's will on others	A statement of the parameters for involving the third party in discussions between SR and SP Process descriptions to determine how the parties interact A schedule for regular interactions between the parties, and timetables for resolving issues between the SR and SP A statement of the practices and conduct rules to required to preserve the independence of the independent advisor	Relational Exchange, SLA templates (Mohr and Spekman 1994, Dwyer, Schurr and Oh 1987, Anderson and Narus 1990, Fontenot and Wilson 1997, Lewicki and Bunker 1996)
	Enforcement Plan	Carrot-and-stick; sharing of benefits and burdens	Penalty/reward definitions and formula Conditions under which termination may occur Detailed list of all penalty assumptions (e.g., Implementation process, Reporting process, Due diligence process, HR process, Knowledge transfer)	TCE, SLA templates (Singleton, McLean and Altman 1988, Klein, Crawford and Alchain 1978)

Appendix III Initial Mailing Interviewees

Guus Jacobs/NL/ABAS/PwC
29-09-2011 16:24

To
cc
bcc
Subject Interview tbv afstudeeronderzoek

Beste mr. *achternaam van ontvanger*,

Voor mijn afstudeeronderzoek ten behoeve van de master Operations Management & Logistics aan de TU Eindhoven doe ik onderzoek naar Service Level Agreements (SLAs) in Cloud Computing.
Een onderdeel van dit onderzoek is het inventariseren van SLA elementen die nieuw zijn in Cloud Computing en het herzien van de elementen die gebruikt worden in traditionele IT outsourcing projecten.
Om dit te bewerkstelligen zou ik graag een aantal mensen bij PwC willen interviewen over hun visie op dit gebied.
Gewenste eigenschappen van de geïnterviewde zijn, dat deze:

1. Ervaring heeft met 'traditionele' Service Level Agreements.
2. Bekend is wat de eigenschappen van Cloud Computing zijn, zoals:
   - Service Models (Software/Infrastructure/Platform as a Service)
   - Deployment Models (Public/Private Cloud)

Door middel van deze mail wil ik een balans opmaken, zodat ik kan bepalen hoeveel interviews er gehouden kunnen worden binnen PwC.
De interviews zullen plaatsvinden in de periode van week 41 t/m 43 (10-10-'11 t/m 28-10-'11) en zullen ongeveer één uur in beslag nemen.

Graag zou ik van u vernemen of u zelf zou willen deelnemen aan dit interview? en,
of u eventuele andere collega's weet die ik kan benaderen om deel te nemen aan een interview.

Wanneer u instemt mee te werken aan het interview, zult u ter zijner tijd een voorbereidend document ontvangen met de details van het interview.

Ik zie uw antwoord graag tegemoet.

Met vriendelijke groet, / Kind regards,

Guus Jacobs
PwC | Graduate Itern BAS (CIPS)
Tel: 06 47 99 00 25
E-mail: guus.jacobs@nl.pwc.com
PricewaterhouseCoopers Accountants N.V. (KvK 34180285)
Flight Forum 840, 5657 DV, Postbus 6365, 5600 HJ, Eindhoven

Appendix IV Information for the Interviewees

Datum:	Tijd:

Interview:
Service Level Agreements in Cloud Computing

Doel:

Het doel van het interview is om jouw mening betreffende Service Level Agreements (SLAs) te vragen en mee te nemen in mijn onderzoek. Het onderzoek is gericht op het opzetten van een raamwerk dat bedrijven een overzicht zal geven van de belangrijke elementen die SLAs moeten bevatten in Cloud Computing. In het raamwerk zal een specificatie aanwezig zijn op basis van Service Models (SaaS, PaaS, IaaS) en Deployment Models (Public Cloud, Private Cloud).

Structuur:

Om het mogelijk te maken in het raamwerk een specificatie te geven op Deployment en Service model niveau is het belangrijk dat alle vragen of stellingen in de context van een Service en/of Deployment model geplaatst worden.

Het interview bestaat uit 4 delen:

1. ***Introductie:***
   Achtergrond Guus en doel en structuur van het interview.
   Achtergrond geïnterviewde (ervaring, positie, etc.)
2. ***Open vragen betreffende SLA en Cloud Computing:***
   Dit gedeelte bestaat uit algemene vragen die als uitgangspunt functioneren voor verdere diepgang waar benodigd. Hierbij moet gedacht worden aan vragen als:

Heeft Cloud Computing de manier waarop we SLAs benaderen veranderd?
Zie je verschillen tussen de Service Modellen? En Deployment Modellen?
Wat zie jij als contractuele valkuilen in afspraken tussen service consumers (eindgebruikers) en service providers in Cloud Computing?
Zijn er aspecten in een SLA die belangrijker worden in Cloud Computing dan in traditionele IT outsourcing?
Zie je verschillen tussen de Service Modellen? En Deployment Modellen?
Zijn er aspecten in een SLA die minder belangrijk worden in Cloud Computing dan in traditionele IT outsourcing?

3. Herzien bestaande SLA elementen:

In dit gedeelte worden de bestaande SLA elementen (11 elementen in 3 categorieën) die vanuit theorie zijn geïdentificeerd herzien op toepasbaarheid in de Cloud. Onderstaand overzicht bevat de elementen die volgens de theorie relevant zijn voor traditionele IT outsourcing. Afhankelijk van wat er in deel 2. al besproken is, volgt nog een selectie uit onderstaande vragen:

- De doelen van een relatie worden vastgelegd in de **Service Level Objectives**.

Zal de inhoud van de Service Level Objectives anders zijn in Cloud Computing? Zal dit verschillen per Service Model? Of per Deployment Model?

- De geleverde service wordt gespecificeerd in de **Service Level Contents**.

Zal de inhoud van de Service Level Contents anders zijn in Cloud Computing? Zal dit verschillen per Service Model? Of per Deployment Model?

- De rollen en verantwoordelijkheden van de betrokken partijen worden vastgelegd in het **Process Ownership Plan**.

Zal de inhoud van het Process Ownership Plan anders zijn in Cloud Computing? Zal dit verschillen per Service Model? Of per Deployment Model?

- De communicatie stroom wordt vastgelegd in het **Communication Plan**.

Zal de inhoud van het Communication Plan anders zijn in Cloud Computing? Zal dit verschillen per Service Model? Of per Deployment Model?

- In het **Measurement Charter** wordt vastgelegd hoe, wanneer en door wie de relatie tussen de SR en SP beoordeeld wordt.

Zal de inhoud van het Measurement Charter anders zijn in Cloud Computing? Zal dit verschillen per Service Model? Of per Deployment Model?

- Parameters voor het betrekken van een derde partij en tijdschema's voor het oplossen van problemen worden vastgelegd in het **Conflict Arbitration Charter**.

Zal de inhoud van het Conflict Arbitration Charter anders zijn in Cloud Computing? Zal dit verschillen per Service Model? Of per Deployment Model?

- De boetes en penalties die onderhandeld zijn tussen Service ontvanger en Service provider en de mogelijkheid tot onttrekken van diensten zijn vastgelegd in het **Enforcement Plan**.

Zal de inhoud van het Enforcement Plan anders zijn in Cloud Computing? Zal dit verschillen per Service Model? Of per Deployment Model?

- De processen om veranderingen in toekomstige vereisten en prioriteiten te managen en implementeren zijn vastgelegd in het **Future Demand Management Plan**.

Zal de inhoud van het Future Demand Management Plan anders zijn in Cloud Computing? Zal dit verschillen per Service Model? Of per Deployment Model?

- Het **Anticipated Change Plan** beschrijft de middelen en procedures die bij technologische/industrie/bedrijfsveranderingen benodigd zijn voor efficiënte besluitvorming.

Zal de inhoud van het Anticipated Change Plan anders zijn in Cloud Computing? Zal dit verschillen per Service Model? Of per Deployment Model?

- De procedures voor feedback op geleverde services en implementatie van veranderingen zijn vastgelegd in het **Feedback Plan**.

Zal de inhoud van het Feedback Plan anders zijn in Cloud Computing? Zal dit verschillen per Service Model? Of per Deployment Model?

- Het **Innovation Plan** omvat verklaringen die de processen voor innovatie ontwikkelingen en implementatie hiervan beschrijven.

Zal de inhoud van het Innovation Plan anders zijn in Cloud Computing? Zal dit verschillen per Service Model? Of per Deployment Model?

4. Identificatie nieuwe elementen:

De identificatie van nieuwe elementen die relevant zijn voor Cloud Computing.

Hebben de volgende eigenschappen van Cloud Computing mogelijk invloed op de inhoud van Cloud Computing SLAs?

On-demand Self-service:	Eenzijdige aanpassing (Service ontvanger) benodigd service level
Broad network access:	Gebruik mobiele technologie
Resource pooling:	Meerdere consumers en een,tot op een bepaalde hoogte, onbekende locatie van service en/of data
Rapid Elasticity (scalability):	Ongelimiteerde service. Scale-in / Scale-out

Theoretische achtergrond:

Cloud Computing is een breed begrip, daarom hieronder (en op de volgende pagina) een overzicht van de Service en Deployment modellen zoals deze in mijn onderzoek worden gebruikt.

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.

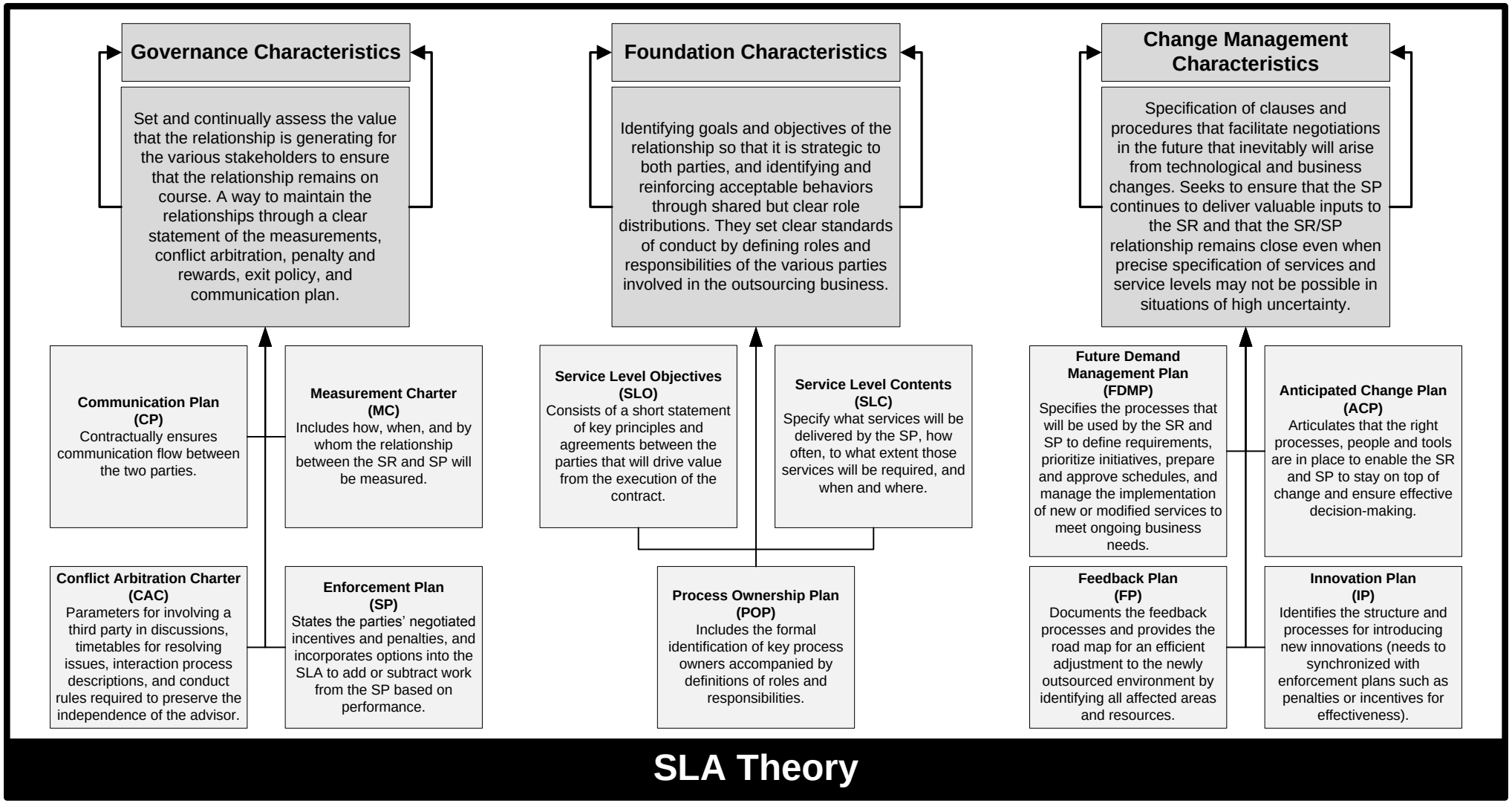
Cloud Infrastructure as a Service (IaaS). The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer 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:

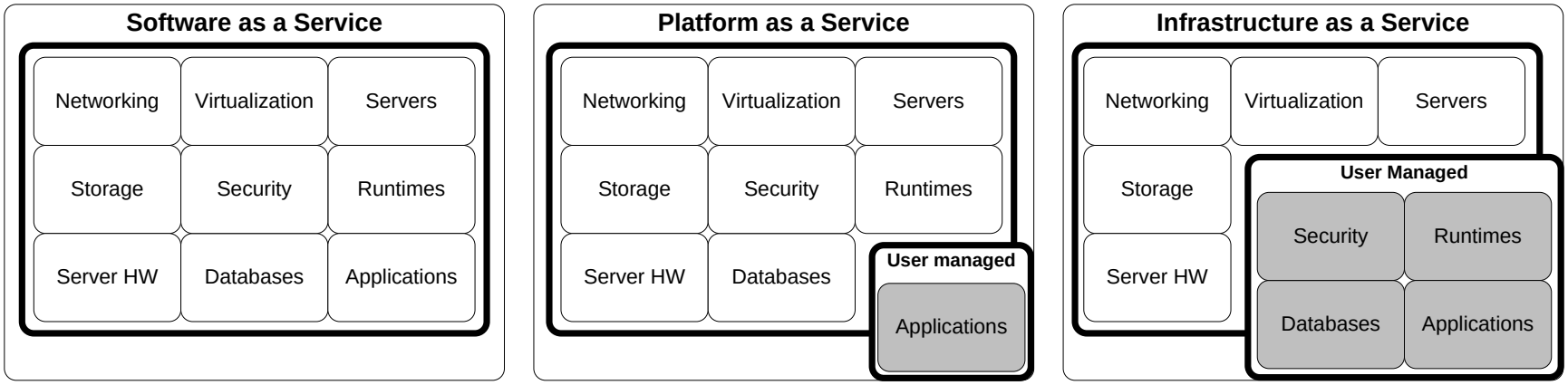
Private cloud. The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.

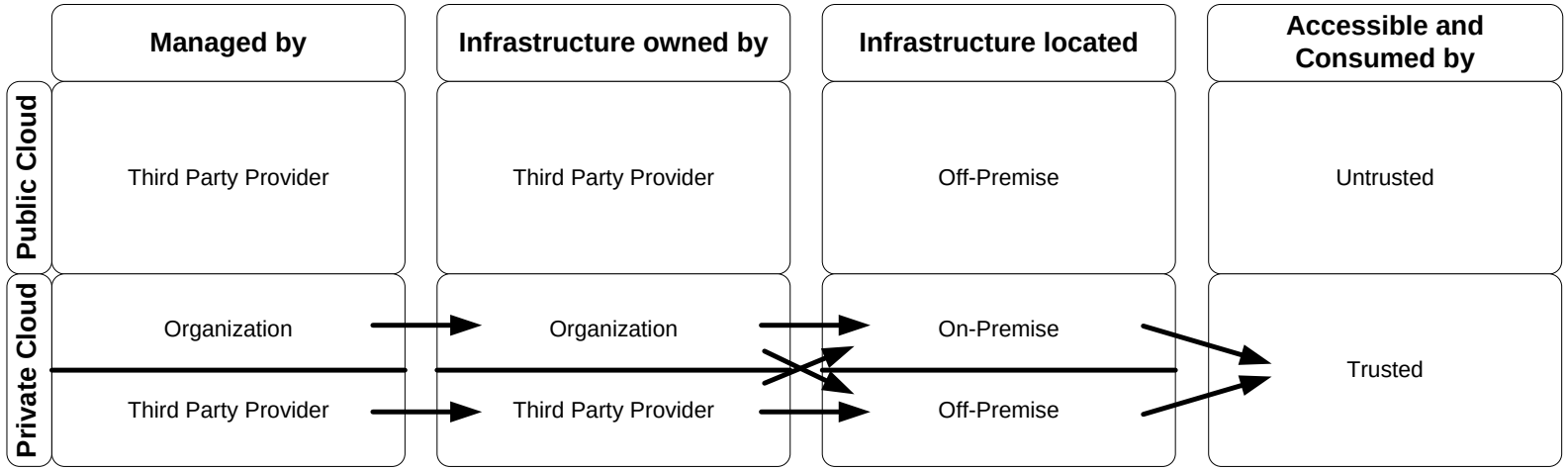
Public cloud. The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.

Het figuur hieronder geeft de relevante SLA elementen in traditionele IT outsourcing contracten weer. Deze zullen de basis vormen voor deel 2 van het interview.



Appendix V Guiding Document Interview





Appendix VI Interview Sections

Section 1: Introduction

The objective of the introduction section was to introduce the researcher, to investigate the professional background of the interviewee, and to 'set the scene'. To guide the interviewee, a basic description of the Service and Deployment models was provided. The figures used are presented in Appendix V. The figures assisted the interviewee to further explain answers and to clarify the characteristics of the Service and Deployment models.

Section 2: Open questions

The objective of this interview section is to extract information concerning SLAs in Cloud Computing that the respondent regards important. Without influencing the content of the answers (i.e. creating interview bias), questions were asked that the respondent could answer to his own preference. A selection of the questions asked in this section is provided below.

Has Cloud Computing changed the way we need to treat SLAs? Do you see differences between Service Models? Or Deployment Models?

Are there SLA elements that become more important in Cloud Computing compared to traditional IT outsourcing? Do you see differences between Service Models? Or Deployment models?

Are there SLA elements that become less important in Cloud Computing? Do you see differences between Service Models? Or Deployment models?

Do you see contractual pitfalls in agreements between Service Recipients and Service Providers in Cloud Computing?

The interviewees were free to deviate from the questions and the researcher only intervened to clarify issues or to introduce a new theme. The themes were induced from the selected theory on SLA elements in ITO (3.1.1). The contents of the 11 elements, and corresponding 3 SLA categories were induced to a set of high level themes. These themes served as initial input to a question that could lead to probing when more detailed information was desired. The induction of theory to interview content is presented in Figure 8.

Section 3: Review SLA elements of traditional IT outsourcing

Depending on the answers that were acquired in the previous section of the interview, the remaining SLA elements from traditional ITO were reviewed. For this, the interviewer kept track of the treated topics in the previous section in a table that listed all SLA elements. When a topic was not, or inadequately treated in the previous section the interviewer would specifically ask questions on the corresponding topic. Again, the interviewee was free to deviate from the questions, but in this section the interviewer kept a tighter schedule to focus the answers on the related topic.

Section 4: Identification of possible new elements

Depending on the answers that were acquired in the previous sections of the interview, the characteristics of Cloud Computing were discussed. The characteristics (e.g., Resource pooling, broad network access, rapid elasticity) of Cloud Computing were investigated whether these would imply that the content of a SLA would be influenced.

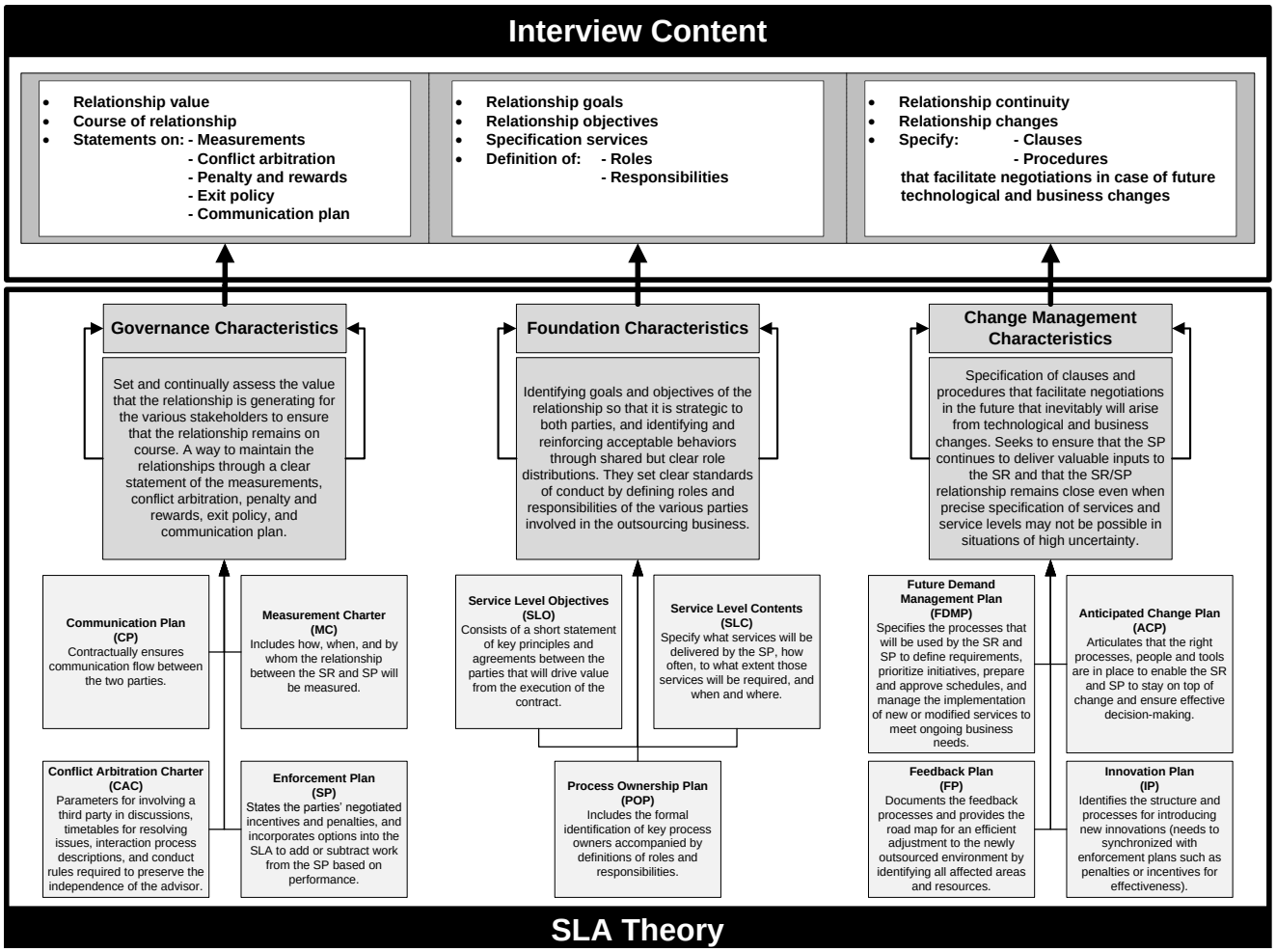


Figure 8 From theory to interview content

Appendix VII *Importance Form*

Hoe belangrijk zijn onderstaande elementen om op te nemen in een *Public Cloud* (U)SLA?

De opzet van het formulier is als volgt:

Kolom A: Beschrijving van het SLA element.

Kolom B: Hierin moet per indvidueel element een keuze gemaakt worden hoe belangrijk het is om dit element op te nemen in de SLA; uit 1 "Niet opnemen" … tot … 5 "Uitvoerig beschrijven"

Kolom C: Ruimte om de keuze gemaakt in Kolom B te onderbouwen.

Kolom D: Hierin moeten alle elementen binnen de betreffende categorie geclassificeerd worden van 1: "Belangrijkste" tot 2-4:"Minst belangrijk".

A	B	C	D	
Categorie: Foundation Characteristics			***1-4***	**Voorbeeld:**
Service Level Objectives	***1 2 3 4 5***	Why?		**3**
Publicizing SR's values, belief and philosophy for clarification purposes. The required capabilities and expectations of a SP are formulated.		(Toelichting op keuze in Kolom B)		
Service Level Contents	***1 2 3 4 5***	Why?		**2**
Specification of required service and service levels determined from business requirements.		(Toelichting op keuze in Kolom B)		
Process Ownership Plan	***1 2 3 4 5***	Why?		**1**
Specification of key process owners with corresponding roles and responsibilities. Scope definition of the process owners' authority to plan, manage and evolve services.		(Toelichting op keuze in Kolom B)		
Data Code of Conduct	***1 2 3 4 5***	Why?		**4**
Specification of boundaries for data storage locations (compliance). Identification of data access, change and deletion authorization.		(Toelichting op keuze in Kolom B)		
Categorie: Change Management Characteristics			***1-2***	
Future Demand Management Plan	***1 2 3 4 5***	Why?		
Definition of planning process and desired methodologies for coping with change, innovations and contingencies that possibly influence service requirements.		(Toelichting op keuze in Kolom B)		
Feedback Plan	***1 2 3 4 5***	Why?		
Specification of desired approaches and attitudes toward better service delivery states within a deal, based on learning by doing.		(Toelichting op keuze in Kolom B)		

(this picture shows the form partial)

Appendix VIII Information for the Validation Interview

Think

Guus Jacobs/NL/ABAS/PwC
13-12-2011 14:02

To Orjan Leuvenink/NL/CFR/PwC@EMEA-NL
cc Ron Broeren/NL/CFR/PwC@EMEA-NL
bcc
Subject Informatie voor interview 10.00 - 11.30, 19-12-11.

Hoi Örjan,

Onderstaande tekst geeft je een overzicht van mijn onderzoek en de doelstellingen voor het interview van komende maandag. Ik zou je willen vragen om deze mail te lezen en de bijlagen globaal te bekijken.

Onderzoeksopzet
Het doel van het onderzoek is de toepasbaarheid van traditionele SLA elementen in Cloud Computing te onderzoeken vanuit een afnemers oogpunt. Hiervoor is een SLA kader geselecteerd vanuit traditionele ITO dat als basis is gebruikt voor het onderzoek. Het is gebleken dat er verschillen bestaan tussen de Public en Private Cloud en vooral in de toepassing van de SLA. Onderstaand raamwerk geeft een high-level overzicht van de aspecten die spelen bij de selectie van een Cloud oplossing. Als eind deliverable in het raamwerk zie je de Public Cloud (U)SLA en Private Cloud (B)SLA. *(U)* staat voor *Unilateral*, wat het eenzijdige relatie karakter in een Public Cloud weergeeft. *(B)* staat voor *Bilateral*, wat het tweezijdige relatie karakter weergeeft in een Private Cloud.

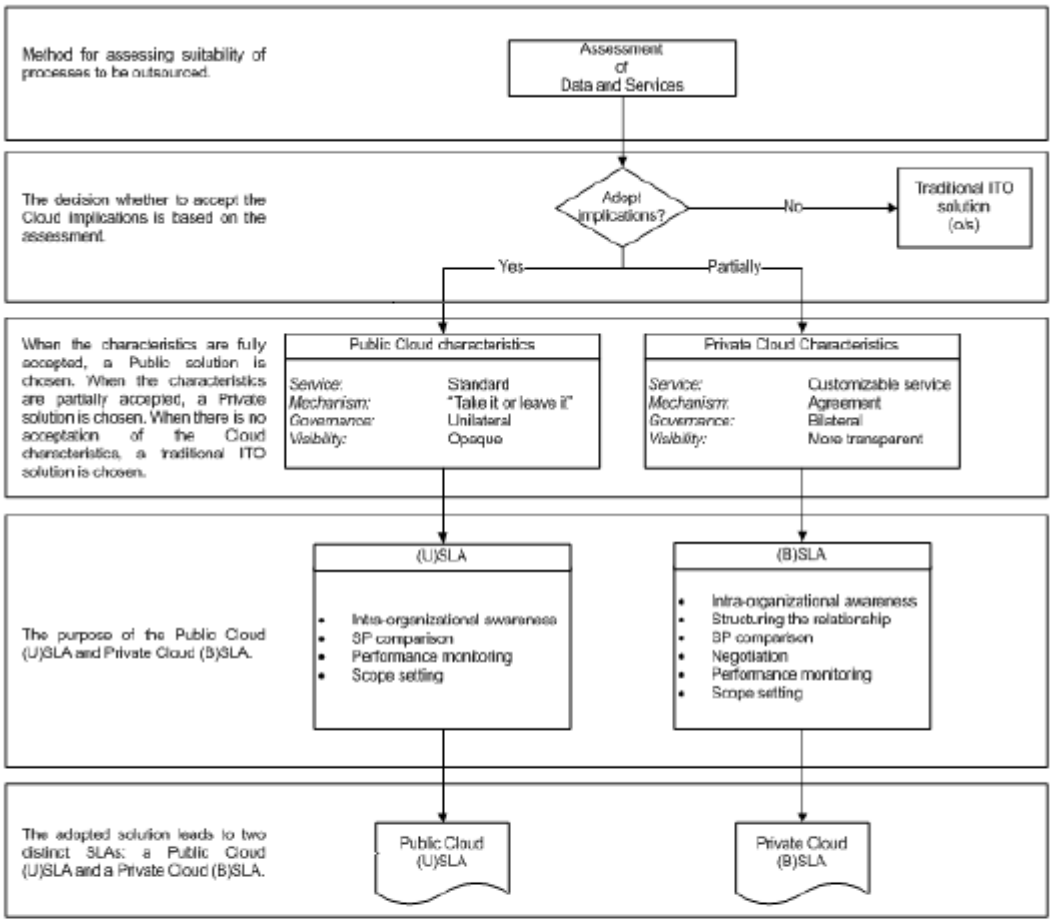
Doelstellingen Interview
De algemene doelstelling van het interview is om het ontwikkelde raamwerk en de SLA kaders te valideren.
Het raamwerk is high-level en eenvoudig te behandelen, de kaders vergen echter meer tijd. Bij het valideren van de kaders wordt de volgende context gebruikt:

Stel dat je gaat kiezen voor een Private Cloud (of Public Cloud) oplossing:

- Omvat het SLA kader dan alle benodigde elementen?;
- Is het duidelijk wat er staat?
- Zou je iets toevoegen?; en
- Zou je iets veranderen?.

Hierbij zullen de kaders voor de (U)SLA en (B)SLA gedetailleerd behandelt worden.
Als er naar aanleiding van deze mail nog vragen zijn voorafgaand aan het interview hoor ik dat graag.
In de bijlagen vindt je het raamwerk en de SLA kaders.

Kaders: **Final_(U)SLA_(B)SLA.zip** Raamwerk: **Final_Framework.zip**



Met vriendelijke groet, / Kind regards,

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Appendix IX Public Cloud (U)SLA

	Public Cloud (U)SLA		
	Contractual element	***Contractual issues of SLA in Cloud Computing***	***Clauses in practice***
Foundation characteristics			
1	Service Level Objectives (SLO)	*Publicizing SR's values, belief and philosophy for clarification purposes. The required capabilities and expectations of a SP are formulated.*	∴ A statement of SR's business objectives from the engagement ∴ A statement of overall objectives from the contract ∴ A statement of expectations and capabilities of the SP
2	Service Level Contents (SLC)	*Specification of required service and service levels determined from business requirements.*	∴ A general description of the services required ∴ A detailed description of service categories and specific service elements
3	Process Ownership Plan (POP)	*Specification of key process owners with corresponding roles and responsibilities. Scope definition of the process owners' authority to plan, manage and evolve services.*	∴ Statement of processes directly involved by the service included in the agreement ∴ Statement of process ownership roles, authorities and responsibilities
4	Data Code of Conduct (DCC)	*Specification of boundaries for data storage locations (compliance). Identification of data access, change and deletion authorization.*	∴ Statement of data location exceptions ∴ Identification and specification of compliance aspects ∴ Statement of data access and change authorization ∴ Statement of data deletion protocols and procedures
Change Management characteristics			
5	Future Demand Management Plan (FDMP)	*Definition of planning process and desired methodologies for coping with change, innovations and contingencies that possibly influence service requirements.*	∴ Demand forecasting process ∴ Process and protocols for scheduling, costing and modifying agreements ∴ Process for technology advancements (scope improvement and technology refreshes/upgrades)
6	Feedback Plan (FP)	*Specification of desired approaches and attitudes toward better service delivery states within a deal, based on learning by doing.*	∴ Road map for an efficient feedback on predetermined parameters ∴ Desired prioritization methodology for tasks and feedbacks
Governance characteristics			
7	Communication Plan (CP)	*The desired approach for disseminating contract related information to all of the parties involved in the relationship.*	∴ Identified SR communication initiative owners ∴ Identified SR's recipients for various communication initiatives ∴ Events for communication initiation
8	Measurement Charter (MC)	*What is desired to be measured and what are the desired measurement processes.*	∴ Definition of what is to be measured ∴ Definition of processes to periodically measure the defined categories ∴ *Interfaces with Feedback Plan*
9	Conflict Arbitration Plan (CAP)	*Specification of desired time windows for resolving issues that threaten business continuity.*	∴ Desired timetables for resolving issues with the SP
10	Exit Strategy Plan (ESP)	*What are the expected roles and responsibilities for the SP in case the engagement is discontinued.*	∴ Specification of desired exit roles and responsibilities for the SP ∴ Time schedule with time window boundaries regarding exit strategy activities ∴ Specification of conditions that cause the exit strategy to be invoked ∴ *Interfaces with Data Codes of Conduct*

Appendix X Private Cloud (B)SLA

	Private Cloud (B)SLA		
	Contractual element	***Contractual issues of SLA in Cloud Computing***	***Clauses in practice***
Foundation characteristics			
1	Service Level Objectives (SLO)	*Spirit of contractual solidarity and publicity of common values, belief, philosophy between organizations(SR and SP) to ensure performance.*	∴ A statement of both SR's and SP's business objectives from the engagement ∴ A statement of overall objectives from the contract
2	Service Level Contents (SLC)	*Specification of obligations in terms of a statement of work, the associated and required service levels, and the price windows to be paid into all sourcing agreements.*	∴ A general description of the services required, major categories of services and specific service elements ∴ A compilation of the most common service levels completed for each service level ∴ Service-level target, time frame definition, quality statement, etc.
3	Process Ownership Plan (POP)	*Number of companies taking part in some aspect of the IS portfolios when outsourced.*	∴ Statement of processes that are delivered via the agreement ∴ Statement of processes directly affected by the service(s) included in the agreement ∴ Statement of processes that are required to manage the agreement between SR and SP ∴ Statement of process ownership roles, authorities and responsibilities
4	Data Code of Conduct (DCC)	*Specification of boundaries for data storage locations (compliance). Identification of data access, change and deletion authorization.*	∴ Statement of data location exceptions ∴ Identification and specification of compliance topics ∴ Statement of data access and change authorization ∴ Statement of data deletion protocols and procedures
Change Management characteristics			
5	Future Demand Management Plan (FDMP)	*Planning process and methodologies for coping with change and contingencies in a long term engagement.*	∴ Joint (SR/SP) demand forecasting process ∴ Assumptions made and process for updating the key assumptions that affect demand ∴ Prioritization methodology for current and future demands ∴ Process for scheduling, costing and modifying agreements
6	Anticipated Change Plan (ACP)	*The joint development of expectations about perceived uncertainties, especially concerned with anticipated conflicts of interest and potential trouble*	∴ Clear definitions of the key categories of change ∴ Roles, responsibilities and decision-making procedures for the SR and SP for each category of change ∴ Top drivers for change – reviewed regularly
7	Feedback Plan (FP)	*Continuous processes for changing interfaces, approaches and attitudes toward better service delivery states within a deal based on learning by doing*	∴ Statement of how changes will be implemented based on measurement results ∴ The road map for an efficient feedback on the identified drawbacks ∴ Prioritization methodology for current tasks and feedbacks
8	Innovation Plan (IP)	*Cooperative innovation, especially joint efforts at continuous performance improvement and planning*	∴ Process for innovation, including implementation and prioritization ∴ Process for technology advancements (scope improvement and technology refreshes/upgrades) ∴ Business-measured innovation (business process improvement)

Governance Characteristics			
9	Communication Plan (CP)	*The approach for disseminating contract related information to all of the parties involved in the relationship through scheduled interaction and communication such as formal meeting and reporting*	∴ Organizational reporting structure ∴ Identified communication initiative(s) owner(s) ∴ Identified recipients for various communication initiatives ∴ Communication schedules and media
10	Measurement Charter (MC)	*Tactical measurements for calculating and reckoning of service performance as well as success metrics derived from the SR's strategic plan*	∴ Statement of measurement methodology ∴ Definition of what is to be measured ∴ Definition of processes to periodically measure the defined categories ∴ *Interfaces with feedback plan*
11	Conflict Arbitration Plan (CAP)	*Balance of power that imposes one's will on others*	∴ A statement of the parameters for involving third party in discussions between SR and SP ∴ Process descriptions to determine how the parties interact ∴ A schedule for regular interactions between the parties, and timetables for resolving issues between the SR and SP ∴ A statement of the practices and conduct rules to required to preserve the independence of the independent advisor
12	Enforcement Plan (EP)	*Sharing of benefits and burdens; Carrot-and-stick*	∴ Penalty/reward definitions and formula ∴ Detailed list of all penalty assumptions ∴ Detailed list of all reward assumptions
13	Exit Strategy Plan (ESP)	*Specification of exit roles and responsibilities for SR and SP including time schedule and conditions under which the exit strategy may be invoked*	∴ Specification of exit roles and responsibilities for SR and SP ∴ Time schedule with details about exit strategy activities ∴ Specification of conditions that cause the exit strategy to be invoked ∴ *Interfaces with Data Codes of Conduct*

Appendix XI Importance Scores

Table 8 (U)SLA importance results

Public cloud (U)SLA													
Category	**Element**	**Individual Importance**						**Relative Importance**					
		Raw scores				Average	STDEV	Raw scores				Average	STDEV
Foundation Characteristics	*Service Level Objectives*	2	3	2	3	**3**	0,58	4	4	3	4	**4**	0,50
	Service Level Contents	2	5	5	5	**4**	1,50	1	2	1	1	**1**	0,50
	Process Ownership Plan	1	5	3	5	**4**	1,91	2	3	4	3	**3**	0,82
	Data Code of Conduct	3	5	5	4	**4**	0,96	3	1	2	2	**2**	0,82
Change Management Characteristics	*Future Demand Management Plan*	3	4	4	3	**4**	0,58	1	1	2	1	**1**	0,50
	Feedback Plan	1	4	2	4	**3**	1,50	2	2	1	2	**2**	0,50
Governance Characteristics	*Communication Plan*	3	4	3	5	**4**	0,96	4	4	4	4	**4**	0,00
	Measurement Charter	4	5	4	5	**5**	0,58	1	1	1	2	**1**	0,50
	Conflict Arbitration Plan	4	5	4	4	**4**	0,50	3	2	3	3	**3**	0,50
	Exit Strategy Plan	3	5	5	4	**4**	0,96	2	3	2	1	**2**	0,82
	Average Interviewee rating	2,60	4,50	3,70	4,20	**3,75**							

Table 9 (B)SLA importance results

Private Cloud (B)SLA													
Category	**Element**	**Individual Importance**						**Relative Importance**					
		Raw scores				Average	STDEV	Raw scores				Average	STDEV
Foundation Characteristics	*Service Level Objectives*	2	3	5	4	**4**	1,29	4	4	3	3	**4**	0,58
	Service Level Contents	4	5	5	5	**5**	0,50	1	1	1	1	**1**	0,00
	Process Ownership Plan	2	4	3	3	**3**	0,82	3	3	4	4	**3**	0,58
	Data Code of Conduct	4	4	5	5	**5**	0,58	2	2	2	2	**2**	0,00
Change Management Characteristics	*Future Demand Management Plan*	4	4	5	4	**4**	0,50	4	1	3	1	**2**	1,50
	Anticipated Change Plan	3	4	5	4	**4**	0,82	2	2	1	2	**2**	0,50
	Feedback Plan	2	5	4	3	**4**	1,29	1	3	2	4	**3**	1,29
	Innovation Plan	1	4	4	3	**3**	1,41	3	4	4	3	**4**	0,58

Governance Characteristics	*Communication Plan*	3	5	5	4	**4**	0,96	5	4	4	2	**4**	1,26
	Measurement Charter	5	5	4	5	**5**	0,50	1	1	1	1	**1**	0,00
	Conflict Arbitration Plan	2	5	4	4	**4**	1,26	4	5	5	4	**5**	0,58
	Enforcement Plan	4	5	5	3	**4**	0,96	2	3	2	5	**3**	1,41
	Exit Strategy Plan	5	5	5	4	**5**	0,50	3	2	3	3	**3**	0,50
	Average interviewee rating	3,15	4,46	4,54	3,92	**4,02**							

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