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Green IS in Infrastructure Software

A study on the adoption of aspects of Green IS in retail and manufacturing organizations

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Abstract:
As the world is becoming a more connected place, organizations become more dependent on infrastructure software such as operating systems and middleware. Infrastructure software and the hardware it is operated on consumes a lot of electricity and in a world where the climate threat is increasingly imminent, aspects of Green IS are more relevant than ever. There are a lot of research done on the characteristics of Green IS but not so much on what is practically adopted, especially not within organizations whose main industry is not IT. In this study, we examine to what extent retail and manufacturing organizations adopt aspects of Green IS to increase their impact on environmental sustainability. Four infrastructure software platforms were surveyed through four group interviews with a total of 25 participants, on their platform's adoption of five Green IS aspects. We found that virtualization and cloud computing as well as efficiency and optimization are well adopted aspects, where automation and monitoring and KPIs are not as prominent. The last aspect, data growth management, was in all cases very little or not at all adopted.

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1 Introduction

With the introduction of information technology (IT), information systems (IS) and consequently the internet, into the human toolbox of conducting business, the world is increasingly becoming a more connected place as information communication technology advancements and investments are on the rise (Stamford, 2013). With the collective expansion and evolvement of the global digital infrastructure there is an increased demand in being able to swiftly create, transmit, receive and read data across the globe; a business's digital infrastructure has shifted from being a business option to becoming a business necessity (Woroch, 2000; Tilson, Lyytinen & Sørensen, 2010). Thus, an organization's IT department has over the past years shifted from functioning as a business support system to becoming a business driver and is now considered as an essential and prioritized component of a business strategy (Henfridsson & Lind, 2014). There are several practical examples of this transformation, such as traditional retail and manufacturing companies and their increased adoption and implementation of E-commerce solutions and transition to online sales, as well as the existence of companies who are operating without physical retail locations and solely base their retailing activities online (Zhu, 2004). This puts new requirements on an organization's digital infrastructure which, depending on the organization's digital processes, digital proportions and digital maturity, either is insourced and operated by the business itself or outsourced and operated by a third party infrastructure provider (Zhu, 2004). Companies utilizing digital infrastructure to conduct business and daily operations are at the mercy of the infrastructures overall performance and thus consequently the performance of each infrastructure subset component (Henfridsson & Lind, 2014).

Infrastructure software such as operating systems and middleware is traditionally operated with hardware equipment residing in a data center, a facility with the purpose of providing storage, electricity and cooling to hardware housed and operated within (Al-Fares, Loukissas & Vahdat, 2008). These hardware components are primarily servers, a headless computer traditionally with the primary task of hosting and running a software service or process (Al-Fares et al., 2008). Other vital hardware components traditionally housed in a data center are routers, switches and hubs which handle the communication between the data center's servers and the outside world (Al-Fares et al., 2008). With all this technology housed under one roof, there are additional hardware components required to safely and reliably operate the data center (Camarinha-Matos & Afsarmanesh, 2003; Uddin & Rahman, 2012). These are responsible for various types of measurements such as temperature, energy consumption and systems for cooling and regulating voltage input as well as battery backup systems (Camarinha-Matos & Afsarmanesh, 2003; Uddin & Rahman, 2012). Data centers must be redundant, meaning that there should be multiple backups ready to take the load if a certain component fail or if there is a sudden drop in supplied electricity and thus data centers are usually fitted with external diesel engines ready to be booted up with the purpose of fueling the data center (Camarinha-Matos & Afsarmanesh, 2003; Bhattacharya, Culler, Kansal, Govindan & Sankar, 2013). Given the immense number of components required to reliably operate an infrastructure setup, data centers are large structures and traditionally make out complete buildings spanning several acres of land and thus forming a sizeable footprint (Camarinha-Matos & Afsarmanesh, 2003; Gabrys, 2014). With business demands driving IS expansions, more and more organizations invest in IS services and solutions and with the cloud, a technical framework enabling off-premise on-demand computing services, more and more data centers are being built today than ever before (Research & Markets, 2014). Furthermore, the data center industry is expecting a compound annual growth rate of 4.18 percent from 2014 until 2019, a growth rate that is noticeable all over the world and in Sweden,

for example, both Facebook and Google have built, or are in the process of building, large data centers (The Next Web, 2011; Research & Markets, 2014; NCC, 2013; DI Digital, 2016).

However, the organizations currently holding ownership of the most data centers are infrastructure and cloud services providers as businesses increasingly see value in the utilization of vendor infrastructure rather than purchasing and operating their own data centers (Camarinha-Matos & Afsarmanesh, 2003; Zhang, Cheng & Boutaba, 2010). But if an organization is big and digitally mature enough there are other aspects of value in the management and operation of internal data centers such as cost efficiency, reliability, security and operational and technical flexibility (Camarinha-Matos & Afsarmanesh, 2003). Data centers are large investments not only in terms of the sheer scale of the constructed building but also in terms of the acquisition of hardware equipment needed to reliably operate the facility (Uddin, Rahman, Shah & Memon, 2012). Given the size of a data center and the components housed and operated within, one can assume that the size of the electricity bill is significant (Uddin et al., 2012). As successful companies, i.e. companies making annual profits, today tend to be cost aware with strategy goals such as cost efficiency as an integral part of their business strategy (Henfridsson & Lind, 2014), aspects of operating data centers is no different and organizations thus tend to strive for operating their data centers as efficiently as possible. However, the primary purpose of a data center is always going to be centered on operational aspects such a network speed and efficiency as well as uptime and availability (Camarinha-Matos & Afsarmanesh, 2003). At the altar of reliability, availability and performance, factors primarily driven by business interests and decisions, aspects of energy efficiency and environmental sustainability are sacrificed (Henfridsson & Lind, 2014).

1.1 Problem Area

Since the first global world temperature measurement performed by NASA Earth Observatory 136 years ago, July of 2016 was the hottest month of the hottest year yet in the entire history of mankind (earthobservatory.nasa.gov, 2016). There is little dispute regarding the fact that humans and the industrial revolution has had a significant impact on this planet, its environment and the ecological activities (Cox, Betts, Jones, Spall & Totterdell, 2000; Root, Price, Hall, Schneider, Rosenzweig & Pounds, 2003). The collective effects that mankind has had, and will have, is caused by the emission of carbon gases, a natural element of our planet's ecological life cycle, but which in excessive amounts cause more extreme weather ultimately resulting in drought, famine, melting icecaps and consequently increased water levels (Root et al., 2003). Just like anything else that consume electricity, data centers and its underlying infrastructure software have their fair stake in the emittance of greenhouse gasses and with the data center industry's expected compound annual growth rate of 4.18 percent, this stake is expected to increase (Research & Markets, 2014). According to the United States of America's Department of Energy (2015), out of the country's yearly power consumption a total of two percent is accredited to powering data centers. From a global perspective, Koomey (2007) accredited data center's yearly global power consumption to an equal two percent. While this number might appear small in comparison to other pollutants such as vehicles with combustion engines or the meat industry, it is not insignificant as data centers houses thousands of hardware components consuming the same amount of electricity as a typical smaller western city (Koomey, 2011).

Not only do inefficient data centers harm the environment, they are also costly from an economical perspective (Vykoukal, Wolf & Beck, 2009). Increased energy consumption translates

into increased energy costs, as argued by Vykoukal et al. (2009) and the operational performance limit of a data center also in many ways define the performance limit of the business (Henfridsson & Lind, 2014). For example, an organization that is operating on inefficient digital infrastructure is directly impacted from an information systems efficiency perspective and thus from an organizational perspective (Henfridsson & Lind, 2014). Slower software processes take longer time to execute and thus consequently consume more power by not allowing other executions to take place (Henfridsson & Lind, 2014). With data centers consuming tremendous amounts of energy, as according to Uddin and Abdul (2011) and Research and Markets (2014), in a world that is already under heavy environmental stress, the interest in constructing efficient data centers with efficient processes, a green profile and with a low or non-existing impact on the environment is a necessity for an organization to combat climate change as well as to remain competitive. According to Vykoukal et al. (2009), the increase in IS related emissions has consequently led to an industrial and societal increase in the interest of building and operating data centers in a more environmentally sustainable way, as well as an overall interest increase in Green IS. This increase is however not enough and with the climate threat spiraling out of control more efforts are required on every front in order to combat climate change and data center construction and operations are no exception (Uddin & Rahman., 2011).

While there is a lot of research performed investigating the characteristics of environmentally sustainable software, for example aspects of Green IS and why organizations could benefit from adopting Green IS practices (Chen, Boudreau & Watson, 2008; Chen, Watson, Boudreau & Karahanna, 2009; Watson, Boudreau & Chen, 2010), there is a lack in research performed in regards to uncovering to what extent aspects of Green IS are adopted in infrastructure software and how it impacts aspects of environmental sustainability, which is supported by Koçak (2013). It proves especially difficult to find research on this within organizations whose primary industry is not IT but who are still heavily involved in IT operations as of being dependant on large internal infrastructure software to operate their business. Therefore, the research problem of this study is that there is lacking knowledge in understanding to what extent aspects of Green IS is being adopted within organizations whose primary industry is not IT and who are dependent on large internal infrastructure software. For example, when reviewing sustainability reports produced by IT companies such as Google, Microsoft and Facebook there is clear and detailed information about what they are doing in regards to the environmental sustainability impact of their data centers and infrastructure software (Google, 2016; Microsoft.com, 2017; Sustainability.fb.com; 2017). But when reviewing sustainability reports from retail and manufacturing companies such as Volvo, H&M and Tetra Pak, there is none or very little information about how they are working towards decreasing their environmental sustainability impact in regards to their IT operations in the infrastructure software (Volvo, 2016; H&M, 2016; Tetra Pak, 2016).

1.2 Research Question

To what extent do retail and manufacturing companies adopt aspects of Green IS in their infrastructure software to increase their impact on environmental sustainability?

1.3 Purpose

Green IS and environmental sustainability are well known acronyms for describing how an organization can operate their infrastructure software engagements without negatively impacting environmental sustainability (Murugesan & Gangadharan, 2012). IT is a vital function in many organizations today and a business area that is rapidly expanding and evolving (Woroch, 2000; Tilson et al., 2010; Henfridsson & Lind, 2014). Academic literature has so far focused on studying definitions and aspects of Green IS and characteristics of sustainable IT but has not with the same depth studied to what extent these aspects and characteristics have been practically adopted in real world organizations (Molla, Cooper & Pittayachawan, 2009). It is especially difficult to find research on the extent of Green IS adoption amongst organizations whose primary industry is not IT but who are still heavily involved in IT operations as of being dependant on large internal infrastructure software to operate their business, which suggests that there is a lack in research on this topic. For example, when reviewing the sustainability reports of retail and manufacturing organizations in comparison to IT companies it becomes apparent that there within retail and manufacturing organizations is a lack of focus in regards to the impact the organization's infrastructure software has on environmental sustainability. Thus, the purpose of this study is to aid informatics researchers in uncovering to what extent Green IS academia is practically applied within retail and manufacturing organizations and thus bridging the gap between research and practice. Our ambition is to have our findings serve as indicators for which aspects of Green IS that are more prominent than others within retail and manufacturing organizations and consequently which aspects of Green IS that are more widely adopted and which that prove more challenging.

1.4 Delimitation

The study will investigate environmental sustainability in relation to infrastructure software and its electricity consumption. Electricity consumption is affected by two primary sources, software process efficiency and hardware efficiency. No other aspects of environmental sustainability will be included. Since there according to Ijab, Molla, Kassahun and Teoh (2010) is a discrepancy issue within today's academia in regards to the defining term for environmental sustainability in information systems, we will in this study consolidate the terms Green IT, Green ICT, Green IT/IS and Sustainable IS as "Green IS". This is in accordance with Ijab et al. (2010) who argues that these conundrums of various terms may serve to impose confusion and ambiguity in regards to the practice and theory of Green IS since the constitution of the "greenness" in these terms, and in the article who defines them, are largely elusive. In regards to infrastructure software, the study is delimited to operating systems and middleware, i.e. software that is managing computer hardware, software resources and is providing common services for software applications. While there are more technical components involved in the operation of an organization's complete digital infrastructure, these will not be part of this study. In terms of studied organizations, this study is delimited to companies whose primary industry is retail and manufacturing as these are companies whose primary industry is consequently not IT. The organization's size and geographical work area is delimited to big and global organizations. Lastly, the theoretical lens used to study the organization is delimited to the Sustainability SWOT Analysis Framework, as the framework will serve as an indicator of adoption maturity in regards to Green IS aspects. Consequently, the framework is limited to strengths, weaknesses, opportunities and threats from an environmental sustainability perspective, no other perspectives will be included.

2 Theoretical Background

In order to fully comprehend infrastructure software in relation to aspects of Green IS it is necessary to provide a comprehensive definition of this study's technical perspective, what the studied infrastructure software's purpose is and how it functions as well as an understanding of environmental sustainability, motivational factors for becoming environmentally sustainable and which, and in what way, Green IS aspects can be applied to infrastructure software. The environmental sustainability topics in this chapter span from an environmental sustainability definition, its importance and how to evaluate environmental sustainability in relation to infrastructure software. The technical topic covers the definition of infrastructure software as well as Green IS and a compilation of Green IS aspects as defined by previous research.

2.1 Sustainability

2.1.1 Sustainability Definition

Sustainability as a concept was first defined in 1987 by the Brundtland Commission, who deemed the term sustainability as "a development within a context that is sustainable by meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987). While the term sustainability traditionally implies an environmental context, the Brundtland Commission (1987) is not tied to a certain context but can also be contained in a social, financial or organizational context with the same implications which is aligned with what Hansen, Grosse-Dunker and Reichwald (2009) writes. For example, while the definition of a sustainable environment implies an environmental context and thus an ecological system which can provide for humans now but will also be able to provide for humans in the future, sustainability in a financial context implies responsible investments so that investments cannot only be made now but also in the future (Hansen et al., 2009). A sustainable organization is an organization whose activities, for example daily operations and short and long term goals, do not affect the environment in which it operates (Costanza & Patten, 1995; Hansen et al., 2009). As mankind have become more and more aware of its global impact on the environment, organizational sustainability has shifted from being a non-existent term to a cornerstone in many leading companies and their business strategies today (Jamieson, 1998). This shift in organizational strategy and behaviour has however not been instant, but instead seen an exponentially increasing adoption rate from the point where the effects of the industrialism began being measured (Nidumolu, Prahalad & Rangaswami, 2009).

As the year of 2016 marks the hottest yet in human history (Earthobservatory.nasa.gov, 2016) beating the previous years and indicating a, in terms of global temperature, negative trend with a globally ever warmer climate, Earth Overshoot Day, the day indicating when the globe's yearly commodity supply has been depleted, occurs ever earlier (Earth Overshoot Day, 2016). There is very little dispute over the fact that humans to an extent are affecting the climate of this planet thus threatening its ecological stability (Root et al., 2003). However, according to Jamieson (1998), humans who tend to perceive sustainability efforts as an opportunity to revitalize technology or as a financial gain instead appreciate the environment and its sustainability for what it is: A necessary life support function essential to mankind.

2.1.2   Importance of Sustainability

2.1.2.1   Motivating Organization to Pursue Sustainability

Today the trend of Green IS is growing and the reason for this is due to the environmental impact that is cause by IT related operations and the problems organizations could solve with help of the IT in regards to the environment (Kuo & Dick, 2009). Further, according to Kuo and Dick (2009) the pressure against organizations to increase their sustainability impact is getting more significant and one reason for this organizational pressure could be because of today's dependency of IS. Therefore the energy and resource requirements gets higher, and with a higher electricity consumption the more notable the environmental footprint is (Kuo & Dick, 2009). In Sweden, companies must today file a sustainability report depending on the size of the organization. In this report the organization has to explain what they are doing to increase the sustainability impact (Regeringen.se, 2016; Regeringskansliet, 2016).

Furthermore, Kuo and Dick (2009) explains that the motivation for organizations to have environmental responsiveness is because it provides to the competitiveness, legislation and social responsibility. The area of competitiveness is more in regards to the aspects of reducing costs by working more efficiently (Kuo & Dick, 2009) but to work in this way also create a long term profitability which is also argued by Bansal and Roth, (2000). It could be about controlling and manage energy, waste and green products. Working in this way does not only provide an organization to have an environmental sustainability responsibility, it also creates a competitive advantage because of the visibility of what the organizations is doing which in turn can generate positive reputation (Bansal & Roth, 2000). However, in some cases organizations choose to focus on sustainability just because of the legislation (Kuo & Dick, 2009). Pressure of regulations, stakeholders, governmental or local communities could influence the survival of an organization (Bansal & Roth, 2000; Kuo & Dick, 2009).

Another aspect of a motivational factor that is not related to legislation or social responsibility is the fact that sustainability investments from a technical perspective often tend to be perceived as a sustainable long-term investment from a financial standpoint (Uddin et al., 2012). For example, an important characteristic of sustainable infrastructure is power efficiency, which means that a sustainability investment to lower the power consumption of a technical component, such as virtualization, also acts as a financial investment since less power consumption from a financial perspective translates into a less costly electricity bill (Uddin et al., 2012). According to Jamieson (1998), companies no longer perceive sustainability as a legislated must but instead consider it as an ethical, societal and financial opportunity to improve.

2.1.2.2   Corporate Social Responsibility

The definition of corporate social responsibility (CSR) and sustainability have throughout its history been vague, but today when organizations talk about CSR and sustainability they refers to the social and environmental issues experienced in today (Montiel, 2008). Montiel (2008) means that the definition of these terms is somewhat unclear and therefore it is may be difficult for organizations to focus and understand the meaning of it. There is different definitions of CSR depending on the research, sometimes researchers focus on only one subject and sometimes they combine many aspects as one subject (Montiel, 2008).

Being CSR compliant is important for organizations today, even though Montiel (2008) argued for the vague meaning of it, which is also supported by Carroll and Shabana (2010). The term includes areas and concepts of business, ethics, stakeholder and sustainability and in the academic world there is a lot of written articles of its subject and concepts (Carroll & Shabana,

2010). However, in the end everything has the same theme and significant meanings such as value, balance and accountability (Carroll & Shabana, 2010).

Carroll and Shabana (2010) writes that the definition of CSR has been changing since the World War II, and the concepts and meaning of CSR have been developed with time and world events. Today, the arguments of being CSR compliant is that organizations should take responsibility towards their workers, communities and stakeholders, but also for society (Carroll & Shabana, 2010). These types of initiatives are supported by the public, i.e. the fact that organizations have a responsibility in regards to contributing to a better world, even though the organization needs make sacrifices to get it done (Carroll & Shabana, 2010). According to Kuo and Dick (2009), it is rare that a company's interest to invest in matters of sustainability is solely connected to a strictly organizational motivation in the resolvement of issues, compliancy, profitability or appeasement of external parties but that instead the more common motivation of such engagements are sourced from the motivations of the employees of the company. This indicates that pure sustainability engagements are often socially or morally motivated, which of course must be considered as good (Kuo & Dick, 2009; Carroll & Shabana, 2010). However, the rapid ethical shift that is required for organizations to make in order to increase their sustainability impact cannot only rely on the will of the employee but must impregnate the entire organizational culture (Kuo & Dick, 2009).

2.1.3 Evaluating Sustainability

2.1.3.1 The SWOT Framework
SWOT, an acronym that stands for strengths, weaknesses, opportunities and threats, is a structured planning framework that enables organizations to evaluate these four perspective in relation to a certain engagement within the organization (Ghazinoory, Abdi & Azadegan-Mehr, 2011). This engagement can either be part of a business model, such as a specific strategy, or a project with a certain goal in which the organization has an interest in (Ghazinoory et al., 2011). A SWOT analysis can serve as an indication of whether or not an engagement will be successful as the framework allows for identification of which variables that are favorable or unfavorable in relation to the posed engagement (Ghazinoory et al., 2011). The SWOT framework is structured as a matrix with two rows and two columns and where each of the four cells are designated to one of the four perspective (Ghazinoory et al., 2011). Strengths indicate the characteristics of the engagement that enables superiority and competitiveness over others as weaknesses indicate the characteristics of the engagement that play to the organization's disadvantages compared to others (Ghazinoory et al., 2011). Opportunities describe those characteristics of which the organization has an opportunity to exploit in order to gain an advantage relative to others, essentially elements that can be turned into strengths (Ghazinoory et al., 2011). Lastly, threats define those characteristics that an organization directly cannot impact as they are represented by external forces which could cause harm or trouble for the posed engagement (Ghazinoory et al., 2011).

While the origin of the SWOT remains somewhat unknown as argued by Ghazinoory et al. (2011), the SWOT framework is one of the most commonly known and applied frameworks within organizations today. Its benefits are derived from its ease of use and its principles allow a team within an organization to quickly get an understanding of whether an objective is obtainable or not (Ghazinoory et al., 2011). However, due to its seeming simplicity, critiques imply that findings made in SWOT analyses are rarely used within later stages of projects in which it was introduced and that these findings are often simplified and misrepresent reality (Ghazinoory et al., 2011).

2.1.3.2 The Sustainability SWOT

The Sustainability SWOT, from now on abbreviated as sSWOT, is an analysis framework used by organizations for analyzing their maturity in relation to a form of sustainability such as societal sustainability, financial sustainability or environmental sustainability (Metzger, Putt del Pino, Prowitt, Goodward & Perera, 2012). To evaluate environmental sustainability, the sSWOT could therefore act as a lens for an organization to target its environmental sustainability strengths, weaknesses, opportunities and threats (Metzger et al., 2012). The sSWOT can provide deep and rich insight in terms of achieving awareness and an understanding of the organization's position in relation to environmental sustainability (Metzger et al., 2012). An sSWOT analysis can also provide the organization with strategies to achieve higher corporate social responsibility in terms of environmental sustainability (Metzger et al., 2012). This is supported by Pesonen and Horn (2012) who argues that an sSWOT analysis could be used as a tool for organizations to brainstorm regarding their environmental sustainability.

Even though the sSWOT anaysis is based on a relatively old model, it is still considered as very usable because of its ability to target the adequate areas of environmental sustainability allowing for ease of planning from a strategic perspective in terms of achieving potentially identified opportunities (Pesonen & Horn 2012). Using the sSWOT analysis as a theoretical lens contributes an organization with an overview of what is being done well in regards to environmental sustainability but also in regards to what things that needs to changed or to be better in the future (Azapagic, 2003; Metzger et al., 2012). With this said, an organization can with help of an sSWOT analysis as a theoretical lens gain insight into which of its organizational attributes must change, are considered as threats, are lacking or is accomplishing in regards to environmental sustainability (Pesonen & Horn 2012).

Table 2.1 Example Summary of an Environmental Sustainability SWOT (Azapagic, 2003)

Strengths: Characteristics of the organization that has a positive impact on environmental sustainability	**Weaknesses:** Characteristics of the organization that has a negative impact on environmental sustainability
Opportunities: Elements that the organization can adopt to have a positive impact on environmental sustainability	**Threats:** Elements that can cause the organization to have a negative impact on environmental sustainability

According to Azapagic (2003), when organizations is using the sSWOT framework for analyzing their organizational sustainability, the aspects of environmental, economic and social could also be considered because they affect each other in some cases. However, the sSWOT framework is also subject to target a specific area, such as environmental sustainability (Azapagic, 2003).

2.2 Infrastructure Software

2.2.1 Definition of Infrastructure Software

Infrastructure software is defined as platforms and working softwares such as operating systems, compilers and middleware, i.e. software that is managing computer hardware, software resources and is providing common services for software applications (Schmidt & Porter, 2001; Schirmeier & Spinczyk, 2007; Barroso, Clidaras & Hölzle, 2013). An operating system is a software artefact which manages computational hardware and software and ultimately coordinates these to provide the most common and basic services for computer applications (Rosenblum, Bugnion, Herrod, Witchel & Gupta, 1995). Middleware, often described as "software glue", is layered between the operating system and an application and provides services to software applications that the operating system alone cannot offer (Hadim & Mohamed, 2006). Database management softwares are also included in the definition of infrastructure software (Schirmeier & Spinczyk, 2007).

2.2.2 Operating Systems

An operating systems is a standardized platform consisting of many layers of softwares working together with the purpose of managing computational processes and resources (Tanenbaum, 2009). There are many different operating systems in use today such as the Windows, Linux, FreeBSD and macOS platforms (Tanenbaum, 2009). The operating systems is running in a kernel mode, a mode which means that the operating system has access to the all hardware components and can execute instructions depending on the hardware's capabilities (Tanenbaum, 2009). Another mode is the user-mode which allows applications and softwares working through a user interface enabling the user to give instructions to the operating system through a set of controls (Tanenbaum, 2009). The operating system's job is essentially to manage the resources in an orderly fashion and through allocated processors, memories, and I/O devices (Tanenbaum, 2009).

Operating systems running in data centers are called mainframes, or server operating systems, and has the task to coordinate multiple processes and job queries at once, resulting in big requirements for I/O processing (Tanenbaum, 2009). Server operating systems typically provide a data center with three basic services such as batching, transaction processing and time sharing (Tanenbaum, 2009). Batching provides enables processing routines and execution of the right process at the right time without the need of a present user (Tanenbaum, 2009). A transaction processing system takes care of a large number of requests as there could be hundreds or thousands requests per second (Tanenbaum, 2009). Lastly, time sharing allows multiple remote users to utilize the computational device and run several jobs at once, which for example can have an impact on a database in terms of querying (Tanenbaum, 2009). A server operating system can also facilitate with print services, file services or web services (Tanenbaum, 2009).

2.2.3 Middleware

Middleware is defined as a software layer that is operating on top of the operating system and is contributing with data structure and various operational resources (Tanenbaum, 2009). There are many different types of middleware platforms with varying contributions to the operating

system in terms of offered services (Tanenbaum, 2009). One example is document-based middleware, which is protocols and unique URLs with DNS which in this case would be a name containing a file, very similar to typical web services, showing graphs of documents or pointing to other documents (Tanenbaum, 2009). Another example is file-system based middleware for a distributed system, for example a global file system, which allows the users to read and write files with specific authorities (Tanenbaum, 2009). Lastly, another example is object-based middleware which servers as objects in terms of documents and files to invoke operations toward servers and client machines (Tanenbaum, 2009). In many instances, middleware is talked and written about in association with operating systems even though it is not a proper operating system platform per Tanenbaum's (2009) definition. This is why the term infrastructure software serves as a proper umbrella term (Schmidt & Porter, 2001; Schirmeier & Spinczyk, 2007). As Tanenbaum (2009) states, middleware can be different things, because it is a software layer on top of the operating system. According Schirmeier and Spinczyk (2007), middleware could also be databases, which is line with for example the Oracle platform which provides databases as middleware software (Greenwald, Stackowiak & Stern, 2013).

2.3 Green IS

Green IS is according to Murugesan and Gangadharan (2012) defined as the practice of environmentally sustainable IT and IS operations. Murugesan and Gangadharan (2012) aligns this definition with the previously mentioned Brundtland Commission (1987) sustainability definition whereas Green IS contains the practice of designing, using and disposing of hardware and software components in such a way that it has minimal or no impact on the environment. Green IS also includes topics of software processes and their hardware utilization with the purpose of optimizing the workflow, this ultimately seeking to minimize processing power in order to consume as little electricity as possible (Murugesan & Gangadharan, 2012). With an increased awareness in matters of environmental sustainability as according to Root et al. (2003), the industrial and societal interest in Green IS has seen an increase as there are a multitude of different aspects in regards to how Green IS can impact an organization's IS related operations. One of the more prominent technologies which defines the type of positive environmental sustainability impact Green IS can have is Grid Technology, a design principle with the purpose of reducing idle hardware by distributing processing power (Murugesan & Gangadharan, 2012). Another technology that is covered by Green IS is monitoring tooling software with the purpose of analyzing and visualizing performance at application, hardware or data center level in order to better understand variables of performance and power consumption efficiency (Murugesan & Gangadharan, 2012). According to Kuo and Dick (2009), which is also supported by Hovorka, Labajo and Auerbach (2011), it is highly important for organizations to realise that systematized utilization and continuous optimization of software processes in IS greatly can aid and positively impact efforts of becoming more environmentally sustainable. Green IS is according to Butler & Daly (2009) included in some of organizations CSR practices. However, those companies that define Green IS in their CSR practice had the triple-bottom-line framework which the organization uses to depict their social and environmental responsibilities (Butler & Daly, 2009).

There is lot of research done on the characteristics of Green IS and according to these articles, Green IS is made up of several different aspects that address different areas of how software and hardware impacts environmental sustainability (Chen et al., 2008; Chen et al., 2009; Watson et al., 2011) and when reviewing these articles and their content, five prominent aspects

emerge. These five aspects concern efficiency and optimization, virtualization and cloud computing, automation, monitoring and KPIs and data growth management and are all argued to have a very significant impact on aspects of environmental sustainability (Chen et al., 2008; Chen et al., 2009; Watson et al., 2011).

2.3.1 Efficiency and Optimization

Data centers are traditionally not commonly associated with sustainability due to the sheer amount of electricity that is required for operating the vast number of hardware components such as servers, network equipment and surrounding systems housed within (Al-Fares et al., 2008; Uddin & Rahman, 2012). According to Gao, Curtis, Wong and Keshav (2012), a study of Google's data centers showed that they alone consumed $2.26 * 10^6$ MWh in 2012 which is equivalent to the yearly pollution of 280 000 cars traveling 10 000 miles emitting a total of four tonnes of carbon dioxide gasses. Given the physical footprint of a data center, its power consumption is according to Gao et al. (2012) justified but putting its power consumption in relation to a real world example is an effective tool for raising awareness about environmentally sustainable data centers. The data center's power consumption is directly related to the efficiency of the infrastructure housed within and thus consequently also directly related to the efficiency of the software applications running on the infrastructure (Al-Fares et al., 2008). How optimized a piece of software is, regardless of whether it is an application or an operating system, thus in many ways can have an impact on electricity consumption (Koçak, 2013; Koçak, Miranskyy, Alptekin, Bener & Cialini, 2013). Therefore, a characteristic of sustainable infrastructure software is that it is optimized in such a way that its processes are operating as efficient as possible (Koçak, 2013; Koçak et al., 2013). This will consequently allow for the hardware it is running on to either operate at a lower pace requiring less electricity or to open up for more processing space on the housing CPU allowing for more computation to take place with a lower digital footprint (Koçak, 2013; Koçak et al., 2013). This will in the long end result in a lowered demand for physical footprint and consequently reduce the data center's requirement for physical hardware (Koçak, 2013; Koçak et al., 2013). An example of a typical issue that is closely related to infrastructure software and power consumption is dead servers, as according to Uddin and Rahman (2012). A dead server is a server that is idle and which currently lacks an operational purpose but is still plugged in and consuming electricity. According to Uddin and Rahman (2012) an average data center has roughly 30 percent idle hardware which from an environmental sustainability and cost perspective is a very serious issue. Vykoukal et al. (2009) supports this by highlighting that there are several examples of ill-optimized infrastructure causing large stock of idle hardware which over time racks up not only large electricity bills but large environment bills.

Another important aspect of Green IS and efficiency and optimization is lifecycle management (Chen et al., 2009; Tarnekar, 2011). LCM is the practice of actively renewing something's version as new and better instances of it becomes available and is relevant for software as well as hardware (Chen et al., 2009). LCM is usually considered as an organizational practice or policy, as stated by Chen et al. (2009) and should occur naturally for the sake of maintaining an increasingly efficient infrastructure software stock. According to Gangwani and Popli (2014), to be able to perform proper LCM, organizations needs to follow specific phases for the software where for example automation could be one such processes. Adequately managing and performing LCM helps organizations with data centers and infrastructure software to reduce its electricity consumption as continuously reviving and implementing new and efficient version of software lowers its footprint (Tarnekar, 2011).

2.3.2 Virtualization and Cloud computing

A common method for resolving issues with idle infrastructure is virtualization (Uddin & Abdul, 2011). Virtualization is a technology used for instantiating a virtual version of something rather than an actual version and can be applied to a wide span of different software and hardware areas but is most commonly used within desktop and server operating systems and network hardware (Bajgoric & Moon, 2009). In an infrastructure software context, virtualizing implies the ability to run several operating system instances on a single hardware platform, similar to how one can ship several containers of various content on a single boat (Bajgoric & Moon, 2009). For example, if an organization has an imminent requirement of a specific test environment on a specific platform, virtualization offers the possibility of very quickly instantiating this environment in a container and subsequently host it on a random server supporting virtualization (Xavier, Neves, Rossi, Ferreto, Lange & De Rose, 2013). However, if an organization with the same imminent requirement lacks the ability to virtualize they are forced to implement a dedicated physical server, effectively increasing the physical footprint through the use of more hardware (Celebic & Breu, 2015). Since virtualization essentially means dividing hardware resources into resource pools that can be easily utilized when there is an increased software demand, utilization of the technology directly impacts aspects of sustainability (Uddin & Abdul, 2011). As Xavier et al. (2013) points out, there are different types of virtualization with different impact on environmental sustainability. While for example a hypervisor is a type of virtualization that implements a completely isolated environment through VM software, container-based virtualization offers a lightweight version of a hypervisor by offering separate containers but by still using shared performance resources, all types of virtualization can in the long run be considered as environmentally sustainable as increased system agility implies the possibility of better utilization of hardware which in turns lowers physical hardware footprint (Xavier et al., 2013; Uddin & Abdul, 2011). Virtualization results in a decrease of operational complexity since infrastructure agility is increased, which ultimately to ease of maximizing utilization rate of hardware and reducing idle hardware stock which in turn leads to a lowered physical footprint and thereby lowered energy consumption (Uddin & Abdul, 2011).

According to Garg and Buyya (2012), cloud computing is a technology that is enabled through virtualization. Virtualized data centers and software as a service (SaaS) for organizations is what defines the cloud (Garg & Buyya, 2012). The benefits of using the cloud is that they enable high scalability and helps organizations not to worry about configuring and maintaining their own infrastructure (Garg & Buyya, 2012). Technologies such as resource virtualization and workload consolidation enables cloud computing to be energy efficient and therefore environmentally sustainable (Garg & Buyya, 2012). Also, cloud computing can decrease electricity consumption by server consolidation in terms of enabling different workloads to share the same physical virtualized host and also allowing for servers are currently without workload to either be powered down or even switched off (Garg & Buyya, 2012). Furthermore, consolidating servers that are underutilized with the help of multiple virtual machines by letting them share the same physical host at a higher utilization could result in organizations achieving a lower carbon footprint by moving their infrastructure software activities to the cloud (Garg & Buyya, 2012).

2.3.3 Automation

According to Chen et al. (2008), automation is defined as a process where information technology substitutes human effort by automating a task or procedure. Organizational IS is in many times considered as automation and cost reducing (Chen et al., 2008). With help of IS

automation organizations not only achieve efficiency of processes but it could also provide with long-term benefits (Chen et al., 2008). Even though automation directly does not result in enabling environmental sustainability, it has the ability which makes it considered as a Green IS aspect (Chen et al., 2008). Another perspective of how a Green IS automation perspective can contribute to a lowered electricity consumption is in regards to a host not being used and then automatically powered down or turned off (Paul & Gangulay, 2013). While automation in itself is not inherently energy efficient as the efficiency is the defined by a multitude of different factors, Rahman, Guo and Yi (2011) argue that automation through, for example scripting, can be environmentally sustainable as the developer can decide to either script automation processes for being power efficient or performance driven. With help of scripting organizations could also get an overview of their power consumption data (Greveler, Glösekötterz, Justusy & Loehr, 2012) and further get a control over the environmental footprint.

2.3.4   Monitoring and KPIs

An important aspect of Green IS and infrastructure software is the monitoring and analysis of KPIs (Key Performance Indicator) relevant for aspects of environmental sustainability (Celebic & Breu, 2015). Celebic and Breu (2015) argue that an organization's sustainability environment in relation to their IS operations must be actively monitored, analyzed and reviewed in order for an organization to effectively succeed and continuously improve their Green IS strategies, this is also supported by Loeser (2013) who emphasizes the importance of tracking and monitoring green KPIs and defines it as an integral part of a Green IS initiative. The authors essentially argue that even though an organization may very well be invested in Green IS initiatives and pro-actively working for a better sustainability impact, they must actively monitor, analyze and follow up their initiatives through the measurement of relevant KPIs in order to get an understanding of the impact of their Green IS initiatives (Celebic & Breu, 2015; Loeser, 2013; Kipp, Jiang & Salomie, 2012). There are several reasons, in excess to the obvious with an organization wanting to be able to track their engagements, as to why an organization would benefit from monitoring environment sustainability KPIs (Celebic & Breu, 2015).

For example, monitoring and measuring energy consumption in regular intervals can help identify irregular patterns of energy usage and thus allowing for diagnosing and problem identification (Bachour & Chasteen, 2010; Celebic & Breu, 2015). Furthermore, KPIs like these can help adaptation efforts in relation to power consumption irregularities such as allocation or capping of power, efficiency improvements in regards to electrical and cooling systems in data centers and increase service level automation (Celebic & Breu, 2015). Celebic and Breu (2015) has performed an extensive literature review and found several environmentally sustainable KPIs relevant for infrastructure software, KPIs that are considered as part of the information layer such as response time, energy aware application performance, throughput, availability rate and application performance indicators, which is aligned with Kipp et al. (2012). Monitoring and KPIs are an integral aspect of Green IS as they serve as continuous pointers for evaluating and further planning an organization's environmental sustainability strategy (Celebic & Breu, 2015; Loeser, 2013; Kipp et al., 2012). By continuously tracking, evaluating and improving environmental sustainability efforts related infrastructure software an organization has a greater chance of improving this aspect (Celebic & Breu, 2015; Loeser, 2013; Kipp et al., 2012; Bachour & Chasteen, 2010).

2.3.5 Data Growth Management

In the wake of a global civilization that is becoming more and more connected, more and more data is generated (Woroch, 2000; Hazas, Morley, Bates & Friday 2016). Since data within organizations today is commonly perceived as highly valuable, there is a widespread resistance towards uncontrolled data deletion (Woroch, 2000; Hazas et al., 2016). But when organizations stockpile data for which they have no direct use there is an obvious risk in terms of environmental sustainability as more data to store requires more data storing hardware thus increasing physical hardware footprints and consequently energy consumption (Uddin & Rahman, 2011; Koçak, 2013; Hazas et al., 2016). For this reason, a Green IS aspect of infrastructure software is to have clear data retention and management policies (Koçak, 2013). A data retention policy is essentially a plan of what, where, how and for how long data produced by software should be stored (Koçak, 2013). A data retention policy that can facilitate business needs but which also makes sure not to store data that is without purpose can be considered environmentally sustainable as it actively combats the issue of data growth (Koçak, 2013).

2.4 Aspects of Green IS

As a result of the literature review, five emerging aspects of Green IS have been identified. A table has been compiled with the purpose of highlighting the identified aspects, their key notions and its supporting literature.

Table 2.2 Aspects of Green IS and Supporting Literature

GREEN IS ASPECT	KEY NOTIONS OF ASPECT	SUPPORTING LITERATURE
Efficiency and Optimization	• Optimized infrastructure software enables lowered electricity consumption • Efficient infrastructure software • Reduction of high workload on data centers and infrastructure software • Proper LCM policies	(Al-Fare et al., 2008) (Vykoukal et al., 2009) (Chen et al., 2009) (Tarnekar, 2011) (Uddin & Rahman, 2012) (Gao et al., 2012) (Koçak, 2013) (Koçak et al., 2013)
Virtualization and Cloud Computing	• Lowered physical footprint (lowered hardware demands) • Enabling cloud computing • Higher utilization rates	(Bajgoric & Moon, 2009) (Uddin & Rahman, 2011) (Garg & Buyya, 2012) (Xavier et al., 2013) (Celebic & Breu, 2015)
Automation	• Reduce human interactions • Streamline processes and tasks	(Chen et al., 2008) (Boudreau & Watson, 2008) (Rahman et al., 2011) (Greveler et al., 2012) (Paul & Gangulay, 2013)
Monitoring and KPIs	• Enables learning and understanding • Enabled strategies for environmental sustainability • Highlights inefficient workloads	(Bachour & Chasteen, 2010) (Kipp et al., 2012) (Loeser, 2013) (Celebic & Breu, 2015)
Data Growth Management	• Storing unused data increases hardware footprint • Data retention policies enabled environmental sustainability	(Woroch, 2000) (Uddin & Rahman, 2011) (Koçak, 2013) (Hazas et al., 2016)

3 Research Method

In the following chapter we will describe the methodology used when conducting our research. The chapter serves to explain the overall research strategy and approach used when conducting the research, how we set out to collect data, designed the interview guide and the analysis techniques used. Finally, we will review ethical aspects and issues such as reliability, validity and bias and how related issues of these were mitigated.

3.1 Research Strategy

When choosing an adequate research strategy for this study we primarily considered to facilitate the collection of rich and relevant data that would aid our investigation. According to Eder and Gallagher (2017), people working within the IT industry tend to not perceive their line of work as impactful on matters of environmental sustainability. Eder and Gallagher (2017) argues that software engineers tend to miss out on correlating lacking efficiency of produced software to the negative impact inefficient software can have on aspects of environmental sustainability. Furthermore, while aspects of Green IS may be generally applied to any kind of infrastructure software, it can be difficult to fully grasp the specifics of a certain Green IS aspect adopted on a certain infrastructure software as the underlying platform technology can greatly vary. For these two reasons, we deemed it vital to speak directly to the interviewees in order to be able to utilize a semi-structured interview format, allowing us to interview on broad subjects with the option of investigating platform specific details. To facilitate this, we concluded that a qualitative approach would best suit our investigation as, according to Recker (2013), qualitative methods are designed with the purpose of assisting researchers with understanding a certain phenomenon in its context.

While we did initially consider the possibility of a quantitative approach, this was quickly ruled out primarily due to the mentioned issue of being unable to construct a quantitative collection method that would be able to consider the specifics of a certain platform technology. Being unable to collect accurate data would threaten the ability to generalize the findings of this study which in turn would question its quality, as argued by Kvale (1996). To continue, the issue of interviewees potentially not realizing how their work can influence aspects of environmental sustainability may result in questions of quantitative nature being completely misunderstood or ignored. Furthermore, according to Neuman (2014), quantitative studies are best suited for research questions where the answer is expected to be easily quantifiable and where the collected data is expected to be characterized by numerical fillings. Given the abstract characteristics of environmental sustainability and Green IS, we expected to collect data that was very rich in content but not easily quantifiable. This gives weight to not use a quantitative research approach, as argued by Neuman (2014).

3.2 Research Approach

Our research approach centers on unveiling what aspects of Green IS that are practically adopted, with the purpose of bridging the gap between academia and practice. We argue that this is an appropriate approach for this study as our intention was to clearly define the studied phenomena in a set of aspects through a thorough literature review and then investigate whether those aspects are practically adopted within a targeted, as per this study's delimitations, organization. As we do not seek to prove any hypothesis but rather explore and investigate a phenomena in a context which is supported by Kvale (1996), Yin (2006) and Ritchie and Lewis (2003), our approach seeks to provide incentives for which aspects of Green IS to further investigate in future studies.

3.3 Data Collection Technique

When deciding upon which data collection technique to perform our data collection with, we deemed interviewing as most suitable. This is in line with the research strategy as interviewing is one of the more common data collection techniques when performing a qualitative study, as argued by Ritchie and Lewis (2003). Given the complex nature of infrastructure software and the technical platforms there are commonly several people and professions involved in operating them (Ballejos & Montagna, 2008). As we wanted to collect as much and as rich data as possible, we deemed it necessary to collect the answers and opinions of anyone who had any stake in the operation of the platform, thus we decided to perform group interviews. A group interview, also known as a focus group, typically involves around six to eight people meeting and being interviewed at one instance (Ritchie & Lewis, 2003). When seeking complete responses, Ritchie and Lewis (2003) argues that group interviews and focus groups are likely to be able to provide a deep and complete data set useful for extracting empirical findings. In addition to this, the authors also argue that group interviews are the best method to resolve information that can be conflicting, as the researches has direct opportunity to detect and consequently investigate the apparent conflict (Ritchie & Lewis, 2003). Lastly, Ritchie and Lewis (2003) argues that group interviews are a good way to discuss issues at a strategic level and directing the conversation on underlying causes and possible solutions or ideas on how to mitigate these causes, since this study's identified Green IS aspects are abstract in nature this gives further weight to performing group interviews.

As our research purpose was to uncover what aspects of Green IS that are being practically adopted we deemed it necessary to utilize a theoretical lens with which we could evaluate an aspects degree of adoption. To facilitate this need we decided to use the sSWOT Analysis Framework as presented by Metzger et al. (2012) as we deemed it sufficient to identify the adoption state of an aspect as well as, since it requires the involvement of the interviewees, easily understandable and flexible enough to be introduced and understood during the group interview's introductory part. However, we also deemed it very likely that the multitude of the interviewees in some way had been in contact with a SWOT analysis earlier as this is, according to Pesonen and Horn (2012), a very commonly used framework within global organizations today and that there consequently in general would be none or very few complexities related to this as an sSWOT analysis is not very different from a normal SWOT analysis (Mertzger et al., 2012). An sSWOT analysis has its evaluating basis in environmental sustainability which means that one categorizes an organization's strengths, weaknesses, opportunities and threats in relation to environmental sustainability and a certain engagement environmental sustainabil-

ity engagement. By determining a platform's environmental sustainability strengths, weaknesses, opportunities and threats in relation to aspects of Green IS, we can render a good overall picture of the current state of the platform in relation to environmental sustainability and through this overall picture determine what aspects of Green IS that are more prominent and adopted than others, as this would be revealed through the organization considering one aspect as a strength, a weakness, an opportunity or a threat. In what way the sSWOT framework was used during the interview and used for data analysis will be explained in the interviewing and data analysis chapters.

3.4 Interview Guide Design

In light of Ritchie and Lewis (2003) and Kvale and Brinkmann (2009), we decided to perform a semi-structured interview and consequently designed a semi-structured interview guide with the purpose of having a rich conversation. This is in line with the qualitative nature of this research project as Kvale (1996) argues that qualitative interviews have open characteristics. Ritchie and Lewis (2003) argues that data collection through group interviews are less structured than interviewing one-on-one, partly since group discussions are more difficult to completely steer around a set structure but mainly since a key feature of group interviews is the emergence of data as a result of the groups interactions. Further, Kvale and Brinkmann (2009) argues that a semi-structured format is more suitable in regards to having a conversational approach. When designing the interview guide we consequently followed the tips and guidelines from Ritchie and Lewis (2003) in regards to creating a group interview guide which allow for easy data collection throughout the interview process. The interview guide questions were derived from the aspects and key aspect notions of table 2.2 found in the last subsection of the literature review and were open questions about each aspect that would seek to indicate whether or not a certain Green IS aspect were practically adopted and to what extent, with what technology and how the operation team thought that it could impact aspects of environmental sustainability. Thus, we mainly asked "how" and "what" questions rather than implying speculation and asking "why" questions, which is better suited to this study's qualitative research strategy as supported by Kvale and Brinkmann (2009). However, since different infrastructure system platforms has different underlying technology and structures, some questions were slightly adapted to better fit the interviewee's technical language and allow for us to in greater detail explore specific functionalities of a platform.
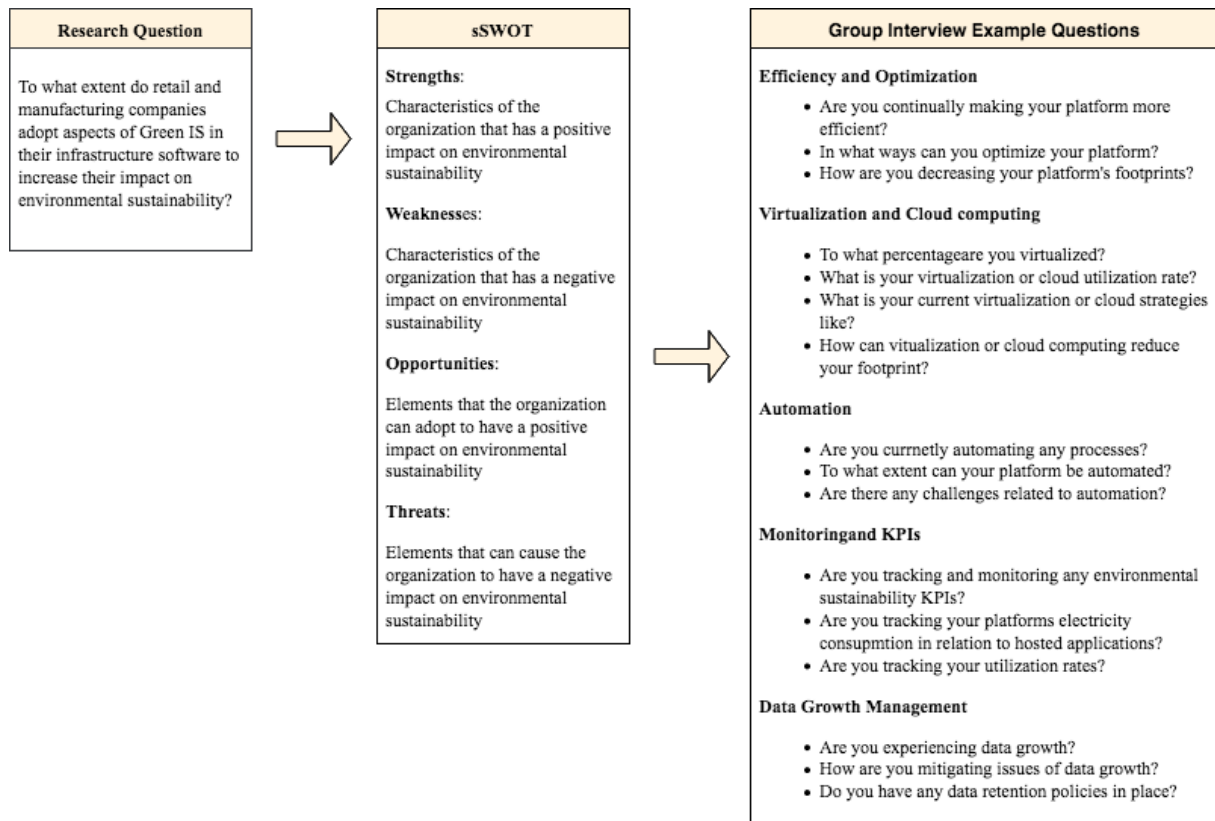
Figure 3.1: Overview and Example of the Interview Guide

The interview guide, as a result of the mentioned tips and guidelines, has been broken down into seven parts and are as follows:

Part 1: Introduction, presentation and warm up questions
This allowed us to explain that we were recording the group interview and that they were granted confidentiality, i.e. that no personal names or company names would be mentioned in the study. Furthermore we presented ourselves and gave an introduction of the research problem and the purpose of the research project. We then asked them to introduce themselves and what their role was. Then, to initiate the conversation we started with a few short warm up questions in relation to their daily operations and environmental sustainability.

Part 2: Efficiency and Optimization.
At this part we asked question and discussed topics in regards to how they were working with efficiency and optimization.

Part 3: Virtualization and Cloud computing.
This part covered question about virtualization and cloud computing. To what extent how they were achieving it and their perception of it having an impact on environmental sustainability.

Part 4: Automation
Part four was similar to part three where questions about automation was asked in regards to what extent, technologies used and how the team believed it could be affecting environmental sustainability.

Part 5: Monitoring and KPIs
In this part we asked if they were monitoring or tracking environmental sustainability KPIs regarding different aspect of environmental sustainability.

Part 6: Data Growth Management
The last group interview questions was in regards to how they are handling aspects of data growth management and how the impact of data growth on their platform might affect its impact of environmental sustainability.

Part 7: Closing questions and Debrief
When concluding the interview we asked if there was anything they wanted to add in regards to the aspects discussed. We also instructed that we upon completion of the transcript would distribute it to them for commenting or additions and lastly thanked them for their participation and time.

3.5 Context Selection

The context selection was performed based on several criteria derived from the research project's delimitations. As this study's research question revolves around the retail and manufacturing industry, naturally the targeted organization must have its primary source of income from retail and or manufacturing operations. Furthermore, the organization had to have a clearly stated ambition of environmental sustainability as a part of their overall business strategy. This was to make sure that the organization would be relevant for our study as there would be no point in studying an organization in regards to its adoption of aspects of Green IS if there were no presence of environmental sustainability within the strategies and or culture. A third and quite obvious criteria was that the organization in some way must IT and infrastructure software to in any way support their business operations. Lastly, the fourth criteria was that the organization had to be considered world leading within their industry and have a global presence in terms of locations where it operates and conducts business. The reason for this criteria is that the larger an organization is, the more likely it is to have a large infrastructure software is in regards to the number of platforms involved but also the number of people operating those platforms. Not only is a more comprising infrastructure software likely to have a bigger environmental sustainability impact as it requires more computing power and hosts to operate but it also allows for more nuances of Green IS aspects to be revealed, allowing us to study the phenomena in a context that would allow for a greater depth.

Due to the natural complexity of infrastructure software as a result of the many different technologies that can comprise it and in combination with this research project's limited time scope, we decided to target a single organization that meets all of the above stated criteria and perform group interviews with all teams within the organization responsible for a specific infrastructure software platform. We approached seven companies inviting them to participate in the study where five did not respond, one declined and one agreed. The agreeing organization presented four of their major infrastructure software platforms that, per this study's delimitation and definition of infrastructure software, would be relevant for this study. The approached teams were responsible for the daily operations and development of the AIX (operating system), Linux (operating system), Windows (operating system) and Oracle (middleware) platforms. Each platform is by the organization considered as a vital part of their IT operations and overall business model as they are responsible for operating critical information systems such as finan-

cial systems, paying and invoicing, HR, e-commerce and web platforms as well as other solu-tions and applications vital to the operations of the business. Since our ambition was to conduct group interviews with the purpose of collecting as much and as rich data as possible we asked each approached team manager to include as many persons as possible up to eight, with insight and knowledge into the technical aspects of the daily operations and development of the plat-form. Due to organizational resource limitations, all team managers were not able to provide eight team members but all in all a total of 25 persons participated in the interview sessions. The platform manager was present in all interviews and were accompanied by either a product specialist or a system specialist, professional roles that are by the organization considered to have more than adequate knowledge of the daily operations and development of the infrastruc-ture system platform as they are the ones operating them.

Table 3.1: Overview of Context Selection

Platform	Number of inter-viewees	Professional Roles	Group Interview Session		
			Duration	Date	Type
AIX	8	• AIX Infrastructure Man-ager • 3 Product Specialist • 4 System Specialist	1h 30 min	March 2nd, 2017	In Person
Linux	8	• Linux Infrastructure Man-ager • Linux Infrastructure De-signer • 3 Product Specialist • 3 System Specialist	1h 19 min	March 30th, 2017	In Person
Windows	3	• Windows Infrastructure Manager • 2 Product Specialist	1h 30 min	April 3rd, 2017	In Person, Skype
Oracle	6	• Oracle Infrastructure Man-ager • 2 Product Specialist • 3 System Specialist	1h 28 min	March 9th, 2017	In Person, Skype

3.6 Interviewing

According to Ritchie and Lewis (2003) qualitative group interviews is usually conducted face-to-face to gain an in-depth insight and be able to discuss and answer but also ask rich questions. Therefore, we chose to conduct all of our four group interviews face-to-face. For the group interview of Windows and Oracle, there where one interviewee participating through Skype. However, this had no effect on the execution of the group interview. We followed the stages of group interview as argued by Ritchie and Lewis (2003). The stage have five steps, scene setting and ground rules, individual introduction, the opening topic, discussion and lastly ending the discussion. The stages helped to make it easier to start the group interview but also to learn to know each other. During the group interview, at the stage of discussion, we applied the sSWOT as a theoretical lens in regards to environmental sustainability and infrastructure software. Azapagic (2003) argues that organizations know how to adapt a regular SWOT easy, and that was also proved in our case when we noticed that the interviewees understood how to discuss and interact with the sSWOT analysis. What we did was to have an sSWOT table visibly and when the interviewees had agreed on a strength, weakness, opportunity or threat we inputted this characteristic or element into the table so they could see it which is aligned with Ritchie and Lewis (2003) in regards to creating an activity so the group that is being interviewed starts to cooperate.

Our role in the group interviews resembled a hybrid role in regards to both moderating the group interview but also just supporting the process and progress of the group interview, which is supported by Ritchie and Lewis (2003). The interviewees were talking very freely and provided us with in-depth information about what they are doing, how and why in regards to the questions based on the interview guide. But even though the discussion was very open provided us with rich data, the interviewees could in some cases start talking about irrelevant things and subjects which is why followed Ritchie and Lewis (2003) recommendation about smoothly take them back on the right track without interrupting. This were done by asking a question about the current Green IS aspect question, so that they started to discuss about that instead. Further, as Ritchie and Lewis (2003) explains about different personalities in group interviews such as dominance persons or quiet, shy and cautious, was definitely something we could notice. We had only one case of a shy personality that did not want to talk and we followed Ritchie and Lewis (2003) recommendation of trying to smile and make eye contact to give the person in question the confidence to participate in the group interview, which worked. We also noticed that the infrastructure managers in some cases could be the person that Ritchie and Lewis (2003) describes as the dominant person, but they did still have respect to the other interviewees and did not over speak anyone.

After the group interview, we did as the last step of what Ritchie and Lewis (2003) argues about of ending the discussion and thanking them for their time. We also told informed them once again that we uphold our confidentiality agreement for the sake of the organization and the interviewees privacy and that the transcription documents would be sent out for review upon completion.

3.7 Transcription of Interviews

Since the data collection technique chosen for this research study was group interviews, a number of different issues in relation to transcribing the recordings had to be mitigated before the interview proceedings. A group interview implies that there are several interviewees involved and this unquestionably puts a strain on the transcription procedure as a multitude of different voices, at sometimes talking simultaneously, as argued by Ritchie and Lewis (2003). To mitigate this issue we followed the five stages of Ritchie and Lewis (2003) and had each interviewee present themselves and state their role at the beginning of the interview so that we during the transcription process easily could map an interviewee's voice to their role. In some of the interviews, all interviewees were not able to be physically present and thus joined the session by Skype. This put another strain on the transcription process as the quality of the voice at times could deteriorate and to combat this we made sure to set up several recording devices at different places within the interview room, as argued by Ritchie and Lewis (2003). We used two types of recording devices, desktop clients running QuickTime Player and cell phones running the operating system standard voice recording software.

Kvale and Brinkmann (2009) argues that there is no right guideline of how to conduct transcriptions, instead it should be done so it achieves the purpose for the researcher in terms of analysis. The actual work involved with performing the transcription was divided amongst us, and for the sake of time efficiency and relevance of the transcribed content we decided to exclude noises and sounds that did contribute to the interview such as introductory conversation, laughter and other uncontrolled sounds, pauses and concluding remarks. When the transcription document was completed it was distributed to the attending interviewees for them to review. This would ensure complete transparency in the interview process but also allowed for the interviewees to comment on the transcription in regards to faulty responses made by them or conversation parts or words that had been wrongly transcribed, as recommended by Kvale and Brinkmann (2009). All the transcription was approved by our interviewees.

3.8 Data Analysis

According to Kvale and Brinkmann (2009), if researchers are not clear on how to analyse the collected data at the point of the analysis stage of the research project it is most likely already too late to develop and perform an adequate such. For this reason, we found it crucial to have an established plan and methodology for analysing the collected data prior to the analysis stage which is where the sSWOT Analysis Framework played an important tool. As argued by Azapagic (2003), Pesonen and Horn (2012) and Metzger et al. (2012), the sSWOT is used to evaluate an organization's position in relation to environmental impact which means that the sSWOT served as a very suitable analysis tool for this study. By categorizing characteristics and elements of the discussed aspects together with the interviewees we could detect which aspects that were more prominent than others. For example, if a platform had several strengths in regards to a certain aspect than that aspect could be considered as more prominent, as argued by (Azapagic, 2003; Pesonen & Horn, 2012). When looking at the result of all the performed sSWOT analyses, the same kind of conclusion in regards to the extent of an adopted Green IS aspect could be justified, which is supported by Azapagic (2003) and Pesonen and Horn (2012).

However, as we wanted to make sure that no data was lost in the interviewing process we deemed it necessary to perform transcription coding. All transcription documents have been

rigorously coded with the purpose of being able to derive empirical data and completely uncover the meaning and sentiment of the performed interviews and their transcriptions. We choose to have a concept-driven coding procedure, as presented by Kvale and Brinkmann (2009) where the codes were drafted from the five aspects of Green IS which were drafted from the literature review. The underlying reason for choosing concept-driven coding as our coding method was because we wanted to effortlessly correlate and map the empirical findings onto the five aspects of Green IS. Since the five aspects of Green IS served as the foundation for the interview guide, we argue that it makes sense to consequently include one code for each aspect. While the transcription work was divided amongst us, the coding was not. We went through each transcription document together with the purpose of rigorously and from two perspectives identify the semantics of a sentence, i.e. its theme and meaning, and consequently mapped it to its correlated code. Since our interview format was semi-structured, an interviewee's sentence can contain multiple codes as the interviewee was allowed to freely roam across topics. Also, given the nature of the context of infrastructure software and the phenomena of environmental sustainability and Green IS, questions and topics could often touch upon multiple aspects of Green IS.

The utilization of the sSWOT Analysis Framework, i.e. the categorization of characteristics and elements discussed in regards to the surveyed platforms and aspects of Green IS, in conjunction with transcription coding, is according to an adequate means for data analysis of the collected data. The following table contains the crafted codes and their corresponding color.

Table 3.2: Transcription Codes

Codes	Aspect of Green IS	Color
EO	Efficiency and Optimization	Green
VC	Virtualization and Cloud Computing	Red
A	Automation	Blue
KPI	Monitoring and KPIs	Orange
DGM	Data Growth Management	Purple

3.9 Ethics

Throughout this research project we have followed the ethical principles and guidelines as argued by Bhattacherjee (2012) with the purpose of uncovering ethical issues and borders so that they could be mitigated before the initiation of the data collection. The importance of research ethics cannot be understated, as according to Recker (2013) and Bhattacherjee (2012) and consequently we have made sure that the research process has been ethically scrutinized. This began by us making sure that the interview process would be on par with the mentioned ethical guidelines, all participants were informed that their participation was completely voluntary and that their participantship would be free of any interactions from us as researchers in regards to aspects that does not concern asking questions, i.e. the interviewees could say whatever they wanted and leave as they wished, which is an ethical guideline supported by Bhattacherjee

(2012). We explained to our interviewees that the interview would take place in a completely confidential setting and promised full anonymity. Prior to the initiation of the interview session we announced to the interviewees that the interview would be recorded by audio and the the audio would be transcribed. However, to address our promise of full anonymity, we also instructed that the transcript upon completion would be sent out for the interviewers to review. Sending out the transcript for approval is beneficial from two perspectives, partly from an ethical perspective as giving the interviewee an opportunity to review the transcript increases the research project's transparency, as argued by Recker (2013), but also because it allows the interviewee to review what has been said and make sure that the transcription has been correctly compiled.

Our ambition was to communicate to the interviewee that the interview and participating in it would be harmless and that there were no consequences for the participants, which from an ethical perspective is of high importance to emphasize (Bhattacherjee, 2012). To further protect the identity of the interviewees we also made sure to mask such details discussed during an interview session which could give away the identity of the interviewed organization such as its name and location of offices, which is supported by Bhattacherjee (2012). Lastly, we informed the interviewees that upon completion of the transcription and when the transcription document was approved by them, we would immediately destroy the audio files. By adopting all of the mentioned actions to mitigate ethical issues in the interview process, we were able to guarantee our interviewee's full confidentiality.

3.9.1 Reliability

To solidify the reliability of this study we have made sure to address concerns of reliability throughout the research progress. Yin (2009) argues that research reliability is defined as the demonstration that the operations of a study, such as the data collection procedures, can be repeated with the same results. The issue of research reliability thus depicts concerns about not being able to reproduce the study and come to the same conclusion as a result of poor documentation (Yin, 2009). Since the findings of this study depends on its ability to be replicated within a different context, i.e. a different organization, combatting this issue is of highest priority. According to Yin (2009), a good guideline for doing performing a study is to conduct the research so that an auditor could repeat the procedures and arrive at the same results. By rigorously depicting the research process and its core methodologies and including these in the research paper's method chapter, we aimed to mitigate issues of research reliability. Solidifying the overall structure of the report also further increases the study's quality and thus also its reliability.

3.9.2 Validity

A number of actions were taken throughout the research process to ensure that the study's validity would remain intact (Yin, 2009). Validity defines the extent to which the contents of a study, for example its literature review or its findings, actually corresponds to the real world (Yin, 2009). According to Yin (2009), a research design is supposed to represent a logical set of statements which means that these can be tested through certain logical tests. Yin (2009) highlights two tests relevant for an study: Construct validity, the ability to identify correct operational measures for the concepts being studied and external validity, the ability to identify the domain to which a study's findings can be generalized. These tests have been applied to the study in order to determine its overall validity. In regards to construct validity, the common

points of criticism people usually have is in relation to the fact that an investigation fails to develop a sufficiently operational set of measures which in turn can also mean that scientists use subjective judgements are used to collect the data (Yin, 2009). To combat this, we made sure to define the concept of environmental sustainability and Green IS and, based on those definitions, select aspects reflecting them. The selection of the aspects were drafted from established scientific journals within the same field that define environmental sustainability as according to this study, which should solidify the study's aspect of construct validity. External validity, which as according to Yin (2009) deals with the problem of knowing whether a study's findings are generalizable beyond the immediate case study, has been addressed in this study through a detailed and thorough description of the selected organization in this study. According to Yin (2009), critics state that studies looking at a single context offer a poor basis of generalization, however, since this study will rely on analytic generalization the issue of external validity can be combated through the provision of a thorough description of the criteria upon which the study's organization was selected, which will allow for this study's theory to be tested in a replication scenario. If the study's findings are replicated in a different case, which is what we expect, the findings of this study can be considered to be generalizable.

3.9.3 Bias

During the interview process we noticed a pattern of interviewees being very passionate about the organization they work in and that this passion could serve as an issue in regards to interviewee bias (Ehrlinger, Gilovich, & Ross, 2005). The source of the bias could originate from a multitude of different aspect such as the surveyed organization objectively being a world leader within its market, but also as a result of lengthy employments. As researchers conducting our investigation, we discovered that there was a lurking challenge associated with to not becoming affected by this enthusiasm and consequently not being able to remain objective and critical throughout the interviewing process. To combat this, we worked actively throughout the interview processes by contextually analyzing the responses made by the interviewee and made sure to thoroughly explore those aspects that were disregarded by the interviewees as irrelevant or unsubstantial. By the arguments of Ehrlinger et al. (2005) this aided us in remaining critically vigilant so that we could maintain our own judgement and not be affected by potential interviewer bias and enthusiasm (Ehrlinger et al., 2005).

4 Empirical Findings

The conducted empirical study is based on the analysis of our four group interviews within different platform teams each managing a specific infrastructure software platform where they were interviewed on their adoption of aspects of Green IS. The results will be depicted in depth to create a rich picture of how aspects of Green IS have been adopted within each infrastructure software team. All interviewees have been anonymized.

4.1 Efficiency and Optimization

In terms of efficiency, AIX is considered to have multiple options for adapting environmentally sustainable technologies. The surveyed platform team claims to have been running Green IS for at least six years (2:307), are on the front edge of sustainability and there are several empirical findings found to support these claims. In terms of basic operating system efficiency, the latest version that is implemented at the surveyed company is POWER8 and POWER9, the two most recent version of the software (2:2) and according to an interviewee the more recent versions of AIX are consequently more efficient as they consume less power (2:248). In regards to aspects of environmental sustainability, this is considered as a strength and was identified as such during the interview. The recent POWER versions allow for various power saving features such as cores not in use being powered down (2:441). Furthermore, AIX allows for Capacity on Demand which is implemented by the organization (2:4; 2:7). Capacity on Demand essentially enables the platform to utilize extra processing power on demand which, when there is no longer any need for, can be returned to the pool from which it was claimed (2:7). This enables the organization to dynamically adjust their processing power and thus power consumption so that more electricity is required only when there is a demand for it, effectively reducing risks related to idle or unutilized hardware (2:4). However, not all parts of the AIX system have Capacity on Demand enabled which means that there is an identified opportunity to expand its adoption (2:18). Two other identified aspect that can greatly benefit the impact Capacity on Demand has on the environment, as a result of its own efficiency, is more efficient working routines regarding the activities surrounding its operations (2:55; 2:57) and also the implementation of Dynamic Optimization to use with Capacity on Demand (2:78).

According to an interviewee, the organization is characterized by an old way of looking at capacity (2:335). The interviewee gives an example of application owners ordering too much capacity, i.e. capacity that is not utilized, which through low utilization rates results in idle hardware and is something that is difficult to address afterwards due to lacking flexibility (2:337). The interviewee states that the organization needs to change their mindset about capacity which in the end can result in fiscal and power savings which consequently would impact environmental sustainability (2:337). Another interviewee mentions owners of applications continuously ordering a lot of processing power but only using a fraction and recognizes that this is a problem (2:354) whilst a third interviewee highlights that perhaps the customers of the AIX infrastructure software services does not realize the impact of ordering too much capacity (2:339).

LCM is considered within AIX in regards to decommissioning old systems and consolidating their functionality into new and more efficient platforms (2:434). An interviewee gives an example of recently shutting down two old machines which had a notable impact (2:138; 2:140).

Another aspect of LCM within AIX is that the platform is running the latest possible versions of the operating system (2:2). However, the team identifies an opportunity within LCM to continuously implement aspects of sustainability when ordering new platforms (2:434). An interviewee highlights that IT architects within the company do not consider aspects of sustainability when building new systems, which gives further weight to LCM and sustainability opportunities (2:459). Lastly, the AIX team highlights that the vendor actively seeks to effective each new generation in terms of efficiency and power consumption which in the long run impacts aspects of environmental sustainability (2:472).

The Linux team offers TS4 as the default installation version for the Linux operating system (3:7). From a sustainability perspective, this is considered as a strength sin TS4 is considered a sustainable version, consuming eight to seven percent less power than the previous Linux installation version, TS3, and it does this by shutting down resources that are not in use (3:9; 3:10; 3:22; 3:12). The team also claims that for each generation of new platform software, the vendor provides a more energy efficient such consuming less electricity (3:33; 3:34; 3:35). However, the current ratio between TS3 and TS4 installation is 20 to 25 percent (3:14) which means that the team identifies an opportunity in expanding this ratio and believe it will happen naturally through LCM and decommissioning of old TS3 installations, since TS4 is the current default version (3:33; 3:17). However, the Linux team also state that they have difficulties with LCM practices because they lack ownership of the hosted applications (3:24), while the team has the ability to inform application owners about the importance or need to LCM they do not have the authority to enforce it and it is generally difficult to continuously oversee and update aspects of LCM (3:26; 3:27). According to the team, from a sustainability standpoint, LCM is one of their biggest sustainability related weakness (3:65; 3:77). Another weakness that is making LCM difficult, and consequently having an LCM related sustainability impact, is the inter-dependencies between various applications across the Linux platform (3:86). From a sustainability perspective, this is also identified as one of the biggest environmental sustainability thieves since application owners are afraid to LCM their applications because they feel that there is no control over what can happen a few steps down the chain, if they drastically alter the platform their application is running on, the general perception is that there is no idea of knowing the repercussions on interconnected applications (3:87) This hinders LCM practices which results in delayed work with making application and its underlying infrastructure more efficient, ultimately impacting aspects of sustainability (3:86).

Further expanding on this subject, an interviewee identifies a related weakness is that a lot of applications operated on the Linux infrastructure platform are quite old (3:85). This is, according to the interviewee, due to frameworks and methodologies that are outdated by several years which means that they are difficult to adapt into more modern ways of thinking and working and ultimately negatively impacts aspects of sustainability (3:85). In terms of development frameworks, the team also identifies a weakness in not having development frameworks instructing developers on how to build optimized applications that are more in line with the infrastructure and its configuration (3:106), for example an interviewee states that they do not know how the applications perform and consequently it is difficult to adapt their operations for virtualizing software such as VMWare (3:108). Lastly, these identified weaknesses sum up a third weakness identified within these area as an interviewee claims that a lot of the infrastructure platform is running on old hardware (3:54). Thus, there is an obvious opportunity to refurbish applications and adjust related ways of working to more modern methodologies, including cutting ties to legacy test environments (3:85).

Even though the team is capable at running their infrastructure on sustainable settings or in a balanced mode, depending on the specific requirements of the platform part (3:37; LINUX, 38), there is a threat in relation to sustainability regarding an "always on" requirement on the production environments (3:101). The interviewee states that running the systems at lower consumption with lessened ability to handle load is worrisome due to the fact that sudden processing peaks or hardware failures instantly can require the ability to for an individual unit to handle more processing (3:101). This is why the infrastructure is rather run with some headroom to take on sudden load, rather than powering down in favor of sustainability aspects (3:101). The interviewee also states that there are software which is able to "play Tetris with the machines", meaning distribution of load, but because of the mentioned risk strategies the organization is not yet ready to adopt such types of technology (3:104).

The Windows team is a bit different from the other infrastructure software teams as their perspective concerns both servers and clients. There are several strengths identified including aspects of new equipment provided by vendors being expected to be more efficient (4:61) and that the team has an overall strategy of utilizing hardware in a sustainable way meaning that utilization rates are monitored and that the underlying infrastructure is adapted accordingly (4:144). One example of how software enables sustainable utilization of hardware on the client side is through the usage of power schemes (4:194), meaning schemes that automatically adjust the client's power related setting based on the scheme's characteristic. An interviewee states that this has a significant impact on aspects of environmental sustainability and brings up an example of 130 000 clients using a power scheme where a monitor, if not being used, is powered down (4:194). Expanding on this, an interviewee identifies an opportunity with implementing reports on client power schemes, essentially what they are set to and how they are being utilized which could potentially enable enforcing of sustainable power schemes (4:194).

Overall, the team states that the utilization of the Windows platform is considered good but identifies a number of different opportunities and weaknesses in regards to its operations. Capacity on Demand is not possible to utilize with the current setup, which is considered a weakness, however in relation to this, the team identifies an opportunity in regards to being able to enabling Capacity on Demand if, or when, they "go cloud" (4:148). However, an interviewee states that a cloud strategy, i.e. moving parts of the platform to the cloud, will not mitigate issues with availability, meaning the high requirements put on the platform by business to always be able to process incoming data, or if there is a hardware failure (4:217). The interviewee continues and makes a notion of that availability demands driven by business will always take hand over sustainability considerations, meaning that they would rather run their systems at high capacity with low utilization rather than running them on lowered capacity, more environmentally sustainable, but then risking the ability to be available (4:209). With test environments it is however different and the interviewee stated that there is an opportunity in powering down test environments when not in use, as they are not as critical as production environments (4:156). Overall, the team identifies that there is an opportunity in implementing schedules where non-critical environments, similar to how a service window would work but instead label it as a "sustainability window", for example during the night, can be powered down (4:222; 4:258; 4:252). A weakness that the team identifies is in regards to lacking governance and LCM strategies and decommission (4:280). An interviewee states that there is a pattern of service and application owners within the organization holding on to environments that are old or not utilized as a backup or of reasons beyond defensible from a technical standpoint and that this hinders LCM (4:292). This interviewee argues that better LCM and better LCM strategies will enable easier data growth management and thus consequently environmental sustainability (4:292).

Compared to the other software platforms examined in this study, Oracle share both significant similarities and significant differences due to it being mainly considered as middleware software instead of a traditional operating system platform. For example, a significant strength identified within the Oracle team that is unique to their technical platform is the usage of Active Data Guard (5:20). ADG is a feature that enables idle databases, for example a standby database, to take on some capacity meaning that if an application has ADG enabled, all read queries are redirected to the standby database thus removing its redundancy and balancing the load (5:22). This is beneficial from an environmental sustainability standpoint as it makes it possible to utilize otherwise idle hardware and according to an interviewee this is a recommended and standard option within the company today (5:49). However, even though the technology today is available, the team has identified threats and opportunities in relation to ADG. According to an interviewee, not all applications operated by the company today uses this and according to this person, depending on the application, the ADG adoption time can be long which ultimately can delay the environmental sustainability impact it provides (5:33). To counter this, the team has identified an opportunity with, within the company and to their end-users, market ADG as something that is beneficial and ready to be implemented (5:42). In terms of sheer platform installation, the team actively practices an ongoing strategy to lower the installations' footprint (5:72). Examples of measures that are being taken to lower the footprint is disabling features, procedures and functions which the interviewee argues will have an impact on environmental sustainability (5:72). However, according to an interviewee, the team is still struggling with low utilization rates of the installations, meaning that they have instances of installations that are not utilized enough and consequently are over capacitated (5:113). Expanding on this, an interviewee states that there is an opportunity in consolidating functionality of many installations into one as this would effectively deal with issues of low utilization (5:52).

When it comes to LCM the Oracle team has several strengths. According to the team, they practice a strong LCM policy of keeping the infrastructure software up to date and are currently in the midst of a project to upgrade the entirety of their stock to Oracle 12c, which is the latest version of the software (5:92). This is beneficial from an environmental sustainability perspective, as an interviewee claims that each new release by the vendors is considered to be more efficient and more thought through (5:92). Another interviewee agrees and states that the software vendor is continuously working a lot with reducing footprints, increasing CPU efficiency, enabling better compression and overall lowering the platform's power consumption (5:105; 5:107). But in regards to new technology supplied by the vendor, the team also identifies a weakness in regards to business hindering the team to be early adopters of new technology as it is considered to be less tested and thus more unstable, which delays potential environmental sustainability impacts the technology might provide (5:105). Continuing on the team's LCM practices, an interviewee highlights a strength regarding decommissioning and states that once a decommissioning order comes in, it does not take long to execute which is identified as a strength (5:118). An interviewee brings up an example of LCM where a team member was able to decommission a cluster in a small datacenter in the US (5:116). The interviewee states that they are expecting to see a notable drop in the data center's power consumption as the hardware on which the infrastructure software was running was considered very old and consumed a lot of electricity (5:116). Another interviewee stated that this is an excellent example of proper LCM as later software and hardware versions are naturally more efficient (5:117). However, the team also testifies to having issues with actually getting those order in place and states that there is a weakness in regards to decommissioning solutions (5:121). Essentially they argue that the rate of decommissioning is too slow as it is difficult to find and enforce environments that

should be decommissioned, and that this is ultimately impacting aspects of environmental sustainability (5:121; 5:120).

Lastly, the team identifies an opportunity within adopting multi-tenancy technology (5:52). Multi-tenancy is a fairly new software architecture adopted by the vendor and will allow for several new features that can have a significant impact on environmental sustainability such as more consolidation, simplified maintenance and reusing footprints (5:96).

4.2 Virtualization and Cloud computing

When it comes to virtualization, the AIX team have essentially reached full virtualization (2:4; 2:130). According to an interviewee, they are virtualized at 99,9 percent (2:4; 2:130), and are also operating on virtualized I/O, essentially virtualized adapters such as switches and network equipment which according to the interviewee reduces network hardware footprint (2:188). The virtualization technology implemented by the team is virtualized hardware, which compared to more traditional virtualization technologies where the virtualization is performed on a virtualization platform, is more energy efficient as according to an interviewee (2:378). Another identified strength is that all software running on the AIX platform is supported virtually, meaning that all applications hosted within the virtual AIX platform has official support in its virtualized state by its manufacturer (2:408). The team have also identified several opportunities to further improve their virtualization technologies. In excess of continuously surveying how to make their virtualization more efficient and how to consolidate more functionality into a single virtualization instance (2:249). By implementing a cloud based POWER7 or POWER8 and interviewee states that a subset of different tools such as VMWare, suspension and better monitoring would be enabled (2:37; 2:40). Another opportunity is the implementation of flash caching, something that an interviewee thinks can be done quite easily (2:194; 2:196) and can from a sustainability perspective have an impact in the form of faster execution and reduced load times (2:200) which ultimately would impact aspects of sustainability due to a lowered power consumption (2:129). The team mentions an opportunity of enabling Energy Scaling on machines, a technology that is available today, however not activated (2:127) but would enable a reduction in power usage through allowing data analysis predict trends (2:129). However, due to loads on virtual systems differentiating to a great extent, energy scaling is difficult to properly implement (2:129).

The Linux team's virtualization ratio is according to an interviewee above 70 percent, which contributes to a lowered physical footprint and therefore is considered as a strength (3:59). The team states that they are heavily invested in a strategy of enabling physical to virtual LCM, meaning that when an old physical server is lifecycle managed out of its existence, the content it houses in instead of being on boarded to another physical devised, on boarded into a virtual environment (LINUX, 67). However, specific requirements by specific applications hinders the possibility of becoming fully virtualized, meaning that some applications requires a physical host, which is identified as a weakness, but does not change the fact that the current strategy is to virtualize as much as possible (3:61). This is why the standard offering today is a virtualized environment, as stated by an interviewee, and that requirements for a physical environment are handled as exceptions (3:61). An interviewee also highlights that there are ongoing trials and an overall strategy to virtualize "higher up in the stack", meaning that the virtualization would also take place at application level using container technology, essentially allowing several application instances running isolated on a single host (3:69; 3:70). The team states that with an

expanded adoption of virtualization, LCM will become much easier as they can virtually lifecycle the infrastructure beneath the applications and thus not having to impact certain applications' environments, which ultimately has a positive impact on aspects of sustainability (3:64). However, the team has also identified a threat in regards to running certain applications in a virtualized environment as some of them may not be supported by the vendor when running in a virtual environment (3:155). Lastly, the team highlights a weakness in regards to the infrastructure software located at the company's retail locations stating that they are not running virtual solutions and also identifies a consequent opportunity with replacing these with virtual solutions (3:118; 3:124).

The Windows team state that they are heavily invested in virtualization strategies both on central and distributed systems and that the physical footprint has been reduced a lot over the recent time resulting in a 90 percent virtualization ratio (4:80; 4:88; 4:90; 4:146). An interviewee mentions that the virtualization ratio in central is especially good compared to other companies acting in the same industry (WINDOWS, 80) but also highlights an example of a virtualization project taking place at the company's retail locations reducing the number of physical hosts from eight machines to six (4:83). However, according to an interviewee, there is an opportunity to further adopt virtualization in distributed areas (4:87; WINDOWS3; 92). An identified strength in regards to virtualization is the team's strategy to lifecycle manage software from physical hosts to virtual, according to an interviewee there was practices in place that lifecycle from physical to physical but upon discovering that this was an inefficient practice there was a decision made to lifecycle to virtual (4:129). According to the interviewee, the infrastructure's customers, i.e. application and service owners, perception of virtualization has changed over the past five years (4:129). Five years ago there was a disbelief in the virtualization technology due to claims that it was not as stable as physical hosts, this has however changed and today virtualization is being accepted to a greater extent (4:129). Lastly, the team identifies a threat in regards to a cloud based virtualization strategy, meaning that handing over the operational controls to a third party operator could affect the company's influence on matters of sustainability, i.e. how to cloud is operated and where the cloud operator's electricity comes from (4:227).

The Oracle team has identified many strengths in relation to its capability to virtualize (5:2). According to an interviewee, they have a high ability to virtualize and while not all areas of their platform is capable to virtualize, they note that the middleware stack is fully virtualized (5:2). For example, the team's infrastructure software is currently supporting single databases on VMWare (5:12). But this has not always been the case, according to an interviewee, who states that there has been a pattern of "lagging behind" in terms of the virtualization strategies and that there are still environments that are running on physical hosts (5:12). However, according to an interviewee once a physical environment is life cycled it will be life cycled to a virtual host indicating that physical to virtual is an important physical to virtual LCM is an important part of the virtualization strategy (5:14). Even though the Oracle team can provide virtualized infrastructure software, an interviewee states that there is a weakness in regards to vendors not being able to support applications that are run on virtual hosts (5:100). This is considered as a weakness as it hinders efforts to virtualize applications and thus consequently delays the impact virtualization has on environmental sustainability (5:100). According to an interviewee, the company is on a journey to cloudify a lot more and the overall digital strategy is to move possible parts to the cloud (5:56). The interviewee highlights that in relation to this cloud journey, databases are quite behind and identifies this as a weakness (5:58). There are pre-studies initiated for investigating possibilities of cloud services for databases, as well as

cloud services in general, which is according to the team considered as a strength (5:151). However, one interviewee argues that more cloud computing might necessitate stronger network resources and that it is, from an environmental sustainability perspective, thus important to look into how much the network usage would increase if the cloud adoption was expanded (5:100). Lastly, an interviewee identified that data backups are physical and not cloud based is considered as a weakness (5:32).

4.3 Automation

The biggest strength within AIX in relation to automation is the previously mentioned use of Capacity on Demand as it according to an interviewee allows better automation procedures such as Dynamic Optimization (2:86). Another aspect of implemented automation that is considered a strength is the Infrastructure Platform Automation project (2:280) and an identified opportunity aligned with this is the implementation of IPA Internal Power (2:425). However, an interviewee believes that extended automation of software on the AIX platform requires more hardware to account for the varying load which ultimately would increase the AIX footprint (2:517), which is from a sustainability perspective identified as a threat.

The Linux team is currently running several automation projects, identified as opportunities, with the end goal of, where possible, removing requirements for human involvement (3:83). The ambition is to automate as much as possible in regards to application automation, DevOps methodologies and infrastructure automation such as current ongoing projects like EDA and IPA solutions (3:83; 3:130). Another example of automation project that will have a positive impact on aspects of environmental sustainability is automating the process of ordering test environments, meaning that when test environments are ordered they cannot be done so without including an end date for the usage of the test environment, i.e. a date which when is passed will mean that the test environment is automatically shut down (3:83).

The Windows team describes a working climate where aspects of automation is difficult to imagine due to the sheer complexity of the IT environment they operate within (4:346). While the interviewees did express that automation projects in general would be beneficial from multiple aspects, for example implementing automation policies for disable cores when not in use (WINDOWS, 346), there is an overall hesitance towards these types of project due to complexities and interdependencies of the IT landscape (4:346).

The Oracle team highlights ADG, Active Data Guard, as a source for being able to bring more aspects of automation into their daily operations (5:49). According to an interviewee, ADG enables automation of processes such as automatic data quality checking in regards to data blocks but also automatic health checkup of database primaries which is considered as a strength (5:49). An example of an automation opportunity identified by the team revolves around the implementation of multi tenancy, as it according to an interviewee also contains aspects of automation (5:96). Ultimately, the team seeks to lower required human involvement as much as possible (5:49).

4.4 Monitoring and KPIs

The AIX team currently has a lot of different tool at their disposal in regards to monitoring and collection of operational data (2:68). According to an interviewee they are able to get a good picture of specific subsets of the platform, which is considered a strength (2:68) but it is at the same time difficult to consolidate the collected data, which is considered as a weakness (2:68). Consequently, improved monitoring with the ability to view data in a bigger context is by the team considered as an opportunity and a way to become more efficient (2:70; 2:72). A big weakness identified within the team is lacking sustainability KPI practices (2:343), for example the team is not monitoring KPIs in relation to virtualization and capacity usage on each service (2:348). Being able to monitor capacity usage for each application could enable improvements (2:351) and is thus implementing sustainability KPIs on application level monitoring usage is considered as an opportunity (2:353).

In terms of monitoring and KPIs, the interviewees of the Linux team state that they currently at their disposal have tools for examining the power consumption of the infrastructure software platform (3:97). An example of this is how the team discovered that the previous default installation version, TS3, consumed seven to eight percent more electricity than the current default installation version TS4 which was done by implementing a monitoring solution collecting and comparing power consumption data (3:97). The team continues and argues that better knowledge of power consumption could assist in matters of driving LCM, especially in regards to being able to monitor and correlate power consumption at application level (3:160). However, there have already been such instances recorded where collected and analyzed data was used as a foundation for driving the implementation of TS4 as the default installation standard, which the team identifies as a strength (3:164).

The Windows team is currently engaged in monitoring its hardware stock for power consumption, both servers and clients, which is considered a strength (4:79; 4:113) but the interviewee expresses that they see an opportunity in being able to utilize this to a bigger extent (4:116; 4:118; WINDOWS3; 119). The team also claims that they have good KPIs in place for surveying virtualization ratios and that this is also something to be considered as a strength (4:123; 4:131; 4:135). However, similar to the previous teams, the Windows team also state that being able to monitor application consumption usage such as CPU, memory and actual power consumption, would be beneficial from an environmental sustainability perspective as well as from a general operating cost perspective as the collected data could be used for deciding, for example, whether an application should be operated in-house or outsourced to a cloud (4:158). An opportunity to implement resource utilization reporting across all environments of the platform was identified, essentially to get an overall better understanding of "who consumes what" which ultimately could be used to motivate efficiency strategies (4:173). Lastly, the team identifies an opportunity with implementing a solution for monitoring and detecting behavioral patterns to learn more about how clients and servers are being used which in the long run can have a significant impact on aspects of environmental sustainability in terms of efficient utilization (4:254).

For monitoring and KPIs, the Oracle team can utilize the Oracle Enterprise Manager which is a control system, a central management system that is connected to all Oracle installations and gathering data (5:114). According to an interviewee, the team has the capability to look at KPIs regarding consolidation and utilization, but they do not have a complete dashboard of the multitude of all installations but instead they monitor some applications more frequently than others (5:114). The interviewee states that they are actively monitoring for thresholds but that these

thresholds concern upper limits of consumption or utilization, when there is a need for more processing power (5:114). Consequently, the interviewee identifies an opportunity in regards to implementing monitoring for thresholds that are on the spectra of low to non-usage arguing that measures can be taken proactively to eliminate idle hardware (5:114).

4.5 Data Growth

The AIX team reports that there has been a notable increase in data growth over the past year and that there is currently no plan in action regarding making their end-users more aware of matters of sustainability related to data growth (2:453).

The Linux team in relation to data growth sees an imminent threat in an issue with an increasing number of test environments (3:78). These environments contribute to a growth in data processing but also take up space and is ultimately, according to an interviewee, an issue with how the company is going about its business (3:80). According to the team, the issue lies in the face that test environments are too difficult to shut down and not utilized to their full extent and since according to the company's way of working, once a test environment is ordered the Linux team is not allowed to touch it (3:82).

For Windows, an interviewee highlights lacking data management policies as a notable weakness (4:269). The interviewee claims that data management policies, or data retention policies, can avoid the increase of data footprint and avoids adding more disks and having bigger storage solutions as a response to an increased need of storing more data (4:269). Consequently, an identified opportunity is to implement efficient data management principles for archiving data, for example by identifying hot data, using data tiers and so forth (4:272; 4:276). There is an obvious need for these kinds of archiving solutions in order to manage data growth, as well as by looking into data retention policies through, looking at how often data is touched (4:310; 4:327).

Since Oracle is a middleware team and consequently exposed to databases, they are heavily affected by aspects of data growth. For example, they are experiencing an escalating situation of multiplying test environments that are not fully utilized, which is considered as a weakness (5:83). There is a pattern of test environments being duplicated or even triplicated without an, according to an interviewee, usage purpose (5:83). While there are ambitions for consolidating these test environments, or other environments, the team identifies a threat in regards to main projects and their capability to overrule the Oracle team's plans to consolidate functionality into existing installations with the purpose of reducing the number of environments and consequently data processing growth, which is considered as a threat (5:79). Another identified weakness is in regards to data archiving and the fact that the team states that there is not archiving solution in place as well as not data retention policy in place (5:122). An interviewee states that this is a major issue and that the problem seems to be that business is lacking in clear instructions to the owners of the applications in regards to what kind of data, and for how long to store it (5:127). Another interviewee states that data retention policies are very important and that they are in place before an application is launched as it can be difficult to adapt the operations of an application once they are live (5:146). According to the team, only a set of very few applications have a clear policy regarding how to store the data (5:144). To combat these weaknesses, the team identifies an opportunity with performing investigations on data growth with the purpose of determining what data to archive as well as compiling data retention policies (5:128).

4.6 Summary of Empirical Findings

The empirical findings have been summarized through a consolidation of the performed sSWOT analyses. The table displays the number of times a studied aspect occurs as a strength, weakness, opportunity or threat. An occurrence represents an instance where an interviewee has answered a question and its categorization has been performed in accordance with the key notions of the aspect as identified in the literature review.

Table 4.1 Summary of Empirical Findings

STRENGTHS	Occurrences	WEAKNESSES	Occurrences
Efficiency and Optimization	10	Efficiency and Optimization	1
Virtualization and cloud computing	6	Virtualization and cloud computing	2
Automation	2	Automation	0
Monitoring and KPIs	2	Monitoring and KPIs	1
Data Growth Management	0	Data Growth Management	4
OPPORTUNITIES	**Occurrences**	**THREATS**	**Occurrences**
Efficiency and Optimization	9	Efficiency and Optimization	1
Virtualization and cloud computing	4	Virtualization and cloud computing	0
Automation	1	Automation	0
Monitoring and KPIs	5	Monitoring and KPIs	0
Data Growth Management	1	Data Growth Management	5

The table indicates that efficiency and optimization as well as virtualization and cloud computing are considered as present strengths or possible opportunities while automation, not to the same extent, is also considered a present strength. Monitoring and KPIs appear to be considered more as opportunities as the empirical results show that there are tools in place for monitoring but they are not used in an environmental sustainability purpose. Lastly, data growth management are mostly considered as a weakness or a threat.

5 Discussion

In this chapter we will review the findings of the empirical results in the relation of the findings and content of the literature review, primarily in relation to the table defining the aspects of Green IS surveyed in this study. We will correlate each aspect's theme to our corresponding empirical finding and review it in detail.

5.1 Efficiency and Optimization

In regards to efficiency and optimization we have observed an emerging pattern of platform specific efforts put in place to optimize infrastructure software platforms with the purpose of enabling more computational power per host or reducing the required electricity to power a host. While there is a common theme across all surveyed teams to perform optimizations, the methods and the technology behind it varies greatly depending on the platform and the infrastructure software that powers it.

The most notable optimization that the AIX team has done is in regards to Capacity on Demand, a technology that allows service operated on the platform to, depending on the current computing demands, adjust its ability to process data by claiming more capacity from an availability pool (2:5). When the increased computing demand is lowered, the claimed capacity can be returned to the pool so that another service can utilize the available capacity in the pool when needed (2:5). This is a practical example of how the organization deals with issues of idle hardware which is, as described by Uddin and Rahman (2012), a physical hosts that is plugged in and consumer electricity but lacks an operational purpose. Since Capacity on Demand enables the ability to lend and return computing power, the risk for operating a data center with idle hardware is effectively lowered since unutilized hosts can be repurposed to other services. This can therefore be considered as a substantial example of how a Green IS aspect is practically implemented and suggests that this is an aspect which the industry considers operationally viable. Another example of how the organization deals with idle hardware is in regards to the Oracle platform's Active Data Guard (5:20). ADG is a technology that makes use of an idle and stationary backup database by allowing it to receive and process ready-only queries (5:20), while the database's primary task is to be redundant it is no longer idle as ADG allows it to take on some workload. Therefore, ADG is another applicable example on how the organization has taken steps towards mitigating issues with idle hardware as described by Uddin and Rahman (2012). However, the stated examples should stand in light of the fact that while it is apparent that the organization is trying to reduce the idle hardware, they are also stating that the current number of idle hardware within their various platforms is unknown but most likely significant (3:75; 5:56).

While there are platform specific optimization projects in place, we have also discovered a pattern in regards to the version state of the infrastructure software. Across the multitude of the platforms that has been surveyed, each team is dedicated to running the latest available versions of the infrastructure software (5:92; 2:2; 3:7) and according to the interviewees, new versions of the infrastructure software is increasingly more efficient with each release (5:117; 2:248; 3:97; 4:61). The practice of continuously updating and maintaining a platform by operating the latest version available can therefore be considered as an optimization effort and is supported by Koçak (2013) who argues that how optimized a piece of software is, regardless of whether

it is an application or an operating system, has an impact on the host's power consumption (Koçak, 2013). This indicates that the organization is in line with this aspect of Green IS theory in regards to version states. However, an important observation made in conjunction with this is that even though the teams current strategy is to continuously install the latest infrastructure software versions, this is not always possible due to limitations and issues in regards to application related LCM. While this study focuses on infrastructure software and not the applications that are being operated on top of it, the difficulty with LCM for applications makes it difficult to LCM the underlying infrastructure which in turn has an impact on environmental sustainability.

All in all, we have observed several efficiency and optimization efforts throughout all surveyed platforms in the organization. From technologies that reduce idle hardware such as Capacity on Demand and Active Data Guard to client desktops running Windows with Power Schemes lowering the screen brightness when not used, there are several empirical findings that support efficiency and optimization as a prominent aspect of Green IS adopted within the organization. While there might be several reasons as to why this aspect seems prominent in its adoption we would argue that one of the more plausible reasons is that the efficiency of infrastructure software has a very notable impact on the organization's electricity bill. The multitude of the surveyed platform teams have stated that decisions which has a significant impact on environmental sustainability rarely are taken because of that purpose, but that the reason is rather driven by cost or performance and that the related environmental sustainability win is considered as an extra benefit or an additional reason as to why that specific decision should be taken. Thus, as successful organizations generally tend to be cost aware one can argue that they consequently tend to be aware of their efficiency and continuously want to improve their efficiency, which is supported by the prominence of the efficiency and optimization aspect we have identified in this study. For example, when the Linux team life cycle managed their TS3 installation standard to TS4 which consumed eight to seven percent less electricity than the previous version, one can definitely see the benefit from both a cost and environmental sustainability aspect if several thousands of physical hosts consumed seven to eight percent less electricity.

5.2 Virtualization and Cloud computing

In regards to virtualization it is appears as if that each infrastructure software provides a set technologies that serve as virtualization enablers. This argument can be derived from the fact that each surveyed team states that their virtualization ratios are high and that, when looking at the ratio between the numbers of physical hosts versus the number of virtual hosts, the majority of each infrastructure software's hosts are operated on a virtual platform. The AIX team states that their platform is virtualized to 99.9 percent, the Linux team states that their platform is virtualized to roughly 70 percent, the Windows team state that their platform is virtualized to roughly 90 percent and the Oracle team states that their platform has a strong capability to virtualize (2:130; 3:59; 4:103; 5:56, 151). Furthermore, each platform team states that their ambition is to continue their virtualization journey and that they are actively engaging in virtualization strategies with the purpose of increasing their virtual ratio to their physical ratio. There are also examples of emerging virtualization technologies being adapted early on, for example on the Linux platform where virtualization focus is no longer solely on virtualizing on an operating system level but also virtualizing on an application level (3:63).

All these findings point to virtualization as an aspect of Green IS that seems very prominent within the organization. When it comes to cloud computing, several interviewees has stated that

the organization is on a journey to cloudify its IT operations and that there are cloud strategies in place for further investigation how to adopt cloud services. However, cloud strategies are not nearly as mentioned or was as thoroughly discussed in the group interviews which perhaps indicates that cloud computing is not as matured as virtualization within the organization. The reason to this might be explained by the simple fact that cloud computing is a fairly new set of technologies and that the organization is not mature enough or has the agility to swiftly transition its infrastructure software to IaaS (Infrastructure as a Service) solutions (Oliviera, Thomas & Espadanal, 2014). However, several interviewees states while their infrastructure software is on premise, the organization still has thousands of SaaS (Software as a Service) solutions. Thus, one can argue that virtualization and cloud computing are aspects of Green IS which is relatively well adopted or is pursued to be well adopted. The reason for this might be that virtualization and cloud computing has a great impact on the organizations cost efficiency as both these technologies main contribution is a lowered physical footprint. By lowering its physical footprint, the organization not only reduces its electricity consumption and environmental impact but also reduces its electricity costs, hardware purchasing costs and hardware maintenance costs.

5.3 Automation

Looking at the motives of why AIX, Linux, Windows and Oracle is automating we could see that there are commonalities with theory. AIX automation in the form of Capacity on Demand and Dynamic Optimization (2:86) and as Chen et al. (2008) is arguing this is efficient software processes and has a positive impact on the energy consumption in the long term. Even though, AIX sees automation as a long-term opportunity for the environmental sustainability (2:425) they claim that automation would involve more hardware and because of this it would question its environmentally sustainability (2:517), which is something that is not mentioned in the theory. There have been no mentions throughout this study's theory that automation could in anyways involve more hardware which is an interesting empirical find. Both Linux's and Oracle's main goal with automation is to reduce the involvement of humans (3:83; 5:49) which is aligned with the arguments of Rahman et al. (2011) and Greveler et al. (2012). But reducing the human participation does not directly affect environmental sustainability, it is true that it could aid in terms of faster executing software processes but just the human involvement does not directly decrease the footprint. Further, Linux is automating their applications to reduce the impact of the environmental sustainability (3:83; 3:130) which supports Greveler et al. (2012). Linux has also implemented automation that shuts down test environments (3:93) which in the long-term reduces electricity consumption and increases environmental sustainability, which is mentioned by Paul and Gangulay (2013). This is an effective way of automating as earlier mentioned, which is proven by our findings as well as by theory.

Something that we also did not find in the theory was how difficult it can be for organizations to implement automation. Windows explained their difficulties of implementing automation throughout their IT-landscape because the landscape composition is too complex (4:346). This is a very interesting aspect in relation to automation because theory is overall glorifying automation which stands in contrast to the Windows platform's difficulty implementing it. However, Windows mentions how automation would help them in the daily operations with policies in regards to turning down cores when they are unused which could aid with lowering electricity consumption and efficiency (4:346; Chen et al., 2008; Rahman et al., 2011; Greveler et al., 2012; Paul & Gangulay, 2013). However, this is nothing they have done because of the previously stated problems the platform has in relation to automation. Oracle states that they in terms

of automation would be aided by the use of Active Data Guard as they could quality check data and to check if the database is operating in an optimal way (5:49). This helps Oracle with control over their processes and can in an overall picture display that the organization functions in a desired way but also allows them to optimize it (Chen et al., 2008).

To summarize, it appears as if the Green IS aspect of automation is present throughout all platforms and that there are current and future solutions in place that will further automate software processes. However, it seems as if the organization does not agree with the theory in regards to the fact that it has such a notable impact. Perhaps this is due to the varying impact an automated task can have, i.e. if it ranges from health checking a database to automate Capacity on Demand procedures. Also, the fact that the technology powering each platform greatly varies can also mean that some platforms have a better opportunity to automate than others which is demonstrated between AIX and Windows.

5.4 Monitoring and KPIs

In terms of monitoring and KPIs, there is a lot to be wished for in regards to the organization adopting it as an aspect of Green IS. While the organization in multiple instances and across the multitude of the surveyed platform demonstrate that they have good capabilities for monitoring, tracking and analyzing data there is little evidence that would support its purpose being motivated by environmental sustainability factors. For example, the AIX platform team claims that they have multiple tools for the collection and monitoring of data but states that that the organization is not well equipped with environmental sustainability KPIs (2:68; 2:348). Another example is the Windows platform which is equipped with monitoring and tracking electricity consumption for the hardware that is operating the infrastructure software (4:113). However, the team claims that the data is not used for any purpose and the team consequently claims that they could become a lot better at applying findings of monitored data to improve the overall operations of their environments (4:158). Out of all the surveyed platforms, Linux were the only platform team to measuring and act upon an environmentally sustainability KPI partly from a Green IS perspective but also partly from a cost perspective (3:97). By comparing the electricity consumption of the TS3 installation standard with the TS4 installation, the Linux team could verify that the new installation standard did in fact consume less electricity and used this argument to, from an environmental sustainability perspective, amongst other arguments motivate the standardization of the TS4 installation. Lastly, the Oracle platform team states that while they do have good tools for collecting and monitoring data it is not in any way related to aspects of environmental sustainability KPIs, although they also state that it would not be that difficult for them to adopt it (5:114).

According to Celebic and Breu (2015) and Loeser (2013) one of the most important aspects within Green IS is to not only adopt its practices but also to monitor your adoption. For an organization to know how well it is performing in terms of its impact on environmental sustainability it must monitor, track and measure its progress in relation to environmental sustainability KPIs (Celebic & Breu, 2015; Loeser, 2013; Kipp et al., 2012). This will not only allow the organization to orient itself in regards to its environmental sustainability work but also allow for enforcement and development of environmental sustainability strategies (Celebic & Breu, 2015; Bachour & Chasteen, 2010). Thus, it becomes somewhat apparent that the organization has no interest in following up its progress on its work with environmental sustainability which gives weight to this being an aspect of Green IS that is not at all adopted. An organization may very well have good practices installed for working with environmental sustainability but if in

order to become aware and continue to improve its progress, it is vital that they monitor their progress (Celebic and Breu, 2015; Loeser, 2013). Why monitoring and KPIs from an environmental sustainability perspective is not an as prominent aspect of Green IS as other aspects and concludingly is not that important is somewhat abstruse as, per our literature review, there are multiple evidence suggested that organizations can make huge gains in terms of cost efficiency by monitoring these types of KPIs. Perhaps the organization has not realized the potential gain that environmental sustainability KPIs can result in and are more worried about performance figures concerning availability, as suggested by an interviewee (3:132).

5.5 Data Growth

One of the more imminent threats towards the organization is in regards to its lack of data growth management. Throughout our research we have recorded several instances across all surveyed platforms where interviewees state that one of their most imminent problem in regards to environmental sustainability is their lack to deal with the current growth rate of stored and processes data (2:453; 3:78; 4:269; 5:146). As one interviewee mentioned, the organization is currently in a large growing phase and the interviewee argues that consequently everything that does not facilitate growing must take a back seat (5:125). According to Woroch (2000) and Hazas et al. (2016), data is becoming an increasingly valuable organizational asset which can imply that the studied organization is very reluctant to let go of the data it is collecting. With business requiring more data to store and process, more hardware is required to facilitate this in need which in turn increases the organization's physical footprint and ultimately results in a higher electricity consumption (Koçak, 2013). There is therefore no questioning in the fact that uncontrolled data growth is a threat to environmental sustainability, an argument supported by both current academia as well as our empirical findings.

While all teams recognizes that this is a threat and states that there are currently none of very few solutions in place for managing it, it is obvious that this is an aspect of Green IS that is very unlikely to in anyway be adopted. Why this is not being looked upon with a more serious approach is somewhat unclear as its implications is very threatening not only from an environmental sustainability perspective but also from a cost perspective as an increased physical footprint results in an increased electricity bill. It can however also have organizational agility implications, as proper data retention and data management policies can allow for a better functioning organization as argued by Koçak (2013). A plausible reason to the negligence of this aspect might have to do with a business demand for continued growth and that capacity in relation to this growth is relatively cheap, as argued by an interviewee (5:125).

6 Conclusion

In this section we will summarize the findings of this study. We begin by reviewing the key findings made in the study and thus consequently answering the study's posed research question. As per the study's result, we then conclude the paper by giving our recommendations as to how fellow researchers can build upon and further investigate our presented findings.

6.1 Empirical Key Findings

So, as our research question states, "to what extent do retail and manufacturing companies adopt aspects of Green IS in their infrastructure software to increase their impact on environmental sustainability?" As a result of this study and by surveying its findings, we have discovered an emerging pattern suggesting that different Green IS aspects have different adoption rates. In regards to efficiency and optimization there are several examples on platform specific technology enabling more sustainable ways of operating the infrastructure software. These result in a better ability to utilize existing capacity or to lower the energy required for operating the platform which ultimately has a positive impact on aspects of environmental sustainability. However, there is a collective issue in regards to proper LCM practices which ultimately causes efforts to effectivize and optimize to be delayed, consequently delaying the impact it can have on environmental sustainability. However, several opportunities and ambitions to mitigate issues in relation to LCM was also identified. Thus, this is an aspect of Green IS that is considered to be quite well adopted but still faces important challenges.

Virtualization on the other hand is very well adopted throughout the organization as each team have high ratios of virtualized hosts, suggesting that this is an aspect of Green IS that is well explored by the organizations. There have also been indications of cloud computing strategies in practice, as well as strategies to further virtualize which gives further weight to this aspect being well adopted. The automation aspect appeared to be somewhat present within all teams as each of them stated having ongoing projects to remove human intervention as much as possible, however it did not appear as if the organization was convinced of the impact automation could have on environmental sustainability. In regards to monitoring and KPIs, we found that the multitude of the surveyed teams has tools and practices in place for monitoring and collecting data. However, there were very few instances in which the monitoring was primarily motivated by environmental sustainability factors and even though some KPIs such as virtualization ratios tangent environmental sustainability themes, this aspect in regards to monitoring and tracking sustainability KPIs does not seem to be very widely adopted. Lastly, we have found that there seems to be very low adoption of aspects surrounding data growth management. While all teams recognized that failing to deal with data growth is a serious issues we recorded very few instances of attempts to implement data management policies mitigating the associated threat.

6.2 Summary

To summarize, our findings suggest that virtualization and cloud computing is the most adopted aspect of Green IS within the surveyed organization. The adoption of the efficiency and optimization aspect does also appear to be notable but depends on the specific available technology features of the specific platform, whilst all platforms share an issue with managing LCM principles in relation to the applications they are hosting. Automation appears to be more adopted than monitoring and KPIs as all teams have ongoing automation projects and while there are solutions for monitoring and collecting data, they are largely not motivated by sustainability factors. Lastly, data growth management appears to be one of the less adopted aspects of Green IS as there are several recorded instances of team members reporting data growth management as a serious issue but none or very few instances of ongoing projects to solve it.

6.3 Limitations and Further Research

A limitation of our research findings is that our context was limited to one organization. We believe it would be of great value to see the results of an identical study performed on one or several different organizations within the same industry, or within organizations whose primary industry is not IT, with the purpose of seeing to what extent the results align. Furthermore, since the research field of Green IS is rapidly evolving we believe that there is a possibility of other major aspects of Green IS that could be studied in a similar setting or more in depth.

Furthermore, in the wake of the findings of this study several questions can be raised and several research areas emerge. As it appears as if the industry are quite well aware with virtualization technologies compared to management of data growth issues, there is an opportunity in investigating why data growth is difficult to manage and perform a more in-depth study of how it impacts aspects of environmental sustainability. Lastly, since this study indicates that virtualization and cloud strategies will increase in importance over the coming years it would be of very high interest to study the implications on the environment when an organization transitions its IT infrastructure from on premise to cloud. Also, investigating the tradeoff between running multiple physical hosts on low power or fewer virtual hosts on high power can be subject for an important study characterized by aspects of Green IS.

Appendix 1 – Interview guide

Introduction

- Get permission to record and explain that the transcription will be sent to them for auditing and that company name and interviewees name will be anonymized.
- Introduction of interviewers and what we are doing, why we are conducting the interview.
- Introduction of the interviewees.

Warm up question:

- Tell us about your division and daily operation.
- How many applications does your division have?

Main session:

Efficiency and Optimization:

- Are you continually making your platform more efficient?
- In what ways can you optimize your platform?
- How are you decreasing your platform's footprint?

Virtualization and Cloud computing

- To what percentage are you virtualized?
- What is your virtualization or cloud utilization rate?
- What is your current virtualization or cloud strategies like?
- How can virtualization or cloud computing reduce your footprint?

Automation

- Are you currently automating any processes?
- To what extent can you platform be automated?
- Are there any challenges related to automation?

Monitoring and KPIs

- Are you tracking and monitoring any environmental sustainability KPIs?
- Are you tracking your platforms electricity consumption in relation to hosted application?
- Are you tracking your utilization rate?

Data Growth

- Are you experiencing data growth?
- How are you mitigating issues of data growth?
- Impact on the usage?
- Do you have any data retention policies in place?

Closing questions

- *Anything specific you would like to add?*

Debrief

- *Informing of how we will send out the transcripts and when.*
- *Thanks for your time.*

Strengths, Weaknesses, Opportunities and Threats (sSWOT)

Appendix 2 – Group Interview Transcript AIX

Date: 2th of March 2017
Present: Omid Asali (**OA**) and Olof Kindblad (**OK**)
Location: Helsingborg
Interview Type: Group Interview
Length: 1 hour and 30 minutes
Number of participants: 8

Interviewee roles:
AIM: AIX Infrastructure Manager
PS1: Product Specialist 1
PS2: Product Specialist 2
PS3: Product Specialist 3
SS1: System Specialist 1
SS2: System Specialist 2
SS3: System Specialist 3
SS4: System Specialist 4

Row	Role	Dialog	Code
1	OK	To what extent are you today working with virtualization? Is this something you have adopted?	
2	AIM	Yes, we are running on POWER7 and POWER8.	EO
3	OA	Yes.	
4	SS2	We are fully virtualized. So, that is our strength plus we try to reuse capacity on demand. It is also a very good thing and has a direct impact on power consumption.	VC EO
5	AIM	We can basically, both increase and decrease capacity.	EO
6	OA	Okay.	
7	PS2	And we use it on daily basis.	EO
8	AIM	Yes.	

9	OA	And everything is POWER7 and 8? There is nothing that is going on the old ones?	
10	PS2	PS2: No.	
11	OA	No? So everything is upgraded?	
12	SS2	We have one old system in Dortmund.	EO
13	PS1	Three.	
14	OA	Three?	
15	SS1	Yes, there is couple of ones but, those are so small that it is not.	
16	PS1	Yes.	
17	SS3	They don't jeopardize the business in that sense.	
18	SS1	Just yesterday we turned of 2 systems.	EO
19	OA	Okay.	
20	AIM	Yes!	
21	SS1	They were old and bad.	
22	OA	Then you have control on it, you know what it is.	
23	SS1	Yes.	
24	SS2	Yes.	
25	OA	Running POWER 7 and 8…	
26	OK	What is the biggest difference between POWER7 and POWER8?	
27	OA	This is cloud based right?	

28	AIM	No.	
29	OA	You have the opportunity to cloud it?	
30	AIM	Yes.	VC
31	SS3	There are opportunities for cloud base.	VC
32	OA	Yes, and how would that affect the business if POWER8 would have the opportunity to cloud it? And AIX starting to cloud it, is there any opportunities with it?	
33	SS2	There is a ongoing project to do that right now.	EO
34	OA OK	Okay.	
35	SS2	[confidential] could not come because he is working with it, so that is ongoing.	
36	OK	Okay, so it is an ongoing activity with POWER8 and the cloud?	
37	SS3	A Cloud based POWER 8 would probably give us opportunities for some specific tools as well.	VC
38	OA	Is that like power consumption, is that efficient.	
39	SS3	Yes. That one and cloud…	VC
40	SS2	Suspensions of you know like VMware where you can suspend something…	VC
41	OA OK	Yes.	
42	SS2	And you don't, shut it down, but you put it to a state that you could easily run it up again to the state that you had it before.	VC
43	OA	Okay. That is good.	

44	SS3	We can also with that cloud based actually monitor all HMC world wide if we had all cloud based. And see the power consumption and so on.	KPI
45	OA	Okay, nice. I mean this team have control of it, it is good.	
46	OK	We mentioned POWER7 and POWER8. Let also talk about this on demand thing.	
47	OA	Capacity on Demand.	
48	AIM	Yes.	
49	OK	So this is running on the entire…	
50	PS2	No, it is only on the central.	EO
51	AIM	Centrally. Yes, for the central systems we have this. It is to new to have it on the distributed environments.	EO
52	OA	Is it under control then?	
53	AIM	We can say that, we have it and it is under control. But we can do it better.	EO
54	OA	You can do it better?	
55	AIM	Yes. We can make it more efficient.	EO
56	OA	Okay.	
57	AIM	So, with the just by having the improvement working routines, we could. Yes, we could make it more efficient	
58	OA	Nice.	
59	OK	So how do we summarize? That is a opportunity right?	
60	AIM SS1	Yes.	

	SS2		
61	AIM	More efficient working routines with Capacity on Demand.	EO
62	OK	Are you, monitoring how well Capacity on Demand performs? How…	
63	AIM	How much we use…	
64	SS1	Yes.	KPI
65	AIM	How much we use Capacity on Demand.	KPI
66	OK	Alright, and it is, is the monitoring as suffcent as possible? Do you know if you have any like monitoring issues or? I mean in regard to control as Omid were talking about?	
67	SSA	I am not quite sure what you are after?	
68	AIM	I am thinking that we have have two thesis workers and they are here to do for instance. They are here to create a dashboard, right? Part of it can be to insure that we know how much Capacity we are using on an overall picture, because we might not always have, we have a lot of tools, lots of monitoring systems and possibilities. But, we need to go in each in every one of them to see, how those it look like there, or there. So we have a better overview of it.	KPI
69	OK	Alright.	
70	AIM	We believe that, it can be more, efficient.	KPI
71	OA	Okay.	
72	AIM	There it will go to do monitoring. Monitor, it is a opportunity at least.	KPI
73	OK	Yes. Definitely.	

74	OA	The POWER7 and 8, correct me if I am wrong here. It is from IBM right? When IBM is working a lot with sustainability, it is their guideline and practices. So they have like dynamic system optimizers in the machines which should allow [confidential] to actually optimize the machines after your business in total. So you should like have control, do you think in those pattern or do you try to find gaps if something… because when we had group interview with other teams, we see that there is a lot of gaps in the business, like they say they have it, but they do not use it fully. Because the machines actually allows you to use something, but some functions does not like, it is there but the people does not use it. Is there anything you feel you have but that you do not use?	
75	SS1	There is some part that we do not use.	EO
76	AIM	Yes, but the one, you know if it is a special tool, for that one.	
77	AIM	Which one?	
78	SS3	That the, dynamic optimization. It is a [inaudible] stuff and we need to look into it.	EO
79	SS2	We are not using it.	EO
80	OA	Okay, so you are not using it?	
81	SS2	No we are not using that.	EO
82	SS3	I read about it.	
83	SS1	I think it is something about automation also.	A
84	SS3	I have it on a spreadsheet somewhere.	
85	OA	Do you believe that it will help you to be more efficient? I mean, it gives you a overview perspective of how everything actually works and where the gaps is.	
86	SS3	When I read about it, I kind of liked it	

87	OA	Yes, okay.	
88	SS3	But, then we have people in DC that is responsible for that and when I asked he was… it could have been a opportunity, but that is a opinion.	A
89	AIM	What do you think?	
90	SS3	He was a little bit…	
91	AIM	Suspicious.	
92	SS3	I mean, in someway we have control of it but, yes I don't know. It looked good when I looked at it.	A
93	OA	Yes, I mean that is an opportunity too. Because, you buy machines there is a lot of functionality but not all functionality is used. So, yes. Now we have technical problems again, sorry.	
94	AIM	Haha, yes.	
95	SS2	Haha. Windows.	
96	OK	Haha.	
97	OA	Haha, yes, exactly. That is why we are mac lovers.	
98	OK	The mouse stopped working for some reasons, but. I guess it is not an essential tool when you are using the computer, right?	
99	OA	I am writing it down here.	
100	OK	Perfect.	
101	OA	Allting stängdes ner asså.	
102	OK	Ja.	

103	OK	Nä den funkar inte…	
104	OA	Vart la du allt?	
105	SS1	Have you disabled your tracker?	
106	OK	No, it is not disabled.	
107	OA	Var har du slidesen?	
108	OK	De ligger på mejlen. Så vi har inte dem här. Does anyone have an external mouse or anything?	
109	PS2	You can take this one.	
110	OK	Perfect, thanks.	
111	OA	POWER7 och 8. Strunta i dem. Cloud based.	
112	SS2	Tappade du allting?	
113	OK	Ja, såklart. Of course.	
114	OA	Och det sista var där [confidential] pratade om…	
115	OK	Approve overall monitoring.	
116	OA	Precis. Och sen så var det opportunity, att energy scale on, på Power, alla funktionaliteter är ej använda.	
117	OK	Vad sa du?	
118	OA	Energy scale på POWER maskinerna är, asså alla funktionaliteter är ej använda.	
119	AIM	Improve working routines också.	
120	OK OA	Just det.	

121	OK	Routines.. Vad sa du energy?	
122	AIM	Working routines och capacity on demand.	
123	OK	Just det. Tur att vi spelar in allting som sagt.	
124	AIM	Ja.	
125	OK	Enable energy scaling on all machines, could you say that?	
126	SS1	Har vi inte redan det [confidential]?	
127	SS2	We don't have it activated for [confidential].	EO
128	SS1	Okay.	
129	SS2	There is a ability to use it but, because of our loads are, what do you call it? The loads on the systems that the virtual servers are running, you know, differentiates so much it is hard to do energy scaling. Because, yes. Some one wants that, other one wants that and that at that time and so, there is an opportunity that we have is maybe mapping more what I said yesterday to you [confidential] with predictable trends and analyzing trends for the different systems to enable, power scaling and bring down power usage. And to do the, what we called before suspending. But that is ongoing we have opportunity with the product so we could see about, yes. We could do that.	EO VC KPI
130	AIM	I think one of the strengths that we mentioned before is that, we are fully virtualized.	VC
131	OK	Yes that is true, I will fill that in.	
132	OA	Have you seen, what the affect of that is? Have you been like, measure it? Not measured it but, have you like seen when it was not fully virtualized? And now when you are? Have you seen the differences?	

133	AIM	Well.	
134	SS1	Sort of, from an economic standpoint.	
135	SS2	Yes.	
136	SS3	Yes, it is less machines.	EO
137	OA	Okay.	
138	AIM	Just, yesterday we shuted down two really old machines. And, found out that if, we would have that technology now within machines, we are six machines now. And if those six machines would been replaced with that old we would have 1 380 machines.	EO
139	OA	Wow. Okay, of course.	
140	SS1	There is an effect.	EO
141	AIM	Haha, yes.	
142	OA	Would you consider that as a strength then?	
143	AIM	Yes.	
144	SS3	That is only actually on the AIX machines, then you have the switches and all of that behind the wall. That would explode in that case.	
145	OA	Okay, but does this have any weaknesses? Or any threats for this then? If this goes down, what happens? Or would, is this always up, is it impossible for this to go down?	
146	AIM	Basically...	
147	SS1	More or less, it is several layers of redundancy to that. So, the only way of virtualization more or less going down is if you have…	VC

148	PS2	Hardware failure.	
149	SS1	Yes, several hardware failures and we need to stress than several because the machines themselves are redundant as well.	VC
150	AIM	Mm.	
151	OA	Okay.	
152	SS2	They have built in redundancy.	VC
153	AIM	We had security workshop yesterday, and went through all this and the likelihood of this and this happening. Pretty unlikely.	VC
154	OA	Okay, nice.	
155	PS2	And, we have a new feature now, which is remotely. When the hardware is completely down we can get the virtual server to another hardware.	VC
156	OA	Okay.	
157	PS2	Without doing anything with the hardware.	VC
158	OA	Nice.	
159	SS3	Depending on, it depends on the virtual…	VC
160	PS2	When there is a [inaudiable] with all the services. And yes.	
161	PS1	So one of the biggest differences here between this technology and other technologies is that hypervisor is in the hardware itself. So you are not depending on any software hypervisor or so on. The hypervisor uses mirrored memories and so on. So it is very robust and stable.	VC
162	OA	Okay.	

163	OK	What kind of systems are you running on all the AIX systems? Is it..	
164	SS1	Most of it is data based workloads, we run several large and critical things. Databases for our web for instance, both for the new..	
165	SS3	And the old web.	
166	SS1	What?	
167	SS3	The old web.	
168	SS1	Yes, we run everything. The logistics systems and so on.	
169	SS2	Finance.	
170	SS1	Finance.	
171	OA	So all the heavy systems is running.	
172	AIM	Yes!	
173	SS1	Yes the backend stuff more or less.	
174	OA	Okay. And you talked about the databases and you are looking for a cloud based database if I am correct here? Like Oracle…	
175	SS2	We have it if you think about the extra data.	
176	OA	Okay.	
177	SS1	But that does not run on our.	
178	OK	Okay.	
179	OA	Cause I saw something about Oracle 12c?	

180	AIM	Yes.	
181	OA	Is that something you are running?	
182	PS1	Yes.	EO
183	OA	Okay.	
184	SS2	Not in cloud form.	VC
185	OA	Not in cloud form. But the functionality is there?	
186	SS2	Yes, it is there if we want to.	VC
187	OK	Okay. Do you have any other strengths you can think about environmental sustainability? Like efficiency? hardware efficiency? Software efficiency? Do you have any software process that are not as suffcent as you like it to be? Or do you have any ongoing tasks to, improve. Since you have Capacity on Demand, I guess this is already exhausted?	
188	SS1	One more strength is we fully virtualized and we run on virtualized IO. How can we call it? Adapters? So network and fiber adapters. So we do not need…	VC
189	PS2	Supporting adapters.	
190	SS1	As other platforms need. So, that reduce the amount of switches and the amount of network and such, you know.	VC
191	PS2	Even if we have hundred of servers, hundred of virtualized servers. We only use four ports so we have fully redundancy. Three gone and they still running.	VC
192	AIM	Haha.	
193	OA	Okay, nice. I thought about, or been reading some about flash caching. Is that something?	

194	SS2	We are looking, there have been discussions of looking into it but, it has only come up as a discussion.	EO
195	OA	Okay.	
196	SS2	Flash caching, yes. That is something we can implement, we can implement it quite fast, but…	EO
197	SS3	It is [inaudible]	
198	SS2	Yes, and you need a customer really wanting it.	
199	OA	Mhm. Would that help the business in anyway if you had flash caching? You it make your days easier?	
200	SS2	I mean, from a sustainability point of view. The only thing I can think about is that, orders going through quickly, more quickly. And maybe reduce data power rend and therefore…	EO
201	PS2	Maybe it is more useful in new web back prompt.	EO
202	SS1 SS2	Yes.	
203	SS1	Where you have small transaction all the time.	
204	SS2	To lower power consumption, yes.	EO
205	OA	And if you are going to have the flash caching, you need SSDs right? In the hardware?	
206	SS1	No there is several technologies for that. It does not have to be SSDs.	EO
207	OA	So it does not have to be SSDs?	
208	SS2 SS3	No.	

	PS1		
209	SS1	It is memory based and so on.	
210	PS2	You can, use I think. Everything we can keep in the memory.	
211	OA	Okay.	
212	PS2	If it is small transfers, we can use…	
213	SS1	It all depends on, the requirements there. Because you can have workloads that needs to write, to memory very fast and once in awhile you flash that down to a normal storage. Then you have larger amount, yeah, then you probably need a external device running SSDs. But it works in the same way, they just take it and storage it and flash it down to other disks once it have time.	EO
214	OA	So, I believe you have a cluster where everything is multi threading, right? Between this? Yes?	
215	SS2	Mm.	
216	OK	So, talks about SSD and flash caching, it is mostly a political issue. But from a sustainability standpoint, would it be a opportunity?	
217	SS1	It does not. I do not believe that it is a political issue, because when I am talking about it, I talk about it in general terms. If we talk specific vendors than yes. It could be a political thing, but if we just talking flash storage in general terms. I do not see that thing.	
218	SS3	Flash cache and so on.	
219	OK	But it would be a opportunity in terms of sustainability. Because it would affect and lower the power consumption of the hardware.	

220	SS1	It is hard to say, it all depends on the workloads.	EO
221	OK	Okay.	
222	SS1	I would say. I mean this is not a universal solution for everything but for workloads, yes. It could have an effect.	EO
223	OA OK	Okay.	
224	OK	What kind of input do you have on the hardware aspects? Are you owners of the hardware's as well?	
225	SS1	Yes.	
226	AIM	Central hardware.	
227	OK	Central hardware.	
228	SS1 SS2 SS3	Yes central hardware.	
229	OK	So…	
230	SS2	But we have the design authority of the distributed hardware as well.	
231	AIM	Yes.	
232	OA	Okay.	
233	OK	Alright, so…	
234	SS2	From a naturally standpoint the distributed hardware is owned by the distributed sites. But we provide them with the technical standards so they use our standardize servers and machines and so on, for it.	
235	OA	Okay.	

236	OK	OKYou..	
237	OA	But.. Ah, sorry.	
238	OK	You make the calls when you are buying new hardware?	
239	SS3	We present a solution and it is up to them to accept it or not.	
240	OA	So if…	
241	AIM	Another thing about the Capacity on Demand [confidential] says that we do not own the hardware anymore, we lease it.	EO
242	SS2	Yes, you are right!	
243	AIM	So we both own and lease and had single authority over that stuff. That we own and lease.	
244	SS2	Haha.	
245	OA	Okay.	
246	OK	Yes, the reason is asking is cause, as we mentioned before, hardware is an important aspect. I mean we like to know your thoughts on sustainable hardware, is that a precipitative? Anyway, in the technical recommendations you make, do you look at power efficiency?	
247	SS2	Of course, we look at it. We look at it from many aspects from what I see. It is both power consumption that is why we going over to POWER7 and POWER8 as much as possible because, we can get more bang for the buck.	EO
248	SS3	They use less power.	EO

249	SS2	Yes, they use less power. And also we look very much at the virtualization. How we can improve the virtualization and squeeze more stuff in basically. That is always an over going process.	EO VC
250	OK	You just said, bang for the buck. It is mostly motivated by the buck? Meaning that has sustainability aspects ever been a holding critical point?	
251	AIM	No.	
252	SS1	No.	
253	SS2	No.	
254	OK	No? It is power consumption? Since less power means less money.	
255	SS1	Yes more or less.	
256	AIM	We do not, choose our hardware for the power consumption. That is not the reasons why, it is as [confidential] said, more bang for bucks. Be able to deliver more for less money. And being more efficient, and much of it is taking less space in the data centers and so on. But we do not have environmental sustainability as a driver it is just a plus.	EO
257	SS1	I don't know if you are aware of this, probably but IBM is the only one that actually creates this platform. So we do not have the opportunity to go to different vendors to see what they offer.	
258	AIM	No.	
259	PS2	In terms of environmental sustainability.	
260	SS1	Exactly. So we have one vendor. But their as you said before, they are on top of this and making sure that every generations is more efficient and so.	EO
261	SS3	It is their standard.	

262	AIM	We do have one more strength actually when it comes to that because even though we can not choose between vendors. But we do have this [confidential] which is not here today, he sits in a forum.	
263	SS1	Yes.	
264	AIM	At IBM. A customer forum, so, they are not many in the world sitting there.	
265	SS3	We are the only ones in the Scandinavia of all the countries that has that.	
266	AIM	Yes. So he can sit there and influence what they could do.	
267	OA	Okay.	
268	SS3	He talk directly to the technicians.	
269	OA OK	Okay.	
270	AIM	So he goes one week per year he goes to Austin, Texas. And sits in forums and discusses with the developers and planners, we want this and we want that. And so on.	
271	OK	Alright.	
272	AIM	So we can affect	
273	SS2	So we can say like we wish you to go this direction and so on.	
274	AIM	Yes.	
275	OK	Alright.	
276	OA	Okay, but do they listen?	
277	SS2	Of course.	
278	AIM	Yes.	

279	OA	You are a big customer so.	
280	AIM	I mean, for instance now we have the automation infrastructure platform productivity, product so to say. And we had issues with storage. Missing support, IBM does not have support for one of the drivers so [confidential] have for couple of years said okay please support this. Now it is ongoing.	A
281	OA	Okay, nice. It is actually good to have [confidential] sitting their.	
282	AIM	Yes.	
283	OA	And tell them what to do.	
284	OK	Has [confidential] ever brought up aspects of environmental sustainability? At these, at this. I mean it is maybe difficult to track.	
285	SS2	I have no idea. Wish he was here to answer that.	
286	OK	Maybe we can do a follow up with him-	
287	AIM	We can put it up as an opportunity.	
288	OA	I thought of one thing when you said that you are leasing. [confidential] were you, I mean, if POWER10 is coming in like three years. Then you have you like, what do you do with POWER7 and 8? Is there anyone here that is responsible of actually recycle the machines or now you have a leasing contract….	
289	SS2	It is IBM that is responsible for it.	EO
300	OA	Exactly. That is good, but do you follow up that they actually are recycling the machines or what they are doing with it?	
301	AIM	No.	

302	SS2	As you said, they are heavily involved in environmental sustainability. So, of course. That is a point we could…	EO
303	SS1	No, but we should do that.	
304	SS3	I do not think that we do, but…	
305	SS1	No, not we as a team but part of facilities. Because they make sure that the vendors follow [confidential] guidelines in regards to that and we have companies handling decommission old hardware and they need to follow [confidential] rules. So it is being done, but we are not doing it.	
306	AIM	I think, one weakness that we have that we have not talked about is the, how can I say it? If we take for instance the Linux platform. They have one release that was in somehow classified as sort of environmental sustainability, Green IT release. And it sounded very good. I think that we are not as good when it comes to PR to say how good this platform is sustainability wise. And we do not have a way to market how good it is and when it comes to sustainability. It is a sustainable choice.	
307	SS3	We are not good at PR but we are running Green IT since about six or eight years.	EO
308	AIM	Yes.	
309	SS3	That is why they moved that to green as well.	
310	OA	That is the point of measuring stuff, because if you measure it and actually do graphs. You can show, because numbers do not always say stuff. Visualization tells more. I mean, your team is quite green.	
311	AIM	Yes.	

312	OA	You are doing a lot of right stuff, in most of the parts. There is nothing here, or something but this is the front edge, this is now. So I mean, maybe is the weakness the communication of what you actually doing right? and in a right way?	
313	AIM	Yes!	
314	OA	Cause I don't believe, I don't know. But I don't believe that Linux is greener than your team is?	
315	AIM	No. The amount machines they have.	
316	SS1	I don't know how to classify a weakness or a threat. But there is one thing we have hard to shape of, is that we are perceived as expensive.	
317	AIM	We are more expensive.	
318	SS1	Yes, we are more expensive. But at the same time…	
319	AIM	Less expensive than Gartner is, or what others are.	
320	SS2	At the same time, as you are saying. We are at the front edge of sustainability when it comes to lot of things.	EO
321	SS3	Question is what we should put it on as more expensive? The hardware, of course it is more expensive. If we compare to [inaudible] or what ever. But perhaps that part is not more expensive to…	
322	PS2	Others.	
323	SS3	Others. That is also difficult to know how we should do it?	
324	OA	That you are expensive is quite natural? I mean, you drive heavy software and…	

325	SS3	It is as you said we are driving more or less the heavy market enterprise machines.	
326	OA	Yes, and so. I don't know, the expensiveness that usually contracts with the vendors? Or leasing? That could be more..	
327	SS2	I think it is also, how can I explain this? The part of [confidential] business is to see like yes if you want high environmental sustainability, if you want that it does not come cheaper and that is the thing. If you want to invest in environmental sustainability it will cost you.	
328	OA	Yes. In short term sustainability costs. But in long term you get the money back usually.	
329	SS1	I can see one thing that could be, is a ordering process of new, how do you say not hardware but ordering new platforms and stuff like that. To bring sustainability aspects in that ordering also, I can see that as a strength when they go to IT and say I want this system, okay they have underneath there, they have sustainability…	EO
330	SS2	I think that is an opportunity.	
331	SS1	Yes, an opportunity.	
332	OK	Oh, there is no?	
333	SS1	No no there is no.	
334	OK	Okay.	
335	SS1	But there is more as well if we talk in that perspective. I mean the one thing that impacts sustainability very much is the actual capacity usage on all of our platforms. And we have quite old way of looking at capacity…	EO
336	AIM	Yes!	

337	SS1	Because we are talking cores and memory and some product out there they need something, so they look at the back of the box more or less and say we need ten cores and five hundred gigs of RAM. And then that gets ordered, there is no real flexibility in that. So we might end up in a situation where ten cores and five hundred gigs of RAM were to much or we way to little in some senses. And then it more or less, this is very hard to change as the fact. So as an organization we need to change the whole mindset into something we just talked about delivers and then we tweak all the capacity parts to where it actually runs in a optimized way. And that could also then decrease our usage of capacity on demand and save us money, use less power and so on and those kind of things.	EO
338	SS2	Basically what you are saying is that we are not pushing our application or our software vendors. To think of sustainability, because they say that…	
339	SS1	Probably they think about it but not in those terms that what they actually order in the end and run affects it that much. I do believe that they think about it but to have most impact we have to change our entire mindset about this things. And I am sure we are getting there, I mean the more we go to cloud based it is a different approach to that part.	EO VC
341	AIM	I think we have too poor KPIs as well.	KPI
342	SS1	Yes.	

343	AIM	The KPIs, I mean there is KPIs were like facility is showing power consumption and so on. That is good. Then we have another KPI showing how virtual our platforms are and that one is sort of lying. In two aspects. One on the Linux part because they cutting out some "we can't do anything about this" so we just take them away. And then it looks much better, so the KPI is not true. Then we are not even shown because we are to good. So, like we are 100% so why should we been shown? Because we can not improve when it comes to virtualization and that does not really, if we were up here and Linux down here that would show come on, improve. But now they are removing the best one and removing the bad ones from the Linux platform showing that Linux is good in the virtualization aspect. That is not really giving the effect, that it should have.	KPI
344	SS2	That is true.	
345	AIM	So the KPIs are bad, mhm.	KPI
346	OK	How would you summarize it? Poor KPI practice? Or…	
347	AIM	Bad KPI presentation perhaps.	KPI
348	SS3	Yes, when it comes to virtualization. And then what we should have is really capacity usage on each on every service.	VC KPI
349	SS1	Mm.	
350	SS2	Yes.	
351	AIM	Not the infrastructure service, but the applications. If they had a KPIs showing how much they use out of what they have, they could see that they, it would be much easier for them to realize that "ah I can actually do something about that". That should not be that difficult.	KPI
352	SS2	To put the KPIs to call it like a sustainability factor or something like that…	KPI

353	AIM	Yes. Implement sustainability KPI for sustainability capacity, something KPI, for all the applications. How much capacity they actually utilize?	KPI
354	SS3	Because we have discovered some applications that just orders CPU whatever, and they use a fraction of what they order. It is still a problem, they order more and think that is the solution for it.	EO
355	OA	So does everybody talking about Linux as the Green IT?	
356	AIM	Because they have marketed. All of our versions are green so they don't think about that. But Linux comes up with that they have released one that was green. That was an achievement.	
357	SS1	If you look at it world wide, they also market Linux as green alternative. And that has also to do with the development cycles and how they have developed that, it is open source most of it and a lot of companies. But it also comes down to the hardware, what they run. If we talk about Google if we talk about what you call it? Facebook and talk about Amazon and talk about all those. They built their own hardware.	
358	SS3	And Google now build their own power.	
359	PS2	Yes, Google building their own power.	
360	SS1	Of course all of those companies want lower power consumption because it costs them with all the huge data running. So they build their own, because they can not buy out of the box the sustainability for AIX hardware, they build their own, purpose built exactly for having lower power consumption.	EO
361	AIM	In seriously cold places.	
362	SS1	In seriously cold places, haha.	
363	OA OK	Haha.	

364	SS3	What I think is many talk about Green IT, it that is what you said KPI, going from dedicated to virtual. We have been virtual and green…	KPI VC
365	PS2	Five years!	
366	SS3	For five years.	
367	PS2	More than five years.	
368	OA	Is Linux dedicated? Or virtual?	
369	SS2	Both.	
370	PS2	Both.	
371	AIM	Both.	
372	PS2	They don't have any data for it.	
373	OA	You guys are giving us good information for the group interview with them.	
374	SS2	And we need to say, that the virtualization is not on the same phase as we are because they are running on VMware which is another, it is a hypervisor on top of other system.	VC
375	PS2	They are running on all kind of thing.	
376	OA	Haha, okay.	
377	SS2	They are running on a virtual on a, virtualization platform that runs on a hardware. We are running hardware that is virtualized inside of the hardware that runs directly on the hardware that is lower power consumption to even to start there.	VC
378	OA	The virtual virtualization, sounds like a quick fix.	

379	SS1	This is not only for Linux it is for Windows as well. We should not only bash on Linux.	
380	SS2	Question, were the sustainability a part of discover services?	
381	PS2	Haha, No?	
382	AIM	No? What is the service offering.	
383	SS2	It should be a part.	
384	AIM	Having service offering in it self?	
385	SS2	No the aspect of sustainability should, you should…	
386	AIM	Oh in the services, no! Good idea.	
387	OA	What services?	
388	AIM	I am in part of a project that is about writing down the service offerings for OSS. And the part of finalizing that and he just mentioned that sustainability is not a part of it.	
389	SS1	This not specific for…	
390	OK	Ah okay.	
391	AIM	No it is not in there.	
392	SS1	That is something the technical teams are suffer from so it is not something special for us. But I think that as a organization if we change our mindset regarding that there is a lot to gain in the end from a sustainability perspective.	
393	OK	Alright. Then we put it up but we will mark it to state that it is a global perspective than just for the team.	

394	SS1	Yes!	
395	OK	How would you phrase it?	
396	SS1	Just as I said.	
397	SS1	No but…	
398	OK	Change the mindset..	
399	SS1	Since capacity affects the power consumption we need to change our mindset of how we order and deliver capacity.	EO
400	OA	Okay.	
401	SS1	Does that make sense?	
402	OA	Yes, of course.	
403	SS2	For example, if we think of Linux side again, sorry for bashing on Linux. But when it comes to their Oracle databases, they will not, Oracle will not support any virtualized databases for example.	
404	OA	I was reading the white paper for Oracle about the Oracle rack and the Oracle 12c cloud based database and they don't mention sustainability in their white paper. They just talk about cost efficiency…	
405	SS2	Mm.	
406	OA	Then you can see if cost effective, cost efficiency is sustainable in the end. But still nothing about the environmental sustainability part for their software or their solutions.	
407	SS2	And 99% of all the database that we run in Linux and AIX is Oracle.	
408	SS2	One strength that we have is that, yeah. All software that run on our platform is supported virtually.	VC

409	OK	And that will fall under the fully virtualize aspect.	
410	OA	Would you like to take a pause? We have been sitting here for one hour now. If you want to stretch your legs.	
411	SS2	Or maybe you guys need to think a little bit.	
412	OA	No, no.	
413	SS1	How long do we have scheduled for this?	
414	AIM	Until 12.	
415	SS1	Than let's take a couple of minutes.	
416	AIM	We were talking about it as the IPA project.	
417	SS1	Which is an internal cloud setup.	VC
418	OK	Okay. Then I understand.	
419	AIM	So put it up as IPA internal power.	
420	OK	For POWER8?	
421	SS1	All.	
422	AIM	Yes it will be for POWER8.	
423	SS1	Yes but the IPA project itself is not only for AIX and POWER.	
424	AIM	No.	
425	PS2	It is for all.	
426	SS1	Yes.	

427	OK	Okay.	
428	SS1	We will utilize POWER8 and POWER9 when that comes.	EO
429	AIM	Yes.	
430	OK	Alright.	
431	PS1	Monitoring, it is also an IBM checking for the sponsor user program. So they got a lot of requests from customers and we are one of those that sensing the requests.	KPI
432	PS1	I like that one.	
433	AIM	Which one?	
434	PS1	Implement sustainability aspects when ordering new platforms. First choose should always be our platform and then.	EO
435	SS1	[confidential] is a power evangelist.	
436	OK	That is perfect from a sustainability aspect as well.	
437	PS1	Implement sustainability.	
438	SS2	So we have that today from a platform perspective but not from the application service perspective.	EO
439	PS1	Mhm. Suspension? Oh what is that? Is it the hypervisor thing?	
440	OK	Maybe we can clarify it.	
441	PS1	When things are not used in AIX system, those cores are not used. So the POWER system will turn of things by default. So that one is more or less just to…	EO
442	SS2	I just remembered that we had a discussion before, specially DH2.	

443	PS1	Yes, but it actually requires some storage and in the virtualized service normally, save you memory somewhere.	VC
444	SS2	Is it a threat that we perhaps grow that fast that the environmental sustainability sometimes end up in the back seat of things?	
445	AIM	Yes. That is a factor why we do not work more focused on it.	
446	OA	Okay.	
447	SS1	One threat is a also that, as to say we always be cost efficient. And we do not put these sustainability factors into the cost.	
448	OA	As we said earlier, that the sustainability is a short term cost but in the long term you get the money back. And that is a threat, like talking about cost efficiency, maybe yes, the sustainability part then falls behind.	
449	OK	We did, in the slide you sent us, see some growth increase. That is what we talking about when we growth speed right? The number of connected devices?	
450	AIM	Yes. Then it was like this and now like that.	
451	OK	How come, is it because the company's global expansion increase business demands or?	
452	AIM	Yes.	
453	SS2	Well we have not really thought about it, bringing in also overall growth with how, [confidential] is working with sustainability for the end user. How do wake our customers to be more sustainable.	DGM
454	PS1	Yes, I have one threat.	
455	OA	Yes?	

456	PS1	[confidential] architects…	
457	PS2	Haha.	
458	PS1	Because they can just by making a change. They can demand for physical boxes, they can demand for for separation of things and so on.	
459	AIM	So, sustainability focus among the architects are too low.	EO
460	SS2	Does that compliment sustainability aspect when ordering platform?	
461	SS1	That is on a different level.	
462	OA	So you mean that [confidential] architects does not think in a sustainable way?	
463	AIM	No.	
464	PS1	They choose a platform, like this is the platform to go. And then they choose it and then they say "We need to separate network we can not be together" what so ever.	EO
465	PS2	Yes, needs operate hardware, needs…	
466	OK	That is a good point. Are there any other points to make about this?	
467	SS1	Mostly we are most reactive coming to that [confidential]. We want to be more proactive.	
468	AIM	For example when it comes to looking into if we can reduce capacity during weekends.	EO
469	SS1	Yes, stuff like that.	
470	AIM	And how do we get working routines to make sure that we do not have too little capacity.	EO

471	PS1	Some sys admin work. Checking out opportunity once in awhile, keeping track of applications and services.	KPI
472	AIM	But not at Hawk, if they were example for weekends again. Having Intel that okay this friday I should turn it down so much then I can turn them up again. Having that as a schedule routine.	EO
473	PS2	I think that is a bad example. We can.	
474	SS1	It is one example.	
475	AIM	It is one example.	
476	SS2	It could be for example in the middle of [inaudible]…	
477	PS2	Yes, but if you use one…	
478	SS3	[confidential] said before, that the POWER server itself brings down the CPU if it is not utilized.	EO
479	SS1	Yes but sustainability is one aspect then you have cost as well.	
480	AIM	Yes.	
481	SS3	There is bigger problem, when you putting it in that like economic…	
482	PS1	Core as one day. It is good way too…	
483	AIM	Yes to bring them down during the night.	
484	SS1	Let not go into that discussion.	
485	PS1	Because that process also include talking to the guys on the services if they want to have some cost savings, they maybe they should have a lower share.	

486	SS1	Yes and we have that in there as well in the sustainability capacity KPI for all the applications.	KPI
487	AIM	I think it should be a extra part of the service offering. So they can choose to be more sustainable choose.	EO
488	SS1	Yes.	
489	AIM	And then they have some demands.	
490	SS1	[confidential] had that.	
491	AIM	Yes, but that is specific. Like they can order it specifically and then they have some demands. Like this is what you have to do and…	
492	SS3	That is a threat in that case or a weakness for [confidential] for application, all does not think about that part in that way.	
493	PS1	If I were a service owner and I bought eight virtual processors I would never satisfy purchasing ten and gaining one as, this is what we guarantee you, the rest you have to borrow in the pool. I would never purchase that one, if it was not like 50% KPI or cost off.	VC KPI
494	SS1	I think we are getting too deep into it here.	
495	AIM	Yes.	
496	PS1	But, the problem is not thinking of that turning off, turning on and move things.	
497	SS2	But that client have some interesting following aspect then each service and us also we have to prove our sustainability. You understand what I mean? We have to document it to show it, somehow. Linux has to do, Windows has to do, we have to do it.	

498	PS1	Sustainability is not concerning about the cost of licenses.	
499	SS2	No the cost is not there. It is the impact of sustainability of each of this have.	
500	PS1	Things that is not used by POWER is turned off by default. So that is something you can write.	EO
501	OA	I have a question, I do not know if it is wrong but can you go back in history, like 5 years and see how the usage have been? And then optimize it with patterns and nodes.	
502	SS1	Not the optimize part but we know how the usage have been over the years.	KPI
503	OA	Okay, like know it is eastern, many people are free they buy online or something. Lets pull the POWER usage up.	
504	AIM	We use that!	
505	SS1	We have that already.	
506	OA	Okay.	
507	AIM	We do that.	
508	SS1	That we do.	
509	AIM	We know for instance, during christmas some need more some need less. We know that…	KPI
510	PS2	March and september financial.	
511	AIM	Yes. For financial year end we know that the financial systems need more and extra.	
512	SS1	So we do stuff like that already.	

513	PS1	But if we let it go to be all automatically, up and down or whatever. I probably say that we need the double of amount of hardware. Because things are going to go up and when ZEBRA are utilizing 400% ZEBRA is not just going to, if he want to go for the applications and doing this. He is going to increase the ZEBRA.	V
514	OA	So now it is like real time data coming out and [inaudible] and it is optimized by itself?	
515	PS1	Yes, they can learn patterns.	EO
516	SS1	But ZEBRA is something that we do not have yet.	EO
517	PS1	No, but if we do any automation work for ups and downs backs and forths. I think we need to have a lots of more hardware. Because we sell ten and give one and then we just hope that those guys do not run at the same time. Because that would give us some problems.	A EO
518		[interview ends]	

Appendix 3 – Group Interview Transcript Linux

Date: 30th of March 2017
Present: Omid Asali (**OA**) and Olof Kindblad (**OK**)
Location: Älmhult
Interview Type: Group Interview
Length: 1 hour and 19 minutes
Number of participants: 8

Interviewee roles:
LIM: Linux Infrastructure Manager
LID: Linux Infrastructure Designer
PS1: Product Specialist 1
PS2: Product Specialist 2
PS3: Product Specialist 3
SS1: System Specialist 1
SS2: System Specialist 2
SS3: System Specialist 3

Row	Role	Dialogue	Code
1	OK	Vi skulle vilja börja med att helt enkelt be om en kort beskrivning på hur er mjukvarustack ser ut.	
2	LIM	Nerifrån, hårdvara, så intelservrar, hela vägen upp genom virtualiseringslager och operativsystem då. Både x86-hårdvara och x86-virtualisering, det vill säga VMWare är på företaget då och Linux. Allt som körs på företaget, i stort sett alla applikationer… det är ett fåtal som inte körs hos oss, på ett eller annat sätt.	
3	PS1	Stora delen är väl egentligen databaser och WebLogic...	
4	LIM	Ur ett Linux-perspektiv ja, men tittar vi sen på hårdvara som sitter där och sen har vi virtualisering som sitter där så har vi ju hela köret, både Windows, Linux… det enda som inte touchar där är väl de rena AIX systemen och VMX system, MHS och… CNS, OMS och EPS.Men de flesta körs ju där på ett eller annat sätt. Ja, det är en väldigt bred bild… utifrån ett software- och process...	
5	OA	Capacity on Demand, är detta något ni kör idag?	
6	LIM	Nej. Vi har… det vi har på Linux-sidan är ju Linux TS, är ju byggd… det är [namn] som kan det här… med sustainability.	
7	PS2	Om man tittar på såna här… processorerna att de ska gå ner i energiförbrukning och så… jag vet att det är ett alternativ men jag vet inte om vi använder det.	EO

8	LIM	Jo… man kan väl säga som så att TS4 är det default configuration.	EO
9	PS2	Jo, det jag vet om TS4 är att man förbrukar mindre energi på samma hårdvara.	EO
10	LIM	Jo men det är för att den är, det är ju förra versionen, det vill säga TS3, så byggde ju [namn] en sustainable version som var en optional, det vill säga att man kunde välja den, default var ju inte den, men sen när TS4 släpptes så var det sustainable versionen som var den defaulta.	EO
11	OA	Men om den är optional, är det så att ni väljer att den ska köras då… ?	
12	LIM	Nej, inte den senaste då, den som installeras på allting nu, det är den sustainable som ska stänga ner resurser som inte användas och vad det nu är den drar ner.	
13	OA	Hur ser ration ut i stacken mellan andelen installationer som är sustainable och andelen installationer som inte är det?	
14	LIM	Vet vi hur mycket TS4 vi har på det totala? 20 procent? 25 procent?	EO
15	PS2	2500 något sånt där…	
16	OK	Men praxis är att man installerar TS4 idag?	EO
17	LIM	Praxis idag är att om man inte beställer en specifik version, det kan ju vara att man inte har gjort sin livscykelhantering och att dom applikationerna bara kan köra på en äldre version så beställer dem det, men annars beställer de och säger "vi behöver en Linux default" och då får de den senaste.	EO
18	SS2	Men de flesta som beställs kör ju virtuellt då och jag vet inte riktigt hur det blir då, ur ett sustainabilityperspektiv, hur en sustainabilitykonfiguration påverkas av en virtuell kontra en fysisk.	EO
19	OK	Okej, så ni har liksom en sustainable, som är uppe, vad var det, TS4 hette den?	
20	PS2	Ja.	EO
21	OK	Och den är nu default?	
22	LIM	Den är default.	EO
23	OK	Men, vad var det, 6000 kontra 2000, 25 procent ungefär gick på den som inte var sustainable?	
24	LIM	Ja, men det är ju då äldre versioner… tanken är ju att dem ska livscykelhanteras men vi har ju inte ägandeskap på det utan det ligger på applikationsägarna att göra liksom hela vägen ner. Sen så har vi ju, man kan säga att vi har ägandeskap på informationen på vad det är dem ligger på och att informera dem om att, "ni ligger på denna versionen men	EO

		ni behöver gå till denna så när hade ni kunnat planera in den här åtgärden?".	
25	OA	Görs detta kontinuerligt eller görs det när det finns tid?	
26	LID	Nja, det är svårt.	EO
27	LIM	Det är ju det som är problemet att det görs ju inte i den takten som det börs, så vi ligger ju efter rent livscykelhanteringsmässigt. Och det är ju en av det absolut största identifierade svagheterna, det är livscykelhantering.	EO
28	OA	Men som jag ser det så finns det i alla fall en styrka i att TS4 nu är den standard som installeras?	
29	LIM	Ja och den är då som sagt defaultad som sustainable.	EO
30	OA	När kom den upp?	
31	SS2	Två år sen knappt.	
32	OK	Och sedan finns det förstås en möjlighet i att utöka den här ration, det vill säga att man inte har den här 25 procentsanvändningsgraden?	
33	LIM	Ja, det blir det ju för varje, förhoppningsvis varje installation så ökar ju procentsatsen och förhoppningsvis så sker det även decommission i andra änden och andra version. Och sen så är det ju, det är ju operativsystemsidan, den stora boven är ju kanske hårdvaran, alltså gammal hårdvara som… det är ju naturligtvis att leverantören presenterar ju, för varje ny generation av hårdvara, så har de ju tryckt ner energiförbrukningen...	EO
34	LID	Ja, det blir effektivare.	EO
35	LIM	Precis, det blir ju effektivare.	EO
36	OA	Så när ni väljer hårdvara och så, utgår ni från aspekter som energiförbrukning eller energieffektiviteteklassificeringar och så? Att det finns funktioner som bejakar sustainability, som till exempel Capacity on Demand, Power Top, Active Energy Manager och liknande?	
37	LID	Njae, det kan jag inte påstå att vi gör, men däremot så finns ju möjligheten att i hårdvaran ställa in det. Det görs på en hel del av systemen men en del behöver köra fullt.	EO
38	LIM	Men det finns ju inte i våra x86-burkar, Capacity on Deman-möjlighet...	EO
39	LID	Nej, det finns inte.	
40	LIM	Så att du liksom smetar en full CPU med minne och stänger av rent licensmässigt.	

41	OA	Men finns det någonting, någon form a sustainabilityfunktionalitet, "påslaget"?	
42	LIM	Jojo, det finns det, på vissa men inte på alla. Vad är defaulten? Defaulten är att den är balanserad.	
43	LID	Ja, sen är det ju era system som idag...	
44	SS1	Vi kör ju allt på max.	EO
45	PS1	Ja, vi kör max.	EO
46	LID	Ja, de virtuella hostarna behöver ha allt max men de som inte är virtuella kör balanserad.	VC
47	OA	Hur ofta byter ni ut maskinerna? Eller det är kanske inte ni som tar de besluten?	
48	LID	Vi sätter upp och testar av det nya och så säger vi att, "ja, den här och den här går ut, out of support om ett år så ni får planera in och göra en SEM på er hårdvara också" men det är samma problematik där som på operativsystemet.	
49	OA	Hur ser det ut vid återvinningen av hårdvaran, är det ni som har hand om det?	
50	LID	Nä, det är ingen av oss… nä, det är nog egentligen [namn] som sitter i [namn]s team. Han sköter det avtalet, vi har ju ett återvinningsavtal med leverantören, så han har ju den kommunikationern med leverantören och jag har för mig att de nere i källaren samlar ihop så att det blir liksom pallvis, så när där är ett antal pallar så tar man kontakt med leverantör och skickar det till dem. Och sen vissa, jag tror att de sorteras också utifrån hur gamla de är så vissar går väl till leverantören direkt till skrot och återvinning, vissa går väl då så att leverantören kan sälja dem eller återanvända dem för reservdelar eller hur det nu är leverantören hanterar dem.	
51	OA	Är det här avtalet globalt och för samtliga av era platser?	
52	LIM	Det vet jag inte riktigt, men jag har för mig att det är lokalt.	
53	OO	Men för att återknyta till det vi pratade om innan då, kan man säga att det är en svaghet att det ändå finns så pass mycket gammal hårdvara?	
54	LID	Ja, det tycker jag.	EO
55	SS3	En fråga här då, jag vet inte om vi kan svara på den men… vad är skillnaden mot att byta ut hårdvara mot ny kontra kostnad och sustainability impact och så vidare för att tillverka nytt hela tiden. Nyare och modern hårvara är ju effektivare och snabbare och bättre på alla sätt men är det verkligen så att det alltid blir billigare när det tillverkas nytt?	EO

56	LIM	Jaa… är det plusfaktor eller är det en minusfaktor?	
57	SS3	För det är ju mycket snack med det där, "vad ska det bli av med det gamla, det kostar för mycket ström och allting… men det är ju klart att de vill sälja nya.	
58	OK	Ja, absolut, det finns ju en viss komplexitet där i att avgöra huruvida någonting är sustainable.	
59	LIM	Men en styrka i det här måste ju vara att vi ligger på en virtualiserings-grad, totalt sett alltså om vi nu tittar på centrala miljöer, på över 70 procent nu vilket gör att det fysiska avtrycket blir väldigt mycket mindre jämfört med om du skulle köra allting fysisk, 50 till 1. I och med att vi har tryckt ihop ett virtualiseringslager på x86-sidan och AIXen är ju nästan 100 procent, 99,9 virtuellt… och på x86 tror jag vi är över 70%.	VC
60	OK	Är målet att nå 100 procen virtualisering?	
61	LIM	Det kommer vi aldrig nå förmodligen för det kommer alltid finnas spe-cifika behov som… men vi siktar ju på att öka den graden, det är vår standard idag. Det är ju vår standard idag, alltså virtuellt, det är vårt standard offering. Ska de ha en fysisk miljö då är det en exception-hantering.	VC
62	OK	Ja, det är bra.	
63	LIM	Ja, absolut jo det är en styrka, alltså det är ju en sustainabilitytanke bakom det bland annat. Enkelhet och konsolidering och… det finns ju många vinningar på att virtualisera och även nästa steg i Linux-platt-formen, OpenShift och Container är ju också en form utav att virtuali-sera ännu hårdare och ännu högre upp i lagret. Det är ju inte bara att vi virtualiserar ner på infrastrukturen utan att vi faktiskt virtualiserar ända upp i applikationslagret, så det är ju också en… med, om man nu ska ta det åt sustainabilityhållet, så är ju det ett plus och en styra och även en möjlighet att låta det växa.	EO VC
64	PS3	Och det blir ju en väldigt möjlighet sen för att göra LCM på hårdvara. I och med att dem kör virtuellt, då behöver vi inte gå ut till serviceä-garna och "säga att nu måste ni LCMa eran server" och de säger "nej, den måste vara uppe"... det blir ju ett jätte back-and-forth där liksom att det ska avtalas… nu kan vi ju säga det att "ja, er maskin kommer vara uppe hela tiden men vi, undertill, byter vi hårdvara" och det är ju en väldigt möjlighet.	VC
65	LIM	Ja, precis, det är ju verkligen en styrka ur ett sustainabilityperspektiv att vi kan göra våran LCM precis när vi vill och behöver.	EO
66	OK	Så det hade underlättat för er om adoptionsarbetet med virtualisering hade gått snabbare? Ni nämnde att ni aldrig kommer bli 100-procentiga men så mycket virtualiserade ni kan bli?	

67	LID	Vi jobbar ju ganska hårt med den physical-to-virtual, det vill säga att när en server, en gammal server då ska LCMa och de ska gå över till en virtual, att den processen ska gå så lätt och smidigt som möjligt för dem.	VC EO
68	OK	Ni nämnde tidigare att ni har börjat arbeta med att virtualisera så att säga "högre upp i lagret", vad innebär det mer exakt?	
69	LIM	Ja, nästa lager är ju container-tänket och då virtualiserar du snarare på applikationsnivå… kan man väl säga.	VC
70	SS2	Ja, du tar ju din applikation och de beroendena och lägger i en container så att du slipper duplicera en hel server för att köra hela applikationen så du kan ta en applikation, eller tio applikationer eller 20 applikationer och köra på samma server.	VC
71	LIM	Ja, precis, på samma operativsystem.	
72	OK	Så är detta ett containersystem liknande exempelvis Docker då?	
73	LIM	Ja, det är Docker.	
74	OA	Hur hanterar ni "idle hardware"? Det vill säga, har ni koll på hur exempelvis den övergripande utilisationgraden på CPUerna? Har ni tillexempel servara som bara står och snurrar utan att göra något?	
75	LIM	Oja.	EO
76	OA	Är det på grund av livscykelhanteringen då?	
77	LIM	Ja, precis, det är den största svagheten vi har, det är livscykelhanteringen.	EO
78	SS2	Ja, och det är inte bara den för att det är ju testmiljöerna… det är ju jätte… det är ju en annan sak, visst, det handlar om att virtualisera till en högre grad, det är ju jättebra men om man ser det kanske ur ett annat perspektiv som det totala antalet servrar… det bara exploderar.	VC DGM
79	SS3	Ja, det är för enkelt.	DGM
80	SS2	Så den totala impacten blir ju ändå större och större och större… och det är ju ett helt annat problem, det är ju inte technics problem egentligen utan det är ju egentligen hur vi bedriver vår verksamhet med tester och projekt och så vidare.	DGM
81	OK	Är det svårt att stänga ner testmiljöerna?	
82	LID	Oja, ja, och det är väl, och projekten har väl haft en, tycker det är lite krångligt att beställa testmiljöer så när de väl har sina testmiljöer på plats så får man inte röra den.	DGM
83	PS2	Och det blir ju en del i den här automatiseringen också nu, att man ska kunna beställa testmiljöer och att man ska kunna sätta ett slutdatum	A DGM

		också på servrarna så att de decommissionas efter tre månader om man inte ber om att få behålla dem längre. Så det kommer nog bli bättre.	
84	OK	Ja, det verkar vara ett stort problem?	
85	PS2	Ja och det är också väldigt drivet av att många av applikationerna är ganska gamla, sättet att jobba på är väldigt gammalt, ramverk och metoder är ligger kanske flera år tillbaka i tiden och det är väldigt svårt att anpassa det till ett modernare tankesätt. Både ur ett test- och utvecklingsperspektiv, det finns ju enorm potential i att styra om applikationerna och utvecklingsprojekt att jobba lite modernare helt enkelt. Att inte ha de här beroenden till legacy test-servrar som de har, men det är ju som sagt en helt anna fråga egentligen, men det finns ju en enorm potential egentligen.	EO
86	LIM	Sen är ju vårt applikationslandskap sammanvävt som en jädra spaghettigryta… vårt nya, fina e-handelssystem som vi klumpar ihop och kallar "Multi-channel-programmet", för att de ska kunna testa hela kedjan krävs det 159 solutions… och då kan man väl fråga sig om man har lyckats med sin design eller… alltså det blir ju att testmiljöerna blir ju gigantiska och hanteringen, livscykelhanteringen, så hela det här beroendet blir ju helt… vilket gör att, ja, vi har svårt att nerifrån infrastrukturnivån få LCM att funka per automatik. Så utifrån ett sustainability-perspektiv är det nog en av våra största bovar… även om vi säger att vi producerar en ny server för att ersätta en gammal så kanske inte totalen är ett plus för att det kostar en massa energi och kemikalier och annat skit för att tillverka en ny maskin, men… ur vårt perspektiv, att titta på hur använder vi våra datahallar, hur använder vi vår energi och kyl och allt det här så… vi är ju tvugna att underhålla en jäkla massa gammalt skräp som skulle kunna vara en miljöbov ur ett energiperspektiv men också ur ett miljöperspektiv.	EO
87	PS2	En svaghet… kan man sätta det som så att, det är länkat, det är för många beroende för en LCM till att… alltså, det är lite det vi har problem med att det länkas så mycket att om du ändrar en LCM där så kommer det i fem steg mer kunna påverka det som ingen har sett. Tyvärr har det ju hänt och därför är folk väldigt rädda för att LCM:a, de vågar inte ta sitt besult att "vi kör här upper" för det vet inte vad som händer längre ner i kedjan. Och den komplexiteten då om vi nu tar det som ett exempel på 159.. ni kan ju gissa att det inte är alla dem som är stenkoll på vad de gör. Det går ju inte.	EO
88	LIM	Och sen så är det väl… även om de säger 159 lösningar så är det kanske 20-tal som är identifierade för att testa, asså göra testerna till 99 procent så är det 15 system som inte är identifierade. Sen så är det då kringberoenden och sådär...	
89	OK	För att återkoppla till den diskussionen vi hade om att avveckla gamla servrar och att köpa nytt, om man nu räknar in ert företags återvinningspolicy, kan det då kanske ur ett miljöperspektiv kanske vara ett	

		incitament till att köpa nytt? För om det då avvecklas på rätt sätt och sedan återvinns eller säljs vidare, då kanske det ger upphov till att anta...	
90	LID	Ja, trycket kanske inte blir så stort i och med att man återvinner det gamla...	
91	LIM	Det är skitsvårt att veta… likadant att vad kostar det energimässigt att återvinna? Visst, om du bara skruvar ur moderkortet och använder det i en annan frame då är det mänsklig kraft men är det så att du behöver smälta ner det för att bygga om… ja, då är det helt annan...	
92	SS3	Ja, vad är break-even undrar man ju?	
93	OA	Mäter ni strömförbrukningen på något sätt, exempelvis genom använd-ning av sustainabilityrelaterade KPIer?	
94	SS3	Ja, vi har ju en Splunk-dashboard men… vad jag vet tittar vi inte på den regelbundet.	KPI
95	LIM	Tja, ja, det är ju [namn] som tittar på den lite då och då, han har ju sustainability-rocken på sig.	KPI
96	OK	Okej, men det finns i alla fall någon typ av lösning för att övervaka det här vilket får ses som en styrka. Finns det något praktiskt exempel på en sådan dashobard?	
97	LIM	Ja, men det är ju det [namn] då har gjort, en dashobard i Splunk som nummer ett mäter att TS4, den sustainable-varianten som default-vari-ant vid installation… och där har vi ju då gjort en dashboard för att se vilken impact den har jämfört med den andra. Så det är den KPIn som hänger ihop med TS4 och att den sustainable-configen är default-config och den så har vi då gott om dashboards för att följa det. Var det inte någon flagga i firmwaren som vi satte upp?	KPI
98	LID	Nja, utan den datan hämtas ju från input.	
99	LIM	Jo men var det inte någon jävla… som vi satte upp?	
100	LID	Men det kan vara det vi prata om innan, att grabbarna här kör med full power men… annars så är flaggan satt till balanserad.	EO
101	PS2	Men det motiverar ju vi genom att om man kör full power och utnyttjar det till max så klarar man att virtualisera mer och vinningen… så skulle vi stänga ner och köra CPUn på low och minnesbussen på low i frenkvenshastighet så får vi inte den fyllnadsgraden, densiteten mins-kar… vi kör ju fullt järn och så vinner vi högre virtualisering och det är ett medvetet beslut. Eftersom vi inte äger bron på testmaskinerna och där vi ska köra allting sånt så är beslutet taget att… always on. Om ett testcentra hade gått till den, att de var tvungna att boka sina maskiner till att vara uppe, då hade vi vågat ta det men eftersom det inte riktigt är någon som vet när det smäller i produktion och när de behöver ha det uppe så är det ett risktagande som vi har bedömt är inte okej att ha.	VC EO

		Potentiellt kan det ta för långt tid och förväntningen är att det ska vara always on.	
102	OK	Men om vi tittar där på virtualiseringen, ni är runt 70 procent virtualiserade, hur ser er utilisationsgrad ut i de virtuella klusterna?	
103	PS2	Så hög som… ja, det är ju också med… vi hade kunnat bli bättre på det, vi ligger med luft i systemen för att vi äger inte, eller vi äger inte konsumtion, vi vet inte riktigt hur servrarna går. Så därför ligger vi med så pass mycket luft att vi kan ta rätt så fina peakar men går vi högre så är risken att när peaken kommer, så går allt dåligt och då vill ingen virtualisera och då hamnar man på fysiska servrar som börjar byggas upp. Så där är också ett risktänk...	EO VC
104	LIM	Jo det är ett medvetet beslut men det ligger på över 60 procent va?	
	PS2	Ja över 60 procent på minne, jag tror det är 80 till 85 procent på minne, CPUn är ju så vass idag också så det är svårt att komma högre än 25, 30 procent men det är ju för att applikationerna beter sig som de gör. Men där har vi ju också möjlighet till nästa, CPUn är så pass bra, ja, men på bumpar vi upp minnet till, idag har vi en halv terra i minne, men bumpar vi upp minnet till en terabyte så att de ska försöka följa varandra lite i alla fall och då gör vi ju en utnyttjad grad där och då gör det att vi får en mer utökad maskin och färre fysiska hostar, så vi gör ju medvetna val på så sätt… men det finns ju fina program som spelar Tetris med maskinerna men de har vi inte igång, som sagt det här med risktagandet. Vi är inte helt villiga att ta det eftersom vi inte vet riktigt hur det konsumeras.	EO
105	OK	På vilket sätt påverkar applikationernas utformning ert arbete med LCM och liknande saker som påverkar sustainability, finns det ramverk för hur dessa ska designas?	
106	LIM	Ja, det är ju en av våra svagheter att vi inte riktigt har ett ramverk ur ett dev, absolut väldokumenterat perspektiv.	EO
107	OK	Är det så att applikationerna generellt "spelar" dåligt med systemet?	
108	LIM	Nja, snarare så att vi inte vet hur de spelar. Alltså det finns inget ramverk där vi kan säga "det är inom de här gränserna som våra applikationer är specificerade att verka eller se ut eller hur man nu ska uttrycka det… som gör att, ja i och med att de är inom det då vet vi ju också hur vi ska konfigurera och använda inbyggda funktioner både i VMWare, i firmware och i operativsystem. Men idag kan ju applikationerna se ut hur fan som helst och agera hur fan som helst.	EO
109	OK	För att komma tillbaka till virtualiseringsbiten så tänkte jag bara fråga om, det blir väl lite av ett businesskrav på att det ska vara så pass mycket luft i systemen, är det då ur ett sustainabilityperspektiv kanske lite av ett hot?	

110	PS2	Ja, det kan man väl säga lite så, att om inte har krav så kan inte vi ta kontrollen. Sen är det ju det att vi måste ha viss luft för att kunna göra vår LCM och om vi då har en LCM planerad, vi tar ner en host i klustret och så har vi samtidigt ett hårdvarufel på en annan, ligger vi för tight där så kan det bara… vara 2500 VMar som går som sirap. Så det är också ett risktagande i det hela, det är väldigt lätt att se det som att "ja nu när allting är uppe så ligger ni ju bara på 70% minnesutnyttjande, stäng ner lite hostar då", och ja, men pratar man då om risker, om det händer och det händer ja då är vi rökta, är vi villiga att ta det? Nej. Så det är också just det här för att kunna göra LCM och för att kunna göra underhåll på hårdvara så behöver man luften också så det ges ju möjligheter med att inte köra så fullt och det tycker ju vi från våran sida som administrerar att det är också viktigt att tänka på, vi måste ha möjlighet att underhålla systemen, annars är det som sagt då kommer de börja beställa fysiska maskiner för att, ja, "virtualisering funkar ju ändå inte" och där vill vi inte hamna.	EO VC
111	LIM	Nä, det har ju varit en utav de stora slagpåsarna från det att vi implementerade VMWare, eller virtualiseringsbygget, det har ju tagit väldigt lång tid innan det har liksom tagits emot av konsumenten. Så det har ju slagits i många många år för att få konsumenterna på att gå med på att virtualisera sina, de har ju velat ha sina maskiner och klappa på och säga "den här är min" och nu har vi ju sen ett och ett halv år, två år tillbaka, kommit över den där punkten där vi framförallt själva LCMade och kom upp i den version av VMWare som kunde hantera saker och ting bättre, resursen var bättre vilket direkt gav avtryck och förtroende att "ja men den här skiten funkar ju faktiskt" och är inte något som de försöker sälja på oss utan det funkar faktiskt. Och vi vill ju inte skjuta oss själva i foten genom att gå för hårt på utilization eller stänga ner bara för att vinna i ena änden, där förlorar vi ju mångfalt i andra änden i så fall i fall vi inte levererar vad som förväntas och då vänder den här skutan igen och så blir det plötsligt fysisk installation och då har vi verkligen tappat i sustainability. Det handlar om balans och det är ett risktagande och strategiskt beslut vi tar och vi belyser ju det då och då och ser om vi ska förändra det naturligtvis. Beroende på vad konsumemternas krav är, och likadant det här jobbet som vi gör med att ja nu har ju applikationer och så vidare kommit upp i en nivå att nu börjar minnesutnyttjande springa iväg på CPU, ja "behöver vi förändra configen då? Ja det kanske är bättre att vi går upp i en terrabytes-maskiner så blir det mer jämt", så att det är ju det kontinuerliga arbetet som grabbarna gör med plattformen.	VC EO
112	OA	Är det ett mindset hos konsumenterna att "virtualisering inte funkar"? Är det befogat idag?	
	LIM	Förr var det väl befogat i vissa lägen, förr var det helt enkelt vissa applikationer som gick skit på den första plattformen vi hade.	VC
	PS2	Och vi hostade ju också på, med, tänket vi hade då var ju "det gör ingenting ifall vi överallokerar minnen", det är det VMWare är till för, men	VC

		sen kom det in en applikation som inte mådde alls bra av att överallokera minne, så det har vi tagit lärdom av nu då och bildat egna kluster för såna som inte mår bra, men vi kommer ändå få ungefär, säg att vi får kanske 25 till 1 på dem maskinerna men vi överallokerar ingenting, sen i andra generella kluster kanske vi kan lägga upp till 50 virtuella maskiner på den fysiska hosten, där gör det inget ifall de lånar lite minne av varandra, för att förklara det enkelt. Så det är också en grej som vi har blivit mer mogna av att hosta, vi förstår hur det fungerar bättre helt enkelt.	
113	LIM	Vi förstår våra konsumenter bättre.	
114	PS2	Och på de små bitarna får vi ju lite info i alla fall.	
115	SS3	Sen är det ju då vissa applikationer där leverantören säger att "vi stödjer inte virtuellt alls" och då får vi ingen support ifall vi kör virtuellt.	VC
116	PS2	Och så var det ju för fem år sen, då var det mer en regel eller undantag att de faktiskt sas så från leverantörerna. Men nu är det ju i princip, nu har ju nästan varje leverantör fattat att det här med virtualisering och VMWare, det är ingen bubbla som kommer spricka utan det är här för att stanna och då har de börjat hoppa på tåget och certifiera sina applikationer för det, och testa och supportera. Så det är ju inte bara vi som har lärt oss hantera det utan det är ju faktiskt så att mjukvaruleverantörerna där ute har också fattat att, ja, det är dit vi ska.	VC
117	LIM	Det är där kunderna kör så det är ju därför de har börjat certifiera sig.	
118	SS3	Så ute i varuhusen har vi ingen virtualiseringslösning utan där ute måste vi köra fysiskt.	VC
119	PS2	Ja, när vi pratar Linux så är det ju som du säger.	
120	LID	Ja, där är det bara fysiskt.	
121	OO	Så alla varuhus har någon typ av linuxburk som står där ute?	
122	LIM	Ja, de har Windows- och Linux-burkar fysiskt där ute, de har ett Hyper-V-kluster men där kör de ju bara två hostar i det på två fysiska hostar.	VC
123	LID	Ja, så det är ingen vinning direkt.	EO
124	LIM	Näe, inte direkt, det är ju inte någon sustainable lösning direkt. Men det har man ju som en möjlighet faktiskt, där håller vi på att arbeta på ett koncept för varuhusen, ur hela vägen då ur ett infrastrukturperspektiv med virtualisering och kanske hyper converge-lösningar och så vidare, så att vi får in både storage, compute, virtualisering och alltihopa i en lösning, så att vi inte behöver sitta där ute med, vad kan det vara, 10 till 15 fysiska hostar idag så förhoppningsvis kommer vi ju ner till två, eller ja, det ska ju helst vara klustrat och så vidare så tre, tre fysiska hostar istället för 15. Så det är ju någonting som vi håller på med just nu att titta på, att bygga en sån lösning.	EO VC

125	OA	Finns det några andra exempel kring den teknik ni basar över vad gäller effektiviseringar ni gjort som har en inverkan på hållbarhet? Exempelvis vad gäller automatisering?	
126	LIM	Ja, alla här är ju involverade i olika automatiseringsprojekt, infrastrukturautomatiseringar, ADA, applikationsautomatiseringar, container, DeevOps-tänk och alltihopa det här så att det är ju en bit i resan både vad gäller styrkor och möjligheter att vi fullföljer dem initiativen och aktivt gör något bra av dem.	A
127	OK	Så du menar att ni automatiserar mjukvaruprocesser och så mycket redan nu?	
128	LIM	Ja, vi har automatiserat en hel del och vi jobbar kontinuerligt med att automatisera så mycket vi kan för att få ner avtrycket vad gäller mänsklig inblandning.	A
129	OK	Finns det något exempel på ett pågående automatiseringsprojekt?	
130	LIM	Ja, vi är ju hårt inblandade i EDA, vad heter det, Environment Deployment Automation. Och ett delprojekt där är ju då IPA, Infrastructure Platform Automation, som vi är väldigt mycket inblandade i. Och sen är det ju Open Check-projektet som ju är en del i container-rörelsen, så det är väl de två stora automatiseringsinitiativen som vi… det ena driver vi själva och det andra har vi mycket kompetens i projektet.	A
131	OA	Hur fungerar kommunikationen kring energikrävande processer vilka kan ha en inverkan på sustainabilityaspekt? Finns det någon kommunikation kring det här eller handlar det mer om prestandaaspekt och business rakt av?	
132	LID	Det är mer snack kring performance och så… "keep the lights on".	
133	PS2	Utan vi kollar mer som, vårat exempel där då med att gå upp till en terabyte, ja men det verkar lämpa sig med dem nya, då gör vi det men vi vet ju egentligen inte om det kommer ge oss mer eller mindre watt, det gör vi ju inga tester och benchmarkar på så sätt, det gör vi ju inte, utan det är ju ett antagande… vi tror ju att mer densitet är bra, men det kanske det inte är, då hade vi satt upp en burk till med 256 gig minne i och asså, det kanske… men det är som sagt, antagandet är ju att desto mer i burken desto bättre. Så visar ju i alla fall de siffrorna som vi har...	EO KPI
134	LIM	Det måste ju vara det att ju färre fysiska burkar vi har desto bättre måste det ju bli… även om en sån burk i sig själv tar lite mer, det måste ju ändå vara plus i slutändan.	EO
135	PS2	Som sagt, vi har ju inga exakta siffror som påvisade att "japp, här sparade vi 10 watt per timme" eller något.	KPI

136	OA	Skulle det vara möjligt att börja samla in och titta på den här typen av data? Det vill säga sätta upp lite KPIer och liknande för att se hur situationen faktiskt ser ut?	
137	LID	Jo, det skulle ju gå.	KPI
138	SS3	Ja, men man måste ju får med till exempel kylning i datahallen och sånt då...	
139	LIM	Ja, nä sånt kan inte vi mäta…	
140	LID	Hur mycket power consumption det är ser vi direkt från servern.	EO
141	LIM	Ja, nä men det är ju en av [namns] KPIer, eller vad heter det, dashboards, mäter ju det. Och det görs bara på Linux-maskinerna va? Är det bara de fysiska då?	KPI
142	PS2	Ja, bara de fysiska.	
143	OK	Så ni har alltså en hel del redskap för att kunna samla in och övervaka data i syfte att bilda den här typen av KPIer alltså?	
144	PS2	Ja, Splunken är ju mångsidig...	KPI
145	LIM	Jag vet inte vad där finns för möjligheter i HPSim och så… det måste väl finnas möjligheter där.	
146	PS2	Ja, det finns dashboards tools och finns där en API så kan man oftast koppla sig mot dem.	KPI
147	LIM	Ja, möjligheten måste ju finnas.	
148	OA	Men för att få en korrekt bild av strömförbrukningen på er infrastruktur så måste man då kunna korrelera det mot exempelvis kylningen av datacentret då?	
149	PS2	Ja, precis.	
150	SS2	Sen beror det ju på applikationen också, hur mycket den drar, CPU och så...	
151	LIM	[namn] är ju den som har byggt mycket på den dashboarden som mäter strömförbrukningen… vad är det vi mäter där?	KPI
152	PS3	Strömförbrukningen på den fysiska hårdvaran. Vi ville se att den nya versionen av Linux var mer strömeffektiv, så då tänkte vi "jaha, då måste vi ju se att det stämmer", det där med att den var sju till åtta procent mer energieffektiv… och det stämde.	KPI EO
153	OK	Hade det varit intressant att se energieffektiviteten på applikationsnivå?	

154	LIM	Ja, det måste ju finnas möjligheter eftersom vi har Spunk till att logga det mesta, så måste vi kunna titta över hela x86-området så att säga, bara den fysiska...	KPI
155	PS2	Ja, finns infon någonstans så går det ju att hämta ut. Sen får man vara observant på om den är relevant… liksom, vad är det för siffror vi ser här och som vi pratade lite helheten med kyla och allt sånt. Vi kan ju ta våran bit och sedan kan någon annan räkna på någon annan och sen plussa.	KPI
156	LIM	Problemet är ju att vi kan inte ta kyla, vi kan ju bara ta watt...	KPI
157	SS1	Men frågan är ju då vad man ska titta på, ska man ta watt per VM eller E6 eller per applikation… ?	KPI
158	LID	Kan börja med E6, det är ju lättast.. men kan ju vara svårt att binda dem till ett chassi.	
159	OK	Men detta är något som ni ser som en möjlighet då, att expandera och implementera mätningar av systemet i relation till energikonsumtion?	
160	LIM	Ja, man kan ju ta lite synergi i det också så att man kan bevisa att gamla G5an tar X antal procent mer per timma så kanske man kan driva LCMen med hjälp av det. Man kan ju säkert använda de här mättalen i olika syften, så får man inte bara en klumpsumma av det, utan att man gör en specifik mätning för att jämföra olika gamla versioner och hård-vara… så här mycket tar vår fysiska kraft, så här mycket tar vår virtuella kraft per host. Det måste ju vara intressant att ur ett virutellt perspektiv så tar en host en tiondel av en fysisk.	KPI EO V
161	PS3	Det ser faktiskt ut som om G5orna drar dubbelt så mycket ström som G6 och G7 eller G8 i Splunk.	EO KPI
162	OK	Händer det att ni tar beslut kring teknikinvesteringar eller förändringar som främst motiveras av sustainabilityaspekt?	
163	PS2	Decomission och virtualization är ju väldigt hårt anknutet till det.	EO VC
164	LIM	Och även valet att göra TS4, att göra den sustainable configen som re-dan fanns i version tre men som en optional, vi tog ett aktivt besult med TS4 att det är den som är default installationen. Så får den andra vara optional om man då av någon anledning inte kan köra med varierad hastighet.	EO
165	OK	Men samtidigt finns det då en risk från business i form av krav på till-gänglighet?	
166	PS2	Ja, om processerna hade varit tillräckligt mogna och kontrollen hade funnits där på andra led hade vi ju vågat stänga ner, möjligen.	EO

167	OA	Och det faller då tillbaka lite grann på det här problemet med LCM och så vidare?	
168	LIM	Ja, och lite grann på det är med dåliga development frameworks och så vidare… vi vet ju inte hur det uppför sig när man blandar in virtuella krafter.	EO VC
169		[interview ends]	

Appendix 4 – Group Interview Windows

Date: 3rd of March 2017
Present: Omid Asali (**OA**)
Location: Helsingborg
Interview Type: Group Interview
Length: 1 hour and 30 minutes
Number of participants: 3

Interviewee roles:
WIM: Windows Infrastructure Manager
PS1: Product Specialist 1
PS2: Product Specialist 2 (Skype)

Row	Role	Dialog	Code
1	OA	Ehm. So yeah. Can you just tell me the average. What is Windows doing on a regular basis day?	
2	WIM	Mm.	
3	PS1	That is going to take a while.	
4	WIM PS1	Haha.	
5	WIM	Can take a while. Eh. Okay, so. Basically we are the Windows team in the Technical Infrastructure.	
6	OA	Yeah, exactly.	
7	WIM	We are, a big team. About, 30 people.	
8	OA	Wow.	

9	WIM	In the team globally. Scattered I will say. But not very scattered. Seen March because Dortmund moved to Cloud. So we are in Shanghai, Philadelphia, Älmhult and Helsingborg. That's the locations. We are eh, doing. When you think about Windows you think about Microsoft operative system.	
10	OA	Yeah, usually.	
11	WIM	WIM: Yeah basically. So we have server and client. That is a part of operative. And even, there are more things into it. There are more or less the whole Windows team divided into two legs. One is delivery, which is plattform deliveries to [confidential] the other leg is running services, keeping the lights on for operational.	
12	OA	Okay.	
13	WIM	So, eh. That is basically where we are in plattform part. That is what we deliver the new operating system and new capabilities to Windows oh no to [confidential] and to server platform. Which we have around 6500-ish… right?	
14	PS1	Yeah.	
15	WIM	That is targeting all sites at [confidential] it is not only stores or warehouses we have offices [inaudible].	
16	PS1	Yeah, [inaudible] I think one thing that is important to notice is we have central Windows parts and distributed environments.	
17	OA	Okay.	
18	PS1	Basically… one part, one leg in Windows is in the data centers. Were things get delivered and the other leg is sort of in the distrubuted environemnt.	
19	OA	Okay.	
20	WIM	More or less targeting all sites. Älmhult and Osby. [confidential] and [confidential] is considered as those sites.	
21	OA	Yeah yeah.	

22	WIM	More or less.	
23	PS1	We, maybe we, the rough technical overview we do like application delivery on Windows with Citrix to the centrally and distributed, basically. We do printing on Windows, ehm, file sharing as completely Windows based.	
24	OA	So you have everything, that have with Windows client to do. You have a part of it?	
25	WIM	Yes.	
26	OA	That is a lot.	
27	PS1	And basically, like every big capability, I would say… that gets delivered to the end users is more Windows involved in one way shape or form. Either on the client side or applications delivery, to the users on the sell floor windows is the operative system running the Citrix platform and the [inaudible] servers basically. Ehm, yeah, there is not only windows because if you look into eeh, some of the processes is done with like VMWare on Linuxes and so on. So it is not completely Windows but we have a stake in many very important like deliveries to the users and customers.	
28	WIM	So we are connecting to Linux and AIX team. But more about Windows, we also delivering tablets that you will see more in the stores soon.	
29	OA	Nice!	
30	WIM	And the, also the industrial handle devices there actually receive goods, scan and then connect it to the systems were actually before was a manual thing.	
31	OA	Paper and pen? Wow..	
32	WIM	So that is, I mean, we implemented that couple of years ago. But now we are even more in that area. Eh, forklift terminals, if you look at the warehouse were actually [inaudible] that is a thing from us. So we deliver everything up to the application.	

33	OA	Okay.	
34	WIM	To the application stack, then the applications to the infrastructure.	
35	OA	Wow.	
36	PS1	Cause kind of [inaudible] the provider or infrastructure with [inaudible] everything but [confidential] the classes that is application responsibility. So yes we are called Windows team, but just to mention on the handle devices is running Android on those.	
37	OA	Okay.	
38	WIM	So that is a delivery also within the Windows team also. That why I am say it is a bigger…	
39	OA	It is wider than name says actually…	
40	WIM	Yes yes. So to not going into more details then that I think, we have quite a large footprint in our [confidential] environment as i mentioned we have around 6500 servers, we have handled devices total of, what say 120 000 to140 000, and clients like these around…	
41	PS1	150 000? No?	
42	WIM	No, 130 000. Yeah.	
43	PS1	Hundred, yeah right.	
44	WIM	So if you going to the store you will probably have touched, maybe not because as mentioned before…	
45	OA	I have hard to go to the stores.	
46	PS1	Haha.	
47	WIM	Haha, okay. There is self serve portal where you can find the goods. I need to buy a sofa where it is. So you can actually, so those a…	

48	OA	That is your things too?	
49	WIM	Yeah, so there is application on top. Now we are doing, there will be a [inaudible] delivered soon.	
50	PS1	[confidential] scanners also work on Windows with, that also is delivered as key host, which is a client platform or terminal servers platform so kitchen planners for example.	
51	WIM	Where you draw your kitchen and such things.	
52	OA	Yeah, so you guys, do everything.	
53	WIM	Yeah but not, the application that what I am saying. But to that level.	
54	OA	Yes.	
55	WIM	So that is, yeah, it is a big…	
56	OA	Footprint?	
57	WIM	Big footprint.	
58	OA	Do you have, like strategies to minimize the footprint? To decrease them, to decrease the impact?	
59	WIM	Eh, In terms of sustainability?	
60	OA	Environmental sustainability.	
61	WIM	Okay. Yeah, eh. Lets, if we just go back a bit. Like we talked about client and server, were we are. For the client we and server we have… what to say, limited vendors we work with. So we have partnership with some vendors. That is in that road map, that we are actually, I know eh. This was many years ago when I brought it up, when we were.. quarterly and yearly meetings. Okay for new models we are seeing and entering for [confidential] is certifying those are, how is the renewable material and how is the actual footprint on the energy consumption, because we are expecting that everything that we are having on [confidential] will follow I mean, will be reducing the carbon footprint.	EO

62	OA	Okay that is, that is good.	
63	WIM	Yeah. Eh, so, so, those things are in there. Eh…	
64	PS1	For, for clients there is also, they announce from Shanghai for example, that before we used to like for the clients were out of 1G people could actually buy them from [confidential] and there have been problems with it that people either selling them or ended up [inaudible] behalf on [confidential] so now we are not selling them for as I know, we announces it. In Shanghai we are not selling them to the co-workers so we are able to collect them and have them destroyed or handed back to the vendor, for recycle.	
65	OA	It is the company policy right?	
66	WIM	Yeah, no. Well, company policy is not targeting this specific but it is a framework.	
67	OA	Okay. Yes.	
68	WIM	Eh. And correct we are not doing that anymore. And I know we are looking into this for the server part, I think you might got this from AIX and [confidential] team, the Linux team. Could be, because we are looking into I mean kind a eh, sustainable loop with the server parts. AIX servers which running either Linux or Windows, basically. And eh, product doing, having that in the contract with the vendor that they actually taking the hardware pacing it, recycling in a sustainable way, that we used.	
69	OA	I see this as a strength that your team have.	
70	WIM	Yes!	
71	OA	How would you phrase it?	

72	PS1	You could do this in 2 ways. Right? Either, like one way would be actually. I would say quite a large degree ehm, within the, like sustainability is a part of [confidential] roadmap as well so we have that this get looped into more a global scale that we are aware of this things like how the vendor is doing, do they take hardware back and so on. Or we do it like on individual points, which that would probably take more time but… I have a could of other parts that comes to mind but, how we try to do this, but this is like if you want it in like detail i would say like working with sustainable vendors or something like that or like taking in taking into account to some degree to have the hardware recycled.	
73	WIM	I think that is eh, Sustainable vendors. Because it is in the vendors or within the vendor's contract and where I, I am pretty sure we have this with all the vendors. That is on the agenda.	
74	OA	Mm.	
75	WIM	I mean in some cases. Like okay, how can we scratch this in a, but some I mean for the material example. We want this to be 100 percent I mean the material should be…	
76	OA	Recycled?	
77	WIM	Recycled, and that we should really stress that we are picking the models as well. That have that better footprint.	
78	OA	Okay. Do you look at the hardware efficiency? How the hardware is working, not only the material and goods are recycled but…	
79	WIM	I think that… Yes	KPI
80	PS1	I think that the biggest point there is like concerning the servers is the virtualization strategy. To get like proper usage out of the hardware and to integrate more on a like smaller hardware footprint.	VC
81	WIM	Yes!	
82	PS1	And that is pretty cohesive now a days. Both distributed and centrally. So I think that should probably have a extra point.	VC

83	WIM	So, so we push this really hard. Both Linux and Windows actually. Virtualization ratio in central environments.	VC
84	PS1	In central, very much.	VC
85	WIM	Yes. But…	
86	PS1	Distributed…	
87	WIM	Now we pushing it also to distributed. [inaudible] hopefully project.	VC
88	PS1	I mean, not to like undersell ourselves but I mean. With the terminal server virtualization, we reduce a lot of hardware already.	VC
89	OA	How virtualized are you?	
90	PS1	Well… Eh.. We're running, we went from running, rough figures because this is all always depending on store size. Because store have a, larger hardware footprint server so this is only servers now. We went from maybe 8 to 10 machines on big stores to… Like lets says 5-6 machines now. Specific part of the servers are virtualized. And the, from 2 host, with 2 hosts is delivering essentially 4, what used to be 4 individual machines on their middle basic.	VC
91	OA	Would you be able to achieve a point where you feel that you are 100 percent virtualized?	
92	PS1	That is, that is standard local Infra. There is a project started up and running and will hopefully deliver some point were that everything is delivered on one hardware stack basically. It is like couple of clustered hosts must like blade cabinet that delivers multitude of different virtualized…	VC
93	OA	Okay.	
94	PS1	Ah, instances.	VC
95	OA	So you are working with it right now?	

96	PS1	That's going to come, and I am pretty sure that it will deliver because, it is a problem of economics and that is what is driving it. If you are running a distributed environment as we are. The numbers get out of hand and the amount of money for servicing these many physical machines, is pretty like overwhelming at some point. And you need to, that I think that was the major of, it was not actually the sustainability. Sustainability is more or less, a need side effect. It is more about the warranties and hardware and availability with like integrated class that set out that can deliver much higher availability and so on. I think that is the main drivers but to get the sustainability on the side for free I would see. More or less.	EO
97	WIM	But, I think, I mean how virtualized are, are we? We are.. We need to look into to get numbers, I think that is something that we could actually..	VC KPI
98	PS1	[confidential] have reports on this.	
99	WIM	Yes. And, This is roughly. If I recall this right. [confidential] please if you have more information around this, but I know in central environments that we were pushing this quite hard and I think that we are up to 90%, more than 90% virtualized. So, and I think that we did a benchmark from other companies. We are more virtualized then other companies.	VC KPI
100	PS2	Yes. We kinda virtualized quite a lot.	VC
101	WIM	Yes. So that is in central environments.	VC
102	PS2	Yes, that is the centrally environment.	VC
103	WIM	Yes. The distributed environments, we were about 50% That is basically, I think we will have some more. We will have that with the new project. So that is our opportunity.	VC
104	OA	So you are virtualizing, do you see any opportunities with it?	
105	WIM	Yes. Virtualize more in the distributed environments. That is the opportunity.	VC
106	PS1	Yes!	

107	WIM	You asked if we know how much we, the power consumption and those things?	KPI
108	OA	Yes.	
109	WIM	We have that capability.	KPI
110	PS1	Facility, right?	
111	WIM	No actually on the client.	
112	PS1	Oh, okay!	
113	WIM	So there is, actually alias that you can turn on login to see. Where the most power consumption are. That is, we can identify, if it is a maybe, an SSD drives or what ever that we actually can see that this drive is taking… But we are not using it much. Haha you did not know about this?	KPI
114	PS1	No, I did not.	
115	WIM	It is not very, so that could be used on occasionally, and then taking…	KPI
116	PS1	That would maybe be a opportunity. To start use it.	KPI
117	OA	Could you do something better with it if you used it?	
118	PS1	Yes, we could use it for report basically.	KPI
119	WIM	If we get rate we could actually see that this LCD for this specific models taking all… then we go back to this vendor and say.. Why?.	KPI
120	OA	Yes.	
121	WIM	And then push that, so we can do that but, we can not turn on login on 130 000 clients, so..	

122	OA	But are you measuring anything? Do you have like specific KPIs that could help you with your strategies regarding the environmental sustainability? Like, for take a example. Linux was measuring the energy consumption, eh. But it was not for the environmental sustainability aspect more to control, because the vendor had said it was 7 percent 8 percent lower energy consumption for the new system. But they are still doing it so they have the overview of it. AIX was like, so virtualized they could be and they had this KPIs to see, and create strategies with it. Do you have any KPIs or measurements that could help you in anyway?	
123	WIM	No, but we having the same measurements, for the virtualization ratio.	KPI
124	OA	Okay.	
125	WIM	For the central environments, as you mentioned Linux. Because, that is on the hardware or actually by the hardware. So, on top on then we have our virtualization engine.	VC
126	OA	Okay.	
127	WIM	And then we put Linux and Windows and trying to push, we had some, what was it 3 years or 2 years ago, hm no, 1 year ago.	
128	PS1	Virtualization right?	
129	WIM	Yeah, no. We were lifecycling some physical hardware that was just, there was initial. It was end of support, so just lifecycle it from physical to physical. But then I said no. We going to push as much as we can. There is some specific needs, that needs the physical. And I think we managed to do this. This was for both Linux and Windows. Pushed that very much because. It is better today but if we just go back 5 years. Now we need physical hardware. We do not trust the virtualized. Even if we provide the prove, saying that this will run exactly the same as we do or can be even better. I mean those are, I think it is more, today the understanding is better, if put it that way.	EO VC
130	OA	So you have KPIs for the virtualization?	
131	WIM	Yes.	KPI
132	OA	That gives you a awareness of how it is?	

133	WIM	Yes.	KPI
134	OA	Do you see that as a strength?	
135	WIM	Yes.	KPI
136	OA	Okay.	
137	WIM	And, Recently I saw for distributed environments as well.	
138	PS1	We used to have, I am not sure, if we still. But we used to have virtualization KPIs as well. Right?	KPI
139	WIM	Yes.	
140	PS1	Like, there was a big push on servers should be utilized above a certain percentage.	OA
141	WIM	Yes.	
142	PS1	That was actually used to argue for virtualization, to some degree. They called this…	VC
143	WIM	The Utilization [inaudible] Used Capacity.	KPI
144	PS1	Exactly! To use the hardware in a, like good sustainable way. I mean, sustainability [inaudible] but of course there is cost considerations. You don't want 5000 servers running there, like 50% CPU usage because maybe you could do it like… 2500 or 2000 servers if you were able to use the CPU, the resources of the machines.	EO
145	OA	Yeah.	
146	PS1	So that was one thing we had. I am not sure if it still there. But I mean the outcome of all of these was like… Okay, virtualize more and that is still the strategy we are going with.	VC
147	OA	Is there is anything like, Capacity on Demand on something or your machines? Or for the applications? Like, okay we have 4… No?	

148	WIM	On AIX, there is. We don't have that on Windows machine yet. It will be when we cloud enable.	EO VC
149	OA	Okay.	
150	WIM	But we have that capability. That, I know there will be some tests. Which we actually can do, in the cloud environments more or less, pay as we use. When it stoped used is it gone.	VC
151	OA	Exactly. If you need capacity somewhere else it sends over it right?	
152	WIM	That is, a opportunity more or less. Because there is, from the cloud we could actually do that on perm as well.	VC
153	PS1	Okay.	
154	WIM	But we need to identify what we can do. That is a threat. The challenge here is there need to be a strategy to patch and lifecycle.	EO
155	OA	Okay.	
156	WIM	From the whole stack as well. That is why. If you looking into the data centers we are not powering down. I mean mostly it is productional environments. For development environments, that is a different thing. And I think, for the development environments we have opportunity.	EO
157	OA	Okay.	

158	PS1	Or you could see this as a, like. One of the weaknesses maybe, associated with this is like you know what to do AWS you pay either by the demand of data by goes on the wire or by the amount of processing power you need to use and so on. So you could these. But I think the weaknesses we have, is that, we don't never clear the overview of the demand that we have. Like if you were to say if you wanted to know, for example [confidential], one of our big sale applications. How much processing power overall does it consume at the moment. That is nothing we have, right? And to be able to, like do this properly in the cloud and see what like okay, makes sense to do in the cloud? and what makes sense to keep local as one part of this we would need to know, okay who consumes what? You know? To what degree. And I think that maybe could would be something we could improve.	KPI VC
159	WIM	But that, that is a big thing. We are a production environment, it is not a low hanging fruit or do-able. It is development environment.	
160	PS1	Yes, but...	
161	WIM	Today...	
162	PS1	This does not say, about things that are easy.	
163	ALL	Haha.	
164	WIM	No, of course not. But I am looking into things that we could actually…	
165	PS1	Yeah.	
166	OA	I actually have a question here. The understanding of the workload and the behavior and that is one thing about workload and the behavior to see, the[confidential]. Maybe is it a big thing, and hard to get to.	
167	PS1	I would also help with billing, right? If could put a price tag on like the delivery of certain application and ideally… how much in the distributed and how much centrally so you know. We could actually say that you are consuming half of the network, so at some point you will get billed for half of the network cost for each site right?.	KPI

168	WIM	Okay. But we do have this. [inaudible]	
169	PS1	Njaha…. But.. Yeah.	
170	WIM	But if we look at…	
171	PS1	He does not want this point in there. Haha. I really think it is a big opportunity to look into this. It is difficult for sure. But this would drive a lot of like, optimization on what we do where and how expensive things are? Which we don't see really good at the moment.	EO
172	OA	How would you, if you would say it in a phrase. If we putting it in the opportunity like, how would you say it? Optimization of?…	
173	PS1	Reporting and… resource utilization reporting across environments of platforms and so on. So let say CDO, memory, network. Who consumes what basically. Just think if we had that. We could go to application and say like, if you do this distributed. It going cost that much in network in CPUs and so on and if you do this centrally, that will cost that much. And if you, because for the cloud this is quite easy to do this sort of, if you know what kind of processor demands you have and so on. Amazon can you can do this now yourself. They tell you, like you know, how to do it basically. Ehm, you will get a price tag but to do this like centrally I don't know if we can. So then you can really compare them, compare the different ways of setting something up. Not only from an availability perspective but also a cost and sustainability perspective.	KPI EO
174	OA	Yes. It is good. We can take it as an opportunity if it is okay.	
175	PS1	Yes, but [confidential] says this is tricky and that it will take a long time.	
176	OA	Do you following any environmental sustainability frameworks? I know Windows is quite good at actually following by machines and operating system and stuff. But are you guys having frameworks of, like.. Okay, let's work like this. Like an example do you have any ISO? Like okay, we should take this framework and work around this or we should think about it.	

177	PS1	That is one of the questions I had to you actually. I mean according to company policy we doing it with the vendors. I am not sure to what degree we are doing it with like, our suppliers, let's say Microsoft, HP and so on.	EO
178	WIM	It is there.	EO
179	OA	Okay.	
180	WIM	All, all of our suppliers.	
181	PS1	Okay, then it will be company policy then.	
183	PS1	That is the [confidential] framework.	
184	OA	Yes.	
185	PS1	Not only sustainability but also like, workers rights and working conditions, fabric conditions, working hours. All of those. The company policy is pretty… you know it right?	
186	OA	Good. I don't remembered if I asked, yeah about the hardware efficiency right?	
187	WIM	Yes.	
188	OA	Yes, I did. And it was the Capacity on Demand. Do you have any other options for the hardware? Does like, the hardware you have give you any options to maybe, if you, can always script stuff. But, like if this is not been used, go down in power and hold it there. And when the traffic is coming go up.	
189	PS1	No, for the clients there is the power schemes. That we have aliases to set them for what I know.	EO
190	WIM	Yeah, we did that for couple of years of ago. We are actually looking into that. Looking into, yeah. Power scheme.	EO
191	PS1	Balance and high of. What is it called like.	

192	WIM	I don't know but if we just go back for a moment. For operating system before, then maybe the screen was on and now it is turned down. So that, for all of the 130 000 computers, it makes a difference.	EO
193	OA	Of course.	
194	PS1	But, I mean the opportunity here is that we have the capability but we don't report it and we don't really [inaudible] you know like there is no many reports going out saying well out 150 clients all of them is set to high power or something like that. You know, actually we don't enforce any of this even on the server side.	KPI
195	WIM	We can highlight it.	EO
196	PS1	Yes.	
197	WIM	For clients, and on the servers it is more about the utilization.	
198	OA	Do you see the utilization on the servers as an opportunity?	
199	WIM	Now the thing is, a project running for this. But I know it have been, have you heard about [confidential]?	
200	PS1	No.	
201	WIM	Okay, they are actually looking into it.	
202	PS1	Oh, the Linux guys that was using something, was that the same? Or?	
203	WIM	This was for all the platforms, not only for Windows and Linux or AIX. But the we have the good utilization on the most of the environment but for some environments we are actually, for most connected to multichannel and ecommerce the utilization is not that good.	EO
204	OA	Okay.	
205	WIM	So that was the decision made. But I think that is back on the actually, what do you say…	

206	PS1	In scope?	
207	WIM	In scope. We are looking into that as well.	
		I mean there is one problem with utilization depending on where you are looking into it right? I mean, for data centers it is quite straightforward. Like, because they are much more flexible with, lets say CPU wise right? You determine how high you want your utilization to be and it is fairly easy to like add more resources when you need them. With the CPUs at the site it is much more challenging because you need to account for certain amount unused resources for future use because you can't push out new hardware that easily for the distributed sites. Let's say standard local infra develops cabinet, everything will be virtualized on that for example. You would need to have a account for resources available over the lifetime of this cabinet, because it won't be easy to maybe you could upgrade it. But that is also someone going out to the site and like installing another ranched or upgrading another CPU and this is very challenging to do if you are talking about 600 sites. You know, it is global project for you so. For some degree the distributed site system utilization is more challenging because you need to have [inaudible] in case of someone has to buy something more like a application you cant all the time say okay we need to instal another processor because our utilization is optimized at 90% already, you know. It is more challenging there but it don't think it is, it is depending on what you wanted like, how you account for both and like on a application site more or less. And I think it is already moving into the right direction because at the moment we have the challenge on the individual level. Let say the file server is not virtualized yet but the direction is to virtualize more of them and hopefully the standard local infra is having everything on a like very limited amount of machines then you get some flexibility with the resources again because you are not buying CPUs for the terminal servers buying for the file servers, or memory for the file servers you have a big stack and then you say like. Yeah, you have the ability to say this server needs more ram and hopefully you have it in it already. It is just, I highlighted that. Yes it is an opportunity much more tricky depending what environment you talking about.	EO VC
208	OA	Yeah.	

209	PS1	I would say it at least. If you are running like 1000s of virtual machines on huge stacks on data center to account for like growth and so on it is more easier, because it is much more integrated. You say like add 20 more CPUs we need more, it is comparatively easier in data center not that easy to do it in like 6 or like 800 sites. And of course some of the strategy is to get away from the sties but then you have this kind of strategies clashing with availability and other costs like you know, once you centralised more the network usage will go up it is the same discussion with the cloud right so there is quite a fine balance you need to weight and have very good data to do the right decisions. I think that, but we have that already you need to be aware what you using and where and you associated cost and impact basically and I think that is where many of the opportunities for distributed environments are. Because we don't have like very good pictures across the board there. We had weaknesses but I forgot. One of the weaknesses is, and probably will stay like that is availability and yeah, availability always takes percipients over sustainability considerations. I would note it down, but I don't know what to do about it.	VC DGM EO
210	WIM	Haha.	
211	PS1	I mean if you have availability so under control that you don't need to worry about it any no more. Then you could mitigate that weaknesses but i don't see that happening that very soon.	EO
212	OA	I believe it would disappear from the weakness as soon as you are fully virtualized and have the cloud as you said and the capacity on demand. Then it is no weakness any more. Because then you have control over the power consumption and the availability.	
213	PS1	The problem with that is that cloud does not solve the availability issues.	VC
214	OA	No but, it offers you capacity on demand.	
215	PS1	Yes. Right.	
216	OA	You get fully control over it.	

217	PS1	Although, that shifts the discussion from [confidential] controlled environments to the cloud vendors. I mean, if we want to use, let's say as a goal. We want to use 90% of the CPUs everywhere, and we don't have like and it becomes challenging to count for how many CPU processing power will we need to tomorrow. That same problem happens in the cloud as well from Amazon, trust in a bigger scale but that also means that they have a some degree of reserve resources for growth and so on. That does not go away because it is in cloud it is not [confidential] problem any more. But if you look at it from a holistic perspective. It is still the same problem. You know, you can shift it from us and we can say, well we have computing on demand. Yeah, but Amazon has to solve the problem in a same way, you know.	VC
218	OA	Do you check like how the cloud provider is working? Like regarding the sustainability?	
219	PS1	That is something you need to check with the cloud team, I have no idea.	
220	OA	Ah, it is [confidential] team right?	
221	PS1	Yes.	
222	WIM	No but, I know there was some delivers with some [confidential] company that was purchasing per hour. For rendering. they needed capacity in the cloud and that was based on okay, they needed power from the cloud and yeah. They do all the rendering stuff. But when it was powered down it was not consistent so it was kind of, say a virtual environment. Where we put in a power down mode which is same on the.. I know they looked into also for the Windows environment but in the cloud and on [inaudible] it is still entirely staged. But also looked into, I mean you can setup a schedule when you want to power down and things. And I know in stores, all stores is powering down, right?	VC
223	PS1	Yes.	
224	WIM	Because reserve back up during the night.	

225	PS1	In the offices they shutting of the sockets. You have to be very careful what you plug in the distributed office somewhere and I even think that IT. Like, sometimes they use the clients you run batch jobs over night or something and you have to make it right that you are on the right socket because otherwise the power goes away. So they doing this yeah.	
226	WIM	But it connects to, the overall strategy with do-able energy 100 procent. I think that is, but do we have any other. I mean..	
227	PS1	Threats right? One of the big challenges is that we eventually we talk to HP about [confidential] and so on. I think we have a much, like worse grip on them as lets say to post to the vendor we are starting up and the new supplier that we are starting up the new contract with in China or something like that. It is much easier, if we are doing a contract with a new supplier to say that. This is how we do it and if you don't do it we find someone else. With like big shots IT wise I think this is much more challenging and I think that is actually a threat. Because we can't, first of all we don't know, I don't know how much insight we getting from HP on how sustainable they are with their power consumption. The same goes for the cloud is Amazon telling us, how much theirs servers are running on renewable energy or not, I hope they are but I don't know. And I mean even if they were not, let say if Amazon there is so many players in this market if you want global server hardware with a certain level of professionalism and so on. There is so many shops you can go to the same goes to cloud solutions right? Google, Amazon, Microsoft maybe couple of small ones but that is about it. You don't have the same negotiation position. On what you want, like okay we want all of the data centers to be 100% renewable energy… Yeah good luck, finding a cloud vendor having that. So I think that is a threat specific for IT. Where you deal with bigger shops you have demands on global scale and there is just not enough, like opportunities like options to choose from.	EO VC
228	OA	So…	
229	PS1	Weaker negotiating position when putting on demand on IT vendors. I don't know, unless the company policy insist.	
230	WIM	I mean we have all of vendors have some…	
231	PS1	Okay.	

232	OA	Because I know [confidential] for facility [confidential] is making sure that the vendors or suppliers should follow the company policy. I know that in China they don't follow the company policy because they feel that they have better suppliers and can do better by themselves and so forth. So that could be a problem maybe. But still.	
234	PS1	Okay, then it could be that the company policy is not enough. I don't know how IT specific the company policy is to conserving like CPU utilization or something like this or renewable energy for data centers, is that in the company policy no?	EO
235	WIM	That is very specific what you are mentioning.	
236	PS1	Right. But I mean, it is easy, maybe it is easy for them to fulfill the company policy we have..	
237	WIM	But I think that one practice as you mentioned is that local markets. And on the both sides actually no company policy is too hard but we want more.	
238	PS1	It is also a cost issue right? I mean if you mark for you supplier to be company policy compliant they going to have costs and if you are trying to cut through the prices, that is like a challenge.	
239	WIM	But I think that most or many companies are doing this. I know we had some companies here, I know it was, we putted demand that they needed to secure all the labor. I mean where the labor should not be utilizing…	
240	PS1	Child labor.	
241	WIM	Yes. Child labor and those. But some of the companies could not guarantee that. Okay we need to back all the steps because we have sourced this particular part to all of the companies, so they need to follow the whole chain. And like okay now we can sign this. I think that it was, and I hope also for the many of this were we implemented. So we implement this for all.	
242	PS1	Yes, I mean which is essential for local markets. But I mean in India or something like it is legal for 14 I think or 15 or something, child to work, basically. I think I read that somewhere. It is not the same laws. Like they, because [inaudible]	

243	OA	The discussion of India is interesting. We have a Indians in our class now and they tell us that we have the wrong picture from India. But, it is the wealthy families that comes to Lund and study to so you never know the real picture of India, it is hard to get.	
244	PS1	The problem is that you need to be really really hands on. I mean, I saw a documentary about like global thing manufacturing in India. How the big clothing are doing and so on and that is also about factoring conditions, work times and so on. And even how the workers are treated and so on. And it is very very a lot of room of improvement there and if you want to ensure that someone that sources in India you basically need to go to the factory floor and do you own checks and controls and so on.	
245	OA	As the company policy is doing actually.	
246	PS1	PS1: As the company policy is doing but then you can talk about like, how often and how much.	
247	OA	Yes.	
248	PS1	And so on, you know it is like, yeah.	
249	OA	Yes I know that the company policy department have 30 persons working full time going to the, how do you say manufactures to check them. So that…	
250	PS1	A start.	
251	OA	A start. Trying. Anything else you have about your strengths, weaknesses, opportunities or threats? You said something about Windows and Linux on the data center right? On the servers. Do you feel like that is a weakness do you somehow, if Windows can be power efficient, work in a power efficient way. Does that, like provide of how do you say it. Does that make Windows to not achieve the sustainability aspect as you want to because Linux cant, you cant either.	

252	WIM	No, this is just how it is running and on the virtual environment. One weakness as I can see now when we are looking into our team. It is a weakness or a threat is that, do we have this, I mean, we are were much stirred from the application site on the IT service, right? So, this, I mean the power consumption and uptime and downtime and all from IT service, say we want this be up and running 24/7. Even though it might not be used 24/7. So, I think from that, if we can have a better picture from the IT service, lets say that from a sustainability, it can be during these hours it can be, not all the service windows, but sustainability window if we call it like that. That could be something like…	VC EO
253	PS1	Theoretically it would be problematic right? I mean if, lets say if resources are used and CPU power down, you know like the host. Maybe it does not completely sleeps but maybe you have…	EO
254	WIM	But then you need a pattern and a behaviour pattern. Because it can be that you reducing finance systems or HR systems and you know. Some of those is where we have for what you say.. bokslut?	KPI
255	OA	Revenue.	
256	PS1	Yes.	
257	WIM	Those systems are really going on high level and during that… So those are things that is a behavior acting.	
258	PS1	But I am not entirely sure, but I think that is do-able for both in Linux and Windows, like lets say cores can like shut down, CPU cores and so on you know can shut down, if there is no demand CPU wise. If your laptop all of a sudden start something very CPU sensitive you would start consume more power and so on. And I think you can do that on the server side. I am just not sure that how, like how engran it is on carbon platform you know. Specially if you talk about hosts, are the VMWare hosts doing that you know, and in this way I don't know. I think that the biggest weakness is probably that we don't have someone working on we don't have any resources on this.	EO VC
259	WIM	Yes. I think, we can put that. I totally agree. If I just look at, we have bill service as you know. And the only action, I mean let us say when we doing decommission. Then we get a order on decommission that we do power down on the system because we have that on 2 weeks, power down in 2 weeks. And, if then…	EO

260	PS1	Screens?	
261	WIM	Screens, yeah it will be removed. More or less, that is a initiative for the IT service. And I know that maybe you seen those regular mail sent to the IT service owners. Like okay if you order a new environment you should think about decommissioning the old ones. And that is a really, I think that we are still like lacking by that.	EO
262	PS1	The process?	
263	WIM	We have the process. But…	
264	PS1	Governance.	
265	WIM	Governance that actually follow up.	
266	OA	The other teams talked about Lifecycle Management for data and the test environments.	
267	WIM	Yes!	
268	OA	Nobody is closing it. There is still data and test environments for like five years ago that is still up and running full power.	
269	PS1	We don't, connected to that we don't have data management properly implemented. So, like 80 percent of the data is not touched but it is using the resources.	DGM
270	OA	Yes.	
271	WIM	Just the, not control the CPUs. But work with sustainability in the Windows teams.	EO
272	PS1	Because, I mean the opportunity is, we can talk about the opportunities like, for 2 days or something like that. Like what you can do if you start thinking about it. One thing is data management so we can reduce the footprint of data. So we don't need to add like more disks all the time and have bigger storage solutions and stuff you know. If we were archiving thing for example, that plays into this. That is all…	DGM

273	WIM	Efficient data management.	DGM
274	PS1	Yes, efficient data management, haha. Thank you. It is hard to put things. It also comes with offline and online storage in the data center. I am not aware of how well we are doing this, I mean for example Facebook is having different tier of storage of how hot the data is.	DGM
275	WIM	Yes.	
276	PS1	So very hot data is on expansive SSDs that is probably consuming, ah or probably not. But data that is not touched in a certain while is moved to different storage implementation so they have stacks of spitting disks that is powered down where the least used data sits on disk arrays that is started up in certain month when someone is requests something. You know, these kind of things. There is a lot of opportunities we would have in general. But that is not Windows specific, so I don't know. But you can ask the storage team about this. I think their answer would be interesting.	DGM
277	WIM	But there are some tiers in the data centers.	DGM
278	PS1	Yeah? Then I am very impressed.	
279	WIM	Okay, so. [name] are you still with us?	
280	PS1	The governance issue we should bring up we have something about governance.	EO
281	PS2	Yes, I am still here.	
282	WIM	Okay, great. So we are not. Yeah good.	
283	OA	The governance..	
284	PS1	For LCM and decommissioning.	EO
285	OA	So. Governance for LCM and Decommissioning.	
286	PS1	Processes governance I guess. Is the LCM and decommissioning the..	

287	WIM	I think we are talking about the LCM strategies for the new environments. When you keeping to the old ones for just in case and people turn to forget and then there is cost. We are not working in a…	EO
288	PS1	Yes.	
289	WIM	Working with it in a good way. So…	
290	PS1	That is LCM…	EO
291	WIM	But now I am think about. If we take it one step ahead and more, cause for the service report. It is tricky.	
292	PS1	Yes. If you look at it in module perspective. LCM is different versions of modules and older modules we are looking at it already with the clean up activities and so on. That is reducing, I mean it is a little bit of a stretch but ultimately reducing the amount of data we having on the file servers which enables us to have hopefully small file servers. If we were not doing this at all, it would be growing and growing and growing.	EO DGM
293	WIM	So, we are in a solution, haha.	
294	PS1	But, that is just very specific for the modules basically. On like the centrally as well..	
295	WIM	[inaudible] if this is done. But lets say. So a weakness is not to LCM process on decommission. Is not fully anchored.	EO
296	OA	The LCM policies for [confidential] total. Is a weakness, have we seen in every team now.	EO
297	WIM PS1	Yes!	
298	WIM	And it goes for Windows as well.	
299	OA	So can I write policies for LCM?	
300	WIM PS1	Yes!	

301	PS1	Does decommissioning include LCM? Or is it like decommissioning a separate point? Like, well technically it is a part of lifecycle management right?	EO
302	WIM	Yes it is a part of the lifecycle management. But then, I mean, I think we should also, LCM policies is one thing. But one additional thing is decommissioning, how do you say.	EO
303	PS1	[inaudible]	
304	WIM	Governance.	
305	PS1	Governance, Yes.	
306	WIM	Decommissioning governance.	
307	OA	I don't know if I. I will fix this later.	
308	PS1	You are missing at least an O somewhere, haha. Yes.	
309	OA	Yes I will fix this later.	
310	PS1	We had, what did we have. Was the, yeah. I really would like to have archiving so we can use like storage better. Is it storage or Windows?	DGM
311	WIM	That is storage. We can put that as a weakness as well. Archiving.	DGM
312	OA	Archiving solution?	
313	PS1	Archiving solutions, yes.	
321	PS1	Well, there is many ways of doing archiving but, the weakness here is we don't work with it.	
322	OA	Yes, you're not doing anything?	
325	PS1	No, I mean it is also like assessing data. How often is it touched.	DGM

326	WIM	Yes, right!	
327	PS1	These kind of things. The moment we went from tapes to the DVDS. It is no easy solution for us to not even have data on disks anymore, which arguably it is something you want at some point you know. Be able to now have it on your disks but have it on tape that sitting somewhere consuming any power or whatever space, you know what I mean. So the, there are really good archiving solutions and I think at some point we need to look into having one of them.	DGM
328	OA	Mm.	
329	WIM	Okay, so.	
330	PS1	For us, one of the weaknesses is also I mean, it is a little bit connected to the local market threats. But also like local demands, for different countries. If you think about, [inaudible] application or automatic [inaudible] routine. In some countries they don't even allow look into the data so a certain point like the germans again and you know like the user data and so on. Like if it is in the drives no one can touch it or we have like deletion policies for the exchange drives for example, that all of a sudden because data users put up you can not do it in some countries or some countries do not want you to do that, and these kind of things. So local demands, that is a threat I think.	
331	OA	Yes.	
332	PS1	Not only from the market, but also from like local laws and regulations that is stand in your way when you want to do certain things.	
333	OA	So local demands in different countries. Customer forum, we talked about it earlier, if you just can affect your vendors. But I mean you have many vendors or do you just have one?	
334	WIM	No, we have many.	
335	OA	Yes, do you think that if you said like. To one of your vendors, maybe in Sweden not in other countries like China. Would they take that as a thing, would they take that seriously and try to change it?	

336	WIM	Yes.	
337	OA	Okay. That is good, because [confidential] actually putting guidelines for other countries. Regarding the sustainability. If you check the report for Facebook, Twitter, all of the Silicon Valley companies they are talking about power consumption and where they are getting the power from etc. And in the sustainability report, there is a little short part about IT, there is not much. And [confidential] wants to show what you are doing with help of the IT for the environmental sustainability. So that is a big strength, that [confidential] is so big that you can actually affect…	
338	WIM	Yes.	
339	OA	The vendors.	
340	PS1	I mean if you talk about renewable energy for example that is something IT more or less except for the data centers but in the distributed sites we getting it sort of it free. If you strategy is to have all your local sites on renewable energy to certain amount it is actually like long term focus to have it on 100% or something like that. We do it with solar and wind and so on, specially for the stores your IT stuff will be sustainable by just by being in the store you know. So, but I know for the data centers this is…	
341	OA	So we have some things here, good. Do you feel you have anything else you want to fill in?	
342	WIM	No, I just hope that we can we talked about because it is one linears. But once again, you have recorded so.	
343	OA	Yes, I know what we talked about. I have gone through my questions too. I asked about the energy consumption, hardware level, application level, the KPIs, the capacity on demand, energy manager, eco-mode, the workload and behavior and virtualization. So everything came in a natural conversation, I did not need to ask that much.	
344	PS1	Weakness in any degrees, maybe some can be put in, I'm not sure how to bring it up, but the complexity of things? In general, like anything you want to do, we want to do in scale with Windows is automatically very complex. Like if we look into…	EO
345	WIM	It has a high impact.	EO

346	PS1	And has a high impact, like if we look into the energy consumption, like implementing a policy that would like disable cores or something like that all of a sudden you have to deal with the applications running the virtualization stack, the Citrix environment, everything co-ops with everything that you are trying to do. So that makes things, very complicated and complex to implement I guess.	A EO
347	OA	How would you describe it?	
348	PS1	That the level of complexity and integration. I would say is challenging. For everything new you try to do. You understand what I mean right?	EO
349	OA	Like this?	
350	PS1	Makes the implementing new capabilities challenging. I guess. We see this everywhere. When we are doing a new version of the iOS, all of a sudden you are dealing with 3 500 applications if they can run properly. If you doing a patch and you know it enables, and all of this can be. It is a general problem and challenge all of this can relate to sustainability if you want to do sustainability specific things. If we were put up a patch that, like pushes different power scheme or something like that. You would have to think of all of this basically. So that is challenging and complicated stuff.	EO
351	OA	Because, we said this to Linux in their interview that there is, frameworks because they was complaining about application that are done is not power friendly at all. And there is frameworks that actually follow to make a power friendly application.	
352	PS1	Yes.	
353	OA	With scalability, availability, everything.	
354	PS1	Turning of cores, running more cores when you have high demand.	EO
355	OA	Exactly. Do you feel the same? That there is no policies or frameworks for the applications creators to actually follow these guidelines?	

| 356 | PS1 | They don't even know, their demand. When you ask [confidential] today, like how. What is the typical, what kind of hardware should we buy to support so many sessions for the store. It is like, everyone is having question marks in their faces. The stores as for us actually but I think that it is more demand we would have up in application site. We should be able to form an application site say, we need for each users that kind of you now like certain percentage of CPUs or something like that. Down to the model of hardware, where they do a evaluation and say, if we want to support 50 users in small store it is better to buy this model with this CPUs if we want to support 200 or 300 users in a big store or [inaudible] it is better to use this configuration and so on. You know what I mean. Nothing. You know, that is like, it is echoing this the applications is completely not aware of how to… | EO |
| 357 | | [interview ends] | |

Appendix 5 – Group Interview Transcript Oracle

Date: 9th of March 2017
Present: Omid Asali (**OA**) and Olof Kindblad (**OK**)
Location: Helsingborg
Interview Type: Group Interview
Length: 1 hour and 28 minutes
Number of participants: 6

Interviewee roles:
OIM: Oracle Infrastructure Manager
PS1: Product Specialist 1
PS2: Product Specialist 2
SS1: System Specialist 1
SS2: System Specialist 2
SS3: System Specialist 3 (Skype)

Row	Role	Dialogue	Code
1	OK	So to start us off, perhaps you could tell us a little bit about your system and its infrastructure?	
2	OIM	Well, you have different layers of the stack that builds up the solution. You have facilities, you have storage, you have hardware, operating system and then on top of that comes the middleware and the Oracle part so we're not physically connected to data centers in that sense. We are in the data center but mapping sustainability to power consumption is probably not a value that we can say but what I think is the biggest strength where we contribute the most is the capability to virtualize. We don't do it in all areas, with all the technologies, but if you look at it from a middleware point of view, we are fully virtualized. On the database side, we are virtualizing on the AIX, that is the [Oracle] database that are for AIX. On Linux it is the single installations that are virtualized but when it comes to clustering technology, on the other side, on Linux, we're not there, so that's probably considered a weakness.	KPI V
3	OA	So is this considered as an opportunity?	
4	OIM	It is.	V
5	OK	How would you compile this into a sentence?	
6	OIM	Software installations, how can we frame it so that it is understandable?	
7	SS1	"Some kind of configuration is not running on the environment?"	

8	OK	So perhaps "lacking clustering configuration on virtual Linux"?	V
9	OA	So, most parts of your stack is virtualized, is there anything that is falling behind, besides the Linux databases? It seems as if you have a quite large and complex stack, is there any part of the stack that in regards to virtualization is lacking?	
10	OIM	It wasn't that long ago since we took the decision on virtualization, we've had in the test environments for a while to try it out and see how it works and then we took the decision on the Linux part… what was it [name], six months ago?	V
11	PS2	Six months ago, yes.	
12	OIM	Now we support single databases on VMWare, so in regards to "lagging behind", yes, we most likely have systems still running physical but from the decision and onward, from the reinstalls or whatever, these go on virtual platforms.	V
13	OK	So you are looking virtualize these as well?	
14	OIM	Yes, they will be life cycle managed and they will be re-installed at some point in time and they will get virtualized or end up on the virtual platform.	EO V
15	OK	Which services do you as a team offer the rest of your company?	
16	OIM	So we as a team provide database services of a couple of different flavours. We have Oracle on Linux which [name] is responsible for and Oracle on AIX which [name] is responsible for. We have central and a distributed version of Oracle for AIX where the warehouses have Oracle installations on AIX, which is a separate platform. [name] also has the Linux arch central and distributed, it's the same type of package but it's different in AIX. Then on the Oracle middleware side we have WebLogic which is an application service, it's one of the market leading application servers and there's a lot of applications consuming that technology, both locally in our datacenters but also distributed. Then we also provide a service called forms and reports, this is a service that is fairly small in comparison to the other ones, it's an old Oracle technology that around 15 consumers in our company use. And the last part is what we call Oracle CT, it's our shared IT infrastructure, also called Oracle Enterprise Manager, that's where we do our administration of Oracle parts. It's like a central admin platform which we use for patching, backups, scheduling jobs and a number of maintenance activities like monitoring and so forth. All parts are very large if you compare to other companies, apart from forms and report which is fairly small. But maybe big from another company's perspective but we have a very large pool in this company compared to other enterprises. This is a very quick summary of course.	

17	PS1	And to add to this, there are also other Oracle supporting products, application products and high availability products.	
18	OIM	Yeah, that comes with different flavors of the database, high availability, DSR, Rnode, application services and so forth.	
19	OA	This high availability is something that Oracle writes a lot about in their white papers, cost savings in regards to time and such, but nothing about sustainability. I know that Oracle is aligning with the EU directive of low voltage but still in the white papers there are nothing that mentions environmental sustainability, high uptime means high power consumption, do you measure this [power consumption] in any way and do you follow up on this?	
20	SS1	There is a point regarding the high availability that Oracle introduced already some years ago, a new possibility. Because the high availability database project is based on having standby databases, so yes as you said, another server and another database that is doing nothing really. But now you have a possibility to use it, it is an option that is called Active Data Guard. This means that if you have an application using this, all the read only activity goes to that side [ADG side] which is very good. First of all you can have less load on the active database because on the other side you can use the active standby with a purpose also. And if you want to you can even structure so that for example can take backup from the active standby instead from the main database which means that you reduce the load on the main database. This Active Data Guard is implemented more and more because probably it's something that has always been a little "OK" but without any return.	EO
21	OIM	You know we're coming from a scenario where we have an active capacity where it always waits for something to happen.	
22	SS1	But some application is starting to use it for, of course, you know, the application before they verify structure and that. But now they are starting with some important application and moving the read-only queries to the active standby.	EO
23	OA	So if I understand this correctly, there is a cluster, like a spider web?	
24	SS1	It's more like one side that is primary and one side that is standby, and on the standby you have a database that in the past was just a "not open database", it was unusable, it was just nothing more. Now, you can open it, not for update but you can open it for read, which means that you can transfer part of the load of the application to these databases which means that of course, as a consequence you can have more traffic on the application without increasing the processing power for the primary database.	EO
25	OA	So you share the workload?	

26	SS1	Yes, you share the workload. That's a point from Oracle that they have started to support now, it's a strength that we are trying to promote, Active Data Guard, as much as possible also to use as input for replication. The users are implementing and implementing and implementing and of course we are running behind.	EO
27	OK	To what extent is this implemented, looking at your entire stack?	
28	SS1	This is default today, to always have data guard because it also gives much better protection for the data quality and other things. Then it is up to the application team to decide how much they want to use Active Data Guard.	EO
29	SS2	And from our internal side we take the backup from the active side.	
30	SS1	Yes, we are still structured to take the backup from the active side and this is something we discussed just now, that we have to move to the Active Data Guard.	EO
31	OA	Is the backup physical or cloud based?	
32	SS1	It's physical.	VC
33	OIM	But there's an adaption time towards Active Data Guard, I mean it's from an application from a point of view. We can maybe supply the capability of Active Data Guard but then we need to have the application to adapt to that kind of technology, so making it available doesn't mean that it magically happens. So there is an adaption rate from a full stack point of view but it's a nice opportunity to expand this and a strength that we can utilize it today.	EO
34	OK	But you said that this only supports read queries?	
35	SS1	Active Data Guard will always just support read because otherwise it would be a different kind of configuration, not just a stand by really.	
36	OIM	The main purpose is high availability but to utilize the high availability of the previous passive part of the availability to a larger extent than just waiting for something to happen.	EO
37	OK	So is this a pretty new feature?	
38	SS1	Not so new, but we have gotten it just recently because it's a feature that is separated and has a separate license and then we started to implement it and so you know. You cannot use it if you don't pay a special license.	
39	OA	Are you using Capacity on Demand?	
40	SS1	No, not right now.	EO

41	OK	So, I just want to reconnect to the part that just because you implement Active Data Guard doesn't mean that it magically happens, so a threat to this from a sustainability point of view would be that the applications do not adapt to this support this technology, is this correct?	
42	OIM	I think it could be considered an opportunity where we can probably advertise or market this functionality more to our consumers and say, "hey, we have this, it's a really cool feature, you can do this and that and we can support you and what you need to do in order to complete the move".	EO
43	OK	Does this mean effectively that the applications get more computing power, or… ?	
44	OIM	You could say so, you're taking away load from the primary to the secondary.	EO
45	SS1	In some case, the application may have a separate database for the reporting and in this case you can use Active Data Guard instead of having one more database and one more server. So in that case we save for sustainability.	EO
46	OA	So you could describe an opportunity as to "increase and promote use of Active Data Guard?"	
47	OIM	Yes.	EO
48	OA	Could an increased adoption of Active Data Guard in any way affect you negatively?	
49	SS1	No, not really, perhaps increased license cost, but this is our standard already. If there's nothing stopping the application from using it, then it is our recommendation. Also because Active Data Guard offers other features such as automatic control of the quality of the data block, similar to a block check. You also have some kind of automatic check-up of the health of your database primaries.	EO A
50	OK	Are you experiencing times of the day when you are processing a lot of data? Would it be useful or possible for you to utilize capacity on demand?	
51	SS2	Today we don't have so many shared services systems, before we had mostly sharing and in that point of view we did use capacity on demand, but nowadays we do have a lot of dedicated-, or one system using a dedicated server and this means that we don't have any peak time or low time for that part. Perhaps in the future when we have the possibility to share more...	EO
52	OIM	Multitenancy might give us an opportunity there, in regards to moving forward.	EO

53	SS1	I think that something like this is being done with the AIX system because they have a lot of virtualization and they have very dynamic possibilities in sharing and moving CPU from one part to another and memory and so on. And they also have some kind of agreement with IBM that I think they can immediately activate some resources if its needed. But I mean it's not done so that we in the day run some kind of special configuration and then at night some other but it's more used for an emergency. Just now, the use configuration of the servers is "fixed", and in case of an emergency there is the possibility to take some help and maybe give back.	
54	PS1	I think that the AIX team still does that on a regular basis. Because they have some batches running in the night which they take some power to and then in the morning they give it back.	
55	OA	Does this mean that your physical machines are always running on full power? And I ask this question in regards to physical footprint and power consumption.	
56	OIM	I don't have full control over, I mean we have a very large stock, over 4500 servers or something like that and we cannot say if we are utilizing our CPU and memory to 100 percent, I don't think we are, if you would do a survey I think that both the CPU consumption of the host and on database level it would be not 100 percent. Oracle's Capacity on Demand I think is a cloud service and we are heavily on prem right now but this company is on a journey right now to cloudify, which we didn't say. The new digitstrats, the new strategies that are coming out, where we are venturing more into the cloud and we have invested in a number of cloud services and platforms so far and that's where we in the database area are quite late in that journey, not enough right now. We are looking into it and that number of activities in the coming years.	EO VC
57	OA	Do you believe that if the entire infrastructure would become cloud based, would that help the environmental sustainability in regards to the activities of your team and technology?	
58	OIM	If I look egotistically, yes, I would have a less footprint on the company premise but it's also very important how the vendor of the cloud, that the vendors that provide their cloud, I mean they might be running on 5000 physical machines but say "we are a cloud". Yes, we would lower our footprint on the company side but the responsibility is partly given to the supplier.	VC
59	OA	What about Traffic Director?	
60	PS2	That's on the WebLogic side.	
61	OIM	Yeah, we can't really give you that much information on this. It's a load balancing type of mechanism that is built within Oracle, instead of having an external load balancer shifting traffic left or right, there's	EO

		a built in functionality that kind of enables applications and infrastructure to shift load in a smart and integrated way.	
62	OA	Is this used today in any way?	
63	OIM	No, it's currently not used in any production system but it is possible that we will go for it. It's being evaluated and no decision has been taken whether to pursue it.	EO
64	SS1	But is this substituting a load balancer?	
65	OIM	It could be. I'm being very vague here. It's a technology we're looking into. It's in a couple of our test systems.	EO
66	OK	So this would be considered an opportunity then we presume? Because from a sustainability point of view load balancing is a gain in terms of power consumption and data processing.	
67	OIM, SS1	Yes.	EO
68	SS1	But we have in any case a load balancer that is up from WebLogic, a load balancer that is distributing traffic that is coming from the outside to the different application servers, in a typical configuration we have two data centers and with distributed application servers for availability also, but both of them are used and there are load balancer, don't ask me because it's a piece that is outside from us, but it is distributing traffic with different logic depending on the kind of application between the different application servers. So there is some kind of, yes, load balancer.	EO
69	OK	But it would still be a benefit for you to use a load balancer within the Oracle sphere?	
70	OIM	It could be. Nothing has been decided and there is an opportunity but it could be a go a no-go, it's all technical discussions of course, sustainability is one thing but we need to look at the capabilities and see what it provides. It's like that with all of the decisions.	
71	OK	Have you ever taken a decision within the team based on a purely sustainability aspect? Or is this always outweighed by a time or cost efficiency perspective?	
72	PS2	We've never taken a decision based only on sustainability, but it comes as a part of it. I mean, we have several strengths as well, we have this strategy where we're trying to lower the footprint for installations basically. Basically disabling features, procedures, functions and stuff like that to lower the footprint on each installation, but, that is not purely a decision based on sustainability, it's more licence cost, storage, which in the long end is sustainability, but not as the first point.	EO

73	OIM	I think when we discussed the virtualization on Linux, we talked a lot about the sustainability area of not consuming physical hardware. We didn't do the maths on exactly how much but we were doing the Linux team of course that is more connected to the physical consumption. But it was not a pure sustainability decision, the technology advantages to virtualize and cost was.	VC
74	PS2	And connected to that one, lower footprints on installations, we have a weakness as well with a lot of installations which is not utilized enough. We have a lot of installations with low utilization so we could probably consolidate that more. Consolidation of functionality is indeed an opportunity.	EO
75	SS1	Yes, to have one database used for more than one small application maybe.	EO
76	OIM	I can see a use case of fewer test environments.	
77	SS1	Yes, we have a lot of test environments. Like, how many test environments are coming every day?	DGM
78	OIM	We can probably place and consolidate more in the test environment than what we can in the production environments.	DGM
79	SS1	Yes, yes, surely, but today the test environments are just multiplying. The main projects take over our plans of consolidation and just asking "I want these two, three, four times and no discussion". The main project are sometimes absolutely for us a threat since we cannot stop those. Or do you agree?	DGM
80	OIM	It's both yes and no. Well, I think we have the chance to influence the design sometimes not depending on urgency or some valid reasons. But I think we have a good opportunity to, you know, set standards and directives and how it should be placed.	
81	SS1	Yeah, business requirements can overrule our consolidation plans or can bypass it.	
82	OA	Is there anything else in regards to sustainability engagements and test environments that can affect your company and the daily operations?	
83	SS1	Yeah, it can affect a lot. It can affect operations, it can affect redundant environments that are not used to 100 percent and you know, duplication of environment, triplication of environments and more, it's just to have a lot to just test this. So of course they, the test environments, are not used to 100 percent.	DGM
84	OIM	I was just thinking, before I forget it, it's a complete subject change but [name], do you have anything to add?	
85	SS3	Yeah, in regards to the discussion about cloud computing I have one point to bring up. Cloud computing might necessitate stronger network	VC EO

		resources and so I think that's something that we might to have to keep an eye on. How much would our network usage increase and what more to cloud computing. Have you had any discussion yet about cloudable databases and Oracle 12, and what opportunities that might present for us to have more efficient use of resources?	
86	OIM	I agree, that's an opportunity for the future.	
87	OK	What kind of distribution do you have on the different versions? We presume you're not running version 12 as of now then?	
88	SS1	No, we are. We are currently in a migration program that is going to be closed within around two months and have been running for 18 months to go from 11g to 12.	EO
89	OA	And which version is WebLogic?	
90	OIM	It's 11 and 12 is to be released any day.	EO
91	OA	So it's up to date?	
92	OIM	Yes, the company has a very strong policy when it comes to Life Cycle Management.	EO
93	OK	And this is something you consider as a strength?	
94	OIM	Yes it is. I think so, and as vendors release new products they are more efficient, more thought through. At least we hope that they deliver better capabilities.	EO
95	OK	What kind of new capabilities will Oracle 12 and multitenancy provide?	
96	OIM	Consolidation, maintenance, simplified maintenance, reusing the footprint of databases, efficiency in the way of databases such as automation. It's a completely new architecture from Oracle that will be the bond moving forward, where they kind of step away from the old traditional ways of running a database and now moving into a more multi tenancy architecture.	EO A
97	OIM	I also wanted to lift the question on threats. We are not developing the database platform ourselves, I mean we are buying it off, in the case, Oracle, and maybe it's a threat where we want to do something but the vendors do not support it.	
98	OA	Do you perceive it as if you are locked with one vendor?	
99	OIM	As it is today, yes. Our technology is based on Oracle database and say that we want to use this cool feature that's on the market, but Oracle has yet to certify or support it.	

100	SS1	Was not that also the example for virtualization of the database in case of Linux? Oracle was not officially supporting Oracle database on VMWare. And then of course, they didn't say "you cannot have it", they said "run it on VMWare, but if there's a problem then you have to reproduce the problem outside VMware otherwise we will not accept it". They do not say "oh, we know that it can run, but we do not certify it". And that of course is a big, it created a lot of delay, deciding in any case to introduce it.	VC
101	OK	Do you have any power to affect Oracle in these types of matters? Are you part of any Customer Forum or like that?	
102	OIM	Yes.	
103	OK	Are you raising any issues of sustainability in this forum?	
104	OIM	To be honest, no. Not until now at least, and that's why we're talking about… I mean, the discussion is around consolidation and multi tenancy in these forums but I think when you read the manuals they don't talk about sustainability and I think that if in the forums maybe they don't...	EO
105	PS2	To some extent they do actually. I mean, they, with 12c they implemented the multithreaded architecture but we decided we won't use that one because it's not pure enough. It's still a new technology, it's a new for Oracle, we will not use it in this release. It might be used in future releases, but, I mean, so they are working as well with trying to lower the footprint when it comes to memory and CPU and so forth but we are not implementing it as an early adopter.	EO
106	OIM	But they're not really talking… they're talking in a more of a technology kind of way. They're not taking it into, I mean in the words of environmental sustainability.	
107	PS2	They might be doing it but we are not in contact with Oracle's hardware. Because we are more or less using, I mean everything is software products, and they don't directly preach sustainability but they do mention compression and lower power usage and those kind of things to reduce it. If you are closer to the servers I think they would say something about it.	EO
108	OA	But you could in someway kind of effect the vendor in the customer forum, since you have such a big voice?	
109	OIM	Yes, I'd say it's an opportunity that we can feedback them and also have direct requirements. But if they are picked up or not, that's a different question but we can at least influence them that we do with all the suppliers.	
110	OA	Do you monitor your platform in any way? Is there something similar to a dashboard of all the applications and their usage? For example in	

		a scenario where something is running on a 100 percent CPU load but isn't used?	
111	SS2	We had some monitoring before to find out a view or a report of how much capacity is used by a certain application, but unfortunately we didn't continue this.	KPI
112	OK	So it was implemented for a while then, did you manage to draw any conclusions from ti?	
113	SS2	For that time we could see that we don't use that much capacity, we do have installations for database and we consume a lot of hardware but utilization of that is not really high. So, this is kind of something that we can do in the future perhaps.	EO KPI
114	OIM	I mentioned before that we have this Oracle Enterprise Manager, kind of a central management system connected to all Oracle installations whatever they are, gathering data sources. We have the capability today to go and look at consolidation and how much is utilized, we don't have a complete dashboard of all the X amount of thousands of databases, that would be humongous but some applications we are looking at more frequent than others. And then we also have the, that is more on consumption, where we have our pro-active monitoring that alerts us based on usage when it's about to go to a certain threshold. It's not on the lower side when it's actually consuming five percent of the total power, if you know what I mean, so we have it but it's more when it's about to breach a certain threshold so that we can take proactive measures based on those values but the capability is there I think. To use it, or use the data.	KPI
115	SS1	We do not have everything on the Enterprise Manager, for example the AIX server is not there. But to know, I mean, you will see if a database is consuming CPU but you will never know exactly from Enterprise Manager if there is more CPU or not available. That is on the server side. Also because the technology behind AIX virtualization is completely, it's kind of a mystery with this "capped on capped core", you never know what you really have. You have some fraction of something and you really not know how to translate it.	KPI
116	SS3	I have one small example of that from the US, we have one pretty small data center in our office and just a week ago we were able to shut down our oldest running cluster. We've been running an Oracle 8 database, a custom database, which we were finally able to shut that down and retire it last week. And I know that they were monitoring power consumption and were expecting, I haven't seen the actual numbers yet but they were expecting to see a fairly notable drop just from shutting that one cluster down because it was such an old and inefficient server.	EO KPI
117	OIM	I think I promised you cake as well when that would happen, so yeah, we need to travel, which is not really sustainable for a cake. But that's very good news and that also shows life cycle management, and life	EO

		cycle management is not just the database but it also concerns the hardware and the later versions which is more naturally efficient and so forth. So, perfect example of life cycle management.	
118	SS2	And we do have a good process for decommission of databases. So, in this case, it is quite good for the environment.	EO
119	OA	Do you know exactly which databases are used and not used? When do you decommission them?	
120	SS2	Well, the thing with this company is that we don't own the database but we have the process once they come in. We can push also, and say "this environment or this database, you are not using" and what are we going to do with that? So once they come in to get confirmed, we run the process for decommission for that.	EO
121	OIM	I agree, once the order that is coming for decommission, there's a ticket and it's the size of that coin. I think that this company is slow at decommissioning solutions, you know, that rate can be higher. Because it's a high cost, a huge impact from a sustainability perspective but once they actually order the decommission, it's quick. We're keeping too much solutions too long.	EO
122	PS2	And that goes with data as well I would say. We're not archiving data, we're not having any data retention time and so on, so it's a huge weakness I would say.	DGM
123	OK	Yes, we were going to ask you about data growth. We've seen some graphs from this company, from other teams, showing a steady increase in stored data, will this affect you as well?	
124	SS1	Yes.	DGM
125	PS2	Yes, this has two sides. One side is of course the growth of this company, but we should have data retention times in place and we should have a thought about having multiple test environments consuming a lot space and so on. That is one part as well, so the bad side is the number of test environments that are growing and the other side, well, the same side, is the data retention but on the other hand it is good that we are growing.	DGM
126	OIM	Yes, otherwise we probably wouldn't be sitting here.	
127	SS1	Yes, and about the data retention, as I understand it is quite often business that is lacking clear instructions on what to store. They don't say "okay, I need this data for five years, not longer and after five years we can remove, clean up or archive it" and this is a kind of information that quite often business also is missing clear requirements or something like that, on what to store.	DGM
128	OIM	Yes, I fully agree and it's kinda the same with decommissions. We don't own the data, like, we in this room, so if we see that we have 300	EO DGM

		databases that are just standing idle, I'd love to just go and power them down because they are not used, or even remove them, but we don't own the data so I, or we, cannot take a decision to decommission that server or database, it needs to come by order by the one that is owning the data, the solution owner or someone like that. So that's up to, well, we can of course recommend, we can do investigations on data growth, we could say "you could archive this in some way that is beneficial", but it's of high impact.	
129	OK	How do you perceive the communication in the company around data retention and how to store data?	
130	OIM	You know, it's a lot about mindset. And I can reflect on it myself, it's hard to let go, but at some stage you need to. But you shouldn't wait until forever until you let go, until absurdum in some cases, so that is maybe a policy or something that needs to be set to increase the speed but then once the order comes, we do it in an hour. They've kept it for a year, you know.	DGM
131	OA	So do you think that this is a mindset for the, for example Solution Owners, that they might need this database at some point?	
132	OIM	Well, it's… it's tough to let go.	DGM
133	SS1	They are afraid that they could need it later.	DGM
134	OIM	If I then take the database away for ever, well, "what if I need it?". But you haven't used it in two years! Ah, I'm kind of playing this scenario here.	DGM
135	OK	Is it difficult for them to get a new database up and running, if they need it? If they have new requirements of capacity?	
136	OIM	Most of the time they have something that is already running, their new nice piece of software.	EO
137	SS1	But when they get something new they usually decommission but it's more for some old application that should not be in use anymore or some component.	EO
138	OIM	Data growth, purging of old data, removing old data that is no longer needed is a huge win in that. That's where you really let go and then they don't have anything, you just remove stuff that is no longer needed. You know, like you guys have a personal drive at home or the university and sometimes you clean up, sometimes you don't, you just keep, and it keeps on growing and 10 years later you go "I still have that folder".	DGM
139	OA	That's me, I have organized chaos in my drive.	
140	OIM	I'm not saying we have organized chaos...	

141	OA	No, no, I have.	
142	OIM	The use case for it… I can understand them but at the same time we are concerned.	DGM
143	OK	So is there currently any data retention policy in place?	
144	SS1	No. Not clear. There are a very, very few applications that have a clear policy regarding this.	DGM
145	OIM	Some work with it well, IOW… it's very easy to have capacity.	EO
146	SS1	Also usually because if it's not a point... if it's not been taken into account from the beginning the of the sign of the application, it is very very hard to apply later. Some kind of clean up, or very huge amount of data, there's also some practical...	DGM
147	OIM	But I think that's a valid point when we're looking for other things outside of the database area where we're looking at application sign that supports sustainable way of working. Purging data, less footprint-ing, the whole stack so to say, I think that's a good takeaway for you and as [name] said, if you haven't thought of it from the beginning it's very hard to invent it mid-life of an application, it's a re-write some-times...	DGM
148	OK	Are there any other aspects of performance improvements in relation to your infrastructure software that we haven't talked about?	
149	OIM	We are going to look at cloud services or database as a service, like, starting up pre-studies to understand what is possible for us to do. We're talking about cloud opportunities… but I think you can perceive that as an opportunity that we are investigating the capabilities and what we can do. We're looking at vendors and not just Oracle but maybe placing Oracle's database in a cloud environment only to un-derstand and then take a decision if it's good for us or not.	VC
150	OK	Because such an activity, as you said earlier, would effectively lower your footprint? But in that case you would, from a company manage-ment perspective, require some kind of policy to make sure that the vendors in turn are sustainable… do you have a lot of cloud services?	
151	OIM	Yes, this company is heavily invested in cloud services, a lot of SaaS and so forth… I think we have over 1000 cloud services towards the company, from a small website to like, bigger SaaS solutions, so it's very big and emergent with the new digital strategy. I mean, everything from travel booking systems to websites that are hosted somewhere else, that's a cloud, offered as a service… solution. We don't really think of it like that but it is, instead of hosting it internally we buy it from the vendor. So a lot.	VC

| 152 | | [interview ends] | |

References

Al-Fares, M., Loukissas, A. and Vahdat, A. (2008). A scalable, commodity data center network architecture. ACM SIGCOMM Computer Communication Review, 38(4), p.63.

Azapagic, A. (2003). Systems Approach to Corporate Sustainability. Process Safety and Environmental Protection, 81(5), pp.303-316.

Bachour, N. and Chasteen, L., (2010), April. Optimizing the value of green it projects within organizations. In Green Technologies Conference, 2010 IEEE (pp. 1-10). IEEE.

Bajgoric, N. and Moon, Y. (2009). Enhancing systems integration by incorporating business continuity drivers. Industrial Management & Data Systems, 109(1), pp.74-97.

Ballejos, L. and Montagna, J. (2008). Method for stakeholder identification in interorganizational environments. *Requirements Engineering*, 13(4), pp.281-297.

Bansal, P. and Roth, K. (2000). WHY COMPANIES GO GREEN: A MODEL OF ECOLOGICAL RESPONSIVENESS. Academy of Management Journal, 43(4), pp.717-736.

Barroso, L., Clidaras, J. and Hölzle, U. (2013). The Datacenter as a Computer: An Introduction to the Design of Warehouse-Scale Machines, Second edition. Synthesis Lectures on Computer Architecture, 8(3), pp.1-154.

Bhattacharya, A.A., Culler, D., Kansal, A., Govindan, S. and Sankar, S., (2013). The need for speed and stability in data center power capping. *Sustainable Computing: Informatics and Systems*, *3*(3), pp.183-193.

Bhattacherjee, A., (2012). *Social Science Research: Principles, Methods, and Practices*. 2 Edition. CreateSpace Independent Publishing Platform

Brundtland Commission (1987). Out Common Future. Brussels: World Commission on Environment and Development.

Butler, T. and Daly, M. (2009). Environmental responsibilty and green IT: An institutional perspective. *European Conference on Information Systems (ECIS)*.

Camarinha-Matos, L. and Afsarmanesh, H. (2003). Elements of a base VE infrastructure. Computers in Industry, 51(2), pp.139-163.

Carroll, A. and Shabana, K. (2010). The Business Case for Corporate Social Responsibility: A Review of Concepts, Research and Practice. *International Journal of Management Reviews*, 12(1), pp.85-105.

Celebic, B. and Breu, R. (2015). Using Green KPIs for Large IT Infrastructures' Energy and Cost Optimization. 2015 3rd International Conference on Future Internet of Things and Cloud.

Chen, A., Boudreau, M. and Watson, R. (2008). Information systems and ecological sustainability. *Journal of Systems and Information Technology*, 10(3), pp.186-201.

Chen, A.J., Watson, R.T., Boudreau, M.C. and Karahanna, E., (2009). Organizational adoption of green IS & IT: An institutional perspective. *ICIS 2009 proceedings*, p.142.

Costanza, R. and Patten, B. (1995). Defining and predicting sustainability. Ecological Economics, 15(3), pp.193-196.

Cox, P., Betts, R., Jones, C., Spall, S. and Totterdell, I. (2000). Nature, 408(6809), pp.184-187.

Department of Energy. (2015). [online] Available at: http://energy.gov/sites/prod/files/2015/01/f19/UMPChapter20-data-center-IT.pdf [Accessed 6 Sep. 2016].

DI Digital. (2016). Uppgifter: Google bygger serverhall i Sverige. [online] Available at: http://digital.di.se/artikel/uppgifter-google-bygger-serverhall-i-sverige# [Accessed 25 Oct. 2016].

Earth Overshoot Day. (2016). Earth Overshoot Day 2016. [online] Available at: http://www.overshootday.org [Accessed 25 Oct. 2016].

Earthobservatory.nasa.gov. (2016). July 2016 Was the Hottest Month on Record: Image of the Day. [online] Available online: http://earthobserva-tory.nasa.gov/IOTD/view.php?id=88607 [Accessed 2 Sep. 2016].

Eder, K. and Gallagher, J. (2017). Energy-Aware Software Engineering. *ICT - Energy Concepts for Energy Efficiency and Sustainability*.

Ehrlinger, J., Gilovich, T., & Ross, L. (2005). Peering into the bias blind spot: People's assessments of bias in themselves and others. Personality and Social Psychology Bulletin, 31(5), 680-692.

Gabrys, J., (2014). Powering the digital: From energy ecologies to electronic environmentalism.

Gangwani, D. and Popli, N. (2014). IT for Environmental Sustainability. *International Journal of Emerging Technology and Advanced Engineering*, 4(7), pp.836-842.

Gao, P., Curtis, A., Wong, B. and Keshav, S. (2012). It's not easy being green. Proceedings of the ACM SIGCOMM 2012 conference on Applications, technologies, architectures, and protocols for computer communication - SIGCOMM '12.

Garg, S.K. and Buyya, R., (2012). Green cloud computing and environmental sustainability. *Harnessing Green IT: Principles and Practices*, pp.315-340.

Ghazinoory, S., Abdi, M. and Azadegan-Mehr, M. (2011). Swot Methodology: A State-of-the-Art Review for the Past, A Framework for the Future. Journal of Business Economics and Management, 12(1), pp.24-48.

Greenwald, R., Stackowiak, R. and Stern, J., (2013). *Oracle essentials: Oracle database 12c*. " O'Reilly Media, Inc.".

Greveler, U., Glösekötterz, P., Justusy, B. and Loehr, D., (2012), January. Multimedia content identification through smart meter power usage profiles. In *Proceedings of the International Conference on Information and Knowledge Engineering (IKE)* (p. 1). The Steering Committee of The World Congress in Computer Science, Computer Engineering and Applied Computing (WorldComp).

Google (2016). Environmental Report. [online] Google. Available at: https://static.goog-leusercontent.com/media/www.google.com/en//green/pdf/google-2016-environmental-report.pdf [Accessed 25 May 2017].

H&M (2016). *The H&M Group Sustainability Report 2016*. [online] Stockholm: H&M, pp.1-124.Available at:http://sustainability.hm.com/content/dam/hm/about/documents/en/CSR/2016%20Sustainability%20report/HM_group_SustainabilityReport_2016_FullReport_en.pdf [Accessed 23 May 2017].

Hadim, S. and Mohamed, N. (2006). Middleware: Middleware Challenges and Approaches for Wireless Sensor Networks. IEEE Distributed Systems Online, 7(3), pp.1-1.

Hansen, E., Grosse-Dunker, F. and Reichwald, R. (2009). Sustainability Innovation Cube - A Framework To Evaluate Sustainability-Oriented Innovations. International Journal of Innovation Management, 13(04), pp.683-713.

Hazas, M., Morley, J., Bates, O. and Friday, A., (2016), June. Are there limits to growth in data traffic?: on time use, data generation and speed. In *Proceedings of the Second Workshop on Computing within Limits* (p. 14). ACM.

Henfridsson, O. and Lind, M. (2014). Information systems strategizing, organizational subcommunities, and the emergence of a sustainability strategy. The Journal of Strategic Information Systems, 23(1), pp.11-28.

Hovorka, D.S., Labajo, E. and Auerbach, N. (2011) 'Information Systems in Environmental Sustainability: Of Cannibals and Forks', Green Business Process Management, pp. 59–72.

Ijab, M.T., Molla, A., Kassahun, A.E. and Teoh, S.Y. (2010): Seeking the"green" in "green IS": A spirit, practice and impact perspective. Pacific Asia Conference on Information Systems (PACIS).

Jamieson, D. (1998) 'Sustainability and beyond', Ecological Economics, 24, pp. 183–192.

Kipp, A., Jiang, T., Fugini, M. and Salomie, I., (2012). Layered green performance indicators. Future Generation Computer Systems, 28(2), pp.478-489.

Koçak, S.A., (2013), October. Green software development and design for environmental sustainability. In 11th International Doctoral Symposium an Empirical Software Engineering (IDOESE 2013). Baltimore, Maryland (Vol. 9).

Koçak, S.A., Miranskyy, A., Alptekin, G.I., Bener, A.B. and Cialini, E., (2013). The impact of improving software functionality on environmental sustainability. *on Information and Communication Technologies*, p.95.

Koomey, J., (2011). Growth in data center electricity use 2005 to 2010. A report by Analytical Press, completed at the request of The New York Times, 9.Vancouver

Koomey, J.G. (2007). Estimating Total Power Consumption by Servers in the US and the World. Lawrence Berkeley National Laboratory, Berkley, CA, USA.

Kuo, B. and Dick, G. (2009). The greening of organisational IT: what makes a difference?. Australasian Journal of Information Systems, 16(2).

Kvale, S. (1996). *Interviews*. Thousand Oaks London New Delhi: Sage.

Kvale, S. and Brinkmann, S. (2009). *Interviews*. 1st ed. Los Angeles: SAGE.

Loeser, F., (2013). Green IT and Green IS: Definition of constructs and overview of current practices.

Metzger, E., Putt del Pino, S., Prowitt, S., Goodward, J. and Perera, A. (2012). sSwot a sustainability swot. 1st ed. [ebook] World Resources Institute, pp.1-6. Available at: https://www.wri.org/sites/default/files/pdf/sustainability_swot_user_guide.pdf [Accessed 14 Mar. 2017].

Microsoft.com. (2017). *Corporate Social Responsibility | Microsoft*. [online] Available at: https://www.microsoft.com/en-us/about/corporate-responsibility [Accessed 23 May 2017].

Molla, A., Cooper, V.A. and Pittayachawan, S., (2009). IT and eco-sustainability: Developing and validating a green IT readiness model. *ICIS 2009 Proceedings*, p.141.

Montiel, I. (2008). Corporate Social Responsibility and Corporate Sustainability: Separate Pasts, Common Futures. Organization & Environment, 21(3), pp.245-269.

Murugesan, S. and Gangadharan, G. (2012). Green IT: An Overview. Principles and Practices, pp.1-21.

NCC. (2013). Serverhall Facebook, Luleå. [online] Available at: https://www.ncc.se/vara- projekt/serverhall-facebook-lulea/ [Accessed 27 Oct. 2016].

Neuman, W. (2014). *Social research methods*. Boston [u.a.]: Pearson.

Nidumolu, R., Prahalad, C. and Rangaswami, M. (2009). Why Sustainability Is Now the Key Driver of Innovation. Harvard Business Review.

Oliveira, T., Thomas, M. and Espadanal, M., (2014). Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors. Information & Management, 51(5), pp.497-510.

Paul, P.K. and Ganguly, J., (2013). Green Computing: The Emerging tool of Interdisciplinary Environmental Sciences-Problems and Prospects in Indian scenario. *International Journal of Pharmaceutical and Biological Research*, 5(04), pp.210-214.

Pesonen, H. and Horn, S. (2012). Evaluating the Sustainability SWOT as a streamlined tool for life cycle sustainability assessment. The International Journal of Life Cycle Assessment, 18(9), pp.1780-1792.

Rahman, S.F., Guo, J. and Yi, Q., (2011), January. Automated empirical tuning of scientific codes for performance and power consumption. In *Proceedings of the 6th International Conference on High Performance and Embedded Architectures and Compilers* (pp. 107-116). ACM.

Recker, J. (2013). *Scientific Research in Information Systems*. Berlin: Springer Berlin.

Regeringen.se, (2016). 1st ed. [ebook] Regeringen.se, pp.32-52. Available at: http://www.regeringen.se/49aea4/conten-tassets/951e5cdee12e439c87828e06c7f268a6/foretagens-rapportering-om-hallbarhet-och-mangfaldspolicy [Accessed 14 Mar. 2017].

Regeringskansliet. (2016). Nu ställer vi krav på hållbarhet för företag. [online] Available at: http://www.regeringen.se/debattartiklar/2016/05/nu-staller-vi-krav-pa-hallbarhet-for-foretag/ [Accessed 26 Oct. 2016].

Research And Markets, (2014). Data Center Construction Market by Data Center Types, by Design Types, and by Tier Types - Global Forecast to 2019. Markets and Markets. Global: Research And Markets, p.181.

Ritchie, J. and Lewis, J. (2003). *Qualitative Research Practice*. 1st ed. SAGE Publications.

Root, T., Price, J., Hall, K., Schneider, S., Rosenzweig, C. and Pounds, J. (2003). Fingerprints of global warming on wild animals and plants. Nature, 421(6918), pp.57-60.

Rosenblum, M., Bugnion, E., Herrod, S., Witchel, E. and Gupta, A. (1995). The impact of architectural trends on operating system performance. ACM SIGOPS Operating Systems Review, 29(5), pp.285-298.

Schirmeier, H. and Spinczyk, O., (2007), September. Tailoring infrastructure software product lines by static application analysis. In *Software Product Line Conference, 2007. SPLC 2007. 11th International* (pp. 255-260). IEEE.

Schmidt, D.C. and Porter, A., (2001), May. Leveraging open-source communities to improve the quality & performance of open-source software. In *Proceedings of the 1st Workshop on Open Source Software Engineering*(Vol. 1).

Stamford, C. (2013). Gartner Says Nearly Half of Large Enterprises Will Have Hybrid Cloud Deployments by the End of 2017, [online] Available online: http://www.gartner.com/news- room/id/2599315 [Accessed 12 Oct. 2016]

Sustainability.fb.com. (2017). *Facebook Sustainability | Sustainability Energy Efficiency & Renewable Energy | Facebook*. [online] Available at: https://sustainability.fb.com/ [Accessed 23 May 2017].

Tanenbaum, A. (2009). *Modern operating systems*. 3st ed. Upper Saddle River: Pearson Prentice Hall.

Tarnekar, S. (2011). Green IT: A Path to Environmental Sustainability. In: *Computing For Nation Development*. [online] Available at: http://Proceedings of the 5th National Conference; INDIACom-2011 [Accessed 12 May 2017].

Tetra Pak (2016). *Sustainability Update 2016*. [online] Tetra Pak, pp.1-38. Available at: https://endpoint895270.azureedge.net/static/documents/sustainability/sustainability-update-2016.pdf [Accessed 23 May 2017].

The Next Web. (2011). Facebook confirms it will host its first non-US data center in Sweden. [online] Available at: http://thenextweb.com/facebook/2011/10/27/facebook-finally-confirms-it-will-host-its-first-non-us-datacenter-in-sweden/ [Accessed 25 Oct. 2016].

Tilson, D., Lyytinen, K. and Sørensen, C., (2010). Research commentary—Digital infrastructures: The missing IS research agenda. *Information systems research*, 21(4), pp.748-759.

Uddin, M. and Abdul, A. (2011). Virtualization Implementation Model for Cost Effective & Efficient Data Centers. International Journal of Advanced Computer Science and Applications, 2(1).

Uddin, M. and Rahman, A. (2011). Techniques to implement in green data centres to achieve energy efficiency and reduce global warming effects. International Journal of Global Warming, 3(4), p.372.

Uddin, M. and Rahman, A.A., (2012). Energy efficiency and low carbon enabler green IT framework for data centers considering green metrics. *Renewable and Sustainable Energy Reviews*, *16*(6), pp.4078-4094.

Uddin, M., Rahman, A., Shah, A. and Memon, J. (2012). Virtualization Implementation Approach for Data Centers to Maximize Performance. Asian Journal of Scientific Research, 5(2), pp.45-57.

Volvo (2016). *The Volvo Group Annual and Sustainability Report*. [online] Göteborg: Volvo AB, pp.1-208. Available at: http://www.volvogroup.com/en-en/investors/reports-and-presentations/sustainability-reports.html [Accessed 23 May 2017].

Vykoukal, J., Wolf, M. and Beck, R. (2009) 'Does Green IT Matter? Analysis of the Relationship between Green IT and Grid Technology from a Resource-Based View Perspective', PACIS, 51.

Watson, R.T., Boudreau, M.C. and Chen, A.J., (2010). Information systems and environmentally sustainable development: energy informatics and new directions for the IS community. MIS quarterly, pp.23-38.

Woroch, G. (2000). Competition's Effect on Investment in Digital Infrastructure. University of California-Berkeley mimeo.

Xavier, M.G., Neves, M.V., Rossi, F.D., Ferreto, T.C., Lange, T. and De Rose, C.A., (2013), February. Performance evaluation of container-based virtualization for high performance computing environments. In *Parallel, Distributed and Network-Based Processing (PDP), 2013 21st Euromicro International Conference on* (pp. 233-240). IEEE.

Yin, R. (2006). *Case study research*. Thousand Oaks, Calif. [u.a.]: Sage.

Yin, R. (2009). *Case study research*. Thousand Oaks, Calif. [u.a.]: Sage.

Zhang, Q., Cheng, L. and Boutaba, R. (2010). Cloud computing: state-of-the-art and research challenges. *Journal of Internet Services and Applications*, 1(1), pp.7-18.

Zhu, K., (2004). The complementarity of information technology infrastructure and e-commerce capability: A resource-based assessment of their business value. Journal of management information systems, 21(1), pp.167-202.Vancouver.