Självständigt arbete på avancerad nivå

Independent degree project – second cycle

Master of Science
Computer Engineering

Cloud Computing
Evaluation, as a platform for Scania Architecture

Muhammad Anas Siddiqui
Abstract
Cloud computing has been given a great deal of attention during recent years. Almost all the technology market leaders and leading hosting service providers (like IBM, Microsoft and Verizon) have entered into the Cloud market as Cloud Providers. Cloud computing promises to provide highly available, secure, low cost, agile and highly scalable solution to the consumers.

Scania is a global company and one of the world’s leading heavy vehicle manufacturers with 35,000+ employees. All the large organizations such as Scania, aim to constantly update themselves with the latest technology in order to meet their business requirements but, these organizations must always be convinced that there is a strong reason(s) to implement new technology.

This research provides the method and criteria in relation to initiating Cloud computing. A number of Scania’s specific business requirements that it is possible to map to the Cloud are addressed in this thesis. The methodology of research is split in two parts. Firstly, the identification of business cases at Scania and their requirements with the Cloud and Secondly, the evaluation and comparison of the functionalities and capabilities of different vendors. The accumulated data is then compared and suitable vendors, according to those business requirements are suggested.

This thesis also shares the experience of moving on premise applications to the Cloud. These are Scania specific applications which are currently being hosted in-house. The research also addresses the possibilities of portability between the Cloud providers. Although there is no standardization in relation to Cloud computing, some initiatives such as OpenStack are available and its current position and some application and data migration tools are also discussed.

The thesis concludes with a general discussion, recommendations in relation to adapting Cloud computing and selecting the Cloud provider. This recommendation applies to every organization including Scania.

Keywords: Cloud Computing, Scania, Amazon AWS, Microsoft Windows Azure, IBM SmartCloud, Verizon Cloud Services, IaaS, PaaS, SaaS, Public cloud, Private Cloud, Hybrid Cloud, Portability, Security, Privacy
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Appendix B: Master Calendar Configuration in Cloud

Open HTTP port on Cloud Instance

Add Rule in firewall for port 80

Change JBoss Server Port

Add JBoss to Task Scheduler
# Terminology / Definitions

## Acronyms / Abbreviations

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<thead>
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<th>Acronym</th>
<th>Definition</th>
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<tr>
<td>AD</td>
<td>Active Directory</td>
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<tr>
<td>ALM</td>
<td>Application Lifecycle Management</td>
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<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>AWS</td>
<td>Amazon Web Service</td>
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<tr>
<td>AZs</td>
<td>Availability Zones</td>
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<tr>
<td>CaaS</td>
<td>Compute as a Service</td>
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<tr>
<td>CDN</td>
<td>Content Delivery Network</td>
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<tr>
<td>CPs</td>
<td>Cloud Providers</td>
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<tr>
<td>EC2</td>
<td>Elastic Compute Cloud</td>
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<tr>
<td>IaaS</td>
<td>Infrastructure as a Service</td>
</tr>
<tr>
<td>IAM</td>
<td>Identity Access Management</td>
</tr>
<tr>
<td>KVM</td>
<td>Kernel-based Virtual Machine</td>
</tr>
<tr>
<td>NIST</td>
<td>National Institute of Standards &amp; Technology</td>
</tr>
<tr>
<td>PaaS</td>
<td>Platform as a Service</td>
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<tr>
<td>RAMAS</td>
<td>Repair and Maintenance Administration System</td>
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<tr>
<td>S3</td>
<td>Simple Storage Service</td>
</tr>
<tr>
<td>SaaS</td>
<td>Software as a Service</td>
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<tr>
<td>SDLC</td>
<td>Software Development Lifecycle</td>
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<tr>
<td>TFS</td>
<td>Team Foundation Server</td>
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<tr>
<td>VM</td>
<td>Virtual Machine</td>
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<td>VPN</td>
<td>Virtual Private network</td>
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1 Introduction

1.1 Scania CV AB

Scania is a global company and one of the world’s leading heavy vehicle manufacturer which was founded in 1891. Scania’s sales and service operations operate in more than 100 countries. Scania has around 37,500 employees around the world. Its head office is located in Södertälje [31]. The following figure is a panorama of Scania’s presence around the world.

![Scania's Presence Around the World](image)

Figure 1: Scania’s Presence Around the World

1.2 Scania IT AB (InfoMate)

Scania’s IT department was created in 1986 and officially named as Scania Data AB in 1990. Scania transformed its IT department and administration technique in Scania Data AB. Now, InfoMate is the IT subsidiary of Scania and this was created in November 2001. InfoMate’s mission is to provide IT products and services as per business needs and demands. Operations are mainly conducted in Sweden, France, Netherlands and Latin America. InfoMate has almost 700 employees and around 250 consultants. InfoMate is responsible for the installation of IT

Figure 1: Scania's Presence Around the World
equipment, different levels of support and development, maintenance and the management of IT systems.

1.3 Background and problem motivation

Cloud Computing has gained the attention of the majority of the organizations within the world of technology. Every organization would like to be up-to-date and use the latest technology in order to provide them with the maximum benefits. There are several research projects which have been conducted by different organizations regarding the implementation of Cloud Computing. Large organizations must always be totally convinced that there is a strong reason to adapt or implement new technology.

The benefits of the Cloud Computing are not limited to the IT industry rather it can assist improving education system, economy and society. A human society’s worth is calculated by its knowledge, not its earning. It is the knowledge that brings human comfort. In relation to education system, Cloud Computing is able to provide distributed management system that can deal with shortage of teaching staff. Around the world, there are several areas which have small classrooms. By virtual classroom through Cloud Computing this problem can be solved as a student can attend the class at his home with the teacher who can actually be miles away from him/her. Knowledge sharing can also be achieved by doing assignments on the cloud with the team.

In relation to economy, Cloud Computing can bring many job opportunities. According to the IDC’s research, Cloud Computing is expected to create 14 million new job opportunities by 2015. These opportunities will surely assist in stabilizing local economy and ultimately it will benefit the World Economy.

Cloud Computing can also assist the emerging markets which have lack of legacy IT systems. With Cloud computing these markets can achieve rapid growth and save operational cost. For the new business, Cloud Computing can assist with lowest upfront cost.

In relation to potential disadvantage, rather concern of Cloud Computing, there is one major risk i.e. privacy and data protection. In society, each and every person has concern over privacy issue. With the use of Cloud Computing, all the data would reside in the Internet. This data may be extremely private such as bank account information, health care
record and sensitive documents. To deal with this threat, every Cloud Provider is following an ISO standard for privacy and security which is ISO27001. The cloud consumer now have to put his/her faith on the cloud provider.

In relation to IT and organizational benefits, there are several reasons described by cloud providers which motivates towards the use of Cloud Computing. Despite a number of debates and discussions relating to privacy and security issues, this will still provide anxieties for organizations. There are additional motivational factors for organizations, to use a Cloud, some of which are described below.

The use of a cloud means that there will be less hardware inside the organization. This factor benefits the organization in multiple ways. When there is hardware inside organization only approximately 20 percent to 30 percent of its capacity is actually in use and for the remainder of the time it is idle. Thus a cloud can prove to be beneficial as the organization will merely pay for what they use, additionally this will reduce the electricity, maintenance and license costs and reduce the workload for IT staff. Similar benefits can be acquired from some other cloud competencies such as:

- IT expenses can be predictable as the cloud provider is responsible for maintenance, support and disaster recovery. Thus in the case of system failure, the organization is not required to pay more than the services they use.
- For new business, there can be low upfront costs as the company does not have to invest in hardware, operating system, database, licenses for different software and overhead costs.

A Cloud enhances the accessibility (mobility) as it can be accessed and managed from any location with the assistance of the internet. Administrators are no longer bound to manage or update from a specific location.

A Cloud system is easily able to add new technologies and functionalities. This feature increases the adaptability factor as the organization is not required to perform any of these actions themselves as they are now the responsibility of the Cloud provider does that all.
In relation to the Cloud, there can be rapid implementation (rapid implementation) which enables the client to start taking benefits in terms of implementation even with limited upfront costs. Clients are no longer required to invest months of time in implementing and deploying client-server applications.

Large organizations may have some applications which do not contain private and confidential data and it is possible to implement these in a cloud to avoid unnecessary traffic inside organization network.

The use of a Cloud (especially SaaS) means that it is unnecessary for software to be installed on every user’s computer. There is no requirement of installing, patching or updating multiple software configurations thus saving money, labour and time.

The solution provided by the cloud provider is highly scalable and it is possible for the Cloud to easily handle scalability in either way (upwards and downwards). Organizations thus have no concerns in relation to the performance of the system due to scalability. In addition, an increase in the volume of storage data will pose no problems. These are some of the factors which make Cloud Computing so attractive. As the majority of factors involve cost savings a Cloud Solution would appear to offer more advantages than other traditional solutions.

1.4 Overall aim

The aim of this thesis is to explore how the cloud can be used as a strategic part of Scania’s architecture and what the demands of the cloud will be in relation to the development environment, patterns, etc. This research aims to focus on the implementation of the cloud with respect to business possibilities (by analyzing business cases) inside Scania. The research includes many aspects including the development environment, cost, portability, privacy and security issues, etc.

1.5 Scope

The basic scope of this project is with regards to Scania. This project is intended to provide an introduction of the cloud to Scania according to its business requirements. However, there are certain aspects of this project that are applicable to every large organization and thus approximately 50% of the study addresses general issues and thus other organ-
izations can also utilize the information. The remaining 50% is Scania specific

1.6 Concrete and verifiable goals

The pros and cons for different cloud architectures are investigated and this is complemented by practical observations gained by evaluating Microsoft Azure and Amazon AWS.

The following aspects will be particularly addressed.

- Investigate the Scania specific business needs that can be mapped to cloud features
- Evaluate and compare different cloud vendors.
- Experience of porting on-premise .Net application to the cloud
- Experience of porting on-premise Java application to the cloud
- Portability / Migration between different vendors

1.7 Outline

Chapter 2 describes all the theoretical aspects related to Cloud Computing. These aspects are general and this chapter addresses the different cloud providers, their capabilities, cost model and other theoretical concepts of Cloud Computing.

Chapter 3 describes the approach and method adopted in order to conduct the study. It also addresses Scania specific business requirements with the cloud and the mapping of these requirements with the functionalities offered by the cloud providers.

Chapter 4 discusses the experience in relation to the practical work conducted during the study (such as porting legacy applications). It also addresses the issue of the development environment for the cloud in large organizations. Another very important aspect about portability and application / data migration between cloud providers is also discussed in detail in this chapter.

Chapter 5 shares the results and experience achieved during the whole project.

Chapter 6 discusses the conclusion based on the results and recommendations for Scania and other organizations about the cloud. It also has
suggestions for continuing this project and for the next step of the investigation and evaluation of the cloud
2 Theory / Related work

2.1 Cloud Computing

The term “Cloud” had been used to refer to the Internet in network diagrams. In recent years, its concept has been changed to the new technology known as Cloud Computing which is a metaphor for the Internet. It has gained the attention of several businesses but is still not completely clear to everyone.

Cloud computing refers to the concept concerning an external service through the Internet that provides highly scalable computing resources. It enables accessibility of everything from everywhere with the assistance of an Internet connection. It is a broad term with several meanings with respect to the context. It can be anything, from a simple access to resources and their use [1] to a service for hosting and delivery that provides such access, according to the scenario [2].

Cloud Computing is an area that covers a broad domain. It has been defined by several communities, organizations and analysts in different ways. Lutz Schubert wrote a general and broader definition of Cloud Computing in a European Commission report. According to him:

“A ‘cloud’ is an elastic execution environment of resources involving multiple stakeholders and providing a metered service at multiple granularities for a specified level of quality (of service).” [3]

The National Institute of Standards & Technology (NIST - U.S. Department of Commerce) has defined Cloud Computing as follows:

“Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.” [23]
2.1.1 Enterprise Cloud

Enterprise clouds have much the same benefits as commodity clouds. In particular they provide the same flexible, virtualized and scalable environment. An enterprise cloud allows private access and these types of clouds are usually controlled by a group of or by a single organizations [14]. Some of the main differences between an enterprise cloud and commodity cloud are:

- Often allows the definition of more complex networking and routing topologies.
- Typically provides a wider range of security options making it possible to fulfill different organizations’ specific requirements.
- Often allows customers to place their own hardware equipment in a cloud data center.
- Typically complements the self service portal with many types of consulting services (DBAs, system administrators etc)
Service level agreements (SLAs) and contracts are negotiable to suit each organization.

Billing is based on negotiated contracts rather than on public prices shared by all customers and are in the form of monthly invoices rather than being charged to a credit card.

As a consequence of the differences, enterprise clouds are more expensive than the commodity cloud services, it is usual for the enterprise cloud providers to offer a pool of resources such as storage, RAM and clock in order to be able to adapt to a user’s requirements.

Consumers should select cloud services, either enterprise or commodity clouds, on the basis of their particular requirements. They should determine which type of cloud would best support their applications [5].

The organizations which are hesitant or worried in relation to outsourcing their information, such as government agencies, may embrace the enterprise cloud model. Verizon Terremark Cloud Services, Oracle Cloud, IBM Smart Cloud and Salesforce are well known enterprise cloud service providers (CSPs).

2.2 Cloud Service Models

There are three major service models for Cloud Computing. This division for the service model has been conducted according to the level of capability provided. These service models are listed below.
2.2.1 IaaS

Infrastructure as a Service (IaaS) holds a variety of hardware capabilities (such as storage, network, compute, and etc.). It allows the customer or consumer to use their own layer of platform, software, or data solutions in order to deploy a complete IT offering [15]. It is ideal for and designed for those who have knowledge in relation to configuring software portion and who wish to avoid the hardware side. This type of service is usually paid on usage (e.g. consumption of storage and network capacity etc.) [13]. There are three key services in IaaS:

- Compute
- Storage
- Network

Some of the value-added services that are offered by IaaS are as follows [18]:

- Load balancing
- CDN
- VPNs
- VLANs
- Backup and archiving
- File and Block level storage

2.2.2 PaaS

PaaS is the delivery of a more complete computing platform. In addition to infrastructure, PaaS may include the “rent for use” of operating systems, tools, and applications as a service. PaaS enables users to develop, test, deploy, host, and update services using a single, streamlined cloud environment.

PaaS is declared to be a complete application platform by Forrester. It is a platform for multi-tenant cloud environments. It includes services, administration tools, management tools, and development tools [30]. PaaS is a successor to IaaS as it contains all the features of IaaS and some additional features of its own.

Some of the PaaS offering tools are as follows [18]:

- ESBs (Enterprise Service Bus)
- Development tools and Application Lifecycle Management.
2.2.3 SaaS
SaaS (Software as a Service) is hosting the applications provided by Cloud Providers. The service or cloud providers deliver their hosted services to customers on a pay-per-use basis. Cloud Providers are responsible for all systems, hardware, software and their required support including the maintenance of applications [10]. In SaaS (Software as a Service) the consumer has the capability to use the applications which are running on the cloud infrastructure [23]. In this case, the provider manages and maintains the whole technology stack including the storage and applications [13]. User access to SaaS is through a rich Internet application mechanism or web browser [18]. In the SaaS offering, the user does not control or manage the underlying cloud infrastructure and is thus able to focus on using application instead of managing and maintaining [23]. Some of the commonly used SaaS applications are listed below [18]:

- Social networking services
- Web conferencing
- Web analytics
- CRM
- Human Resource Systems

2.3 Cloud Deployment Models
2.3.1 Private Cloud
A Private Cloud is a deployment model that uses organization specific resources. It provides many of the benefits of Cloud Computing without being concerned about the privacy and security issues which are associated with other cloud deployment models [19]. This model can either be managed by the organization itself or by some third party and may exist accordingly either on or off the premises [23].
Cloud Computing - Evaluation, as a platform for Scania Architecture
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2 Theory / Related work

2012-12-20

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Increased Privacy</td>
<td>Expensive</td>
</tr>
<tr>
<td>More internal capacity</td>
<td>Limited elasticity</td>
</tr>
<tr>
<td>Self controlled security</td>
<td></td>
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</table>

2.3.2 Public Cloud

A Public Cloud offers IT capabilities such as a service over the public Internet. Its infrastructure exists on the premises of the cloud provider [23]. In the public cloud infrastructure, there is a pool of services, storage, applications, and servers which are shared and available to multiple end users [19].
2.3.3 Hybrid Cloud

A Hybrid Cloud is the mixture of two or more distinct (private and public) cloud deployment models [23]. In this deployment model, some applications are hosted inside organizations while other applications are deployed to the public cloud. These two deployment models remain separate and they can be connected so that data can be shared between them [10].

![Hybrid Cloud Diagram](image)

Figure 6: Hybrid Cloud [19]

<table>
<thead>
<tr>
<th>Advantages</th>
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<tr>
<td>No infrastructure investment</td>
<td>Security and privacy concerns</td>
</tr>
<tr>
<td>High Scalability</td>
<td>Vendor Lock in</td>
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<tr>
<td>High efficiency</td>
<td></td>
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<tr>
<td>Greater agility</td>
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<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>High capacity</td>
<td>Complex management and monitoring</td>
</tr>
<tr>
<td>More control over legacy systems</td>
<td>Cost for additional security</td>
</tr>
<tr>
<td>Increased privacy</td>
<td></td>
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2.4 Risks

2.4.1 Lock-in

Lock-in is one of the prime concerns of customers in the Cloud Market. Currently, there is no standard data format, tools or procedures that could allow service and data portability (although some initiatives exist). This situation leads to potential dependency on the Cloud Provider and thus there are many concerns and questions for the customers.
It is also important to understand the nature and strength of a lock-in as these will vary according to the service model [8].

**SaaS Lock-in**
In the Cloud Computing market, SaaS providers have their own application, engineered according to their targeted market. SaaS lock-in is the strongest lock-in in the Cloud Computing Market. Customers buy (or rent) services from a specific provider and later on, if for any reason, a customer wants to switch to another Cloud provider, the first consideration is to find the same services in the other Cloud provider’s product portfolio. If it exists, then a customer must start from the beginning [8].

**PaaS Lock-in**
A PaaS lock-in can either occur at component level or the API Layer. PaaS providers do not share the same set of APIs. Customers must use the provider specific API to develop code and data access routines must also be coded in such a way that they are compatible with the provider’s back-end data store. Even if some cloud providers offer compatible APIs, this code might not be portable across those providers, as data access models may differ [8].

**IaaS Lock-in**
All the IaaS providers do not possess the same hardware type and virtual machine format. A lock-in at the compute level of IaaS exists because of the incompatible virtual machine formats between cloud providers. Within the storage area, IaaS providers have different storage methods. Some cloud providers use simplistic key or value based data stores while some use file based stores. Therefore, a data lock-in is also a concern. There are no storage portability initiatives from cloud providers although some third party data migration tools do exist [8].

### 2.4.2 Loss of Governance
While using a cloud, the customer does not retain control over a number of issues provided by the cloud provider and these may affect security. Moreover, the Cloud provider might further outsource services to third party providers who may not offer the same guarantees or who may change terms and conditions according to their policy. This loss of control and loss of governance could have a severe impact in terms of lack of confidentiality, data availability and integrity, security requirements, performance and quality of service [8].
2.4.3 Isolation Failure
Two of the core features of Cloud Computing are multi tenancy and shared resources. They refer to the shared storage, computing capacity and network among multiple users. Isolation failure refers to the risk of a mechanism failure that separates routing, storage and memory among users. The probability associated with this risk depends upon the cloud model. It is low for a private cloud while it is higher for public clouds. The impact could be the loss of data and service interruption [8].

2.4.4 Legislation and Jurisdiction
The data of a customer may be retained in multiple regions and data centers. Usually, each of the cloud provider’s data centers falls under different legislation and jurisdictions. If a data center is located in a state that does not respect international agreements or that has an unpredictable legal framework, the privacy of the data could be compromised and this is one of the prime concerns of customer. Customers are always concerned about a situation for which local government (where data center is located) requests any data from the cloud provider without informing the original owner of the data [8].

2.4.5 Data Protection
There are some data protection risks for the cloud customers as well as for the providers. A Cloud customer cannot usually check the data processing carried out by the Cloud provider thus making it of concerns as to whether or not it is being handled in lawful manner. The problem is highlighted more clearly in the case of data transfer between federated clouds. However, there are some cloud providers who do provide information about data processing and its certification summaries (for e.g. SAS70 certification providers) [8].

2.5 Cloud Providers
2.5.1 Amazon AWS
Amazon entered the cloud market in 2002 using the market name AWS (Amazon Web Service). AWS initially began by offering only an IaaS product but they have subsequently also increased within the PaaS market. The first PaaS component AWS introduced was Elastic Beanstalk in 2011. Now, they have a number of PaaS components including IAM (Identity Access Management), Cloud Watch, etc. Currently AWS is operat-
ing through 8 mega data centers around the world and these are called regions.

Within the cloud market, Amazon AWS is considered as a market-share and thought leader. Based on all the IaaS providers, AWS has richest product portfolio. According to a recent analysis of the cloud market, AWS is focused on reducing price and in providing a constant expansion of its services. Amazon AWS owns the largest pool of capacity and this ownership makes AWS suitable for elastic batch computing. Another feature that significantly differentiates AWS from others is its different availability zones within regions. AZs (Availability Zones) can be understood as multiple data centers which are in close proximity. AWS enables (and recommends) each application to run on multiple AZs. Thus, the customer has responsibility for altering the architecture of the application according to his/her needs. With this strategy, high availability is achieved [16]

AWS provides a rather mature and stable product in the cloud market. In relation to the present, cloud providers, AWS, offers the most features and services and is constantly expanding by introducing new and innovative services within their product portfolio thus making it difficult for competitors to catch up.

![AWS Platform Overview](AWS Presentation at Scania)

**Figure 7: AWS Platform Overview (AWS Presentation at Scania)**

AWS IaaS
Within the Storage area, AWS presently has a more complete set of services than any other vendor. Amazon offers table, blob and block level storage as well as Glacier for backup and for long term archiving.

AWS Compute Services include EC2 (Elastic Compute Cloud), Cluster Compute Instance for high performance computing, Auto Scaling for elasticity and scalability and Elastic MapReduce for Hadoop. Furthermore, AWS has three types of instances which are reserved instances, on-demand instances and spot instances.

In Network Services, Amazon offers Elastic Load Balancer for load balancing, Route 53 as a scalable DNS and CloudFront as global CDN. AWS also offers Direct Connect to establish a dedicated network connection to connect AWS with its own premises.

Gartner placed AWS as a leader in its Magic Quadrant for Cloud IaaS in October 2012.

AWS PaaS
Amazon has already entered the PaaS market although it is not yet considered as a market leader. They understood that merely being an IaaS provider is not sufficient but it would appear that AWS has entered in this market with complete analysis and preparation. Their first PaaS component was Elastic Beanstalk which was introduced in 2011. Today, Elastic Beanstalk has the largest number of supported platforms in
relation to the present cloud vendors (Java, .NET, Ruby, Python, PHP and since recently the two major mobile platform APIs, Android and iOS).

Apart from Elastic Beanstalk, AWS has number of other PaaS components. Amazon’s Cloud Search and SES (Simple Email Service) are two of the newly added components and, at the present time, these are in beta version. No other PaaS provider offers these types of services. Cloud Search is a fully managed search service with which customers can integrate search functionality in their applications. While Google is considered as the leader in relation to search engines, for Google Search, there is no such component in the Google App Engine or in Microsoft Azure.

For resource management, Cloud Formation is also unique service that, at the present time, is only offered by AWS. It assists developers to quickly, repeatably and reliably create and manage collections of AWS resources.

There are many more PaaS components in the AWS PaaS product portfolio including the Cloud Watch for monitoring and the SWF (Simple Work Flow) service for coordinating application components. AWS is not yet considered as being a thought leader in the PaaS market but its innovation and continuous addition of components, while continuously lowering prices, is remarkable.

2.5.2 **Microsoft Windows Azure**

Microsoft introduced its application platform for its public cloud in 2010 with the brand name Windows Azure. Microsoft’s product has functionalities and capabilities for all three service models of the cloud, which are IaaS, PaaS and SaaS. Although Microsoft entered the Cloud Market in 2010, it has already gained significant momentum. In a similar manner to Amazon AWS, Azure also supports a large number of development platforms including windows 8 phone and iOS. Microsoft is currently working towards enabling Android SDK to be available in Azure.
Microsoft has large number of customers from SMBs (Small or midsize businesses) up to large enterprises. Within the cloud market, Microsoft is the unique provider in terms of ALM, as it binds its versioning system to the ALM planning tool. Microsoft's Visual Studio supports 13 languages and now Microsoft is adding cloud deployment through its TFS (Team Foundation Server) [22].

Microsoft has extensive experience in providing key platforms and development tools so it is being considered as the thought leader in the Application Lifecycle Management (ALM) market. Microsoft is one of a number of providers who offer the broadest set of ALM functionality [22].

Microsoft is one of the few vendors who cover all aspects of the Software Development Lifecycle (SDLC). The biggest challenge for Microsoft is in relation to the support for Non-MS Development. Microsoft has already made significant steps towards support for Eclipse and is also focusing on enhancing TFS with Java.

The development tool is one of the key strengths of Microsoft Windows Azure. Although it only entered the cloud market in 2010, Forrester listed Microsoft as the leader in the ALM area within the cloud market in 2011.
In the Magic Quadrant for ALM report from Gartner, published in June 2012, Microsoft was again considered as the leader within the same area.

Another aspect which makes Microsoft Windows Azure unique is its common architecture of both the public and private clouds. Azure’s private cloud and public cloud share the same hypervisor type. If any organization wants to switch from a public to private cloud or vice versa, all that is required is to take the image of the existing cloud deployment model and restore it to the other. Microsoft’s System Center has the capability of acting as a portal for this migration and it can also manage other capabilities of Microsoft’s cloud and non cloud products.

Despite its late entry into the cloud market, Microsoft Windows Azure is still considered as being a mature and stable product with almost all the required capabilities. It has a rich product portfolio in both the IaaS and PaaS market. Microsoft is focusing on being innovative and also on a development environment for the cloud. Microsoft can compete with other vendors in relation to price and ALM, which makes it an important entity within the cloud market.
2.5.3 **IBM SmartCloud**

IBM has now entered into the cloud scene. There were very high expectations associated with IBM in the Cloud market but so far, IBM has not succeeded in fulfilling these expectations and market demands. IBM has set a target to compete with Amazon in the cloud service.

IBM is at the present time considerably behind in relation to Cloud Providers. It appears that IBM was extremely eager to enter the market and yet it has only produced an immature product as compared to the others within the market. Although, IBM has some rather impressive targeted features that they would like to introduce and, it is said that these will be available shortly, it is the case that, for whatever reason, IBM has not yet set the expected period or date for this release. IBM is keeping its roadmap confidential, which is disappointing for the customers. David Parker (Vice President of Cloud Marketing at IBM) said the company plans to expand the offering but declined to provide any more information regarding its timing.

Dana Gardner (president and principal analyst at Interarbor Solutions) says

> “IBM stepped into the cloud early, but the market has been very dynamic the past two years. When people think of the cloud now, they think about mobile, big data and analytics, along with cost reductions and simplifying. IBM hasn’t stepped up to the latest zeitgeist around cloud to take all this on.” [32]

Drue Reeves (analyst at gartner) said,

---

1 Description of SmartCloud was written before Oct 2012. IBM may have introduced more features since then.
"IBM has an opportunity to demonstrate a cohesive strategy for all your Cloud Computing needs, but instead it is saying, ‘we’ve got a little bit here and a little bit there,’ and this approach does not position them as a leader. This scattershot approach to Cloud Computing could scare away customers." [20]

Timothy Happychuk (regional IT director for Sun Media Corp.) shared his experience with IBM and comments about it. He says

"It’s like going to a fine restaurant where you expect the chef to prepare you an amazing meal and wait staff to serve it to you, but instead you are invited into the kitchen to help cook and then the bill is the same” [20]

IBM IaaS
For any organization, one of the highest costs is to set up a development and test environment. IBM launched a “Development and test service” for its cloud in June 2009. Since then, no other service has been introduced by IBM in the IaaS area. IBM’s Parker has stated that its IaaS is growing at a healthy speed and the company is in the process of moving some customers to production. However, IaaS is only available for development and testing at the present time.

IBM is not providing any other applications in IaaS and it only recommends Infrastructure as a Service for development and testing; why not other applications?” Gartner’s Reeves said. “Is it not ready?” [20]

IBM’s current IaaS offering does support batch processing, website hosting and, in addition, large amounts of data but, presently, it is not fully functional right now. In the forthcoming release, including these, more functionalities and capabilities are expected.
IBM PaaS

IBM’s PaaS offering is WebSphere on AWS. This meets the minimum requirement for PaaS but it is not the competitive offering with true PaaS. It requires development to enable it to be brought up to enterprise standards.

WebSphere runs on Amazon Machine Image on AWS. Developers must bear in mind the underlying infrastructure and, according to them, there is a fabric layer missing in WebSphere. This fabric layer enables developers to write applications without the need to be concerned or to consider the underlying infrastructure. According to Vimal Goel (CTO of Hiptide LLC), WebSphere is monolithic software that is not designed for the cloud. IBM, itself does not appear to be completely satisfied with its WebSphere solution. Jerry Cuomo, CTO of WebSphere and IBM Fellow has stated that the company was working on a new PaaS offering which will be Java-centered. However, at present, only a Java RESTful API is available only [20].

IBM has some very attractive features such as SAP, Analytics Services, Billing as a Service and, mainly, Integration. IBM is a trustworthy and a very large entity in the market but in relation to the Cloud area, IBM lags far behind the others. They have a good objective and plans but they have no clear timeline for achieving those objectives. The reason may be that a timeline does not exist or that it is being kept confidential. As David Parker (Vice President of Cloud Marketing at IBM) said

\[
\text{The company plans to expand the offering but declined to give more information on its timing.}[20]
\]

From the customers’ point of view, there is no reason for it to be confidential. If customers have knowledge of the timeline, then consideration might be given to a wait for it to appear as every organization is analyzing in-depth all the available options. IBM’s reputation and name in the market could possibly attract customers.

The following chart shows IBM’s intention with regards to features in specific categories of the SmartCloud. A number of these are expected to be in IBM’s upcoming release.
Hence, the current release of “IBM SmartCloud” is not sufficiently capable of facilitating all the basic needs of any organization. The upcoming release may offer something of interest but, at present, it is not known when the new release of SmartCloud will occur. Currently IBM is the second most expensive cloud provider.

IBM has a long history of helping enterprises to manage their business processes and data centers. IBM is known for its smart business and marketing strategy and there are many organizations expecting IBM to produce a good and easy to manage product. Integration as a Service is one of IBM’s offerings which is being eagerly anticipated by their customers. It is possible not suitable, at the present time, to be evaluating IBM’s products and their SmartCloud should be analyzed after the new release.

### 2.5.4 Verizon Cloud Services

Verizon used its 10 years of extensive experience of hosting services when they entered the Cloud Computing market in 2009. They introduced Compute as a Service (CaaS) and it was awarded the best service introduced in 2010, based on a survey conducted by Total Telecom and Telemark Services [27].

Compute as a Service (CaaS) is a service in the cloud architecture of Verizon (and some others). It is suitable for the customers who want
flexible and on demand infrastructure without purchasing, configuring or maintaining it. According to Verizon, CaaS delivers datacenter resources as a service instead of capital expenditure [12].

A CaaS environment consists of:
- Secure multi-tenant enabled infrastructure
- Orchestration tool
- Self service portal

Verizon is aware that it is unable to compete with other cloud providers such as Amazon, Microsoft and Rackspace in terms of price and therefore is focused more on providing great deal of control and flexibility in relation to the computing hardware and communication infrastructure. This approach differentiates Verizon from others [6].

Verizon enters into the Cloud Computing market as an enterprise cloud provider. Within enterprise solutions, they offer two editions that are Express Edition and Managed Addition

**Express Edition** [33]
- Enables the creation of the desired system on blank server images.
- Persistent Storage.
- Web GUI to build and manage on-demand virtual network
- Integrated security, network and load balancing.

**Managed Edition** [33]
- Allows customizing, storage, servers and network services.
- Virtual Servers (suitable for web application servers)
- Physical servers (suitable for database or email servers)
- Virtual Farms (Virtual firewall, virtual load balancer)
- Management portal to view reports and provision servers.

Verizon has plans to offer Verizon Private IP that will enable the customers to isolate their CaaS completely from the Internet. In this case, the user is only able to use the backhaul communication, which is an attractive feature for enterprises [6].

Verizon has a very user friendly and attractive portal that even allows the users to drag and drop objects. It also provides a very nice grouping of resources into clusters and systems that can be managed by different groups or individuals.
Based on Verizon’s fully functional product and its attractive, user friendly portal, this might be a possibility for Scania to consider at a later stage regarding enterprise solutions in the cloud.

2.6 Cost Model

<table>
<thead>
<tr>
<th></th>
<th>Amazon</th>
<th>Azure</th>
<th>IBM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Virtual Machine ($ / hour)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Windows</td>
<td>Linux</td>
<td>Windows</td>
</tr>
<tr>
<td>Extra Small</td>
<td>0.020</td>
<td>0.020</td>
<td>0.020</td>
</tr>
<tr>
<td>Small</td>
<td>0.115</td>
<td>0.065</td>
<td>0.115</td>
</tr>
<tr>
<td>Medium</td>
<td>0.230</td>
<td>0.130</td>
<td>0.230</td>
</tr>
<tr>
<td>Large</td>
<td>0.460</td>
<td>0.260</td>
<td>0.460</td>
</tr>
<tr>
<td>Extra Large</td>
<td>0.920</td>
<td>0.520</td>
<td>0.920</td>
</tr>
<tr>
<td><strong>Storage ($ / GB)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First 1 TB / month</td>
<td>0.125</td>
<td>0.125</td>
<td>0.165</td>
</tr>
<tr>
<td>Next 49 TB / month</td>
<td>0.110</td>
<td>0.110</td>
<td>0.150</td>
</tr>
<tr>
<td>Next 450 TB / month</td>
<td>0.095</td>
<td>0.095</td>
<td>0.130</td>
</tr>
<tr>
<td>Next 500 TB / month</td>
<td>0.090</td>
<td>0.090</td>
<td>0.120</td>
</tr>
<tr>
<td>Next 4000 TB / month</td>
<td>0.080</td>
<td>0.080</td>
<td>0.100</td>
</tr>
<tr>
<td>Over 5000 TB / month</td>
<td>0.055</td>
<td>0.055</td>
<td>0.080</td>
</tr>
<tr>
<td><strong>Web Container ($ / hour)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Windows</td>
<td>Linux</td>
<td>Windows</td>
</tr>
<tr>
<td></td>
<td>0.03</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Data Transfer Out ($ / GB)</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10 TB / Month</td>
<td>0.120</td>
<td>0.120</td>
<td>0.150</td>
</tr>
<tr>
<td>40 TB / Month</td>
<td>0.090</td>
<td>0.090</td>
<td>0.110</td>
</tr>
<tr>
<td>100 TB / Month</td>
<td>0.070</td>
<td>0.070</td>
<td>0.090</td>
</tr>
<tr>
<td>350 TB / Month</td>
<td>0.050</td>
<td>0.050</td>
<td>0.080</td>
</tr>
<tr>
<td><strong>SQL Database ($ / Month)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 GB</td>
<td>125.28</td>
<td>13.99</td>
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</tr>
<tr>
<td>8 GB</td>
<td>432</td>
<td>37.97</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Cost comparison between AWS, Azure and Smart Cloud

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2 This data has been collected from official websites of Microsoft, Amazon and IBM
3 Methodology / Model

This research builds on real world scenarios. There could be two possible approaches, either to only deal with the technological aspect or to also consider business aspects. The best approach is to consider both aspects thus the research would be business driven, not vendor driven. This approach would address the real world experience and would determine exactly how the cloud could be implemented in industry.

To analyze whether the cloud is able to provide business value to Scania, an in-depth study concerning the available functionalities or capabilities of the three cloud providers (Amazon AWS, Microsoft Windows Azure and IBM) has been conducted (see section 2.7). Additionally, in order to analyze Scania’s specific requirements according to the business scenarios, a number of meetings with different groups within Scania were conducted. Once the required data has been accumulated from both analyses, Scania’s business requirements could be mapped to the functionalities or capabilities of the cloud.

The following includes a number of business scenarios at Scania which can be mapped to the cloud.
3.1 Potential Business Cases at Scania (for this research)

3.1.1 RAMAS

RAMAS is acronym for Repair and Maintenance Administration System. It is a client - server application, engineered on the .Net platform. It supports the administration of Repair and Maintenance (R&M) contracts during the whole contract life cycle. It also supports the users during the contract negotiation phase (similar to version handling of quotation). RAMAS controls incoming workshop invoices and calculates customer invoice information during the contract period. At the end of the contract, the user is able to settle the contract, which is based on risk sharing information in RAMAS.

RAMAS is integrated with several other common systems at Scania. In RAMAS, all information about contracts is also stored in the Scania Business Analyzer (SBA) R&M which enables in-depth analyses of the market and can assist in accurate future pricing of contracts.

The RAMAS working group at Scania is continuously analyzing and evaluating the application. The group also updates the application while focusing on both the perspective of the performance and capabilities. Currently the RAMAS 4.0 version is in use. There are approximately eleven modules in RAMAS including invoice and report generation.

![Figure 14: RAMAS 4.0 Application](image)

3 Taken from Scania internal documentation
This application has several batches that are shown in the following data flow diagram of the system:

![RAMAS 4.0 Data Flow Diagram](image)

### 3.1.2 Master Calendar

The Master Calendar is a Java based application that creates and maintains calendars with working days, part periods and other functions in order to support stakeholders with dates and events. The current version of the Master Calendar is implemented for production (End Assembly) but Scania is looking forward to enhancing the functionalities of this application so that it can be used by other business units and for other purposes.

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4 Taken from Scania internal documentation
### 3.1.3 Agora

Agora is the social networking service for Scania. At the present time, Scania is being assisted by a third party (Tibco) to run this service. Tibco has taken IaaS from AWS and provides all the services to Scania as PaaS. As Scania is looking forward to adapting Cloud, it would be advantageous to evaluate the Hosting criteria for Agora. The evaluation result will provide information regarding whether Scania should continue “Renting” as is the case at present or if Scania should deploy it in the Cloud as IaaS, PaaS or SaaS.

### 3.1.4 Scania for Me

The “Scania For Me”, Human Resource software is being hosted outside Scania. In this case, Scania has already dealt with the privacy issues for confidential information. It may prove to be useful to implement and deploy “Scania for Me” in the cloud. An evaluation regarding the pros and cons of this application can be conducted within this project.

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5 Taken from Scania internal documentation
3.1.5 **XML Security Gateways**
XML gateways are solutions (either hardware or software based) to implement security for SOAP, XML and REST based web services. Scania is also using the XML gateway to secure this area of its network. In this project, an evaluation of the possibilities with regards to implementing XML gateways in cloud in order to secure data is a possibility. This evaluation will also describe the advantages, disadvantages and obstacles which can occur during implementation.

3.1.6 **Identity Access Management**
Identity Access Management is an important and vast area. The scope of identities for Cloud Computing can be divided into three categories:

- **Enterprise** → Enterprise Users and Applications which access Cloud Applications.
- **Internet** → Customers, partners and dealers who access cloud applications.
- **Cloud** → Cloud applications which access other cloud applications.

It would be interesting to evaluate the challenges and issues that may occur while implementing or using IDM in a Cloud environment. There are some Cloud based solutions available for IDM, for instance, Amazon Web Service provides API that integrates their IDM Service with Microsoft AD.

3.1.7 **Trust Identity Model**
It is also possible to evaluate the integration of plugins for Social networks (Such as Facebook and Linkedin) in the cloud. These plugins are not applicable in every case, but, they are really common and in the future, they will be widely used. For Scania, it would be an advantage to evaluate the trust identity model for cloud.

3.1.8 **Scania Dealer Locator**
There is mobile application for Scania titled “Dealer Locator”. It is already deployed on a mobile platform and is publicly available. A small business case could involve the deployment of the server side of this application to the cloud and then mobile users will access it directly from the cloud. This is able to offer a good experience of Mobile Applications in a cloud environment.
### 3.2 Functionality Comparison between AWS, Azure and IBM

<table>
<thead>
<tr>
<th>Features</th>
<th>Amazon AWS</th>
<th>Microsoft Azure</th>
<th>IBM SmartCloud</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Storage</strong></td>
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<td></td>
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</tr>
<tr>
<td>Table Storage</td>
<td>SimpleDB</td>
<td>Azure Table Storage</td>
<td>N/A</td>
</tr>
<tr>
<td>Blob Storage</td>
<td>S3 (Simple Storage Service)</td>
<td>Azure Blob Storage</td>
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<td>Storage transfer</td>
<td>AWS Import/Export</td>
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<td>Option available in Persistent storage</td>
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<td>Backup and Archiving</td>
<td>Glacier</td>
<td>N/A</td>
<td>Object Storage</td>
</tr>
<tr>
<td>Block Storage</td>
<td>Elastic Block Store</td>
<td>Azure Drive</td>
<td>Block Storage</td>
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<tr>
<td><strong>Database</strong></td>
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<td></td>
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<tr>
<td>SQL Database</td>
<td>RDS (Relational Database Service)</td>
<td>SQL Azure</td>
<td>DB2 Images</td>
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<td>NoSQL Database</td>
<td>DynamoDB, SimpleDB, EC2 non-relational DB, 10Gen, Couchbase</td>
<td>Azure Table Storage, MongoDB, Sones GraphDB, Neo4J, Cassandra</td>
<td>MongoDB</td>
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<td><strong>Compute</strong></td>
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<td></td>
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<tr>
<td>Virtual Machines</td>
<td>EC2 (Elastic Compute Cloud)</td>
<td>Role Instance</td>
<td>Virtual Machine InstancesPlatinum-M2</td>
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<td>Scaling</td>
<td>Auto Scaling</td>
<td>WASABi (Auto Scaling Application Block)</td>
<td>Stingray (F5)</td>
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<td>Big Data (Hadoop) Analytics</td>
<td>Elastic MapReduce</td>
<td>Big Data as a Service (Hadoop on Azure)</td>
<td>BigInsight</td>
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<tr>
<td>High Performance Computing</td>
<td>Cluster Compute Instance</td>
<td>HPC Scheduler</td>
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<td><strong>Messaging</strong></td>
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<tr>
<td>Push notifications</td>
<td>SNS (Simple Notification Service)</td>
<td>Service Bus</td>
<td>Built-in option in Software stack</td>
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<td>SES (Simple Email Service) Beta</td>
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<td>SQS (Simple Queue Service)</td>
<td>Azure Queue Storage Service</td>
<td>IBM Built-in Queue Storage</td>
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<tr>
<td>----------------------------</td>
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<tr>
<td><strong>Caching</strong></td>
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<td>Content Delivery</td>
<td>CloudFront</td>
<td>CDN (Content Delivery Network) Service</td>
<td>Third Party tools</td>
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<td>In-Memory Caching</td>
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<td><strong>Networking</strong></td>
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<td>Load Balancing</td>
<td>Elastic Load Balancing</td>
<td>Traffic Manager / Fabric Controller</td>
<td>Stingray (F5)</td>
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<td>Peering</td>
<td>Direct Connect</td>
<td>Azure Connect</td>
<td>Physical VPN &amp; VLAN Service</td>
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<td>DNS Web Service</td>
<td>Route 53</td>
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<tr>
<td>ESB</td>
<td>CFT Elastic Server</td>
<td>Azure Service Bus</td>
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<td><strong>Monitoring</strong></td>
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<td>Performance Monitoring</td>
<td>CloudWatch</td>
<td>AzureWatch (System Center)</td>
<td>Tivoli Live Monitoring</td>
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<td><strong>Security</strong></td>
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<td>Identity Access Management</td>
<td>Identity Access Management</td>
<td>Azure AD</td>
<td>Possible through Harware VPN</td>
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<td><strong>Development</strong></td>
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<td>Resource Managing</td>
<td>CloudFormation</td>
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<tr>
<td>Web Container</td>
<td>Elastic Beanstalk</td>
<td>Web Role</td>
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<td><strong>Other Services</strong></td>
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<tr>
<td>Workflow Service</td>
<td>SWF (Simple Workflow Service)</td>
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<tr>
<td>Managed Search Service</td>
<td>CloudSearch</td>
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</tr>
</tbody>
</table>

Table 2: Capabilities and Functionalities comparison of AWS, Azure and Smart Cloud
## 3.3 Link between Business Case and Cloud Functions

<table>
<thead>
<tr>
<th></th>
<th>Table Storage</th>
<th>Blob Storage</th>
<th>Storage transfer</th>
<th>Backup and Archiving</th>
<th>Block Storage</th>
<th>SQL Database</th>
<th>NoSQL Database</th>
<th>Virtual Machines</th>
<th>Auto Scaling</th>
<th>Content Delivery</th>
<th>In-Memory Caching</th>
<th>Load Balancing</th>
<th>Performance Monitoring</th>
<th>IAM</th>
<th>Web Container</th>
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<tr>
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<td>X</td>
<td>X</td>
<td>X*</td>
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</tr>
</tbody>
</table>

* will be applicable if moved to PaaS

Table 3: Scania’s potential business cases mapping with cloud functionalities
4 Design / Implementation

In order to maintain the precise nature of this research and to meet the deadlines, the focus will be on only three business cases. There will be prototypes (small implementation) regarding the selected business cases. These prototypes will assist in understanding actual problems and issues which have occurred during a practical implementation.

To gain experience of a cloud and to analyze how to make an application cloud aware, two legacy applications, which are being used at Scania, were ported to the cloud. These applications were ported on AWS and Azure in order to evaluate and compare the differences in porting and performance. In addition, during this study, setting up a development environment for the cloud also proved to be a challenge. While sharing this issue with the providers, it was felt to be very common and was faced by a number of the organizations. The issue occurs due to the network security implementation within the organizations. Based on the importance and hype surrounding this issue in the cloud market, it is briefly addressed in this report.

From the research perspective, vendor lock-in and portability between cloud providers is one of the major concerns for cloud consumers as well as providers. Therefore this topic is also addressed in detail.

4.1 RAMAS

RAMAS is a client – server application. Its server part is engineered as a web service while its client part is a desktop application. Its storage tier is based on a MS SQL Server. Currently, dealers and other users of this application are provided executable files for client desktop installation. The client, once installed, is connected to the RAMAS server at Scania.

There are several ways to deploy such an application to the cloud. In this case, the whole application was migrated to an EC2 instance including the database storage. Thus, while porting RAMAS to the Cloud, the EC2 instance with IIS 7 and a SQL Server 2008 were used. The same application was deployed to Azure VM with SQL Server 2012 support and, as expected, there was no difference in deployment.
During the implementation, it was found that the RAMAS client side has a connection string which specifies how it will connect to the server side and this connection string does not currently contain any authentication part. To address the security aspect, credentials are required in the connection string so that application remains secure in the cloud. Since this implementation was for testing purposes and to determine problems and other complexities while moving from the premise .net application to the cloud, both the client and server sides were implemented on the same instance of Amazon EC2 and Azure. There was only one minor problem related to the IIS Server which occurred on both cloud environments and this is discussed in Appendix A7. However, to use the application efficiently and with the best performance, there are some solutions proposals listed in the “Conclusion” section.

4.2 Master Calendar

Master Calendar is a Java web application that is based on the JBoss server. Its storage tier is based on a MS SQL Server. To test this application in the cloud, Azure IaaS offering was selected. Azure Windows Server 2008 R2 VM, with SQL Server support, was created. It was only the Jboss server that was required to be installed on the created virtual machine. The application was deployed on the JBoss server as a traditional method and no extra work was required. This migration was only for test purposes and to identify problems and complications occurring in hosting the on-premise Java web application in the cloud. In a real world scenario, the Master Calendar is attached to the Active Directory of Scania but, for this test case, the application was detached from the AD and authenticated by a local database.

As expected, there was no problem in porting the application to the cloud although, some small steps were required in order to operate the application in the cloud seamlessly.

* JBoss, by default, works on port 8080. In order to make this application a default web service, the operating port of JBoss was changed to 80. In addition, JBoss’ executable file was required to be run with some extra parameters (-b 0.0.0.0) so that it could accept connections from other IP addresses over the public Internet. This parameter allows there to be a connection to the JBoss server from all IP addresses.

---

7 Refer to Appendix A: RAMAS Problem and Solution
• JBoss is not the same as the Apache or IIS server, both of which starts with the operating system. So its executable file was added to system startup from the Task Scheduler.⁸

4.3 Development Environment at Scania

Scania office network has a web proxy together with authentication to secure its office network. As is the case for other large organizations, Scania has also blocked the ports for security reasons. This kind of security mechanism is very common and is being used in almost every organization. Thus, the experience gained in this case is applicable to all large organizations.

During this research, development on Amazon AWS and Microsoft Windows Azure was tested, which was based on IaaS as well as the PaaS service model. One of the main components of the IaaS development is a virtual machine and, usually, the application is deployed on it after accessing it remotely or via telnet. In both cases, the web proxy did not allow the traffic through, while the same connection was tested through the public Internet and it worked in a satisfactory manner. In the case involving the IaaS, organizations that use a web proxy will have to make the required changes in their network security area either by the addition of exception in the firewall or by creating a VPN tunnel or some other solution.

The same problem relating to bypassing of the proxy occurred in the PaaS development on both environments (Azure and AWS). The two development platforms tested were the Eclipse for Java development and Visual Studio for .Net development. In the Visual Studio there is no means for defining the proxy server with authentication and it is also the case that the Team Foundation Server is unable to perform in this scenario. However, a means has been determined to configure the Visual Studio to bypass web proxy without the credentials. The proxy can be defined in the configuration file that is mapped to the Visual Studio executable file. However, no solution exists to configure the Visual Studio to bypass the web proxy with authentication. Creating a VPN will also not work in this scenario if the same machine is connected to the public Internet. There is no known solution that can direct Visual Studio to use VPN instead of the public Internet. The sense is that VS

⁸ Refer to Appendix B: Master Calendar Configuration in Cloud
has priority of Internet connectivity over VPN. However, other solutions can be discussed such as creating a virtualized development environment that is only connected to VPN. This solution is practical, but not recommended, for the long run. Scania should investigate other possibilities of setting up development environment.

4.4 Portability between Cloud Providers

The term "portability" refers to the characteristic of a computer program when it can be used in environments or operating systems other than that for which it was created, without making significant changes. "Porting" refers to the process of moving an application to the new environment. Generally, programs built on standard interfaces are portable. In the Cloud Computing market, portability is at the present time, a hot topic. Customers are very much concerned about vendor lock-in. The PaaS providers do not support the same APIs and libraries for development. The majority of the cloud providers support Java, .Net, and other common platforms but, the use of a different set of libraries makes it difficult to move an existing application from one cloud provider to another without the requirements for any changes. If the desire is to migrate applications from one provider to another, this may involve either a significant or lesser amount of effort and which will rapidly increase as a customer moves upwards in the service model stack (i.e. from IaaS to PaaS).

In this scenario, Rackspace realized this requirement of the customers and they offered the use of a single platform that potentially could be used by different cloud vendors. Rackspace is considered as one of the leading IaaS providers in the cloud market [7]. In 2010 Rackspace, along with NASA, introduced the concept of a “cloud operating system” that could be compatible with multiple cloud vendors. NASA contributed its core compute infrastructure Nebula to empower the compute part while Rackspace contributed Cloud Files platform to empower the object storage area [24]. This concept’s implementation is called OpenStack.

4.4.1 OpenStack

OpenStack is an open source cloud computing platform for both private and public clouds. It is a huge global collaboration between developers and Cloud Computing technologists. It is presently focused on the IaaS service model. The mission of OpenStack, as seen by Rackspace and NASA, is to enable Cloud Computing providers to offer a standard
platform. As is the case for other IaaS providers, OpenStack also has a portal (or dashboard) in which a user can manage and administer large pools of networking, computing and storage resources through a data center. OpenStack is available under the Apache 2.0 license. The OpenStack Foundation has noted the cutomers concern with regards to lock-in and thus intends to offer an open development model at the IaaS level [25].

![OpenStack: The Open Source Cloud Operating System](image)

There are more than one hundred and eighty members in the OpenStack community including AMD, Intel, HP, Dell, IBM, Cisco, Redhat, AT&T and Yahoo. However, the Amazon AWS and Microsoft do not, so far, form part of this community. The management API for the compute and storage services of OpenStack are compatible with AWS EC2 and S3. Therefore, AWS written client tools can also be used with OpenStack [24]. Since October 2010, there have been six releases of OpenStack. The latest release was on 27th September 2012. Following are the release of OpenStack with added components and release date.

<table>
<thead>
<tr>
<th>Release Name</th>
<th>Release Date</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austin</td>
<td>21-Oct-2010</td>
<td>Compute, Object Storage</td>
</tr>
<tr>
<td>Bexar</td>
<td>3-Feb-2011</td>
<td>Compute, Object Storage, Image Services</td>
</tr>
<tr>
<td>Cactus</td>
<td>15-Apr-2011</td>
<td>Compute, Object Storage, Image Services</td>
</tr>
<tr>
<td>Diablo</td>
<td>22-Sep-2011</td>
<td>Compute, Object Storage, Image Services</td>
</tr>
<tr>
<td>Essex</td>
<td>5-Apr-2012</td>
<td>Compute, Object Storage, Image Services, Identity, Dashboard</td>
</tr>
<tr>
<td>Folsom</td>
<td>27-Sep-2012</td>
<td>Compute, Object Storage, Image Services, Identity, Dashboard, Networking, Block Storage</td>
</tr>
</tbody>
</table>

Two positive reasons concerning OpenStack are:
- OpenStack promises the elimination of vendor lock-in. One of the main purposes of the OpenStack community is to enable customers to move their code seamlessly between different OpenStack vendors.

- OpenStack is supported by more than 180 financial supporters. It appears that OpenStack will constitute the centerpiece of the cloud industry’s commoditization as it has gained sufficient momentum [4].

OpenStack is not, as yet, a ready product but is rather in a development Many questions have arisen in relation to migrating from one cloud provider to another. All the cloud providers in the OpenStack community are building solutions on top of OpenStack. In addition, every vendor is also attempting to make unique innovative services available for their customers so as to differentiate them from the others. These additional and unique services will introduce vendor lock-in. For example, the Rackspace management portal is more robust than the default OpenStack portal. Although there is no lock-in in terms of technology it is still possible for there to be support and a management lock-in. If, for instance, a customer wants to move from the Rackspace to other OpenStack provider, it would still be difficult and require a significant amount of learning, training and adoption of their own solutions into the new management portal. Similarly, if one provider uses KVM and another uses XenServer, the complexity to move workload is not clear [18].

In the OpenStack roadmap, there is already another release scheduled. Thus there is much more to come in OpenStack.

4.4.2 Application and Data Migration Tools

There are certain cloud application and data migration tools that can port applications and/or data from one cloud vendor to another. These tools do not address all cloud vendors, rather, every tool supports a different set of vendors. However, to some level, these tools provide interoperability between some cloud providers. There are already some data and application migration tools available and, probably, more will be added in the future. Three of these are:
CloudBerry
CloudBerry Lab was founded in August 2008. Rackspace is an official partner of CloudBerry Lab. CloudBerry has several products within the Cloud Computing area. For instance, CloudBerry offers a desktop client for Amazon S3, Microsoft Azure, Google Storage and Rackspace Cloud Files. CloudBerry also offers a client application in order to provide backup of on-premise data to Amazon S3. Within the context of interoperability, CloudBerry has a web based data migration tool that can transfer data directly from one cloud provider to another. At present, this tool supports data migration between Amazon S3, Amazon Glacier, Azure Blob Storage, Rackspace Cloud Storage and FTP Server. It can be considered as a tool to aid in as storage migration between some cloud providers.

![CloudBerry Data Migration Web Portal](image)

CloudSwitch
CloudSwitch offers application migration in the cloud. It has a virtualization technology layer that runs between the user’s operating system and the cloud vendor’s hypervisor. CloudSwitch has the ability to port a created virtual machine in one cloud provider to another or to a customer’s data center.

CloudSwitch’s works in a simple way. When a customer signs up for the services, s/he places a CloudSwitch Virtualized environment called Cloud Isolation Technology in the virtual machine created with the cloud provider. This Cloud Isolation Technology has virtualized storage, CloudSwitch Instance and a Data Server. It runs the user’s application within its own instance and application related storage also resides in its virtual storage. If a customer wants to port application from one provider to another, the whole Cloud Isolation Technology virtualized
environment will be moved to the other provider’s VM and it takes all the data along with it as it is stored within this environment. During migration, CloudSwitch performs some operations by itself [9]:

- Encrypts the data.
- Along with the application, it also moves the associated data as well.
- It “ports” the application in such a way that it runs in the new target environment with the same configuration as in the old.
- It migrates the application with a layer-2 bridge encrypted tunnel between the source and the destination.

CloudSwitch takes care of network connectivity and encryption and the customer is not required to modify anything.

![CloudSwitch demo](image)

**Racemi Cloud Migration**

Unlike CloudSwitch and CloudBerry, Racemi facilitates the customer with interoperability at the hardware level. Cloud Path is able to migrate an existing virtual machine and cloud server instance to another cloud provider. There are two migration levels of Racemi which are:

- CloudPath
- DynaCenter

Cloud Path, is Software as a Service that allows for the rapid migration of existing physical and virtual servers between supported cloud providers [28]. In general, the Racemi Cloud Path requires binary compatible hardware between the source and target servers.
DynaCenter enables the migration of server workloads between dissimilar virtual, physical and cloud platforms [29]. There is an important component of the Racemi DynaCenter known as Management Appliance. It is similar to a black box that receives reports of software which is running from managed servers. Racemi’s agent software must be installed on every server. This agent software stores an image of the running server with its hardware and software environment. To move an application, the administrator connects to the managed appliance and shuts down the agent. The captured service can then be deployed to the targeted environment. Racemi accesses the VM created on the targeted environment and replaces the default software with the captured software. The virtual machine then reboots and it starts running a RAM disk based image using the Racemi software. The management appliance then accesses both, the captured and target environments and initializes mapping between them. Upon the completion of the mapping, the process of application migration is also completed [9].

The core and unique part of Dynacenter is the ability to compare the configuration between two environments and to make changes accordingly during migration. This causes the captured environment to be compatible with the target environment [9].

At the present time, Racemi is applicable or supports four cloud providers namely, Amazon AWS, Rackspace, Verizon Terremark and GoGrid.
5 Results

Based on this study, several results and recommendations have been determined.

- The cloud market is still not mature. There are new providers entering into the market, competing head to head (or in some cases overtaking) well known providers. The market is still progressing. It is unpredictable as to who will lead the market in two years. All the providers are adding components to make their product more effective and unique.

- During this study period, two legacy applications were successfully ported to the cloud. One of those applications was Java based and the other was .Net based.

- For any organization, it is important to identify its own business requirements with the cloud and to select the provider accordingly. This approach can offer the maximum benefits of the cloud and also avoids risks.

- To make this technology an asset to any organization instead of a liability, it is necessary to choose the correct XaaS (Service Model i.e. IaaS, PaaS or SaaS).

- Movement in an upwards direction within the stack in the service model (i.e. from IaaS to SaaS), causes there to be more lock-in and thus a greater dependency on the vendor. IaaS has the least lock-in.

Furthermore, during this study, four of the well known cloud providers were investigated. Two of these were Enterprise Cloud Solutions while the other two are commoditized products. According to the first identified requirements of Scania’s business scenarios, Commodity cloud products appear to be more suitable. Therefore, Amazon AWS and Microsoft Windows Azure are discussed in greater detail. A comparative analysis can be found in this report between these two providers. The following activities and tasks were performed in this context:
A detailed comparative study was conducted for the collection of the offered functionalities and capabilities of these providers.

Real business cases scenarios for Scania were mapped to the functionalities offered by the cloud providers.

Porting of a legacy .NET application to the cloud. The application that was selected for this task is known as RAMAS. It is a client-server application that is being used by Scania and its dealers / re-sellers. The application was ported to the IaaS service model of Azure as well as AWS.

Porting of a legacy Java based application to the cloud. The application that was selected for this task is called Master Calendar. It is a web based application that runs on a JBoss server. It is being used to back-track the production process. As in the case for RAMAS, Master Calendar was also ported to the IaaS offering of both Azure and AWS.

The motive behind the porting of legacy applications to the cloud was to compare on-premise deployment with deployment in the cloud. As expected, no major difference was found, apart from some firewall exceptions. Another positive experience achieved with this porting was in relation to understanding how to make a legacy application cloud aware. It is briefly discussed in this report.

This study also includes experience about setting up a development environment for the cloud, while web proxy with authentication is implemented in the network. This structure is being used in the majority of organization at the present time and thus this portion is not Scania specific, but can be considered as a general market perspective.

Another important section of the report addresses the portability and data / application migration between different cloud providers. This topic is related to one of the major customer concerns in the cloud market which is vendor lock-in. In the relevant section the majority of the currently available methods and procedures used to avoid vendor lock-in are discussed.
6 Recommendations / Conclusions

From the observations made during this study, some recommendations for adapting and, additionally, the initial procedures associated with the start-up when using a cloud with regards to organizations are now provided.

- The most important aspect is to identify the particular requirements of the business from the cloud before any investigation is conducted into which cloud provider is the most suitable. This is not actually concerning either a good or bad product as it is possible that the leading provider in the market will not fulfill particular requirements while this is possible from an average provider. It is thus advisable to proceed in a cautious manner.

- Before proceeding with the cloud it is very important to understand the pricing structure and cost model. Typically there are no hidden costs but a single desired feature may add costs to the multiple billing portions. A common example is the use of SQL server in the cloud. The consumer has to pay for the SQL server instance as well as data in and data out, which is mentioned separately by every cloud provider. Thus it is important to gain an understanding of the pricing model before proceeding with a particular model.

- To port or migrate on-premise legacy applications without the necessity for changes, IaaS proves to be the most suitable service model.

- While on the other hand, in most cloud products, PaaS has more rich features and is suitable for building new applications for the cloud. PaaS is recommended when the consumer would like to engineer a new application that is cloud aware but does not want to manage the OS, networks, and hardware and storage parts.

- SaaS is similar to buying a service and running it without having any knowledge about it apart from the application. Its applicability depends on whether there is any SaaS that fulfills the customer specific requirement.
Apart from the above, there are some more case specific conclusions and recommendations which are listed below.

6.1 **Portability**

At the present time, portability between cloud providers is similar to science fiction. Bill Claybrook (Ex Research Director Linux, Red hat and Open Source) stated in his blog:

> “Vendors do not want clouds to become commodity products because they do not want to compete on price alone.”

[9]

The above mentioned statement appears to be logical. Thus vendors have already started introducing several components, tools and services within their cloud offerings in order to differentiate themselves from the others. These tools minimize the benefits of OpenStack but cause the lock-in problem to return. In addition, OpenStack introduces interoperability to some extent. However some well known cloud providers such as Amazon, Microsoft, and Oracle appear to not be interested in OpenStack or cloud provider’s interoperability at present. A great deal more can be expected from OpenStack as it already has two more releases scheduled. It has gained significant momentum with more than 180 members including IBM, Dell, AT&T, HP, Intel and AMD.

On the other hand, Eucalyptus, the open source cloud is fully compatible with Amazon and VMWare.

There are some application and data migration tools which provide storage interoperability and compute interoperability between some cloud providers. Some of them are:

- CloudBerry
- CloudSwitch
- Racemi

CloudBerry Lab, a Rackspace partner, makes Amazon S3, Amazon Glacier, Microsoft Azure Blob Storage and Rackspace Cloud Files interoperable in terms of storage.

CloudSwitch facilitates users with application migration between different cloud providers with the assistance of its own virtualized envi-
6.2 Development Environment

It is very common in organizations to use web proxy with authentication to protect their network. Scania uses the same method to protect its office network and to prevent it from every type of attack. The development tools available for cloud development mostly include the same legacy tools, such as Visual Studio and Eclipse. There is no interface in Visual Studio where it is possible to configure a proxy server with credentials. The addition of some code to a configuration file associated with an executable Visual Studio file can make it possible to some extent, however, it is still unable to work with credentials. It is possible to add proxy server and its port to the configuration file and if there is proxy without credentials, it will allow the traffic to pass. However, even after continuous long term efforts and coordination with vendors (Amazon and Microsoft), it proved still to not be possible to configure a web proxy with credentials in these development tools.

However, there is one suggested solution that could be used as a temporary measure while determining another solution. It is possible for an organization to build a virtualized development environment that is connected to cloud provider through VPN. The developer, at the host PC, is the able to remotely connect to that environment and to begin development in the cloud. The VPN solution cannot be implemented directly to a developer’s PC along with an Internet connection, as in the case of Internet availability, as the development tool will use the Internet connection as it has higher priority than the VPN.
Currently, it is possible to develop applications in the cloud through Scania’s guest WLAN account as it uses a transparent web proxy (i.e. without authentication).

### 6.3 RAMAS in the Cloud

The ported Cloud version of RAMAS is working as expected although the scalability aspect has not, as yet, been checked. It is assumed that the current solution is scalable as there are no observed complexities and problems. However, the current solution is not efficient as it requires connection all the time and consumes a high bandwidth.

<table>
<thead>
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<th>Current Deployment</th>
<th>Proposed 1</th>
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<th>Proposed 3</th>
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<td>Database Logic</td>
<td>Database Logic</td>
<td>Database Logic</td>
</tr>
<tr>
<td>Citrix Client</td>
<td>Web UI for Client</td>
<td>App with some local logic</td>
<td>Web Service</td>
</tr>
<tr>
<td>SSH / Terminal</td>
<td>HTTP / HTTPS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>User</td>
<td>User</td>
<td>User</td>
<td>User</td>
</tr>
</tbody>
</table>

- More Round trips
- Connectivity all the time
- High bandwidth consumption
- Complex System

- More Round trips
- Connectivity all the time
- Less Bandwidth
- Easy solution

- Less Roundtrips
- Offline work
- Rich GUI
- Less Bandwidth
- Suitable for places with bad Internet connection

- Less Roundtrips
- Offline work
- Rich GUI
- Less Bandwidth
- Suitable for places with bad Internet connection
- Most effective solution
6.3.1 Proposed 1: Web Client for RAMAS
The easiest solution, with regards to implementation, is to develop a web based client side for RAMAS. It is the most common solution used for this type of application and it will consume less bandwidth than the current one. This solution would also be convenient for clients, as there is no need to install any desktop Citrix client application. Clients merely have to open a web page and use the application. It is both fast and efficient.

6.3.2 Proposed 2: Application with Local Logic
It is always a good strategy to be concerned with a long run for any project or application. The coming era belongs to the apps, which can either be tablet apps or smart phone apps possibly, even be desktop apps (for instance in Windows 8). Here, the proposed solution is an application (tablet, PC, Smart Phone) with some local logic.

For example, if a customer wants to generate an invoice before completion of a project, in order to have an estimate of the costs already incurred, then use will be made of the Customer Invoice section of the application. Local logic means that it is possible to conduct such tasks locally and this pre-invoice will not be stored in the server. There can be some other examples similar to this which require an in-depth analyses of the application.

In such cases, the application can become quite useful. There are many other benefits of this solution, such as the ease with which a customer can obtain such an app (download from app market etc.), as there is no dependency to the owner of the app. The only requirement is to have some knowledge of some simple settings (like URL of server etc.). This solution requires significant development and initial costs, but will also provide significant benefits.
6.3.3 Proposed 3: Application with Local Cache

This is quite similar to the previous solution but adds “caching” for some offline capabilities. By adding a local cache, the client is not require to be connected to the Internet at all times. It becomes possible to use the application and save the work in the local cache and the app will automatically send data to the server as soon as it finds Internet connectivity. This is very suitable for clients located at places which have poor Internet connection. As stated in the proposed 2 section, the main hurdle is the initial development cost in relation to supporting the required platforms (IOS, Android, Desktop, etc.)
6.4 Master Calendar in the Cloud

Master Calendar’s migration to the cloud has been successful without any problem and complications, as was expected. The application is a Java web application and as per usage it is an ideal solution. There is little to propose about the solution although according to Scania’s planning, the application will be used widely in the near future for some other purposes inside Scania as well as outside the organization (dealers etc.). In that case, the application’s performance and scalability should be the primary concerns for the administrators. If the application is hosted in AWS, auto scaling is not a problem, but, Azure’s IaaS offering does not possess auto scaling. In this case, auto scaling can be achieved by means of Microsoft’s recommended tools Rightscale or ScalExtreme.

6.5 Future Work

This study concludes an introduction and to the theoretical aspects of the cloud to Scania. This work can be continued in various directions. One of the good aspects of the cloud could be in analyzing and investigating the capabilities of a service bus in the cloud. The service bus can, in some ways, assist in communication which can then bypass the network level restrictions while maintaining a secure environment.

Another interesting topic for an in-depth investigation and experience could be storage in the cloud. There are different types of the storage offered by cloud providers including blob storage, table storage, block storage.

It could also be interesting to investigate back-up and synchronization patterns in the cloud. These patterns could be from one cloud provider to another as well as from on cloud to an on-premise environment.

Apart from the above mentioned features, there are many more capabilities of the cloud which require investigation. In addition, as the cloud market is growing rapidly, there will be more aspects to be aware of. It is thus necessary to keep a watchful eye on any new developments.
References


Cloud Computing:
http://searchcloudcomputing.techtarget.com/tip/Improving-cloud-interoperability-with-application-migration-tools


References


Appendix A: RAMAS Problem and Solution

Installation of RAMAS in the cloud is same as defined in RAMAS installation manual that is available as an internal document at Scania.

There is only one minor problem occurred during RAMAS deployment in the cloud. The RAMAS server returns “HTTP Error 404.2 – Not Found” as shown in the image below:

![Server Error in Application "DEFAULT WEB SITE/RAMASWS"
HTTP Error 404.2 - Not Found
The page or resource you are trying to access cannot be served because of the ISAPI and CGI restrictions in the web server.

Installation of RAMAS in the cloud is same as defined in RAMAS installation manual that is available as an internal document at Scania.

There is only one minor problem occurred during RAMAS deployment in the cloud. The RAMAS server returns “HTTP Error 404.2 – Not Found” as shown in the image below:

It is because of **ISAPI and CGI Restrictions** in IIS Server. **ASP.NET v4.0 services** are set to “Not Allowed” by default as shown in image below.

![Internet Information Services (IIS) Manager](image)

To solve this problem:

- Open IIS Manager
- Go to ISAPI and CGI Restrictions
- Change ASP.NET v4.0xxxx services to “Allowed” by simply right clicking on it.
Appendix B: Master Calendar
Configuration in Cloud

Open HTTP port on Cloud Instance
When a Virtual Machine is created on Amazon AWS or Azure, by default, there is only one port enabled which is Remote Desktop (3389). In order to access web service deployed in the cloud, respective port (http 80 and SQL 1433) must be enabled. To enable port, AWS and Azure have their own ways in portal:

AWS → While on EC2 instance portal, click on “Security Groups” in the navigation pane. After selecting respective security group, select “Inbound” tab at the bottom and add required ports.

Azure → On portal, select respective Virtual Machine. Click on “Endpoint” then click on “Add Endpoint” at the bottom. Click “Next”, specify the respective port in the field and click “Finish”.

Access created virtual machine by Remote Desktop Connection and perform the following steps.

Add Rule in firewall for port 80
- Click “Start” then “Run”, type “wf.msc” and press enter. It will open “windows firewall and advance security” settings.
- Click on “Inbound Rules”. On the right side, in Action pane, click on “New Rule”.
- A window will appear. Select radio button against “Port”, click “Next”, specify port in field, click “Next”, Select “Allow the connection”, click “Next”, check “Public” option, click “Next”, give this rule a name and click “Finish”.

Change JBoss Server Port:
- Locate and open bindings.xml in
  C:\jboss5\server\default\conf\bootstrap
• Look for following code

```xml
<property name="serviceName">jboss.web:service=WebServer</property>
<property name="port">8080</property>
```

• Change 8080 to 80.

Add JBoss to Task Scheduler

• Open Task Scheduler
• Click on “Create Basic Task” and specify name and description for task then click “Next”.
• Select “When the computer starts” radio button and click “Next”
• Browse for “run.bat” in JBoss directory, write “-b 0.0.0.0” in the Argument field, click “Next” and then click “Finish”.