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Project Presentation

Surfing Towards the Opportunity of Real Migration to Cloud-based public Services (STORM CLOUDS) is a project partially funded by the European Commission within the 7th Framework Program in the context of the Capital Improvement Plan (CIP) project (Grant Agreement No. 621089).

The project has the objective of exploring the shift to a cloud-based paradigm for deploying services that Public Authorities (PAs) currently provide using more traditional Information Technology (IT) deployment models. In this context, the term "services" refers to applications, usually made available through Internet, that citizens and/or public servants use for accomplishing some valuable task.

The project aims to define useful guidelines on how to implement the process of moving application to cloud computing and is based on direct experimentation with pilot projects conducted in, at least, the cities participating to the consortium.

STORM CLOUDS will also deliver a consolidated a portfolio of cloud-based services validated by citizens and Public Authorities in different cities and, at the same time, general and interoperable enough to be transferred and deployed in other European cities not taking part in the project. This portfolio will be mainly created from applications and technologies delivered by other CIP Policy Support Program (CIP-PSP) and Framework Program 7 (FP7) projects, as well as resulting from innovation efforts from Small and Medium Enterprises (SMEs).

The project is composed by the following consortium:

Member	Role/Responsibilities	Short Name	Country
Ariadna Servicios Informáticos, S.L.	Co-ordinator	ASI	Spain
Hewlett Packard Italiana S.r.l.	Participant	HP	Italy
EUROPEAN DYNAMICS Advanced Systems of Telecommunications, Informatics and Telematics	Participant	ED	Greece
Research, Technology Development and Innovation, S.L	Participant	RTDI	Spain
Aristotelio Panepistimio Thessaloniki	Participant	AUTH	Greece
Alfamicro Sistemas de Computadores LDA	Participant	Alfamicro	Portugal
Manchester City Council	Participant	Manchester	United Kingdom
Ayuntamiento de Valladolid	Participant	Valladolid	Spain
City of Thessaloniki	Participant	Thessaloniki	Greece
Câmara Municipal de Águeda	Participant	Águeda	Portugal

For more information on the scope and objectives of the project, please refer to the Description of Work (DOW) of the project [1].

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Executive Summary

For the evaluation of STORM CLOUDS project exploitation plans, it is necessary to understand the "as is" situation of the STORM CLOUDS market, in order to identify opportunities, challenges and scenarios to explore.

This document analyses the market taking the perspective that it will provide guidelines for platform as a service (PaaS) and Infrastructure as a service (IaaS) platforms. It is important to highlight that assumptions are based upon academic research, expert views, analyst reports and industry white papers. Additionally, it is backed up with a Porter's 5 forces model in order to determine the market's attractiveness. This model is slightly adapted in order to better fit current market developments and requirements.

The description of the market takes a macro-environmental level and then narrows down the market, to then finalize with specific market business models. For this reason the cloud computing market and its forecasting trends are initially described, followed by an analysis of the STORM CLOUDS specific market segment and then finalizing with a benchmark of current business models of the cloud computing industry.

Lastly, this document will be used in order to provide STORM CLOUDS business models and plans to be delivered later throughout the project life.

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Abbreviations

Acronym	Description
AWS	Amazon Web Services
B2B	Business-to-business
CAGR	Combined annual growth rate
DoW	Description of Work
FCC	Federal Communications Commission
HP	Hewlett-Packard
IaaS	Infrastructure as a service
IT	Information technology
L2	Layer 2
NIST	National Institute of Standards and Technology
OpEx	Operational expense
OSS	Open source software
P2P	Peer-to-peer
PaaS	Platform as a service
SaaS	Service as a structure
SANs	Storage area networks
SCP	Storm clouds platform
VMs	Virtual machines

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1 Introduction

1.1 Purpose of the document

This document analyzes project STORM CLOUDS market.

It consists of the initial analysis that will allow to determine project STORM CLOUDS business models and business plan.

The document is organized in the following chapters that are divided in subsequent sub-sections:

- **Chapter 1 – Introduction:** Overview of the document and executive summary briefly describing the project's objectives and document's objective;
- **Chapter 2 –Market overview:** Definition and description of the cloud computing market, segments, benefits, concerns and future trends;
- **Chapter 3 – STORM CLOUDS market:** Definition of STORM CLOUDS' market segment and assessment of its profitability and market size;
- **Chapter 4 – Benchmarking of the market business models:** Evaluation of existing cloud computing business and pricing models;
- **Chapter 5 – Conclusion:** Summary, key findings and main conclusions

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2 Market overview

2.1 Driver forces

The internet has revolutionised the way people work, live and interact with each other. [4] Since 2005 there has been an explosive growth in data created on a daily basis and the speed at which new flows of information are processed. As figure 1 shows, Hewlett-Packard (HP) estimates that by 2020 more than a trillion applications will be exchanging 58 zettabytes of digital data over 100 billion devices. Additionally, the installed base of "things" is expected to grow by 30% from 2009 to 2020, reaching an amount of 26 billion units.

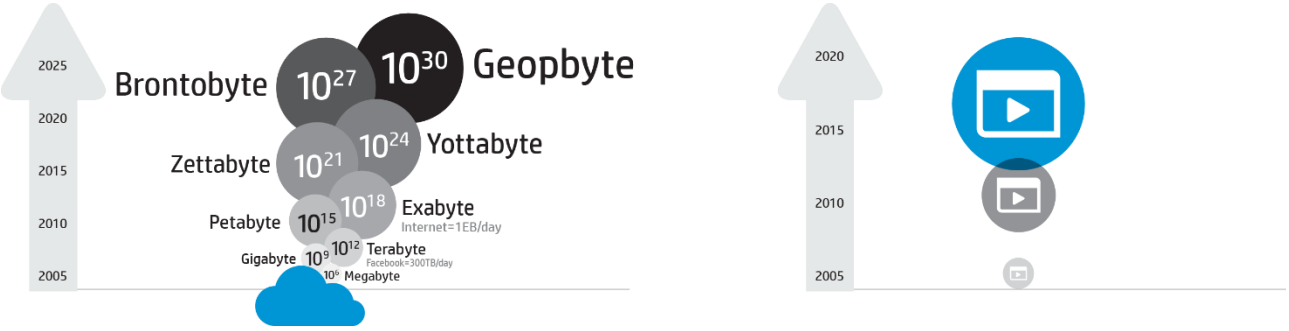

Figure 1 Estimation of data and IT complexity growth from 2005 to 2025 [42]

This combination of explosive growth in data creation, new applications and devices is profoundly changing IT complexity and creating challenges in what concerns storage and management of data.

Challenges mentioned in the former paragraph, are precise examples of drivers that have the tendency to change and re-shape industries and markets. In fact, it is argued that the IT industry tends to see technological macro-environment shifts, occurring approximately every decade. Over the past years, the main trends moved on from client/server to the Internet, topics that were deeply explored and suffered from several developments. Nowadays, the focus has shifted to four major trends: mobility, social media, big data, and last but not least cloud computing.

According to literature, the advent of cloud computing represents the next "evolving paradigm" [5] shift in personal computing as well as traditional models of computing. Even though certain

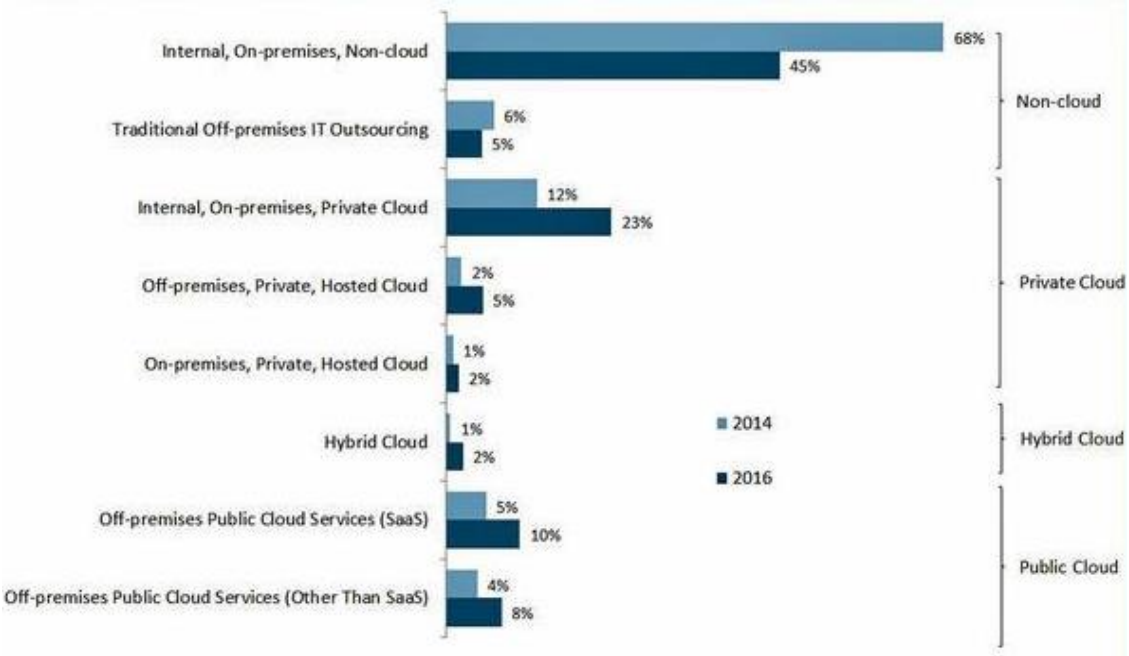

Figure 2 Cloud computing adoption rates from 2014 to 2016 [42]

academics contest this statement by stating that cloud computing only draws on existing technologies, it is widely accepted that cloud computing is a new shift in the sense that it combines and integrates these existing approaches. [6] An example is the combination of virtualization with open source software (OSS). Figure 2 evidences the importance and imminence of this next paradigm shift, as it portrays that cloud computing is expected to be widely adopted by users. More specifically, it is estimated that by 2016 only 45% of users will

still keep using traditional IT delivery models, whereas the remaining 55% will be turning for a specific type of cloud solution.

It is important to reinforce the fact that IT industry shifts have been mainly driven by business needs to gain competitive advantage over other market players, as a form of fighting industry structural changes and challenges. This competitive advantage is mainly aligned around speeding-up innovation, enhancing agility, lowering costs and better serving clients.

Cloud computing therefore represents a new major industry trend that promises to unleash new markets and create opportunities for businesses, consumers, the environment and economic growth. [7]

2.2 What is cloud computing?

Up until 2011, there were several definitions of cloud computing, often referred to as simply "the cloud" [30]. In September 2011, the National Institute of Standards and Technology (NIST) released a Special Publication SP 800, defining cloud computing as 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." [9]

Boss et al. [10] provides a more technical and detailed definition of the term cloud computing. He claims the term is used to describe both a platform and type of application. A cloud computing platform is able to dynamically provision, configure, reconfigure and de-provision servers as needed. Servers in the cloud, which he defines as "a pool of virtualized computer resources" [10], can be physical machines or virtual machines. Moreover, advanced clouds typically include other computing resources such as storage area networks (SANs), network equipment, firewall and other security devices. Cloud computing also describes applications that are extended to be accessible through the Internet. These cloud applications use large data centers and powerful servers that host Web applications and Web services, which are "accessed via browsers but with the look-and-feel of desktop programs" as complemented by Lawton. [11] This means that cloud computing serves a large market, as anyone with an Internet connection and a browser can access a cloud application. Finally, according to Skillicorn, cloud computing also implies "component-based construction", meaning that applications can be developed through dynamic re-use and recovery of fragments like services, third-party software or libraries from the cloud. [12]

In short, cloud computing is a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies. [13]

The NIST also divides the cloud model into three service models, and four deployment models. [9] This allows for a clearer categorization of the cloud computing market into sub-segments, as they differ in their service provisioning that will be briefly explained throughout the following sections.

2.3 Cloud computing service models

Platform-as-a-service (PaaS)

Platform as a service provides a cloud-based environment with everything required to support the complete lifecycle of building and delivering web-based (cloud) applications, without the cost and complexity of buying and managing the underlying hardware, software, provisioning and hosting. In short, this delivery service focuses on managing applications instead of infrastructure [13]. Advantages are:

- Focus on development of applications and faster market reach;
- Rapid deployment of new web applications;
- Reduced complexity with middleware as a service;

Infrastructure-as-a-service (IaaS)

Infrastructure as a service provides companies with computing resources including servers, networking, storage, and data centre space on a pay-per-use basis. [13]

It provides IT capabilities that can be briefly described as follows:

- Computational services: the ability to start Virtual Machines (VMs) running an operating system and, optionally, application software;
- Storage services: the ability to create storage elements (virtual disks or files);

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- Networking services: the ability to create network elements like Layer 2 (L2) networks, subnets, DHCP services, etc;

Generally speaking, when applications are deployed in a cloud environment, the IaaS layer provides the run-time environment for the execution [14]

Software-as-a-service (SaaS)

Software as a service run on distant computers that are owned and operated by others and that connect to users' computers via the Internet and, usually, a web browser. [13]

Most prominent examples in the SaaS area are Google Apps with their broad catalogue of office applications such as word and spreadsheet processing as well as mail and calendar applications that are entirely accessible through a web browser. An example from the business-to-business (B2B) sector is SAP that delivers their service-oriented business solution Business by Design over the web for a monthly fee per user. [44]

2.4 Cloud computing benefits

Increasing adoption of cloud solutions represented in figure 1, portray the economic, micro and essential advantages brought by cloud computing. These are briefly tackled during the next sections.

Reduced costs

To begin with, cloud computing dramatically lowers the cost of entry for smaller firms trying to benefit from IT intensive businesses, that usually available to larger corporations only. These computational exercises typically involve large amounts of computing power for relatively short amounts of time. Cloud computing makes this dynamic provisioning of resources a possible feature. Cloud computing also represents a huge opportunity to many third-world countries that have been so far left behind in the IT due to lack of proper infrastructure. Nevertheless, expansion to developing markets can bring disadvantages that the next section will describe. [15]

Accessibility and net savings

Cloud also benefits immediate access to hardware resources, with no upfront capital investments for users. This creates faster time to market in many businesses. When looking at IT from an operational expense (OpEx) approach, cloud reduces the upfront costs in corporate computing, as figure 3 suggests [16].

EMEA: Cumulative Economic Benefits 2010-2015

	France	Germany	Italy	Spain	UK	EMEA
	€ mil	€ mil	€ mil	€ mil	€ mil	€ mil
Business development opportunities	24,599	32,642	23,995	16,866	29,555	127,657
Business creation	51,377	69,507	43,305	30,939	20,026	215,153
Net total cost savings *of which:*	26,323	37,740	28,463	22,008	26,206	140,740
– IT CapEx savings	*28,653*	*36,378*	*30,461*	*23,013*	*36,176*	*154,682*
– IT OpEx savings (FTEs / productivity)	*13,818*	*18,139*	*14,533*	*10,396*	*16,943*	*73,829*
– IT OpEx savings (power & cooling)	*11,107*	*14,345*	*11,821*	*8,510*	*10,566*	*56,349*
– additional cloud services expenditure (PAYG) *	*- 27,255*	*- 31,122*	*- 28,353*	*- 19,910*	*- 37,481*	*- 144,120*
Indirect GVA	60,450	81,351	55,007	40,737	42,202	279,747
Total Economic Benefit	**162,749**	**221,239**	**150,770**	**110,550**	**117,989**	**763,297**
Direct and Indirect employment ('000s)	**469.4**	**789.4**	**455.8**	**392.5**	**289.0**	**2,396.2**

** This category of spend is captured for private cloud through lower firm-level CapEx and OpEx savings. The firm-level CapEx and OpEx savings are higher under hybrid and public cloud, but there can expect to also be incurred new spend on external cloud services*

Figure 3 Cloud computing OpEx savings by country from 2010 to 2015 [16]

This allows for new investments derived from OpEx savings, which is what happened with Internet start-ups Jungle Disk, Gigavox, SmugMug [15]. The cloud becomes an adaptive infrastructure that can be shared by different end users, each of whom might use it in very different ways. The cloud allows users to have a flexibility to use it on-demand, since standardization of infrastructure enables easily adding computing capacity. It also

benefits from economies of scale as demand goes up, due to a demand load system built in a rather stochastic sense [15].

Scalability

Cloud computing makes it easier for enterprises to scale their services according to client demand. Since computing resources are managed through software, they can be deployed in a fast manner as new requirements arise. Indeed, this benefits seasonality businesses or those whose demand suffers trend peaks. In fact, the goal of cloud computing is to scale resources up or down dynamically through software APIs depending on client load with minimal service provider interaction [16].

Disaster Recovery

Additionally, Cloud Computing is a great solution to avoid and manage physical disasters. Since when benefiting from Cloud Computing solutions most servers are located externally, whenever occasional natural disasters, such as theft, vandalism, earthquakes, floods occur, the companies do not need to activate insurance policies or require to engage in activities to save existing hardware.

Open Source

The advent of the cloud, together with the emergence of open services, is now making it attractive for use by companies that traditionally were happy with a commodity.

OSS appeared as smaller cloud vendors joined efforts in order to gain market share against market leaders' proprietary solutions. OSS main objective is to attract third parties that will unite their efforts in order to enable the offering to catch up with more established solutions. In short, it presents code and data that is open to the public, thus promoting collaboration amongst stakeholders. According to academics, OSS is defined as a "computer software with its source code made available with a license in which the copyright holder provides the rights to study, change and distribute the software to anyone and for any purpose". [17] For instance, OpenStack [18] is the largest free and open-source software cloud computing software platform that users usually use to deploy IaaS solutions. [19] It was established in 2012 by the OpenStack Foundation (A NASA and Rackspace joint-venture) which is a non-profit corporation [3]. Currently OpenStack is a tool that is facing exponential growth, especially in the cloud markets with over 189 organizations and more than 9,100 individuals engaging in the community. [20]

OSS main advantages is the fact that it opens up all cloud markets. It promotes competition within the markets against competitors such as VMware and Amazon Web Services (AWS), "as large cloud service providers and enterprises adopt a dual open source/VMware strategy" [15]. More specifically, OSS will bring several economic advantages for the industry as it creates scalable, interoperable and reliable solutions. Indeed leveraging data or code re-use reduces the density of bugs or problem detection as well as improving efficiency with reduced costs and higher savings, as well as faster time-to-market answers. Figures 4 and 5, both derived from empirical studies by Mohagheghi, et al. and Daffara, et al. [22] evidence the previous statements. Moreover, according to literature, it is believed that maintenance effort in OSS is significantly lower [21].

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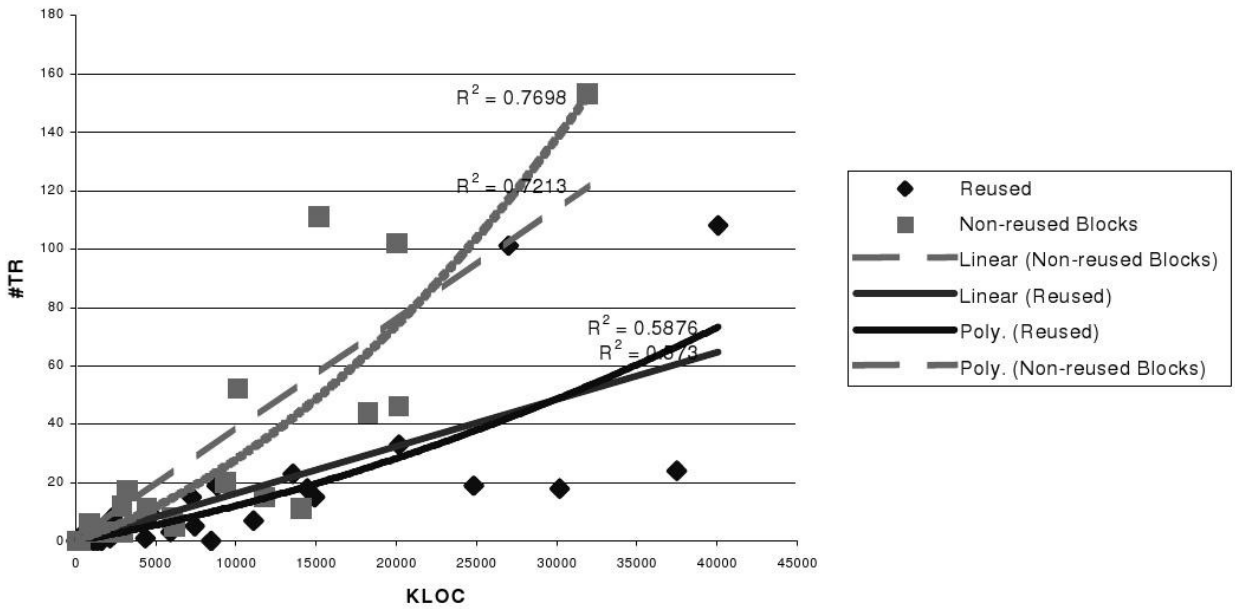

Figure 4 Benefits of data re-use [22]

Project size (lines of code)	% of OSS	total cost (Keuro)	Savings	duration (years)	avg. staffing
100000	0	1703	0%	1.7	20.5
100000	50	975	43%	1.3	15.4
100000	75	487	71%	0.9	8.6
1000000	0	22000	0%	3.3	141.7
1000000	50	12061	45%	2.6	103.2
1000000	75	3012	86%	2	32
10000000	0	295955	0%	7.5	818
10000000	50	160596	46%	5.9	631.2
10000000	75	80845	73%	3.8	421

Figure 5 Savings and time-to-market increase of data re-use and open source [21]

2.5 Cloud computing concerns

The storage of data on virtual servers online does not only present benefits, this IT area suffers from a set of security risks, external threats and disruptions that counter-balance its much publicized benefits mentioned in the above section.

Security issues

To begin with, according to a survey conducted by the IDC on cloud computing adoption, [23] 54% of respondents cited security as their top concern for transitioning to the cloud. This finding is aligned with other surveys conducted by McKinsey [24], for example, where 78% of respondents also reported security issues as their main concern respectively.

Taking into account that cloud offers worldwide accessibility to data, respondents are afraid that cyber-terrorists are able to involve in data breaching methods and actions. CISCO's annual security report points out that cyber-attacks rose by 14% from 2013 to 2014. [25] In fact, a survey conducted by anti-malware Company Kaspersky Lab and B2B International, revealed that 91% of organizations interviewed registered attempts of cyber-attacks over 2013, as depicted in figure 6. [26] For instance, the US major banks admit to index losses

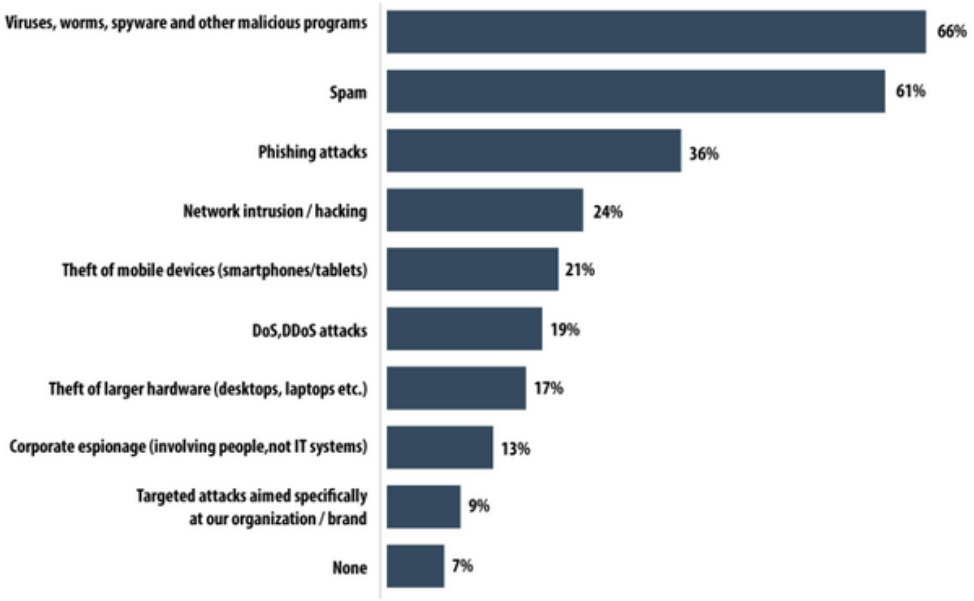

Figure 6 Number of cyber-attacks in 2013 by type

of around 25% regarding fraudulent activities related with internet home-banking. [28] Similarly, citizens and other users of SaaS or other types of cloud provisioning are also under the threat of attacks, such as online note-taking application Evernote's US hack, in March 2013, [29] leaving users to wonder if their records had been leaked. Not surprisingly, multinationals, SMEs and other cloud users are reluctant to store confidential data on the cloud, apprehensive of the risk of losing control over its information.

Unclear cloud legislation also presents a potential threat of cloud data being transmitted or sold on to third-party groups. As privacy policies of IT major firms such as Google, Microsoft or even Facebook remain uncertain regarding data protection from growing online marketing firms (in 2012, online adspend in the USA accounted around US$30.0 billion), [29] this remains a major barrier to the uptake of the technology. This type of data that is constituted amongst others from Web browser "cookies" containing behavioral information about users or enterprises, compose non-controllable risks that are often subject to media attention, for firms, citizens and public authorities [30].

Drawing a closer focus on the public sector, which according to project STORM CLOUDS' description of work (DoW) represents a core stakeholder to address, [2] they might represent a third party with strong interest in stored data. Here too concerns should be raised on hypothetical future legal actions blocking government agencies to use external cloud computing providers. This has been the case in specific Scandinavian countries for instance. [29]

In order to stop possible cloud users from postponing their decision to leave traditional IT solutions, vulnerabilities in the security area need to be improved and handled better by providers in order to overcome final client's concerns. This will include improving identification and authentication with certificates, as well as providing higher transparency for firms in service delivery and operations based on specific requirements to ensure compliance, security and SLAs.

Market immaturity issues

Even though long-term reduction of cost consists of one of cloud computing's main advantages, research indicates that initial current public cloud prices have dropped at a slow rate since 2006. According to figure 7, from Google, [31], even though hardware costs have decreased by 20 to 30% since 2006, public clouds have only fallen by 6 to 8% over the same period of time, resulting in perceptions of higher initial investment costs for firms and users. This can be correlated with market immaturity issues. [31]

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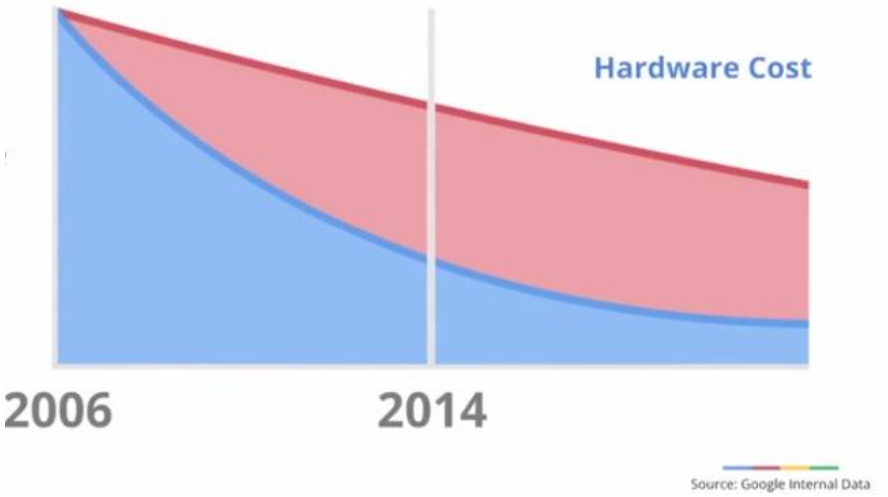

Figure 7 Public clouds and hardware price evolution from 2006 to 2014 [41]

Increasing innovation and competition inside the market is therefore mandatory in order to prices down and increase up-take of cloud solutions. In the first instance this means comparability between offerings and their characteristics, as well as approaches to cloud bursting. [31]

Proprietary issues

Another challenge of using a cloud service advents from the possibility to exchange a current service to another without seeing an impact on the quality of the service. As James Mitchell, CEO of Strategic Blue mentions, "anyone who has tried migrating from one cloud service to another will know that they are not precisely fungible. In fact, making the switch requires careful comparison of capabilities, performance, pricing and the accompanying legal documents". [30]

For this reason, reducing lock-in to proprietary solutions through means of increased portability and interoperability is mandatory, to give organisations confidence that they can transport their application and data from one cloud infrastructure or platform provider to another as well as developing interoperable applications hosted by other cloud providers in the business-to-business (B2B) segment. Currently, the answer to vendor lock-in relies in OOS solutions and their scalability through the cloud, as the next section will explain in more detail.

Internet availability issues

External challenges might also be derived, at a macro level, from the inadequate provision of high-speed Internet infrastructure in many developing nations. A weak connection in developing countries can increase loading times and latency which would raise time-to-market and inefficiency of the cloud market. As portrayed in figure 8, the percentage of businesses in developing countries with access to local networks is increasing and remains high.

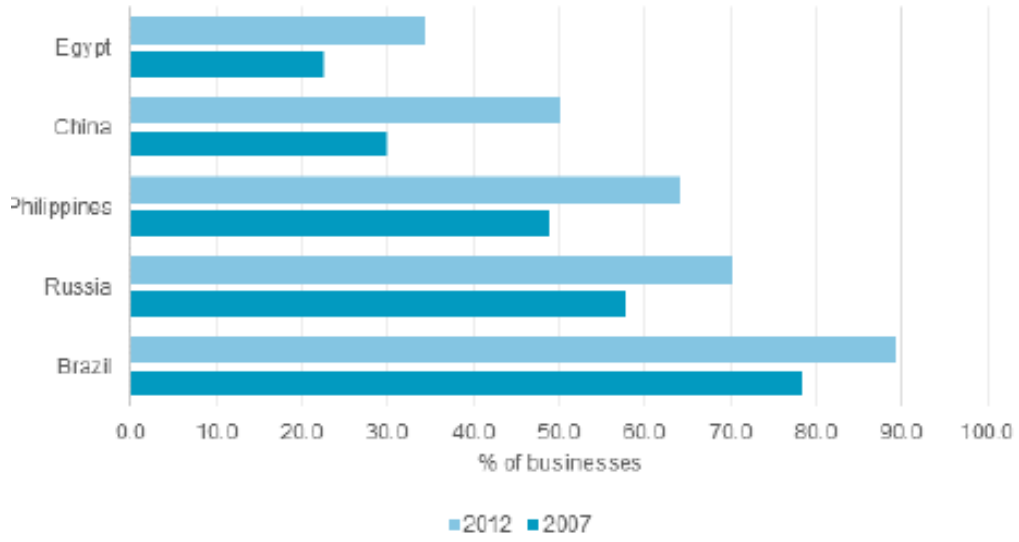

Figure 8 Businesses with Local Area Networks in Selected Developing Countries from 2007 and 2012 [29]

The necessity to secure fast bandwidth to avoid cloud usage bottlenecks, could in turn increase costs. For instance, in Brazil, almost 90.0% of official businesses had a local area network in 2012, yet the country has slow average Internet speed. [29]

Moreover, this threat poses real concern and should be carefully regulated by Governments of developed countries too. [29] In 2007, USA internet service provider Comcast slowed down network traffic within its servers that came from peer-to-peer (P2P) networks [35]. After being confronted with the incident and being claimed illegal by the United States Federal Communications Commission (FCC), Comcast confessed that traffic from P2P networks were slowing down other network traffic. [36]

2.6 Market forecast

The previous sections described in all of the above sections characterize the "As is" cloud computing market. As this market continues evolve through its life-cycle giving answers to its current threats, challenges and opportunities, since 2013 this market is taking a clear direction towards [29]:

- The **rapid adoption of the IaaS market** and **explosive growth of the PaaS segment** (deriving from market maturity and enhanced innovation)
- A gradual **move towards hybrid clouds** instead of private and public clouds (addressing privacy and security issues)
- The **growth and adoption of OSS frameworks, such as OpenStack and CloudStack** (which tackle vendor-lock and transparency issues)

According to project objectives defined in the project Description of Work document (DoW) [2], "the project partners declare strong commitment **to an open approach**" and needs to be "**interoperable** enough to meet project stakeholder's objectives". This trend falls to a great degree under the STORM market segment as the next chapter will describe in more detail.

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3 STORM CLOUDS market

According to Deliverable D2.2.1 and project STORM CLOUDS' consortium, the SCP can either be provided as a IaaS, PaaS or a combination of the two, based on OSS [14]. In fact. Taking the market overview previously described into account, a conclusion is reached that within the cloud computing general market that the SCP falls under hybrid **IaaS-PaaS segment**.

The next section analyses this specific cloud computing segment, by using an adaptation of Porter's 5 forces model, initially drafted by Crespo de Carvalho [32]. Porter's 5 forces model is a strong tool to analyze the profitability or attractiveness of a specific industry or market. As the model was designed in the 1980's [33], some features can be updated if not in accordance to market drivers. Small adaptations were therefore made to better fit could computing's innovative and IT based market.

To begin with, the overall market profitability will be described to then focus on each variable's attractiveness, supported by academic literature and research findings.

Furthermore, project STORM CLOUDS's DoW clearly states that one of its objectives relies on defining "useful guidelines on the process of moving applications" to a "cloud computing paradigm" [2]. Consequently, the project could vertically integrate the cloud computing market and supply consulting services to its clients. Part of the next section briefly tackles this additional sub-segment of the Iaas-PaaS cloud market, hereinafter referred to as the **cloud computing consulting segment**. It describes competitors and does an overall assessment of the segment, based on empirical and academic findings.

The last part of the following section focuses on project STORM CLOUDS targeted clients, within the STORM market.

3.1 Market profitability

STORM CLOUDS market attractiveness is moderately high. According to figure 9 and complemented by table 1, indicates that the results of the Porter's 5 forces analysis overall attractiveness yields 3.36 points, which falls under the lower "medium" level of market pull factors.

		ATTRACTIVENESS OF THE PaaS CLOUD COMPUTING MARKET					
		Very Low	Low	Medium	High	Very High	
Competitive Strenght		**ACTUAL**					
Threat of entrance of new entrants	High		x				Low
Bargaining Power of Suppliers	High				x		Low
Bargaining Power of Costumers	High			x			Low
Threats of Substitute Products	High					x	Low
Rivalry within the industry	High				x		Low
Global Evaluation					x		

Figure 9 Attractiveness of the STORM CLOUDS market

Table 1 Value of each variable on market attractiveness

	Individual variable strength	Result on global attractiveness of the market
Threat of entrance of new competitors	4.40	1.60
Bargaining Power of Suppliers	2.29	3.71
Bargaining Power of Costumers	3.17	2.83
Threats of Substitute Products	1.25	4.75
Rivalry within the industry	2.08	3.92
	Total	3.36

Findings assess highly attractive intensity of rivalry, giving a 3.92 result. When looking at the IaaS-PaaS industry segment under Porter's model, the fact that it is mainly dominated by two players even though they are facing increasing levels of competitors, means that the industry allows to sustain incumbent's competitive advantages. Additionally, lower barriers to exit add to this variable's attractiveness.

Moreover, low bargaining power of suppliers and medium power of consumers, indicate 3.71 and 2.83 points respectively. The market is therefore attractive for incumbents and new entrants as they benefit from more negotiation power over their service offerings, as well as higher flexibility to compete in the market.

Substitute goods are scarce, giving the variable a "very low" value of 4.75 which is considered a highly attractive factor. When lacking the threat of new products from entering the market, industries are protected against fewer competitors and can retain more consumers. This variable is more relevant in markets and industries that are more mature.

In regards to the STORM CLOUDS market, the only significant threat level consists of new entrants, the variable that presents the lowest attractiveness factor with an overall result of 1.6 points. This concludes that future entrants can easily steal market share and dilute the market, which is the only market factor that reduces its attractiveness.

The following sections will support and detail the overall result of each variable.

Intensity of rivalry

A crucial aspect to establish STORM CLOUDS market profitability is to evaluate competitors. This could turn into an exhaustive process, for this reason figure 10 assesses the key market players that provide combined IaaS-PaaS solutions. In combination with figure 11 that evaluates competitors' positioning within the market, it is found that Amazon and Microsoft are the two market leaders and several other players follow behind.

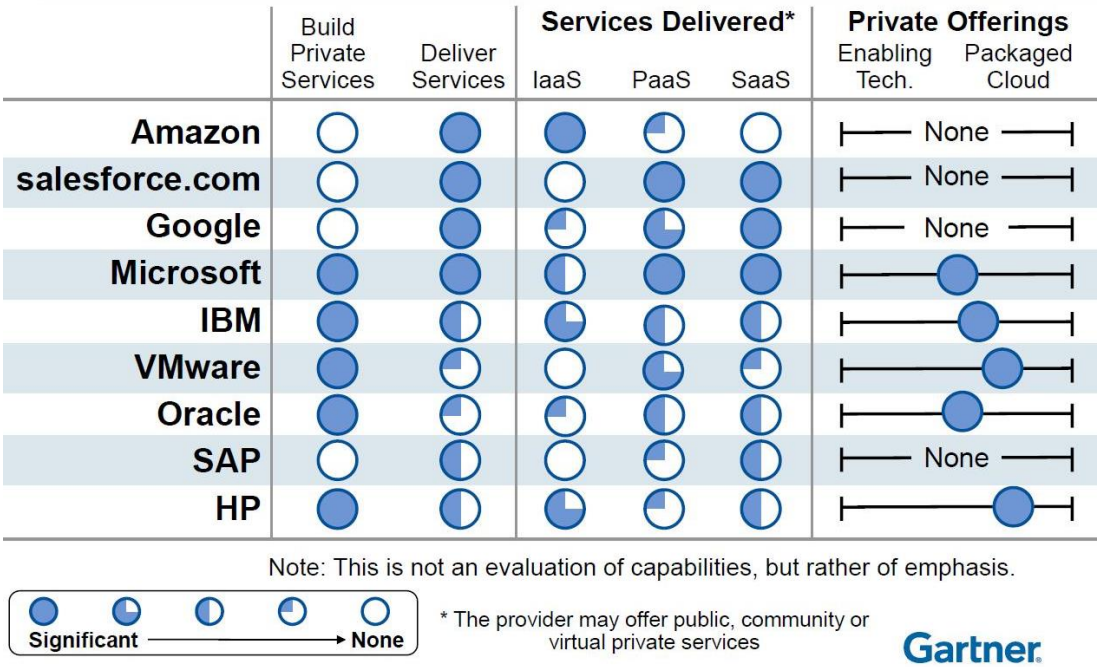

Figure 10 Summary of major vendor emphasis [42]

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Figure 11 Cloud computing providers positioning map [34]

This analysis allows to establish that STORM CLOUDS' market is substantially concentrated on a few players which translates into an appealing market for Microsoft and AWS or other competitors that could reach their positioning in the future. In opposition, the market does not appear attractive for current players that cannot gain market share. Also, the market sustains a large variety of competitors which emphasises the tendency for certain players to sustain competitive advantages and therefore reducing industry overall market attractiveness. [34]

Furthermore, according to Gartner, in terms of STORM CLOUDS competitor's value proposition and positioning, "IaaS providers that target enterprise and midmarket customers generally offer a high-quality service, with excellent availability, good performance, high security and good customer support". [34] Nevertheless some players benefit from external competitive advantages such as a first mover advantage, which is the case of Amazon. Other factors such as continuous open innovation can also result in more market advantages.

The degree of fixed costs involved in the STORM CLOUDS market represents a more difficult evaluation process. This is due to the fact that IaaS providers deal with infrastructures of cloud computing that results in rather important shares of investment and IT spending. On the other hand, when providers of PaaS solutions only to focus on managing the infrastructure in order for applications that run on top of the infrastructure layer work in an efficient manner. In this case, fixed costs can be considered lower in comparison to IaaS clouds. Nevertheless, since the main focus of the STORM CLOUDS market remains on the provisioning of a combined IaaS-PaaS, this combination results in significantly high fixed costs requirements. The previous statement can be reinforced with the high fixed costs inherent of cloud providers and vendors and the technological initial investments required. [35]

Regarding consumer's switching costs, the rise of OSS will reduce costs. However, current business models (explored in detail in chapter 4, section 3.1) still impose a high level of commitment for end-users to change to a different cloud provider. In particular this high commitment level is derived from possible data loss, the harassment procedure and lack of incentive to change, as potential better quality cloud providers do tend to follow similar pricing models as competitors. This leads to low perception for consumers that cannot clearly understand higher quality level if not clearly reflected upon selling prices [35]. Changing costs are thus considered high.

Overall exist costs are low, as legislation in the cloud market is still unclear and the main exit costs would be reflected upon fixed costs and initial investments.

STORM CLOUDS cloud computing analysis Aplication of the model of 5 strenghts of porter		Contribution to the strenght							
		Very low	Low	Medium	High	Very high			
Rivalry within the market									
Number of competitors	Low			1			High		
Degree of concentration of the market	High	1					Low		
Market growth	High		1				Low		
Fixed costs	Low				1		High		
Costs of change to the consumers	High		1				Low		
Degree of variety of competitors	High			1			Low		
		1	2	3	4	5		Average	15
Global value of the strenght	Low			2.5			High	Result	2.50
Exit Barriers									
Exit costs concentrated	Low			1			High		
Emotional barriers	Low	1					High		
Legal and social restrictions	Low	1					High		
		1	2	3	4	5		Average	5
Global value of the strenght	Low		1.66667				High	Result	1.67
GLOBAL VALUE OF THE STRENGHT	Low			2.08			High	Final Result	2.08

Figure 12 STORM CLOUDS market intensity of rivalry

Intensity of rivalry presents a great strength for the STORM CLOUDS market, as summarized in figure 12.

Threat of new entrants

Based on Gartner evaluations, figure 13 shows that the IaaS and PaaS will consist of rising services until 2016 inside the cloud computing market. In particular, the IaaS that will consist of the larger two markets will grow significantly. Similarly, the PaaS segment that was less than 100 in 2012 is estimated to follow exponential growth rates of 26.6% Combined annual growth rate (CAGR) to reach around 1000. This will results in an estimation of $2.9 billion spent. Although adoption rates will still be higher for the IaaS segment, the PaaS will rise at a more rapid pace [36].

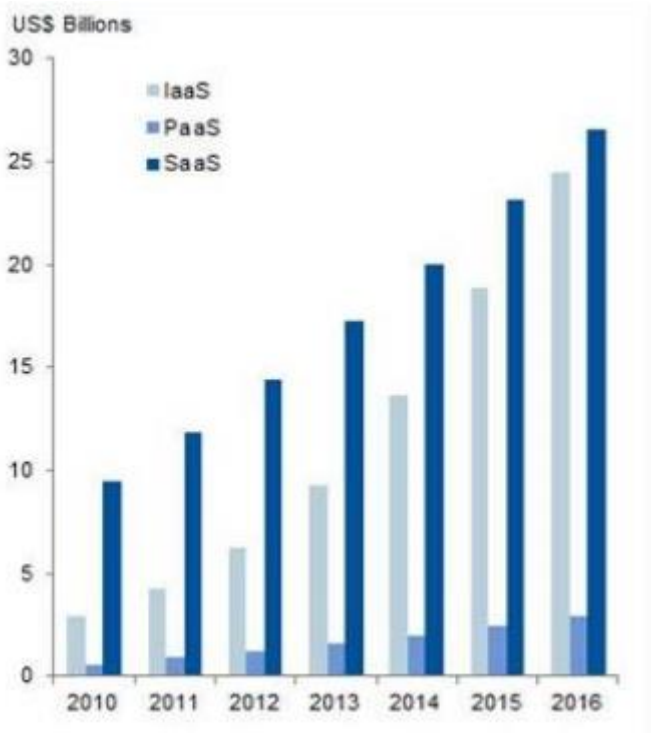

Figure 13 Cloud computing adoption forecast [35]

These findings are highly relevant to determine STORM market's threat of new entrants. Let alone the increasing level of adoption by users, by adding exponential growth rates for the IaaS and PaaS it is evident that new entrants have market entry possibilities.

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Additional factors, such as the lack of protectionist policies for existing firms, low switching costs for consumers and higher availability of technology (according to growth rate levels), result in higher attractiveness of this variable to the market.

Threat of new entrants therefore presents an unattractive variable for the STORM CLOUDS market, as summarized in figure 14.

STORM CLOUDS cloud computing analysis Aplication of the model of 5 strenghts of porter		Contribution to the strenght							
		Very low	Low	Medium	High	Very high			
Threat of entrance of new competitors									
Product Differentiation	High				1		Low		
Brand Identification	High			1			Low		
Capital need	High				1		Low		
Cost of change to the consumers	High				1		Low		
Difficulty to access to distribution channels	High					1	Low		
Protectionist Policies	High					1	Low		
Difficulty to access to the technology need	High					1	Low		
Difficulty to access to materials	High					1	Low		
Experience effects	High				1		Low		
Probability of retaliation by the existing companies	High					1	Low		
		1	2	3	4	5		Average	44
Global value of the strenght	Low					4.4	High	**Result**	**4.4**

Figure 14 STORM CLOUDS market threat of entrance of new competitors

Threat of substitute products

Arguably, substitute products could consist of grid computing IT systems, although these have not been thoroughly explored in commercialization terms. [39] The fact is that grid computing does not quite manage to centralize IT in data centers in order to raise savings on scale and scope at a same level.

Certain research projects such as Biz2Grid and GridEcon projects have attempted to develop mechanisms and software to realize these pricing models concepts in Grid environments as well. Nevertheless, those topics are not well received amongst science Grids. [39]

However, cloud computing adoption rates seem to point out for its excellence in comparison to the grid alternative. [39] Following this line of thought, disposal of grids would thus be highly attractive, as cloud computing solution provide better alternatives.

In addition, the SCP is built in an interoperable fashion that allows its users to opt for the type of platform they desire (i.e. IaaS, PaaS, Public or Private Deployments) [14]. This greatly reduces danger levels of adoption alternative technologies of users.

Therefore the market operates under low levels of retaliation strategies of suppliers of substitutes and low "price-performance" relation of substitutes in comparison to the STORM CLOUDS market. Additionally, the cost to change to a grid environment is considered high, as this would involve shifting to a whole new IT system. Similarly to switching cloud providers mentioned previously, one could argue that users would find lower incentive in doing so due to the high involvement level put into the current provider.

For this reasons, substitute products do not present a great threat for STORM CLOUDS market, as summarized in figure 15.

STORM CLOUDS cloud computing analysis Aplication of the model of 5 strenghts of porter		Contribution to the strenght							
		Very low	Low	Medium	High	Very high			
Threat of substitute products									
Disposal of substitutes	Low	1					High		
Cost for the clients to change to substitute products	High		1				Low		
Aggressiveness of the suppliers of substitute products	Low	1					High		
"Price-performance" relation of the substitute products compared to the market	Low	1					High		
		1	2	3	4	5		Average	5
Global value of the strenght	Low		1.25				High	**Result**	**1.25**

Figure 15 STORM CLOUDS market threat of substitute products

Bargaining power of consumers

Bargaining power of consumers presents a medium threat for STORM CLOUDS market, as summarized in figure 16.

STORM CLOUDS cloud computing analysis Aplication of the model of 5 strenghts of porter		Contribution to the strenght							
		Very low	Low	Medium	High	Very high			
Bargaining power of consumers									
Number of clients in the market	High				1		Low		
Concentration of the clients in the market	Low					1	High		
Willingness of customers to change suppliers	High				1		Low		
Weight of the costs of products sold by the market on consumer's total costs	Low			1			High		
Disposal of substitute products to the consumers	Low	1					High		
Disposal of information for the customers about the market	Low		1				High		
		1	2	3	4	5		Average	19
Global value of the strenght	Low				3.17		High	**Result**	**3.16667**

Figure 16 STORM CLOUDS market bargaining power of consumers

Regarding the number of clients in the market, research mentioned in section 3.1.3 argues that the IaaS and PaaS segments are smaller than the SaaS market. Even though these will benefit from increasing market growth rates in contrast to SaaS services, the latter is expected to continue growing linearly [15]. For this reason client number is considered low.

Following this line of thought, as both the above mentioned segments are lower than SaaS, the same statement could be disputed.

Moreover, customer willingness to switch suppliers is certainly very low, as costumer present low switching incentive. [30]

Lastly, the costs are not fully passed on to consumers inside a cloud computing value chain, making this variable of medium contribution to the strength. On the other hand, disposal of substitute products for consumers is non-existent as mentioned previously in section and consumers seem to not fully grasp the IaaS-PaaS market, as they are more acquainted with SaaS cloud services. [30]

Bargaining power of suppliers

Several market players could be considered as suppliers, due to the cloud computing IT architectural complexity.

Figure 17 shows that the IaaS and SaaS market are continuously turning to open source when it comes to datastores suppliers.

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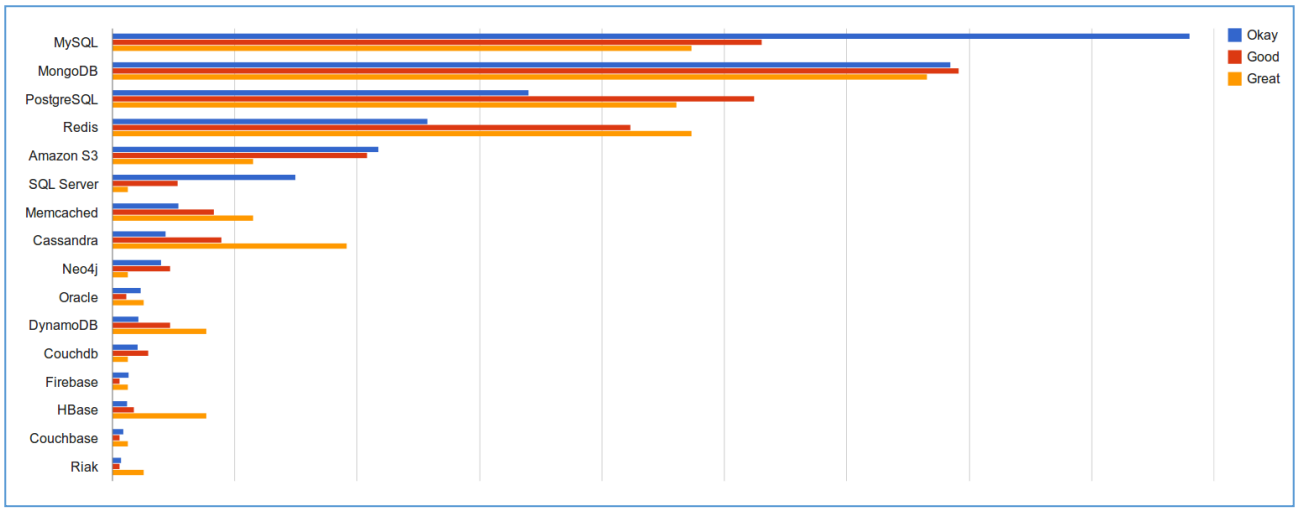

Figure 17 Usage rates of OSS-based datastores [41]

Moreover, when considering the IaaS segment only and compositional fabrics as suppliers, VMware has dominated the market over the past years, along with AWS [36]. These consisted of paying models. However, as OSS were developed, such as OpenStack[1] has become widely used in the market, innovation has spurred in this area [36].

The previous statement is valid for PaaS segments, as the industry is exploring a number of open alternatives for compositional PaaS fabrics. Examples include OpenShift or Cloud Foundry, with the latter being considered to fall under massive adoption levels and becoming what OpenStack has achieved for the IaaS market. [14]

This is also true for the SCP whose IaaS service is built using OpenStack, as well as its PaaS service provided by Cloud Foundry. [14]

The main take-away is that through development of OSS, such as OpenStack the number of providers has increased significantly, as these project imply lower costs purchasing for its clients as well as switching costs. Indeed the market has a wider variety of suppliers and its open source means that the quality of the products purchased are not has relevant as they can be leveraged and improved.

Bargaining power of suppliers therefore presents a medium threat for STORM CLOUDS market, as summarized in figure 18.

STORM CLOUDS cloud computing analysis Aplication of the model of 5 strenghts of porter		Contribution to the strenght							
		Very low	Low	Medium	High	Very high			
Bargaining power of suppliers									
Number of suppliers in the market	High			1			Low		
Importance of the market as client	High				1		Low		
Cost of change of suppliers	Low	1					High		
Weight of the costs of purchased products by the market on total costs	Low	1					High		
Importance of the quality of the products purchased	Low			1			High		
Degree of differentiation of the products purchased by the industry	Low			1			High		
Profitabilty of the suppliers	Low	1					High		
		1	2	3	4	5		Average	16
Global value of the strenght	Low			2.29			High	**Result**	**2.3**

Figure 18 STORM CLOUDS market bargaining power of suppliers

It is important to highlight, that if suppliers are considered companies that provide and facilitate hardware, then this analysis would be entire different in nature and the global value of the strength would most likely fall under a more threatening zone.

[1] Refer to chapter 2, section 2.4 for more details on OpenStack

3.2 Cloud computing consulting segment

The cloud computing consulting segment can represent a particular niche of two big markets:

- The cloud computing market, explained throughout chapter 2 and 3 of this document;
- The IT consulting market, that includes firms that provide their client companies with services such as: writing; testing and supporting custom software; planning and designing integrated hardware, software and communication infrastructure; and on-site management of computer systems and data processing facilities and off-site data processing and hosting services. [43]

Segment overview

The increasing need of all companies to reduce costs, improve efficiency and adopt technological changes have been the main drivers of the consultancy industry is recent years [44]. All these factors represent advantages of shifting from traditional IT provisioning infrastructures to cloud computing systems, which explains notable forecasted growth levels of the consulting cloud segment from analysts. Until 2017, ICD expects a 4.1% rate, and 5.2% both in 2015 and 2016 according to Gartner [45].

As seen for the cloud computing market, the size of potential client is increasing with rising cloud computing adoption levels, and a large number of private, public and individual actors interesting in taking-up cloud solutions.

The cloud computing consultancy segment thus certainly represents a profitable market in terms of size and growth.

Segment key players

The cloud computing consulting segment is composed of three types of players. Multinational firms that also dominate the cloud computing market and offer integrated solutions, with cloud infrastructure, platforms of software along with the consultancy service per-se. International big IT consultancy companies that can focus on the IT cloud provisioning. Local SMEs or external consultants that specialize in cloud computing consulting services.

The main actors of the first group of competitors are: Microsoft, IBM and Cisco, amongst others.

The main actors of the second group of competitors are: Accenture, Deloitte, SAP, amongst many others.

The third group is composed of an infinite amount of companies that differ from geographical area. Examples from the US market include companies such as: Cloud Technology Partners, Elegrity, BMC, etc.

The number of rivals within the segment can be regarded as rather condensed with domination from large multinationals that have already established competitive advantages within other markets and have integrated the cloud consultancy segment as well, and smaller firms that have already specialized in this specific sector of the industry.

In addition, as the IaaS-PaaS is forecasted to growth at a large growth rate (see section 2.6), the number of competitors within the cloud consulting segment should expect to follow the same direction.

Overall segment assessment

In conclusion, it is interesting to note that the consulting segment follows a similar trend to the IaaS-PaaS cloud computing market. The market is expected to grow at considerable growth rates with high levels of demand for consulting services, accompanied with the entrance of new competitors. [45] Suppliers and customers will pose a threatening presence in the market, as the nature and type of service offered is rather dependent on quality of service and reputation levels. Similarly, as mentioned in section 2.1, cloud computing is considered the new IT paradigm [5] which means that substitute products will not likely take over cloud computing within the next years.

This segment could therefore be perceived as a **new and evolving attractive market**. Nevertheless, the intensity of rivalry already composed of big multinational companies and vast number of small consultancy firms or individual consultants from the IT consulting market and cloud computing market turn **this cloud consulting market segment somewhat more competitive than the IaaS-PaaS market**. The need for reputation and good quality service is mandatory.

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3.3 STORM CLOUDS clients

STORM CLOUDS' target market is composed of public authorities that use or wish to transpose their applications to the cloud. Taking this perspective into account, clients will mainly consist of municipalities and other public institutions in the Europe or the European Union.

Municipalities

Table 2 [37] represents an estimation of these European public authorities, portraying the number of potential municipalities existing within the European Union.

This estimation evaluates a total over 90,000 potential clients. Even though in comparison to the cloud market this might be referred to as a "niche", STORM CLOUDS client base is sufficiently large for profitable revenues. In particular since the target base has room to grow, as public authorities could be expanded to public institutions or private-public-partnerships that have been left out from the analysis.

Table 2 Number of European municipalities

EU Country	Administrative Division
Austria	Around 2,400 municipalities in nine federal states
Belgium	589 municipalities in 3 regions
Bulgaria	264 municipalities in 28 administrative regions
Cyprus	33 municipalities (urban) and around 350 communes (rural) in 9 administrative districts
Czech Republic	Around 6,200 municipalities in 14 regions
Denmark	98 municipalities in 5 regions
Estonia	39 cities and 202 municipalities in 15 countries
Finland	415 municipalities in 6 provinces
France	36,569 municipalities (communes) in 22 regions
Germany	Around 14,000 municipalities in 16 federal states
Greece	900 municipalities (urban) and 131 communities (rural) in 13 regions
Hungary	Around 3,100 units of local government: upper-tier counties, cities and towns
Ireland	80 towns and boroughs and 5 cities in 4 regions
Italy	8,101 municipalities (communes) in 20 regions
Latvia	530 municipalities in 26 regions
Lithuania	60 municipalities in 10 provinces
Luxembourg	116 municipalities (communes) in three regions
Malta	68 municipalities
The Netherlands	443 municipalities in 12 provinces
Poland	2,478 municipalities in 16 provinces
Portugal	308 municipalities
Romania	319 cities and 2,686 communes in 41 counties
Slovakia	2,891 municipalities in 8 regions
Slovenia	210 municipalities
Spain	8,109 municipalities in 17 regions
Sweden	290 municipalities in 21 counties
United Kingdom	England 284 municipalities and 124 single-tier authorities in 9 regions (from 2009); Scotland 32 municipalities; Wales 22 municipalities; Northern Ireland 26 municipalities

Even though not all these public authorities will manage services that they wish to shift to a cloud paradigm, in parallel, the Smart City market is emerging and growing at a considerable pace. This is mainly due to innovation and investment at government levels. In accordance to the IDC Government Insights', the global Smart City analyst team has identified estimations for 2013 [40]:

- By 2013, 70% of worldwide spending on Smart City projects will be focused on energy, transportation, and public safety. 90% of these will be at least partially funded by national or international government.
- Smart City Information Challenges will begin to be framed as Big Data Issues
- Growth will be focused on medium-sized to large cities.
- Cities with Open Data Initiatives will drive an incremental amount of **50% private citizen participation and crowd sourced mobile applications**.

This market might therefore increase the need for "smarter services" in line with technological developments and, subsequently, increase adoption rates of cloud solutions for local governments and public authorities.

Other clients

Although STORM CLOUDS Project directly targets the specific characteristics of the Municipalities, the project results can be also applied to other type of customers as:

- Companies that provide services to large number of customers may have similar characteristics to a city providing services to large number of citizens. We may find examples among:
    - Public and Private health care providers
    - Utilities companies
- Other Public bodies, like regional governments.

This increases meaningfully the number of potential customers that can be reached by the exploitation of STORM CLOUDS results.

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4 Overview of the market business models

This section describes pricing models and consumption models used within the current cloud computing market. The structure of this section is split into two subsections devoted to alternative exploitation models based on STORM CLOUDS results.

- On the one hand, we gives a brief overview of different cloud provision model, complemented with advantages and disadvantages, when applicable.
- The other approach is the consulting model. STORM CLOUDS industrial partners will be in a privileged position to provide consulting services to customers willing to move their systems to the cloud.

This will help defining STORM CLOUDS business model and plan that will be developed in more depth throughout STORM CLOUDS project deliverables D.6.3 STORM Business Models and D6.4 STORM Business Plans, to be delivered, as according to the DoW, during months 18 and 36.

4.1 Cloud exploitation models

According to literature, at the moment two main business models dominate the online cloud storage and infrastructure market. The utility model and pay-as-you-go pricing model, as well as the "quota" model and subscription pricing model. Alternatively, reserved instance as well as licensing models have been designed but have not been widely accepted or incorporated by the public or firms.

The utility model and pay-as-you-go pricing model

The utility model and pay-as-you-go pricing models represents more of a true cloud-like service [36]. According to current developments, in user-driven environments, the model is usually more appropriate for cloud computing SaaS services. In this model, the user pays a static price for a given number of used units, measured in time units (hours), data quantity (GB) or CPU-hours, amongst other possibilities. It then associates these units with a fixed price value. In this model, transfer and storage are separate items, such as accesses and updates.

It is advantageous for products and services whose mass production and widespread delivery has made price negotiations impractical. However, impractical price negotiations could also mean higher barriers to entry for new firms entering the market and their consequently difficult new customer adoption and retention.

The "quota" model and subscription pricing model

The "quota" and subscription models, instead of a real cloud service can be considered more of an online storage service [36]. This models appropriates of the items metered in the utility model explained above, but operates under a flat rate. In particular, a user of a service that follows this model subscribes the usage of a selected combination of units at a fixed rate for a given time-frame (usually monthly or yearly). There are, however, overage charges for exceeding quotas. [15]

Extra service layers

Additionally, extra value-added service layers can be offered on top of the infrastructures of the models mentioned above for additional fees [36]. Even though the business model are still referred to as "utility" and "quota", they present certain subtleties worth mentioning. [15]

- Support, management and specialized access methods, such as special backup software.
- Premium pricing for a specific guaranteed level of performance or other service level guarantees.
- Special features such as interconnectivity with other services or integration with third-party services.

Reserved instance model

In spite of utility and "quota" model's predominance [15], new trends in the cloud market might demand other solutions. An alternative to the on-demand models mentioned before is the reserved instance model. This model first appeared in 2009, Amazon launched this innovative pricing structure [30]. The new structure allows cloud users to make an advance payment for the option to use on-demand services at a discounted price in the future. One of its core advantages is that it allows cloud providers to gain market share, as its discounting nature might give consumers more incentive to adopt and look for alternatives.

However, according to the press, cloud providers that have adopted this method keep on skewing the terms in their direction. An example is the insistence on larger advance payments, without fear of credit risk of consumers. [30]

Licensing model

Similar Grids, another IT computing paradigms, cloud providers could use a licensing model [44]. The core concept behind the licensing of software is that the more of the same product a business can sell, the more money it is going to make.

Current licenses are bound to a single user or physical machine. However, in order to allow the efficient sharing of resources and software licenses, there has to be a move towards usage-based licenses, penalties and pricing. [38]

Furthermore, an extra disadvantages concerns its inability to not create a "fidelity" contract with the users of the cloud service, which results in opening up possibilities for costumers to look for other services better tailored to their needs. [30]

Attention trust model

Individual's privacy records stored on cookies' websites or clouds, in this particular case, are usually regarded as confident information and issues not be dealt with. However, the attention trust model first appeared in 2005, targeted sales of private data about individuals. The main idea of the model was that browsers should own, control and profit from data about themselves and their online activity. [30]

US start-up Haggle collects information about individual's preferences, online behavior and online influence in order to offer discounts at restaurants that are keen to attract a particular type of costumer [30]. Similarly several online advertising entities might be incline to get access to this type of information.

Nevertheless, the model failed to gain attention as individuals are more reluctant to put information online, rather than to look at the comfort that it can bring to their online experience and timeliness of marketing material received. [30]

Consultant Paul Miller at The Cloud of Data argues that cloud computing might benefit from such a model, as "cloud-based services are now hoping to make that idea a reality" [30]. Obviously, this process would require a total different perspective by societies and require strict legal restrictions. It would however provide better and improved user experience and efficiency, since if personal data was stored in a cloud and given permission to access by companies, then paperwork and bureaucracy could be avoided. For Public Authorities, this could present great potential.

4.2 Consulting Services model

STORM CLOUDS industrial partners are achieving a body of knowledge, experience and future references that will be a key asset in the consulting market.

As detailed along this document (see section 2.1) the cloud market is expected to have important growth rates in the coming years. In parallel, the complexity of the IT, security considerations and interoperability functionalities will increase the need of IT customers to have specialized advices and professional services. Consulting services will cover, among other, the following aspects

- Support to cloud migration. A direct application of STORM CLOUDS guidelines and experience targeting different organizations.
- Security definition. Data privacy is a key element to be considered in every deployment of an information system that is handling information of citizens. A professional cloud will be a safe place with protocols and quality levels over average. However, the customer may have the feeling of "loosing" control of their data and many of them will demand professional IT security services; as well as security audits.
- SLA. A customer hiring the services of a cloud provider will ask also for independent consultant to assess the Service Level Agreement and Contractual terms that will regulate the relationship with their providers.

The main idea of the model is to act as a services to clients, in return for a detailed contractual fee, as seen in other industries. The goal of the consulting service model would be to leverage project STORM CLOUDS expertise to the whole cloud computing market. In this case, the project would take a holistic approach to the whole market and act not only as a cloud provider but as a cloud specialist for all actors and stakeholders involved.

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5 Conclusion

This document has described the market analysis of project STORM CLOUDS.

STORM CLOUDS general market is considered to be the cloud computing market, however due to the specificity of the SCP architecture, project STORM CLOUDS can be classified as the hybrid IaaS-PaaS sub-segment of the cloud computing market.

Currently, the cloud computing market is undergoing through some major trend changes that fall precisely under the STORM CLOUDS market segment. The slight difference relies in the fact that the STORM CLOUDS market presents particularities, as it is targeted to public authorities and their running applications. This target base presents valuable size for the scale of the project.

Finally, establishing the STORM CLOUDS market enables the analysis of this segment that is certainly positive and attractive, according to this document's findings. Interestingly enough, the SCP and project STORM CLOUDS solution are placed in an advantageous position to enter the market, target the public authorities' niche and leverage from its pilot's networks and key learnings to pierce the market.

Project STORM CLOUDS is a dynamic project, and this document still needs to be complemented with further research of the project's business models and plans, following (or not) the direction mentioned in the previous chapter. Particularly important will be the definition of business models for the services hosted by STORM CLOUDS Platform, foreseen from the second period of the project.

5.1 Disclaimer

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