Cloud Computing

Cyber Security and Green IT

The impact on e-Skills requirements

Final Report

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0. Executive summary

E-skills are crucial for competitiveness, innovation and growth in the ICT sector as well as in related sectors.[1] It is therefore important to ensure that European enterprises have access to an e-skilled workforce as well as ensure that European ICT practitioners are provided with the right incentives and training opportunities to constantly develop and update their e-skills to meet the requirements of enterprises. Moreover, it is important that entrepreneurs have the e-skills required to exploit fully the innovation potential of ICT. From a policy perspective, the key challenge is to ensure that European education and training systems are sufficiently prepared to meet the future demand for e-skills in Europe. Cloud computing is increasingly rolled out in large and small enterprises, and cloud computing can potentially leverage the strengths of European SMEs and increase their innovative abilities. Besides legal issues, its future success depends on the following factors:

- First, whether potential users will regard it as reliable and secure enough compared to their current on-site solutions. Cyber security is therefore a key topic that cannot be left out of the cloud computing debate.

- Second, the skills of ICT practitioners, users, managers and entrepreneurs (e-skills) play an important role, as the adoption and further development of these technologies can be enhanced by the right mind-set, knowledge and skills.

- Third, on the readiness and motivation for SMEs to embrace cloud computing both from an ICT perspective but also from a managerial and business perspective.

- Fourth, whether viable start-up environments use and develop cloud computing solutions and take the lead in a market that is taking off right now.

Even though numerous studies and surveys have been conducted on cloud computing, green IT and cyber security *none of them has focused specifically on the skill requirements* that could potentially be a vital part of European competitiveness and innovation. Consequently, the European Commission has launched this project on future e-skill requirements for two important target groups, i.e. ICT practitioners and entrepreneurs. The study will provide topical and accurate input to the e-skills agenda and the e-skills sector, where there is a pressing need to understand trends and developments and recruit the best skilled workers.

This study contributes to the above by identifying and proposing evidence-based recommendations for policy measures that will help ensure access to and development of critical e-skills in the domains of green-IT, cyber security and cloud computing. In short, the objective of the project is to:

[1] See: http://files.eun.org/eskillsweek/manifesto/e-skills_manifesto.pdf

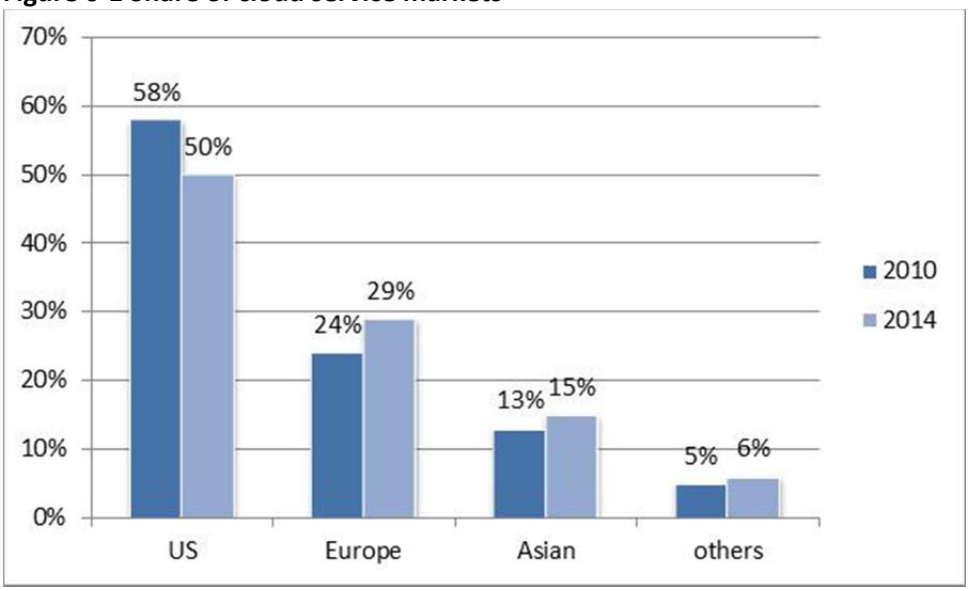
- Study the specific e-skill requirements relating to green-IT, cyber security and cloud computing with special focus on competitiveness and innovation and the needs of SMEs and start-ups.

- Formulate concrete proposals to address e-skill requirements and recommendations for follow-up actions at EU and national level as well as identify and promote best practice.

0.1. Cloud computing trends and growth

US-based cloud vendors currently lead in terms of market share, scale and technology. Even though forecasts predict that European cloud vendors will gain market shares in the coming years, US based companies are the market leaders. According to a study from the Gartner Group, US-headquartered companies represent 58 pct. of cloud vendors - but account for over 90 pct. of market revenue, and their revenues are expected to increase the next couple of years from €5.9 billion in 2010 to €11.3 billion in 2013. European companies are expected to gain market shares by leveraging the lessons from the first generation of service providers primarily from the US and utilising a second generation of cloud products and services. Therefore, the European market share is estimated to grow by 5 pct. to a 29 pct. market share in 2014.

Figure 0-1 Share of cloud service markets



Source: www.gartner.com/resId=1378513

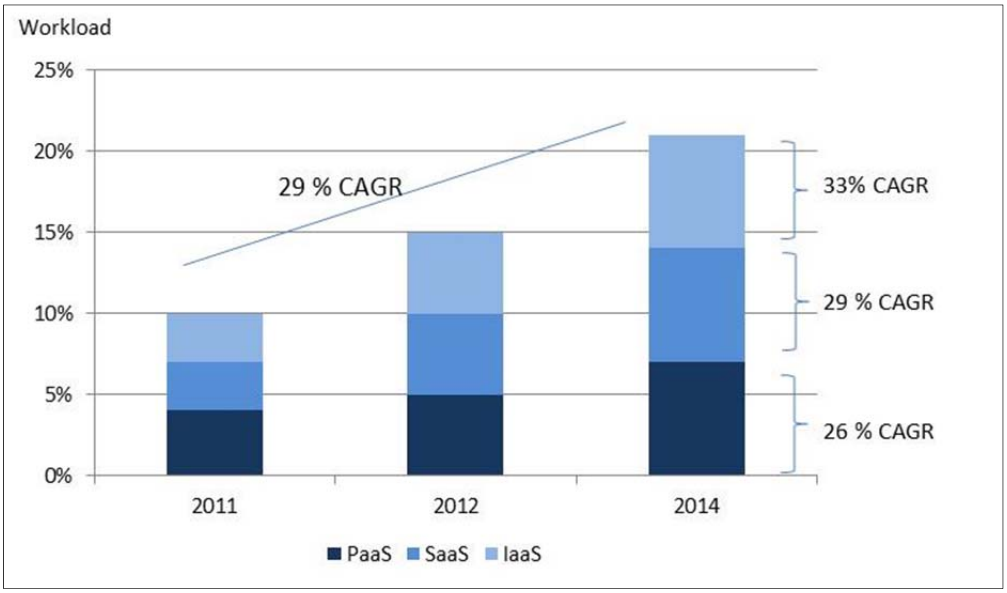
Cloud computing takes off - market set to boom as migration accelerates[2]

A number of forecasts and predictions have been made about cloud computing, but the uptake of cloud computing is currently taking off. Cloud computing has been discussed and hyped in recent years, but 2011 showed an increased use of cloud solutions in both large and small companies.

[2] See: www.morganstanley.com/views/perspectives/cloud_computing.pdf

The reason for the discussion surrounding cloud computing is, among other reasons, the size of the market. Forrester Research expects the global cloud computing market to reach $241 billion in 2020 compared to $40.7 in 2010. Over the next three years, both the breadth and depth of public cloud usage is expected to expand greatly in terms of application workloads expected to be run in public cloud environments. Given the combination of workloads shifting to public cloud environments and the increasing utilisation of on-premise server environments, forecasts for the coming years show a 29 pct. increase in the compound annual growth rate (CAGR) for platforms, software, and infrastructure.

Figure 0-2 Growth in workloads a clear positive for cloud service providers



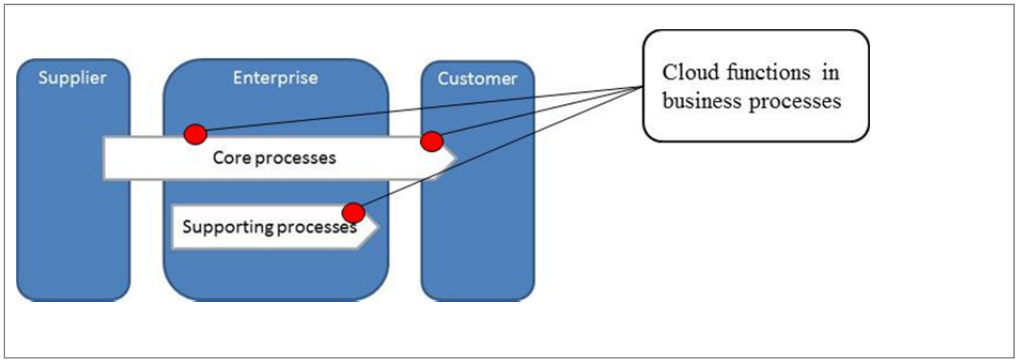
Source: www.morganstanley.com/views/perspectives/cloud_computing.pdf

Business value from cloud computing

Cloud computing covers a wide spectrum of services related to platforms, infrastructure and software. The question is how these services generate value in SMEs and how cloud computing supports business processes.

In this analysis, we distinguish between business processes that are core to the business and support functions as non-core processes. The analysis shows that ICT practitioners primarily integrate cloud computing into non-core processes whereas business managers potentially perceive cloud services as a way to strengthen core processes including the innovation and agility of the company. Cloud solutions integrated in both core and non-core processes are therefore important for the competitiveness and innovation of European enterprises.

Figure 0-3 Business value from cloud computing



The understanding of business managers regarding business value generated from cloud computing is primarily related to business growth and agility. The analysis shows that the potential is not fully exploited.

When asking ICT practitioners what kind of cloud solutions are being implemented, the results primarily point toward cloud solutions related to the ICT backbone of the enterprises and not to core business-related functions. This discrepancy between business managers and ICT practitioners points towards the fact that ICT practitioners could potentially play an important role in the core business processes and the uptake of services that not only cut costs but also increase growth, agility, and innovation. In short, the analysis shows that SMEs can create business value in relation to business processes in four dimensions, namely business revenue and growth, agility, cost reduction and innovation. The results indicate that currently business value is primarily generated through cost reductions and that competitiveness and innovation in SMEs can be further strengthened when cloud services are explored and deployed in more aspects than just those related to cost reductions.

Forward-thinking ICT practitioners and managers must deploy computing as a strategic tool, not just for IT but also to enable full business transformation and eventually change how the company operates its business.

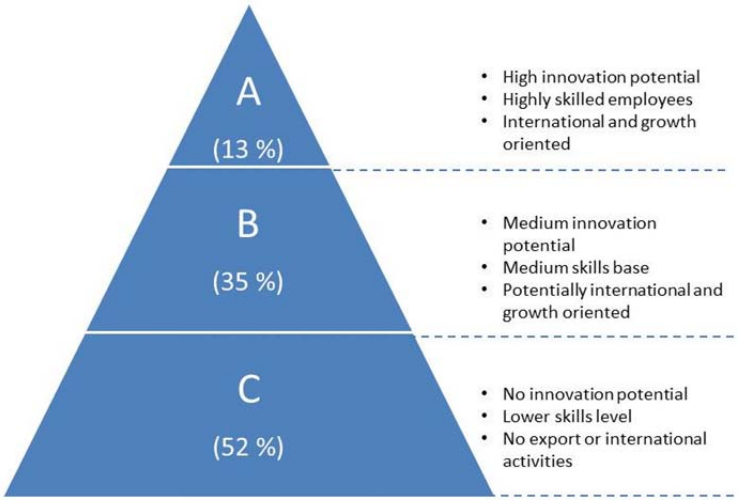
Looking forward, cloud computing can potentially enable a much tighter connection between IT transformation and business transformation. Innovative ICT practitioners and managers think business transformation first, then how technology enables it. They are the ones strategising with their business management to look beyond simple cost calculations to the business agility that cloud computing can enable. This is especially true for the A-segment of innovative enterprises.

0.2. e-Skills requirements in SMEs and start-ups

The variation across SMEs regarding use of ICT and innovative strengths must also be taken into consideration when assessing future e-skill requirements. SMEs represent a great diversity of companies from high-tech businesses to start-ups tuned towards international markets, from more traditional companies, such as crafts companies that are active in local markets, to family businesses. These different characteristics have a strong impact on strategies for skill development as the challenges SMEs face when

coping with human resource management differ accordingly. The figure below shows a distinction between three types of SMEs in terms of skills, innovative strengths and growth capabilities.[3]

Figure 0-4 Innovation potential among SMEs



Only a minority of the SMEs have innovation potential (13 pct.) whereas B and C-level companies have a medium or low innovation potential. When assessing the skills needed by ICT practitioners, it is important to distinguish between these levels. In the following section, we focus on e-skills for B and C companies and following this, we take a closer look at e-skill requirements in A-level and start-up companies.

Although cloud computing, green IT and improved cyber security have significant advantages for SMEs, embracing these technologies without ensuring an accompanying adjustment of skills among ICT practitioner and entrepreneurs could prove risky.

Future ICT management in SMEs will move from the technical side to business applications. The challenge for SMEs is to keep track of the technical developments in the ICT area to discover new and improved business support and perform strict change and costs management at a strategic level. ICT is no longer just a technical support function. Instead, it is getting closer to the core business, i.e. what the employees need to do in their jobs rules. Consequently, the role of ICT departments becomes to find out what the users need or what must be improved and check with existing service providers how this can be done efficiently.

Below, we address how the rapid spread of cloud computing and the increased focus on green and security aspects in ICT affect the role and future skill demands facing European ICT practitioners.

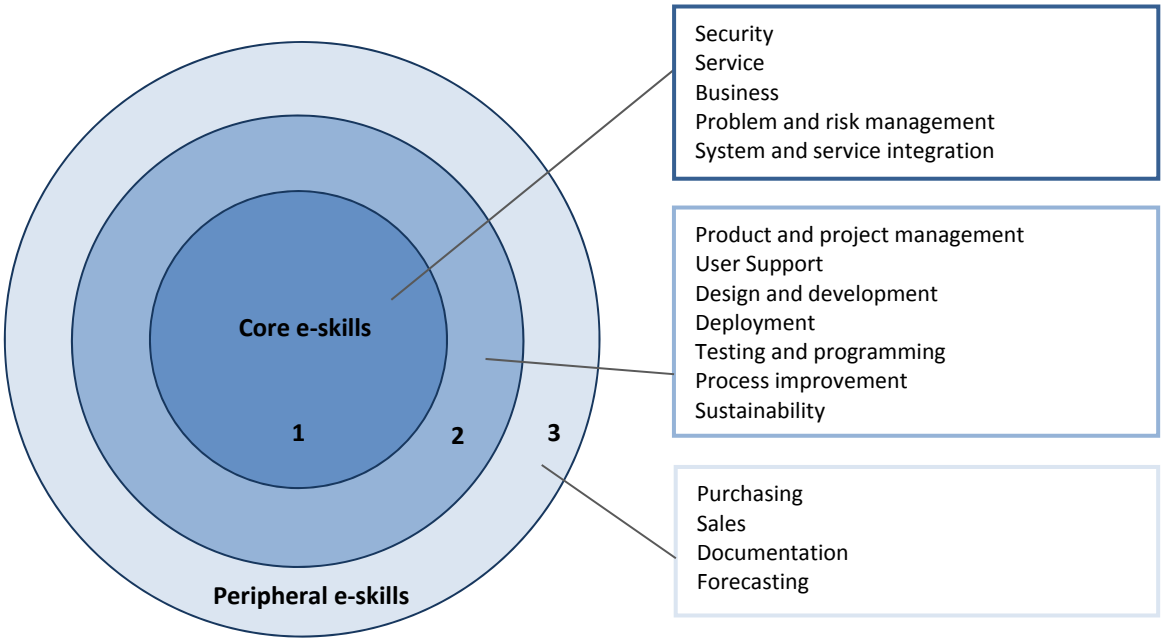
The future role of the ICT practitioner: moving up the value chain

[3] Analysis conducted by DTI among 108,369 Danish SMEs. Even though the segments of companies vary across countries, the analysis provides a proxy for different types of SMEs.

Cloud computing undoubtedly changes the role of the ICT practitioner, but instead of introducing an entirely new set of professional skills, it rearranges the importance of functions and skills already in the practitioner's toolbox.

The figure below groups a number of skill areas according to projected future importance in ICT-using companies when cloud adoption has reached a significant level across European SMEs.

Figure 0-5 Future core and peripheral e-skills



In terms of practitioner functions, the *running* of ICT systems will remain the most important task of the practitioner. However, the *way* systems are run is likely to change significantly. Running ICT systems will not so much be about operating local area networks, providing user support, analysing and repairing PCs or installing, upgrading and maintaining locally installed software. Instead, it will largely be about ensuring a smooth and user-friendly interplay between cloud systems, ensuring stable internet connections as well as effective communication and collaboration with cloud vendors on delivery of service and security. Skills that are related to *enabling* and *managing* ICT are projected to rise dramatically in importance. From being less important today, these functions are believed to become just as important as the traditional core tasks of *planning* and *building* ICT in the near future.

With enabling and managing related functions on the rise, the future ICT practitioner will generally be required to take a step up the value chain and help solve tasks that were traditionally the sole responsibility of the CEO. Although he may not lead the efforts, the practitioner will increasingly be involved in analysing existing systems, detecting demands for new solutions, formulating these into strategies and service level agreements and orchestrating efforts to implement them. Using a skill

terminology, horizontal and business-related skills will generally grow in importance. In terms of professional skills, high-level specialised skills will remain crucial, but crosscutting skills related to management and enabling will be added.

The growing demand for management, business and security skills

Skills likely to experience the highest increase in demand are generally related to strategy development, reading demands, planning of activities as well as integration, and daily management of ICT systems. Skills within the following specific categories are projected to grow most dramatically in importance as SME uptake of cloud computing increases:

- system integration;
- service level management;
- information security strategy development;
- business change management; and
- ICT quality strategy development.

The declining demand for architecting, programming and user support skills

When looking at skills of declining importance, vendors will increasingly take over tasks related to system architecting, programming, testing, and user support as cloud computing finds its way into European SMEs.

The ICT practitioner will instead play a more important role in detecting demand for services, identifying appropriate vendors, solutions, and securing a steady and efficient interplay between cloud systems once they are up and running. Skills related to the following areas are among those believed to experience the most significant drop in importance in the coming years:

- application design;
- user support;
- design and development;
- solution deployment; and
- design architecture.

The reason for this decline in design- and architecture-related skills is that the task of designing systems from scratch will tend to be outsourced to providers wherever cloud computing is implemented. Practitioners will of course still need to detect and describe the demand for ICT systems, but instead of moving to design of specific solutions, they will turn to the cloud for already existing solutions that can be adapted to suit their specific needs

Information security skills at the top of the agenda

In a business environment where new ICT solutions constantly see the light of day, there is growing pressure for developing matching security solutions. Security experts generally agree that security is usually a step behind the development of ICT solutions, resulting in solutions and systems that are unstable and easily exposed to threats.

Digital security has received increased attention in recent years - both at political and company level - but the interviewed experts agree that there is still a substantial need for more focus and more specialised professional skills in this area.

Skills related to ensuring secure ICT systems across European SMEs rank close to the top today and are projected to increase even further in importance to become the far most wanted skills only few years from now.

For the IT practitioner to be sufficiently equipped to secure the data flows of the SME, a very high level of highly specialised skills is in great demand. Although practitioners face a general increase in demand for business-related skills, organisational skills, service-related skills and communication skills across the board, they are of minor importance when it comes to cyber security. Skills related to carrying out the day-to-day management of system security are believed to become the single-most important practitioner competence of all. Skills related to ICT strategising are projected to grow from being in average demand to being in very high demand within few years.

The growing but still not very high importance of green IT skills

The green IT phenomenon seems to have had its heyday 2-4 years ago, and experts generally perceive skills in this area to be of limited importance today.

Although there is still substantial focus on the sustainability agenda in society, European SMEs generally struggle just to survive the financial crisis – and the few SMEs that do embrace green initiatives do not commonly do it through ICT.

However, even though green IT skills are not in particular high demand at present, they are expected to grow somewhat in importance over the coming years. Experts believe that sustainability will become a common phenomenon in ICT operations in the future. This is not likely in the form of separate green initiatives or strategies running in parallel to core ICT operations, but rather as an integrated component in all ICT processes. In terms of skills, no new specialised skills are generally needed to work efficiently with green IT. What is needed is primarily an overarching ability to view ICT from a green perspective.

Innovative SMEs and start ups

Cloud computing can be used both for agility and cost cutting, but it can also be integrated into development activities by innovative companies. One of the key findings from the report’s section on cloud computing in SMEs is that companies focus less on business creation through clouds services and more on cost cutting. The question is how companies can use cloud solutions to create growth and what are the future e-skill requirements? The report presents some of the most forward-thinking, innovative businesses based on cloud solutions.

For entrepreneurs there is now interesting changes in applications and solutions related to software as a service with increasing focus on software-enabled service. Both large established vendors and SMEs are following the trends in connection with service innovation and how software enables service.

ICT transformation and how it is connected to business transformation is one of the areas that start-ups are looking into compared to 1st generation legacy systems. Trends within cloud computing point towards mobile clouds, the social enterprise and new business models, and start-ups are now exploring this field. Another interesting development is how some of the open platforms, e.g. from OpenStack, allow users and developers to build on those platforms.

Above all, for start-ups, ICT needs to be cheap, secure, and easy-to-implement, require little maintenance, and be highly user-friendly. Cloud computing holds a number of advantages in this regard – but only if applied correctly. If a start-up operates in the ICT sector, the most demanded skills are clearly high-level and highly specialised ICT skills within the company's area of operation. If operating outside the ICT sector, entrepreneurs need a basic but broad set of ICT skills in areas such as calendar and planning, text editing, spreadsheet usage, digital communication, and e-business.

In relation to security, start-ups generally rely on off-the-shelf hardware and software and their built-in security solutions. Without being in a position to invest in separate security initiatives, start-ups are, in most instances, forced to trust the security standards applied by suppliers – cloud or non-cloud. Consequently, in terms of skills, entrepreneurs primarily need basic awareness of security issues in ICT, the ability to read and understand security measures offered by ICT providers, and the ability to ensure that security systems are kept updated.

Successful entrepreneurship – more than just a matter of skills

Although important, ICT skills only make up a limited part of the collective competences needed to succeed as a start-up. Equally important are business skills, i.e. business understanding, networking abilities, etc., and a thorough knowledge of available technologies, platforms and security solutions. Last, but not least, successful entrepreneurship, whether inside or outside the ICT sector, always hinges on what experts frequently refer to as "the entrepreneurial mind-set". This was described by one expert as:

"…entrepreneurship is about passion, motivation, knowing the right people, knowing what your budget can support, willingness to take risks and having an understanding of what you can do yourself and what you need help with."

0.3. The provider landscape of courses and certificates

There has been a strong trend among vendors, not-for-profits, and universities towards designing and training courses related to IT skills and cloud computing. To collect best practises and to enrich the study with the views of practitioners and course participants, eight case studies were carried out across the three ICT domains green IT, cyber security and cloud computing. The case studies revealed seven key crosscutting findings.

Vendor neutrality was a contested point

Often industry-led training is criticised for not being vendor neutral fostering the business of a certain company. More than half of the courses we looked at were in fact vendor neutral, but some of the industry-led initiatives go to extremes to deliver

courses based on principles that are applicable across the industry. An example is the Cisco Networking certificate that has gained global recognition in the industry. However, particularly for SMEs, the next phase will be about choosing the right cloud solution and hence courses operating on a vendor neutral basis were very appreciated by SME participants.

Courses lack business aspects

The shift to cloud computing, security or green IT is primarily a business decision. It was striking how technical most of the courses were. None of the case studies cooperated directly with management or with leadership courses and showed a lack of focus on organisational decision-making procedures (business case, business risk management).

The type of certificates matters

All the courses we looked at issue certificates. However, the strength of the certificate varied considerable. Some had become de-facto industry standards and a requirement for certain job families, while others seemed more a "nice to have" certificate. Generally, the accreditation to global standards strengthened the importance of the certificates and this could strengthen green IT courses as well as cloud courses.

Lack of holistic thinking between cloud, security and green IT course providers

Cloud computing and security seems to be well integrated even if the security course ISC2 still treats cloud computing as a marginal issue of relevance to its core target group. The cloud computing courses did not include aspects of green IT, nor did the green IT courses include cloud computing as a module. Participants highlighted that they would welcome better alignment between these certifications.

IT moves fast, formal education and the accredited certificate markets move slow, but industry seems to be filling an important gap by showing local leadership

Unsurprisingly, vendors moved quickly and effectively to satisfy the market, but generally offer only courses attached to their own products, services, and technologies. Education systems, however, do not seem to be working fast enough to meet the current industry demand for IT professionals. The private sector is showing true local leadership by trying to fill the gap and help align the formal educational sector better with the skills needs. The collaboration between IBM Poland and Wroclaw University of Technology is an example of industry working with universities. In Milan, CEFRIEL is an example of a three-way partnership between local businesses, the municipality of Milan, and the technical the University of Milan. Here the university provides a 2-year academic training programme for job starters, who are selected through a very competitive process. This partnership is expected to stimulate the IT industry in the Milan region positively.

A key role for US companies in cloud computing

All case studies highlighted the importance of global networks and in particular strong links to the US R&D communities within vendors but also beyond. For example, to assure the success of its programme, CompTIA joined forces with the key players in the technology industry and many other partners worldwide. These include

CompTIA's three thousand member organisations, the United States Environmental Protection Agency, and the Climate Savers Computing initiative.

The business case behind cloud courses is in building strong collaboration partnerships

The vendor industry operates in partnership with both private and public educational providers. These contracts are generally open to universities, but they are often not found to be competitive. Cisco collaborates with public and private institutions including schools, universities, businesses, non-profits, and government organisations ensuring that the programme content top-quality and that instruction content fits real world needs. More research would need to be undertaken to discover whether this link could be strengthened.

Box 0-1: Case studies undertaken as part of this study

The case studies included government programmes or initiatives, industry-led initiatives, initiatives by education and certified training institutions, partnerships and initiatives launched by individual companies considered industry leaders in their specific ICT domain.

1. Cisco Networking Academy – Security certifications, Global
2. Multipurpose Cloud Computing Centre, Poland
3. Cloud Computing Security Knowledge Course (CCSK), Alexandra Institute, Denmark
4. British Computer Society (BCS) - The Chartered Institute for IT, intermediate certificate in the EU Code of Conduct for Data Centres, UK/Global
5. CompTIA Green IT, Global
6. CEFRIEL, Apprenticeship 'Centralised system for Cloud computing', Italy
7. [(ISC)2®], Systems Security Certified Practitioner (SSCP®), EMEA office, UK
8. Microsoft cloud computing services: Training and Certification, Global

1. Introduction

1.1. Scope

The objective of the study is to analyse the specific e-skill requirements relating to green IT, cyber security and cloud computing with a special focus on competitiveness and innovation and the needs of SMEs and start-ups. Secondly, the study contains identification and promotion of best practices and the formulation of concrete proposals to address the e-skill requirements and recommendations for follow-up actions at EU and national level.

This report presents the final findings of the study in chapters:

- Chapter 0 is the executive summary
- Chapter 1 is the introduction outlining the scope, background and methodology of the study. It also defines key terms and concepts being frequently applied in the report.
- Chapter 2 presents a technological roadmap for the implementation of cloud computing, cyber security and green IT in European SMEs.
- Chapter 3 analyses how cloud computing potentially can promote competitiveness and innovation in SMEs and analyses the impact of ICT functions in the SMEs.
- Chapter 4 discusses how the spread of cloud computing and the increased focus on cyber security and green IT changes the role and skill demands of the European ICT practitioner and entrepreneur.
- Chapter 5 contains eight case studies analysing concepts of education and training provision within the three ICT domains.
- Chapter 6 proposes evidence-based recommendations for policy measures that will help ensure access to and development of critical e-skills in the domains of cloud computing, cyber security and green IT.

1.2. Background

E-skills are crucial for competitiveness, innovation and growth in the ICT sector as well as in related sectors. It is therefore important to ensure that European enterprises have access to an e-skilled workforce as well as ensuring that European ICT practitioners are provided with the right incentives and training opportunities to constantly develop and update their e-skills. Moreover, ensuring that entrepreneurs have the e-skills required to fully exploit the innovation potential of ICT is essential. From a policy perspective, the key challenge is to ensure that European education and training systems are sufficiently prepared to meet the future demand for e-skills in Europe. Further details around the technological and business context of the study will be presented in chapters 2 and 3.

1.3. Methodology

The study is based on desk research and interviews.

The desk research includes academic literature, think tanks, consultancy reports and reports from interest organisations, policy bodies, public institutions, and enterprises.

The list of interviews includes industry, academia, associations and public authorities and a sample of SMEs and entrepreneurs. The interviews were conducted in four rounds. The first round was a short round of exploratory interviews with general ICT experts with the purpose of identifying the most pressing issues related to the overall topics of the study. The second round contained detailed in-depth interviews focused on specific issues i.e. cloud computing, cyber security, green IT, e-skills in SMEs and e-skills for entrepreneurship. The third round of interviews tested specific perspectives and hypotheses and closed a number of gaps in the interviews conducted in round two. The fourth round took place six months after phase three and sought to verify the answers given in the interviews by feeding experts with a short questionnaire. In this questionnaire they were asked to rank specific e-skills related to different practitioner functions according to importance. Comparing this to their original answers enabled a more robust analysis. The full list of respondents is presented in the Annex 2.

1.4. Terms and definitions

This section defines a number of key terms used frequently in the present study. First, the e-skills concept will be defined followed by a short presentation of key concepts related to the three focus-areas; cloud computing, cyber security and green IT. Lastly, the definition of what constitutes an SME and a start-up will be presented.

1.4.1. E-skills

The concept of e-skills refers to a broader categorisation of ICT skills, other skills, knowledge and competences necessary for optimising the use of ICT and working in a knowledge economy context.

The European e-Skills Forum defines three main types of e-skills:

1. ICT practitioner skills (or ICT specialist skills);
2. ICT user skills; and
3. E-business skills.

Table 1.1: e-Skills taxonomy

ICT practitioner skills	The capabilities required for researching, developing, designing, managing, producing, consulting, marketing, selling, integrating, installing, administering, maintaining, supporting, and servicing ICT systems.
ICT user skills	The capabilities required for the effective application of ICT systems and devices by the individual ICT users. User skills cover the utilisation of common software tools and the use of specialised tools supporting business functions within industries other than the ICT industry. At the basic level, they cover "digital literacy".
E-business skills	The capabilities needed to exploit opportunities provided by ICT, notably the internet; to ensure more efficient and effective performance of different types of organisations (private or public); to explore possibilities for new ways of conducting business/administrative and organisational processes; and/or to establish new businesses. E-business skills are strategic and related in particular to innovation management, rather than pure technology management skills, which are part of ICT practitioner skills.

Note: INSEAD (2010) has introduced the concept e-competences referring to an integrated set of technical and managerial capabilities that organisations need to achieve their objectives. E-competences are e-skills with a strong emphasis on inter-personal and business skills.

In order to be as specific as possible, the analysis of e-skill requirements for ICT practitioners and entrepreneurs takes root in the European e-Competence Framework 2.0. This enables a rather specific and operational analysis encompassing a wide span of skills and competences within the area of ICT. The framework will be presented in further detail when turning to the analysis of the changing role and skills requirements facing ICT practitioners in Section 4.

1.4.2. Cloud computing

How to conceive, implement, and manage ICT facilities following cloud computing has become an important issue in recent years in industrial enterprises, public administrations and elsewhere. Whatever the specific points in case there may be, the term cloud computing denotes a phenomenon addressing issues that arise from, and in fact motivate, a significant change in how deployment of ICT is approached in general. This applies to focusing on ICT applications and their applicability as services providing certain functionalities.

Over time, the purpose of ICT applications vs. options to satisfactorily meeting them in terms of deployment turned out to be considerably less special in many cases than always necessitating exclusive investment, ownership, and administrative regimes regarding rigid, one-for-all ICT assets. Instead of owning huge capacities for some use, but most of the time running below peaks, users have become increasingly interested in having scalable and elastic ICT solutions geared at functional demand and related swings as well as ICT infrastructures and software that can be provided or

booked on demand when needed. For this to become a viable business option, there are three service models so far:

1. *Infrastructure as a Service* (IaaS) implies that clouds of (scattered) hardware resources, e.g. computers, storage, networks, can be pooled and inter-operated in such ways that users, after having gained access, may then flexibly deploy a virtual infrastructure for their purposes without having to deal with hardware complexities. However, they also need to adapt it to their own purposes first, e.g., installing software, storing data, etc.

2. *Platform as a Service* (PaaS) means that users may gain access to (virtual) hardware infrastructures and already functional run-time environments where they may then develop, test, or run software (or environments), etc., without needing to deal with the complexities of an operational environment or hardware in cloud.

3. *Software as a Service* (SaaS) means that users that have gained access to the cloud may work flexibly in a virtual environment with on-demand functional software applications with whomever on whatever (non-ICT) projects without needing to engage in related ICT administration.

Apart from the appropriateness of the technical functionalities, choosing between the above service models may boil down to basic economic reasoning in terms of "cost-of-ownership" vs. "operational costs" balances.

Apart from categorising service models, it also makes sense to differentiate between cloud computing schemes with regard to the selected deployment model. To begin with, "private clouds" only provide access to (virtualised) ICT infrastructures managed by a certain organisation to members of and users within this organisation to operate the ICT in question. In this instance, non-exclusive access is usually linked to fees (but not always as is the case with, e.g., registered memberships in open source community projects). By contrast, providers offer "public clouds" to anyone interested in pay-per-use accesses - beyond which no other involvement of the latter would occur. Similar to this "community clouds" provide access to virtualised ICT infrastructures, etc., for a distributed crowd of users. In this instance, however, the users are to some extent involved in running and/or at least financing the cloud and are thus sharing cost and efforts. Finally, "hybrid clouds" could offer and eventually provide access to a combination of private and public cloud spheres tailored to their users' needs. However, operating such a scheme may necessitate more sophisticated business models than with other schemes.

1.4.3. Cyber security

Cyber security is a new way of practicing in confronting risks to be expected from the internet while carrying out professional, business-related operations or pursuing private activities. Regarding the dynamics of potential threats and the complexity entailed by exposing the public operating on the world-wide-web, it appears to be important not only to focus on universal tools to feature all-encompassing functionalities and technical security. It is also important to focus on how to recognise

and implement the diverse security measures that ICT users can and need to adapt to specific requirements.

Providing cyber security should be a service to ICT users, such as producers of commercial goods and/or services and public and private administrations to protect their operations and not obstructing for the sake of one's own convenience. In other words, the pragmatic challenge to accounting for cyber security is not to obstruct or strangulate operative business and organisational development, but to enable businesses where innovative steps may inevitably imply and entail taking certain risks to progress, e.g. in areas such as pursuing open innovation, leveraging social media opportunities, and other forms of organisational and value proposition-related change. Another related trade-off concerns whether strictly limited information exchange via the internet should compromise relevant operations. For example, social media are increasing in importance, not only for private users but also for business development. Nevertheless, there is disagreement and sometimes confusion in many organisations about the chances and risks of leveraging social media opportunities.

1.4.4. Green IT

Nowadays, issues concerning green IT (or ICT) may follow approaches of related notions in a narrower and a wider sense. In a narrower sense, ICT is being focused on "turning green", which may potentially relate to new pieces or systems of hardware and software to inherently feature and enable a more favourable resource and energy utilisation along product lifecycles than is feasible via functionally comparable older (or traditional) equipment – all that usually referred to as "asset aspects of ICT". It may also relate to new approaches and actual practices of administering the hardware and software. This is usually referred to as the "service" aspect of ICT. "Green ICT" has become shorthand for both of those aspects (Socitm, 2009).

1.4.5. SMEs

The current definition of what constitutes a micro, small and medium sized enterprise (SME) was adopted by the European Commission in 2003.[4] It defines an SME as a company employing fewer than 250 persons while at the same time having either an annual turnover of less than € 50 million and/or an annual balance sheet total not exceeding € 43 million. The table below illustrates the requirements for each of the three SME sub-categories:

Table 1.2: European Commission definition of micro-, small- and medium sized enterprises

Enterprise category	Headcount	Turnover	Or	Balance sheet total
medium sized	< 250	≤ € 50 million		≤ € 43 million
Small	< 50	≤ € 10 million		≤ € 10 million
Micro	< 10	≤ € 2 million		≤ € 2 million

Source: European Commission – Enterprise and Industry website

Recommendation 2003/361/EC

The 23 million SMEs currently found in the EU make up an estimated 99 pct. of the total number of European companies. Of these, 92 pct. are micro-companies employing fewer than 10 persons.

The European SMEs currently provide around 90 million jobs. Promoting their competitiveness and innovation levels through efficient and secure use of e-solutions thus has a substantial impact on the European economy as a whole.

Recent Eurostat data shows that a clear majority (84 pct.) of European SMEs have fixed broadband access. Bearing in mind that some enterprises may exclusively use mobile broadband connections and that some enterprises may use PCs without being connected to the internet, the number of ICT-using SMEs is likely to be even higher. ICT thus plays an integrated role in the everyday operations of close to all of the European SMEs. However, whereas most European SMEs use ICT, they primarily appear to use isolated and locally based tools such as text editing, spread sheets, calendars, and e-mail. When it comes to deeper and more integrated business operations, i.e. budgeting, invoicing, purchase and sales, customer relations, etc., ICT clearly plays a more limited role.

Some experts believe this to stem from a general lack of sufficient e-skills among European SMEs. This, they state, prevents them from fully exploiting the advantages of ICT, which in turn makes them less competitive than what they could have been if equipped with the right set of skills. Most people have learned how to use the basic office applications, but when it comes to solutions that are more complex and thinking about ICT as an integrated part of one's business operations, knowledge and skills often stops.

1.4.6. Start-ups

There is currently little agreement on what constitutes a start-up. Some definitions include "a company with a limited operating history" (Wikipedia), "an organisation formed to search for a repeatable and scalable business model" (Blank, 2010) [5] and "a fledgling business enterprise" (Merriam-Webster). Although a common definition remains to be accepted, three criteria seem to emerge repeatedly in related literature:

1. a time-criterion (has been on the market for a short period of time);
2. a staff-number criterion (employs a relatively low number of people); and
3. a cultural criterion (in search for an identity, exploratory and experimenting business approach).

Where the exact limit in each criterion should go, and whether all, two or just one of the criteria should be met simultaneously to qualify as a start-up is an on-going discussion with no clear answers. What is left is that a start-up can be characterised as a fairly young and fairly small company that has not yet fully found its niche.

[5] See: http://steveblank.com/2010/01/25/whats-a-startup-first-principles/

In related literature, the concepts “start-up” and “entrepreneur” are often used interchangeably. In this study, however, “entrepreneur” will refer to the person behind a new business opportunity whereas “start-up” will refer to the company he or she has set up to realise this. The term “start-up” will therefore only be used if the entrepreneurial activities have materialised into an actual enterprise.

Box 1-1: The European Commission’s definition of entrepreneurship

> “Entrepreneurship refers to an individual's ability to turn ideas into action. It includes creativity, sense of initiative, innovation and risk acceptance, as well as the ability to plan and manage projects in order to achieve objectives. In a broad sense, entrepreneurship should be considered as a mind-set that can be usefully applied in all working activities and in life. Therefore, entrepreneurship is a key competence for all.”

2. Technology Roadmap – Adoption Curve

2.1. High Level for *aaS

Cloud Computing is commonly expected to play a very important role in the ICT domain over the next 10 years, or even more. Over the last years its importance has already risen to a state where it often plays a decisive role in the planning of projects needing to be scalable without losing efficiency or reliability.

The reasons for such a development are diverse. More and more companies look for possibilities to outsource parts of their IT infrastructure or IT services without risking a loss in quality or agility. Some businesses temporarily require additional (IT) capacities for particular needs, without the need to build up additional infrastructure of their own. Cloud computing services (or cloud services) provide companies with an environment which can be used for experimental reasons thus avoiding disruptions within their own spheres. Even more cloud services can help to maintain business continuity and can also contribute to disaster recovery. They can also be utilised as a kind of neutral territory for joint enterprise operations allowing businesses to work on common ground without opening up their core infrastructure to others too much. Especially in small and medium sized enterprises cloud computing allows a low-cost entry into ICT provision based on the modular adaptability and combination of cloud services according to the individual requirements.

2.1.1. Basic Characteristics of Cloud Computing

Generally, the term “cloud” describes the aggregation of servers and low-end computers for the storage hosting and processing of programmes and data. The key factor of the cloud is that it is accessible via the internet from anywhere in the world. Through cloud computing people or companies can access various services (storage capacities, computing power and software) over the internet in a very cost-efficient way depending on their individual demand.

Cloud computing has a few characteristics that differentiate it from traditional hosting:

- It is depending on the demand, thus pricing models are flexible.
- It is adaptable, flexible or even modular, i.e. users can get exactly the needed level of services at any given time.
- It provides a certain level of reliability if multiple redundant services are used.
- It is scalable and elastic due to dynamic provisioning of resources near real-time.
- It allows a continuous performance monitoring.
- It can improve security due to the centralisation of data and the focus of security resources.
- It is usually completely managed by the provider.
- It provides enough computing power to run high-level virtualisation applications as well as distributed computing tasks.
- It is programmable and allows the automated distribution of computing power and data across the cloud whereby the risk of data loss is diminished.

- It is comparatively easy to maintain since no applications need to be installed on the user's computers (client-side).

Cloud computing is broadly divided into three categories which can be seen as service models, namely Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). In the following these three types will be explained in more detail.

Infrastructure as a Service (IaaS)

IaaS provides computer infrastructure as a service, which is usually a virtual server instance or even a platform virtualisation environment including storage capacities and networking. Instead of investing in servers, software, data centre space or network equipment by themselves, companies purchase such resources as a full service pack from the provider. Suppliers typically bill such services on a utility computing basis; the amount of resources consumed (and therefore the cost) will typically reflect the level of activity. Examples of infrastructural cloud services are Amazon S3, SQL Azure.

Platform as a Service (PaaS)

"Platform as a Service" (PaaS) provides a computing platform as a service utilising a set of software and product development tools which are hosted on the vendor's infrastructure. PaaS facilitates the development and deployment of applications from the customer without the cost and complexity of purchasing and running the necessary hardware and software layers. PaaS providers usually use APIs, website portals or gateway software which is installed on the client's computers. Examples of platform services from the cloud are forbes.com, the Google App Engine as well as the Windows Azure platform.

Software as a Service (SaaS)

"Software as a Service" (SaaS) runs software applications as a service over the internet. Users will not need to install and run the applications on the customer's own computers (client-side) which is a big advantage because maintenance and support will thus be simplified. The vendor runs and maintains the hardware infrastructure, the software product completely on his side and usually interacts with the customer through a front-end Web portal. There is a broad range of services, from Web-based e-mail to inventory control and database processing. Examples of cloud software services are Google Docs, Salesforce CRM and SAP Business by Design.

2.1.2. Future Developments in Cloud Computing

With an increasing use of cloud computing business will have to face a number of obvious changes:

- increasing business responsiveness to market demands and problem solutions;
- accelerating the creation of new services via rapid prototyping capabilities;
- reducing acquisition complexity via service oriented approach;
- enabling a more efficient usage of IT resources via sharing and higher system utilisation;

- reducing energy consumption;
- improving the handling with new and emerging workloads;
- scaling to extreme workloads quickly and easily;
- simplifying IT management;
- providing platforms for collaboration and innovation easily; and
- cultivating skills for next generation workforce.

It is quite obvious that cloud computing in its entirety is a disruptive technology that will change how IT does business and how business uses IT. There are a couple of disruptive effects that cloud computing will have in a variety of dimensions. In the following these effects will be portrayed in brief.

Firstly, cloud computing will influence the **organisation of human resources and staff management**. Roles and responsibilities will have to be brought into alignment with the changed business processes to meet the requirements of product or service delivery. The staff will have to be specifically trained to manage and fully utilise the potential of the cloud. Additionally, the business might need to undergo some reorganisation to adopt a more extensive service focus. Success metrics might also need to be updated and brought into alignment with the new requirements and process stages of the changed business operations. Through all the changes it is also recommendable that companies establish a knowledge management system thus enabling knowledge transfer as well as knowledge conservation.

Secondly, cloud computing will have major effects on companies' **business processes**. In project planning, and especially in capacity planning, the focus will shift from an infrastructure and maintenance point of view to a service point of view. Computing resource procurement and the development and management of service levels will be one of the key changes. Business processes will need to adapt to certain technologies and applications will need to be prioritised. A more extensive end user support will be another challenge and key factor to a sustainable success.

Thirdly, the turn to cloud computing will result in major changes on the **technology** side of businesses. It holds certain requirements concerning the computing architecture so that its potential can be fully utilised, such as the rethinking of data management strategies, privacy and security concepts, interoperability standards, programming models and API's, integration technologies (since EAI, ETL and EII will not be sufficient in the case of cloud computing for several reasons), as well as resource tools for a real-time or near real-time monitoring, controlling and auditing. Furthermore, besides the adaption of the system's management strategy it will be a necessary task for businesses to develop detailed strategies regarding the handling of data and identity management as well as data security. Eventually, all companies will also need to find reliable ways for the evaluation of cloud computing vendors and the implementation of their products into their own business processes. These topics will be elaborated further in the following section 4.2 with a deeper look into the cloud computing adoption process of SMEs.

2.2. Adoption of Cloud Computing From a Technology Perspective

Cloud computing in big enterprises has often been leveraged in a hybrid kind as a mixture of public and private clouds. IT managers have mostly realised that it is an opportunity to achieve more services with less investment in own infrastructures, to better cope with internal (management) and external (market) demands without the need to acquire resources that can hardly be seen as sustainable in the long run. Cloud computing has widely become a reliable way to deal with variable workloads and to delegate services and utilities. It has become a feasible alternative to IT outsourcing. However, IT departments in big companies are currently working more and more to establish a private cloud which is able to securely interact with public clouds to exchange with data and services in an increasingly transparent way!

As it already mentioned above, the leveraging of cloud computing in small and medium enterprises has happened because SMEs have limited capacities in nearly all business areas (limited IT budgets, restricted infrastructures and limited workforces so that infrastructure and architectures IT specialists are often lacking). That is why cloud computing holds some major advantages for SMEs and finds convinced supporters among them as Gartner's latest study on cloud computing has shown. However, it is still quite often the case that adoption of new IT technologies is at a low level, hence resulting in inefficiencies that also quite often negatively affect the productivity level of the whole company and thus its competitiveness in the market(s). With cloud computing, SMEs are allowed to have complex and sophisticated tools at hand without the hardly manageable task of acquiring and managing a complicated technological infrastructure. Indeed, the difficulty is that there is hardly a golden way into cloud computing. On the contrary, there are many individual ways and with them come many individual technical and regulatory problems that need to be taken care of. In the following sections, a number of IT transformations as well as business process changes will be outlined that seem to be necessary to push forward the adoption of cloud computing technologies in SMEs within predictable and reliable lines.

2.2.1. Cloud Computing Framework and Technology Perspective

To fully utilise cloud computing technologies and cloud services, the IT in small and medium enterprises need to be transformed to meet the requirements of a cloud computing ecosystem. To pave the way to the adoption of cloud computing, SMEs need to consider the following points:

Rationalise infrastructure & applications

As a very basic step companies need to look at their own IT infrastructure as well as their operational applications and try to identify redundant, outdated, or underperforming components. The goal of such an examination is to get rid of error sources, avoid unnecessary system loads, consolidate computing power and servers and thus drastically reduce the complexity of those IT infrastructures that need to be maintained and managed by the company itself.

Define the cloud architecture

Coming from their own architectures the companies need to create a cloud architecture, i.e. the architecture of the software systems that are involved in the delivery of cloud computing. Usually this comprises not only single components but

also multiple cloud components communicating with each other. Businesses can define their own cloud architectures by leveraging e.g. Service Oriented Architectures (SOA), a piece of software architecture for creating business processes that can be packaged and used as services. Furthermore, enterprises can define their cloud architecture on the infrastructural side, e.g. by introducing utility computing[6], and the enterprise service bus (ESB)[7] for a deeper integration with appropriate standards, governance, and reference architectures. It is certainly advisable to give extended thought to the cloud computing reference architecture describing key components (actors, interfaces, data artefacts and profiles) and the interrelationships among these. In the following, we elaborate further on the single components of the reference architecture since these are extremely important to define:

- There are usually three prime actors:
  - *The cloud service provider*, who makes services of any kind and complexity available to consumers at an agreed service level and costs
  - *The cloud service consumer* (either an organisation or individuals), who contracts for services with the cloud service provider and then use those services
  - *The cloud service developer*, who designs and implements the components of a service.

- A company needs to define functional interfaces (endpoints that accept and respond to messages, e.g. API's) through which developers and consumers interact with providers to request, deploy, manage and use services.

- The data exchanged over these functional interfaces, the data artefacts, also need to be described in detail regarding their semantic content and format (e.g. XML). Furthermore, data artefact types usually also contain information about service requests, different service level-agreements (SLAs) or further contracts, offerings and service templates.

- Profiles at last can be conceived as specialisations or extensions of the interfaces and artefacts. They are used to address certain contexts and "…simplify the interactions and the potentially complex definitions and negotiation needed to request, manage, and use services."[8] Examples of profiles would be a security manager or a contract billing administrator within a company who need a special view into the provider interface.

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[6] Utility computing is one of several IT cost reduction strategies. It involves a consumption-based billing of IT services. In this case, the service provider charges customers in accordance with the number of the services rendered.

[7] The enterprise service bus is an abstraction layer on top of an Enterprise Messaging System. It is a fundamental approach to an integration architecture that goes beyond the scope of the enterprise application integration (EAI). Such an EBS architecture is service-oriented and is used for the communication between various back-end systems and business services within a company.

[8] DMTF. Interoperable Clouds White Paper. p17.

Build cost profiles for each application

Every application or service or product has a certain cost profile to it regarding the costs of its support, updating, and operation. Before adopting integration cloud computing services, an enterprise needs to identify those costs and aggregate them to a certain cost profile for each individual application which can be broken down to a user basis. Since one of the major characteristics of cloud computing is invoicing based on the amount of services rendered by the provider to its customers, it is important to be able to calculate application costs on a per-user basis.

Identify and assess *aaS service models and alternatives

As mentioned before, there are several service models for cloud computing technologies and cloud services. With the given analysis of the company's infrastructure and application system (first point in this chapter), enterprises need to identify those services that they wish to transfer to the cloud either due to reasons of economic efficiency, reliability, scalability or flexibility of services. The different service models of *aaS (comprising BPaaS, SaaS, PaaS and IaaS) offer various opportunities. However, they also differ in complexity, requirements and necessary preparations. The following list describes the different *aaS service models as points of departure for the adoption of cloud computing regarding their driving factors, requirements and challenges:

<u>SaaS for external Services</u>

- Driving factors:
  - By utilising SaaS for external services companies can quickly gain new capabilities which extend their service portfolio.
  - Use of SaaS can immediately reduce up-front costs and also holds the potential for the reduction of lifetime costs.
  - Use of SaaS allows companies to eliminate licensing risks and get rid of version compatibility struggles since the software is managed and maintained by the service provider.
  - Use of SaaS for external services allows companies to select the best solutions for their services which include already well defined integration methods (EDI) and thus reduce the efforts to establish SaaS.

- Requirements:
  - Besides strategic considerations and the creation of data interfaces for the exchange of data, there are no technological requirements necessary in order to establish SaaS for external services.

- Challenges:
  - Governance is a big challenge in the establishment of SaaS. It comprises all components (people, processes, and information technology) required to create consistent and proper handling of data across the business enterprise. Governance is linked to certain goals at nearly all levels of the enterprise, such as increasing the consistency and the confidence in decision making, decreasing the risk of regulatory fines, improving data security, maximising the income generation potential of data, designating

accountability for information quality, establishing process performance baselines to enable improvement efforts.
    - The given security models need to be revised and extended including the clarifications of data protection, data privacy and ownership of the data in the business relationship to the 3rd party (the provider).
    - Due to a business relationship with a 3rd party (the provider), the creation of service level agreements (SLA) is needed. The SLA usually records formal definitions about services, priorities, responsibilities, guarantees, and warranties, defining a level of service for each of these service areas. It also specifies the levels of, for instance, availability, performance, operation, or other attributes of the service, such as billing.
    - While a certain service is rendered by the vendor (cloud service provider) directly to the customers of a company, the enterprise needs to make sure that the end user support is integrated at all levels of the service and has full rights to view all stages of the process.

SaaS for internal Services

- Driving factors:
    - Agility is one of the major driving factors for using SaaS internally. Since not every department in a company uses the same applications, SaaS offers a way to utilise the proper software instruments needed by single departments or working groups without the need to buy expensive licenses for the whole company. Furthermore, SaaS offers a way to quickly and easily adapt to changing demands regarding user numbers.
    - Internal SaaS maximises the reuse of data within the boundaries of a company, also by utilising SOA approaches. Multiple people can use services at the same time. Therefore, a consistent deployment methodology guarantees that each single service does not have to be treated individually. With the reuse of data its redundancy is also minimised, processing power and time is saved, necessary storage capacity is decreased and the complexity is partly reduced.

- Requirements:
    - In order to use SaaS internally, IaaS must have been established internally before. Thus the company is able to fully control the confidentiality and integrity of data stored and data in transit.
    - When using SaaS for internal services, companies need to virtualise their applications before they can be integrated into the virtual server or platform environment.

- Challenges
    - When SaaS is used for the provision of internal services, companies have to develop monitoring tools and interfaces (dashboards, etc.) for the application and resource management. Usually those tools are part of the service when SaaS is used for external services, then those tools are provided by the cloud computing vendor.

IaaS for external Services

- Driving factors:
  - The main advantages for the use of IaaS for external services are its possibilities regarding adaptability and scalability of storage and computing power. When internal storage and computing resources are overflown then external (IaaS) resources can be allocated ("cloud bursting") on demand.
  - Thus, the full utilisation of IaaS also holds the potential for companies to develop new services which can be even more computer intensive. Thereby companies are able to extend their own service portfolio.

- Requirements:
  - Before being fully operational, IaaS companies need to adapt and transfer their own applications, data and processes to the cloud infrastructure. Usually it requires a detailed scheduled process to move individual services or process jobs to the cloud.
  - At the same time companies to need to consider their own connectivity and infrastructure gateways regarding a sufficient quality of connection power and, e.g., sufficient internet bandwidth.

- Challenges:
  - The most important challenge when using a 3rd party vendor for cloud services such as IaaS is to scrutinize the security features of the provider as well as undertake appropriate security measures for oneself. Security issues are covered in more detail in section 4.3.

IaaS for internal Services

- Driving factors
  - The main advantages of internal use of IaaS are again the agility and the flexible adaptability of services to changing demands in storage capacities and traffic loads. Moreover, the internal use of IaaS may potentially maximise economic and ecologic efficiency and the return on assets (which shows how profitable the assets of a company are in generating revenue) since the investments in hardware decreases and the efficiency of services increases.

- Requirements:
  - To fully operate internal use of IaaS, companies need to push forward the virtualisation of servers.
  - At the same time, they need to establish a management process which allows for automated infrastructure provisioning and organisation. This needs to be part of an integrated systems management suite comprising monitoring functions and management control mechanisms.
  - When changing to virtualised infrastructures, companies need to agree on adapted service level agreements (SLA) that strictly define the modes of operation and specify the levels of availability, performance, serviceability and billing.

- Challenges
    - When businesses decide to use IaaS for internal services they need to consider classifying applications silos that define which application runs on which instance so that no conflicts arise during operation independently of the degree of scaling.

PaaS

- Driving factors:
    - With the use of PaaS (a computing platform as a service utilising a set of software and product development tools that are hosted on the vendor's infrastructure) companies would be able to develop and deploy applications without the cost and complexity of purchasing and running the necessary hardware and software layers. Such an external development environment – which is accessed via APIs, website portals or gateway software – maximises the cost efficiency in connection with hardware and software maintenance and deployment waves.

- Requirements:
    - In order to fully utilise PaaS, companies need to acquire a thorough understanding of SaaS applications and data models.

- Challenges:
    - The integration of data, applications and roles of back-end systems are one of the challenges that businesses face when adapting to the use of PaaS.
    - Additionally, they need to ensure the privacy and security (confidentiality and integrity) of all data stored and in transit. Moreover, they need to think about and regulate ownership issues for data sets and developments.
    - When changing to virtualised platform environments, companies need to develop adequate service level agreements (SLA) that define all modes of operation between the provider and the customer.

If these service models are not available companies should at least target alternative utilising service-oriented architectures (SOA). This architecture provides a modular approach to processes and systems and links them via networks (e.g. the internet). Such a flexible, adaptable IT architecture also supports distributed data processing. Since all the applications are integrated into the (SOA) architecture, business leaders would also be able to be quickly informed about current events and processes. On this basis, they can operate in nearly real-time and react quickly and flexibly to deviations (e.g. variations in production or quality control). The service-oriented architecture functions can be created as services and then be shared among various applications, which can access these services through a service-oriented middleware infrastructure.

Build new applications on a SOA foundation

With the full utilisation of cloud computing technologies and services as the prime goal, companies need to bear in mind that all new applications, especially those requiring significant development processes, should be designed on a SOA foundation

with particular focus on the virtualisation of these applications and their operation in the cloud. Service-oriented architectures are a certain way to create applications, whereas cloud computing refers particularly to the infrastructure as well as the delivery model for those applications. It is very important to take into account at an early stage interfaces, data formats and specifications as well as data models within the business processes.

Create cloud enablement roadmap for retained applications

Many applications undergo various stages in their development and some of them will not be released and rolled out. With the adoption of cloud computing it might be important for companies to take another a look at the applications and redefine a development roadmap that migrates the retained applications to a cloud model through outsourcing (SaaS), replacement (SaaS or SOA), or further development (SOA).

2.2.2. Challenges in the adoption process

Today, there is a lot of movement in the cloud computing scene and a lot of different players offer similar but also different solutions. However, "…there is no full scale middleware existent which commonly addresses all cloud capabilities"[9], as the Software & Service Architectures, Infrastructures and Engineering Unit of the Commission of the European Communities (Information Society & Media Directorate-General) states in their 2010 report on the future of cloud computing. The report goes on:

> *What is more, not all capabilities can as yet be fulfilled to the necessary extend, even though an essential basis has been provided from both commercial and academic side. The current set of capabilities fulfils the requirements to realise simple cloud systems (as was to be expected given their availability on the market). The particular issue of interest thereby is in how far the available support fulfils the expectations towards cloud systems in their various appearances and use cases…*[10]

The report clearly identifies gaps on the technical side as well as on the non-technical side. These gaps need to be addressed for further investigation to pave the way for a broad adoption of cloud computing. The identified technical gaps relate to a number of non-excluding aspects that will be described in the following:

Manageability and self

Cloud-based systems focus heavily on intelligent management of resources that allow a guarantee of certain availability of services through their replication and distribution to customers. The management systems are currently mostly only allowing for limited features that usually target elasticity and availability of services and thereby lack other features of interest such as resource usage relating to energy efficiency or limited resource availability. A general approach to management features is still missing, most of them are very use-case specific. There are a couple of important criterions that need to be established:

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[9] European Commission (2010). The Future of Cloud Computing. p 28.

[10] Ibid.

- A general performance management of cloud systems needs to be designed regarding e.g. the managing up-scaling processes (e.g. when bandwidth exceeds a threshold) as well as down-scaling processes of resource usage.
- A reliable self-detection system needs to be integrated, which is able to discover failures and detect resource-shortage or free loads within the system and can initiate suitable actions accordingly.
- In distributed computing systems (thus distributed management) interoperability across the different resource environments needs to be established as well as the capability to quickly adapt to changes within the environment, regardless of whether these changes apply to the customers' side or on the technological side (e.g. relevant libraries in SaaS and IaaS or operable engines in PaaS).

Data management, federation and interoperability

With the constantly growing amount of decentralised data, which are produced, transferred and processed on the web as well as on non-public networks, we have reached a state where the available data are at the verge of exceeding the growth of storage capacities and bandwidth availability. As the European Commission states in its report:

> *As data may be shared between tenants partially or completely, i.e. either because the whole database is replicated or indeed a subset is subject to concurrent access (such as state information), maintaining consistency over a potentially unlimited number of data instances becomes more and more important and difficult.*[11]

The huge challenge is to manage the data and its constant availability (even when scaling-up the demand and access) as well as its consistency and security regarding storage, exchange and ownership. More adequate control mechanisms need to be developed that allow for extensive monitoring and real-time management of data which is widely distributed over various infrastructures provided by different vendors. Such governance mechanisms and the management solutions should allow for full control regarding data location and all aspects relating to elasticity such as connectivity, availability and scalability (which becomes extremely important with regard to the establishment of commercial quality of service requirements and fulfilments).

Another big challenge is to guarantee seamless use of data and applications so that they cannot only communicate with each other, but interoperate. Data portability and interoperability have become a core issue. The EU has even put "…interoperability at the heart of its Digital Agenda, recognising that the interoperability of services and data are central to promote user acceptance, increased value and choice."[12] Development of standards is a major topic for cloud computing providers as well as the responsible policymakers:

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[11] European Commission (2010). The Future of Cloud Computing. p 29.

[12] Business Software Alliance BSA (2010). Cloud Computing. Policy Agenda for Europe. p 4.

> *Importantly, European initiatives relevant to technology standardisation, including the Commission's on-going reform of the IT Standardisation Framework, should reflect these principles, endorsing technology neutrality and avoiding mandated standards or preferences that will frustrate, rather than promote, interoperability among cloud services and solutions.*[13]

Currently, the IEEE also works on developing interoperability standards as well as a cloud portability roadmap (e.g. utilising the DTMF's OVF import standard)[14] by breaking down single vendor formats and recombining the most effective ways.

In data management one of the most critical issues, especially when using a 3rd party vendor for cloud services, is to establish a working security systems that guarantees the security (integrity) as well as the privacy (confidentiality) of the data which is stored, transferred and processed. Security features of the provider as well as appropriate security measures undertaken by the customers play an equally important role. Security issues will be covered in more detail in section 4.3.

Virtualisation, elasticity and adaptability

Virtualisation and cloud computing are closely connected. Often cloud computing is seen as a pool of virtualised resources of different kinds. Virtualisation refers to the creation of a virtual instance of something "real" usually with the goal to centralise administrative tasks, maximising economic (cost) and ecologic (energy) efficiency and improving availability and power of services through scalability of workloads. There are different types of virtualisation:

- hardware virtualisation;
- desktop or operating system virtualisation;
- software virtualisation;
- memory virtualisation;
- storage virtualisation;
- data virtualisation; and
- network virtualisation.

However, virtualisation can only be considered a first step for cloud computing which is the more complex paradigm. As Brad Anderson, Corporate VP at Microsoft and Head of Management and Security Division, stated: "Let's be clear: Virtualisation is

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[13] Ibid.

[14] The DTMF (Distributed Management Task Force, Inc.) developed the "..Open Virtualisation Format (OVF) [as] a packaging standard designed to address the portability and deployment of virtual appliances. OVF enables simplified and error-free deployment of virtual appliances across multiple virtualisation platforms." Taken from the DTMF. Source: http://dmtf.org/standards/ovf (2011-12-23).

not cloud computing. It is a step on the journey, but it is not the destination."[15] Anderson continues:

> *We are entering a post-virtualisation era that builds on the investments our customers have been making and are continuing to make…This new era of cloud computing brings new benefits - like the agility to quickly deploy solutions without having to worry about hardware, economics of scale that drive down total cost of ownership, and the ability to focus on applications that drive business value - instead of the underlying technology.*[16]

With cloud computing allowing to rapidly adapt to changing workloads by the instant provisioning of virtual machines or physical machines, a cloud computing platform supports highly scalable programming models and highly flexible workloads. Thereby, it enables companies to participate a) on their cost-side from economies of scale, b) from the speed and flexibility of the deployment of virtual instances and c) from the agility of resource (re)allocation.

Integration technologies

Integration is a topic that is likely to become a key roadblock to the full exploitation of cloud computing technology and services. The first-generation integration technology has existed for many years and was of course not been designed for cloud computing. With a cloud computing environment (or rather environments), the solutions may probably need to address certain product deficits, e.g. the ability to support and handle numerous disparately located integrations, or the provision of a flexible "write-once, deploy-anywhere" model. Existing technologies such as Enterprise Application Integration (EAI), Extraction, Transformation and Loading (ETL), and Enterprise Information Integration (EII) need to be changed to meet the requirements that come along with cloud computing.[17] The above-mentioned integration technologies will unfortunately not be applicable to cloud computing for several reasons:

- With the EAI framework an organisation has been able to centralise and optimise the integration of applications across the enterprise. EAI usually uses some kind of event-driven push technology. However, EAI technologies have been developed to handle complex on-premise integration tasks. With the widely distributed computing that comes along with cloud services EAI might turn out to be rather ineffective since it has a lengthy ramp-up and deployment

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[15] Taken from the article Microsoft: 'Virtualisation Is Not Cloud Computing' on readwriteweb.com. Source: https://www.readwriteweb.com/cloud/2011/08/microsoft-virtualisation-is-no.php

[16] Ibid.

[17] Of course custom coding should not be forgotten since it has always been another way to enable integration of systems and applications across the enterprise. But even custom coding is not suitable for cloud computing since it totally contradicts the efficiency issues that cloud computing addresses. The creation of custom code must always be judged against the programming time (each custom integration essentially starts from scratch), the maintenance burden for the code, and the error-proneness of the code and the lack of systematic and consistent management capabilities.

cycle. Additionally the hardware, the operating system, the used software at different stages would have to be considered.

- On the other hand, the ETL framework does not target applications but data such as data warehouses, data marts or data stores. The framework assimilates data, through e.g. batch processing, from the operational environment of a company (which usually consists of heterogeneous technologies) into consistent data which is then suitable for consumption by individual decision support processes. With cloud computing, ETL's focus on batch operation as well as its limited real-time management capabilities and deployment options cannot be aligned to cloud computing strategies. ETL lacks a stringent and coherent workflow as well as the ability to recognise events and act accordingly.
- The third integration technology, the EII framework, is used for real-time integration of data which is usually disparate and originates from multiple sources inside or even outside an enterprise. EII aims to provide a universal data access layer, by using pull technology or on-demand capabilities. EII is usually used by a person via a dashboard or a report.

2.3. Risks and cyber Security

The overall adoption and full utilisation of cloud computing technologies and cloud services by businesses as well as by individual consumers depends heavily on cloud providers' overall attitude towards security measures and each individual cloud service's security level implementations. Cloud vendors need to provide transparent information about their security practices to enable customers to make informed decisions. However, cloud computing itself also brings along some benefits for the network and information security. The European Network and Information Security Agency (ENISA) published an extensive report about the benefits, risks and recommendations for the information security in cloud computing. Even though this paper was published in 2009, it still offers a thorough view on IT and information security and most of the points made neither lost their importance nor their validity since. As a very core insight of the paper the authors also conclude that:

> *…the cloud's economies of scale and flexibility are both a friend and a foe from a security point of view. The massive concentrations of resources and data present a more attractive target to attackers, but cloud-based defences can be more robust, scalable and cost- effective.*[18]

No matter which role we look at within cloud computing – whether it is a provider or a user, whether it is a government or SMEs – there are risks and benefits that come along with cloud computing regarding network and information security. These issues need to be considered by anyone who wants to use and fully utilise cloud computing services. The risks as well as the benefits exist at different levels – they are of legal, regulatory, political, technical or commercial nature. In this part of the paper it is most convenient to take a look at the technical implications although they cannot be fully separated from the other dimensions, e.g. the regulatory framework concerning information policies.

[18] ENISA (2009) Cloud Computing. Benefits, risks and recommendations for information security. p 4.

2.3.1. Security risks of cloud computing

It is important to note that the level of risks and their threat potential vary significantly with the user/company and especially with the kind of cloud service and architecture. Furthermore, it is important to recognise that all risks need to be considered in relation to the business context around it (commercialisation, business opportunities, etc.) and evaluated against the cost benefit that could be obtained from the use of cloud services. Additionally, it is advisable to always compare the risks that arise while working on cloud infrastructures and utilising cloud services with those which would exist or arise with maintaining traditional infrastructures and working with established systems. In the following, the major risks will be briefly described.[19]

Infrastructure-related risks

With cloud computing usually being on-demand services with varying access system loads, the underlying infrastructure (servers, virtual instances and broadband connections) bear high potential risks. The core feature of cloud computing is the constant availability, flexible adaptability and scalability of servers in relation to (rapidly) changing access demands, so cloud providers need to maintain a proper allocation of resources at all times to keep up these features. Resources are usually allocated by utilising statistical estimation (or rather projection). Thus, false modelling of the resource allocation could, on the one hand, lead to complete *service unavailability* (e.g. CPU or memory overloads) or, on the other hand, to excess *resources*. Both scenarios would lead to "…economic and reputational losses due to failure to meet customer demand"[20] and would also decrease profitability. In the worst case scenario, service unavailability would result in compromised access control to the system, putting data privacy and data integrity at risk. The unavailability of services could also be caused – as the recent history has shown in a few instances – by a DDoS attack.[21]

Another class of failures relates to the multi-tenancy and sharing characteristics of cloud computing, where the infrastructures of a provider of storage capacities, networking, and computing power are shared by multiple users most of the time. Depending on the cloud model in operation this may lead to *risks of failure of mechanisms which separate these functions* which would put the data at risk of being lost and could lead to severe service interruptions. Having multiple users sharing resources of one cloud means, for instance, that risky activities or malicious data of

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[19] The identification of risks follows the ENISA study on cloud computing risks and benefits (cf. ENISA (2009). Cloud Computing. Benefits, risks and recommendations for information security. p 33 ff.), However, some of the risks will be subsumed under more general aspects.

[20] ENISA (2009) Cloud Computing Benefits, risks and recommendations for information security p 34.

[21] Definition: "Denial of Service (DoS) is an attack designed to render a computer or network incapable of providing normal services. The most common DoS attacks will target the computer's network bandwidth [flooding the network with high traffic volume] or connectivity [flooding the network with high connection requests volume].. A Distributed Denial of Service (DDoS) attack uses many computers to launch a coordinated DoS attack against one or more targets. Using client/server technology, the perpetrator is able to multiply the effectiveness of the Denial of Service significantly by harnessing the resources of multiple unwitting accomplice computers which serve as attack platforms." Taken from: W3C (2003). The World Wide Web Security FAQ. Source: www.w3.org/Security/Faq/wwwsf6.html (2011-12-22)

one user could affect other tenants as well. Again all this would result in economic and reputational losses.

The "lowest" class of technical risks regarding the infrastructure comprises the *hardware* itself and the layer above, the *service engine*. The hardware could always be defective (that is why it is important to have redundant structures on the provider's side) or be affected by failures in the electric power supply. The service engine, the layer above the hardware responsible for the management of the hardware resources at different levels of services, is at risk, e.g. through poor code quality, attacks[22] or unexpected failures.

Data-related risks

As mentioned above, the privacy and integrity of data are some of the most important issues but at the same time also one of the most vulnerable issues. Due to the fact that the given distributed cloud computing architectures means that most of the data has to be constantly transferred between different instances of the provider in order to be processed, changed, synchronised, etc.. Furthermore this means that the data in transit bear a high security risk potential. One of the risks is the *interception of the data* in transit which is usually exchanged through web clients or similar interfaces. While the widespread VPN-like connections are not always given in cloud environments, the data in transit is threated by, for instance, sniffing, spoofing, man-in-the-middle- or side-channel attacks.

Furthermore, data are transferred between the customers and their providers and could be *leaked or intercepted* during this process. One of the vulnerable instances on the customer as well as the provider side is the management interfaces which control virtual machines and are prone to manipulation. These "…pose an increased risk especially when combined with remote access and web browser vulnerabilities."[23]

Change of cloud providers or termination of cloud services holds additional risks because in such cases data need either to be transferred (which is then prone to interception attacks) or *deleted* (which could be problematic since full deletion of data is usually only possible by destroying the storage unit which might not be possible because it may also store data from other customers). Effective encryption helps to reduce the risk that clients get hold of the non- (or ineffectively) deleted data. However, encryption holds another risk, i.e. the *loss of encryption keys* needed to authenticate to various security measures (SSL, file encryption, password protection, and digital signature).

When we look at cloud computing service sectors we have different sides of the service, i.e. customers and providers. With organisations and humans involved (either employees of these organisations or individual customers) additional sources for risks

[22] The ENISA report states a couple of examples for such attacks which can be done by "..hacking it from inside a virtual machine (IaaS clouds), the runtime environment (PaaS clouds), the application pool (SaaS clouds), or through its APIs." Source: ENISA (2009). Cloud Computing. Benefits, risks and recommendations for information security. p 43.

[23] Ibid. p 37.

arise. Employees of cloud providers could act as *malicious insiders*, abusing their high-privilege roles (e.g. system administrators, auditors, security managers) to harm data integrity, availability and confidentiality.[24]

Other risks

The ENISA report gives a detailed list of other risks that exist within the cloud computing sector. These risks will not be listed here in detail due to the limited space and time. They are mainly related to policy or organisational issues such as lock-in risks, loss of governance, compliance challenges and supply chain failures.[25] Moreover, there are legal risks such as unfavourable changes in jurisdiction, regulatory data protection and licensing risks.[26] Finally, the report lists other risks that are not specific to cloud computing like network breaks, social engineering attacks, unauthorised access to premises and theft or loss of equipment.[27]

2.3.2. Security benefits of cloud computing

Besides the advantages of cloud computing in terms of economic, ecologic and technical efficiency, it offers a substantial potential to help improve security. As the ENISA report states: "Put simply, all kinds of security measures are cheaper when implemented on a larger scale."[28]

Scalability provides a number of benefits because large-scale investments into security features such as defensive measures (filtering, hardware and software redundancy, patch management, etc.), multiple locations (data mirroring) and threat management – improves protection. Rapid scaling by "…dynamically [reallocating] resources for filtering, traffic shaping, encryption, etc…"[29] also increases the support for defensive measures e.g., against DDoS attacks.

The provision of *standardised interfaces for managed security services* helps to bring current security technology to each customer independent of his own level of security. This is of course supported by the provision of more timely and efficient update circles on virtual machines and software modules in use. Such regular and timely updates (including patches) minimise the vulnerability of service systems and closes security breaches.

The possible impact of security breaches as well as the resulting need for a set of penalties for various risks in SLA's have brought forth more frequent *auditing* of cloud computing. With a more systematic and cost-effective storage of log files through cloud services future auditing requirements are supported. Additionally, with

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[24] With the growing importance of cloud computing and the increasing use of it this may not always be on a voluntary basis but can also be forced through criminals by blackmailing or similar activities.

[25] Cf. ENISA (2009). Cloud Computing. Benefits, risks and recommendations for information security. p 25-33.

[26] Ibid. p 44-47.

[27] Ibid. p 47 ff.

[28] Ibid. p 17

[29] Ibid. p 18

more storage scalable space, it is also possible to *gather evidence in case of security incidents,* e.g. by making images of virtual instances for later investigation (which itself could be done quicker and easier using cloud computing power).

2.3.3. A wider framework – European rules and regulations

Cloud computing has become an important factor in the provision of IT systems in the enterprise sector (big, as well as SMEs). The importance of establishing EU-wide rules and regulations that support risk prevention and security provision becomes more and more apparent. Self-regulatory initiatives like the "Cloud Computing Information Assurance Framework", which has recently been recommended by ENISA, are important ways that could help to accomplish such a goal.

In order to fully develop the potential of cloud computing the data protection framework at a European level needs so be reviewed, rules need to be clarified and regulations related to privacy and data protection need to be changed according to the potential of cloud computing and its accompanying risks. Below follows some very brief starting points which need to be considered to be implemented consistently across the EU:

The requirements for (telecommunications) data retention need to be harmonised in each individual Member State in order to clarify at a European level to which the according (Data Retention Directive 2006/24/EC)[30] applies and establish a coherent and cost-sensible retention period.

- In using cloud computing, businesses need to be able to transfer data worldwide. Thereby they need to rely on appropriate safeguards for the data in transit as well as during processing. "In order to reduce the bureaucracy and burden on companies transferring data, one possibility could be to streamline and harmonise the notification and approval requirements for Binding Corporate Rules (BCRs) and Model Clauses mechanisms."[31] In addition, the current revision of the legal framework on data protection at the European level gives quite a good opportunity to extend the notification obligation in case of security breaches which would support user's protection and increasing the rust and overall confidence in online services (cloud services).[32]
- Currently cloud computing providers face various different and sometimes even conflicting legislation within and outside the European Union, e.g. regarding the disclosure of the information they store. Cooperation between cloud computing players and European policymakers to derive minimum protection levels for the security of data would be advisable to achieve a better

[30] Formally: "Directive 2006/24/EC of the European Parliament and of the Council of 15 March 2006 on the retention of data generated or processed in connection with the provision of publicly available electronic communications services or of public communications networks and amending Directive 2002/58/EC".

[31] Business Software Alliance BSA (2010). Cloud Computing. Policy Agenda for Europe. p 3.

[32] Moreover, it would a useful step to extend the European breach notification regime (currently implemented in the e-Privacy Directive [2002/58/EC]) from providers of electronic communication services (ECS) to also cloud computing service vendors.

understanding of legal issues and a harmonised market with regard to security levels.

- Cloud computing providers and policymaker should also continue to extend the coverage of the WTO General Agreement on Trade in Services (GATS) to address online delivery of software and services.

3. Competitiveness and innovation

In this section, we first focus on the cloud *providers* to give the perspective and trends of the cloud markets from the vendor's point of view. Next, we analyse how cloud computing can increase competitiveness in European SMEs from a *user* perspective. This includes an analysis of business drivers, but we also offer an organisational perspective and describe how cloud services affect IT departments. Finally, the chapter presents cloud computing from a *start-up* perspective, which also reflects on the insights from the previous chapters.

The objective of the study is to analyse the specific e-skill requirements for ICT practitioners relating to green IT, cyber security and cloud computing with *special focus on competitiveness and innovation and the needs of SMEs and start-ups.*

> *"Everyone seems to talk about cloud computing, but no one really knows what it actually means!"* - Cloud computing expert

The quote above indicates that the understanding of what "cloud computing" really is, is still unclear to many European enterprises. According to expert interviews, many European companies actually use cloud services without referring to them as such. Many enterprises make use of, for instance, online applications, digital communication or online data storage, but if asked directly whether they use "cloud computing" in their companies, many would still say no.

What also characterises the cloud computing discussion are the promising forecasts. Looking ahead, cloud computing is considered a key growth area for the ICT sector and a key enabler of growth in ICT-using industries.

- The cloud computing marketplace will reach $16.7 billion in revenue by 2013 according to a new report from the 451 Market Monitor, a market-sizing and forecasting service from The 451 Group. Including the large and well-established software-as-a-service (SaaS) category, cloud computing will grow from a revenue of $8.7 billion 2010 to $16.7 billion in 2013, a compound annual growth rate (CAGR) of 24 pct.

- Deloitte is predicting that cloud-based applications will replace 2.34 pct. of enterprise IT spending in 2014 rising to 14.49 pct. in 2020. The overall conclusion is that enterprise spending on on-premise solutions will fall, as cloud computing reduces the need for licenses, hardware and software.

- Gartner predicts that the cloud system infrastructure (cloud IaaS) market will grow by 47.8 pct. through 2015. According to IDC, by 2015, about 24 pct. of all new business software purchases will be of service-enabled software with SaaS delivery being 13.1 pct. of worldwide software spending. IDC further predicts that 14.4 pct. of applications spending will be SaaS-based in the same period.

- Strategy Analytics predicts that the SaaS market will reach $1.2 billion in 2011 and grow to $3.7 billion by 2016, with a five-year compound growth rate (CAGR) of 25.8 per cent. The ability to integrate business applications on smartphones, tablets and other wireless devices is predicted to accelerate SaaS adoption in the corporate business environment.

- Forrester forecasts that the global market for cloud computing will grow from $40.7 billion in 2011 to more than $241 billion in 2020. The total size of the public cloud market will grow from $25.5 billion in 2011 to $159.3 billion in 2020.

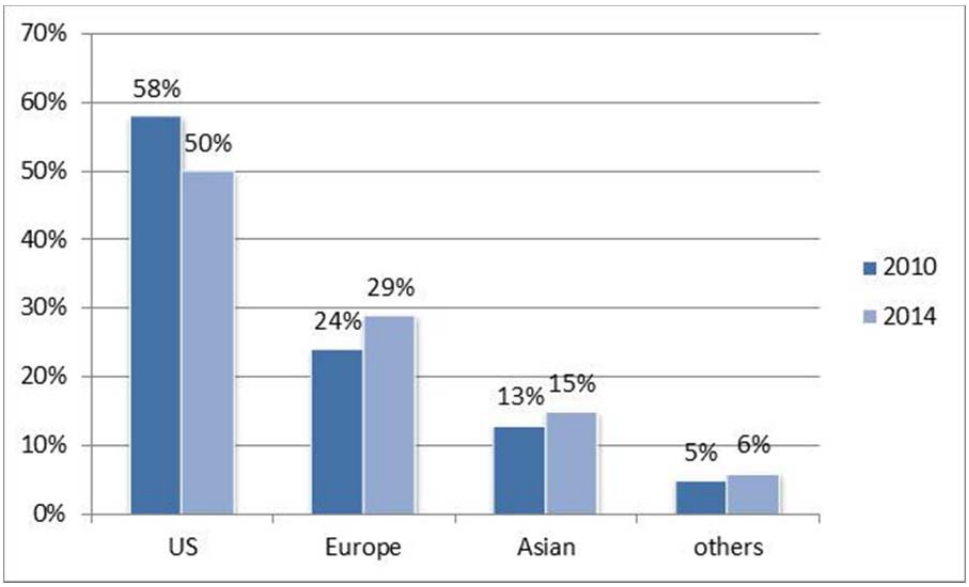
To place these forecasts into a perspective and understand the expectations we will have a closer look at the cloud providers.

The perspective of the providers

In the following section, we present an overview of the cloud providers and the trends on cloud services. First of all, this includes a global overview of the cloud services market. Next, we analyse the battlefield of service providers and how this affects the users. From a cloud user and a skill perspective, this battlefield impacts the standards, consolidation and trends of the market.

So far, cloud services are dominated by US vendors. According to a study from the Gartner group, US-headquartered companies represent 58 pct. of cloud vendors - but account for over 90 pct. of market revenue, and their revenues are expected to increase the next couple of years from €5.9 billion in 2010 to €11.3 billion in 2013. European vendors are expected to gain market shares – also by leveraging the lessons from the first generation of service providers primarily from the US and utilising a second generation of cloud products and services. Therefore, the market share of European vendors is estimated to grow by 5 pct. to a 29 pct. market share in 2014.

Figure 3-1: Market shares for cloud vendors



3.1.1. The cloud business

The interesting characteristic of the cloud business is that providers come from different sectors but are now competing head to head for the same customers in the same market. The big players each have different backgrounds. Amazon's core business is delivery of online retailing; Google was - or is - a research and digital advertising business; Microsoft is a software systems specialist; and IBM, as a newly re-invented consultancy, is competing against new companies such as salesforce.com and Rackspace.

From a business perspective, platform providers depend on the attractiveness of their platforms and the range of apps written for their platforms. Currently, Microsoft's Azure platform, the Salesforce.com force platform and Google's app engine are some of the big players. Providers offer highly specialised services that integrate code management and testing with storage and hosting in a web-based interface. PaaS is aimed at developers and start-ups that want to bring products to market quickly and want the freedom to write their own software with the convenience of streamlined production. However, the downside to PaaS is vendor lock-in, as most current PaaS providers do not offer portability or compatibility outside their own platforms.

Infrastructure-as-service providers benefit from the growth in cloud apps because software cloud providers use a cloud solution to back up their own services. The infrastructure can be commoditised, but it requires resources of scale. This area is currently led by Amazon Web Services (AWS). The competitiveness of cloud services is highly dependent on the providers' ability to build up capacity at a scale that is greater than any individual user or firm is capable of and to be able to automate the allocation of these computing resources. The total demand can then be amortised over this scalable and automated service and sold back to the user at a much lower cost than users could provide themselves. Scale and technology are thus critical factors.

Software as a service is "outsourcing" in its original form, where providers offer customised, hosted software to fill needs previously solved by licensing or developing software in-house. Nuts-and-bolts applications, such as CRM, human resources, and payroll, or production drivers, such as asset management and dispatching, content management, and collaboration software, are ideal SaaS candidates.

Setting aside the technological competition, the commercial competition focuses on control of the end user relationship and how the business can extract value from the end user relationship no matter whether it is a B2B or B2C game. One recent example of this is Apple's strategy and the launch of its iCloud. Apple's iCloud cloud storage and syncing play let users store music, photos, apps, calendars, documents, etc., in the cloud and automatically pushes the content to multiple devices wirelessly.

The fact that Apple is getting behind cloud computing is a major step and validates the arrival of the market. As an increasing number of employees "bring their own device" to work and expect the IT department to make them work in a business context, the B2C suddenly becomes B2B indirectly, which once again underlines how competition and markets in cloud computing are immature and can evolve in several directions. The confluence of mobile, social and open cloud solutions are key enablers of the so-called social enterprises, characterised by open collaboration and agile business structures. Mobile clouds are forecast by some experts to be *the* direction of cloud computing.[33] Another direction is the mobile cloud. The massive increase in apps shapes the mobile cloud direction - access to all cloud apps from all devices has become a strong value proposition. "Cloud Sherpas" has built its business model around access and availability, it is reselling solutions from Google and is pairing them with various cloud services as well as its own application that adds management functions on top of Google Apps not available elsewhere. The combination is a value proposition that gives Cloud Sherpas a major differentiator and yet another way to generate revenue from cloud computing.[34]

Regardless of how business applications are delivered, they are almost never used out of the box, as is, without some form of customisation. Solutions that allow users to change platforms and solutions for their needs, and perhaps build new business applications that leverage customer data are in great demand. The result is that the cloud itself must be both elastic and agile. Moreover, the degree and ease of configuring and customising is a competitive differentiator for vendors across the categories of cloud computing.

Some of the ways that vendors try to accommodate this agility on scales large enough to meet the needs of cloud computing are through technologies that support virtualisation, Virtualisation is defined as the abstraction of computing, storage and networking resources from underlying infrastructure and automation - the elimination

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[33] Forecast by CEO of Salesforce.com Mark Benioff
See: www.crn.com/news/cloud/231600584/dreamforce-benioff-shines-light-on-salesforces-social-enterprise.htm

[34] See: www.cloudsherpas.com

of the need for human intervention in common, repeatable tasks and decisions. The cloud computing model enables this degree of efficiency in running customised business systems for end users. Because the service providers in terms of software, platform, or infrastructure are able to optimise for all customers at once, a given advancement in efficiency pays off much more (and much faster) for the service provider than it would for a single customer. Multi-tenancy is what makes the economics work for both the business user and the service provider. Platforms and standards

Standardisation is another immaturity aspect of cloud computing. Many ICT practitioners and developers consider the lack of cloud computing standards a potential barrier to adoption because of cloud providers' lock-in fears and inability to move virtual machines and data from cloud to cloud.

However, standardisation can lead to commoditisation, which is another perspective pushed by cloud providers. For instance, Microsoft is using its software and services as part of its Azure offering. This is one example of how services can differentiate; otherwise, the alternative is that vendors only compete on price.[35]

Today, OVF (Open virtualisation Standard) is considered a standard pioneered by VMware for facilitating the mobility of virtual machines, but it does not solve the cloud interoperability issue alone. One solution it to develop a cloud API (Application Programming Interface) like the network API, TCP/IP. This API is under discussion as a standard that could implement cloud products and services and promote transparent interoperability. The argument is that this could increase the confidence of cloud users, because it allows users to leave their providers whenever they want. It would also eliminate the notion that it is easy to get into the cloud but difficult to get out.

The vendors with the best shot at providing de facto cloud API standards are VMware and Amazon. In 2011, VMware re-launched its Cloud Foundry platform, which supports Java, Spring and Ruby on Rails. Another example is the desktop-based cloud-testing environment *Eucalyptus* aimed at recreating the Amazon Web Services APIs. Eucalyptus has made a niche for itself as a test bed for Amazon-targeted applications, and using this cloud operating system, developers can test their projects without having to pay per CPU on Amazon. Eucalyptus has also been making headway in the enterprise area with its new Eucalyptus Enterprise Edition. This means that it also supports Windows and Linux and compatibility across multiple hypervisors. Eucalyptus has been operating for three years, making it one of the most consolidated cloud operating systems.

Launched in July 2010, the Rackspace and NASA-led OpenStack open-source cloud initiative gained momentum in 2011. The project has now drawn more than 120 participating companies, including Cisco, Citrix, and Dell into the OpenStack community. Recently, HP has also joined OpenStack. The OpenStack project has

[35] See: http://cloudcomputing.internet.com/management/article.php/3933411/Do-Cloud-Standards-Matter.htm

some 300 active developers and it has had more than 50,000 downloads from its code repository.

Finally, with regard to standards and platforms, it is also important to mention the work of *The Open Grid Forum* that is developing guiding principles revolving around interoperability, portability and integration.[36]

- *Interoperability:* allows different cloud providers to collaborate without data format translation, facade/proxying between APIs and understanding and/or dependency on multiple APIs
- *Portability*: no technical/vendor lock-in and enables services to move between providers; allows clients to switch easily between providers based on business objectives (e.g. cost) with minimal technical costs, thus enabling and fostering competition.
- *Integration:* the specification can be implemented with both the latest infrastructures and legacy infrastructures.

To sum up, US-based cloud vendors currently have the lead in terms of market share, scale and technology. Even though the forecasts predict that Europe will gain market shares in the coming years, there is a need for a discussion of what role cloud computing can play for European competiveness for both vendors and users, and what can be done to embrace the technology and develop the business around it.

In addition, cloud standards are an important issue both from a technology perspective and from a business perspective. Because cloud computing is maturing and developing, an entire business can be shaped just as previous examples of software development show.

3.2. SME competitiveness

The e-Business Watch of the European Commission (2008) emphasises SMEs' role in the production structure clearly:

> "*SMEs form significant industry segments in the EU and account for the majority share in EU employment. Thus, they require specific policy attention. While their strength lies in the flexibility with which they can adjust to changing market conditions, their small size makes them less able to face high up-front costs.*"(p. 53).

This section explores how cloud computing creates value at company level, i.e. what does cloud computing mean for SME business processes and how does this change the competitiveness and innovation of European SMEs. Furthermore, a detailed business process perspective provides additional value to the detailed analysis of e-skill requirements.

[36] See: www.gridforum.org/standards/

The potential is clear and the forecasts are promising, yet the readiness of European SMEs for the transition remains underexplored. The exploration of readiness must be considered taking into account the diversity of SMEs in terms of sectors, markets and operational models to explain how these promising forecasts will actually play out in SMEs.

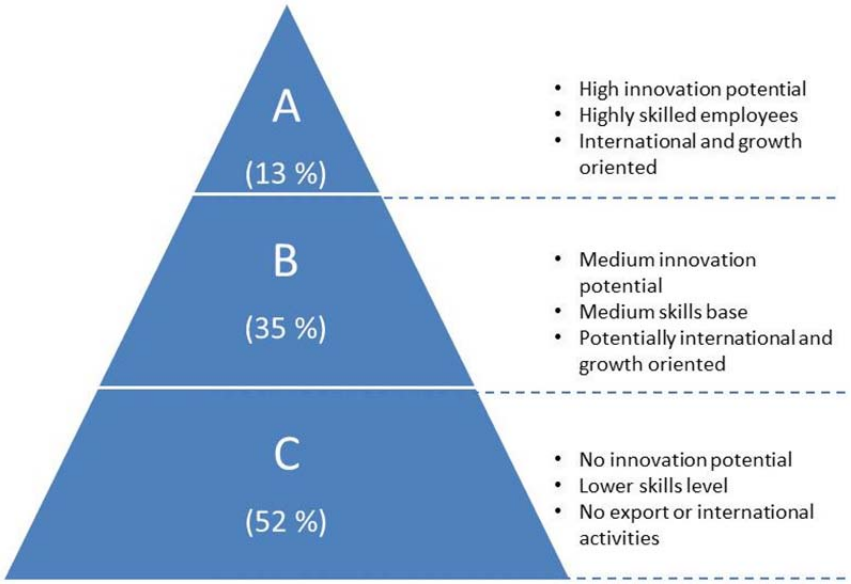
The group of SMEs covers more than 23 million companies in Europe. Moreover, SMEs represent a great diversity of companies ranging from high-tech businesses to start-ups tuned towards international markets, more traditional companies, such as crafts companies, which are active in local markets, to family businesses. SMEs can be segmented in many different ways. However, cloud computing is not about SME segmentation. Cloud computing is more about evolving business models and how companies can pursue new opportunities through ICT. However, any business model adopted has a strong impact on strategies for skill development, as the challenges SMEs face when coping with human resources management differ accordingly. Three elements are important for the segmentation of SMEs, namely internationalisation, knowledge intensity and added value.

- Internationalisation: cloud solutions deliver connected scalable services and provide even small companies with global market opportunities without upfront investments.
- Skills: the number of employees with higher education as a proxy for knowledge intensity.
- Added value: gross value added per employee as a measure of the level of advanced product or services.

The figure below shows a distinction between three types of SMEs in terms of skills, internationalisation and added value.[37] When assessing the skill need of ICT practitioners, these levels should be considered. The adoption of cloud computing by enterprises can also be segmented into three levels. The most advanced usage not only uses cloud solutions but also designs and develops applications critical to the core business. Companies that are medium level adopters use off-the shelves cloud solutions, but have specific needs related to, for instance, logistics or data storage. The third category of companies with limited use of ICT does not have specific needs. Nevertheless, these companies could potentially benefit from cloud computing as the transition does not require major ICT investments.[38] The figure below shows that 13 pct. of the analysed companies can be described as advanced companies with highly skilled employees and a high potential for growth and innovation. 35 pct. of the companies are in the B segment with medium potential and 52 pct. of all the analysed companies are in the C-segment with lower skill levels and no international orientation.

[38] Analysis conducted by the Danish Technological Institute among 108,369 Danish SMEs. Even though the segments of companies vary across countries the analysis provides a proxy for different types of companies.

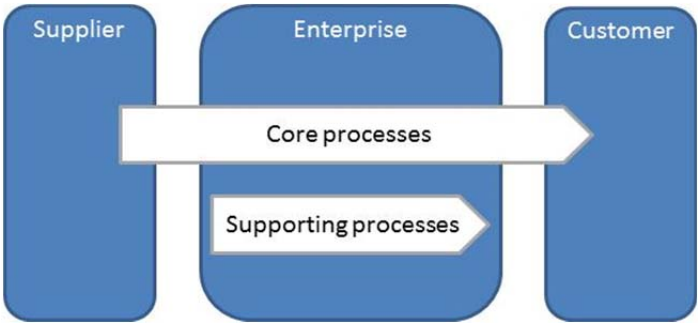
Figure 3-2: Company segmentation of growth and innovation potential



The company segmentation will be used throughout the report when assessing business growth and skill requirements. It could be argued that the segmentation also should include IT uptake, but cloud solutions offer more than just an update of IT solutions as they also affect business models and business processes, and therefore a more generic view on the growth and innovation potential has been chosen. In the following, we will take a closer look at business processes in relation to cloud computing.

The processes in a business can be described as core or non-core process. Core processes are directly linked to the business, for instance through customer management or production management, whereas non-core processes are only indirectly linked, for instance human resource management or pay roll systems. IT can also been categorised as a non-core or back office function. A back office process is that part of a company where tasks dedicated at supporting the company take place. Typically, office processes are those used for developing products or administration with no interaction with the customers. Other tasks include IT departments that keep the phones and computers running, financial accounting, and HR activities. A back-office system will also keep a record of the company's sales and purchase transactions, and update the inventory as needed. In general, the core processes include interactions with suppliers and customers, whereas supporting processes focus on internal processes. The figure below simplifies the business processes.

Figure 3-3: Business processes



For both core and supporting processes, cloud computing solutions are entering the sphere of the company. Over the years, various software solutions have been integrated in companies and now cloud computing solutions are replacing these solutions with online delivery of the software "as-a-service". A selection of cloud solutions is presented in the table below

Table 3-1: Cloud solutions related to business processes39

Core business processes	Supporting business processes
Asset management	Accounting
Business process management	Business intelligence
Call centre solutions	Collaboration
Channel management	Community site services
e-commerce	Compliance and risk management
Manufacturing solutions	Document management
Marketing	E-learning
Product lifecycle management	Enterprise resource planning
Productivity	Expense management
Sales force automation	Human resource management
Service desk management	Knowledge management
Supply chain management	Payroll
Transportations and logistics	Web analytics
Vendor management	Talent management
Work order management	Project management

The table focuses on the software solutions from cloud computing. As described in the technology section, these software solutions depend on the infrastructure and the platforms in the cloud. In the following, we focus on software delivered as a service. Even though companies are not familiar with the latest technology trends and the range of possibilities from cloud computing, it is worth looking at cloud computing from the end users' point of view, i.e. not only focusing on what is possible but what added value cloud computing has when looking at the needs of the core business. ICT solutions related to the business processes used to depend on the IT department. In the past, when an end user in a company was looking for an IT service, such as a customer

[39] Own compilation of software solutions derived from http://cloudshowplace.com/saasshowplace/application.html

relationship management system or knowledge management system, this required the knowledge and skills of an ICT practitioner who could create, compose, integrate, or configure software systems to meet those needs. Adding to this, non-technical professionals were highly dependent on their ICT practitioners to determine how computing could solve a particular problem. Thus, IT departments have traditionally been the only choice when solving the computing needs of companies.

From a business perspective, the alternatives to internal IT would be to use external vendors, but the costs have traditionally been high and would immediately have to be rationalised against internal IT. Furthermore, because of the complexity of infrastructure, platforms and customised software, these alternatives would tend to be long-term commitments, which therefore diminish the possibilities of finding new solutions or setting up pilot projects on alternative solutions compared to internal IT. The economics and technology of cloud computing change this dependency. Now the costs of external services are low, and they can be tried out on a short-term basis, which means that companies have many alternatives and can gain economic advantages from a cloud solution compared to internal IT.

This change of perspective affects the IT departments as well as cloud-based architectures. The demand for cloud-operated infrastructure can be derived from the need for more efficient application delivery and operations, which in turn comes from the accelerated need for new software functionality driven by end users. The result is that IT departments in companies adopting cloud solutions are being pushed to focus on innovation and creating business value compared to their previous function of maintaining a regime of license renewal and break-fix infrastructure problems. Given the increasing reliance of companies on a strategic and lean IT organisation, cloud computing will ultimately grow in importance and will be a key channel for how IT services are delivered and consumed.

Putting the importance of the IT department into perspective, the primary barriers identified by the Danish SMEs to the use of ICT are:

- lack of skills in connection with using new ICT solutions (53 pct. of respondents);
- uncertainty about the benefits of innovative ICT use (52 pct.);
- lack of overview of the market supply of new ICT solutions (51 pct.); and
- lack of standard ICT solutions that support business needs (45 pct.).[40]

Business needs and overview of technology can enhance the uptake of ICT and cloud solutions in both core and non-core processes.

The example below shows a company that was aware of the risk of cloud computing but that has now embraced it fully.

[40] Rambøll Management (2009)

Box 3-1: Image2output[41]

"We chose to shift to the cloud, because it is the future. It will become so important that companies will not be able to operate effectively without it in the future. For Image2Output, the intention is to completely embrace the cloud"

- Image2Output, Mark Middlebrook

Integrating core and non-core processes
The cloud solutions cover back office, front office accounting, and workflow in one single package. Image 2 Output is stuck in the middle ground as being not big enough, but not small enough. There is a gap in the cloud market for these organisations, and few companies target them. On the accounting side, they are still not in the cloud. Even though it is the easiest to migrate, they have a legacy system that is not easy to migrate. For them it has been complicated to get one fundamental solution to get everything you want accountancy, CRM, managing stock, back office.

They chose to shift to the cloud, because there was better security in the implications of backup of data, and greater flexibility in terms of access that any employee has to data. They also got greater control of machines that employees use. Employees no longer had a personal machine, but could go to any terminal to access the same data. Furthermore, now the company could own and control all documentation associated with any employee rather than their data being located on laptops or local disks. It also saved costs.

They do not have to reinvest into the hardware infrastructure in the business, and do not need to buy sophisticated backup systems. This will provide them with a long-term benefit. There is also greater licensing flexibility, as they can pay monthly, rather than other accountancy systems with annual fees. They crunched the numbers and felt that the cloud was more competitive.

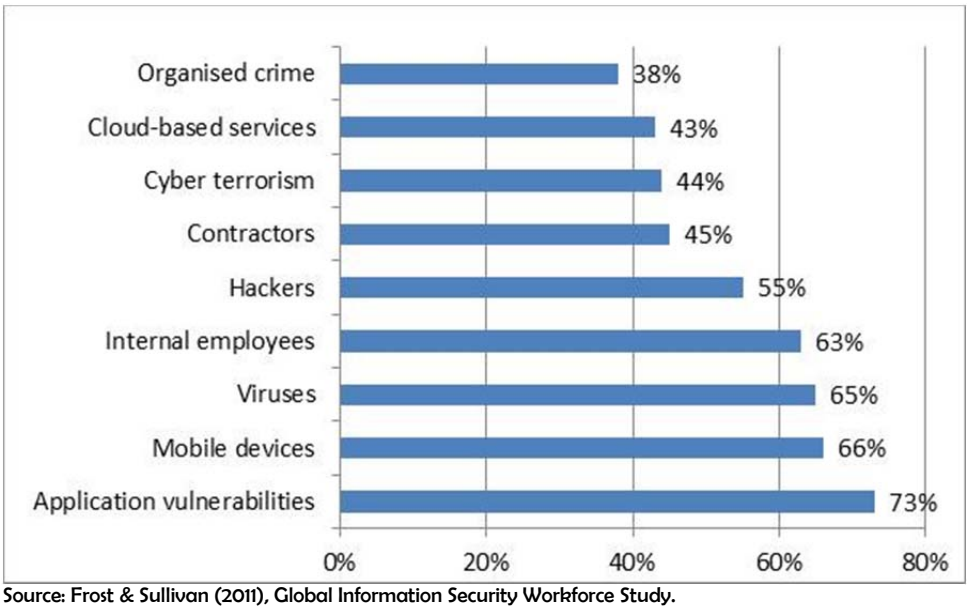
About
Image2output provides graphic arts consumables. It has 15 employees and operates in the print industry. It is growing at twenty per cent per year.

3.2.1. Cloud computing and security

Security issues regarding cloud computing are often mentioned as one of the main barriers to uptake of cloud computing solutions. In 2011, two spectacular security breaches were revealed by Sony and Amazon. Both breaches were well covered in the media and cloud computing was discussed. When asking the ICT practitioners the security of cloud computing was not their biggest concerns as the figure below illustrates.

[41] See: www.image2output.com/index.php?cPath=488

Figure 3-4: Cloud computing as a threat?



Source: Frost & Sullivan (2011), Global Information Security Workforce Study.

Application vulnerabilities are clearly regarded as being the greatest threats, reaffirming the need for skills in detecting security flaws in both operational solutions and solutions in the make. The use of mobile devices in enterprises of all sizes has risen considerably over the past couple of years. A recent estimate states that mobile devices are used by at least half of the employees in almost half of the World's enterprises. This number is probably significantly higher if we look exclusively at Europe. Many companies already use a number of solutions to protect their mobile networks, but as mobile solutions and devices become even more advanced, so do the skills requirements in areas such as network access control, encryption, and VPN management.

The interviewed security experts considered security a prerequisite for successful development of new products, services and processes in European enterprises. Currently, business and ICT developments are implemented at such a high pace that practitioners responsible for making them secure have a hard time keeping up. Many ICT solutions currently in function in European enterprises are therefore not sufficiently secure. Although this has not yet led to a lack of willingness to innovate and implement new strategies, experts fear that this might be the case if – or rather when – large security breaches start to happen and the stories of these starts to circulate. In a macro-perspective, there is therefore currently a substantial gap that needs to be closed – or in the words of one respondent, "a ticking bomb that needs to be diffused".

3.2.2. Creating business value

We need to understand how the clouds affect business processes and create business value. In the following, we look at companies that have adopted cloud solutions and how this has added value.

First, cloud computing incorporates all the characteristics of how the services of the IT department should operate as a business, i.e. agility, accessibility, flexibility, cost

efficiency, virtualisation, automation, service management and user metering. Second, the structure of cloud computing means that capital expense (CAPEX) for IT provisions depreciates over time to changes to operational expenses (OPEX), where expenses can be offset immediately against income. For SMEs, IT outsourcing has not been relevant as the economies of scale have not been sufficient and the sunk costs related to ICT have been a barrier. The same sunk costs can be a barrier to cloud sourcing, but the economies of scale are not an issue the same way, and cloud computing provides SMEs with the opportunity to increase their competitiveness without massive capital expense.

When companies are asked about the business value generated from cloud computing, three areas stands out, namely agility, cost reduction and revenue growth. We can add innovation as a fourth dimension:

- *Business revenue and growth*
  Cloud services allow the business to focus on business because the enterprise can now reduce the need to provide low-business value via high-cost labour to support commodity IT services. The companies also reduce non-differentiated services and are able to allocate resources to value creating activities. Finally, cloud solutions provide a platform for collaboration that eventually accelerates time to value and reduces time to start up and complete projects.

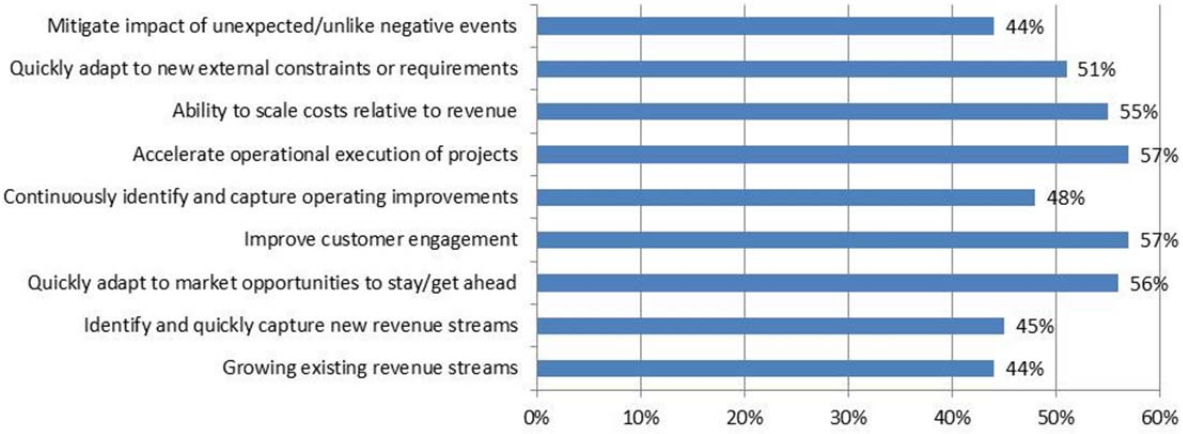
- *Agility and flexibility*
  Cloud services provide greater flexibility on architecture and sourcing options and scale up and down as needed, which then maximises efficiency and adds additional capacity when needed. The introduction of cloud solutions that integrate suppliers and customers in core business processes in real time also means that the boundaries between the companies and the vendors and customers are blurring. The social enterprise is therefore another perspective related to the agile and flexible company using cloud solutions.

- *Cost reduction*
  Cost reduction is specifically related to reduced energy consumption and a more general shift from capital expenditure to operational expenditure. Cost reduction can also have a perspective related to employment because cloud provides the option of simplifying IT management,

- *Innovation*
  Business value is also related to innovation. Cloud computing means that SMEs avoid the need to handle time consuming upgrades in-house, as users outsource the operation and maintenance of software and as upgrades happen automatically, the need for redesign of data centres or IT upgrades is decreasing. Therefore, ICT practitioners can potentially focus on deploying applications or delivering new projects that drive business benefits and innovation.[42]

In the figure below from a VMware survey, the first two rows are related to agility, the next three to cost reduction and the last four rows are related to revenue growth. The figure shows that most respondents agree that cloud can help businesses improve the customer experience (57 pct.), accelerate the operational execution of projects (57 pct.) and quickly adapt to market opportunities (56 pct.). The ability to scale cost relative to revenue (55 pct.) is also important for the companies. The survey thus shows that the understanding from business managers on business value generated from cloud computing is primarily related to business growth and agility.

Figure 3-5: Business value generated from cloud computing



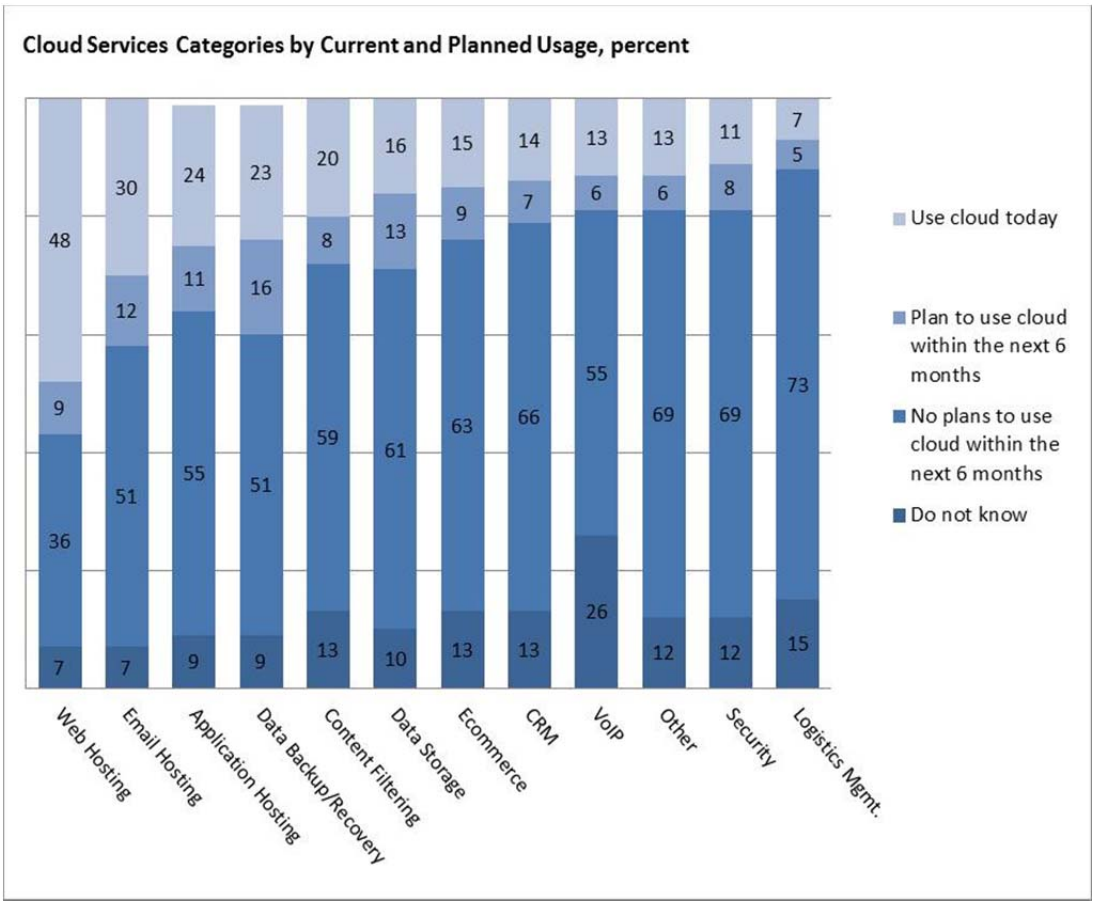
Source: Business Agility and the True Economics of Cloud Computing (2011), VMware, Business Whitepaper.[43]

The figure above depicts what sort of business value managers think cloud computing can generate. However, what cloud computing solutions can the companies *actually deploy* in their organisations?

The figure below shows cloud services categories by current and planned usage from a survey conducted among ICT practitioners in SMEs (Spiceworks 2011). It shows that that currently hosting of web, e-mail and applications is mostly used by SMEs. Data backup and data storage are the next cloud solutions that will be deployed. According to the discussion about value generated from cloud computing, one tentative conclusion is that currently ICT practitioners point towards solutions that are related to the supporting processes, whereas CRM, logistics and e-commerce are not deployed or planned for the next 6 months. The value created from cloud computing is therefore mostly related to cost reduction and not revenue growth.

Figure 3-6: Cloud services – current and planned usage

[43] www.interop.com/lasvegas/downloads/white-papers/VMware_Business_Agility_and_the_True_Economics_of_Cloud_Computing.pdf



Source: *State of SMB IT 2H 2011 - Semi-Annual Report On Small and Medium Business Technology Plans and Purchase Intent*, Spiceworks (2011).

As cloud computing is integrated in companies, the role of IT is also changing, as are the user experience and the business outcomes. Previously companies were locked into specific solutions and organisations built and owned everything related to IT. This way of organising IT around core and supporting processes created rigid costs and complexity. Cloud computing has a much simpler environment, which is not so much about being locked as opting in. Employees and managers can now conduct all types of business from wherever they choose, and this leads to a stronger emphasis on a service delivery approach to IT. Consequently, cloud solutions must be flexible and rely on service delivery. This way of creating business value means that IT departments need to focus on the core business and not just the supporting processes. It also means that company ICT practitioners will have a direct impact on business through orchestrating, aggregating and delivering services when and where they are needed.[44]

An example of cloud solutions related to core business that provide agility is the chocolate producer TCHO showcased in the box below.

[44] See: www.channelinsider.com/c/a/Virtualisation/Citrix-CEO-Dont-Fight-the-Consumerization-of-IT-542778/

Box 3-2: TCHO – mobile cloud solutions for monitoring of production

Everything is connected to an Ethernet node with its own IP address, which is how TCHO monitors and controls the lab remotely via iPhones.

THCO can control the production from anywhere as long as there is a signal. A customised iPhone app allows TCHO employees to monitor production remotely, just as the company can monitor the minutiae of fermentation thousands of kilometres away. The sensors dotted around the production plant allow it to visualise every stage of chocolate making.

On the factory floor, there is a flat screen TV on which an avatar wanders around a virtual TCHO factory. The system is still in the demo stage, but TCHO hopes to have it providing real-time information about what is going on inside the vats, mixers and pipes, where it is too dark - and too hot - for a human. Soon technicians will be able to walk around the factory, hold up their iPhones and "see" what is happening in the tanks on the screen.

In summation, the analysis shows that SMEs can create business value in relation to core and non-core process on four dimensions, namely business revenue and growth, agility, cost reduction and innovation. The results indicate that currently the business value is primarily generated through cost reductions and that the competitiveness and innovation in SMEs can be further strengthened when cloud services are explored and deployed in more aspects than just those related to cost reductions.

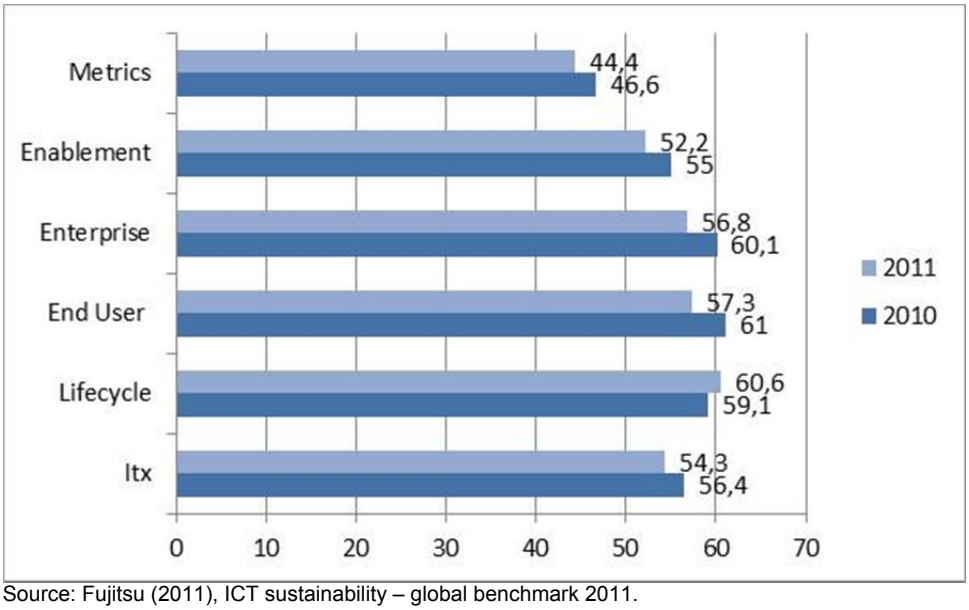
This means that forward-thinking ICT practitioners and managers can potentially deploy computing as a strategic tool, not just for IT, but also to enable full business transformation, and eventually change how the company operates its business. Looking forward, cloud computing can potentially enable a much tighter connection between IT transformation and business transformation. Innovative ICT practitioners and managers think business transformation first, then how technology enables it. They are the ones strategising with their business management to look beyond simple cost calculations to the business agility that cloud computing can enable. This is especially related to the A-segment of innovative enterprises.

3.2.3. Green IT

The uptake of cloud computing was analysed in the previous section. This section includes the green IT perspective in order to shed light on reduction in energy use, which is one of the main positive effects of the implementation of cloud computing, which is why the two areas are closely interlinked. Because less attention is devoted to the topic as an isolated issue, not many studies have been conducted on the issue in Europe the last two years. The most recent European data only cover a limited number of industries or countries making general comparisons difficult.

A quite recent survey from Fujitsu shows that measured on several parameters the maturity of green IT is low and comparing 2011 and 2010 the level of maturity is declining.

Figure 3-7: Green IT maturity index, 2010-2011



Source: Fujitsu (2011), ICT sustainability – global benchmark 2011.

From a business perspective, an interesting finding from the Fujitsu study is the lack of visibility of ICT power bills. Only few of the surveyed organisations measure the energy consumption and efficiency of ICT. We have previously shown that cloud computing cost cutting was one of the areas which was highlighted when deploying cloud computing, but the results from Fujitsu indicate that not all the factors related to cost cutting and cloud computing is taken into consideration.

A study among 756 medium and large American organisations demonstrates how green IT is being implemented in modern enterprises in the Western economy where 74 pct. have or are developing programmes to manage and reduce IT energy use. They are deploying more power-efficient core switches (39 pct.), using the network as a platform to manage and reduce energy costs (24 pct.) and adapting InfiniBand technologies (23 pct.). The main barriers to investment in green IT are budget restraints, senior managers prioritising other projects and insufficient awareness of energy savings measures (CDW, 2010). A national study from Denmark shows an equal trend for medium and large organisations where around 70 pct. (compared to 74 pct. in the US) have developed initiatives to reduce IT energy use (Statistics Denmark, 2011).

The above numbers indicate that green IT lives a quiet but strong life in most organisations and confirm the view expressed by a number of experts, i.e., that green IT is primarily regarded as a means to minimise costs and strengthening the company's commercial brand.

The Danish study shows that green considerations are only drivers for purchasing new IT in 19 pct. of the cases (Statistics Denmark, 2011), while in the American study almost 40 pct. see energy efficiency as a very important consideration when purchasing new IT equipment (CDW, 2010). Although the data are not directly

comparable, they appear to indicate that a reduction in energy use (and thus spending) is far more attractive than just helping the environment.

3.3. ICT in today's SMEs

As today's technology evolves quickly it is difficult for a small internal IT department or individuals in an SME to remain on top of trends including security, new products, managing mobility and social media. Additionally, in a small business with a small IT department the responsibility for IT provision is often assumed by someone who is busy with his or her day job with little or no time to ensure that the data are safe, the environment stable or how IT can best serve the business. Therefore, IT outsourcing can help to get a better and more flexible service at a reduced cost, and the SME also avoids hiring skilled and expensive IT experts. Overall, the biggest benefit IT outsourcing provides to SMEs is to lower the complexity, and it allows the SME to focus on its core business – and save time and money.

ICT infrastructures in SMEs and start-ups are as diverse as the companies and their business objectives themselves, so there is no such thing as a "standard SME ICT landscape". Instead of a systematic approach to SME ICT, we find IT infrastructures that are mainly derived from the company's history. Typically, an IT infrastructure is not planned based on a predefined strategic IT roadmap, IT governance guidelines, or thoroughly analysed business processes. Instead, SME IT solutions are introduced pragmatically when needed, and migrations are undertaken when older solutions start to become obsolete. So flexibility becomes more relevant than planning. IT in SMEs is driven bottom-up. Thus, user and business requirements define ICT infrastructures, and time, costs, human resources and technical limitations are the most dominant hurdles.

Even though there is no standard SME ICT landscape that fits all companies, some typical functions can be described following a 3-tier approach that all lead to typical IT tasks:

The *infrastructure tier* provides the "raw iron" and consists of hardware, operating systems and computing power along with raw (block) storage and networking. Infrastructure creates the foundation for servers and client systems. *Infrastructure management* covers the physical side of ICT, i.e. monitoring and management of the base physical systems such as physical servers, networking and storage. Included in this infrastructure are the management systems focused on managing resource allocation of services and applications.

The *server tier* covers centralised applications and services such as database management systems, enterprise resource planning (ERP), customer relationship management (CRM), web server, application server, document management solutions or a huge variety of legacy systems and middleware products.

With the increased use of web-/intranet-based applications, client and server tier grow closer together. Applications run on web/application servers and are used via a web browser on a local machine. This means that no software installation is required**.**

Server management includes everything that focuses on running services on the provided infrastructure. This mainly covers software and operating system-related tasks. Due to the central role of servers, monitoring and control, service management, continuous improvements, IT security, reliability and performance management play important roles. To ensure interoperability of services and enterprise application integration, configuration management and patch management and versioning control have to be performed.

The *client tier* covers applications and services for delivering software functionality to the end user on his local device. Applications can roughly be divided into two groups, i.e. common generic software functions that found on more or less every computer and specific software related to SMEs' business areas.

Client management covers all tasks required to manage and maintain the end users' devices, such as laptops, desktop computers, pads or mobile devices. This includes typical tasks such as hardware management and maintenance, application software installation and management, licensing, operating system deployment, patch management, IT security, user helpdesk and remote-administration. Because of the huge variety of different end user devices, specific software needs and preferences client management easily becomes a big effort.

In a typical SME the IT management functions on all three layers have to be covered by IT experts, be they internal (employees) or external (service providers). Unfortunately, even if many individual functions are outsourced to external service providers, the company itself has to keep control of the tasks to be performed at an operational, technical, organisational and management level instead of focusing on its core business.

However, why should an SME deal with ICT infrastructure, server or client management that do not contribute to its core business at all? How can non-ICT SMEs keep up with IT innovations and trends without wasting too much time? A shift is required here, i.e. from a hardware/infrastructure centric point of view towards a user/application/business point of view. The question in the future is not 'how can we implement a specific function in ICT?' but 'what do we need to do/improve our business and how can this be organised?'

3.3.1. Cloud based ICT organisations in SMEs

Cloud architectures open up new ways to organise ICT in SMEs. Following the 3-tier model described above, how can clouds support ICT in SMEs?

Infrastructure clouds, also referred to as resource clouds, address the infrastructure tier. Instead of buying, installing, running, maintaining, managing own hardware as an SME, Infrastructure as a Service (IAAS) provides (managed and scalable) resources as services that can be utilised. Computing power, storage and special hardware can be used on demand – flexible and cost effective. Peak performance can be obtained when needed – at extra cost. The idea is that physical systems can be decoupled from the digital elements that they host. This separation of concerns means that software and data management can be separated from physical infrastructure management.

This moves all technical administrative tasks from the SME towards the IaaS provider. As the IaaS provider is in a position to operate in large scale with huge procurement volumes, a streamlined organisation, major installations and 7x24 h availability of specialised experts (maybe offshore), the service provider can deliver a higher service level at a reasonable price. SMEs utilising IaaS to operate and run their own server tasks and services on remote infrastructures somewhere in the cloud can almost ignore infrastructure operations.

One level above the infrastructure level, cloud platform services – known as Platform as a Service (PaaS), deliver a computing platform or solution stack as a service upon which applications and services can be developed and hosted. PaaS (often based on infrastructure clouds) facilitates deployment of applications without the cost and complexity of buying and managing the underlying hardware and software layers. Consequently, the PaaS concept goes one step further than IaaS, i.e. the SME not does only run its server tasks and services on a cloudy infrastructure. It also utilises server tasks and services 'out of the box' operated by third party.

Databases are a sound example on how to utilise PaaS. Companies usually use numerous databases as the persistence backbone of various applications (ERP, CRM, accounting, etc.). Operating a database system is hard work where database administrators constantly have to monitor system state, performance and storage conditions, manage users and user privileges, perform backup and recovery tasks and optimise the system while in use. This is an expert job, but not the core business of an SME. In most cases, hiring an expensive database expert for an SME is not cost-effective. Consequently, the next logical step in a cloudy landscape is to move database operations to cloud platform services to be able to better focus on the SME's core business. The database is professionally operated somewhere else and used by the SME via a network.

On the application tier, application clouds – known as Software as a Service (SaaS) – implement specific business functions and processes that are provided with specific cloud capabilities. SaaS is a good option for all types of standard applications and can be offered to various clients in a public cloud. Sound examples of applications clouds reflect this as they cover only standard software functionality. They include Google Docs (office applications), Salesforce CRM, and SAP Business by Design (ERP).

If specific or customised applications are required, the SaaS concept has limitations. Large companies could use the option to run their own private cloud hosting with their tailor-made specific applications. For SMEs, this is a costly option, and instead they should check if there is a standard application available that could work for them, or go back to the PaaS level and deploy their own application at that level.

There are numerous cloud technology options for SMEs. So, what is the right strategy for SMEs when using clouds? Clouds offer a good way to move tactical ICT operations with no or limited contribution to business success to third parties, while strategic ICT is kept in-house. Consistent use of clouds in SMEs can reduce ICT overheads to a minimum.

Three scenarios may help to explain the business perspective of clouds.

- SMEs with strong IT skills, which consider their ICT competences on server/service level a valuable strategic asset, may decide to rely on infrastructure clouds and run their own server processes on remote infrastructures. This could be the case for SMEs that use a variety of in-house developed server software that perform specialised tasks that cannot be transferred to standard software tools. Outsourcing the hardware layer should not negatively affect the strategic component of their ICT competences. So the benefit of getting hardware on demand (storage, computing power, etc., can be utilised without losing ICT core competences and maybe unique selling points toward the SMEs customers.

  Example: SME specialised in thermodynamic computer simulations. The company's own engineers and physicists have developed its simulation software (typically based on a common commercial simulation platform). Thus, the SME has strong competences in software development, they definitely need hardware on demand (CPU and storage), and they do not want to give away their software. However, infrastructure management is not a desirable task – so IaaS becomes an attractive business option for this particular SME.

- SMEs with unique competences at the application level may decide to rely on Platform as a Service infrastructure to do away with infrastructure management and server operations, but to keep application knowledge as an important success factor in-house. This could be the case for SMEs that use a variety of in-house developed applications that rely on common database servers, ERP/CRM systems or middleware products. Running these standard tools in-house creates no contribution to business performance, but they are a necessity to set up mission critical applications on top of them. Consequently, the idea of moving server operations and hardware management towards a cloud infrastructure is obvious.

  Example: SME running a best price portal on the internet. The company has developed its own application to retrieve current prices from the web and manage price and product information via the SME's own client software. The software uses a database system to store the price information and a web/application server to give users access to the system. Consequently, the company needs infrastructure (CPU, storage) and platform services (database system and web/application server). However, running its own servers creates no contribution to economic success – it is just a tactical necessity, not a strategic option. The SME could reduce its overheads by utilising platform and infrastructure cloud services to reclaim the freedom to concentrate on their core business, i.e. continuous improvement of their best price portal.

- SMEs which describe themselves as ICT users may only want to get rid of most of their ICT tasks – ideally all of them. So, how far can they go? End user devices are still a must, but they can be rented or leased with a full service

contract for hardware, OS and software maintenance. In modern companies, users have a lot of freedom to choose their individual device – a nightmare for IT administrators, but a great option for users. Concepts as 'bring your own device' give employees total freedom to choose the device they prefer, such as laptop, smartphone, pad or a mix of some devices that use numerous operating systems. Classical software management approaches cannot handle this - but applications clouds and desktop virtualisation can! By moving typical business applications (office tools, time and project management, CRM/ERP, document management) to the server side, the user's physical device becomes less relevant. The user's personal device only has to have network access and a working browser to be part of the corporate ICT landscape. Network access can be performed by corporate LAN or – to further lower the SMEs ICT tasks – by wireless internet providers. This way, the users can access Software as a Service via public Application Clouds or a private cloud for special applications when needed.

Example: SMEs in the consulting business often do not have a corporate ITdepartment, as the employees usually work remotely while travelling, visiting customers or from their home office. So, if no physical corporate headquarter exist, why invest in costly corporate ICT when the web offers most of the required functionality via clouds? Everything needed is a personal computing device and network access, which can be found everywhere without the need for corporate ICT.

In the real world, these three scenarios often will be mixed. Some functionalities will be moved to clouds and others will stay in-house. This has to be decided in any given SME. Thus, standard software may be moved to application grids whereas special functions may be installed on infrastructure grids. The power of cloud infrastructures lies in their flexibility.

Clouds also offer ICT migration paths. Maybe an SME will decide to utilise infrastructure clouds to remove the burden of managing its hardware infrastructure. If this works out, maybe in the future some server tasks will be moved to platform cloud services – step by step – and in parallel office functionalities will be moved to application clouds (SaaS).

From a business perspective, cloud computing generates value through increased business revenue, agility and cost cutting. From an IT department perspective, the decision criteria when discussing ICT outsourcing to cloud services are somewhat different. They can be clustered in three parts, namely non-functional, economic, and technological capabilities addressed. Non-functional aspects represent the qualities or properties of a system. The most important aspects include:

- *Availability*, the ability to introduce redundancy for services and data so failures can be bypassed transparently is a core aspect of clouds! Fault tolerance also requires the ability to introduce new redundancy of services without a significant performance penalty.

- *Reliability* denotes the capability to ensure constant operation of the system without disruption, i.e. no loss of data, no code reset during execution, etc.
- *Quality of service* measures metrics like response time, throughput, etc., that must be guaranteed at least to ensure that the quality guarantees given to the cloud user are fulfilled.
- *Elasticity* covers the scalability of the underlying infrastructure to adapt to changing requirements and dynamic integration and extraction of physical resources to the infrastructure, such as amount and size of data supported by an application, number of concurrent users, etc.
- *Agility and adaptability* include on-time reaction to changes as well as adaptation to changes in the number of requests, size of resources, but also the environmental conditions that e.g. require different types of resources, different quality or different routes, etc.

Economic considerations are one of the key reasons for introducing cloud systems in a business environment. Relevant aspects to consider include:

- *Cost reduction* is one of the first concerns to build up a cloud system that can adapt to changing consumer behaviour and reduce the cost of infrastructure maintenance and acquisition. Notably, setting up a cloud system typically entails additional initial costs to become "cloud-ready".
- *Pay per use,* the capability to build up cost according to the actual consumption of resources is a relevant feature of cloud systems. By removing the need for upfront capital investments and implementing operational expenses, cloud computing enables SMEs and entrepreneurs to accelerate the development and adoption of innovative solutions.
- *Improved time to market* via infrastructures dedicated to specific use cases that take over essential capabilities to support easy provisioning and thus reducing time to market. This is essential for SMEs that want to sell their services quickly and easily with little delay caused by acquiring and setting up the infrastructure.
- *Turning initial capital expenditure into operational expenditure* is vital for smaller SMEs and entrepreneurs. Traditional IT systems require initial capital expenditure to build up a local infrastructure. Outsourcing computational resources to cloud systems on demand and scalable to gain operational expenditures while using the infrastructure.
- *Going green* is relevant to reduce energy costs and the carbon footprint.

Technological challenges implicitly arise from the non-functional and economical aspects, when trying to realise them.

- *Security, privacy and compliance* are obviously essential in all systems dealing with potentially sensitive data and code.
- *Virtualisation* hides the technological complexity from the user and enables enhanced flexibility (through aggregation, routing and translation), ease of use, infrastructure independency, adaptability, and location independence.

- *Data management* is an essential aspect in storage clouds, where data are flexibly distributed across multiple resources. Data consistency has to be realised over a wide distribution of replicated data sources with reasonable latencies. Data management issues have to be addressed as the size and distribution of data may change at any time
- *Tools and APIs* are essential to exploit the cloud features to a maximum and to support development, adaptation and usage of cloud services.
- *Metering* of any kind of resource and service consumption is essential in order to offer elastic pricing, charging, and billing.

Future ICT management in SMEs will move from the technical side to business applications. The challenge for the SMEs is to keep track of the technical developments in the ICT area to discover new and improved business support and perform strict change and costs management at a strategic level. ICT is no longer a technical support function. Instead, it gets closer to the core business, i.e. what the employees need to do in their jobs rules. The role of ICT departments then becomes to discover what the users need or what has to be improved and check with existing service providers how this can be done efficiently.

3.4. Entrepreneurship and start ups

A number of studies show that Europe is not short of entrepreneurship and start-ups, but Europe is short of start-ups that grow and innovate at international competitive levels (Aslesen et al 2008).

This section presents how cloud computing and start-ups are related and will highlight some of those successful European start-ups that *use* cloud services and some start-ups that *develop* cloud services. In order to get the insights from these start-ups, vignettes representing users and developers will showcase what it takes to make a start-up successful. However, first we present the structural background of the European start-up environment.

For a number of years, the European ICT sector has experienced several forms of multi-stakeholder partnerships and strong industry involvement, but what characterises these initiatives and projects is that they are run by large corporations like Microsoft, Cisco, IBM and SAP. This has some positive perspectives, but there is a need to also assess how SMEs can become more integrated in such initiatives or create their own innovation environments through networks and different models of innovation.

The pan-European business association for ICT SMEs is one way to secure higher involvement and development, because the organisation takes the needs of start-ups and SMEs into consideration. However, one of the most pressing challenges for start-ups in Europe in general is the lack of access to venture capital and business angels (Library House 2007, Aslesen et al 2008).

There are several government and EU funds and policies aimed at helping start-ups – known as *gazelle programmes* - but the outcomes and effects of these programmes are not widely known. A European-wide analysis and impact evaluation on the effects of

gazelle programmes and different models of incubators for knowledge intensive start-ups such as ICT companies could inform European and national policies in the field.

Cloud computing provides three important elements to start-ups. First, it means that the need for investing in ICT capital is scalable to the needs of the start-up. Second, cloud computing services are under development, leaving some room for ICT start-ups, and, third, cloud computing adoption is currently taking off, meaning that there is an immature market with excess demand.

3.4.1. Cloud start-ups in Europe

Over the past couple of months, CloudTweaks has offered corporate profiles of some of the most innovative and fast developing start-ups in Europe to its readers. Some companies on the list are already established in the cloud computing sectors, and others are still developing their services. All the companies are based in Europe, although some of them have offices in North America and Asia, and all are involved in developing innovative products that are almost entirely cloud-based. This is not a complete list of all promising European cloud start-ups. It is a series of profiles of the companies that are already in the market and are growing rapidly.

Table 3-2: Innovative and fast developing European cloud start-ups45

1	***Aepona*** provides application-led products and services to telecommunications operators worldwide.
2	***Amplidata's*** Distributed Storage System provides storage solutions for cloud-based businesses and data centres based on a next generation RAIN grid.
3	***BlueTeach*** is a knowledge sharing community in the cloud, offering a virtual classroom called Eclass. The service features video conferencing tools and whiteboards allowing users to embed graphics and other objects.
4	***Brightpearl*** offers end-to-end web based solutions for SMEs featuring a fully integrated accounting system, CRM, order and stock management, e-commerce and helpdesk capability. The platform integrates with services like Gmail, Google Apps, MailChimp and many others
5	***Cloudmore's*** solution can provide one stop provisioning, billing, integrated identity and service level management that enables companies and organisations to smooth and accelerate their transition to the cloud
6	***CloudSigma*** is an Infrastructure-as-a-Service (IaaS) provider, and its platform is independent of operating systems allowing users to install any operating system they like by choosing from standard server templates or uploading their own
7	***CohesiveFT*** allows users to dynamically define and deploy servers for virtual environments and clouds through its Elastic Server platform. The company also develops VPN-Cubed, a cloud security solution.
8	***Flexiant*** provides cloud infrastructure software and services for hosting providers, data centre owners and telecommunications operators. It is one of only three independent public cloud providers in Europe. Their FlexiScale is Europe's first cloud platform, which was launched in 2007.

[45] www.cloudtweaks.com/2011/04/top-25-european-cloud computing-rising-stars-to-watch-complete-list/

9	Xcerion AB offers its internet OS as a Web 2.0 service under the name iCloud. One of the features that distinguish iCloud from other similar services is the fact that it is free. No subscription fees are applied and no premium paid membership is offered, while customers are able to purchase additional 100 GB of storage space.
10	***iSpaces*** runs a cloud service named NonStopWeb™. In addition, it offers a new product called CloudBrowser, which is a web browser within a browser allowing users to log in to the company's platform from multiple computers, while iSpaces saves the state of their interface to the company's data storage centres in the cloud.

An interesting finding from the above list is that these European start-ups are in the midst of building the 2nd generation of cloud services focused especially on usability and the needs of the customer. Some of the start-ups are developing flexible services that can be customised to their customers in terms of design and the customers' organisation. Podio (see box below) is a solution that allows users with no knowledge of programming to create applications.

If we take a step back and consider one of the findings from the section on SME uptake of cloud solutions, the section indicated that SMEs are still largely using basic cloud solutions with less focus on services that enhance business revenue, agility and innovation. This means that ICT transformation - and how it is connected to business transformation - is one of the areas that start-ups are now looking into compared to 1st generation legacy systems. For entrepreneurs there are interesting changes in applications and solutions related to software as a service with increasing focus on *software enabled service.* Both large established vendors and SMEs are following the trends in connection with service innovation and seeing how software enables service.

Trends from the provider section pointed towards mobile clouds, the social enterprise and new business models, and the start-ups are now exploring this field. Another interesting development is how some of the open platforms, e.g. from OpenStack, allow users and developers to build on those platforms.

The next box presents Podio, a start-up company that won the 2011 TechCrunch Europe Award for Best Business Start-up. Podio has existed for three years and has 27 employees. Some 50,000 organisations use their cloud services.

Box 3-3: Podio – knowing the needs of the users

User needs
Podio was started because the founders thought that people were working in e-mails, documents, etc., and the communication stream was broken. They believed that there had to be a much better way for people to work and collaborate. They looked at the available tools and decided that people should be able to make their own tools rather than relying on IT departments to make their tools for them. Moreover, it was important that users would not need programming skills to create the applications.

How do they run their company?
Everything is in the cloud and is hosted on Amazon. As such, they have no data centre and they do not have an IT department.

Which skills were needed when implementing the cloud solution?
They needed development skills, programmes, design skills (to be able to design the user experience, interaction, and sales experience), marketing, social media basics and finance skills. However, the most important skills are programming, and development.

Everyone on the team had knowledge of the cloud. They had used Google Apps and Amazon before. They interact with many different available cloud services on a day-to-day basis. They have not needed to upgrade their skills by attending courses, but a lot of training has been done on the job. In addition, they have hired new people to get new skills bases that they lacked before.

The impact of Podio on user organisations
For a small company, you could feasibly get rid of your IT department by implementing this solution. However, for most companies with 50-100 employees, this is a complimentary system. You still need someone who knows how to fix the printers.
Phil Chambers CTO

About the solution
Podio is an online work platform with a new take on how everyday work is done. It gives people more power than ever before to manage their work in their own way. They use workspaces to collaborate with specific groups of people, and an employee network for company-wide communication across departments and locations. Work is done on Podio using apps. Anyone can build their own Podio Apps, regardless of technical know-how, or choose from those already available. The apps add structure to the workflow and combine with social activity streams for commenting and discussions.

Podio has announced a new programme to make Podio available free to the 40 million+ university students around the world. Students have always been early adopters of the new technology and are already connecting and collaborating. Considering this strategy in the light of trends discussed above concerning employees *bringing their own devices*, this strategy also takes the blurring boundaries of the social enterprise into account. If the university students get used to the tool they will also use it at work, just as it happened with Facebook.

Business value and innovation

In the previous section, we looked at start-ups within the cloud services. In the following, we present at good example of a start-up that uses cloud services in its business model. One of the key findings from the section on cloud computing in SMEs

was that companies focus less on business creation through clouds services and more on cutting costs. The following start-up example is a showcase of how companies can use cloud solutions to create growth.

CloudApps won the Greenbang 2011 Efficiency Award in the Cloud Computing category. The award celebrates the most forward-thinking, innovative businesses whose projects are designed to create a sustainable business future. The company is thus a pioneer in delivering energy efficiency and driving sustainable values into business. CloudApps is recognised by leading global publications and authorities already three years after starting up in business.

Box 3-4; CloudApp a green IT company enhanced by the cloud[46]

Business value created through cloud
CloudApps delivers its sustainability software in the cloud. This means that it is able to roll out across an organisation no matter where it is based and can scale up or down taking in as many varied data points as the customer needs across data sources as diverse as HR, travel, expense systems, waste disposal service providers, or even smart meters. This allows the customer to realise the impact of sustainability on its business, and put in place effective cost savings, carbon cutting schemes and create positive change.

Innovate to stay ahead
With its cloud solution, CloudApps estimates that it can build applications about five times as quickly and at half the cost of traditional software platforms. This has enabled the company to innovate and stay well ahead of its competitors in terms of its development curve.

CloudApps benefits from the cloud services' ability to support cost-effective growth in addition to business gains due to the innovation that the platform delivers. CloudApps is thus focused on its core business, i.e. guiding its customers through the carbon journey - helping them to comply with global climate change legislation, reduce operating costs and enhance their brand. The idea generation platform allows companies to tap their community of employees, customers and partners to crowd source, identify, rank, iterate and implement unique carbon reduction ideas.

About
CloudApps leads the world in sustainability software, enabling organisations to make exceptional efficiency savings and meet sustainability targets by aligning the entire enterprise behind corporate sustainability goals. CloudApps is unique in solving the sustainability challenge by connecting the sustainability efforts of employees on the front-line, or "bottom-up", with "top-down" commitments made by management.

[46] See: www.cloudapps.com/cloudapps-wins-recognition-greenbang/

4. E-skill requirements in SMEs and start-ups

With the rapid spread of cloud computing and the increased focus on green and security aspects in ICT, practitioners in European SMEs and start-ups face new roles and skills requirements. This section will address how the changes in business-services resulting from uptake of cloud technologies (as discussed in Chapter 3) affect the skill set of the average practitioner. Sections 4.1 and 4.2 analyse the changing role of the ICT practitioner in European SMEs and start-ups respectively and answer questions such as which skills are in highest demand today and in the future? Which specific skills are currently subject to the highest growth in demand? What are the similarities and differences between skills requirements in SMEs and start-up companies? Moreover, are other attributes besides skills important for ICT practitioners to work effectively in the SMEs and start-up of the future?

4.1. SMEs

Cloud computing has significant potential for improving the efficiency and competitiveness of European SMEs. However, embracing this technology without ensuring an accompanying adjustment of practitioner skills could prove risky. This section will discuss likely developments in practitioner skill demands as cloud computing as well as security and green aspects of ICT increasingly find their way into European SMEs.

Following a broader discussion on the evolution of e-skills in general, current and future e-skill demand will be analysed within each of the three focus areas of the study, i.e. cloud computing, cyber security and green IT. The three subsectors are treated individually to ensure the deepest possible and specific treatment of e-skills challenges under each of them. Being aware of their interconnectedness is, however, also important. Most experts consider cyber security a precondition for successful development in the areas of both green IT and cloud computing. Moreover, with the implementation of, for instance, smart grids in green IT and outsourcing of sensitive data to the cloud, new security challenges emerge. Cloud computing, in turn, holds a lot of potential for energy saving and more efficient use of ICT services and infrastructure. In other words, the three areas are closely interrelated.

When looking at skills requirements for SMEs, there are significant variations between different sectors and different types of companies. One important distinction is between companies where cloud computing is implemented as a utility and companies who seek to innovate through cloud computing and make it part of their business strategy. This chapter will focus on the first category of SMEs for whom cloud computing is a way towards improved efficiency, lower ICT costs, improved communication, etc.

4.1.1. General developments in skill demand

In the following analysis, we lean substantially on the categorisation and terminology of the recently developed European e-Competence Framework 2.0.

Functions and skills of the ICT practitioner

The European e-Competence Framework 2.0 divides e-competences into five different competence categories. These categories correspond to different functions performed by European ICT practitioners in their daily operations. The categories are:

- planning;
- building;
- enabling;
- managing; and
- running,

Planning, building and running are core areas, whereas enabling and managing are crosscutting issues. Moreover, planning and enabling represent strategic operations in companies whereas building and running relate to operative processes, and managing relates to daily business administration and improvement (European e-Competence Framework, User Guidelines 2.0).

Furthermore, the framework identifies a number of specific e-competences under each practitioner function (32 in total), and under these again a number of highly specific skill examples. In this section, we focus primarily on the development in importance of each of the competences contained in the framework and its underlying skills.

The changing importance of practitioner functions

Experts primarily appear to agree, that all practitioner functions will grow in importance. In fact, none of the 32 e-competences included in the European e-Competence Framework 2.0 are perceived as becoming less important in the coming years. In other words, there is a widespread belief that a lift in e-skills is required across the board for European SMEs to effectively utilise ICT and compete in the global market.

Projecting skill developments

The projected development in importance of practitioner functions and e-skills in this chapter is based on the opinions of experts. The expert opinions were collected in two rounds in a process leaning on the principles of the Delphi-method. The first round consisted of semi-structured qualitative interviews with all experts. The results of this process laid the groundwork for structuring the second round. This round was a more quantitatively oriented survey focusing on the projected development of each of the 32 e-competences listed in the European e-competence framework 2.0. The survey was purposely carried out six months after the qualitative interviews. Following the data collection procedure, the findings of the two rounds were compared and combined to form a clear and robust image of current and future e-skill developments. In this chapter, the term “future” refers to the point in time when cloud computing – in some form – has become a common phenomenon across European SMEs. The average expert believed that to be in about five years (2016).

Although a general upgrade in practitioner skills is required, some skills experience a more drastic increase in importance than others. Skills related to enabling and managing are expected to see a particularly high growth rate in the coming years. Even though such skills are not in particularly high demand today, they are expected

to catch up and become just as important as traditional core practitioner functions related to planning and building.

This confirms the conclusion of Chapter 3, stating that practitioners are becoming increasingly integrated into the higher levels of the organisation. In terms of enabling, ability to outline and develop efficient strategies for security and quality is specifically believed to become increasingly important in SMEs. The growing importance of ICT management is primarily related to skills in daily management of quality, security and business change.

Another interesting conclusion is that skills related to running ICT systems are – and will continue to be – at the core of the practitioner's skill set. Ensuring stable, operational and user-friendly ICT systems on a day-to-day basis remains the prime responsibility of the ICT practitioner. However, although the importance of running systems effectively will not change, it does not imply that the *way* systems are being run will remain the same. In companies embracing cloud computing, for instance, running ICT systems will to a lesser extent concern operating local area networks, providing user support, analysing and repairing PCs or installing or upgrading and maintaining locally installed software. Instead, running ICT systems will be about ensuring a smooth and user-friendly interplay between cloud systems, ensuring stable internet connections as well as effective communication and collaboration with cloud-vendors on delivery of service and security.

Moving up the value chain

The change in the relative importance of practitioner functions clearly illustrates a growing emphasis on the ability to operate at a general level as opposed to working in narrowly defined areas with very specific technical tasks. In an increasingly cloud-driven environment, there are plenty of online-based solutions that have already been programmed and provide built-in help-desk services. This decreases the importance of skills related to software architecting, user guidance provision, building and programming skills, etc. Instead, practitioners in SMEs are being asked to analyse demands for services, strategise on how to implement them most efficiently, how to make them work together and how to manage the ICT processes once they are up and running. In other words, practitioners are required to take a step further up the value chain.

In the special case of SMEs where cloud computing is implemented as a means of product or process innovation (typically in the ICT sector), the move up the value chain is, however, not always viable. Here, highly specialised competences related to architecting and programming remain top priorities – although in this context they are directed towards architecting and developing cloud driven or cloud-utilising solutions.

Figure 4-1: Job description example: Increased importance of enabling and managing related skills

Solutions architect

Job summary:
To analyse and describe the overall ICT needs of the organisation; to formulate demands and service level agreements for new ICT solutions to improve business efficiency and productivity.

Essential functions:

- Analyse business needs and formulation of specifications for matching business solutions
- Participate in formulation of strategies for service level provision and security
- Interact with providers and end users to ensure technical compatibility and user satisfaction.
- Ensure timelines and budgets are met, and oversee the implementation of a new system
- Analyse demands for training of users and co-ordinate training activities

Professional skills (proficiency in one or more of the following areas):

- Able to identify long-term user and organisational needs
- Able to evaluate service provision against service level agreement
- Able to anticipate and take proficient measures against potential service disruptions
- Able to anticipate and take proficient strategic measures against security breaches
- Able to interpret and act upon service delivery requirements

Transversal skills (proficiency in one or more of the following areas):

- Excellent oral and written communication skills
- Solid administrative skills
- Good analytical and reporting abilities

Additional requirements:

- Awareness of business and ICT interplay
- Knowledge of the organisation's information and business strategy
- Familiarity with the organisational goals and objectives
- Knowledge of best practices and standards in IT service delivery

4.1.2. Skills for cloud computing

Which specific skills do ICT practitioners who work in cloud-using SME need? How does cloud computing change how practitioners perform different job functions? Which skill areas are in relative growth and decline compared to today as cloud computing becomes increasingly common among SMEs? These questions will be answered in the following section.

Cloud skills?

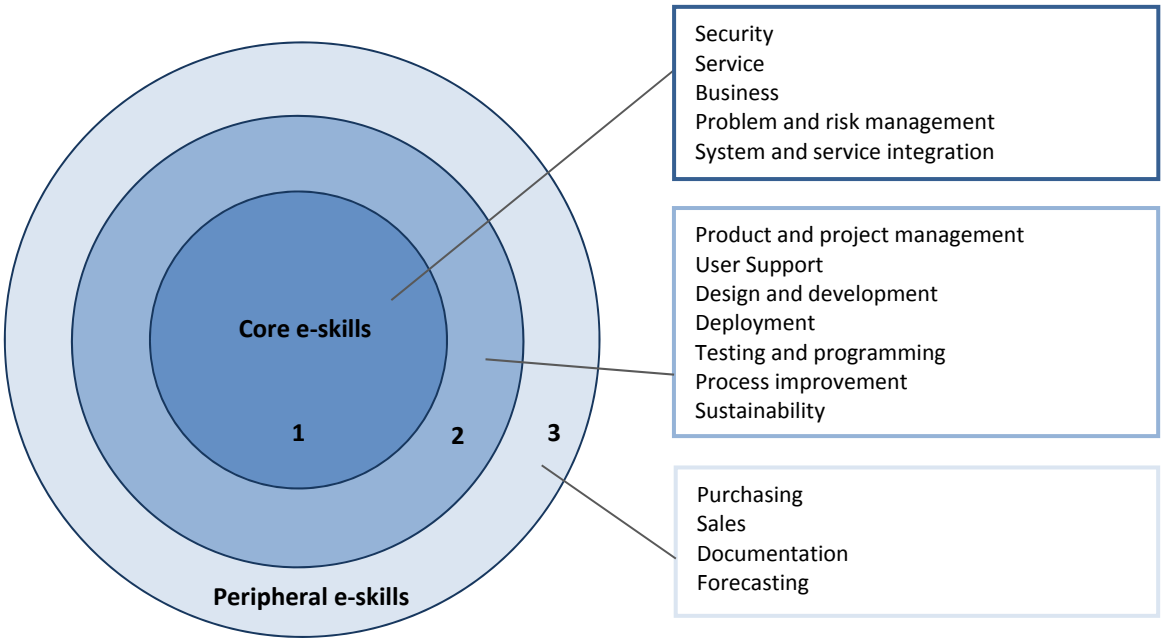
In fact, there is little new about cloud computing. The technology has existed for years and so have most of the skills needed to implement it. What *is* changing is the amount of data being placed in the cloud as well as how and for which purposes cloud solutions are being adopted. A majority of leading experts in the European ICT field holds this view. Successful implementation of cloud computing does, in other words, not require a set of previously unknown skills. Instead, it requires a re-prioritisation of existing skills and job functions. Some become more important than before, while others decline in importance.

> *"Cloud computing increases demand for skills in relation to portfolio management - service assets and service inventory"*
> *- Cloud computing expert*

Future skills requirements in cloud using SMEs

Figure 4-2 groups a number of skill areas according to projected future importance when cloud adoption has reached a significant level across European SMEs.

Figure 4-2 – E-competences grouped according to projected future importance



The set of skills projected to become most important in cloud-using SMEs is generally concentrated around reading service demands in the organisation and delivering corresponding high-quality solutions that are secure and effective.

A large proportion of the skills believed to become most important in the future are related to information security. The evolution of cloud computing presents both new and a higher number of security challenges, placing skills related to both security strategy development and daily management of security at the very core of the practitioner's skill set (see Section 4.1.3). Service-related skills, whether related to reading needs and formulating service level agreements or to actually delivering on-

target and high-quality services, make up another two of the six skills in the top group. Whereas service delivery has always been the focal point of the work of the ICT practitioner, service level management has traditionally been seen as the responsibility of the CIO. However, as software, platforms and infrastructure increasingly move to the cloud, the average ICT practitioner is also faced with the challenge of evaluating the service provided by cloud vendors against the service requirements of the enterprise and act accordingly. Skills related to problem management and system and system integration are also in high demand. The latter illustrates the importance of providing an efficient interplay between different cloud solutions while at the same time ensuring a simple user interface.

In the second group, we find skills in the areas of product and project management, user support, design and development, deployment, testing and programming, process improvement and sustainability. Their placement in the second group means that they are considered important but not crucial for being able to run ICT systems effectively. Most noteworthy perhaps is the fact that skills related to user support, design and development, testing and deployment are found in this category. These were traditionally considered core competences of the ICT practitioner, and although they have already dropped somewhat in importance in recent years, experts believe them to drop to a medium level of importance once cloud computing finds its way into the SMEs.

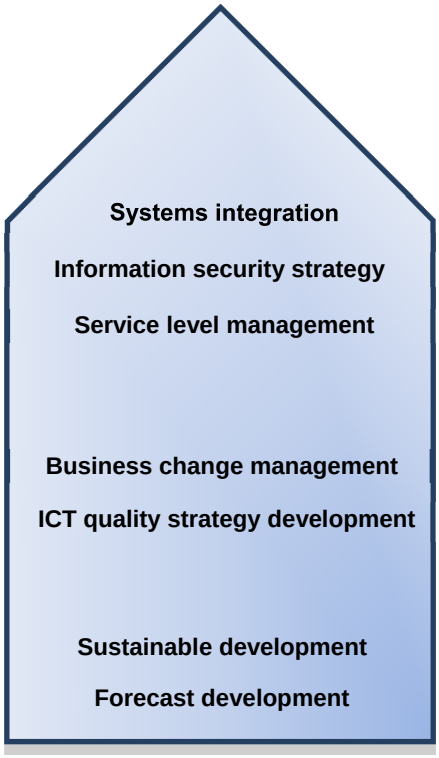
In the bottom group containing the more peripheral competences, we find skills related to purchasing and sales, production of documentation and forecast development.

Skills in relative growth

From looking at the skill set of the future ICT practitioner, we now turn to the perceived development in skill demand in the coming years. Are there interesting patterns to be detected when looking at the specific skills in the most dramatic growth and decline?

Figure 4.3 identifies a number of skill areas that experts believe will grow most dramatically in importance over the next years. The figure also illustrates the current and future level of importance utilising the scale from core to peripheral skills presented in Figure 4.2.

Figure 4-3: E-skills in increased relative demand



As described above, system integration skills become particularly important when an SME moves towards increased use of cloud services. When systems are no longer built from scratch but are increasingly purchased from the outside as almost ready-made products, more systems with no logical interconnection will be forced to coexist. ICT departments will be required to integrate these into one stringently aligned machine while having little or no control over each individual system. Although outsourcing of ICT to foreign countries breeds similar challenges, the almost complete lack of control over cloud systems makes the complexity even higher in this instance. Providers are, however, aware of the importance of interoperability and have begun to take steps to ensure that their products are compatible with those of their competitors. Consequently, some experts project that the process of ensuring interoperability will be automated and that related skills will again decrease in importance in the long term.

Growing even more drastically in importance – from middle to crucial importance – are skills related to information security strategy development and service level management. Together, these two skills point to an increased role of the ICT practitioner in relation to detecting new service and security demands and formulating solutions to address them (the growing importance of cyber security will be addressed in further detail in section 4.1.3). The future practitioner will thus not only implement systems and related security schemes, but will increasingly become a party to formulating the overall strategies guiding the implementation.

Growing from different levels of lower to medium importance are skills related to business change management, ICT quality strategy development, forecast

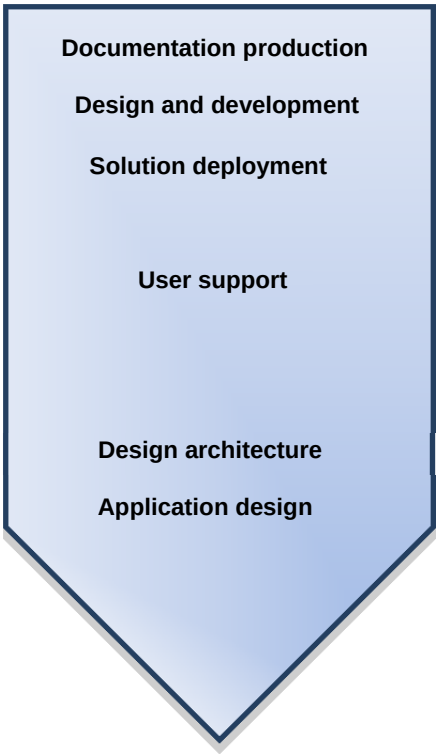
development and sustainable development (the latter will be addressed in further detail in section 4.1.4).

The above analysis of skills in relative growth is generally true for a clear majority of European SMEs for which cloud computing is just one of many instruments in their management toolbox. In SMEs where innovation and product development is built around cloud computing, the image is somewhat different. Here, strategy development and other management tasks are not expected to grow as drastically in importance, whereas highly specialised professional skills related to cloud architecture, development and business-utilisation of cloud will become essential.

Skills in relative decline

The relative growth in importance of the skills described above happens at the natural expense of a number of other skills that are expected to decline in importance over the coming years. Figure 4-4: Key e-skills in relative decline highlights six specific skill areas that experts believe will decline in importance once cloud computing spreads across European SMEs.

Figure 4-4: Key e-skills in relative decline



The skills in the most dramatic decline fall into three main groups: 1) design and architecture, 2) development and deployment, 3) user support.

The most drastic decline is primarily in design- and architecture-related skills. Skills in connection with application design, which are currently seen as highly important, are projected to drop to a level of average importance. Demand for skills related to design architecture is projected to decline even more dramatically from being among the most

demanded skills to becoming almost not important at all. The reason for this decline in design and architecture related skills is that the task of designing systems from scratch will tend to be outsourced to providers wherever cloud computing is implemented. Practitioners will of course still need to detect and describe the demand for ICT systems, but instead of moving to design of specific solutions, they will turn to the cloud for already existing solutions that can be adapted to suit their specific needs.

Development and deployment related functions are also predicted increasingly to move into the cloud, making in-house skills in these areas less important for SMEs. Programming skills will therefore drop in importance, but they will not become obsolete. Instead of being used to develop systems, they will largely be aimed at adapting pre-built cloud systems and ensuring efficient interplay with existing systems.

With regard to user support, many such tasks will no longer be performed by the ICT practitioners as a natural result of outsourcing of infrastructure, platforms and software to the cloud. When systems are no longer placed in-house, it becomes increasingly unprofitable to maintain the in-depth technical knowledge required to support people in how to use them. Moreover, many cloud providers offer direct support to users, thus completely circumventing the ICT practitioners in the organisation.

Apart from these skill areas, skills around documentation production will move from the inner to the outer periphery due to increased automation of documentation processes. Again, an important note is that most of the mentioned skills are only declining in importance across SMEs who are not building products or services around cloud computing. For those, particularly design and development will remain a top priority amongst their practitioners.

Cloud computing in different job functions

In the following, we identify specific e-skill requirements related to cloud computing in different practitioner functions. The findings are summarised in table 4-1 below:

Table 4-1: E-skills for cloud computing in different practitioner functions

	Cloud Computing
Planning	Capturing and prioritising demand, assigning resources based on business objectives and initiating projects that deliver business value. Understanding the costs, benefits and risks of cloud computing and how this translates into to the business strategy.
Building	Utilising design and programming skills to ensure interoperability of cloud systems and efficient interaction between cloud and local systems. Deployment and adaption of cloud solutions to fit organisational needs and infrastructure.
Running	Ensuring high-quality, efficient and secure service delivery. Respond to problems when they arise and deploy appropriate solutions. Ensuring updated and stable infrastructure. Brokers and translators between business and vendors.
Enabling	Formulation of strategies and contracts for service delivery, quality and

Cloud Computing	
	security of cloud solutions. Negotiating with staff in multiple departments and at all levels. Insight into legal issues of privacy, transportation and storage of data as well as the overall business strategy of the company.
Managing	Contributing to the daily management of local and cloud-based operations by ensuring efficient implementation of strategies and contracts for service delivery, quality and security. Management of information security, assessment of risks of risks and implementation of appropriate measures.

Planning

The primary planning-related task facing practitioners in cloud-utilising companies is to define and describe demands for cloud services and suggest actions to accommodate these. The practitioner must therefore have solid analytical skills for evaluating existing or potential future cloud systems and how their performance corresponds with the service needs of the organisation. The next step is to close the identified gaps, and this requires a solid understanding of the performance, costs, benefits and risks of different cloud systems. It also requires knowledge of different solutions, a good ability to formulate explicitly demands for adjustments and solid communication skills to communicate needs and demands internally in the organisation as well as to cloud providers. The key here are abilities related to capturing and prioritising demand, assigning resources based on business objectives and initiating projects that deliver business value.

> *"There are a lot of misperceptions when it comes to architecting the cloud. It is not a stack of Lego-bricks on top of each other. The architects do not need to build everything as before. They need skills around the cloud." - Cloud computing expert*

Building

With cloud computing, the sharp division between the role of the architect and the developer becomes blurry, as companies do not need to build everything the way they did before.

Because cloud computing will standardise infrastructures, ICT departments will spend far less time managing platforms and infrastructures and instead focus on understanding how the multiple cloud offerings could work together and how they could be used to benefit their organisation. Fewer people will be needed to carry out the work of implementing applications, while an increasing number of practitioners will work on tying together different cloud services and hooking these services back to in-house systems.

> *"If we look at the future of ICT practitioners – it is obvious that the IT support as we know it is no longer needed. Practitioners installing software, supporting and testing – their jobs are gone" - Cloud computing expert*

Figure 4-5 – Job description example: Skills for cloud computing

Cloud Specialist

Job summary:
To ensure a smooth transition from local to cloud solutions in areas where benefits clearly outweigh costs and risks.

Essential functions:

- Analyse existing in-house systems and the potential for moving these to the cloud
- Formulate specific specifications for cloud solutions and communicate these to potential providers
- Analyse the operability, interoperability and user-friendliness on an on-going basis following the transition to cloud services
- Formulating needs for adjustments of systems based on tests and analysis and liaising with cloud vendors on making these adjustments.

Professional skills (proficiency in one or more of the following areas):

- Analyse costs, benefits, challenges and barriers of movement from in-house to cloud systems.
- Formulate strategies for efficient implementation of cloud solutions.
- Ensure efficient interplay between cloud systems as well as between local and cloud systems
- Negotiate service delivery agreements and security policies with cloud vendors
- Use scripting languages to automate tasks and gather data
- Conduct performance analysis, proactive troubleshooting and capacity planning
- Implement proficient quality assurance measures

Transversal skills (proficiency in one or more of the following areas):

- Excellent communication and writing skills
- Business skills
- Negotiation skills

Additional requirements:

- Knowledge of enterprise demands and information strategies
- Awareness of available cloud solutions
- Awareness of potential security issues related to implementation of cloud computing

Running

Although a number of traditional running-related services will move to the cloud, it will still be at the core of the ICT practitioner's role to ensure that they operate smoothly together on a user-friendly and stable platform.

In terms of support, the general view of experts is that support functions follow the systems. In other words, if systems move to the cloud, so do user-support tasks. Nevertheless, a number of IT support functions will still be in demand. The physical maintenance of hardware is difficult for companies to outsource to clouds, because internet connections, printers, computers, etc., still need to be installed and maintained. Furthermore, as the software is placed in cloud, ICT practitioners working in the IT support area can be placed in new job roles as brokers and translators

internally between business units and externally between the organisation and cloud computing vendors. This requires communication and cooperation skills.

ICT departments will thus support business units in researching cloud computing services and negotiating contracts and service levels, rather than continue to operate all of the IT infrastructure themselves.

Enabling

The primary task of the practitioner in terms of enabling is the ability to develop robust and on-point strategies for service delivery, quality and security. In a future cloud-driven environment, companies will increasingly rely on the quality and security measures of vendors, and the practitioner will therefore increasingly be involved in formulating requirements and vendor contracts, engage in dialogue with vendors and evaluate purchased systems.

Managing

The ability to implement the formulated quality and security strategies was pointed out as being the primary management related responsibility of the future ICT practitioner. This includes the ability to evaluate and analyse process steps to identify strengths and weaknesses in quality and security and to monitor, understand and act on quality and security indicators. The ability to manage business change was also mentioned among the most important management-related skills headed into the increasingly cloud-driven future.

Conclusion

Cloud computing undoubtedly changes the role of the ICT practitioner. However, instead of introducing an entirely new set of professional skills it rearranges the importance of skills already in the practitioner's toolbox.

The integration of cloud computing in European SMEs will result in the outsourcing of a number of traditional practitioner tasks to cloud providers. They will now increasingly undertake tasks related to system architecting, programming, testing and user support. Instead, the practitioner will play a crucial role in detecting demands for services, identifying appropriate vendors and solutions and securing a steady and efficient interplay between cloud systems once they are up and running.

The future ICT practitioner will generally be required to take a step up the value chain and help solve tasks that were traditionally the sole responsibility of the CIO. Although he may not lead the efforts, the practitioner will increasingly be involved in analysing existing systems, detecting demands for new solutions, formulating these into strategies and service level agreements and orchestrating efforts to implement these. Using a skill terminology, horizontal and business-related skills will generally grow in importance. Moreover, in terms of professional skills, high-level specialised skills will remain crucial, but crosscutting skills related to management and enabling will be added.

The table below summarises the changes in importance of different skill areas due to the increased uptake of cloud computing:

Figure 4-6: Changes in skill demand

E-skills	Type	Importance		Change
		Current	*Future*	
Information Security Management	MANAGE	1	1	-
Service Delivery	RUN	1	1	-
Problem Management	RUN	1	1	-
Risk Management	MANAGE	1	2	-1
User Support	RUN	1	3	-2
Application Design	PLAN	1	3	-2
Systems Integration	BUILD	2	1	+1
Business Plan Development	PLAN	2	2	-
Design and Development	BUILD	2	3	-1
Solution Deployment	BUILD	2	3	-1
Technology Watching	PLAN	2	3	-1
Design Architecture	PLAN	2	5	-3
Service Level Management	PLAN	3	1	+2
Information Security Strategy Development	ENABLE	3	1	+2
Contract Management	ENABLE	3	3	-
Education and Training Provision	MANAGE	3	3	-
IT Governance	MANAGE	3	3	-
ICT Quality Management	MANAGE	3	3	-
IS and Business Strategy Alignment	PLAN	3	3	-
Change Support	RUN	3	3	-
Testing	BUILD	3	3	-
Relationship Management	MANAGE	3	3	-
Process Improvement	MANAGE	3	3	-
Information and Knowledge Management	ENABLE	3	2	-1
Product or Project Planning	PLAN	3	2	-1
Personnel Development	ENABLE	3	4	-1
Purchasing	ENABLE	3	4	-1
Business Change Management	MANAGE	4	3	+1
ICT Quality Strategy Development	ENABLE	4	3	+1
Project and Portfolio Management	MANAGE	4	3	+1
Sales Proposal Development	ENABLE	4	4	-
Sales Management	ENABLE	4	4	-
Documentation Production	BUILD	4	5	-1
Sustainable Development	PLAN	5	3	+2
Forecast Development	MANAGE	5	4	+1
Channel Management	ENABLE	5	5	-

4.1.3. Skills for cyber security

Two of the future top-six practitioner competences fall within the area of information security (see Figure 4-6). This makes the promotion of skills related to ensuring secure ICT systems in SMEs a top priority – not only for SMEs – but also for education providers and policy-makers.

The growing importance of security-skills

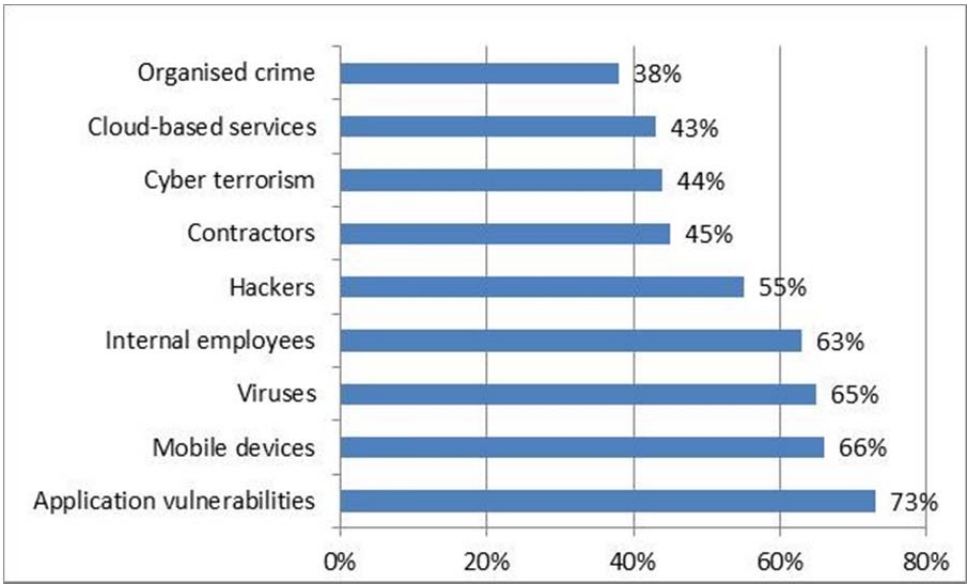
In a business environment where new ICT solutions constantly see the light of day, there is a growing pressure for developing matching security solutions. The interviewed cyber security experts seemed to agree that security is generally two steps behind the development of ICT solutions, resulting in solutions and systems that are unstable and easily exposed to threats. Digital security has received increased attention in recent years - both at political and company level - but the interviewed experts agree that there is still a substantial need for more focus and more specialised professional skills in this area.

Security is far from just an issue in large enterprises. Many experts specifically point out that SMEs are the largest security-sinners, since they often have substantial critical data flows but lack the in-house expertise and specialised staff to guarantee their safety and security.

Security is generally considered a precondition for ensuring successful development of new products and services in the European SMEs. Currently, practitioners have a hard time keeping systems secure due to the rapid speed at which new solutions are developed and implemented. Many current ICT solutions in European enterprises are therefore not sufficiently secure. Consequently, in a macro-perspective, there is currently a substantial gap that needs to be closed – or in the words of one respondent, “a ticking bomb that needs to be diffused”.

A recent worldwide study shows that companies of all sizes increasingly prioritise security and that most organisations are starting to recognise cyber security as a specialist skill (Frost & Sullivan, 2011). The same study reveals nine areas that present the greatest cyber security risks to organisations. The threats are listed in Figure 4-7 in order of severity.

Figure 4-7 – Top security threats



Source: Frost & Sullivan, 2011

Security: a precondition for cloud success

The figure shows that cloud computing presents new security challenges to enterprises. Although only ranked eighth among other potential threats, moving data or storing e-mails on servers around the globe inevitably increases security concerns. For ICT practitioners, operating in cloud-using SMEs this necessitates the ability to analyse the security schemes applied by cloud vendors and demand adjustments to these if they do not meet specific demands. According to the experts, this skill is currently not common among practitioners or CIOs and needs to be developed.

Even though cloud computing affects security, security also has a determining impact on the success of cloud computing. Experts believe security concerns among SMEs to be among the primary barriers to uptake of cloud computing. Although the fear is often greater than the risk, trusting faceless providers to store the company's information at random locations around the planet is an obstacle to many SMEs. Providers of cloud solutions therefore have the dual task of ensuring highly secure systems and convincing SME owners of their competences.

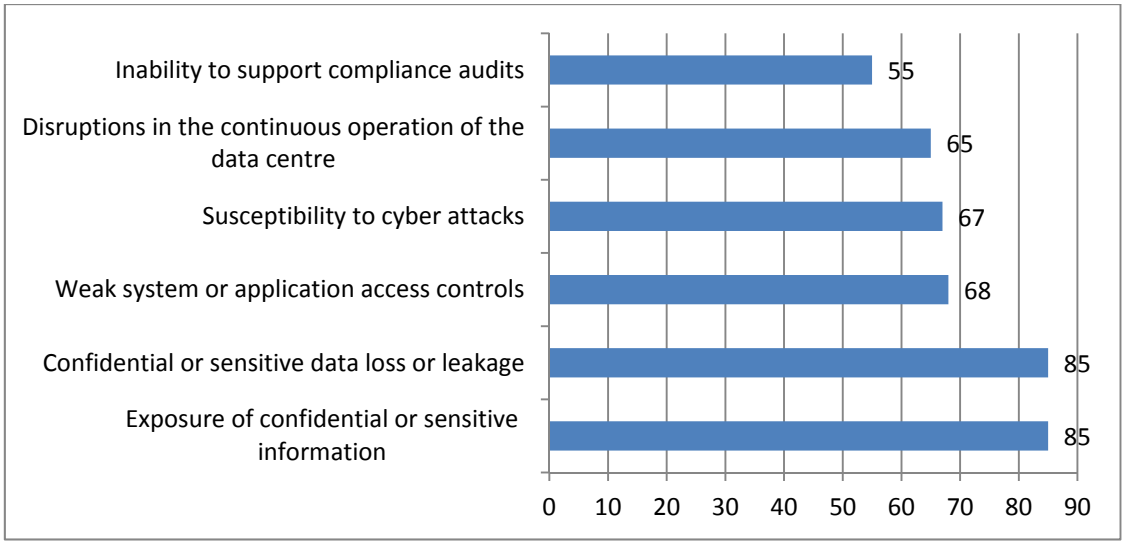
New security skills

What is necessary for security to catch up to technological developments and ensure secure utilisation of cloud systems across European SMEs?

Although practitioners face a general increase in demand for business-related skills, organisational skills, service-related skills and communication skills across the board, they are of minor importance when it comes to cyber security. Information security experts place the primary importance on more, better and yet more specialised professional skills related to security. Carrying out the day-to-day management of system security is believed to be the top-most important single competence – both today and in the near future when cloud computing has taken root in European SMEs, and with ICT strategising growing from average to top-importance.

In relation to security management, there is a specific need for practitioners who are highly skilled in areas such as reverse engineering and malware analysis. Specialised skills are also necessary for analysing security flaws in solutions ranging from individual pieces of software to entire ICT systems in large enterprises. As the experts mention, closing the gaps is normally not the biggest problem. Detecting them before attacks happen is increasingly difficult and generally not something that ICT departments are very good at. The ability to analyse attacks, their courses and sources once they happen was pointed out as being another specific area in increasing demand.

Figure 4-8: New security threats posed by cloud computing (pct.)



Source: Frost & Sullivan, 2011

In relation to security strategy development, practitioners are expected to be able to analyse the current security strategy of the organisation and propose improvements based on developments in the organisation, the internal ICT infrastructure and the external threat environment. Apart from having a high level of professional skills in the area of information security, this requires a solid insight into overall business operations, ability to match this with corresponding security solutions and ability to liaise effectively with enterprise management on implementing them.

Apart from possessing certain skills, some experts also presented the view that working effectively with security is about a certain way of thinking – a constant awareness of potential security issues in one's everyday work. Knowledge about technological developments, threats and accommodating solutions is another key – as are non-skills related ingredients for ensuring secure data and infrastructure in the SME.

Cyber security in different job functions

The table below breaks down the future cyber security skill demand into different practitioner functions:

Table 4-2: E-skills for cloud computing in different practitioner functions

Cyber Security	
Planning	The ability to implement security related aspects in system architecture, product or project planning. Knowledge of ICT solutions and understanding of security-related complications.
Building	The ability to deliver or purchase solutions that are secure and reliable. The ability to integrate security at the earliest possible phase of design and development. Addressing security implications in interplay between and integration of systems.
Running	Delivering secure software, infrastructure and services. A "security mind-set" needed by people undertaking daily execution of activities. Forming and spreading a security culture among users.
Enabling	The ability to formulate an organisation strategy, scope and culture for safety and security of information. Detecting and raising security issues in formulation or purchasing instances.
Managing	The ability to implement the strategy, scope and culture for security in the organisation. Manage security on a daily basis in accordance with business needs and developments.

Planning

The ICT practitioner must be able to detect security gaps, evaluate potential risks and make these matters a part of the everyday activities related to architecture, products and projects. In recent years, the data flows in SMEs have become increasingly complex, involving communication in and between local, cloud and mobile services. This calls for new and highly specialised skills in analysing and securing these complex data streams.

The individual practitioner will need to keep himself constantly updated on new solutions and innovations in the world of ICT and security as well as in the world of business. In a skill perspective, this calls for a mix of appropriate professional skills, business skills and other horizontal skills enabling the practitioner to understand new strategies and innovations and act to accommodate these with appropriate security solutions.

Building

For practitioners involved in project delivery, security is starting to play an increasingly important role. Experts generally agree that there is an increased awareness of security issues among practitioners involved in building, testing and deploying IT solutions. Nevertheless, there is still a long way to go. In the building process, the practitioner must be able to analyse the specific environment in which the solution is to be implemented and detect potential risks.

With the increased utilisation of cloud solutions, security in system integration and interplay between local and cloud systems have become increasingly important. There is often little or no control with the security measures implemented by cloud providers, which makes the ability to analyse cloud security systems, communicate with cloud vendors and formulate specific demands for security improvements increasingly important.

Running

For practitioners responsible for running the daily IT operations of the company, it remains crucial to ensure that systems are stable and secure. In order to do so, security experts primarily emphasise the need for more, better and more specialised professional skills in pressing areas.

Apart from improved specialised skills, many experts also point to the importance of developing an improved "security mind-set" in European SMEs. According to experts, much harm could be prevented if basic tasks such as installing security applications on personal computers, conducting scans, keeping security systems updated, etc., were done properly. Creating a security culture among users in the SME is crucial in this regard.

Enabling

The key role of the ICT practitioner in terms of enabling security is to contribute to the formulation of an organisational strategy, scope and – not least – culture for safety and security of information. An ingredient in this regard is the ability to analyse and detect security issues in functioning infrastructures, platforms and applications, and translate them into operational strategies that are in sync with the organisation as a whole. The ability to analyse and detect security issues when purchasing of solutions is likely to grow in importance with the spread of cloud computing.

Managing

Management in the area of security is primarily about implementing the formulated security strategy through designing potential security projects, prioritising between them and implementing the most relevant ones. This is typically the responsibility of the CIO or at least high-ranking ICT practitioners, whereas most practitioners will primarily be involved in executing the initiated projects.

A number of respondents pointed to the need for more specialised education programmes related to ICT management, where security should play an important role. Some expressed the view that security should not be encapsulated in separate projects or purchases, which is often the case at the moment; it should rather be an integrated part of any new development related to ICT in an enterprise. Improving the quality of ICT systems is closely related to their security. If not secure, their effectiveness is, as respondents noted, simply at stake. Apart from the actual work of detecting and closing security gaps and fighting off attacks, practitioners also increasingly have to handle legal issues.

Figure 4-9: Job description example: Skills for cyber security

Information Security Engineer

Job summary:
To strategise, orchestrate and implement security measures to protect ICT systems from unauthorised access. Responsible for protecting the organisation's large amounts of critical and sensitive information.

Essential functions:

- Perform day-to-day security management activities, including responding to user problems and rectifying faults
- Participate in formulating the organisation's security strategy
- Ensure all security procedures meet compliance requirements

Professional skills (proficiency in one or more of the following areas):

- Perform everyday security management activities, including responding to arising problems and applying corresponding solutions
- Analyse the current security strategy and implement improvements based on business-change, organisational change and changes in the threat environment.
- Perform security audits and act according to their outcomes
- Co-ordinate contingency planning and testing
- Perform maintenance operations such as updating of firewalls, firmware, etc.
- Monitor, read, monitor, investigate and report on incoming data from security devices.
- Detect and respond to intrusion or security breaches
- Assess the impact of new technologies – including cloud solutions – on existing systems

Transversal skills (proficiency in one or more of the following areas):

- Ability to analyse business needs
- Ability to produce professional reports and communicate technical issues using a non-technical language, both orally and in writing
- Able to communicate effectively with staff in all departments and at all levels

Additional requirements:

- Awareness of security issues related to operating systems, networks, hardware and internet-related aspects.
- Ability to understand and assess business requirements in relation to security
- Understanding of protocols, ability to read code and perform basic programming
- Ability to remain calm under high pressure and in stressful situations
- Willingness to continuously update skills and knowledge

4.1.4. Skills for green IT

The growing – but still not very high importance of green skills

The increase in global awareness of the environmental challenge has resulted in an increased demand among businesses for people that are able to translate this into an advantage for their company in terms of more efficient internal processes and new business opportunities. As illustrated in figure 4.3 skills related to green IT are projected to grow substantially in importance over the coming years. However, as the figure also shows, they come from a level of almost no importance today to a level of medium importance once cloud computing takes root. Some experts believe that the current crisis has forced SMEs to leave their green IT strategies in the drawer, but that they will be implemented once the crisis is over. Others feel that green IT is currently more hype than reality, but that it will gain leverage once technologies and methods mature.

> *"Green IT does not necessarily need new skills as the software developments do not change. It is more about the mind-set of the practitioner – the way they apply the skills in a green way. The skills don't change, but how to apply and design the matrix does" - Green IT expert*

Green IT is not necessarily a specific new kind of technology, but a way existing technology and ICT solutions can be used differently to reduce environmental impact. Core skills such as science, technology, mathematics and engineering are some of the central attributes in the area of greening. However, as the expert interviews reveal green IT is probably even more about a green mind-set than about new specialist skills.

This is confirmed by the recent Cedefop report on "Skills for Green Jobs" (2010), which also emphasises, that there is no need for an entirely new skill set among employees working in "green jobs". Another study notes that the key is a cross-disciplinary understanding of how ICT can be utilised for creating smarter and more energy efficient infrastructures, platforms and applications[47]. Some of the key areas in green IT are believed to be:

- ICT optimisation;
- power management (including smart grids);
- green system architecture;
- automated energy monitoring;
- product longevity;
- energy and environmental management applications;
- analysis of environmental footprints of enterprises; and
- telecommuting.

[47] Expert Group on Future Skills Needs (2010): Future skills needs of enterprise within the green economy in Ireland, November 2010: www.forfas.com/media/egfsn101129-green_skills_report.pdf

Even though green IT has been around for some time, the transformation of and impact on businesses is still relatively limited.[48] Green IT skills are therefore a somewhat new aspect of the ICT practitioner's skills portfolio. Table 4-3 below illustrates how the spread of green IT in European SMEs and start-ups influences the demand for e-skills among ICT practitioners. It outlines specific future e-skill requirements related to green IT for each category.

Green IT in different job functions

Table 4-3 breaks down the skills necessary for successful utilisation of green ICT across different practitioner functions:

Table 4-3: E-skills for green IT in different practitioner functions

	Green IT
Planning	The ability to understand the environmental impact of different IT strategies at the general level: the understanding of how to improve business solutions by implementing green aspects.
Building	Technical skills and understanding of environmental impact of the information architecture including process, information, infrastructure, and applications. Making green aspects an integrated part of project formulation, design and delivery.
Running	The ability ICT practitioners undertaking daily support and execution activities in European enterprises to view ICT from a sustainability point of view.
Enabling	Formulation of green strategies for reduction of in-house energy-consumption and development of new market opportunities. Understand ECO Standards and carbon reporting in order to ensure the compliance of regulations and laws.
Managing	Implementation of green strategies. The ability to understand the environmental impact of IT solutions and to manage ICT operations on that basis. Understanding and implementation of green aspects in procurement.

Planning

In order for the ICT practitioner to work effectively with green IT, he must above all be able to incorporate green and sustainability aspects into the ICT strategy of the SME. Green IT calls for the ability of the ICT practitioners working in strategy and innovation to understand the environmental impact of different IT strategies at the general level, i.e., an understanding of how to improve business solutions by incorporating green IT. ICT practitioners working in global sourcing management will need the ability to assess the environmental impact of outsourcing specific IT solutions versus keeping them in house.

[48] e-skills UK (2011): Technology Insights 2011

Figure 4-10 – Job description example: Skills for green IT

Sustainable IT consultant

Job summary:
Accountable for delivering environmental, financial and PR-related results through formulation and implementation of a successful green IT strategy

Essential functions:

- To head the formulation of a green IT strategy as part of our overall new strategy on sustainability
- Play a crucial role in reducing the enterprise's energy costs and carbon taxes and establish a green profile in the market.

Professional skills (proficiency in one or more of the following areas):

- Analyse potential for energy optimisation in daily ICT operations
- Evaluate costs and benefits of potential green ICT initiatives and prioritise efforts accordingly
- Efficiently develop a project pipeline
- Participate in the formulation of service level agreements to guide the implementation of sustainable initiatives
- Promote awareness, training and commitment for the deployment of sustainable initiatives

Transversal skills (proficiency in one or more of the following areas):

- Communication skills (writing and oral)
- Analytical skills
- Organisational skills
- Business skills
- Legislative and regulatory awareness
- Environmental awareness

Additional requirements:

- The "green mind-set", i.e. a natural tendency to look at ICT from a green perspective
- Awareness of regulatory constraints and international standards related to IT sustainability
- Knowledge of efficient green ICT measures in different areas, including best practices

Building

Although many decisions related to sustainability have already been made when arriving at the building phase, there are still important handles to pull to improve energy efficiency. One important element in this regard is the ability to implement green solutions on top of existing solutions by adding new components. Another is to have an eye on the issue of sustainability in the programming or purchasing of solutions in general.

Running

A "green IT mind-set" – as opposed to new specific skills – is generally in highest demand among people undertaking the daily execution and support activities in European enterprises. Although much of green IT focuses on the planning, building and managing stages of the ICT lifecycle, there is also much to be gained in the everyday operations of ICT systems. Practitioners, for instance, play an important role in limiting excess use of energy in the organisation and in forming a green culture and focus among the employees in the organisation.

> *"Green IT does not necessarily need new skills as the software developments do not change, it is more about the mind-set of the developer – the way they apply the skills in a green way. The skills don't change, but how to apply and design the matrix changes." - Green IT expert*

Enabling

The ability to view and work with the company's ICT and business strategy under a green light is one of the key abilities required by practitioners. Making green aspects a key component in the organisation's quality and security strategies is likely to be in future demand, as is the ability to make sustainability issues an integrated part of purchasing activities. Green IT also raises the demand for increased knowledge in areas such as ECO Standards and carbon reporting to ensure compliance with regulations and legislation.

Managing

One of the key management skills required in the area of green IT is the ability to accommodate business change with new solutions that are also green and efficient. Consequently, the practitioner must have a deep insight into the overall activities of his organisation, which requires solid competences in communication, organisational understanding, business analysis and strategies. Essential is also the ability to understand the environmental impact of IT solutions and being able to define and prioritise among these based on this assessment. Another important asset for a future ICT practitioner would be the ability to make carbon consumption a part of the daily quality management of ICT operations. Process improvement and optimisation is in this regard a central component.

4.2. Start-ups

For start-ups, ICT above all needs to be cheap, easy to implement, require little maintenance and be highly user-friendly. Cloud computing holds a number of advantages in this regard – but only if applied correctly.

A crucial precondition for successful uptake of cloud computing in start-ups is that entrepreneurs have a well-developed set of different abilities. Experts point to four particularly important ICT-related prerequisites for successful entrepreneurship, and only two of them are related to skills:

1. ICT skills
2. Business skills
3. Knowledge
4. Entrepreneurial mind-set

4.2.1. ICT-related skills

When talking about ICT skills among entrepreneurs, demand is highly dependent on the context in which they are applied. The type and importance of such skills, for instance, are very dependent on whether the start-up operates inside or outside the ICT sector.

Start-ups in the ICT sector

For start-ups in the ICT sector, professional skills within the company's area of operation are by far in highest demand. Due to the increased global competition and the low importance of geographical factors, start-ups in the ICT sector need to be among the best at what they do. This requires high-level and highly specialised ICT skills. For software developers, for instance, design and development skills within the company's niche of the software market as well as their ability to work effectively on the applied platforms become crucial.

Start-ups outside the ICT sector

For start-ups outside the ICT sector, skills related to implementation and usage of ICT are, naturally, far less important. Instead of being their core business area, ICT is a tool used to ensure smooth and efficient internal processes. The skills in demand are therefore also quite different compared to start-ups in the ICT sector itself.

Recap: Defining a start-up company

There is currently no universally applied definition of what constitutes a start-up company. However, three criteria seem to emerge repeatedly in related literature:

- a time-criterion (has been on the market for a short period of time);
- a staff-number criterion (employs a relatively low number of people); and
- a cultural criterion (in search for an identity, exploratory and experimenting business approach)

When a company applies (or comes close to applying to all three criteria) it is generally considered a start-up.

In this instance, a basic – but highly important – level of e-skills is required. Much like regular household ICT users, start-ups generally rely on off-the-shelf products. For the entrepreneur, major investments in ICT infrastructure or specialised solutions to fit the specialised needs of the company are not viable options. For most, ICT is isolated to a laptop or handheld device and as a means toward stable and efficient business management, communication flows and commercialisation. Experts specifically point to basic skills in the areas below, as being vital for being able to utilise ICT effectively as a start-up company:

- calendar and planning;
- communication (e-mail, audio-chat);
- text editing and spread sheet usage;
- social networking;
- e-business;
- e-commercialisation; and
- PC security (firewall, antivirus, etc.).

However, possessing the right combination and level of ICT skills is by no means sufficient for developing a thriving start-up company – whether inside or outside the ICT sector.

4.2.2. Business skills

One fundamental difference between the start-up and the SME is that the entrepreneur is required to play a role in most of the company's activities – and not only the ICT related ones. This creates a challenge for the entrepreneur, as he will need skills in a variety of areas and, not least, a broad and overall understanding of the business as a whole. According to the interviewed experts, successful entrepreneurs are specifically required to possess a solid:

- understanding of the business context;
- market awareness;
- ability to construct business models;
- networking abilities;
- book-keeping abilities;
- project management skills, and
- the ability to utilise available tools and technologies for commercial and operational purposes.

Of the above-mentioned skills, networking abilities are believed to be particularly important for entrepreneurs to succeed. This not only applies to having the ability to establish contacts with relevant people, but in particular to the ability to know who to involve, how to involve them, and when.

According to some of the interviewed experts, an efficient way to improve entrepreneurship skills is to coach entrepreneurs in starting up and running a business, i.e., assistance from professionals with regard to basic legal support, development of business models and an understanding of how companies and different sectors work. Incubator-environments and various cluster-based initiatives have proven successful in this regard in a number of instances.

4.2.3. Knowledge

For an entrepreneur to be successful, substantial knowledge of available technologies, platforms and security solutions are also required. In order to take full advantage of the latest technologies on the market, a potential entrepreneur will need knowledge about the available solutions and how to implement them. Experts believe that the ability to keep abreast of technology developments and available solutions and not

least understand how they can be translated into more efficient and cost-saving business models is a particularly important asset in the start-up phase. There are, for instance, many benefits to gain from cloud computing that allows entrepreneurs to start up a business easily even with limited skills in the ICT area, as there is no need for a deep understanding of the logic behind the web services.

4.2.4. The entrepreneurial mind-set

Although ICT skills, business skills and knowledge of available technologies and solutions are crucial components in a modern start-up, experts frequently mention one last and more subtle ingredient to ICT-driven entrepreneurship. This is often referred to as "the entrepreneurial mind-set". The focus on this aspect of entrepreneurship is beginning to increase among experts as well as in contemporary literature, including the "European Survey on Entrepreneurship in Higher Education in Europe 2008".

> *"Entrepreneurship has all to do with more intangible attributes such as passion, motivation, knowing the right people, knowing what your budget can support, willingness to take risks and having an understanding of what you can do yourself and what you need help with" - CIO, former venture capitalist and angel investor*

The leading educational institutions on entrepreneurial education increasingly focus on the mind-sets and attitudes of students and not primarily on their skills. The experts interviewed in the area of entrepreneurship are generally sceptical about the term "entrepreneurial skills" since they believe that what is important is primarily presence of passion, motivation and drive. Such attributes are often rooted in personal ambitions and interests in a particular domain and are therefore hard to teach at education institutions. Nevertheless, they can be nurtured and developed in the right entrepreneurial environments.

> *"…entrepreneurship should be considered as a mind-set that can be usefully applied in all working activities and in life."*
> *- European Commission, Education & Training for Entrepreneurship*

Figure 4-11: Job description example: Skills for entrepreneurship

Partner in start-up communication consultancy

Job summary:
To function as the other half of this newly started and promising communication consultancy. Apart from providing consultancy services also responsible for administering the ICT of the organisation.

Essential functions:

- To provide customers with professional consulting services in the field of communication
- Responsible for purchasing and running the ICT of the company (laptops, mobile devices, off-the-shelf or cloud software, internet connection, etc.)
- A myriad of other tasks ranging from sales and administration to watering the plants at the office.

Professional skills (proficiency in one or more of the following areas):

- Excellent professional skills (communication and consultancy)
- A broad range of basic ICT skills and awareness of business value in ICT
- Understanding of how cloud solutions can help improve start-up efficiency and lower investments in ICT.

Transversal skills (proficiency in one or more of the following areas):

- Excellent networking skills
- Excellent communication skills
- Sales and commercial skills
- Business skills

Additional requirements:

- The entrepreneurial mind-set – the ability to spot potential business opportunities and outline successful ways to realise them
- Passion for the field of communication and for the role as a consultant
- Motivation for making this company a success
- A willingness to work hard and do whatever it takes for this start-up to succeed
- A good feeling of who to involve in what and when
- Adjustability
- Willingness to undertake all types of functions – also many tasks not related to the professional field
- An solid understanding of your own strengths and weaknesses
- Understanding of the market and its dynamics (communication consultancy in Poland)

Entrepreneurial skills, knowledge and mind-sets are, of course, particularly important in relation to starting up a business. The same attributes can also be highly valuable in well-established enterprises. Many modern companies have begun to introduce various methods to promote and exploit such attributes among their employees. Thus, although this report primarily treats entrepreneurship in relation to start-up companies, skills, knowledge and mind-sets are also highly valuable in other enterprises as well.

5. Providing e-Skills: Eight case studies

5.1. European best practise examples of courses for cloud skills

The cloud is believed by many to be the future of computing. Therefore, there has been a strong trend among vendors, not-for-profits, and universities toward beginning to offer certificates related to IT skills and cloud computing. It is early days for cloud skills courses, however, but so far, Europe demonstrates local solutions based on local leadership. There is much work to be done to ensure that European IT professionals can and will acquire the skills necessary to ensure that Europe remains competitive in the IT and cloud computing environment.

This section presents the first suggestions for good practice in terms of setups, organisations or educational and training institutions addressing current and future e-skills shortages and demands at national and/or European level in the three domain areas of the study, i.e., cloud computing, green IT and cyber security. Moreover, the suggestions will provide examples of good practice in relation to addressing e-skills needs for entrepreneurs and SMEs.

5.2. Key findings from case studies

Vendor neutrality was a contested point

Often industry led training is criticised for not being vendor neutral fostering the business of a certain company. The interest of the vendor community is the increase in market share of their products and services. Hence, courses tend to be very specific to their products, services and technologies. More than half of the courses we looked at were actually vendor neutral, but some of the industry-led initiatives go to extremes to deliver courses based on principles that are applicable across the industry. For example, the Cisco Networking certificate has gained global recognition in the industry. At the Cisco Networking Academy, Cisco equipment and devices are used. However, the focus and language are concentrated around networking standards and protocols that can be used for all vendor products. Cisco has more than 20 Memoranda of Understanding with national and regional governments in Europe ranging in scope from full integration of the programme into national curricula to localised projects. For instance, in Germany the courses are highly integrated into the regular system of vocational education and training (VET) as part of the ICT programmes. Particularly for SMEs, however, the next phase will be about choosing the right cloud solution. Participants at the CCSK course at the Alexandra Institute in Denmark stressed how important it was to learn about the pros and cons of different industry cloud offers to inform their upcoming business decisions associated with the adoption of cloud computing.

Courses too technical

The shift to cloud computing, security or green IT is clearly a business decision. It was striking how technical most of the courses were. None of the case studies cooperated directly with management or with leadership courses and showed a lack of focus on organisational decision-making procedures (business case, business risk management). An exception was the CCSK course at the Alexandra Institute. This was one of the reasons for the Alexandra Institute to develop a more business-focused course that

seems to appeal to CTOs or IT professionals in the SME community. Future plans for some of these very new initiatives included building links to MBAs or more business focused courses.

The type of certificates matters

All the courses we looked into issue certificates. The strongest certificate among the selection of eight was the ISC2 Certificate "SSCP", which is accredited to the global standard ANSI/ISO/IEC Standard 17024. This global standard includes the USA, thus supporting a global IT security market and true mobility for IT security experts. Since the emergence of this certificate both the course providers and the participants confirmed that this certificate has become a de-facto standard for the IT security profession. The green IT area seems to be lacking global standards. Participants experienced these certificates as less recognised and thus as lesser modules in the professional qualifications set. The big industry-led certificates are targeted at IT practitioners in large companies with large IT departments. Their usefulness for generalist IT practitioners in SMEs, where the shift to cloud computing potentially will cause the most disruption, is questionable.

Lack of holistic thinking between cloud, security and green IT course providers

Cloud computing and security seems to be well integrated even if the security course ISC2 continues to treat cloud computing as a marginal issue of relevance to its core target group. However, the cloud computing courses do not include aspects of green IT, nor do the green IT courses actually include cloud computing as a module. Participants highlighted that they would welcome better alignment between these certifications.

IT moves fast but formal education and the accredited certificate market move slow, but industry seems to be filling an important gap by showing local leadership

IT moves fast, IT is fast out of date, and the risk for businesses is that their existing IT staff will not be able to manage the cloud future appropriately. Hence, the focus of the case studies was on course opportunities to upskill an IT professional or a graduate who wishes to specialise. Unsurprisingly vendors moved quickly and effectively to satisfy the market, but they generally only offer courses attached to their own products, services and technologies. Education systems are often criticised for being slow to adapt, but the formal education systems need to strike a balance between the medium term viability of the skills embedded in the programmes they offer, and the ever changing requirements of industry. It is apparent that IT education trends move first to industry, then to not-for-profits, and lastly to the education sector. This is because private sector operations are very demand led, or close to the market, whereas education is not. This has created a situation where the education sector is not leading the way in this field. The collaboration between IBM Poland and Wroclaw University of Technology is an example of industry working with universities. The courses clearly meet local demand; in fact, they provide a mix of skill training and a virtual internship. It links to the global cloud community of IBM and provides a challenging and competitive learning environment for its participants. Essentially, this collaboration helps align academic training and industry skills needs. In Milan, CEFRIEL is an example of a three-way partnership between local businesses, the municipality of Milan and the technical the University of Milan. Here the university provides a 2-year academic training programme for job starters, who are selected

through a very competitive process. This partnership is expected to stimulate the IT industry in the Milan region positively.

The US R&D knowledge

All case studies highlighted the importance of global networks and, in particular, strong links to the US R&D communities within vendors but also beyond. For example, to assure the success of its programme, CompTIA joined forces with the key players in the technology industry, and many other partners worldwide. They include CompTIA's three thousand member organisations, the United States Environmental Protection Agency, and the Climate Savers Computing initiative. Participants often mentioned that the link to the US R&D knowledge was a clear USP for skills courses.

The business case behind cloud courses is in building strong collaboration partnerships

The vendor industry and third sector course providers operate in partnership with both private and public educational providers. These contracts are generally open for universities to participate, but they are often not found to be competitive. Cisco collaborates with public and private institutions including schools, universities, businesses, non-profits, and government organisations. This ensures that the programme content is top notch and that the instruction content fits real world needs. More research would need to be undertaken on whether that link could be strengthened.

5.3. Selection of the case studies

Cloud skills courses are a new phenomenon and as with any new phenomenon, the objective of the case studies was to gather information and to learn from the practitioners involved as well as the course participants.

Eight case studies were carried out in this phase of the project. The case studies are government programmes or initiatives, industry-led initiatives, initiatives by education and certified training institutions, partnerships and initiatives launched by individual companies considered industry leaders in their specific ICT domain.

Figure 5-1 - Overview of cases

Dimension	Area				Setting		Geography					Stakeholders			
	Domain				*Educational sector*		*Europe*								
Case no. and title	Cloud Computing	Cyber Security	Green IT	SME and/or Entrepreneur focus	Higher education	Adult/Continuing training	Northern	Central	Southern	Eastern	Global	Industry	Government	Education sector	Not-for-profit
• Cisco networking Academy		✓				✓					✓	✓			
• Multipurpose Cloud Computing centre, PL	✓				✓							✓		✓	
• CCSK, DK	✓	✓				✓	✓					✓			✓
• BCS, UK/Global			✓			✓	✓				✓				✓
• CompTIA			✓			✓					✓				✓
• CEFRIEL, IT	✓				✓					✓		✓	✓	✓	
• [(ISC)2®], UK		✓		✓		✓	✓					✓	✓	✓	
• Microsoft cloud computing services	✓					✓					✓	✓		✓	

The list was motivated with regard to, for instance, the impacts achieved by the initiative or the level of innovation with regard to policy measures applied and actors involved. The examples stem from the literature review, the interviewed experts, and the knowledge of the study team and address e-skill requirements for ICT practitioners and entrepreneurs in all three ICT domains:

- green IT;
- cyber security; and
- cloud computing.

Particular emphasis was placed on the relevance of the courses to SMEs and entrepreneurs.

In addition, the following parameters were looked into:

- content reflection of the different levels of education (higher education and adult/continuing training or education);
- public/private provision of learning;
- the challenges anticipated in the initiative and the domain; and
- stakeholder involvement; and
- geographical spread.

For each case study, the practitioners as well as a course participant were interviewed. The following section introduces the best practises, including a short description of the most striking and relevant features. A more detailed and systematic overview of the initiatives can be found in Annex 1.

5.4. Short profiles of the eight case studies

1. Cisco Networking Academy – Security certifications, Global

The CCNA security course is part of the Cisco Networking Academy, which provides students with a comprehensive learning experience that helps them master the foundational ICT skills needed "to design, build, and manage networks, along with career skills such as problem solving, collaboration, and critical thinking." The Academy is also known as the world's largest classroom. It aims to innovate globally to make a difference locally. Cisco collaborates with public and private institutions including schools, universities, businesses, non-profits, and government organisations. This ensures that the programme content is top notch and that instruction content fits real world needs.

2. Multipurpose Cloud Computing Centre, Poland

The establishment of the cloud computing centre provides an innovative example of good practice of collaboration between industry and academia, which anticipate future e-skills needs among ICT practitioners and ICT user in the area of cloud computing. Wroclaw University of Technology, Poland, is the first university to become part of IBM's Multipurpose Cloud Computing Centre – a global initiative available to all institutes of higher education from 2010. As part of this partnership, the Wroclaw University of Technology creates a new academic curriculum, making cloud-focused courses available to more than 1500 students as well as supporting new ways of teaching for current and emerging technologies, of which some is based on cloud computing solutions. The cloud centre provides a shared and thereby unique platform for students and professors, industry partners and government agencies to work on real solutions based on cloud computing that will align people and technology effectively, and will generate value for both services providers and clients. IBM is committed to developing This programme further with universities around the world.

3. Cloud Computing Security Knowledge Course (CCSK), Alexandra Institute, Denmark

In 2010, the Alexandra Institute allied with the Cloud Security Alliance, an International, not-for-profit organisation that promotes Cloud Security. Together, the two organisations designed a three-day training course in cloud security. This programme is the first of its kind to be run outside of the United States. In designing the programme, the Institute kept in mind that Europe and Scandinavia are not on the forefront of cloud computing technologies, and therefore they decided to keep the programme much more basic and "soft" in nature. This programme is different, because it is much more comprehensive, which allows people with no experience as well as professionals to gain knowledge and experience.

4. British Computer Society (BCS) - The Chartered Institute for IT, intermediate certificate in the EU Code of Conduct for Data Centres, UK/Global

The certificate in the EU Code of Conduct for Data Centres is an excellent example of good practice in regards to vendor neutral certification fostering the green IT mind-set and skills in data centres. This certification allows ICT practitioners to learn how to develop an organisation's 'Green' strategy by the effective use of energy by software, ICT systems and support infrastructure, both mechanical and electrical systems within the data centre. It was created around 'Green' strategies of organisation's data centres in terms of effective use of energy by software, support infrastructure, and ICT Systems. Furthermore, it will help organisations to understand the meaning and reasoning behind the EU Code of Conduct, and how to implement the Code's best practices in one's own organisation. It will help a company to develop a language surrounding energy efficiency.

5. CompTIA Green IT, Global

The CompTIA Green IT Certificate provides students with the knowledge and knowhow on how to implement and put environmentally sound techniques into practice within an organisation's IT infrastructure. It furthers a student's existing knowledge by including information on emerging technologies that are critical to the progress of green IT. The course covers areas such as green technologies, standards, policies and design/support techniques. It provides the skills needed in order to adapt a 'Green' strategy including virtualisation skills, how to address carbon footprint management, proper disposal, power preservation best practices, and how to measure the return on investment from green IT activities.

6. CEFRIEL, Apprenticeship 'Centralised system for cloud computing', Italy

CEFRIEL's latest project offers a unique opportunity for young graduates to get prepared for the radical change in management infrastructure caused by the virtualisation of computing resources and cloud computing models. CEFRIEL offers a wide array of courses and programmes, which are all very relevant for the ICT sector and the supply of and demand for e-skills within it. However, the opportunity of particular interest to this study is the very recently introduced apprenticeship dealing with a centralised system for cloud computing. (Start September 2011). The programme aims to offer 25 young graduates the opportunity to combine classroom training at master level and professional experience as the programme is designed and organised in collaboration with leading companies in the ICT sector: ENGINEERING, Gaia, IBM, Reply and Siemens.

7. The International Information Systems Security Certification Consortium, Inc. [(ISC)2®], Systems Security Certified Practitioner (SSCP®), EMEA office, UK

The SSCP certifies a depth of technical knowledge within seven domains of the (ISC)2 SSCP CBK, i.e. access control, administration, audit and monitoring, cryptography, data communications, malicious code/malware, and risk, response and recovery. The objective is to certify people working at an operational level for their knowledge in accepted practices, and the ability to assess risk encountered in day-to-day implementation of policies and procedures. It is a vendor neutral qualification covering areas often otherwise only tackled by the vendors to ensure the required skills independent of technology choice.

8. Microsoft Cloud Services

Training and Certification, Global - This is an interesting and innovative example as Microsoft Cloud Computing Services provides a new set of new curriculums, training resources and skills mapping in regards to their training and certification. Microsoft has incorporated skilling for the cloud into a roadmap that corresponds with associated cloud roles, this is then being utilised in collaboration with academic institutions as an engine for growth in this field. These skills for the cloud, which are now integral to Microsoft certifications, act as a benchmark for employers and align directly to industry demand.

5.5. Stories from field: told by practitioners and course participants

5.5.1. Cisco Networking Academy

Global – Security certifications: the world's largest classroom

> *"The instructors always challenged you to do something more. If you had finished one task, they would say: why don't you do this or that." - Participant*

Cisco Networking Academy: The ´World's Largest Classroom

> *"The instructors always challenged you to do something more. If you had finished one task, they would say: why don't you do this or that." -Participant*

The Cisco Networking Academy offers both online and classroom based courses using a blended learning approach involving interactive tools, instructor-led classes, stimulation and virtualisation and hands on learning activities. Instructors have a great deal of training which ensures that the experience will be "consistently-enriching" for students.[49] The courses allow students to prepare for their careers within the fields of ICT and networking. It allows them to differentiate themselves from other job candidates, and to get the proper training to meet job market requirements. Furthermore, the Cisco learning network website has study materials that include exam topics, self-study literature, and a community area where over 250,000 registered candidates can share information.[50] The Cisco Networking Academy offers a diverse curricula portfolio:

A great opportunity for educational institutions to stay on the forefront of the skills needs in the industry

> *"Cisco's programme has special curricula, which is tested and updated. It has special e-learning in the background. It is a qualification and certification system, so it is a full service vocational training system. Other technology companies' programmes are not part of a total quality management, e-learning system." - Headmaster, Multimedia Vocational School, Germany*

Cisco collaborates with public and private institutions including schools, universities, businesses, non-profits, and government organisations ensuring that the programme content is top quality and that the instruction content fits real world needs.

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[49] World's Largest Classroom. www.cisco.com/web/learning/netacad/WLC/index.html

[50] About Networking Academy: www.cisco.com/web/learning/netacad/WLC/leaderProfiles/maiss.html

The Entry-Level Security course is taught at 200 Academies across 17 different countries in the EU. The course is designed to give students a knowledge base on networking and security and prepare graduates to enter the job market. Cisco provides security certifications at four levels. The course curricula, which is continuously updated, is provided free of charge by Cisco allowing educational institutions and their instructors to focus mainly on the teaching methods.

Certification - an important driver, both for students and employers

The courses are constantly aligned with the international Cisco certifications, and results of the students' training are in general certified, which makes the programme very attractive - international certification is highly valued by employers; and students are well aware of this fact.

The Cisco Certified Network Associate (CCNA) is one of the four most in demand networking certificates as 58 pct. of CIOs polled for the "Hiring Index" ranked network administration as the technical skill set in greatest demand within their IT departments, further demonstrating the marketability of professionals with the CCNA credential.[51]

Not vendor neutral, but neutral enough

> *"The courses are not completely vendor neutral, but neutral enough to be used in public schooling in Germany" - Networking Academy Manager, Germany, Switzerland and Austria*

Often industry led training is criticised for not being vendor neutral fostering the business of a certain company. At Cisco Networking Academies, Cisco equipment and devices are used. However, the focus and language are concentrated around networking standards and protocols that can be used for all vendor products.

Cisco has more than 20 Memoranda of Understanding with national and regional governments in Europe ranging in scope from full integration of the programme into national curricula to localised projects. For instance, in Germany the courses are highly integrated into the regular system of vocational education and training (VET) as part of the ICT programmes.

In the future, security skills will continue to be a core component of networking. The Cisco Networking Academy will continue to support training in this area and align the training with Cisco certification and industry needs.

[51] Today's Most In Demand Certifications. http://certmag.com/print.php?in=3950

5.5.2. IBM and Wroclaw University of Technology, Poland

Multipurpose cloud computing centre programme: a virtual summer internship specialised in cloud skills

> *"There is no escaping from the cloud revolution; the question is simply when it will happen!" - Participant*

In the summer of 2011, IBM Poland and Wroclaw University of Technology introduced the first University Cloud Computing Centre in Poland, a centre that is funded by IBM's Multipurpose Cloud Computing Centre programme. Wroclaw University of Technology is the first university worldwide to collaborate with IBM for this initiative.[52]

The programme had been in the works for around five years prior to its commencement and was formed in the context of a long-standing relationship between the two partners. The centre aspires to use the cloud for education, use the cloud for a remote educational internship, and promote research through cloud technologies and offer services to other faculties and business partners.[53]

> "*The new Cloud Centre will provide a common platform for students and professors, industry partners and government agencies to work on real solutions based on cloud computing that will align people and technology effectively, and will generate value for both services providers and clients " - Professor Czeslaw Smutnick, Director Institute of Computer Engineering, Control and Robotics, Wroclaw University of Technology*[54]

The former Eastern European countries are being heralded as the next European tigers, and This programme has the possibility of providing this region with cloud skills that are in global demand. Poland is the biggest country in the region and there is currently some application of cloud in the academic world but very little application within businesses. This provides a huge potential, one which This programme could help harness.[55]

A new generation of summer internships designed to bring cutting-edge skills to Poland

> *"It was great to get an insight into how cloud technologies work and to apply the skills learnt during this virtual internship in final years of studies. It has helped me prioritise what skills I need for the job market after I graduate." - Participant*

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[52] IBM Academic Initiative. https://www.ibm.com/developerworks/university/cloud/

[53] Krakowstudia.net-University in the Cloud. www.krakow.studia.net/akademicki-wroclaw/3071-politechnika-w-chmurze-i-w-akademii-ibm

[54] IBM Press Release. www-03.ibm.com/press/us/en/pressrelease/32226.wss

[55] Poland IT Report Q3 2011. www.marketresearch.com/Business-Monitor-International-v304/Poland-Information-Technology-Q3-6454261/

The internship offered by the centre is called the Multipurpose Cloud Computing Centre Internship (or MC2 Internship). It provides ten training modules within cloud, which gives interns flexible dates and hours. The internship lasts one month, and all course modules are conducted in English. Wroclaw University of Technology organises the courses, and IBM Poland runs the teaching modules based on IBM Tivoli Software.

Students can choose from a variety of different tasks, and the formal certificate they receive at the end will be based on what role they performed. This allows for practical implementation of projects and *"creativity and smarter planet ideas."*[56] IBM mentors are physically present on the University campus to help with the exercises

The centre has the capacity to offer fifteen hundred students an internship each year. During its first summer, around four hundred students participated. Upon completion, graduates receive an industry-recognised certificate awarded by the IBM Toronto Lab attesting to their mastery of the IBM suite of cloud technologies. The top graduates of programme are awarded a scholarship for work at an IBM research lab.

Moving forward

In addition to the Multipurpose Cloud Computing Centre, IBM has invited Wroclaw University of Technology to join its two centres of cloud excellence. The first is IBM's Academic Skills Cloud in which twenty academic units throughout the world collaborate to form a large educational cloud project. The second is an association of elite higher education institutions working in the cloud computing technologies called the IBM Cloud Academy. (Source: Krakowstudia.net-University in the Cloud)

Wroclaw University of Technology and IBM Poland plan to continue their collaboration in the field of education, PHD programmes and research. IBM plans to initiate similar programmes with other institutes, faculties and data centres in Poland, as well as to integrate with local business communities in the process.

5.5.3. Alexandra Institute, Denmark

Cloud Computing Security Knowledge Course (CCSK): Protecting and Securing Clouds

> *"Cloud computing is at the tip of everybody's tongue. We wanted to be prepared. We are not in the cloud business yet, but wanted to know what it's all about."*
> *- Participant, Software Architect and Business Owner*

Clouds under attack

Cloud computing has many advantages and it has the possibility of transforming an organisation's business through innovation in assembly, externalisation of core capabilities, and business leverage of new technologies. However, there are many risks, including security, compliance, integration, and regulation. Security issues include the fact that data are stored in several data centres.

[56] Interview with Marius Ochla, IBM Technical Exploration Centre Manager, Central and Eastern Europe.

"We have four data centres in the US, two in Europe and two in Asia. Even though you choose to store your data in Europe instead of Worldwide, your data will be stored at least three times. Two times on your main location and one time at a secondary data centre." – MS Azure.[57]

Another example includes Microsoft's dilemma with cloud computing security. The US' Patriot Act may require Microsoft to give customer data to the government without informing customers. This goes against the EU Directive on Data Protection and creates a security dilemma. There is also the risk of services being "down" or having technical difficulties. Furthermore, there is a security issue with insecure interfaces and APIs, which include "evil web services" and "man in middle" attacks.

The programme for getting healthy applications is training, policy, and reviews. In the training stage, developers are trained in web application security. In the policy stage, security rules are laid down for the application. Finally, in the review stage, penetration tests and expert code reviews are intermittently used to test for flows and continue to update security practices.

Tailor-made certificate at the Alexandra Institute of Cloud Security Knowledge

In 2010, the Alexandra Institute allied with the Cloud Security Alliance, an international, not-for-profit organisation that promotes cloud security. Together, the two organisations designed a three-day training course in cloud security. This programme is one of the first of its kind to run outside of the United States and is an early example of how training can be provided in the field of cloud security in Europe. The undertaking is not linked up to the formal education sector. However, in the security field, granting certificates not linked to any formal education is common.[58]

The Cloud Security Alliance developed a one-day training course some years back, which provides basic knowledge and an internet certificate. However, the Alexandra Institute felt that this did not fit the Scandinavian market very well. In designing the programme, the Institute kept in mind that Europe and Scandinavia are not at the forefront of cloud computing technologies, and therefore they decided to keep the programme much more basic and "soft" in nature. This programme is different, because it is much more comprehensive allowing people with no experience as well as professionals to gain knowledge and experience.

Whereas in the United States, the target group for such a programme would be a group of professionals with cloud computing experience, the Scandinavian target market for This programme consists of people who have no training or experience whatsoever with cloud computing. Some target groups for This programme would be:

- Cloud computing companies that provide services, advice, and consultancy relating to cloud computing
- Companies that are looking to implement cloud computing solutions; and

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[57] Cloud Computing Security Go to 2011 PowerPoint

[58] Certificate of Cloud Security Knowledge. https://cloudsecurityalliance.org/education/certificate-of-cloud-security-knowledge/

- Auditing companies that do audits on cloud computing.

Vendor neutrality

Upon completion of this course, graduates are more informed about cloud computing, security issues, and the initiatives and solutions that the Alexandra Institute has created. By sending one or two employees from a company to take this course, a certain general knowledge base is created that will allow for cloud computing knowledge to spread throughout the enterprise. Ultimately, this can be built on in order to start implementing cloud computing solutions in that workplace.

> *"We learnt about the critical areas of focus that you need to consider when you move your business to the cloud. Most important in this regard was that the course was vendor neutral and that we learnt about the trade-offs that you make when you shift your business to the cloud. Critical is the area of security or how to handle personal data for example. You need to have impartial advice BEFORE you choose a cloud solution"*
> *- Participant, Software Architect and Business Owner)*

5.5.4. British Computer Society (BCS) UK/Global

The Chartered Institute for IT, intermediate certificate in the EU Code of Conduct for Data Centres - Shifting focus from IT to Data Centres

A study by Lawrence Berkeley National Laboratory of Data Centre Power Allocation found that the average data centre consumes energy in the following areas. As the chart shows, IT is not the only aspect that needs to be focused on when developing a green technology strategy.

> *"There has been so much recent focus on green IT and not on green data centres. Data centres' carbon footprints stick out like a sore thumb."*

Learning from EU Code of Conduct

BCS recently created the Intermediate Certificate in the EU Code of Conduct for Data Centres to align industry in a way that produces a common best practice around operation and design of data centres. The EU creates best practice documents through knowledge sharing between data centres worldwide. BCS uses these documents to ensure that data centres understand their responsibilities in regards to the larger picture. Attention is given to reducing data centre footprints and improving energy efficiency. This programme is endorsed all around the world by organisations that participate.

Different organisations view green in different ways. Some see green as the opportunity to make money through the so-called green economy, some see green as a means to reduce costs and some organisations that have experienced climate change first hand see green as a necessity. Britain, for example, has passed legislation that requires organisations to market themselves as green to prove their green credentials. This is forcing organisations to put their money where their mouth is and the skill sets obtained by This programme are a good foundation in doing such.

Despite the reasons behind movement in this direction, there is a real interest worldwide in the Green agenda at the moment. This awareness will most surely bring BCS success in its Intermediate Certificate in the EU Code of Conduct for Data Centres.

Cloud Computing meets the Green Data Centre Movement

Since products and services are increasingly offered via the cloud, many data centres have been consolidated into one centralised location. This reduces job and space redundancies and conserves energy. Furthermore, it gives companies the flexibility to choose locations that offer inexpensive energy. For example, some firms have moved their data centres to Iceland, allowing processes to run completely on geothermal energy. Not only does this reduce expenses, but it also reduces carbon footprints. In tough economic times and with energy prices on the rise, many companies are looking for new and innovative ways to cut costs by whatever means possible. The cloud promises to do so without compromising security or the quality of service provided.

A modular approach

BCS believes that the Intermediate Certificate cannot be looked at in isolation in regards to its other programmes.

First, the Intermediate Certificate builds on The Foundation Certificate in Green IT, which BCS launched in May 2009. This is the first and only recognised qualification for green IT. The green IT programme is for those who need a broad and general understanding of what green IT is and what it can do to help their organisation.

Second, BCS offers the CEDA (also known as the Certified Energy Efficient Data Centre Award) accreditation, where it goes to data centres and accredits them against BCS' code of conduct which attests to data centres' energy efficiency. The accreditation can be awarded at three different levels, i.e. gold, silver and bronze.

When all of these things are combined, it becomes clear that this is part of a programme. The idea of creating a whole programme is relatively new to the market. Nonetheless, BCS will continue to develop this modular system in the upcoming months and plans to begin offering several more Intermediate Certificates in the near future.

5.5.5. CompTIA, Global

Green IT - Moving from negative environmental impact to worldwide sustainability.

CompTIA, also known as the Computer Technology Industry Association, is a not-for-profit IT Company that aspires to advance innovation and industry growth through educational programmes, market research, networking events, certifications, and public policy advocacy. It is an independent, vendor neutral organisation. In other words, its courses are not linked to any specific products or software offered by companies such as Cisco or Microsoft. Vendor neutral courses instead instruct participants with a broader, focus, which provides for more objectivity.[59]

[59] CompTIA. www.comptia.org/home.aspx

> *"Brands change and they change quickly. Brands everyone though would be around ten years ago are no longer in existence. This marks why having vendor neutral certification is so important."* – Participant

Why green IT?

In the last decade, increased energy costs, increasing government regulation, and an overall consumer attitude moving towards environmental concern has created a high demand for green IT, which refers to environmentally stable computing. *"In addition to benefits such as lower costs, reduced environmental impact, and improved regulatory compliance, eco-friendly initiatives can ultimately enhance a company's green credentials and improve competitiveness."*[60] For example, 35 pct. of organisations say that they lack the resources for implementing Green IT, and 47 pct. are not able to calculate ROI on Green IT programmes.

The Green IT Certification: viewing the problem from many lenses.

> *"We have a broad spectrum of tools available to us. An individual won't understand his environment unless he has a broad understanding of each." - Participant*

When designing the Green IT Certification, CompTIA aimed to reverse the irony that technological innovation exacts an environmental price.

> *"This is not the way things should be; rather it should be the opposite; that technology should help lead the way in sustainability." –Rick Bauer, Director of R&D, CompTIA*

CompTIA did not want to instruct participants about power savings in the data centre room, nor did it want to simply discuss suspend states in desktops or duplex printing. Oftentimes, these piecemeal efforts do not consider the whole picture and therefore miss key aspects of the issue. In light of this, CompTIA introduced its Green IT Certification in the spring of 2010, which provides a comprehensive introductory curriculum that validates skills and knowledge in all of the areas pertinent to Green IT today.[61]

> *"Someone who has a finger on the breadth of the operation can connect tissues." – Rick Bauer, Director of R&D, CompTIA*

The programme is designed for professionals who desire and have the power to implement green IT initiatives within their organisation. They include IT managers, data centre managers, IT technicians, and system/network Administrator. The Green IT Certificate provides these individuals with the coherence necessary to have an effective IT communication strategy, which will enable environmentally sound techniques to be put into practice within an existing IT infrastructure.

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[60] Strata Green IT. www.comptia.org/Libraries/Strata/greencandidate.sflb.ashx.

[61] CompTIA Green IT. http://certification.CompTIA.org/getCertified/certificates/Green_IT.aspx

The course curriculum is split into two areas, Green IT Techniques and Technologies, and Green IT Policies and Standards.

The Green IT *Techniques and Technologies* concepts consist of the following topics:

- environmentally sound techniques for disposing of hazardous waste;
- preserving power;
- explaining what the purpose of virtualisation technology is and how to apply it; and
- alternate techniques that enhance green IT initiatives.

The Green IT *Policies and Standards* consist of the following topics:

- creating an internal IT strategy for analysing ROI on an organisation's green IT projects;
- naming green IT framework assessment tools; and
- naming strategies that reduce environmental impact in the workforce.[62]

A Global Partnership Network

To assure the success of its programme, CompTIA joined forces with the key players in the technology industry, and many other partners worldwide. They include CompTIA's three thousand member organisations, the United States Environmental Protection Agency, and the Climate Savers Computing Initiative.

CompTIA does not mandate a particular way to deliver the course, and it does not write the textbooks. Instead, it outlines everything that a professional managing green IT within an organisation should know. Subsequently, training companies and universities worldwide take this curriculum, and design courses that cover the outlined topics. Courses can cost anywhere from a few hundred to a few thousand USD.

CompTIA aims to create an exam that is fair, accurate, and contemporary. Therefore, it spends the money raised from green IT exams on updating its curriculum constantly. It does so by bringing in experts twice a year to revise the topics. The credential was designed to be international from the get go.

> *"You can't slice this into just a US or just EU type of approach, it is a global phenomenon that we are trying to deal with." – Rick Bauer, Director of R&D, CompTIA.*

CompTIA plans to continue developing and offering the programme in more locations worldwide in the years to come.

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[62] CompTIA Green IT Exam Objectives. http://certification.CompTIA.org/Training/testingcenters/examobjectives.aspx

5.5.6. CEFRIEL, Italy

Apprenticeship 'Centralised system for cloud computing' - the localised approach - securing cloud skills for the high-tech region of Milan

According to the Centre for Economics and Business Research, the cloud will create 2.4 million jobs in Europe, and it has a possibility of having a 35 billion Euro impact on the Italian economy by lowering costs, creating new jobs, and increasing business efficiency.[63]

On the Job Master's Programme at CEFRIEL

In September 2011, CEFRIEL began offering its Master's level University programme called Centralised Systems for Cloud Computing. CEFRIEL is a not-for-profit organisation, which is part of the ICT institute created by Politecnico di Milano. Its goal is to strengthen ties between academia and industry. Politecnico di Milano is the largest technical university in Italy. It has 35,000 students with seventeen departments in the fields of engineering, architecture, and industrial design.[64]

CEFRIEL and Politecnico di Milano created the programme in collaboration with Assolombarda and five leading companies in the ICT sector, i.e. ENGINEERING, Gaia, IBM, Reply, and Siemens. The course is only offered to residents of the area as it is fully funded by the City of Milan. It ensures that specific cloud skills are developed in a critical high-tech region of Italy.

This course is seen as a unique opportunity for young graduates to prepare themselves for the radical changes in management infrastructure caused by the virtualisation of computing resources and cloud computing models. Since cloud computing is a growing field, there will be a great demand for these graduates.

> *"The point of the programme is to enrich the University to fill the gap created between the known training school and the typical problems of the working world." –John Boniardi, Cloud Infrastructure Consultant at IBM Italy*

A programme only for those most passionate about technology

The course aims to help students understand problems with large-scale systems, of which cloud computing is just one. It is broken into two parts, i.e. a traditional classroom aspect, and training within one of the five ICT companies listed above. The apprenticeship lasts twenty-four months including four hundred hours of lessons at the Master's level at the premises of CEFRIEL. These classes introduce and tackle the following topics: Introducing Centralised Systems, Multi-processor System Architectures, Architectures of Advanced Operating Systems, Architecture of the Host Systems, Virtualisation and Data Centre Consolidation, Cloud Computing, Storage

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[63] Cloud Computing: A future in the clouds www.walkonjob.it/articoli/902-articoli/684-cloud-computing-un-futuro-tra-le-nuvole

[64] Master in Alto Apprentisado. www.cefriel.it/index.php/it/formazione/giovani-laureati-e-laureandi/master-in-alto-apprendistato

Systems and Network Storage, Performance and Reliability of Power Systems, Smart Analytics, Green IT and Data Centre TCO.[65]

The programme is very competitive, and each year only twenty-five students will be accepted. In order to be considered, students are expected to have obtained a Bachelor's degree in an IT-related field, such as:

1) computer engineering;
2) telecommunications engineering;
3) information engineering, electronic engineering;
4) computer science.

They must have graduated from their Bachelor's programme less than eighteen months before applying for the Master's and must be between twenty-one and twenty nine years old. Furthermore, the applicants must demonstrate that they have a love and passion for technology. Students are chosen through a joint decision making process between the programme director at CEFRIEL and the five collaborating companies.[66]

The dream combination for highly competitive job starters: job and additional degree

The benefits to this system are twofold. On the one hand, it provides the student with an excellent training experience within a company, which provides ever more important real-world experience. Likewise, it allows students to foster close relationships with firms who could end up being their future employers on graduation.

On the other hand, it benefits the collaborating companies tremendously. In recent times, there has been a remarkable increase in investment in cloud computing. This has translated into the creation of many new job descriptions, such as Data Systems Managers, Data Centre Architects, Application Managers, and CIOs. Logically, a demand for personnel to fill these positions has ensued. This programme "creates" the skilled professionals that the ICT sector so badly needs. Furthermore, the programme provides the collaborating companies with a competitive advantage, as they will have "first dibs" from a pool of highly qualified graduates with whom they already have a working relationship.

CEFRIEL does not plan to expand any further to, for example, the mature market, as it views the programme as a specific initiative. It is in the process of conducting its first round of courses. As such, no students have graduated from the programme and the concrete outcomes remain to be seen.

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65 Specializing Master. www.dei.polimi.it/didattica/master/master.php?idlang=eng.

66 Master in Alto Apprentisado. www.cefriel.it/index.php/it/formazione/giovani-laureati-e-laureandi/master-in-alto-apprendistato

5.5.7. (ISC)²

> *"The role of the information security professional has been steadily changing during the past decade. They are now responsible for the security of many facets of an organisation, including regulatory compliance, human resource, legal compliance, data security, and access control, to name a few."*[67] *(ISC)² has made its mark by assisting IT security professionals in managing the ever-increasing requirements of their daily jobs in the most sound and effective manner possible.*

(ISC)² is an independent, vendor neutral organisation

(ISC)² is a global not-for-profit consortium of organisations representing active professionals (including 12000 across EMEA) from the academic, industry and governmental sectors in more than 135 countries. It has a reputation built on trust, integrity and professionalism.[68]

(ISC)²'s mission is to make society a safer place by improving *"productivity, efficiency and resilience of information-dependent economies through information security education and certification."* (Source: About Us) It is the global leader in education and certification for information security professionals and was the first IT security certification network to meet ANSI/ISO/IEC Standard 17024, which is a "global benchmark for personnel certification" today. [69] Accreditation to a global standard is key to becoming an industry-success story.

Members form an elite network consisting of almost 75,000 certified information security professionals worldwide. These members include:

- chief security officers;
- chief technology officers;
- chief information officers;
- security managers;
- systems engineers;
- systems integrators;
- chief risk officers; and
- systems and network administrators.

There are two types of information security certifications. The first is vendor neutral and the second is vendor specific. Vendor specific certifications are certifications that are linked to a specific organisation, e.g. Cisco or Microsoft. These programmes instruct students on the workings of a company's particular software, programmes, and devices. (ISC)² provides vendor neutral education products, which delve much deeper into fundamental issues surrounding IT security.

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[67] Frost & Sullivan Survey. www.(ISC)².org/uploadedFiles/Credentials_and_Certifcation/SSCP/2011GISWS.pdf

[68] https://www.(ISC)².org/aboutus/default.aspx

[69] (ISC)² Brochure. https://www.(ISC)².org/uploadedFiles/(ISC)²_Public_Content/(ISC)²-Company-Overview.pdf

SSCP Certification

As information security grows, business models have become increasingly technology driven. Many IT professionals do not fully understand what this means and are not sure how to implement the proper processes to protect the resources of a company. For example, 50 pct. of workplaces have private clouds, but 70 pct. feel that they need more skills to be able to secure these technologies.[70] Vulnerabilities within company applications rank as one of the main threats to companies today.

> "*Simply stated, understanding new dynamics decreases potential danger. It is basically a question of comprehending, anticipating and preventing future security threats.*"[71]

This highlights the need for the (ISC)² SSCP certification.

The Systems Security Certified Practitioner (SSCP) certification attests that professionals working at an operational level have a knowledge base in accepted practices and the have the ability to assess risk encountered in day-to-day implementation of policies and procedures. The SSCP certification covers topics that are otherwise hardly mentioned by vendor specific certifying bodies. It provides a depth of technical knowledge within seven domains of the (ISC)² SSCP CBK, a framework that establishes common information security terms and principles worldwide. These topics include:

- access control;
- administration;
- audit and monitoring;
- cryptography;
- data communications;
- malicious code/malware and risk; and
- response and recovery.

The programme is open to IT professionals with as little as one year of experience, and is ideal for those who aspire to have a career as a Network Security Engineer, Security Systems Analyst, or Security Administrator. It is also beneficial for employees who work within IT but do not always have direct contact with the security department or management team, which is often the case in SMEs, which often do not have the budget for a dedicated security manager.

The benefits of the SSCP include commitment to the profession, better credibility, and access to member resources for the professional. The benefits to the organisation include initiation of best practices, a broad understanding of (ISC)² CBK, access to global industry and subject matter/domain experts, access to broad-based security

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70 Why Certify? https://www.(ISC)².org/sscp-why-certify.aspx

71 (ISC)² Brochure. https://www.(ISC)².org/uploadedFiles/(ISC)²_Public_Content/(ISC)²-Company-Overview.pdf

information resources, and added credibility and technology oriented risk management.

Given the focus on the technical domains and the developing need to fill a knowledge gap in IT, (ISC)² recently opened up the SSCP CBK to post-secondary IT and computing institutions. Resources for educators include an undergraduate level textbook that focuses on real-life cases, hands on labs, and support for curriculum development.

Membership requires keeping skills up-to-date

> *"IC2 requires a continuous updating of skills and knowledge to maintain the member ship one is awarded when one takes the certificates. With the speed of technological innovation steadily increasing, this is very useful to ensure that skills are up-to-date throughout the job hierarchy."- Participant*

People who have obtained a credential from (ISC)² must earn CPE (Continuing Professional Education) credits. This ensures that graduates of the programme are always up-to-date with new trends and developments in the field of IT Security. These credits can be earned in several different ways including at industry events, conferences and mentoring. In addition to earning credits, students must re-certify every three years to keep their credentials.

5.5.8. Microsoft cloud computing services, global

Training and Certification - Adapting IT Specialists to the Cloud World

> *"Cloud computing is not just another buzz word. It is here to stay. In the not so distant future, more commodity services will be offered in the cloud. It is a strategic benefit for an IT professional to attend training now." – Training course participant*

Starting with Customers

Microsoft has created a powerful approach in cloud computing to address and meet the ever-changing needs of its customers. Recently, there has been a fundamental shift in the IT sector, which began with the advent of cloud computing. According to Microsoft, the cloud does not make IT professional skills obsolete, in fact, to the contrary. Cloud computing provides an opportunity for IT specialists to adapt to an environment on the move. Many newly created IT positions have appeared in the past few years. These occupations require new skill sets that build upon those encompassed within more traditional IT vocations. Previous IT job types have also been transformed by the cloud revolution. This shows how important it is for IT professionals to have up-to-date technical and business management skills, i.e. a set of knowledge that is becoming more and more important to career success. [72]

It is in this rapidly changing environment Microsoft created its cloud computing team, which lies within its existing Microsoft Learning division that manages its Training

[72] Microsoft Cloud Services: Training and Certification. www.microsoft.com/learning/en/us/certification/cert-cloud.aspx

and Certification Programmes. The skill paths defined here are focused on future customer and business needs in the context of Microsoft products and solutions. The Microsoft Cloud Computing team has provided an integrated portfolio of curricula, training resources, exams and skills mapping to provide participants the knowledge necessary for success in implementing cloud IT solutions in a vast array of situations. The portfolio design and development are managed out of the United States. The training and certification solutions are based on data from quantitative and qualitative research, surveys and focus groups from customers and partners who are implementing cloud computing solutions. The offerings are provided in collaboration with both commercial training and academic institutions as an engine for growth in this field. The skills essential in obtaining Microsoft certifications act as a standard for employers as they align directly to industry demands.[73]

Obtaining cloud skills is virtually a 3-step process:

- Build core on-premise skills – IT practitioners will continue to need networking, security and administration skills for example.
- Apply core skills for hybrid environments – analyse and plan for co-existence solutions.
- Add new cloud technology/solution skills to adapt to new business requirements and grow one's career.

Microsoft's Training and Certification Programme has incorporated skill training for each cloud category into a roadmap (cf. Training paths for cloud up-skilling) that corresponds with the associated roles that a job in such an environment would entail. Microsoft has broken these roles down into four categories; administrator up-skilled to cloud services manager, developer to up-skilled to cloud developer, infrastructure specialist up-skilled to data centre operations manager, and database developer up-skilled to data steward. Potential candidates can use this roadmap to select the course(s) that fit their needs.

Cloud categories and the corresponding courses are as follows:

1. **Infrastructure as a service (IaaS)**, allows IT professionals to create, use and manage Virtual Machines. New credentials will be offered as newer technologies become available. The following IaaS Certifications are offered by Microsoft:
   - Server Administrator: This programme teaches participants to use cloud infrastructure, and helps them gain Windows Server skills.
   - Virtualisation Administrator: This programme teaches participants to design and implement Microsoft virtualisation products within Windows Server.
   - Microsoft Systems Centre Operations Manager 2007: This programme teaches participants to create and run a private cloud.

2. **Platform as a service (PaaS)** allows Developers to develop and run applications easily. The following PaaS Certifications are offered by Microsoft:

[73] Microsoft Cloud White Paper: www.microsoft.com/learning/en/us/certification/cert-cloud.aspx

- MCDP: Web Developer: This programme teaches participants about core web development skills to help prepare developers for the cloud.
- MCDP: Windows Developer. This programme teaches participants about core Windows development skills, and allows developers to use cloud technology to make applications.
- MCDP: Windows Azure Developer. This programme teaches participants to design, build, and deploy applications that will be hosted on Windows Azure.

3. **Software as a service (SaaS)** consists of applications that provide business value and productivity solutions for users. The following SaaS certifications are offered by Microsoft:
   - MCTIP: Enterprise Messaging Administrator 2010: This programme teaches participants how to perform as the lead engineer for messaging solutions within an enterprise organisation, as well as the ability to design and deploy messaging solutions with Exchange Server 2010
   - SharePoint Administrator 2010: This programme teaches participants how to use SharePoint 2010.
   - Dynamics CRM 2011 Certifications: This is a new certification that will cover skills for cloud and on-premise implementation of Microsoft Dynamics CRM 2011.
   - Lync Server 2010 Administrator: This programme teaches participants about the skills necessary to deploy and configure Microsoft Lync Server 2010.

Skills framework adapts to shifts in job roles

Microsoft's certification programme offers a vast array products and services at varying levels, which correspond to a participant's previous skills. These skill paths are designed to fit the needs of individuals at every level of the IT spectrum. Cloud course offerings are provided at a range of levels as described below:

- The Microsoft Certified Architect programme (MCA) certification highlights the expertise of the best professionals in IT architecture.
- The Microsoft Certified Master (MCM) programme helps experienced IT professionals to deepen and broaden their technical expertise on Microsoft server products.
- The Microsoft Certified Professional Developer or (MCPD) certification gives candidates the skills necessary to develop applications successfully by using Microsoft Visual Studio, and the Microsoft NET Framework.
- The Microsoft Certified IT Professional (MCITP) certification demonstrates that an IT professional has the skills necessary to undertake a certain job related to IT.
- The Microsoft Certified Technology Specialist (MCTS) certification is designed demonstrate an IT professional's skills with Microsoft products.

Continuous Adaptation

Microsoft Learning will introduce new certifications over the next year that integrate cloud skills into IT functions. As it does today, it will continue to focus on the security skills of the solutions on which it is certifying. Instead of a stand-alone credential focused on security, Microsoft learning chooses to embed security as a continuous

theme and topic in all solutions taught and validated in their training and certifications. Microsoft will provide training for these offerings through Official Microsoft Learning Products, including Microsoft Press books, Microsoft Official Courses, and Official Microsoft E-Learning.

In addition to these programmes, Microsoft supports a broad base for customer readiness in cloud. For example, Microsoft offers a global programme called BizSpark that helps software start-ups succeed by giving them access to Microsoft software development tools, connecting them with key industry players, including investors, and providing marketing visibility to help entrepreneurs starting a business. In addition, Microsoft DreamSpark is a global programme that provides students and educators with Microsoft software programmes free of charge. Lastly, Microsoft holds its Imagine Cup yearly, which is a challenge that brings young people together to help solve some of the most complicated IT dilemmas faced by the world today. Taken as a whole, Microsoft's broad product base offers customers special offers and guidance at all stages of learning.

6. Conclusions and policy recommendations

If there is one thing experts agree on, it is that cloud computing is here to stay. SMEs and start-up companies are already starting to reap the benefits of this new ICT domain, and there is consensus that an increasing number of companies will replace local ICT with cloud solutions in the years to come. We are also observing a dramatic increase in focus on digital security among European SMEs. Many of the current systems are poorly protected and the adoption of cloud computing only further increases the complexity of securing data flows. Green IT is a slightly different story. Although many companies wish to prioritise sustainability as part of their ICT strategies, the tough financial times have forced them to focus on other things. In the future, however, green concerns will become an integrated part of the everyday ICT operations in European SMEs. This also raises the question as to what type of policy mix is needed to drive a green agenda within the ICT industry and how the short/medium term priorities can be addressed.

The increased uptake of cloud computing is changing the internal dynamics of the SME. ICT will largely become an integrated part of the organisation as well as in value chains and eco-systems of companies, and ICT practitioners will have to adjust and develop their skills accordingly. This increases the importance of skills related to detecting and prioritising demands, strategising and managing the daily operations at the natural expense of traditional practical functions. Moreover, for security practitioners, a much higher level of highly specialised skills is required on top of that. Education providers address the provision of skills related to the three ICT domains in very different ways with varying success.

This chapter provides the conclusions from each of the chapters of the report followed by specific policy recommendations related to them. The structure of the chapter follows the report starting with the technology and business perspective, ending with the skills and training perspective.

The recommendations for SME, skills and training are structured according to the following logic:

- knowledge and monitoring;
- collaboration;
- actions and tools;
- communication and campaigning;

6.1.1. Standards

US-based cloud vendors currently lead in terms of market share, scale, and technology. Even though forecasts predict that Europe will gain market shares in the years to come, there is a need for a discussion of what role cloud computing can play for European competiveness for both vendors and users, and what can be done to embrace the technology and develop the business around it. In addition, cloud standards are an important issue from a technology perspective, a business perspective as well as in the context of changing business dynamics in value chains. The question is whether the US dominance is related to R&D strengths or business strengths, as the

cloud technology is entirely new. The point is that the large European ICT players did have the technology at an early stage but failed to build the same business models around cloud technology as their US-based counterparts.

Security is one of the main issues regarding cloud computing: first, because of the concerns in connection with storing data outside the company, and, second, but equally important, because of data protection legislation. As regards the first concern, there were major security issues in 2011. One example was the Sony data breach that compromised 100 million customers' data causing distress in the cloud computing industry but also among users.

With regard to standards related to cloud computing, the industry is divided and two different perspectives are promoted. On the one hand, some of the large vendors argue that it is important to avoid commoditisation of the services, and consequently differentiating technology and standards are parameters for competitiveness. On the other hand, the standards discussion on cloud computing is compared to the discussion around internet standards, and if cloud computing is considered a utility then standards must be ensured to tackle the compatibility challenge.

Recommendation: Ensure cloud computing standards and data protection
The recommendation is to ensure development of standards to ensure interoperability and avoid vendor lock-in. In the early phase of new technology adoption, it is important to ensure full market dynamics. Standards also have to include security, and data protection legislation regulators must coordinate these efforts. The key stakeholder in this respect is the European Commission in cooperation with European industry representatives.

6.2. Competitiveness of SMEs and cloud computing

6.2.1. Competitiveness of SMEs

Two interesting findings regarding cloud computing and business value should be highlighted. First, that cloud computing can potentially increase competitiveness via business growth, agility, cost reduction and innovation. Second, even though cloud computing deployment is taking off these years – or even these months – cloud computing is primarily deployed for basic solutions related to non-core business processes. ICT practitioners play an important role in this paradox. Thus, innovative ICT practitioners can potentially deploy cloud computing as a strategic tool, not just for IT, but also to enable full business transformation, and eventually change how a company operates its business. The analysis shows the necessity of distinguishing between the maturity levels of SMEs and this must also be considered in the policy recommendations.

Recommendation: Monitoring and analysis of cloud adoption among European SMEs
In order to design actions and campaigning for SMEs we recommend that the EC monitor the uptake of cloud solutions closely. The key questions are what kinds of cloud solutions are adopted? What characterises the SMEs? What are the barriers to uptake? Uptake of cloud computing, barriers and differences between the SME will provide valuable knowledge for actions and campaigns related to SMEs. The EC plays an important role in monitoring the uptake and the intersection of e-skills, cloud computing and SMEs. The primary stakeholder for this recommendation is EC/DG Enterprise and the national ministries for industry and innovation policy.

ICT uptake in SMEs has been a priority for a variety of initiatives, but adoption of new ICT related technologies has proven difficult for SMEs with limited ICT competences. In order to support the increased use of cloud solutions, further knowledge, actions and campaigning are required.

Recommendation: Establish national initiatives to showcase cloud solutions and advice SMEs
Cloud technology offers new opportunities to SMEs. The uptake of cloud solutions could therefore be supported and initiated at national level in the Member States and industry associations. We recommend the establishment of initiatives that operate to break down barriers that hinder SME uptake of cloud solutions and show how cloud solutions can enhance SME competitiveness and effectiveness. The primary stakeholders are the Member States and industry associations.
Example: The Danish IBIZ-Centre[74] The Danish IBIZ-Centre is a successful example of a national ICT SME initiative. The target group are SMEs with a low ICT uptake. In this way, the objective is to enhance the competitiveness of SMEs and show how SMEs can take advantage of ICT to become more competitive. The aim of the IBIZ-Centre is to gain knowledge, tools, and facilitate dissemination activities at local level.

Recommendation: Communication of business value added from cloud computing
Cloud computing is still unknown territory for a large pool of European SMEs. We recommend dissemination of cloud examples from a business perspective. We also recommend integrating initiatives at national and local levels. The European sector bodies also have an important role to play. The communication of best practice and pioneering companies has two target groups, i.e. managers and ICT practitioners, and the channels to reach these groups differ. We therefore recommend that several stakeholders embrace this communication and campaign initiative. Furthermore, the analysis shows the importance of distinguishing between advanced and mature SMEs on one side and less advanced SMEs on the other side as another specific target groups, and this should also be reflected in the communication. A granular SME-approach that has a narrow sub-sector perspective, which the SMEs can relate to, may enhance the effect of the communication. The objective of the campaigns is to raise awareness, inform, promote and motivate decision-makers and stakeholders to use the opportunities of cloud computing to achieve increased competitiveness, innovation and positive images in SMEs.

[74] www.ibiz-center.dk

Example: ENGINE[75]

ENGINE was aimed at helping the engine of the European economy to become more energy efficient by offering a proper analysis of status quo by means of an Energy Efficiency Checks, working towards regional capacity building by training auditors, and creating networks. ENGINE built up a knowledge pool of concepts, instruments and approaches already available and launched informational campaigns to increase awareness on the issue.

The ENGINE campaign concepts were tailored to the local situation of the regions and were mainly based on the use of information materials and motivation events targeted at decision-makers in the small and medium sized enterprises.

6.2.2. Start-ups

Cloud computing provides three important elements to start-ups. First, it means that the need for investing in ICT capital is scalable to the needs of the start-up. Second, cloud computing services are still being developed, which leaves some room for ICT start-ups. Third, cloud computing adoption is currently taking off, meaning that there is an immature market with excess demand.

There are currently a number of promising European start-ups that are pioneers with regard to technology and business models. These companies are now building SaaS on top of the legacy of the first generation of cloud computing. However, one of the biggest challenges for start-ups in Europe is the lack of access to venture capital. There are government funds and gazelles programmes to help out, but the effects of these programmes are not comparable to capital from venture capitalists. The report presents two award-winning start-ups as well as a number of pioneering cloud entrepreneurs, and the background of their successes would be worth exploring.

Recommendation: collection of data regarding start-up programmes and policies

Collection of further data on start-up programmes and growth pattern measures that support growth and employment creation to support Member State policies for entrepreneurs. Furthermore, the European Commission could support dissemination of European successes across Member States.

Primary stakeholders for this recommendation are the EC and the Member States.

Example: Global Entrepreneurship Monitoring[76]

The annual GEM survey analyses the types of framework conditions and framework policy measures that are most central to fostering innovation and growth in ICT firms - including policy coordination between agencies. Member States should be encouraged to collect longitudinal data on business start-up programmes in ICT to document and analyse promising practice programmes to support policy learning at Member State and EU level.

Above all, for start-ups, ICT needs to be cheap, secure, and easy to implement, require little maintenance and be highly user-friendly. Cloud computing has a number of advantages in this regard. If the start-up operates in the ICT sector, the skills in highest demand are clearly high-level and highly specialised ICT skills within the company's

[75] www.engine-sme.eu/News-Details.84+M5ada0da4832.0.html

[76] www.gemconsortium.org/docs/cat/1/global-reports

area of operations. If operating outside the ICT sector, entrepreneurs need a basic but broad set of ICT skills in areas such as calendar and planning, text editing and spreadsheet usage, digital communication and e-business.

Recommendation: support start-up networks
Start-up programmes - public or private - could potentially include universities and other external actors within national and regional innovation systems. The recommendation is to increase and support networks between entrepreneurs, universities, chambers of commerce (which play a huge role in some countries), innovation partners, and business angels. Primary stakeholders are both at European level and Member State level, but the initiative could be run by the industry as showcased below. The Commission could play an enabling role in disseminating promising practices across Member States.
Example: Start-Up Britain[77] A national campaign by entrepreneurs for entrepreneurs, harnessing the expertise and passion of Britain is helping business people to celebrate, inspire and accelerate enterprise in the UK. The campaign was founded by eight entrepreneurs and was launched on 28th March 2011 by the British Prime Minister with the full support of the Chancellor and HM Government, although it is completely funded by private-sector sponsors. *"We are truly passionate about promoting entrepreneurship and its benefits to our economy and we do this by highlighting the myriad of support that is available to those who wish to start or grow a business, galvanising support where we see a demand and by acting as a voice for small businesses to Government."*

In relation to security, start-ups generally rely on off-the-shelf hardware and software and their built-in security solutions. Without being in a position to invest in separate security initiatives, start-ups are often forced to trust the security standards applied by suppliers – cloud or non-cloud.

Consequently, with regard to skills, entrepreneurs primarily need basic awareness of security issues in connection with ICT, the ability to read and understand security measures offered by ICT providers, and ability to ensure that security systems are kept updated. Green IT is generally of little relevance to the average start-up, unless, of course, it provides services or products in this particular area.

6.3. E-Skills for ICT practitioners

The future role of the ICT practitioner: moving up the value chain

Cloud computing undoubtedly changes the role of the ICT practitioner. However, instead of introducing an entirely new set of professional skills, it rearranges the importance of functions and skills already in the practitioner's toolbox.

To become properly equipped for a cloud-based future, ICT practitioner in European SMEs will need to become more closely attuned to the needs of their businesses. Practitioners will play an increasingly important role in defining, planning and managing IT service and security activities, while traditional tasks related to user support and maintenance of local software and hardware decline in importance. Cloud computing, in other words, poses a direct threat to "blue collar" IT. Eventually, this

[77] www.startupbritain.org

leads to the question, whether cloud computing will provoke a skill gap or actual redundancies among ICT practitioners. In relation to a skill gaps, the short-term solution is that ICT practitioners move up the value chain and work closer with the employees in the core business processes or perform tasks related to securing efficient interplay between cloud systems. The question of redundancy has a medium and long-term perspective. Already today, we see numerous examples of cloud computing solutions that can be used without having even an average level of ICT skills. Experts predict that such solutions will become highly common in the future, and it is therefore likely that the number of ICT practitioners and IT departments will decrease over time.

This means that the policy recommendations related specifically to e-skills include monitoring the disruptive effects on skill demands as well as pro-active measures to align supply and demand.

Recommendation: Revisit the e-CF for cloud related skill requirements
In this analysis, the e-CF was used and provided useful results. From a user perspective, a common framework is important to ensure transparency, alignment, and guidelines for employers and employees. This means that the required quality for a common framework includes robustness for changes over time as well as ability to absorb new skills. The study revealed difficulties in using the e-CF for business related ICT skills. The role of ICT practitioners is changing and a common framework is needed to absorb these changes. The EC is action-oriented in development and promotion of a European competence framework and the recommendations is therefore to ensure a development that embraces the changes for ICT practitioners.
Example: PIAAC[78] One example of soft skill assessments is the OECD initiative PIAAC. At the core of PIAAC is an assessment of literacy in the information age, understood as the "interest, attitude and ability of individuals to appropriately use socio-cultural tools, including digital technology and communication tools, to access, manage, integrate and evaluate information, construct new knowledge, and communicate with others".

SMEs, notably the smallest, find it difficult to overcome the traditional existing external and internal barriers and obstacles for skill development, among which the most common are:

- limited financial resources;
- lack of training programmes and methods suited to the size and needs of such companies;
- lack of knowledge of training offer;
- lack of motivation of workers for further training; and
- risk that trained workers leave the company after the training completion.

Despite all these barriers, SME managers are increasingly aware of the importance of improving their workforce's skills to enhance their innovation capacity[79].

[78] www.oecd.org/document/7/0,3746,en_2649_201185_44378247_1_1_1_1,00.html

Recommendation: Monitoring cloud related skill requirements

Because of the disruptive nature of cloud technology, and because cloud adoption has only recently reached European enterprises, continuous monitoring is of great importance. Previous efforts have concentrated on assessing the impact of global sourcing on ICT jobs. Global sourcing is still highly relevant, but cloud computing ads another aspect to the discussion around sourcing and monitoring is still very much needed. Forecasting in this respect also needs to include the demand in the short and medium term and the impact of cloud as a disruptive technological trend.

This recommendation primarily concerns the EC and the involved partners in the e-CF and other related skills frameworks.

Recommendation: European and national focus on quality and attractiveness at lifelong learning

Disruptive technologies like cloud computing have a major impact on necessary e-skills as the analysis has illustrated with emphasis on transparency and mobility in all areas of the workforce. One of the main components to achieve this is lifelong learning. To engage in continuing training both employer and employee need to be faced with the possibility of and incentives for engaging in training programmes and also the business case for engaging in training for competitiveness pertaining to cloud computing and e-skills. Continuous learning based on knowledge and monitoring is therefore a necessity and this must be addressed both at European and national level.

At European level, the EC should support the development of quality lifelong learning supported by the European tools to promote transparency and comparability in lifelong learning systems and promote the European dimension in systems and practices. The EC should also support the realisation of a European lifelong learning area, which should also include improvement of the quality, attractiveness and accessibility of the opportunities for lifelong learning

The national level should contribute to increased participation in lifelong learning by people of all ages by promoting collaboration between social partners, industry and state authorities.

Example:

In Germany, as in other countries with a dual VET system, state authorities and the social partners jointly run the public vocational training system, thereby providing better access for employees in SMEs that would often otherwise may be less inclined than large enterprises to engage in workforce development, which remains a challenge given the composition of the European industry base. The advantage of the German approach in a training perspective is that it enhances the payoff for the individual enterprises to invest in training and lifelong learning. In another example, Denmark has aligned VET and labour market training in competence and outcomes based systems, which gradually build up competences through recognition of prior learning measures.

[79] www.ueapme.com/IMG/pdf/UEAPME_background_note_learning_while_working_SME_needs_041111.pdf

Recommendation: National focus on long term e-skills strategies
Keep relentless focus on development of a long-term e-skills strategy that incorporates the disruptive changes in ICT technology. As this study shows the effects on e-skill requirements in the short term and different effects in the medium term, the strategies of the Member States should consider both developments. Thus, a long-term strategy builds on the previously mentioned recommendations, i.e. monitoring, the SME campaigns and the life-long learning initiatives and based on this also promotes the best practice across Member States.

6.4. Training and education

The more established IT security market has seen the emergence of de-facto industry standards for job families in the IT security job family that have become competence standards understood as what employees in fact are supposed to be able to do. For the fast moving IT sector, it might be a solution to drive robust courses across the private and public course market as this would allow for more compatibility of qualifications across Europe.

Recommendation: Knowledge pool of supply and training output
Training and education is an important part of the supply-demand equation, but more emphasis could be placed on training outputs as part of evidence based e-skills strategies. We therefore recommend that Member States identify and monitor supply and training output and integrate this into their e-skills strategies. The primary stakeholders are Member States and educational institutions
Example: Trends in Education and Training Output[80] "Monitoring Ireland's Skills Supply - Trends in Education and Training Outputs" is an annual report produced by the Skills and Labour Market Research Unit of FÁS on behalf of the Expert Group on Future Skills Needs. This series of reports aims to provide an indication of the supply of skills to the Irish labour market from the formal education and training system by examining outflows from the formal education system across levels 1-10 of the National Framework of Qualifications (NFQ).

Often industry-led training is criticised for not being vendor neutral and promoting the business of a certain company. More than half of the courses we looked at were in fact vendor neutral, but some of the industry-led initiatives go to extremes to deliver courses based on principles that are applicable across the industry. For example, the Cisco Networking Certificate has gained global recognition in the industry.

However, particularly for SMEs, the next phase will be about choosing the right cloud solution and hence courses operating on a vendor neutral basis are highly appreciated by SMEs.

[80] www.forfas.ie/publication/search.jsp?ft=/publications/2011/title,8225,en.php

Recommendation: non-vendor specific certification
Promotion of non-vendor specific certifications to secure open standards and platforms. Certificates should be based on global standards. This also means continuous adaptation of courses and curricula to the changing job roles for ICT practitioners. The EU Commission plays an important role in dissemination of the need for training as well as dissemination of relevant educational and training best practice, also to ensure widely recognised qualifications and the possibility of internationally recognised certifications.
Example: Systems Security Certified Practitioner The Systems Security Certified Practitioner (SSCP) certification attests that professionals working at an operational level have a knowledge base in accepted practices and they have the ability to assess risk encountered in day-to-day implementation of policies and procedures. The SSCP certification covers topics that are otherwise only quickly mentioned by vendor specific certifying bodies. It provides a depth of technical knowledge within seven domains of the (ISC)² SSCP CBK, a framework that establishes common information security terms and principles worldwide.

Unsurprisingly, vendors moved quickly and effectively to satisfy the market, but they generally only offer courses attached to their own products, services, and technologies. Education systems, however, do not appear to be working fast enough to meet the current industry demands for IT professionals. The private sector is showing true local leadership in filling the gap and helping to align the formal educational sector better with the skill needs.

Recommendation: cross cutting training and collaboration
ICT moves fast, formal education and the accredited certificate markets move slowly. Consequently, bridging of the formal supply and industry certifications are vital for a dynamic and relevant offer of ICT education and training programmes. One of the key findings in the skills analysis is that skills related to ensuring secure ICT systems across European SMEs rank close to the top today and are projected to rise even further in importance in near future to become the far most wanted skills just a few years from now. This reflects the issues in the technology section around security and data protection. Cloud computing raises concerns in the SMEs and skill requirements that match these concerns are not fully available and therefore we recommend the development of training courses that integrate the crosscutting functionalities of cloud computing, cyber security and green IT.
Examples: collaboration The collaboration between IBM Poland and Wroclaw University of Technology is an example of industry working with universities. In Milan, CEFRIEL is an example of a three-way partnership between local businesses, the municipality of Milan and the Technical University of Milan. Here the university provides a 2-year academic training course for job starters, who are selected through a very competitive process. This partnership is expected to stimulate the IT industry in the region in a positive way.

Annex 1 – Case studies

No. 1: Cisco Networking Academy

Case study No. 7	CCNA Security course at Cisco Networking Academy
Brief description	The CCNA Security course teaches core security concepts and skills by instructing students on how to design, build, install, troubleshoot, secure, and monitor computer networks for increased access to career and economic opportunities in communities around the world.
Country	Global
Target Students	The Entry Level course is intended for IT Professionals in the beginning of their careers and students still in education. The courses at Associate, Professional and Expert levels are intended for IT managers, Data Centre or facilities/operating managers, IT technician and system or network administrators.
Educational Sector	Initial and Continuing training, Certification
Type of Qualification awarded	Certificate
Partners	Cisco UN organizations (UNDP, UNIFEM, UNV, UNESCO, ITU) to help extend the programme in underserved communities USAID, to focus on the advancement of women Governments, to establish local initiatives worldwide Corporations including Panduit, SIGMAnet, NDG, to develop educational resources that support the programme. Academies, which teach courses to students
Initiation Date	1997/2009

Description of the Initiative	
Description	The CCNA security course is part of the Cisco Networking Academy, which provides students with a comprehensive learning experience that helps them master the foundational ICT skills needed *"to design, build, and manage networks, along with career skills such as problem solving, collaboration, and critical thinking."* (Source: About Networking Academy) The Academy is also known as the world's largest classroom. It aims to innovate globally to make a difference locally. Cisco collaborates with public and private non-profit institutions including schools, universities, businesses, non-profits, and government organisations, which ensure that the programme content is top quality and that instruction content fits real world needs. Security training is offered at four different levels; entry, associate, professional, and expert. The first and second are the for those with 1-3 years of experience,

	the second is for those with 3-5 years of experience, and the last is for those with 5+ years of experience. (Source: Interactive Career Map)
Length of Course	The courses are based on a 70 hour teaching period. The schools/academies can deliver them as they would like to. Most academies will do this over a semester or a year.
Max number of students	This amount is very high, as the model is designed to scale. Any institution able to teach the course can do so if they meet the entry criteria. This includes schools, colleges, universities, community centres, etc. Top adoption countries in the years FY09, FY10, FY11, and FY12 to end of December 2011 are: Spain, Poland, UK, Romania, Hungary and Italy.
Ratio of applicants versus student participants	Number of applicants is not tracked as the participants apply through the training partners.
Qualifications Students obtain	Depending on the level of the course, and whether the course is part of a VET or university degree. On levels 2-4, a certificate is obtained.
Cost of course	As of August 2010, Cisco invested more than $400 million into the Networking Academy. The curricula developed by Cisco are free of charge for the schools/academies teaching the courses. The costs of the student will be the regular cost of attending the specific school which varies according to countries.
Target Students	• ***Entry:*** *CCNA Security:* This course is intended for university level students who looking to gain entry-level specialist skills, IT professionals looking to broaden their horizon, and CCNA holders who want to continue expanding their knowledge in their early start of their career. • ***Associate:*** *Certified Network Associate Security CCNA Certification:* This programme allows a graduate to fulfil the requirements for jobs such as Network Security Specialists, Security Administrator, and Network Security Support Engineers. • ***Professional:*** *Certified Network Professional CCNP Certification:* This programme is for network and security engineers who want to maintain the relevance of their skills. • ***Expert:*** *Certified Internetwork Expert Security CCIE Security Certification*
Geographical Coverage	Global
Pre requisites for application	• ***Entry:*** *CCNA Security:* Students who join this course are expected to have CCNA-level networking concepts knowledge and skills, along with basic PC and internet navigation skills. There are no prerequisites, but students can complete the CCNA Discovery or CCNA exploration courses to obtain the necessary base skills. • ***Associate:*** *Certified Network Associate Security CCNA Certification:* A Valid CCNA Security certification. • ***Professional:*** *Certified Network Professional CCNP Certification:* The prerequisites to This programme are a Valid CCNA Security certification, a valid CCSP certification, or a valid CCNA certification plus SND exam pass. • ***Expert:*** *Certified Network Professional CCNP Certification: No prerequisites*

Course Curriculum	• ***Entry:*** *CCNA Security:* This programme provides an introduction to core security technologies such as installing, monitoring, and troubleshooting of Cisco Security Technologies. The topics include modern network security threats, securing network devices, authentication, authorization and accounting, implementing firewall technologies, implementing intrusion prevention, securing the local area network, cryptography, and implementing virtual private networks. (Source: CCNA Security Curriculum) • ***Associate:*** *Certified Network Associate Security CCNA Certification:* The curriculum focuses on the necessity of a comprehensive security policy, and reinforces security best practices using the latest Cisco equipment devices and appliances. Candidates must pass both CCNA exams and the IOS Network Security Exam to pass this course. This exam includes topics such as securing CISCO routers, implementing AAA on CISCO routers, mitigating threats using ACLs and, implement secure network management and reporting. The CISCO authorized exam course is called implementing CISCO IOS Network Security (IINS). (Source CCNA Security Certification) • ***Professional:*** *Certified Network Professional CCNP Security Certification:* This course trains professionals to fulfil a job as a Cisco Network Security Engineer responsible for "Security in Routers, Switches, Networking devices and appliances, as well as choosing, deploying, supporting and troubleshooting Firewalls, VPNs, and IDS/IPS solutions for their networking environments. It gives students knowledge on real world security issues, implementing, and troubleshooting engineering skills. Topics of the course include, CISCO IOS Security Features, Security and Connectivity, Intrusion Prevention Systems, Cisco Security Management Tools, and optimization techniques. The following exams are required to receive certification; Securing Networks with Cisco Routers and Switches (Secure v1.0), Implementing Cisco Intrusion Prevention System v7.0 (IPS v7.0), Deploying Cisco ASA Firewall Solutions (FIREWALL v1.0), and Deploying Cisco ASA VPN Solutions (VPN v1.0). (Source CCNP) • ***Expert:*** *Certified Network Professional CCNP Certification: This course gives students knowledge on specific security protocols and components, as well as IP and IP routing. In order to achieve certification, candidates must first pass the CCIE Security Written Exam v3.0, which is a two hour long qualifying exam. It covers networking concepts, and equipment commands. Upon passing this exam, the next step is to take the CCIE Security Lab Exam. It is an eight-hour lab exam, and it tests a candidate's ability to run a secure network in a timed environment. Certification lasts for two years.* (Source CCIE).
Format of Course	Blended learning approach: combination of highly effective in-classroom instructor-led learning with innovative online e-learning curricula and interactive tools. Training in labs with hands-on learning.
Language the course are taught in	English and the entry level learning content is available in several other European languages: French, Spanish, Portuguese, German; Polish, Hungarian
Performance Evaluation	• Detailed monitoring on test and exam scores, numbers of students across all academies. Cisco has a development team considering for instance results of final exams. Exams are frequently refreshed in order to make sure that exams cannot be copied. • Surveying both instructors and students. This provides very valid data to make sure that the course is up to date and that it is meeting the needs of both students and instructors.

Outcomes / Impact	Upon completion of the course, students will have obtained knowledge about core security technologies: installing, monitoring, and troubleshooting of Cisco Security Technologies. This includes modern network security threats, securing network devices, authentication, authorization and accounting, implementing firewall technologies, implementing intrusion prevention, securing the local area network, cryptography, and implementing virtual private networks. As the curricula are frequently updated according to inputs from Cisco technology, industry partners and educational institutions the knowledge gained will be on the forefront of the development.

Business Model	
Description of partners	Cisco was founded in 1984. It sells and designs consumer electronics, networking, voice, and IT services. Cisco is the worldwide leader in networking technologies. The Academy started in 1997
Accreditation	Certificate for levels 2-4.
Type of organization of the lead partner	Industry
Geographical cover	Global, running in 17 European countries.
Financial model	Each new academy will make an agreement with Cisco and provide a person in charge of deciding the courses to run etc. A qualification process takes place to make sure that minimum two instructors per academy are qualified as they need to pass exams from Cisco. It is free of charge to become a Cisco Academy and curricula are continuously provided without charge. However, the instructor course will need to be paid by the educational institution itself.
Success rates	There are 10,000 academies worldwide that are located in 165 countries that teach this curriculum. Over 1 million students undergo this training every year. Over 4.5 million students have taken a Networking Academy course since the inception 1997. (Source: About Networking Academy)
Future Plans	Security is continually going to be a core part of networking and the Cisco Academy will continue to support training in this area and align the training with Cisco certification and industry needs.

Real-Life feedback from student	
No of students who have attended and completed this course	At the end of December 2011, 13,538 students were enrolled in Cisco's security course Globally. Since the course launched in Europe in 2009, 4919 students across the EU 27 have enrolled on it. Year on year growth in course adoption is very high with 1344 taking the course in 2010 and 2710 taking it in 2011. For all Cisco Networking Academy courses, the statistics for EU countries are as follows:

	• Students: 258,141 (+25 pct. of Networking Academy global student population) • Academies: 3376 • Instructors: 6526 20+ Memoranda of Understanding with national and regional governments in Europe ranging in scope from full integration of the programme into national curricula to localised projects.
Background of students	Computer science, most of them are still in education (VET or HE) and not working when they are taking the course.
Reasons for attending the course	In most cases: Recommendation or decision of the teacher at vocational schools or universities. The participant heard about CCNA from other colleagues at her University. They told her that it was very useful, and that the programme covered many interesting topics. First and foremost, it was about curiosity. She had a background in Computer Science and wanted to learn something more than programming. She wanted to see what else was out there. She also believed that the programme would help her to better understand some of the faculty courses and use her networking knowledge in a different environment. Furthermore, she decided to participate because she could join This programme while still in school, as the hours were very flexible and the academy was located in her school faculty building.
What did the student get out of it	The programme consisted of four modules. CCNA 1 was an introductory course. CCNA 2, 3, and 4 started with configuring, which were very hands on and practical. When she was in the course, they started offering a new curriculum, which was better than the old one, because it was more up to date. Classes were organised so that there were ten sessions per CCNA. The first eight consisted of courses and labs, and the last two were reserved for exams. She liked the laboratory aspect of the course, as lessons were inspired from instructors' real world experience. The old curricula had labs, but the new curriculum made them mandatory. The instructors were young, and well informed. *"They always challenged you to do something more."* –Participant The student did not attend a CCNA academy to prepare for the exam. Instead, she studied at home with a study guide. It was satisfying for her, because she did this on her own and she felt very accomplished. She enjoyed CCNA very much. It expanded knowledge and was very practical. It provided a good overview of information relating to the field and the topics were very pertinent to real life situations. Overall, she rated the programme as being very useful. The participant graduated from the CCNA programme after a year and a half with a specialization in Computer Hardware and Network Design.
Highlighted areas for improvement	She would have liked to have had more labs in all of the modules, but especially in CCNA 1. She found CCNA 1 boring, monotone, and too theoretical.

Sources	
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No. 2: Multipurpose Cloud Computing centre

Case study No. 2	IBM Multipurpose Cloud Computing Centre, Poland
Brief description	IBM Poland and Wroclaw University of Technology collaborated to create the first University cloud computer centre in Poland. The Wrocław University of Technology is the first university in the world to take part in IBM's Multipurpose Cloud Computing Centre programme.
Country	Poland
Educational Sector	Tertiary education
Type of Qualification awarded	Certificate
Partners	IBM Poland and Wroclaw University of Technology
Initiation Date	Summer 2011

Description of the Initiative	
Description	IBM Poland and the Wroclaw University of Technology created a curriculum consisting of ten courses and an internship that allows for over 1500 students to master cloud computing every year. During its first summer, around 400 students participated. The main part of This programme is the Multipurpose Cloud Computing Centre Internship (or MC2 Internship), which provides training modules within cloud, and gives interns flexible dates and hours. The University organises the course, and IBM Poland runs the teaching modules. This curriculum is based on IBM Tivoli Software. IBM mentors are physically present on the University campus to help with the exercises. The entire internship is conducted virtually, and is task based not hours based. Students can choose from a variety of different tasks, and the formal certificate they receive at the end will be based on what tasks they performed. The centre has the following objectives: • To use the cloud for education, to use the cloud for a remote educational internship • To promote research through in cloud technologies and to offer services to other faculties and business partners. This course provides students with a T-shape education, in which they are prepared for the workforce through the use of business and technology. Students + Business + Technology = T-shape education. (Source: Mariusz Ochla, IBM Technical Exploration Centre Manager, Central and Eastern Europe)
Length of Course	1 month
Max number of students	1500
Format of Course	Hybrid

Language the course are taught in	English
Performance Evaluation	Performance of students is evaluated in three different ways: • They are automatically monitored every fifteen seconds when they connect to the cloud • They have to pass an exam at the end to receive the formal industry-recognised certificate • Practical projects undertaken as part of the virtual internship are evaluated by the individual and by the team.
Outcomes/Impact	Students complete a virtual Internship, which leads to him or her receiving an industry-recognised certificate awarded by the IBM Toronto Lab. Furthermore, the student gains a knowledge of the IBM suite of cloud technologies, The best graduates of the programme are awarded a scholarship to work at an IBM research lab.

Business Model	
Description of partners	IBM or International Business Machines is a MNC that sells computer software, and hardware. Furthermore, it offers consulting services, and infrastructure and hosting services. Wroclaw University of Technology is a technical university in Poland. Over 32,000 students attend the school.
Accreditation	
Type of organisation of the lead partner	Industry and academia
Affiliation	Vendor Specific
Future Plans	The cooperation will continue in the field of education, PHD programmes and research. IBM Poland will further cooperate with other institutes, faculties and data centres in Poland.

Real-Life feedback from student	
No of students who have attended this course	400
Background of students	The student interviewed was a 21 year old female from Poland. She received a BA in IT, Electronics and Communications. The other students came from a multitude of backgrounds; several were working towards their BA, others towards their Master's. The tasks from which one could choose reflected the level of experience that the student had.
Reasons for attending the course	The student wanted to obtain some practical skills after her first year at university. She chose This programme because IBM is a very well-known corporation, and it could be a potential future employer. She considered this the perfect way to gain a first insight into the technologies and working practices at IBM.
What did the student get out of it	She got good insight about how IBM software works, and what skills are required to work in a cloud environment (including fast thinking, and creative skills). She wants to work for IBM after

	graduation, and after having completed this course, she believes that she has a much higher chance of actually doing so.
Highlighted areas for improvement	She would have liked to have some in company experience to get a feel for the IBM working environment.

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No. 3: CCSK

Case study No. 3	Alexandra Institute - Certificate of Cloud Security Knowledge (CCSK)
Brief description	Three day training course in Cloud Security. This programme is the first of its kind to be held outside of the United States.
Country	Scandinavia (First course in Aarhus, Denmark)
Target Students	Anyone interested in gaining more knowledge about Cloud Security.
Educational Sector	Continuing training, certification
Type of Qualification awarded	CSA Certificate of Cloud Security Knowledge
Partners	Alexandra Institute, Cloud Security Alliance
Imitation Date	September, 2011

Description of the Initiative	
Description	In 2010, the Alexandra Institute allied with the Cloud Security Alliance, an International, not-for-profit organisation that promotes Cloud Security. Together, the two organisations designed a three-day training course in Cloud Security. This programme is the first of its kind to be run outside of the United States.
Length of Course	3 days
Max number of students	15 people accepted per course in order to keep the personal approach that is considered important for the success of the training.
Ratio of applicants versus student participants	As the course is still very new all applicants have been accepted so far.
Qualifications Students obtain	CSA Certificate of Cloud Security Knowledge
Cost of course	The cost of the programme is 16,995DKK (€2165) including the test token and 15,995 DDK (€2065) without it. Prices do not include VAT. The cost to take the test is 300$ a token, which represents a 50 per cent discount, since the institute is a member of the Cloud Security Alliance.
Target Students	The Cloud Security Alliance has teamed up with other organisations to develop a one-day training course, which provides basic knowledge and an internet certificate at the end. However, the Alexandra Institute felt as if this did not fit the Scandinavian market very well. In designing the programme, the Institute kept in mind that Europe and Scandinavia are not on the forefront of Cloud Computing technologies and therefore they decided to keep the programme much more basic and “soft” in nature. This programme is different, because it is much more comprehensive, which allows people

	with no experience as well as professionals to gain knowledge and experience. In the United States, the target group for such a programme would be a group of professionals with Cloud Computing experience, the Scandinavian target market for This programme consists of people who have no training or experience whatsoever with Cloud Computing. Some target groups for This programme would be Cloud Computing companies who provide services, advice and consultancy relating to Cloud Computing, companies who are looking to implement Cloud Computing solutions and auditing companies who do audits on Cloud Computing.
Geographical Coverage	Scandinavia. However, a Spanish and Portuguese student attended the first class.
Pre requisites for application	None
Course Curriculum	Day 1: Marketing and business aspects of the cloud – basic description of cloud computing and the benefits for business, including clarification of the definitions of the associated infrastructure, the precise wording, and the agreed definition. Provision of different business scenarios where companies can use cloud computing. Presentation of real cloud computing solutions. Day 2+3: The security aspects of cloud computing by showcasing actual case examples, which display the problems and solutions from both the supply and consumer side. Drop box is being used as a lab scenario though out the course.
Format of Course	Classroom
Language the course are taught in	English
Performance Evaluation	Cloud Security Alliance Internet Test. The test duration is one hour online. There are fifty questions and it is necessary to get 80 per cent right in order to pass.
Outcomes/Impact	Upon completion of this course, graduates will be able to 1. Point out cloud computing architectural framework 2. Point out cloud computing security challenges 3. Point out cloud computing security controls recommendation By sending one or two people from a company to take this course, a certain knowledge base is created that will allow for Cloud Computing knowledge to spread throughout the enterprise.

Business Model	
Description of partners	The Cloud Security Alliance is a not-for-profit organisation with a mission to "*promote the use of best practices for providing security assurance within Cloud Computing and to provide education on the uses of Cloud Computing to help secure all other forms of computing*." (Source: Cloud Security Alliance)The Cloud Security Alliance is led by industry practitioners, corporations, associations and other key stakeholders. The Alexandra Institute is a "*non-profit company that works with*

	application-oriented IT research." (Source: Alexandra Institute)
Accreditation	The certification is not connected to formal education, which is common in the field of security. However; the fact that the course is developed in collaboration with CSA makes it recognised in the field.
Type of organisation of the lead partner	Non-profit
Affiliation	Cloud Security Alliance
Geographical cover	Scandinavia
Financial model	The participants pay a fee to participate (mainly paid by their companies) and they pay to take the test. The cost of running the programme is complicated to calculate because it depends on the location, which differs and the cost of developing the course, which is on-going.
Success rates	Not reported yet, as the course just started. Reviews were collected from the participants in order to evaluate instructor performance but it is still too early to come to any concrete conclusions.
Future Plans	The institute conducted a course in Aarhus in September in which seven students were present. The Alexandra institute plans to conduct a course in Stockholm in October and Copenhagen in November. The Alexandra Institute has decided to dedicate 2011 to course building. When the courses are completed in 2011, it will plan for next year and develop the concept a bit more concretely. The Alexandra Institute sees expansion possibilities, as it has already gotten an offer from a company in Malaysia to run the course there and in Singapore.

Real-Life feedback from student	
No of students who have attended this course	7 in Aarhus, Denmark 4 in Stockholm, Sweden
No of students who have completed this course	11 students have completed the course and 5 have bought the token to take the test to achieve the certificate. 4 have already taken the test and all passed.
Background of student	The student interviewed was 38 year old Dane. He is a software architect from Denmark, and holds a BA in IT from a Danish University. He is also the owner of his own company.
Reasons for attending the course	This particular student attended the course as cloud computing is "*at the tip of everybody's tongue*" and his company wanted to be prepared. They are not in the cloud business yet, but wanted to know what it is all about as cloud is here to stay as more and more applications are moving into the cloud. He attended this course because there are not that many of this type of course offered, and he found the topics covered to be interesting. Furthermore, he was one of four colleagues from his company

	that took the course. They had a special deal with the Alexandra institute as they do a lot of work with them, which was another reason why they chose this course.
What did the student get out of it	He learnt about the critical areas of focus that one needs to consider when one moves their business to the cloud. Most important in this regard was that the course was vendor neutral and that one learnt about the trade-offs that one makes when they shift their business to the cloud. Critical is the area of security or how to handle personal data for example. The clarification of the definitions of the associated infrastructure, the precise wording, and the agreed definition was very relevant as it is not agreed upon globally. The course enlightened the student to the security aspect of cloud computing, as his company initially wasn't interested in this. In hindsight, he discovered that this was a bit naïve. He learned that in Denmark, there are a lot of laws on how to handle personal information. Legislation is a barrier to the adoption of cloud technologies, and it can have a huge impact on what cloud solution Danish companies choose to implement. He decided not to complete the certificate, as he personally got out of the course what he wanted: to understand the opportunities and risks of cloud computing as relevant to his company.
Highlighted areas for improvement	No areas mentioned by the student.

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No. 4: BCS

Case study No. 4	British Computer Society (BCS) - The Chartered Institute for IT, intermediate certificate in the EU Code of Conduct for Data Centres, Global
Brief description	The certificate in the EU Code of conduct for Data Centres is an excellent example of good practice in regards to vendor neutral certification fostering the green IT mind-set and skills in data centres. This certification allows ICT practitioners to learn how to develop an organisation's 'Green' strategy by the effective use of energy by software, ICT systems and support infrastructure, both mechanical and electrical systems within the data centre.
Country	Global
Target Students	Target groups for obtaining this certificate are Data Centre Managers, Data Centre Operators, Data Centre Design Consultants, Data Centre Technicians, IT Purchasers of hardware and software, IT Architects or Solution Consultants, Independent IT Consultants, CSR or Environmental Champions within the technology departments, and Pre-Sales Engineers from OEM Vendors. (Source: EU Code of Conduct on Data Centres)
Educational Sector	Continuing training, Certification
Type of Qualification awarded	Certificate
Partners	BCS
Initiation Date	Fall 2011

Description of the Initiative	
Description	In 2008, a European Code of Conduct for Data Centre Operators was signed. BCS saw this as a "*sign that the industry is beginning to address the issue of carbon emissions which current forecasts compare to the level from the aviation industry.*" (Source: EU Code of Conduct on Data Centres)This code was developed with many organisations around Europe, including BCS. The Intermediate Certificate followed publication of the EU Code of Conduct on data centres. This programme demonstrates BCS' efforts to change the IT industry environment. BCS wishes to change the environment in such a manner that energy cost, power consumption and carbon emissions issues are better addressed. This certification builds upon The Foundation Certificate in Green IT, which BCS launched in May 2009 as the first and only recognised qualification for green IT. The Green IT programme is for those who need a broad and general understanding of what Green IT is and what it can do to help their organisation. The Intermediate Certificate course is about 'Green' strategies of organisation's data centres in terms of effective use of energy by software, support infrastructure, and ICT Systems. Furthermore, it will help organisations to understand the meaning and reasoning behind the EU Code of Conduct, and how to implement the Code's best practices in one's own organisation. It will help a company to develop a language surrounding energy efficiency.
Length of Course	2 days (10 hours) if the course is taken through a training provider.

Max number of students	There is no limit, but BCS does not recommend that a trainer instruct more than sixteen students during one session.
Ratio of applicants versus student participants	Everyone who applies is accepted.
Qualifications Students obtain	Certificate
Cost of course	The cost of preparation for the exam depends on what training provider chosen and if the student decides to self-study. The cost of writing the exam is £135.
Target Students	Target groups for obtaining this certificate are Data Centre Managers, Data Centre Operators, Data Centre Design Consultants, Data Centre Technicians, IT Purchasers of hardware and software, IT Architects or Solution Consultants, Independent IT Consultants, CSR or Environmental Champions within the technology departments, and Pre-Sales Engineers from OEM Vendors. (Source: EU Code of Conduct on Data Centres)
Geographical Coverage	Global
Pre requisites for application	There are no pre-requisites.
Format of Course	Training for the exam can take place in a number of ways. Firstly, the candidate can take course. The course is offered by BCS certified training providers, and is conducted in a classroom in both lecture and workshop formats. However, although accredited training is recommended, it is not a prerequisite to taking the exam and students can study for the exam on their own.
Language the courses are taught in	English
Performance Evaluation	Exam. The exam is one hour long. It consists of 25 multiple-choice questions, which are based on real-life scenarios. In order to pass, the candidate needs to receive a 60 per cent.
Outcomes/Impact	Upon completion of the course, students will know why the best practice section of the Code was developed, what the Code is, how to implement best practices, and how to implement best practices in a tiered supply environment. The Intermediate Certificate in EU Code of Conduct certifies that the student has gained an understanding of the EU Code of Conduct on Data Centres. A successful graduate will implement and obtain Participant status in the Code.

Business Model	
Description of partners	BCS, also known as the Chartered Institute for IT is an IT company that brings together industry, academics, practitioners and government to share knowledge surrounding IT. It promotes economic progress through the “information society.” BCS is a membership organisation with 72,000 members at present. It also offers a number of products and services. As part of this they have a professional certification portfolio including fifty individual certificates in a number of subject areas. BCS is involved in many Green initiatives. These include work

	with the BCS Ethics Group, the Carbon Footprint Working Group, and the Data Centre Specialist Group.
Accreditation	Certificate
Type of organisation of the lead partner	Profit
Affiliation	None
Geographical cover	Global
Financial model	Each student pays to take the exam and receive a certification from BCS. The programme has not been offered for long enough to figure out the costs to BCS.
Success rates	So far, the certificate has been a success. There is a huge interest surrounding Green IT at the moment. BCS expects that this certificate will be one of its best performing.
Future Plans	BCS is still selecting training partners to deliver training. BCS is dedicated to quality, so setting up this process will take time. BCS does not expect to achieve its target number of students until Q1 of 2012. BCS will continue to undergo research to understand what IT professionals do on a daily basis. It also plans to create more certificates surrounding Green IT, including Data Centre Design, and an Intermediate level certificate on the IT side of the organisation. BCS will continue to work globally with organisations that they have connections with, such as the Japanese Green IT council, and the Green Grid in the USA to bring the most pertinent information together.

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- Certified Energy Efficiency Data centre Award (CEEDA). www.bcs.org/category/13020
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- BCS says IT professionals need new skills to deliver Green IT. www.bcs.org/content/conWebDoc/40305

No. 5: CompTIA

Case study No. 5	CompTIA Green IT, Global
Brief description	The CompTIA Green IT certificate is an excellent example of good practice in regards to vendor neutral certification ensuring the knowledge and skills necessary to implement environmentally sound techniques within an organisation's IT infrastructure.
Country	Global
Target Students	IT decision makers, which include IT Managers, IT Supervisors, Data Centre Managers, and Facilities or Operations Managers
Educational Sector	Continuing training, Certification
Type of Qualification awarded	Certificate
Partners	CompTIA
Initiation Date	Spring 2010

Description of the Initiative	
Description	The CompTIA Green IT certificate provides students with the knowledge and know-how to implement and put environmentally sound techniques into practice within an organisation's IT infrastructure. It furthers a student's existing knowledge by including information on emerging technologies that are critical to the progress of green IT. The course covers areas such as Green technologies, standards, policies and design/support techniques. It provides the skills needed in order to adapt a 'Green' strategy including virtualisation skills, how to address carbon footprint management, proper disposal, power preservation best practices, and how to measure the return on investment from green IT activities. To assure the success of its programme, CompTIA joined forces with the technology industry, and other partners worldwide. These partners include the three thousand companies that are members of CompTIA, the United States Environmental Protection Agency, Climate Savers Computing initiative, etc.
Length of Course	The length of the course depends on what learning partner is teaching it. Training can be done in a quarter or a semester for a University course. In a corporate setting, the training can take place without the labs in less than a week if eight hours are dedicated to programme per day.
Max number of students	This depends on the capacity of the training partner.
Ratio of applicants versus student participants	This depends on where the course is taught, and whether the course is embedded into a curriculum that may be super-competitive or stand-alone in a training program
Qualifications Students obtain	Certificate
Cost of course	CompTIA does not design the courses, but it outlines what needs to be covered in them. Training companies then plan a programme around this curriculum. Courses can cost anywhere from a few hundred to a few thousand USD.
Target Students	This course was designed for professionals who are able to make

	decisions about IT infrastructure. These professionals should be looking to implement green IT initiatives. Usual candidates are IT managers, a Data Centre Managers, IT technicians, and system or network administrators. (Source: CompTIA Green IT.)
Geographical Coverage	Global
Pre requisites for application	The prerequisites are completion of CompTIA A+ and CompTIA Server+. If an applicant has not completed either of these certificates, he or she is required to have another IT certification. On top of these qualifications, applicants must have eighteen or more months of working experience within the IT sector.
Course Curriculum	The Green IT ***Techniques and Technologies*** concepts consist of the following topics: 1. Environmentally sound techniques for disposing of hazardous waste. 2. Preserving power. 3. Explaining what the purpose of virtualisation technology is and how to apply it. 4. Alternate techniques that enhance green IT initiatives. **Environmentally sound techniques for disposing of hazardous waste.** • If batteries, LCD screens, Computers, Toners, and Cleaning Supplies are not disposed of properly, they can harm the environment and the community surrounding them. Students will be instructed on the proper mode of disposal. **Preserving power.** • This includes demonstrating knowledge of power management and power saving features such as BIOS settings, which include ACPI, screen brightness, power saving profile, wake on LAN, CPU states, fan speeds, power on and off timers. Furthermore, the candidate will learn about OS settings that save power such as automatic standby, hard disk power down, sleep, standby, hibernate, UCSB suspend settings, Window's Vista DreamScene settings, etc. Lastly, the candidate will learn about complementary IT policy and procedures such as a shutdown policy for the end of the work day, consolidation of office equipment, reduction of graphic card performance to minimum requirements, using Power over Ethernet, etc. **Explaining what the purpose of virtualisation technology is and how to apply it**. • This includes VDI or Virtual Desktop Infrastructure, virtual lab, server consolidation, storage virtualisation, and application virtualisation. Furthermore, the best practices must be known as well as the pros and cons of virtualisation. The pros include power reduction, reduced infrastructure cost, centralization of computing resources, centralised administration, reduced licensing costs, etc. Cons include a potential single point of failure, more complex administration, high initial investment, training personnel costs, increate network traffic within a single node, etc. **Alternate techniques that enhance green IT initiatives.**

	• These include duplex printing, terminal and blade servers, Energy star rated equipment, low power NAS or Network Attached Storage in the place of file servers, solid state drives, green building infrastructure, smaller margins, paperless documents, online collaboration, etc. The Green IT ***Policies and Standards*** consist of the following topics: 1. Creating an internal IT strategy for analysing ROI on an organisation's Green IT projects. 2. Naming Green IT framework assessment tools. 3. Naming strategies that reduce environmental impact in the workforce. **Creating an internal IT strategy for analysing ROI on an organisation's Green IT projects.** • This includes clearly stating goals and objectives for initiating green IT policies, calculating savings and ROI on green IT investments, hiring project management for proper implementation, understanding the full life cycle assessment of environmental impact for any product, being able to calculate the carbon footprint of an organisation, etc. **Naming green IT framework assessment tools.** • The second requirement is to identify green IT framework assessment tools, organisations, and standards. These include the United Nations Intergovernmental Panel on Climate Change (IPCC), the United Nations Environment Program (UNEP), Agenda 21, the International Federation of Consulting Engineers Project Sustainability Management (FIDIC's PSM), IPD Environmental Code, ISO 21931, U.S. Environmental Protection Agency, Energy Star, TCO Certification, Restriction of Hazardous Substances (RoHS), 2002/96/EC Waste Electrical and Electronic Equipment (WEEE) requirements, Climate Savers Computing Initiative (CSCI), Green Computing Impact Organisation, INC. (GCIO), Green Electronics Council, The Green Grid, and International Professional Practice Partnership (IP3). **Naming strategies that reduce environmental impact in the workforce.** • The third requirement is being able to Identify methods to reduce workforce environmental impacts, which include carpooling, public transport, telecommuting, working remotely, replacing travel with video conferencing, remote interviews, etc.
Format of Course	Hybrid. There are several ways to prepare for the exam. The first option is self-study through the use of books with CompTIA Approved Quality Content Seals. The second option is through e-learning on CompTIA's eLearning and Certification Hub. (Source: Training & Testing).
Language the courses are taught in	English
Performance Evaluation	Exam. The exam lasts for sixty minutes and consists of thirty questions. The passing grade is a seventy per cent. A student can take the test with one of CompTIA's testing partners. Eighty per

	cent of the exam consists of questions on Green IT techniques and technologies, and twenty per cent of the questions are about Green IT policies and standards.
Outcomes/Impact	Upon completion of the programme, students will have a specialised knowledge of current IT methodologies, the ability to develop, deploy, and calculate true ROI for Green IT initiatives, knowledge of cost-cutting power management and IT virtualisation techniques, proven understanding of environmentally-sound waste disposal, and an awareness of global organisations' mandating standards and regulations. (Source: CompTIA Green IT.)

Business Model	
Description of partners	CompTIA also known as the Computer Technology Industry Association is an IT company who aspires to advance innovation and industry growth through educational programmes, market research, networking events, certifications, and public policy advocacy.
Accreditation	The certification is linked to Universities worldwide that teach CompTIA's curriculum. *"More and more schools that are trying to prepare their students for the real world are saying you need to think about planet, people, and profit. Planet refers to the environmental impact, people refer to the notion of social responsibility, and profit refers to the economics. You don't have to sacrifice the environment to make a profit… those days are over."* This highlights the demand for Green IT within these institutions.
Type of organisation of the lead partner	Non-for-profit organisation (Trade association)
Geographical cover	Global
Affiliation	CompTIA built its credential by ANSI and ISO standards.
Financial model	The students pay a fee to participate, and a fee to take the test. The exam fee is paid directly to CompTIA and costs $101. This fee covers the cost of bringing in experts from each domain to come to CompTIA two times yearly to upgrade the objectives and curriculum of the course.
Success rates	The programme is still very new, but results have been positive so far.
Future Plans	CompTIA will continue to broaden students' awareness about how various sectors need to be engaged in "*greening up*" the enterprise. It feels that it has made some strides, but that it still has a long way to go, as the programme has only slowed the rate of growth and expense so far. It hopes that ultimately graduates will help realise significant cost-savings within their organisations.

Real-Life feedback from student	
No of students who have attended this course	Thousands of students attended the course in the first year
No of students who have completed this course	Unknown
Background of	People working in it or in the sustainability offices of their

students	organisation. Logical choices would IT Managers, IT Supervisors, Data Centre Managers, and Facilities or Operations Managers. Furthermore, since more and more companies have started to own up to sustainability pledges, more and more jobs are being created within this field. Highlighting this fact, CompTIA reported that people from HR, Finance, Accounting, and Consultancies have also taken the course. Green IT is also relevant for those looking for a stepping stone to a more intensive programme, or for University students within an IT related study field.
Reasons for attending the course	Firstly, the participant's employer wanted him to complete a Microsoft certification called the Microsoft Certified System Engineer Focused on Security. He could decide between taking Microsoft specific courses for This programme, or taking security related courses and getting them transferred to the Microsoft Certification programme. He did not find the Microsoft courses to be relevant, so he completed CompTIA certification. Additionally, to keep his SSCP certification, he has to continuously gain professional equivalence points, which prove his knowledge in current day issues within the security industry. The CompTIA Green IT Certification could be converted into points.
What did the student get out of it	He used this programme as a stepping stone towards more advanced certifications. He also was able to use the certificate to prove that he has worked with computer security, which would make it much easier for him to find jobs.
Highlighted areas for improvement	He does not like how there is no need for continuous certification with CompTIA. In other words once a participant is certified, he or she will have the certification for ever, which does not require graduates to keep up to date with current topics.

Sources

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No. 6: CEFRIEL

Case study No. 6	'Centralised System for Cloud Computing'
Brief description	2-year Master Programme combines formal education with first job in the industry for job starters
Country	Italy
Target Students	Students with a first degree
Educational Sector	Public university
Type of Qualification awarded	Master's degree
Partners	Politecnico di Milano, CEFRIEL in collaboration with Assolombarda and five leading companies in the ICT sector: ENGINEERING, Gaia, IBM, Reply, and Siemens.
Initiation Date	15. September 2011

Description of the Initiative	
Description	This course aims to help students understand problems of large scale systems, of which cloud computing is just one. excellent training experience within the company to which alternates classroom to get the best results
Length of Course	The apprenticeship lasts for 24 months including 400 hours of lessons at the Masters level at CEFRIEL.
Max number of students	25
Ratio of applicants versus student participants	200/22
Qualifications Students obtain	Master's degree
Cost of course	-
Target Students	Students with a first degree
Geographical Coverage	Region of Milano only
Pre requisites for application	The candidate's bachelor degree must be in an IT related field, such as Computer Engineering, Telecommunications Engineering, Information Engineering, Electronic Engineering, or Computer Science. They must have graduated from this programme less than eighteen months before applying the Master's. Must have a minimum age of 21 and must not be over 29 years of age. The applicant must demonstrate that he or she has a love and passion for technology.
Course Curriculum	Students have to complete 10 course modules and 2 projects. Overview course modules (add more): 1. Introducing Centralised Systems 2. Multi-processor system architectures 3. Architectures of advanced operating systems 4. Architecture of the host systems 5. Virtualisation and data centre consolidation

	6. Cloud Computing 7. Storage systems and network storage 8. Performance and reliability of power systems 9. Smart Analytics 10. Green IT and data centre TCO
Format of Course	Class room based, 4 days of lessons per month (Classroom/online/self-taught/hybrid),
Language the course are taught in	Italian
Performance Evaluation	Students have to complete an exam after each course Project work has to be presented to a commission, which includes representatives of the involved companies.
Outcomes/Impact	This course is seen as a unique opportunity for young graduates to get prepared for the radical change in management infrastructure caused by the virtualisation of computing resources and Cloud Computing models

Business Model	
Description of partners	Politecnico di Milano is the largest technical university in Italy. It has 35,000 students. It has seventeen departments surrounding around Engineering, Architecture, and Industrial Design. CEFRIEL is a not-for-profit organisation, which is part of the ICT institute that created by Politecnico di Milano. Its goal is to strengthen ties between academia and industry. Assolombarda is the largest territorial association of the entrepreneurial system in Italy. It collaborates with about 6,000 firms within the region of Milan to represent the interests of these companies. ENGINEERING is one of Italy's leading consulting and services companies, which integrates business, technology, project, and management within companies. It consists of 11 companies, employing over 6,200 IT professionals. Gaia is an Italian company that was founded to further the fields of sustainability, cooperation, and networking. It studies and structures new services, which guarantees maintainable competitiveness to its clients. IBM or International Business Machines is a MNC that sells computer software, and hardware. Furthermore, it offers consulting services, and infrastructure and hosting services. Reply is one of Italy's leading consulting, systems integration, application management, and business process outsourcing companies. It specialises in the creation of solutions that are based on new communication networks and digital media. Siemens is a German engineering conglomerate, and is the largest in Europe. It is headquartered in Berlin, Munich, and Erlangen. The company operates mostly within the fields of Industry, Energy, and Healthcare.
Accreditation	

Type of organisation of the lead partner	Profit/non-profit Industry, Academia, Government
Geographical cover	
Financial model	Financed by the City of Milano
Success rates	Not reported yet, as it's the first year of the course
Future Plans	Seen as a specific initiative, no plans to expand into the market for mature students.

Real-Life feedback from student	
No of students who have attended this course	22
No of students who have completed this course	None yet as it's the first course.
Background of students	Students come mainly from an IT background, but also from mathematics and physics. The student interviewed was a 24 year old Italian male. He holds a BA in Computer, Science & Technology, and an MSc in Electrical Automation & Engineering from the University of Florence.
Reasons for attending the course	The student interviewed was looking for a job and did not want to move far from home. He liked the idea of having a job and being trained further. Lastly, he expects that the cloud market will grow, and he thought it was a good idea to specialise within this market during his first job.
What did the student get out of it	It is only the first year that the course is being offered, so there are no graduates as of yet. The student interviewed just started the course, and so far he has only taken the introductory module. He enjoys working for a young company and partaking in hands-on learning. Mainly he is working on Amazon Cloud and Microsoft Azure. He hopes to learn much more during his time at the school.

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No. 7: [(ISC)^2]

Case study No. 7	The International Information Systems Security Certification Consortium, Inc. [(ISC)²], Systems Security Certified Practitioner (SSCP®)
Brief description	The SSCP certification provides a depth of technical knowledge within seven domains of the (ISC)² SSCP CBK.
Country	England/Global
Target Students	Network Security Engineers, Security Systems Analysts, Security Administrators, and employees that work within IT but do not have direct contact with the security department (e.g. information systems auditors, application programmers, system network and database administrators, business unit representatives and systems analysts.)
Educational Sector	Continuing education, certification
Type of Qualification awarded	Certificate
Partners	None

Description of the Initiative	
Description	The SSCP certification gives students an in depth technical knowledge about the seven domains of the (ISC)² SSCP CBK, which is a list of topics that are extremely relevant to IT security professionals. This programme certifies that people who work at an operational level have the proper knowledge in accepted practices and the ability to assess risk when implementing policies and procedures. SSCP goes deep into subject areas that often are only quickly mentioned by vendor specific certifying bodies.
Qualifications Students obtain	Certificate
Target Students	Network Security Engineers, Security Systems Analysts, Security Administrators, and employees that work within IT but do not have direct contact with the security department. These include Information Systems Auditors, Application Programmers, System Network and Database Administrators, Business Unit Representatives and Systems Analysts.
Pre requisites for application	1. One year of experience one of the following activities within one of the seven fields of IT 2. Work requiring special education or intellectual attainment, usually including a technical school, liberal education or college degree 3. Work requiring habitual memory of a body of knowledge shared with others doing similar work 4. Management of projects and/or other employees 5. Supervision of the work of others while working with a minimum of supervision of one's self 6. Work requiring the exercise of judgment, management decision-making and discretion 7. Creative writing and oral communication, teaching, instructing, training and mentoring others, R&D If a student does not have the required experience, he or she can earn the Associate of (ISC)² designation. This is done by passing the required SSCP examination. Upon completion of the required

	experience and paying the Annual Maintenance Fee, a student will earn the SSCP certification. Furthermore, the SSCP certification waives one year of experience from the CISSP certification. Therefore, many students use this as a first step to This programme and other more advanced programmes.
Course Curriculum	1. Access Control 2. Administration 3. Audit and Monitoring 4. Cryptography 5. Data Communications 6. Malicious Code/Malware and Risk 7. Response and Recovery
Outcomes/Impact	The benefits of the SSCP programme for a professional employee include knowledge within the field of IT security, commitment to the profession, better credibility and access to member resources. The benefits to an organisation include initiation of best practices within the company, a broad understanding of (ISC)² CBK, access to global industry and subject matter/domain experts, access to broad-based security information resources, added credibility and technology oriented risk management.

Business Model	
Description of partners	$(ISC)^2$ a global not-for-profit consortia of organisations representing active professionals (including 12000 across EMEA) from the academic, industry and government sectors.

Real-Life feedback from student	
Background of students	The student interviewed was a 33 year old Dane. He is a professional services consultant for a security product vendor and holds a BA in IT from a Danish University. He took the certificate in 2005, while he was working for the Royal Bank of Scotland.
Reasons for attending the course	He had the opportunity to take this course with his first job within the IT security team at RBS. The bank fully sponsored this course as training. He wanted to take the programme so that he could get specific knowledge relevant to the field of IT security. He knew that this programme would be relevant since the content of the security courses and exams are continuously updated according to the evolution of job families in the IT security world. For example, cloud computing appeared as part of the courses, but is not a stand-alone course yet, as there are no stand-alone jobs in the industry yet. ISC2 Certificates are accredited to global standards that are recognised worldwide. In the security industry, it is very important that the standards are recognised in the USA as well as in Europe. These accreditations were very important for him when choosing to take the course. He completed his first degree in Denmark, so getting a certificate from the UK was very important for him. He assumed that this certificate would give him better job security, and would allow him

	to be spotted as a person who should be further developed by RBS.
What did the student get out of it	The student chose the one week intensive boot camp for preparation. This is the most expensive way of paying for the programme, but is also the most effective. Since the bank was paying, he did not need to worry about costs. During this time, he also completed an eLearning certificate at CompTIA. According to the student, the CompTIA courses did not even begin to compare with the depth of knowledge he needed to acquire in the ISC2 programme. In the IT security industry, it is industry standard that the CISM and CISSP are required certificates for job applicants. This was not the case in 2005, but nonetheless it has helped and continues to help his career. The requirement for membership is that the student is expected to continuously update his or her skills base. This complements the hands-on training, which is the most important aspect in IT career development. This has allowed him to stay informed and keep his skills base up to date. Many of his former Danish student colleagues have completed ISC2 courses, as it is an independent vendor neutral certificate of international standard.
Highlighted areas for improvement	None

No. 8: Microsoft cloud computing services

***Please note** there is only one Microsoft Training initiative listed on this page. Microsoft offers many different cloud training and certification options- but this was the offer that they considered most relevant.*

Case study No. 8	Microsoft Cloud Services: Training and Certification
Brief description	Microsoft has created a powerful approach in cloud computing in order to address and meet the ever-changing needs of its customers.
Country	Global
Target Students	Data Centre Operations Manager, Cloud Developer, Data Steward, Office 365 Manager
Educational Sector	Adult education and training
Type of Qualification awarded	None
Partners	Training Academies

Description of the Initiative	
Description	The Microsoft Cloud Computing team has provided an integrated portfolio of curricula, training resources, exams and skills mapping to provide participants the knowledge necessary for success in implementing Cloud IT solutions in a vast array of situations. The portfolio design and development is managed out of the United States. The training and certification solutions are based on data from quantitative and qualitative research, surveys and focus groups from customers and partners who are implementing Cloud Computing solutions. The offerings are provided in collaboration with both commercial training and academic institutions as an engine for growth in this field.
Length of Course	Depends on the Course
Qualifications Students obtain	Microsoft's certification programme offers a vast array products and services at varying levels, which correspond to a participant's previous skills. These skill paths are designed to fit the needs of individuals at every level of the IT spectrum. Cloud course offerings are provided at a range of levels as described below: • The Microsoft Certified Architect programme (MCA) certification highlights the expertise of the best professionals in IT architecture. • The Microsoft Certified Master (MCM) programme helps experienced IT professionals to deepen and broaden their technical expertise on Microsoft server products. • The Microsoft Certified Professional Developer or (MCPD) certification gives candidates the skills necessary to develop applications successfully by using Microsoft Visual Studio, and the Microsoft NET Framework. • The Microsoft Certified IT Professional (MCITP) certification demonstrates that an IT professional has the skills necessary to undertake a certain job related to IT. • The Microsoft Certified Technology Specialist (MCTS) certification is designed demonstrate an IT professional's skills with Microsoft products.
Cost of course	Depends on the Course
Target Students	Data Centre Operations Manager, Cloud Developer, Data Steward, Office 365 Manager
Geographical Coverage	Global
Pre requisites for application	Depends on the Course

Course Curriculum	Build core On-Premise skills – IT Practitioners will continue to need networking, security and administration skills for example. Apply core skills for hybrid environments – analyse and plan for co-existence solutions. Add new cloud technology/solution skills to adapt to new business requirements and grow one's career.
Format of Course	Classroom and lab
Language the courses are taught in	English
Performance Evaluation	NSAT Scores

Business Model	
Description of partners	Microsoft is a Multinational Corporation that is headquartered in Redmond, Washington in the US. It develops, manufactures, licenses, and supports many products and services surrounding computing.
Type of organisation of the lead partner	Industry, academia
Affiliation	Vendor specific
Future Plans	Microsoft will introduce new certifications over the next year covering Microsoft cloud services. It will also update many of its current certifications to include cloud-related skills through use of Official Microsoft Learning Products, including Microsoft Press books, Microsoft Official Courses and Official Microsoft E-Learning.

Real-Life feedback from student	
No of students who have attended this course	There were around 20 students. The class had a capacity of 24.
Background of students	The participant interviewed has had 15+ years of mail system experience and some experience with B+ (which was the previous format of Office 365). He also has had experience with using Hotmail, and Google Apps services. Today, he operates a consulting company. He is a computer architect, and designs solutions for customer needs. He mainly focuses on implementing solutions for small companies, and has never worked on major installations. All students in the course had a similar background. They were either MCM graduates, members of the product groups, or MVPs (Most Valuable Professors). MVPs are people who are active with Microsoft products and have contributed to their development through writing books, etc.
Reasons for attending the course	He chose to attend because Microsoft's training facilities in Redmond have a reputation for high quality. The courses provide high end training on products. Furthermore, this is the same training that Microsoft personnel undergo. He previously attended a three week training course in Microsoft Exchange, so he already knew first hand that the classes were good. The second reason that he took the course is *because "Cloud computing is not just another buzz word. It is here to stay. In the not so distant future, more commodity services will be offered in the cloud. Thus, it is a strategic benefit for an IT professional to attend training now."* Furthermore, he felt as if this training would help him serve his clients better in his consulting firm. He needs to be seen as a trusted advisor

	who can describe the benefits and drawbacks of cloud computing to his customers as well as being able to advise them about whether or not it is beneficial for them to move to the cloud. The participant believed that this training would provide him with the knowledge and expertise to provide these answers.
What did the student get out of it	The instructors were very skilled, the content was deep, and everything was thoroughly explained. Everyone was highly skilled, which created an environment where everyone had something to contribute. In sum, the participant was extremely satisfied with the course. *"Taking this course means that you really understand how it works and you can talk about the subjects without guessing."*
Highlighted areas for improvement	He would have liked for the lab server to be available for a year after training. Microsoft needs to reuse these servers for the next round of classes, but he mentioned that having the ability to practice on them for longer would be nice.

Annex 2 – List of interview respondents

Industry Experts

- Peter Hagedoorn, EuroCIO
- Gert De Laet, Cisco, Belgium
- Andrew Harvey Price, e-skills UK, UK
- Carsten Johnson, CISCO Networking Academy, Germany
- Peter Kruse, CSIS security group, Denmark
- Anders Trolle, SaaS-it Consult, Denmark
- Katrina Destree, Alcatel-Lucent, Belgium
- Philippe Saint-Aubin, Alcatel-Lucent, France
- Martin Curley, Intel Corporation, Ireland
- Benjamin Kott, Google (Green Business Operations EMEA)
- Kate Barnes, Microsoft
- Ray Pinto, Microsoft
- Christine Yoshida, Microsoft
- Peter Cladingbowl, Interxion, Netherlands
- Mark Skilton, Capgemini, UK
- Catherine Courage, Citrix

University

- Gérard Valenduc, Research Centre of Fondation Travail-Université, Belgium
- Reima Suomi, University of Turku, Finland
- Arnis Gulbis, Riga Technical University, Latvia
- Tomas Sabol, Kosice University, Slovakia
- Radoslav Delina, Technical University of Kosice, Slovakia
- Doinita Ariton, Danubius University of Galati, Romania
- Nils Fonstad, INSEAD
- Markku Markkula, Aalto University, Finland
- Seija Jäminki, Kemi-Tornio University of Applied Sciences, Finland
- Kenji Kushida, Stanford University
- John Zysmann, Berkeley University

Academia/associations

- Caroline Jacobsson, EMF
- Jonathan Murray, DIGITALEUROPE
- Carrie Hartnell, Intellect, UK
- Jacob F. Kirkegaard, Peterson Institute, USA
- Ulla Scherfig Gilberg, DI ITEK, Denmark
- Henning Mortensen, DI ITEK, Denmark
- Mike Sharpe, PIN-SME, UK
- Werner B. Korte, Empirica GmbH, Germany
- Nigel Payne, e-skills UK, UK

- Michael Brown, SkillsNet, USA
- Bart Pegge, ICT-Office, Netherlands
- Stephane Wojcik, AGORIA, Belgium
- Valentin Negoita, APDETIC, Romania
- Stephan Pfisterer, BITKOM, Germany
- Terry Hook, clock-IT-skills Ltd, UK
- Christian Reimsback Kounatze, OECD, France
- Jonathan Zuck, ACT, USA
- Jakob Illeborg Pagter, Alexandra Instituttet, Denmark
- George Sharkov, ESI Centre Eastern Europe, Bulgaria
- Alfonso Fuggetta, Politecnico di Milano/CEFRIEL, Italy
- Jette Lundin, It-vest, Denmark

Relevant public sector experts

- J. Mutumba, SPF Economie, Belgium
- Nicholas Falck Lund, National IT and Telecom Agency, Denmark
- Morten Ellegaard, National IT and Telecom Agency, Denmark
- Mikkel Leihardt, National IT and Telecom Agency, Denmark
- Thomas Kristmar, National IT and Telecom Agency, Denmark
- Ene Koitla, The Estonian e-Learning Development Centre, Estonia
- Jouni Kangasniemi, Ministry of Education & Science Policy, Finland
- Santa Sipola, The Ministry of Regional Development and Local Government, Latvia
- Luis Magalhães, UMIC - Ministry of Science, Technology and Higher Education, Portugal

SMEs and start-ups

- Michael Setton, Sensaris, France
- Fernando Guerrero, SolidQ, Spain
- Damir Tomicic, Axinom, Germany
- Jesper Christensen, Nykilde, Denmark
- Søren L. Rasmussen, Rosenloeve reklamebureau, Denmark
- Anders Nørhaven, Bookpartnermedia, Denmark
- Dennis Villumsen, Toyjoy, Denmark
- Petteri Vainikka, Leiki Ltd, Finland
- Trudi Schifter, TallyFox Social Technologies AG, Switzerland
- David Bizer, HackFwd, France
- Brian Restall, Projects in Motion Ltd., Malta
- Phil Chambers, CTO, Podio
- Henrik Bennetsen, Katalab, Silicon Valley
- Mark Middlebrook, Image2Output

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