

# CLOUD COMPUTING

Challenges and Opportunities  
for Swedish Entrepreneurs



ENTREPRENÖRSKAPS  
FORUM

# **CLOUD COMPUTING**

**Challenges and Opportunities for Swedish Entrepreneurs**

**Åke Edlund**



NÄRINGSPOLITISKT  
FORUM

Entreprenörskapsforum är en oberoende stiftelse och den ledande nätverksorganisationen för att initiera och kommunicera policyrelevant forskning om entreprenörskap, innovationer och småföretag. Stiftelsens verksamhet finansieras med såväl offentliga medel som av privata forskningsstiftelser, näringslivs- och andra intresseorganisationer, företag och enskilda filantroper. Författarna svarar själva för problemformulering, val av analysmodell och slutsatser i rapporten.

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# Förord

Näringspolitiskt forum är Entreprenörskapsforums mötesplats med fokus på förutsättningar för det svenska näringslivets utveckling och för svensk ekonomisk långsiktigt uthållig tillväxt. Ambitionen är att föra fram policyrelevant forskning till beslutsfattare inom såväl politiken som inom privat och offentlig sektor. De rapporter som presenteras och de rekommendationer som förs fram inom ramen för Näringspolitiskt forum ska vara förankrade i vetenskaplig forskning. Förhoppningen är att rapporterna också ska initiera och bidra till en allmän diskussion och debatt kring de frågor som analyseras.

Näringspolitiskt forums femte rapport syftar till att beskriva mer i detalj vad Molnet är för något, dess möjligheter och eventuella hot. Entreprenörerna är de som sedan flera år ligger längst fram och fullt ut använder sig av och också utvecklar Molnet. I Norden – främst Sverige - finns ett antal bra exempel på unga företag som helt eller delvis baserar sina affärsmodeller på Molnet. Men de utgör fortfarande en begränsad skara och det som saknas är större svenska molnleverantörer och utvecklingsplattformar. Idag hävdar många bedömare att vi i och med Molnet står inför ett paradigmskifte och det finns ett utrymme för politiken att bidra till en mer dynamisk och tillväxtbefrämjande svensk "molnmiljö".

Rapporten är författad av Åke Edlund, tekn dr Kungliga Tekniska Högskolan. Författaren svarar för de slutsatser och den analys som presenteras. Ekonomiskt stöd har bl a erhållits från PwC.

Stockholm i oktober 2012

Pontus Braunerhjelm  
*VD och professor, Entreprenörskapsforum*



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# Molnteknologins betydelse - sammanfattning

Vad innebär det så kallade "Molnet" för svensk ekonomi och det svenska näringslivet? Genomslaget av Internet kan vara en lämplig utgångspunkt. Idag är betydelsen av Internet för Sveriges näringsliv en självklarhet, vilket inte alls var situationen i mitten av nittiotalet då få politiker – men desto fler svenska entreprenörer – alls anade betydelsen av denna globala informationsplattform. Snabbt genomfördes dock reformer som underlättade och stimulerade såväl spridning som användning av Internet.

Idag hävdar många bedömare att vi står inför ett än större paradigmskifte – molntjänster och samhällsekonomiska spridningseffekter kopplade till Molnet. Molntjänsteekonomin bygger vidare på Internet, med den stora skillnaden att användaren nu kan få så mycket mer ut av att ha en uppkoppling mot Internet. Hur väl förberedda är vi att ta till oss den nya teknologin och vad betyder det för den långsiktiga globala konkurrenskraften hos svenskt näringsliv? Detta kan vara en lika avgörande fråga som när användandet av Internet fick fullt genomslag. Molnet har fortfarande inte har fått särskilt stor uppmärksamhet.

I denna rapport beskrivs mer i detalj vad Molnet är för något, dess möjligheter och eventuella hot. Entreprenörerna är de som sedan flera år ligger längst fram och fullt ut använder sig av och också utvecklar Molnet. I Norden – främst Sverige - finns ett antal bra exempel på unga företag som helt eller delvis baserar sina affärsmodeller på Molnet. Men de utgör fortfarande en begränsad skara och det som saknas är större svenska molnleverantörer och utvecklingsplattformar. Det finns ett utrymme för politiken att bidra till en mer dynamisk och tillväxtbefrämjande svensk "molnmiljö".

## *Vad är Molnet?*

Molnet betyder olika saker för olika användare och kan sammanfattas som ett komplett IT-baserat ekosystem som skapar ett flöde av tjänster mellan de som äger maskinerna och nätverket (leverantörerna av infrastrukturen), till de som skapar lösningar (utvecklarna av molntjänster) för slutanvändarna (av molntjänster). Att det hela benämns Molnet beror på att slutanvändaren endast behöver en uppkoppling mot Internet, som ofta grafiskt beskrivs som ett moln.

Men detta har väl funnits länge, varför ett nytt namn? På samma sätt som Internet 'funnits väldigt länge' innan mitten av nittio-talet, hände det något helt plötsligt, något som tog världen med storm: tekniken var redo, det vill säga, tillräckligt bra, tillräckligt billig och tillräckligt spridd. Samma sak denna gång, med Molnet. Amazon lanserade 2006 sitt 'elastiska moln'<sup>1</sup>, en tjänst, inte en programvara som företag behövde ladda

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1. [aws.amazon.com](http://aws.amazon.com)



ner och installera, än mindre köpa – där användaren med sitt kreditkort kunde 'hyra' datorkraft per timme. Det hade gjorts försök av andra långt tidigare med liknande lösningar, men nu var tiden inne – tekniken var mogen, användarna vana att betala med kreditkort över Internet och med god uppkoppling mot detsamma.

En annan viktig faktor – förutom diverse tekniska detaljer kring Amazon – var att Amazon hade, genom sin e-handelslösning, byggt enorma datorcentra. Storleken på dessa gav skalfördelar som gjorde det möjligt för Amazon att leverera denna molntjänst med lönsamhet. Detta var startskottet. Inom kort började tekniskt avancerade entreprenörer bygga tjänster baserade på Amazons plattform. Tjänster som Dropbox<sup>2</sup> lanserades snabbt (eftersom Dropbox inte behövde äga egna datorcenter), globalt (eftersom tjänsten kan nås från alla med Internetuppkoppling) och med låg risk (eftersom Dropbox bara betalade för de resurser som det behövde från Amazon – det vill säga, de växte med kundunderlaget).

Amazon nämns oftast i dessa sammanhang, men långt innan har det levererats 'molntjänster', dock utan att de kallats så. Till exempel kan man se Microsofts e-posttjänst Hotmail som en sådan. Användaren loggar in på sitt konto som finns på Microsofts datorer och nätverk – allt utan att användaren behöver något mer än en webbläsare. Men, den stora skillnaden 2006 var att nu kunde utvecklarna själva bygga liknande tjänster – utan att äga datorerna som levererade tjänsterna.

Idag är alla stora företag med Internetbakgrund med och konkurrerar om användarna. Konkurrensen är stenhård, särskilt om utvecklarna – våra entreprenörer. Men också mellan utvecklarna där konkurrensen är global, alla molntjänster kan nås från alla användare på det öppna Internet. Enligt Nelli Kroes, EU-kommissionens vice president och ansvarig för EU:s digital agenda, kan detta förväntas leda till betydande produktivitetseffekter, högre flexibilitet, ökad effektivitet och lägre kostnader för företagen.

### *Hur viktigt är Molnet för svensk ekonomi?*

Frågan är i vilken utsträckning molnteknologin kan förväntas påverka svenskt entreprenörskap och företagande, dess samlade samhällsekonomiska betydelse och om den föranleder förändringar i den ekonomiska politiken?

Beträffande den första frågan får svaret anses vara ett obetingat ja vilket kan exemplifieras med att t ex 80 procent av Ericssons FoU-satsningar kan kopplas till mjukvara (ca 20 miljarder kronor per år), och Molnet är just en utveckling av mjukvara. Tittar man på mer traditionella branscher framgår att inom t ex fordonsindustrins består insatsvarorna till stor del av mjukvara. Av det totala värdet på en bil uppskattas således 25-35% kunna hänföras mjukvara. För 30 år sedan var motsvarande andel omkring en procent av det totala värdet. En ytterligare illustration är att ca 70% av innovationer inom delar av fordonsindustrin bedöms vara kopplade till utvecklingen av mjukvara.

Beräkningar har också gjorts på molnteknologins effekter på sysselsättning och omsättning. Dessa är av uppenbara skäl osäkra och bör tolkas försiktigt. Inte desto

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2. [dropbox.com](http://dropbox.com)

mindre indikerar befintliga uppskattningar på avsevärda realekonomiska effekter. Mer generellt hävdas att Molnet redan har genererat avsevärda ekonomiska värden för såväl länder som företag, särskilt mindre och nystartade företag. Exempelvis uppskattas omsättningen av öppna molnrelaterade tjänster i USA ha uppgått till 28 miljarder US dollar 2011. Den globala omsättningen 2011 beräknas till mer än 400 miljarder dollar samtidigt som 1,5 miljoner nya jobb skapats. Blickar vi framåt blir siffrorna än mer imponerande: 2015 förväntas molntecknologin ha skapat mellan nio och 14 miljoner nya arbetstillfällen, ganska jämnt fördelat mellan stora och små företag, medan näringslivets intäkter från molnbaserad innovation beräknas uppgå till 1,1 triljon US dollar. Det är främst kommunikation- och IT-branscherna som förväntas bli påverkade, men också den finansiella sektorn och delar av tillverkningsindustrin. Kina och Indien svarar för ungefär hälften av de nya jobben.

För Sveriges vidkommande finns också mer preciserade bedömningar: 2015 beräknas de molnrelaterade tjänsterna ha bidragit med 23 000 nya arbetstillfällena, vilket kan jämföras med mjukvarubranschens samlade sysselsättning 2010 på ca 75000.

### *Att göra för svenska politiker*

Sverige låg tidigt långt framme när det gäller utnyttjande och implementering av Internet när det kom för ca 20 år sedan. Frågan är hur förutsättningarna ser ut idag för ett lika snabbt och framgångsrikt tillvaratagande av de möjligheter som molntecknologin ger upphov till? Finns det något som svenska politiker kan göra för att bistå svenska entreprenörer för att stärka deras konkurrenskraft på den globala marknaden som växer fram kring Molnet?

För det första kan konstateras att det redan förekommit skattemässiga problem för utvecklare av molnbaserad teknologi, där svenska entreprenörer riskerade att bli dubbelbeskattade pga oklarheter om skattesubjektens faktiska hemvist i molntecknologin. Det problemet avhjälpes relativt snabbt men visar hur nya och oväntade situationer uppstår som är kopplade till införandet av nya teknologier.

Bra entreprenörer tar sig visserligen fram oavsett omgivningen, och till en viss del kan dåliga förutsättningar ta fram det bästa ur dessa team. Men, det finns flera fronter för svenska politiker att arbeta på:

- Kunskapsområdet: stöd av utbildningar som krävs för denna marknad – både tekniska som affärsmässiga. Bristen på kompetent arbetskraft är det som hindrar många entreprenörer. Idag arbetar många med globala team, men lokal kunskap är en bristvara.
- Resurstöd: som komplement till ekonomiskt stöd, ge resurstid på Molnet – både på lokala som globala moln. Detta sätt att investera är allt vanligare inom riskkapitalbranschen, främst i USA. Till exempel<sup>3</sup> ger allt fler acceleratorer/inkubatorer

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3. [www.techstars.com/cloud](http://www.techstars.com/cloud) och [www.microsoft.com/bizspark](http://www.microsoft.com/bizspark)

molnresurser till sina bolag. Ekonomin i detta sätt att hjälpa är betydligt enklare att mäta, och direkt användbar för entreprenören.

- Teknikstöd: allt fler tekniska entreprenörer – de som utvecklar och fördjupar tekniska lösningar – behöver lokala molnlösningar att testa och utveckla på. Fördelen med dessa lokala lösningar (små lokala datorresurser, ju större desto bättre) är att de kan testa och utveckla lösningar som de inte kan utveckla på globala publika resurser (de kommer inte åt till exempel Amazons datorer på den låga nivån). Detta arbetar man med i till exempel Finland<sup>4</sup>, vilket leder oss till nästa punkt.
- Etablera nära samverkan med grannländer och EU generellt för att på det sättet skapa den bästa miljön för våra entreprenörer: Molnområdet är under ständig utveckling, ju fler som hjälps åt för att följa – och optimalt, leda – detta, desto större sannolikhet att lyckas.

Allra viktigast är dock att de generella villkoren för entreprenörskap, innovation och företagsbyggande är lika goda i Sverige som i våra konkurrentländer.

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4. [www.cloudsoftwareprogram.org](http://www.cloudsoftwareprogram.org)

# Executive summary

The software industry is shifting towards service based business models gathered under the name 'cloud computing'. The implications of these changes are extensive and considered a paradigm shift, according to some even greater than the introduction of the Internet. The Cloud has already, as shown in the report, resulted in a impressive number of new firms, increased revenue and employment opportunities. The future is expected to bring about even greater real economy effects that can attributed cloud computing.

In this report we describe the challenges and opportunities facing Swedish software industry and its entrepreneurs. The report expands the view of 'entrepreneur' to include entrepreneurs in the whole software related industry, and we expand the geographical view to include the European perspective. To summarize the case we are making in this report:

- The Software Industry is of increasing importance to Sweden<sup>5</sup>
- The Software Industry changes rapidly
- The latest change, cloud computing, is as big a change - most likely bigger - than the introduction of Internet
- This change creates challenges and opportunities to Swedish industry and its entrepreneurs
- Swedish government should consider how to design policies that provides conditions facilitating the development and exploitation of cloud computing, to the benefit of Swedish industry and its entrepreneurs in meeting future challenges
- To get a quick start in helping the Swedish entrepreneurs, the Swedish government should build on results developed by expert groups in EU.
- Sweden need to get more involved in the European and Nordic working groups – to become an active contributing partner, with influence in the common efforts helping our industries and entrepreneurs facing the challenges and opportunities created by cloud computing.
- To do this, Sweden needs to put together a Swedish Cloud Expert Group – and use the findings from the European and Nordic (especially Finnish) expert groups. This group is needed to connect to ongoing collaborations and to build a Swedish strategy on these matters.

To summarize: we should increase our contribution to the Nordic and European efforts addressing the challenges and opportunities facing our software industry and

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5. See the work performed by the Swedish software organization Swedsoft ([www.swedsoft.se](http://www.swedsoft.se)), especially the report from [http://www.swedsoft.se/Mjukvaran\\_är\\_själen\\_i\\_svensk\\_industri.pdf](http://www.swedsoft.se/Mjukvaran_är_själen_i_svensk_industri.pdf)

–through this, build a platform, and ecosystem, for our entrepreneurs from which they can develop and launch their ventures in a competitive way.

# The Cloud – why it matters

*“Cloud Computing will change our economy. It can bring significant productivity benefits to all, right through to the smallest companies, and also to individuals. It promises scalable, secure services for greater efficiency, greater flexibility, and lower cost.”*

Neelie Kroes, Vice-President of the European Commission responsible for the Digital Agenda Setting up the European Cloud Partnership World Economic Forum Davos, Switzerland, 26th January 2012<sup>6</sup>

## Entrepreneurs and intrapreneurs

The challenges and opportunities facing the software industry, stemming from cloud computing, at the same time imply immense entrepreneurial opportunities to develop new businesses. Even more important, this new technology also carry considerable potential welfare gains at the societal level. That is what makes the issue of cloud computing important at the national level and that policies are well designed to enable the exploitation, inclusion and diffusion of cloud computing. Therefore the definition of entrepreneurial activity should not be limited to new start-ups, but also include intrapreneurs in existing industry where the constant innovation pressure due to global competition and shorter life cycles of products and services is more present than ever before.

## International scope

As is described below, the software industry is a highly international industry, and the challenges and opportunities we’re facing in Sweden are much the same as in the rest of the world, and especially in other EU countries. In this report we leverage work

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6. <http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/12/38>

done together with experts from all over Europe, including experts from USA – *the EU Cloud Expert Group*<sup>7</sup>.

In addition we take impression from a longer effort on fostering entrepreneurship and industry in cloud take-up in Finland, the *Cloud Software Finland Project*, run by Tivit.fi. Both these groups have very timely come up with strategy documents – addressing the same topics as this report, and almost at the same time<sup>8</sup>.

In addition, the *IDC/Microsoft report*<sup>9</sup> on cloud computing and job creation, published in Feb-March 2012 adds new data to the market size estimates. The importance of software for Swedish industry is clearly emphasized by the Swedish software industry effort, *Swedsoft.se* (supported by companies like Ericsson, ABB, Saab, Volvo).

## Organization of the report

The report is organized in the following way:

1. Software Industry – what it is, and its importance for Swedish industry. We define what software industry is, beginning from the basic definitions of software, how it differs from hardware, entrepreneurship in this area, and the overall importance of software for Swedish industry.
2. Cloud Computing – what it is, and how it is the software industry. Here we define what Cloud Computing is and how it is changing parts of the software industry and the landscape for entrepreneurs
3. Status today, looking forward and outwards – looking at state-of-the-art and current strategy efforts addressing the challenges and opportunities with cloud computing. Recommendations from the EU Cloud Expert Group and Tivit.fi Cloud Software Finland, and their relevance for the Swedish context, is discussed.
4. Recommendations – short term actions supporting Swedish entrepreneurs and industry: Create a connection point – a Swedish expert group - for international collaboration. Create a Swedish cloud computing testbed for entrepreneurs and industry.

## Background

Swedish software industry – and its entrepreneurs – has over the years produced remarkable international companies. Cloud computing is a new such area where Swedish entrepreneurs for long have been present and have been expanding their

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7. The author of this report is also one of the members and co-authors of the EU Cloud Expert Group and its reports. The author is also one of the reviewers of the Finnish Cloud Software Programmes Strategic Research Agenda for Finnish Software Industry
  8. Tivit.fi, in mid-March 2012; EU Cloud Expert Group report, May 2, 2012
  9. [http://www.microsoft.com/en-us/news/download/features/2012/IDC\\_Cloud\\_jobs\\_White\\_Paper.pdf](http://www.microsoft.com/en-us/news/download/features/2012/IDC_Cloud_jobs_White_Paper.pdf)

efforts. Looking at the bigger picture we're now, more than ever, competing on a global scale. The services we develop are directly accessible over a global network, by customers worldwide. The resulting challenges and opportunities are common to all countries with free access to the web. The challenge for Swedish politicians refer to: How to best design a policy that enables entrepreneurs to participate in the uptake and evolution of cloud computing? We are not working alone on these topics, and much of this report is based on ongoing contributions from the extensive work by the Cloud Software Finland Project<sup>10</sup> from Tivit.fi and the EU Cloud Expert Group. Cloud computing looks like it will change much of the software industry as we know it, but we see that this change is now in a 'through of disillusionment' - a time in its evolution where plenty of opportunities arise.

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10. <http://www.cloudsoftwareprogram.org>



# Software industry characteristics and its paradigm shifts

*“Unlike hardware, software is expected to grow and evolve over time. Whereas hardware designs must be declared finished before they can be manufactured and shipped, initial software designs can easily be shipped and later upgraded over time. Basically, the cost of upgrade in the field is astronomical for hardware and affordable for software.” (Paterson, Fox 2012)*

Cloud computing is the latest big change in software industry. Before explaining what cloud computing is, the reader should understand some of the basic characteristics of software and its industry. Later, the importance of software industry in Sweden and hence the importance of addressing the changes introduced by cloud computing will be emphasized.

The entrepreneur is everywhere in this picture, taking advantage of the new opportunities – both starting new companies with the core part of the business model based on cloud computing as well as being a cloud user, taking advantage of existing cloud services to deliver services in a competitive way. Note that in the latter case, the entrepreneur’s main business doesn’t have to be in software – he/she is just using cloud computing to deliver his/her non-software products/services in a more efficient and productive way. As with previous paradigm shifts in technology, the main overall economic effects can be expected when the technology becomes pervasive. That is also why the ‘entrepreneur’ in this report include persons active in existing mature companies (intrapreneurs), where much of innovation today takes place.

## 2.1 The importance of software in Swedish industry

Before going any further in the discussion, let's look at some numbers hinting why software is a very important part of Swedish industry: For Ericsson the numbers<sup>11</sup> are: 80% of their investments in R&D are software related - a total of 20 billion SEK every year. Maybe more surprising, numbers from the car industry indicate that 25-35% of the value of a car is in its software. Thirty years ago this number was 1%. 70% of the innovation built into Swedish trucks today comes from software developed in-house. Even industries closer to hardware rely heavily on software in maintaining a high productivity and competitiveness on the global market. One of the main purposes of Swedsoft is to meet these global challenges through collaboration in Sweden on software. In this report we suggest to join forces with cloud initiatives on a European level.

## 2.2 Software industry is in constant change

The software industry is one of the most rapidly changing areas in the economy, and the software industry today is affecting most areas using information in any format. Cloud computing is the latest big change, affecting the way we produce and consume software products and services. This change is most likely greater than the introduction of Internet. The cloud market is global and it is all about services consumed over the Internet directly by customers.

Factors explaining this rapid development in the software industry can be found in the fundamentals of software itself: new software development is based on old – successful - software development. That is: the longer this field evolves, the more it is building tools to create new software, solving more complex problems in a shorter time. This is true for all fields, but in software the change is very rapid, as is the uptake and the inheritance (and copying) of previous results.

Another fundamental characteristic of software is how easily the resulting product – the software – is duplicated and distributed. Compared to classic industry products, for example cars, software evolves and spreads considerably faster. Moreover, as was mentioned in the introductory quote *“the cost of upgrade in the field is astronomical for hardware and affordable for software”*, further emphasizes the differences between hardware and software. Due to this feature, i.e. that software is undergoing constant change and continuous updates, software products can have very long life-times<sup>12</sup>.

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11. Numbers taken from [www.swedsoft.se](http://www.swedsoft.se) and interviews with the Swedsoft chair.

12. IDC estimates that, world-wide, 75% of IT spending is tied up with maintenance of legacy systems and routine upgrades – “legacy drag”. Cloud computing is addressing some of these, but many of the legacy systems have been around for decades and very hard to replace.

With this in mind it comes as no surprise that we, again, face a large transition in software industry, an industry where paradigm shifts seems to appear with a regularity of once every decade<sup>13</sup>.

Last paradigm shift in this area was the advent of Internet for public use. Sweden was early in adapting to this change, with early industry and government investments in infrastructure resulting in early take-up by Swedish entrepreneurs. This raises the question what we should do this time to help Swedish entrepreneurs. This will be discussed in the last two chapters.

## 2.3 Cloud Computing is a big change in software industry

While Internet created a new way of communicating data between users and companies, Cloud Computing (see next chapter for more detail) paves the way for a service based economy – where customers consume services – not just data – online. Instead of buying, installing and managing programs on your computer to handle your business, you go online to manage and use all your services. There is no need to handle versions of software, security patches and hardware. All you need is Internet connection and a device to access your services. As a reflection of this change we are now moving into the ‘post PC era’<sup>14</sup>, where smart clients (mobiles, tablets) are good enough to solve many of our daily needs.

## 2.4 Swedish entrepreneurs adapting to the changes

*“Startups of today have a clear advantage in using cloud computing – getting started in no-time with low cost. Compared to when we first started, having to make investments in IT, loosing a lot of time to market”*

(Niklas Zennström and Andreas Ehn<sup>15</sup> at Startup event in Stockholm, February 2012<sup>16</sup>)

The list of Swedish startups using, or developing cloud computing is rather convincing, or to quote Niklas Zennström from his visit in Stockholm in February 2012 – “Sweden is clearly punching above its own weight”. Some recent examples are: Recorded Futures (web text analysis, used by, for example, US Homeland Security, with investments in the company from for example Google); Severalnines (Database as a Service company, EuroCloud Winner); CityCloud (Swedish IaaS); Spotify; Wrapp;

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13. To this picture we could add the upcoming area of ‘Internet of Things’, with connected chips in common devices, ranging from cars to washing machines – everything sending and receiving information for status updates, data information, software updates et cetera. We don’t include this in this report, but there is a clear and very important connection between cloud computing, Big Data and Internet of Things.
  14. <http://techcrunch.com/2012/02/06/when-will-the-post-pc-era-arrive-it-just-did/>
  15. Co-founder Skype and Atomico. Andreas Ehn is co-founder Spotify and Wrapp.
  16. See for example <http://entreprenor24.se/videoklipp/5711-niklas-zennstrom-och-andreas-ehn-snackar-entreprenorskap/>

MineCraft; KLARNA; eBuilder (BaaS); and many more. These startups either build their main business on cloud computing or use cloud technologies to stay scalable and competitive.

Sweden was early in adapting to the opportunities and challenges following with the introduction of Internet. How well are we adapting to the (potentially much larger) change and the challenges introduced by cloud computing technology?

Change happens where entrepreneurs find their ventures. With cloud computing there is a smorgasbord of opportunities: from the basic services that delivers services, to actually developing the services themselves. The higher up in the cloud ecosystem you go the more dependent on other's services you get. In the same way as developers choosing to develop using e.g. Microsoft products in the pre-Cloud era were partially locked-in by that framework, cloud developers can get locked-in by the evolving silos prepared by major companies like Apple, Google, Facebook, Salesforce, Microsoft, only to mention a few. The positive side in building on larger companies achievements, is the opportunity to focus more than ever on the business itself. Never before has there been so many pre-prepared services to help entrepreneurs to develop new business in a short time, with large distribution networks and with a small starting budget. This creates a large number of smaller start-ups trying their luck, over and over again. A good example is the Finnish game developer Rovio with its blockbuster the Angry Birds game. By developing on the Apple Appstore and Google Android platform, Rovio did not only develop their game in a rather short time, but also got distributed world-wide through Apple's and Google's channels – and finally delivered to the 'cloud client' through the iPhone. As an illustration, it took Rovio 35 days to reach 50 million users. This can be compared with the uptake of Radio, 38 years, and TV, 13 years.

# Cloud Computing – definitions and implications on software industry

Cloud computing is a paradigm shift towards a service based economy. Below we try to explain what this means and the impact on entrepreneurs in the software industry.

## 3.1 Cloud Computing – an Introduction

### *Amazon leading the way*

The starting point of cloud computing was the launch<sup>17</sup> in August 25, 2006, of the Amazon Elastic Compute Cloud (EC2, one of the corner stones in Amazon’s Web Services – AWS). Suddenly, anyone with a credit card could rent computers<sup>18</sup> by the hour in a flexible and scalable way. Without talking to a salesperson, anyone with a credit card could start using a computer (and data storage) on Amazon and simply pay for the time one was using the resources. Further, if one needed more than one computer, it was possible just to add another. When the resources were no longer needed, you could just close them down and terminate billing. In short, just pay for the time you use the computers and data storage.

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17. [http://aws.typepad.com/aws/2006/08/amazon\\_ec2\\_beta.html](http://aws.typepad.com/aws/2006/08/amazon_ec2_beta.html)

18. Here we write ‘computers’ while in fact the user ‘only’ gets a ‘virtual image’, an isolated part of a computer using virtualization techniques. The normal user doesn’t see any difference and Amazon clearly defines the size and type of the virtual image the user pays for.

Renting by the hour of compute and storage resources had been offered earlier, for example by SUN, but the earlier business trials never took off and were too limited. Amazon, building on its own experiences from building large data centers and delivering online products, provided the knowledge about how to achieve this in an efficient way.

Amazon is still one of the leading cloud providers and many of its technology choices are regarded as de facto standards. Still, Amazon is only covering parts of the cloud market, namely the infrastructure layer, moving up to the platform layer. There are more areas to be covered in order to become a true vertical player as will be demonstrated below.

## 3.2 A practical view on Cloud Computing

In this section we try to explain what cloud computing is all about, without getting too technical. Later, in the subsection Formal definitions of Cloud Computing, we show the latest attempt to make useful definitions of cloud computing. Definitions, not just one definition but one definition for each user group.

### *It is all about services*

In the service based economy the customers do not install and maintain software to do the work, they use software as a service. The full meaning of this is best illustrated by how the users access and run the services. The user basically only need a screen connected to the Internet. To access the services (to access information and use the services, for example adding and analyzing data) they need to run a web browser or specialized software which is pre-installed on the clients running the screen and Internet access. To be more specific: any computer or mobile running a browser and Internet connection will do. When we refer to 'specialized software pre-installed on clients' we refer to handhelds, for example iPhones, Android and Windows mobiles. These devices have browsers to access any web based service, but they also have applications ('apps') specially developed to run on these handhelds.

There is an important difference in the delivery methods of these web services: the first one –where any open format web browser is enough, is an open alternative for the market, i.e. not locked into one provider. The latter one, with specialized software (e.g. iPhone) is a closed format. We will return to this distinction and how it affects the market and the entrepreneurs developing innovative web services.

### *The Cloud Computing Ecosystem – vendors, developers, customers*

So what is 'cloud computing'? Cloud computing is the name for the whole ecosystem; from supporting delivery of infrastructure to enable web services, to platforms for developing web services and the usage of the final web services. Due to the extensive reach, cloud computing can initially be confusing to the observer. The broad definition is: 'an ecosystem to deliver software as a service'. More specifically, it covers all

steps from delivering infrastructure to developing environments (called ‘platforms’ in cloud computing), and providing services to the final customer. Note that infrastructure, platforms for development, services consumed, are all delivered as services.

*Infrastructure, Platforms, Software – all ‘as a Service’*

In cloud computing jargon these are marked as ‘IaaS’ for Infrastructure as a Service; ‘PaaS’ for Platforms as a Service; and ‘SaaS’ for ‘Software as a Service’. It does not stop there. More layers are continuously being added, for example ‘Database as a Service’ and ‘Business Processes as a Service’. ‘As a Service’ is the key ingredient in all cloud things. When anything is ‘as a Service’ the user of this service will expect: usability, flexibility and pay-only-for-what-you-use (or ‘pay-as-you-go’ as it is often called).

Another way to look at it is: When something is given to me as a service, I expect to get only what I want, i.e. the service, not needing to know anything about how it is being delivered. Cloud computing offers services on all levels, from the hardware and network level (for users who want to be able to make adjustments in these details), to development level (for users who want to develop new services, not just use the services), to the final delivery of the services (for users who want to use services with no interest in how they are developed or delivered and only demand that they are available and secure).

*The more work you give away to someone else – the more control you give away*

The higher up in the cloud stack (the lowest layer is infrastructure, the highest is where the end user consume the services) the more you are relying on other’s work and the less you can influence how this is being done. As a result of this ‘loss in control’ the end user (the consumer of the software as a service) is more locked in to the services being used. The ‘lock-in’ effect is a concern for anyone using a service where control is held by the vendor of the service. The implication of a lock-in is that the user cannot easily (sometimes not at all) transition from one service to another. For example it is hard to move from one customer relationship management (CRM<sup>19</sup>) service to another, without moving data in a more or less manual way - something that can be very costly. Another example is moving from one web mail service to another, something that is possible, but not always easy. Lock-in is one of the concerns commonly raised in the discussion about whether to use cloud services or not. However, as with all changes, it should be an honest comparison with today’s non-cloud situation, where lock-in also applies.

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19. Customer relationship management (CRM), a model for managing a company’s interactions with customers, clients, and sales prospects. Just an example here

### *Less control, higher demand for trust*

Loss of control also implies certain trust issues. The cloud user (meaning users of any of the 'as a Service') expect a service, without need to know the details on how it is delivered, that is always available, flexible, pay-as-you-go and that it is secure. Giving away control to a cloud service provider includes giving away the control over the service being delivered and managed in a secure way. Security concerns are the main barrier for cloud adoption, and have been the primary concern from the start. Security concerns limits the available market for 'public cloud services', and opens up for another interesting alternative: private cloud services. To not confuse the reader, an explanation of 'public' and 'private' follows.

### *Public, Private and Hybrid Clouds – running on someone else's hardware, your hardware or both*

Even though cloud computing delivers everything as services, which is done in different layers ('infrastructure', 'platform', 'services'), there is still software running on physical computers somewhere. The difference now is that the end user (the developer and the final consumer) run most of their work through a browser (the developer, in most cases, still need a computer to do development in order to launch services on the platforms). The computers doing the actual work (computation, storage, networking) are placed either completely out of the user's control – in public clouds – or on computers belonging to the end user – in private clouds.

'Public' means that the services are accessed over Internet from an external provider, i.e. the services are delivered out of the user's control.

'Private' means that the services are accessed over the Internet (or local network) from an internal provider (for example the IT department of the user), that is, the services are delivered completely within the user's control.

There are combinations of these called 'hybrid' clouds, where parts of the services are delivered by an internal provider and parts through a public provider. The motivation for this 'hybrid' delivery model is to have the best of two worlds – the freedom to not having selected data exposed to Internet, and the possibility to use public clouds for less sensitive services. This model is especially useful for handling peak loads – when the internal cloud is not big enough – while retaining more control of the overall services.

While the hybrid model may sound like the best alternative, there is a balance between control and usability. The more control you need, the more work you have to do yourself. And the more work you need to do yourself; the less easy and flexible the service become. Also, being a private cloud provider is costly and time demanding much like a pre-cloud IT situation.

### *Cloud services are delivered by a chain of providers*

To complicate things further, cloud services are often delivered by a chain of cloud service providers – one delivering the infrastructure, one delivering services using the infrastructure, and, in addition, many providers in between. For example, the



popular Dropbox<sup>20</sup> service is delivered as a service to the end user by a company (Dropbox), but the actual storage and delivering of the data is mainly provided by Amazon. If there are security issues surrounding data storage, it is not always clear who is responsible.

### *Cloud ecosystems – verticals*

The major companies active in the cloud computing sector are trying to cover the whole ecosystem, from infrastructure all the way to the final consumer. This is what is usually referred to as ‘verticals’. A company delivering the full chain of services to a customer can offer stronger service level agreements (SLAs) and higher quality of service (QoS) and – often – higher security. To be a complete vertical in cloud space, the company needs to be able to include a model from inception all the way to the client, and optimally own the platforms and the actual hardware and the actual device in the customers hand – the handheld clients. For example Apple is such a vertical, as are Google and Microsoft. Companies like Amazon and Facebook are also expected to expand the effort on the client side.

## **3.3 Definition of Cloud Computing**

Initially there was a long debate in industry and in academia on the definition of cloud. From businesses there were mainly two reactions: this is not new, we have been doing this for ages, and, all technologies used in ‘cloud’ have been around for decades. It turns out, both were partially right. On one hand the technologies and network had finally come to a stage in maturity and bandwidth where the technology was becoming really useful. On the other hand, Amazon’s business model was new and working well – both for the customer as well as for Amazon. When aligned, these developments started a new paradigm in the IT industry which affected all industries relying on software; which is most of the industry. Over night all companies started to rename old services as ‘cloud’, followed by the development of new ‘cloud’ services. Quotation marks around ‘cloud’ are used since during the early years of cloud computing there was not one single definition of cloud computing but many.

As discussed above it wasn’t easy for the industry to agree on a definition of cloud computing. It was quite confusing times not only for the prospective user community, but also for the software industry itself. At Berkeley RAD Lab, the senior research team conducted a study of the cloud phenomenon over time resulting in the clarifying report “Above the Clouds: A Berkeley View of Cloud Computing” (Arbrust et al, 2009). This was the starting point in ending the lengthy discussion on whether cloud was something new or not, and how to organize the evolving cloud ecosystem.

### *3.3.1 Cloud Computing – something new, something old, something borrowed*

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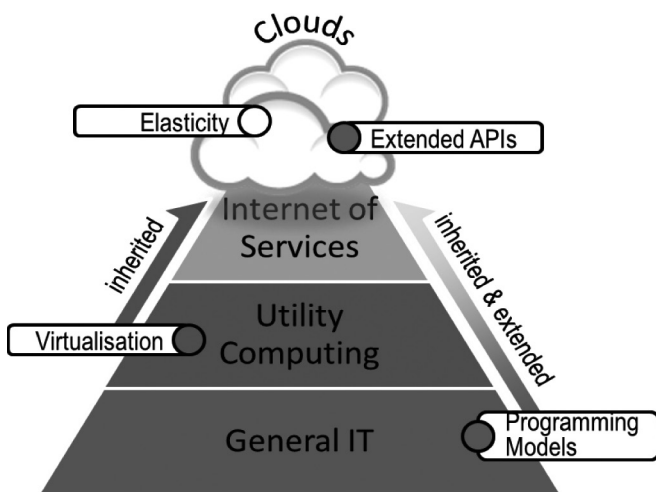
20. Cloud based online backup <http://www.dropbox.com>. A Y Combinator startup.

As mentioned above, a common comment in the advent of cloud computing was ‘this is nothing new, just a new business model’. This is true, and at the same time not very surprising considering that cloud computing is the latest contribution from the constantly evolving software industry. Without going into further details<sup>21</sup>, cloud computing includes most of already existing techniques, adding a focused effort into elasticity, multi-tenancy, resource utilization and availability. All other features like data management, quality of service, pay-per-use, metering and security are inherited, sometimes extended, from already evolved domains.

### 3.3.2 Formal definitions<sup>22</sup> Cloud Computing – The EU Cloud Expert Group

Commonly agreed definitions are crucial in helping an industry to develop in an efficient way. Without common definitions the industry faces risk of overlapping work, gaps in services, poor quality, unclear pricing et cetera. One traceable effect from this is the current ‘through of disappointment’ in cloud computing, where the customers now realize that much of the cloud descriptions, for example elasticity, are visions rather than actual existing services.

**FIGURE 3.1** Inheritance and extension of characteristics across the related domains<sup>23</sup>



21. See a thorough description in, the previously mentioned, upcoming EU Cloud Expert Group report for more details.
22. In this section we use the definitions and text from the EU Cloud Expert Group, a group of experts from industry and academia that is working on cloud definitions and strategies for the European Commission.
23. From Advances in Clouds, EU Cloud Expert Group, May 2012

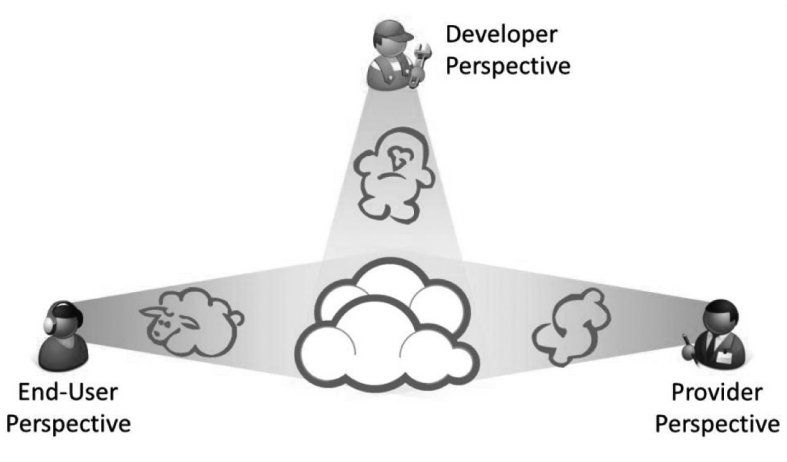
In the beginning of cloud computing as a concept (around 2006 when Amazon first launched its cloud services) the lack of common definition caused confusion, among the vendors as well as among customers and developers. It was clear that a common definition was needed, but few had the ability to agree upon a common definition.

NIST<sup>24</sup> was one such organization, and was early in drafting a first version<sup>25</sup> of a cloud standard. Today this is one of the most widely used in the industry. In Europe, the EU Cloud Expert Group has drafted a similar standard definition on cloud computing with some differences, for example emphasizing ‘elasticity’.

Knowing that cloud computing is still under development, there is a need of definitions that are useful today, as well as in the long run. The latest discussions within EU towards a long-term definition of cloud computing, emphasizes the importance of user specific definitions, i.e. definitions depending on the intended user of cloud computing. Different stakeholders have different perspectives and, therefore, understanding, goals and intentions with cloud computing.

**FIGURE 3.2 Schematic of Three Different Perspectives on Clouds<sup>26</sup>**

**The (Non-Technical) User Perspective**



With ‘non-technical’ we refer to end users and users who don’t care about the underlying technologies. These users are pure end-users. For them “**C**louds are environments which provide resources and services to the user in a highly available and quality-assured fashion, thereby keeping the total cost for usage and administration minimal and adjusted to the actual level of consumption<sup>27</sup>. The resources and services should be accessible for a principally unlimited number of customers

24. (US) National Institute of Standards and Technology, <http://www.nist.gov/>  
 25. <http://www.nist.gov/itl/cloud>  
 26. From Advances in Clouds, EU Cloud Expert Group, May 2012  
 27. Note that this does not necessarily imply optimal or cheap.

from different locations and with different devices with minimal effort and minimal impact on quality. The environment should thereby adhere to security and privacy regulations of the end-user, in so far as they can be met by the internet of services” according to the new definition by the EU Cloud Expert Group.

### **The Provider Perspective**

For providers of cloud services, the definition is: “Clouds are dynamic (resource) environments that guarantee availability, reliability and related quality aspects through automated, elastic management of the hosted services – the services can thereby consist in a platform, a service, or the infrastructure itself (P/S/laaS). The automated management thereby aims at optimizing the overall resource utilization whilst maintaining the quality constraints.”

### **The Developer Perspective**

For developers, for example entrepreneurs in the software industry, using cloud platforms, the definition is: “Clouds are environments which expose services, platforms or resources in a manner that multiple users can use them from different locations and with different devices at the same time without affecting the quality aspects of the offered capabilities (service, platform, resource) - this means in particular availability, reliability and cost-effectiveness. This is realized through automated, elastic management of the services and their environment.”

### **Scoping Clouds**

In light of the above discussions and characteristics identified, we can therefore attempt a minimal definition of a cloud environment, i.e. the conditions a system has to fulfill in order to rightfully claim being a “cloud”:

“An environment can be called ‘cloudified’, if it enables a dynamic number of users to access and share the same resource type, respectively service, whereby maintaining resource utilization and costs by dynamically reacting to changes in environmental conditions, such as load, number of users, size of data etc.”

It must be noted thereby that many additional criteria exist that are generally associated with clouds, but not essential in themselves. For example “pay per usage” which, in a private environment is just a load balancing criteria, or “outsourcing” which again is not effectively true for in-house, private clouds.

# Cloud Computing as a driver for innovation

*“We are at the beginning of a third wave in technology (the prior two were the commercialization of the microprocessor, followed 15 years later by the advent of the web), which is this convergence of mobile and social technologies made possible by the cloud. We will see the creation of multiple multi-billion-dollar businesses, and equally important, tens maybe hundreds of thousands of smaller companies.*

*John Doerr<sup>28</sup>*

“Early stage companies, typically referred to as startups, usually have very small resources to play with and, at the same time, a strong demand for flexibility and scalability: they need to develop business ideas into services quickly, and at the same time be able to adapt to the customer feedback. The match between startups and cloud computing was identified early, making many of the startups early adopters of this paradigm shift.

For startup companies cloud offers a cost efficient, scalable and flexible alternative to buying and managing own hardware for IT. Soon enough a number of new companies evolved, all based on cloud services like Amazon’s, where the actual IT resources were outside the companies’ offices. *This group of entrepreneurs has moved their focus from managing and administering IT infrastructure to developing business value.* Besides developing new services on top of other companies cloud services, there are a number of startups developing lower level cloud services on

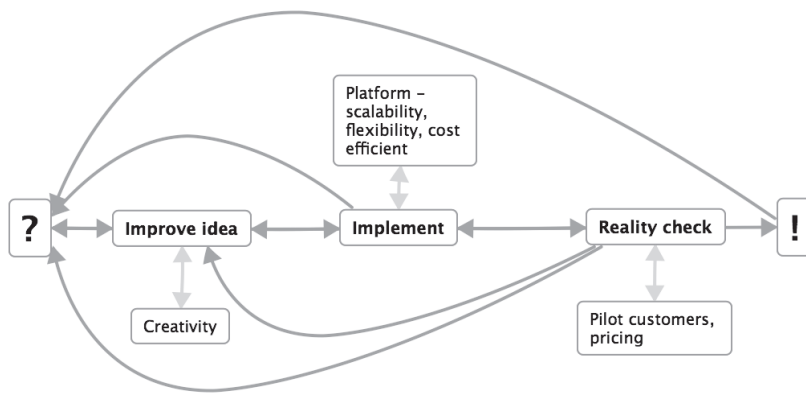
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28. Kleiner Perkins Caufield & Byers (KPCB) is a world-leading venture capital firm located on Sand Hill Road in Menlo Park in Silicon Valley

their own: helping users and companies to turn their own hardware into cloud services. Examples here are mostly from the US, like Eucalyptus, but there are examples also from EU, for example OpenNebula. Both these examples develop software that the user can download and install on their computer clusters to turn their company hardware into a cloud resource – both for the company’s own internal use as well as for external users to access.”

In this chapter we take a closer look at how cloud computing accelerates the highly iterative innovation cycle for startups (see Figure 4.1). A number of examples are given and we also discuss how cloud computing changes the overall landscape for startups and investors in startups.

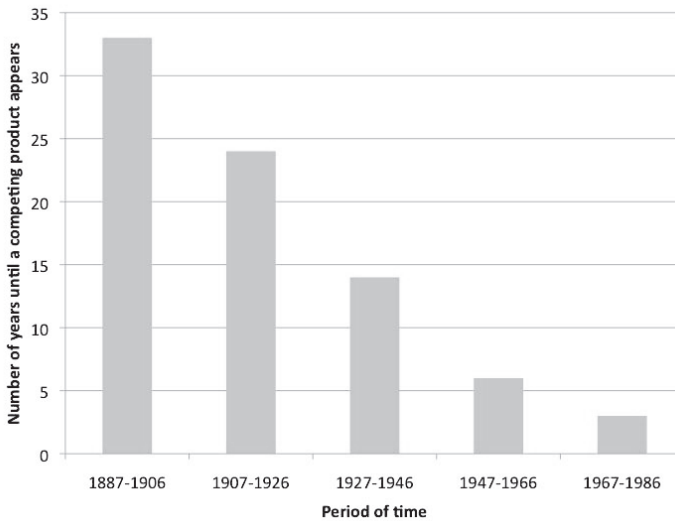
**FIGURE 4.1 - The iterative process of innovation from (Edlund and Livenson, 2011)**



## 4.1 Time to market

During development from the very first idea to a product or a service, time to market is often considered as one of the key components for success. Even if the value of being the very first to a new market is hard to evaluate (Lieberman and Montgomery, 1988; Agarwal and Gort, 2002; Parker, 2009), the ability to adapt rapidly to competition and customer need is not. Figure 4.2 shows a historical perspective on the increasing intensity of competition. Quickly launching early prototypes for customer feedback is very useful for choosing the right path to a new service. This is one of the strong features of the cloud computing concept; to be able to have a rapid and adaptive development and explore new markets. A very similar process also occurs in larger corporations, especially in the R&D department, but also in the interaction with customers and partners. The main difference is that in larger companies, development more often relies on hybrid clouds, consisting of a combination of internal infrastructure and services together with public cloud offerings.

**FIGURE 4.2 - Over the years the time it takes for a competing product to be released to market decreased dramatically.<sup>29</sup>**



#### 4.2 Cloud Computing implications for startups

Using flexible and scalable technologies, the startups can quickly change direction and try new angles. Let us take a closer look at the essential cloud characteristics<sup>30</sup> and their implications for start-ups.

##### 4.2.1 On-demand self-service

**Description:** The user can - without any human interaction with the cloud service provider - take advantage of computing capabilities, such as server time and network storage, in an on-demand self-service manner.

**Implications for startups:** The company can easily and swiftly get needed IT infrastructure in place. For smaller, newer companies, and even more so for not-yet-started companies, negotiating sales contracts is usually not their strongest side. In addition, the need for server time and network storage is highly unpredictable in the early stage, making the on-demand self-service characteristics of cloud computing

29. Picture made out of data from Lieberman and Montgomery, 1988; Agarwal and Gort, 2002; Parker, 2009

30. We use here the definitions from <http://www.nist.gov/itl/cloud>

even more attractive. One early start-up example is Yieldex<sup>31</sup>, using Amazon Web Services to demonstrate the capabilities of their publishing service for investors with a total cost of 40 USD for the first month. This was made possible by allocating cloud resources for the actual meetings, and releasing them directly after the meetings. No human interaction and on-demand.

#### *4.2.2 Broad network access*

**Description:** Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (for example, mobile phones, laptops, and PDAs).

**Implications for startups:** Using cloud services and distribution platform for mobile clients, a whole new field of services arises. With this delivery chain, the smallest company can grow over night into a much larger one by offering services in a scalable way. The most famous examples include Apple App Store distribution platform and Android applications that often rely on the Google App Engine-based backend.

#### *4.2.3 Resource pooling*

**Description:** The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control over or knowledge about the exact location of the provided resources but may be able to specify location at a higher level of abstraction (for example, country, state, or datacenter). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.

**Implications for startups:** Resource pooling is one of the reasons why public IaaS can be more cost-effective than owning own infrastructure.

#### *4.2.4 Rapid elasticity*

**Description:** Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out, and rapidly released to quickly scale down. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.

**Implications for startups:** Through rapid elasticity, the company can quickly adapt its services to address customer demands. This results in a cost effective

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31. Yieldex: advanced forecasting and delivery simulation algorithms to manage digital business for publishing companies. <http://www.yieldex.com>. One of the early examples of cloud startups.



scalable business model which is very useful for both small and medium sized companies. From services that build directly on IaaS, Animoto<sup>32</sup> is the more well-known example, porting its photo presentation application to Facebook which generated a large peak in usage. Animoto came prepared for this, using RightScale and Amazon to handle the peak in an economical way. Dropbox and other storage services sell space on demand in an elastic way thus avoiding large overhead in capacity.

#### 4.2.5 Measured service

**Description:** Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (for example, storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported to provide transparency for both provider and consumer of the utilized service

**Implications for startups:** Being able to calculate the cost of a certain business transaction is very useful when making decision, for example: establishing a price-list for the end customer. Resource usage metrics of the cloud services make this process much easier, as they can be directly converted into monetary values and service level agreements (SLAs).

### 4.3 Changes to the startup ecosystem

Cloud computing opens up for a new way to launch startups. By creating scalable business models with consumption based pricing, the startups can evolve with a higher degree of cost control than earlier. Customer needs and behavior are hard to predict, which means a high risk of developing wrong or too costly services. With a higher level of agility, companies get a better control of cost versus revenue. *In The Future of Web Startup Funding*,<sup>33</sup> Paul Graham lists a number of changes to the startup ecosystem, changes that since then have come true - especially for Paul Graham's startup accelerator Y Combinator<sup>34</sup>: More startups are launched, with faster turn-around from testing to the next step (continuation or end). Many of these startups are web based; most of them rely on cloud computing, and many with cloud computing as part of their offering.

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32. Animoto: automatic production of video pieces from photos, video clips and music. Based on AWS and rightscale <http://www.animoto.com>.

33. <http://paulgraham.com/future.html>

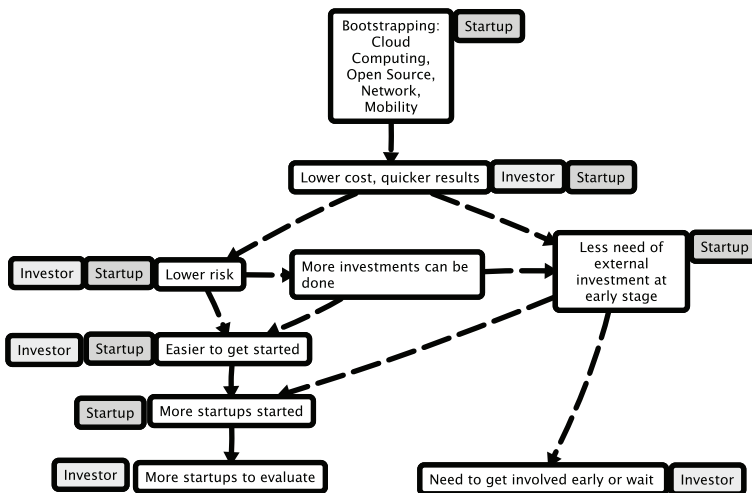
34. Y Combinator seed accelerator <http://ycombinator.com>.

### 4.3.1 Lowering the Barrier to Entrance

As a result of the availability of low cost cloud computing services, mature open source software stacks, high-quality connectivity and novel mobile service platforms, more entrepreneurs start web-based companies in a shorter time. For similar reasons, many new-formed companies can have a more extensive reach than before without the need for external investments. This results in a change in the overall investment chain, with a shift of control in favor of the entrepreneurs.

In Figure 4.3 we try to give an idea of the implications for startups and investor ecosystem. Cloud computing together with a number of earlier changes in IT (open source, network, mobility, commodity low cost hardware) lowers cost for startups. Due to the possibility of a quick launch through cloud computing, the entrepreneurs quickly get feedback on their ideas - as well as the investors on their investments. This lowers the risk and need for initial capital, enabling more investments and start-ups to launch. At the same time, startups can now develop longer before involving external capital, if involving it at all.

**FIGURE 4.3 - Evolution of Startup Ecosystem**



All above-mentioned features of cloud computing are very appealing also from the investors point of view. Investors, for example, business angels, venture capitalists, the entrepreneurs themselves, do not have to make costly IT infrastructure investments at the early stage of the companies anymore, which has been the case for at least a decade. Moreover, they can get relatively quick feedback and later, once the company matures, consider the option of purchasing own infrastructure for security reasons or total cost minimization. This also means that if at some point a certain

startup fails to meet expectations, shutting it down is as easy as stopping the virtual machines, without the hassle of the IT infrastructure leftovers.

#### 4.3.2 Startup and Seed Accelerator Programs<sup>35</sup>

In Figure 4.3 we also point at the investor's point of view: they now need to evaluate more startups if they want to get involved early. This is not possible in most Venture Capital firms due to low staffing and because new models are needed. One new model is a so-called startup accelerator. A startup accelerator program is a new model of funding and assisting startup companies. The model is especially suitable for quick-starting web and media based technology and service businesses with relatively low entry barrier. Cloud computing is key for many of these startups.

Y Combinator was the first startup accelerator<sup>36</sup>, specializing on web services. Y Combinator invites technology focused teams to develop their service within the startup accelerator for a shorter period of time, typically 12 weeks, and twice a year. During this stay the teams evolve from idea to early stage company, and are exposed to the network of investors and services (marketing, sales, legal).

Successful examples from Y Combinator includes Dropbox, Zencoder<sup>37</sup>, and Heroku<sup>38</sup>- all based on cloud computing. In mid-2010 about 25% of the teams had found investors during the 12 weeks stay in the startup accelerator. In exchange for this service Y Combinator takes 2-10% of the company. Through startup accelerators venture capital companies can sometimes get an early look at interesting and upcoming startups. In the Y Combinator case, Sequoia Capital<sup>39</sup> is a partner backing the overall investment process.

#### Nordic Startup Accelerators

Y Combinator has inspired a number of new startup accelerators, for example, Aalto Venture Garage, Startup Sauna<sup>40</sup> and SICS Startup Accelerator<sup>41</sup>. These Nordic accelerators all make use of part of the Y Combinator approach, while leveraging on their own specialties, for example at the SICS Startup Accelerator,

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35. When the accelerator in addition to helping startups also invest in these, sometimes the term 'seed accelerator' is being used. More often today the term 'startup accelerator' is being used, including all accelerators helping startups. 'Seed' is only used for accelerators investing in startups.

36. See top 15 startup accelerators from May 2011 here: <http://techcocktail.com/top-15-us-startup-accelerators-ranked-2011-05>

37. Video encoding on the cloud <http://www.zencoder.com>. A Y Combinator startup.

38. A ruby cloud platform <http://www.heroku.com>. A Y Combinator startup, acquired by Salesforce in 2010.

39. Sequoia capital <http://www.sequoiacap.com/>.

40. <http://www.aaltovg.com>, <http://www.startupsauna.com>

41. <http://www.sics.se/startupaccelerator>, Co-founded by the author of this report

the accelerator make use of its core competences in cloud computing and internet of things.

## 4.4 Cloud innovation platforms

Cloud Innovation Platform is one of the services that a startup accelerator could offer. It comprises a set of prepared and tested ready-to-go recipes to further accelerate the development of startups.

The Cloud Innovation Platform consists of a common set of cloud services available for testing and development - a set of cloud services that will be constantly improved and extended based on the feedback from its users. The Cloud Innovation Platform addresses two main issues: the basic scalable IT functionality needed for implementation of the startup's idea – typically mimicking and incorporating IaaS offerings, both private and public; and a specialized functionality for novel media and content delivery, payments and accounting services and modern programming models. Cloud Innovation Platform can be used both for development of the new services and education in the best practices of cloud computing usage, for example, for the enterprise clients considering migration of the internal IT systems to the cloud. A very important requirement for the Cloud Innovation Platform is its interoperability with other cloud offerings. Ability to move away is a startup-friendly approach that most of the public Platform-as-a-Service offerings, for example, Google App Engine or Microsoft Azure, lack.

Testbeds, including public testbeds, are a key ingredient in these platforms for startups. We will come back to this both in the recommendation chapter – where both the Finnish as well as the EU studies recommend local testbeds – as in the concluding chapter. We also see an increase in cloud computing offerings at startup accelerators and in the startup support from the larger cloud vendors – for example at TechStars Cloud<sup>42</sup>, Amazon<sup>43</sup> and Microsoft BizSpark<sup>44</sup>.

## 4.5 Evolution of the Cloud Based Company

Like any living organism, startups change over time. They can grow into something bigger, get “eaten” by another company or simply die. Figure 4.4 show the most typical stages of the startup development. The usage patterns of cloud computing change with the size and profitability of the company. For example, early stage companies with very little financial capabilities often have no other reasonable option but to go with a public cloud offering for all of their needs. Large and wealthier companies

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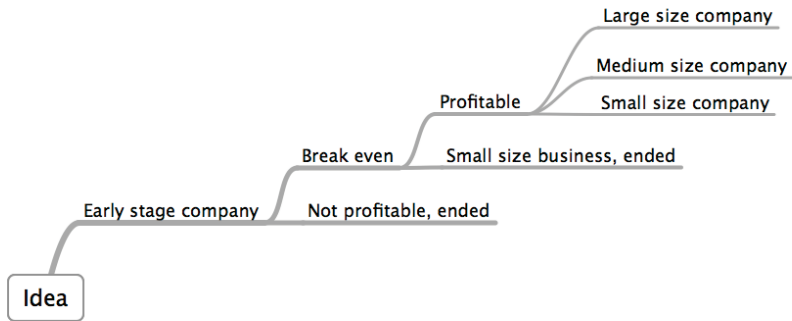
42. <http://www.techstars.com/cloud>

43. <http://aws.amazon.com/startupchallenge>

44. <http://www.microsoft.com/bizspark>

with higher demands on security could choose a more restrictive solution by creating a hybrid or private cloud for some of the more mission critical tasks.

**FIGURE 4.4** depicts a conservative approach of the companies of different sizes to satisfying certain goals.



## 4.6 Bottlenecks, costs and risks

For startups moving into the cloud area many of the old challenges remain, some are mitigated, such as short term investments in IT, some are new – for example in the area of law and taxation. The latter can be illustrated by a resolution with respect to applications: at one point the Swedish application developers were facing the risk of double taxation due to their production of applications in Sweden ( often in international collaboration) while many of the customer ‘consumed’ the applications outside Sweden. This case was resolved<sup>45</sup>, but it illustrates how new technology sometimes can be misunderstood by legal administration.

The list of legal ‘challenges’ with respect to cloud computing can be made rather long. To illustrate, let’s have a look at the legal questions arising in the case of government and cloud<sup>46</sup>. For example:

- Under which circumstances are local authorities legally allowed to procure cloud computing services?
- Problems regarding a single all-encompassing governmental cloud: The authorities might have to aggregate information in separate data centers, for example access of health data by the police to conduct a genetic analysis.

45. Tillämpningsinformation för Skatteverket: Ställningstagande 2011-06-16 ”Mervärdesskatt, svenska näringsidkares försäljning av applikationer” Dnr 131 457645-11/111

46. This list was made together with Johannes Watzl at LMU Munich, Germany, and PricewaterhouseCoopers Germany, and eBuilder AB, 2011. More details on request.

- Cross border data flows: In which way does the data protection law limit cross border data flows? Which legal implications derive from the handling of sensitive data (for example economic, military or research information), especially in a cross border context? Which level of security is needed to do so?
- Issues with telecommunications law: To what extent may telecommunications law apply to cloud computing services?
- Applicable law: The parties have to agree which law shall apply to the individual contract in a European cloud computing project. Within this choice of law: Which mandatory national law applies?
- Service Level Agreement: The parties have to agree upon the provided services on a sufficient level of detail. The Agreement records a common understanding about services, priorities, responsibilities, guarantees, and warranties.
- Exit management: How can the provider be exchanged quickly and at a low cost? In case of bankruptcy of the provider it has to be safeguarded that the data is retransferred completely.
- General provisions on data protection law: What are the principles of data protection law and how do they apply to cloud computing? How is cloud computing classified in the existing data protection regulations?
- PatientSensitive data: Under which circumstances is it lawful to outsource patientsensitive data?
- Social security data: It's special issue because of legal regulationsand secrecy level of, social security data. Under which circumstances is it lawful to outsource social security data?
- Data transfer: May personal data be transferred outside the country and even outside the EU? If so, under what circumstances?
- Data security: Analyzing how the authority can control the technical and organizational measures that have to meet the requirements implemented by the cloud computing provider (for example certificates, description of suitable standards)?

This was just an excerpt of the many problems to address in this area. The reason – except for illustration – this was added is to highlight the need of local cloud services, services that can be used by government and healthcare within the Swedish/Nordic/ European borders. Hence a Swedish testbed is of interest, especially for entrepreneurs developing new services in this sector.

#### *4.6.1 Security*

As mentioned earlier, transitioning from an environment where the user have full control to a managed service, where the control lies in the hands of a cloud vendor, is a big change. For long and still today, security concerns have been the main reason why established companies hesitate moving into cloud service. Looking at the actual details of cloud computing most of the technical security challenges are inherited from non-cloud technologies, but with the addition of dependencies on and trust of external actors. Often the picture is even more complex, due to the fact that many

cloud services are delivered by a number of cloud players, creating a chain of trust. In case of a security incident it is not always obvious where the chain of trust was broken, and who carries responsibility. Even though this sounds like a major change from non-cloud environments, many of these issues are old problems; problems that the larger corporations are trying to mitigate in collaboration, for example under the Cloud Security Alliance<sup>47</sup> (CSA) umbrella. CSA was early in organizing the security problems into categories, clarifying which part of the 'cloud security problem' are due to cloud and which parts are non-cloud, i.e. true in all cases. In addition, CSA have created two living documents, one on 'cloud security recommendations' and one on 'cloud security best practices'. Both these are practical and public. A key question for all companies to ask themselves is how well they are managing their IT security today, and whether it is better managed by themselves or by larger cloud providers. Security is, and will continue to be, a key concern in cloud computing.

#### 4.6.2 Cost components

Balancing out costs and risks is a complicated but necessary step in making a business decision, for example, in the up taking of a certain set of cloud services. One of the key selling points of public cloud providers are that using their offer is more optimal if you take into account all of the cost components. Whether this is actually true often comes down to a specific customer situation. In some cases, potential cloud customers possess something that can make out-of-the box cloud computing offering a bad decision. Some of the more important decision modifiers include availability of server administration know-how, usage of the data regulated by a certain policy and existence of in-house infrastructure.

Below we list and explain major cost inflicting factors of the IT infrastructure from the perspective of the consumer of the cloud resources. We also provide a brief introduction into the risks associated with using cloud computing.

#### Consumed resources – business perspective

The charging model of the cloud providers often includes a pay-as-you-go model. That means that they break down service offerings into many components and charge you according to the monitored consumption. Typical components include virtual machine uptime, average storage used in a month, inbound and outbound network. Quite often there are also more services offered that can be used for creating applications running in the cloud: message queues, databases, identity providers, content distribution networks and so on. While from the sales point of view these services are independent from each other - for example, you can use AWS EC2<sup>48</sup> with your own data storage rather than using AWS S3<sup>48</sup> - in practice this often leads to a considerable overhead, for example, increase in network traffic.

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47. <https://cloudsecurityalliance.org/>

48. EC2 - Amazon elastic cloud. S3 – Amazon Simple Storage Service

The pricing policies are also quite diverse. Apart from the basic pay-as-you-go, there are policies that offer service at a reduced quality for a cheaper price. This is the case for AWS S3 Reduced Redundancy Storage that has a lower SLA on the durability due to a smaller number of replicas of the data being stored. AWS also offers reduced price in case of a certain upfront commitment - AWS EC2 Reserved Instances - and a market-based bidding system for the computational resources - AWS EC2 Spot Instances.

In case of small resource consumption these policies are not really important. However, larger consumption, and also in case of a sustainable business, it is definitely worth taking a look at potential cost optimizations by switching to another pricing policy.

### **Administrative overhead**

Depending on the level of cloud computing offering (IaaS, PaaS, SaaS) there are different needs for administrating services. While buying Infrastructure-as-a-Service does relieve you of a need to manage hardware, network and application, administration is still required. This can be quite expensive unless you have the know-how inside the company. For PaaS and SaaS the overhead is smaller and the required skills are typically closer to the consumer of this service.

### **License costs**

The cloud computing paradigm was quite disruptive with respect to the standard software licensing models as it essentially requires the ability to be able to rent licenses. Moreover, if a company has already bought a set of licenses, it can be the case that they cannot be used for running in a cloud, as it is outside the domain of a company, or that they are linked to a number of working machines, which makes the flexibility of the cloud not really usable.

One of the solutions to these problems was the creation of virtual appliance marketplaces. They provide means for the software vendors to publish their products as a specific software package or even as a full virtual machine image, so that once it is running, the client is paying extra for the uptime of the virtual machine that goes directly to the software vendor. Examples include GoGrid, Exchange<sup>49</sup> and Amazon DevPay<sup>50</sup>.

### **4.6.3 Risks**

Security, again, is often pointed out as one of the main obstacles for cloud computing adoption<sup>51</sup>. Most of the time it means that the risk connected with such a decision is either too high or too complicated to evaluate. While the concept of outsourcing

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49. GoGrid exchange <http://exchange.gogrid.com>

50. <http://aws.amazon.com/devpay>

51. See ENISA cloud computing: Benefits, risks and recommendations for information security <http://www.enisa.europa.eu/act/rm/files/deliverables/cloud-computing-risk-assessment>.



IT-processes is not new and the concept is familiar, there are several new threats introduced by cloud computing that both startups and more mature companies should consider. As mentioned earlier, Cloud Security Alliance<sup>52</sup> has produced several documents addressing these new threats, mostly from the security and technological point of view<sup>53</sup>. For many of the startups, however, functionality is more important than the security guarantees. Picking a cloud provider with the most comfortable set of services and trusting it is the most popular way to go. While this is an acceptable behavior in the beginning, when the overhead of the security analysis is too high, risks should definitely be more thoroughly analyzed once the startup has begun to grow.

Apart from the technological risks, there are also risks related to the way companies operate. Nowadays almost all of the companies generate and store a lot of data. This leads to the risk of vendor lock-in, even if the interfaces are compatible and transition could be smooth. Data storage inflicts a constantly raising cost, as most of the time companies tend to save as much information as possible. This makes storage cost optimization an important problem. However, even if you find a cheaper option for data storage, the “momentum” of the existing data can be a problem - transferring big amounts of data is neither fast nor cheap<sup>54</sup>.

#### 4.6.4 Evolution of requirements

With the development of a company, the requirements for supporting IT infrastructure change to reflect the priorities of the company. Table 4.1 below lists major changes in a company’s requirements based on its size. For example, for a small company the ability to scale their business quickly is important, for a medium size, and especially larger companies, stability and predictability are of higher value. Figure 4.5 illustrates how the evolution of a company reflects on their use of cloud computing based on their maturity level.

**Table 4.1 Importance of IT requirements for companies of various sizes**

	Startup	SME	Large company
Scalability	High	Average	Low
Security	Low	Average	High
Risk analysis	Low	Average	High
Cost optimization	Low	Average	High
Vendor lock-in	Low	Average	High

52. Cloud security alliance: Security guidance for critical areas of focus in cloud computing <http://www.cloudsecurityalliance.org/guidance>

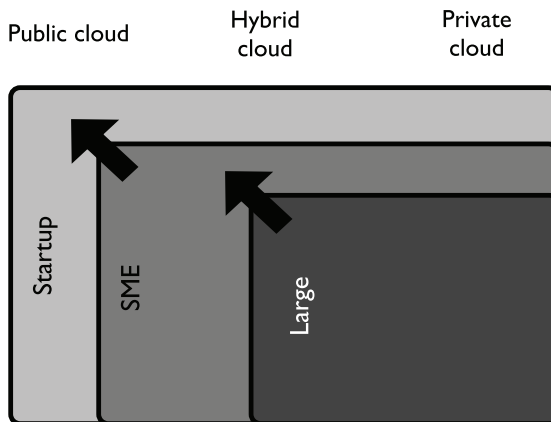
53. Cloud security alliance: Top threats to cloud computing <http://www.cloudsecurityalliance.org/topthreats/csathreats.v1.0.pdf>

54. See for example the Nansuni White Paper on Bulk Data Migration in the Cloud [http://www.nasuni.com/how\\_it\\_works/resources/68-white\\_paper\\_bulk\\_data\\_migration\\_in\\_the\\_cloud](http://www.nasuni.com/how_it_works/resources/68-white_paper_bulk_data_migration_in_the_cloud)

## 4.7 Concluding summary – clouds and startups

*Cloud computing characteristics map to meet the needs of startups very well.* A new group of cloud specific startups are now rapidly evolving. On one hand one could argue that it is just the same active group with the ability to quickly pick up a new technology. On the other hand the number of startups evolving, how fast they can get started and how far they can without major funding is a game changer. Startups have always been good at bootstrapping, getting as far as possible on none or very little funding. However, with cloud computing and high quality open source software, better and less expensive network, a more open mobile market, and a more evolved customer base, bootstrapping can take even further, possibly all the way to a self-supported profitable business. For investors, the market is also changing, creating a need for very early stage, close-to-the-founder, and technology knowledgeable services. This can be provided by the startup accelerators. The startup accelerators act as an early investor, helping the startups with technology decisions, and at the same time helping future investors in the identification of interesting objects. As we will see in the next chapter, this market is quickly expanding.

**FIGURE 4.5** - Adoption of cloud deployment models by the companies of various sizes.



# Evolution of existing and new markets: why cloud computing is important on the aggregate level

*In March 2010, Steve Balmer (CEO Microsoft)  
“Bets the company on Azure<sup>55</sup>”*

As described above, cloud computing is rather to be seen as an ecosystem of services and its user groups. As was illustrated by a number of analyst reports on Cloud Computing, e.g. from Gartner<sup>56</sup>, there are a large number of cloud services and their markets, many of which are in the beginning of their hype curve, while many since long have reached the ‘plateau of productivity’.

In a recent white paper<sup>57</sup> IDC presents estimates on the importance of cloud computing to job creation, seeing a total spending on public cloud IT services around 28 billion USD in 2011, compared with more than 1,700 billion USD in spending on total IT products and services. Hence, some 1,6 percent of total IT products and services spending on public cloud. Note that this is the amount spent on public cloud IT services. The revenue estimates gives some rather large numbers:

*-- it already has begun changing how IT delivers economic value to countries, cities, industries, and small businesses. This is because cloud computing comes with unique*

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55. Azure is Microsoft’s cloud service platform.

56. Gartner, Hype Cycle for Cloud Computing, 2011 David Mitchell Smith Publication Date: 27 July 2011 ID Number: G00214915 © 2011

57. [http://www.microsoft.com/en-us/news/download/features/2012/IDC\\_Cloud\\_jobs\\_White\\_Paper.pdf](http://www.microsoft.com/en-us/news/download/features/2012/IDC_Cloud_jobs_White_Paper.pdf)

*economic leverage that means a little money spent up front leads to impressive returns down the line. IDC estimates that last year alone, IT cloud services helped organizations of all sizes and all vertical sectors around the world generate more than \$400 billion in revenue and 1.5 million new jobs. In the next four years, the number of new jobs will surpass 8.8 million.*

According to IDC this will steadily increase over the next four years, or as summarized by Microsoft<sup>58</sup>:

- Cloud computing will create nearly 14 million new jobs between 2011 and 2015.
- By 2015, business revenues from IT innovation enabled by the cloud could reach US\$1.1 trillion a year.
- Cloud-related jobs will accrue evenly to businesses with 500 or fewer employees and those with more than 500 employees.
- More than one-third of cloud-enabled jobs will occur in the communications and media, banking, and discrete manufacturing industries.
- China and India will account for about half of all new cloud-related jobs.

#### *Swedish numbers*

This IDC/Microsoft study goes into depth – using four years of similar studies for its predictions – including Sweden as one of the listed countries: with an estimated 23 thousand cloud enabled jobs in 2015, equaling to 0,46 percent of the total workforce. As a comparison, in July 2010 about 75 thousand<sup>59</sup> persons was working with software testing, development, support and sales in Sweden.

Predictions are of course hard to make, but the trend is interesting and should be followed closely. A similar – more detailed - study in Sweden would be of great value for the planning of government actions and educational efforts.

#### *Definition of ‘new jobs’*

To create a model that analyzes the role of cloud in job creation, IDC calculated the number of cloud-generated jobs by weighing several factors, including available country workforce, unemployment rates, GDP, IT spent by industry and company size, industry mix by country and city, technology infrastructure by country and city, regulatory environment, among other factors.

In the IDC analysis, since the jobs created are the result of increased business revenue, we assume they match the industry mix by job function — marketing, sales, finance and administration, production, service, and so on. We also consider them net of jobs lost to cloud computing (for example, in the IT organization itself).

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58. <http://www.microsoft.com/en-us/news/features/2012/mar12/03-05CloudComputingJobs.aspx>

59. <http://www.swedsoft.se>

An interesting remark is the feedback from CIOs on how they use the resources they manage to release in using cloud computing: “In discussions we have had with CIOs testing and experimenting with cloud computing, we find that most look at migration to cloud computing as a way to free up existing resources to work on more innovative projects, not to do away with the positions entirely. In that way, cloud computing differs from traditional outsourcing. On the other hand, cloud computing could certainly change the skills requirements in an IT organization.” The remark about skills and requirements is very important for educational planning.

#### *Segment-by-segment*

In the IDC report, SMEs are early adopters of cloud computing. The reasoning behind this is that smaller companies (with less than 500 employees) are more likely to be less dependent on legacy systems – systems that are harder to replace or improve using cloud computing. Also, capital constraints make public IT cloud services more attractive to smaller firms, and at the same time limit their investments in private IT cloud services (buying own hardware, using cloud techniques). The report also looks into how different sectors are adopting cloud computing, where, for example, banking has one of the lowest percentage in spending in 2011 (US numbers) of 3 percent but due to its size in IT spending it stands for about 10 percent (worldwide) of all cloud generated jobs (2011 and 2015). Government is in the middle of the market behavior curves, ‘because of its slow pace adopting to the new computing style’. We believe this is more due to the security and privacy concerns of Government services.

#### *Conclusion*

The IDC/Microsoft report is more of an illustration that cloud computing has moved from merely a discussion topic to something actually used in industry. Still the numbers are small compared to the full workforce and total IT spending, but the field is definitely promising. Also, if the numbers are correct, tens of percent of the Swedish software workforce will be employed in cloud jobs in just a few years’ time.

# Discussion

The uptake of cloud computing into daily industry has been rapid. Currently the market is in what Gartner label ‘trough of disillusionment’, i.e. it has passed the peak of hype. The users are now using cloud computing for their problems and find that many of the cloud promises are still more visions than existing services. One of the major cloud specifics, elasticity, is for example not as easy to achieve as it has been communicated in the marketing.

In the two sections below we bring in the recent<sup>60</sup> comments and recommendations from the EU Cloud Expert Group and the Tivit.fi Cloud Software Finland. Both these groups have – for a longer period, and with a large number of contributors – analyzed the same challenges and opportunities that Sweden is facing.

In addition – as we will see in the concluding chapter – we suggest to make use of some of these recommendations, and to build a Swedish cloud expert group connecting to these two expert groups, as a starting point.

The EU Cloud Expert Group concludes in its latest report<sup>61</sup> that: “With the clouds going through the trough of disillusionment, more and more functionality issues and research questions arise, the results of which will shape what will still be considered “clouds” tomorrow and what their actual capabilities will be. This is a major opportunity for Europe to shape the long-term future development as technology and market matures”

This is where entrepreneurs (in the report, European entrepreneur) can intercept the business opportunity arising from increasing user demand after the ‘trough of disillusionment’. The EU Cloud Expert Group further lists a number of focus areas for EU funding of cloud research, including industry and SMEs. Most of these recommendations refer to how EU public funding should be used to help European industry

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60. Tivit.fi report from March 2012, the EU Cloud Expert Group will be public on May 2, 2012. The author, being part of this expert group, have permission to include results from this report before the release date.

61. From *Advances in Clouds*, EU Cloud Expert Group, May 2012

to compete for the cloud market. Many of these recommendations are about how to increase the focus on how cloud research and work is planned, avoiding overlapping efforts, identifying the fact that cloud computing is overlapping multiple domains. This is about avoiding unnecessary repetition of work, as was seen partially in earlier efforts in, for example, grid computing. Another recommendation from the EU expert group is to focus on industry and commercialization of long-term relevance. The cloud field is moving so quickly that any short-term project is in high risk of being obsolete at the time for release. To succeed in longer-term projects, the industrial sectors need to participate from start. In addition, with any EU funded project, there is a need to further enable the Fast Transition to the Cloud. That is, support of commercialization of outcomes needs to be in place.

A common focus point also advanced by the Tivit.fi group: the importance to cater for environments that allow for large-scale tests and that provide innovative startups with a quick entry point to the market.

*Testbeds with technical, economic and legal aspects supported should be provided to test European solutions in a realistic environment and to showcase demonstrators (Tivit.fi)*

This requires that such environments are easily accessible without unnecessary interference of legislation or security concerns with IPR issues fully maintained. This may imply that *national* providers are needed to ensure maximum compliance.

In addition to national testbeds, the European expert group pointed at the importance of the emergence of large scale cloud providers in Europe. “The European market tends towards (comparatively) small scale, diversified and heterogeneous providers in terms of their resource infrastructures. To compete in the global cloud ecosystem, higher resource needs have to be satisfied than is currently possible with these infrastructures. The group stressed that: “In the area of eGovernment and Healthcare there are requirements (legal, privacy) supporting a Large Scale European Provider(s).” As mentioned in Chapter 5, Government and healthcare seem slow in cloud uptake. This is much due to security and privacy concerns with public clouds, where ‘public’ implies that the actual data is outside Sweden or Europe. The EU expert group goes into further detail on the importance of supporting SMEs, and the importance of open source.

Starting in 2008, the Finnish Cloud Software project<sup>62</sup> has been looking at the challenges and opportunities for Finnish industry. Below is a summary of the latest (March 2012) SRA<sup>63,64</sup>, focusing on the same topics as in this report – and partially similar as in the EU Cloud Expert Group (see above). As is listed in the recommendations of this

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62. Under [tivit.fi](http://tivit.fi)

63. <https://www.cloudsoftwareprogram.org/results/deliverables-and-other-reports/i/27850/1941/strategic-research-agenda-for-finnish-software-industry>

64. The author of this report is one of the reviewers of the Finnish Cloud Software reports.

report – Sweden should consider building a cloud expert group, collaborating with the Finnish Cloud Software initiative and the EU Cloud Expert Group.

The Finnish Cloud Software project has in its latest report made a list of strategic challenges and opportunities and recommendations on how to accelerate the change of the Finnish software industry, creating a competitive edge for their cloud-based business.

In the (public) report a number of observations and challenges are listed. Among these is the strong belief in the importance of building software-based ecosystems, a lesson learned from the US verticals discussed earlier in the chapter on markets. Further, these networked ecosystems require special development of strategies and processes to stay competitive. Recently, lean methods are much favored as a next level of agile methods.

The expert group believes in the importance of Application platforms, which are similar to the earlier mentioned 'Innovation Platforms', where all different players in the ecosystem help in the building of new and innovative application platforms. These platforms can be used either for existing ecosystems or with the intention to create totally new value creation networks. The conclusion from reading and discussing with the Cloud Software Finland program is that we have much in common with them and that should be considered when looking at how to best position ourselves in the new quickly evolving cloud market.

An important comment is that both Tivit.fi and the EU Cloud Expert Group are larger initiatives<sup>65</sup> that have run for a number of years. Aside from the higher-level recommendations, both groups suggest *testbeds and ecosystem building* to help local companies and entrepreneurs to develop new services. Both groups also suggest further development of novel methods for overall development and business development.

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65. See for example the author list from the first EU Cloud Expert Group's report (Lutz et al, 2010)



# Summary - Call to Action

In order to provide an environment conducive to further develop and exploit the opportunities embedded in the cloud computing technology, we recommend that the following measures should be undertaken:

## **1. Create a Swedish Cloud Expert Group**

Sweden needs to join forces with the Nordic and EU cloud experts groups, drawing on their insights and experiences, and share the efforts needed.

- Sweden is already collaborating with other EU countries in the planning on how to address these challenges and opportunities – especially through the EU Cloud Expert Group’s work. Sweden should consider all the recommendations coming out of the EU Cloud Expert Group, and further develop these for Swedish needs.

- Sweden should also consider deepened collaborations with neighboring countries in the work on how to help our industry and entrepreneurs to best address the upcoming challenges and opportunities. Tivit.fi is one of the more mature programs working with this. Sweden should put effort into building a similar effort – in collaboration with Tivit.fi and EU – to provide and diffuse knowledge and experiences on cloud computing together.

- The Swedish Cloud Expert Group should work in close collaboration with already existing interest groups like EuroCloud Sweden (vendors), Cloud Sweden (users, customers), startup accelerators and incubators, and, as already mentioned, Cloud Software Finland (from Tivit.fi) and EU Cloud Expert Group.

## **2. Evaluate building a Swedish cloud testbed for entrepreneurs**

- As a first task, the Swedish Cloud Expert Group should evaluate the idea of a Swedish cloud testbed for entrepreneurs and early stage companies, possibly expanding it to include companies that are developing services for local customers such

as government and healthcare. As we have seen above, testbeds are a recurring recommendation from EU Cloud Expert Group (for testbed on EU level) as well as for Finland (from Cloud Software Finland – Tivit.fi). In the latter case the building of such a testbed has already been started. A testbed is just one piece of the whole ecosystem, but an important one. In addition, local testbeds are of interest to eGovernment and Healthcare services.

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On the entrepreneurial side, Dr Edlund is today an advisor at Severalnines; co-founder of Numeri Ltd; advisor at SICS Startup Accelerator; startup coach at Aalto Venture Garage and Startup Sauna. He is also the founder and Managing Partner Pawn Promotion, a cloud strategy consultancy firm.

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## **Abbreviations**

*AWS - Amazon Web Services*

*AWS EC2 - Amazon Web Services Elastic Cloud*

*AWS S3 - Amazon Web Services Simple Storage Service*

*IaaS - Infrastructure as a Service*

*PaaS - Platform as a Service*

*SaaS - Software as a Service*

*SLA - Service Level Agreement*

*QoS - Quality of Service*

*NIST - National Institute of Standards and Technology*

*CSA - Cloud Security Alliance*

Näringspolitiskt forum är Entreprenörskapsforums mötesplats för frågor rörande det svenska näringslivets utveckling och svensk ekonomis långsiktigt uthålliga tillväxt. Ambitionen är att föra fram policyrelevant forskning till beslutsfattare inom politiken samt inom privat och offentlig sektor.

Rapporten *Cloud Computing - Challenges and Opportunities for Swedish Entrepreneurs* beskriver vad Molnet egentligen är för något och dess möjligheter och eventuella hot. Entreprenörerna spelar en viktig roll i användandet och utvecklingen av molntechnologin och många bedömare hävdar att vi står inför ett paradigmskifte i likhet med när Internet introducerades. Hur väl förberedda är vi i Sverige och vad kan politiken bidra med för att skapa en mer dynamisk och tillväxtbefrämjande svensk "molnmiljö"?

Rapporten är författad av Åke Edlund, Kungliga Tekniska Högskolan i Stockholm.



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