Working paper R2008:008

Information technology in the United States

Environment, initatives and trends

Karin Hovlin, Eva Hunnius Ohlin, Magnus Härviden and Martin A Wikström

itps SWEDISH INSTITUTE FOR GROWTH POLICY STUDIES

Information technology in the United States

Environments, initiatives and trends

Karin Hovlin, Eva Hunnius Ohlin, Magnus Härviden
and Martin A. Wikström

ITPS, Swedish Institute for Growth Policy Studies
Studentplan 3, SE-831 40 Östersund, Sweden
Telephone: +46 (0)63 16 66 00
Fax: +46 (0)63 16 66 01
E-mail info@itps.se
www.itps.se
ISSN 1652-0483

For further information, Martin Wikström
Telephone +1 202 536 1588/ +46 8 456 67 16
E-mail: martin.wikstrom@itps.se

Preface

Over the last decades, information technology (IT) has revolutionized societies and economies all over the world. Changes are noticeable on all levels, from the individual to the multinational. IT is ubiquitous in everyday life in modern countries such as Sweden and the Unites States, and a strong IT infrastructure and inherent competence are also preconditions for research, development and innovation. New applications and services are emerging at high and increasing speeds. The United States is in many ways the dominant country when it comes to research and innovation and it is therefore important to follow American developments. This includes how research and innovation are undertaken, which environments are considered being of special importance as well as the overall technological development.

This report has been written by ITPS for Vinnova. It describes industrial and academic innovation processes as well as federal and state agencies' involvement in innovation and research initiatives in the information technology sector. Two American innovation clusters have been investigated in more depth – Austin (Texas) and the Research Triangle Park (North Carolina). In addition, the report discusses the progress made in certain key IT initiatives such as e-government and e-health, it highlights technology trends and also describes studies in which universities and states are ranked in different IT-related subjects.

The report was written by Karin Hovlin (ITPS Los Angeles), Eva Hunnius Ohlin (ITPS Washington D.C), Magnus Härviden (ITPS Washington D.C.) and Martin Wikström (ITPS Washington D.C., project leader). Thanks also to Magdalena Molin (intern, ITPS Washington D.C.) for contributions to the report.

Stockholm, August 2008

Suzanne Håkansson
Director, ITPS Policy Intelligence

Table of Content

Summary

In this report we describe innovation systems and innovation processes and strategies in the United States' information technology (IT) sector, specifically focusing on some important trends within this area. In addition, we discuss factors of importance for innovation including some public initiatives and the importance of universities.

There is a movement towards the use of open innovation strategies in the IT industry in the United States. According to Henry Chesbrough, a University of California at Berkeley professor, "open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology". However, there are hybrid models where firms may move from a closed environment towards an open, although they are not yet purely open, and the actual strategies depend on the specific companies and their collaborative partners. Some examples are joint labs with universities, fellowships for excellent students and Open Domain repositories (of findings). While it is difficult to find companies that claim that they do not use open strategies, no quantification of the trend has been found. The automotive industry as well as the airline industry appears to use open innovation strategies less than other industrial sectors. Furthermore, for security and military reasons the conditions are somewhat special for the defense industry.

Important partners for IT companies include universities, other companies, venture capitalists, authorities, individual inventors and entrepreneurs. Academic environments are of importance not only as collaborative partners but also as a source for spin-off companies, patents, and innovative ideas as well as a recruitment source of highly qualified personnel.

The report describes two regional clusters consisting of companies, academic institutions, authorities and other organizations with a focus on innovation processes in the IT sector. The chosen clusters are Austin, Texas and the Research Triangle Park (RTP), North Carolina. Both regions illustrate the dynamics and interactions that may take place in a cluster where many different types of organizations, stakeholders and competences are present. The two regions show several common features and characteristics, i.a. the importance of having top-universities in the region, both as a source for talent as well as for performing cooperative and collaborative research. Quality of life and available social and physical infrastructure including good schools are also highlighted as key factors by both clusters. Particularly in Austin, the creative profile and dynamic music scene is considered important for the city's attraction among young people.

In Texas, the state has introduced special measures to strengthen innovation and commercialization at public universities, including the introduction of commercialization activities as one of the required and evaluated areas at academic tenure reviews. The Governor has also taken the initiative to create an Emerging Technology Fund to expedite innovation and commercialization of research. The formation of RTP in the late fifties was a deliberate action to lift the economy of North Carolina and RTP is now one of the largest innovation clusters in the U.S. In both states, the tax structure is an important factor in attracting individuals, companies and/or investments.

Since academic institutions are of great importance for the innovative process, the report also looks at rankings of U.S. universities within the computer science fields. Universities such as Stanford University, Massachusetts Institute of Technology (MIT), University of

Texas at Austin and Carnegie-Mellon University are examples of universities that received top placements in all rankings studied.

Some current federal policy initiatives for innovation such as the President's American Competitiveness Initiative (ACI), the Networking and Information Technology Research and Development Program (NITRD) and the Technology Innovation Program (TIP) are also described.

Federal agencies including the National Science Foundation (NSF), the National Institutes of Health (NIH), the National Institute of Standards and Technology (NIST), and DARPA are discussed separately. These agencies are key participants in the NITRD program and invest heavily in IT-related research and development. NIH and NIST do this both intramurally and extramurally. All agencies mentioned above also adhere to federal programs such as the Small Business Innovation Research Programs (SBIR) to stimulate innovation. NSF and NIST are among the agencies that will benefit strongly if ACI is implemented together with Congress' America COMPETES Act. However, these initiatives have currently not been fully funded.

In addition to the above, the report describes the development and implementation of key initiatives such as e-government and e-health. A few years ago, the implementation of e-government in the U.S. was criticized as being too slow. However, federal adoption has progressed and more services are now available online even though there appears to be potential for further implementations. The number of e-government services available on the state level varies greatly from state to state. The variation between states is also large in areas such as innovative capacity, the use of IT in schools, broadband adoption and the part of the population with online access. Implementation of e-health including the introduction of electronic medical records has been difficult due to a number of factors including confidentiality concerns and a low computer penetration at clinics.

Finally, the report describes the results from a few surveys indicating which technology areas that are deemed to be of particular importance in the coming years. Among these are virtualization technologies, communications tools and internet applications as well as open source initiatives and green technologies.

1 Introduction

1.1 Background

It is hard to overestimate the importance and development of the information technology (IT) sector during the last decades. Information technology is employed in more or less all sectors of modern life and has enabled great leaps for science, technology and innovation. The United States of America (the U.S.) has, since a long time, been the world leader in computer science research with top universities such as Massachusetts Institute of Technology (MIT), Stanford University, University of California (Berkeley) and Carnegie Mellon University. The U.S. is also the top innovator in IT with environments such as Silicon Valley (California) and home to many of the major global IT companies.

Given the U.S. dominance combined with strong financiers, it is of interest to Swedish policymakers and other interested parties to learn more about American developments. For Sweden it is important not least in the research and innovation sectors to learn from experiences of strategic initiatives. It should however always be remembered that the situation in Sweden differs significantly from the U.S. situation due to the different political and societal systems and pure factors of scale, and that conclusions therefore should be drawn with caution.

It is of interest to follow technical development and development of IT services such as for instance services related to e-government. Furthermore, rankings of academic environments and geographic areas that are successful in various aspects of education, research or implementation of the use of IT, are valuable in order to have an updated knowledge of which states and institutions that are at the forefront in various IT-related aspects.

One area of particular importance is how innovation is made in sector specific clusters consisting of companies, universities, state or federal agencies and other organizations. There are many such clusters in the U.S., the most famous in the IT sector being Silicon Valley. In this report we have however chosen to describe the clusters in Austin (Texas) and Research Triangle Park in North Carolina, as they are more relevant in size for Swedish conditions and less known among Swedish policymakers. In addition to this, we have described a few innovation initiatives and factors that we believe are of special importance due to their character. Finally, we have described a number of federal IT-related initiatives and agencies that have a large impact. Quite often such initiatives impact the situation also outside the U.S.

While reading this report, a few things should be kept in mind. First, as the U.S. is a federation in which the 50 states have a high degree of self governance, the situation may vary between the different states. Large research and innovation agencies such as the National Science Foundation (NSF) and the National Institute of Standards and Technology (NIST) are federal. However, a large number of initiatives important for research and innovation are carried out on the state level, which of course impacts the situation in that state significantly (and to some extent in other states). Such initiatives will however not be visible in the federal budget. A number of state actions are included in this report. However, due to the large number of states and state initiatives, it has not been possible to map such initiatives over the whole country.

1.2 Outline and methods

This report starts off by describing some major current innovation trend towards “open innovation” (chapter 2). As universities are important innovation partners for industry and a source for ideas, companies and personnel we thereafter identify which academic institutions that are considered as the best in different IT-related aspects (chapter 3). In chapter 4, we describe, in some detail, two innovative cluster regions important for the IT-sector; Austin, Texas and the Research Triangle Park, North Carolina. We also briefly describe Silicon Valley and the Boston Route 128 cluster, and identify a number of states that are considered to be at the forefront in various aspects of the digital economy. In this chapter, a ranking of the states with the highest “innovation capacity” can also be found. In chapter 5, we describe an interesting example of open innovation. We also describe a number of federal initiatives and agencies that are important for IT-research and innovation. Federal initiatives towards e-health/health-IT and e-government are discussed in two separate sections. In chapter 6, we make a brief description of the outcome of a few studies of current and common technology trends. Chapter 7, finally, discusses the findings and concludes.

The project has been accomplished through interviews, site visits, literature- and web-searches and analysis of the material collected.

2 Major current innovation trends

The purpose of this chapter is to outline a few broad current trends concerning innovation strategies in the U.S.

2.1 Open innovation gains ground

The notion of open innovation is often associated with the University of California (UC) Berkeley professor Henry Chesbrough who in 2003 published the book *Open innovation – The new Imperative for Creating and Profiting from Technology* (Chesborough, 2006). Since then, several reports have been published work in this area.[1,2] Chesbrough describes the shift from models of innovation that were based on a closed paradigm where *control* was a lead word, to today's open models. The open innovation trend has since increased in strength which at least partly may be due to the literature in the area and the increasing number of IT tools. According to a survey made by Bain and Company in 2005, 24 percent of 960 executives claimed that their company used open-market innovation methods. Furthermore according to a 2005 KPMG study 64 percent of U.S. executives said that they plan to increase their use of strategic alliances during the two coming years.

In the closed model, companies – as the concept suggests – generate ideas and innovations within their organizations, relying heavily on internal research and development. The new products that are the result of research and development (R&D) activities generate increased profits and new resources are channeled back to the R&D labs. Intellectual property (IP) is central in the closed model in order to control and safeguard the ideas and innovations.

In his book, Chesbrough takes Xerox PARC (Palo Alto Research Center) as an example of the shortcomings of a closed system. PARC has been the site for much innovation achievements such as the laser printer and the Ethernet. However, PARC showed weaknesses when it came to commercializing research and several innovations were further developed and brought to market in separate spin-off companies, creating little or no value for Xerox' shareholders.

There are several factors that have led to the erosion of the closed innovation model. One is the growing mobility of increasingly skilled people where knowledge and ideas are harder to keep within the walls of one company. Another factor is the emergence of private venture capital (VC), creating improved conditions for the commercialization of ideas outside the established companies. Between 1980 and 2000 VC investments increased from 700 million to 80 billion USD (during the dot com bust there was however a decline and 2001 the figure was 36 billion USD).[3] Yet another factor is that many companies now subscribe to the idea that ideas flowing freely and cooperative research between companies, universities and individuals is beneficial for innovation in a pre-competitive phase (before direct development of commercial products and applications). Finally, the increasingly fast time to market for many products as well as increasingly knowledgeable customers and suppliers has contributed to the erosion of the closed innovation model.

[1] *For an overview of the research field of open innovation, see Vinnova (2008:02).*
[2] *See also Karlsson (2004) and Karlsson (2006).*
[3] *Chesbrough (2006) p. 38.*

According to Chesbrough, *"open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology."*[4] In the open model, both internal and external ideas are used to create value and innovations created within the company's research process may leak out of the company, through departing employees, collaborations, licensing or start-up companies. In the open innovation model, firms are both active buyers and sellers of IP and a company can profit also from other entities' use of the company's ideas. In the table below, some characteristics of the two models are outlined.

Table 1 Contrasting principles of closed and open innovation**.**

Closed Innovation Principles	**Open Innovation Principles**
The smart people in our field work for us	Not all the smart people work for us. We need to work with smart people inside *and* outside our company.
To profit from R&D, we must discover it, develop it, and ship it ourselves.	External R&D can create significant value; internal R&D is needed to claim some portion of that value.
If we discover it ourselves, we will get it to market first.	We don't have to originate the research to profit from it.
The company that gets an innovation to market first will win.	Building a better business model is better than getting to market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win.
We should control our IP, so that our competitors don't profit from our ideas.	We should profit from others' use of our IP, and we should buy others' IP whenever it advances our own business model.

Source: Chesbrough (2006) p xxvi.

It is however important to point out that these are not either/or models, instead there are many hybrid models and firms and industries are moving towards more openness even though they perhaps cannot yet be characterized as truly using "open innovation". There are many well-known examples of companies that have moved from a closed to an open model, e.g. Procter & Gamble in the consumer industry and IBM in the IT industry. The trend towards open innovation strategies is strong and it is difficult to find any companies that admit to doing "closed innovation". However, we have not been able to find any quantification of the trend. One minor indication of the interest may be that the number of Google web searchers for the term "open innovation" has increased by around 50 percent over the last two years. The use and characteristics of open strategies may vary in between different industrial sectors. The automotive and airlines industries are among those using open innovation strategies the least. Furthermore, while the defense industry is involved in open initiatives they are likely to be more protective. ITPS has discussed open innovation in this context in reports on changing R&D investments and internationalization of corporate R&D (Karlsson 2004, 2006).

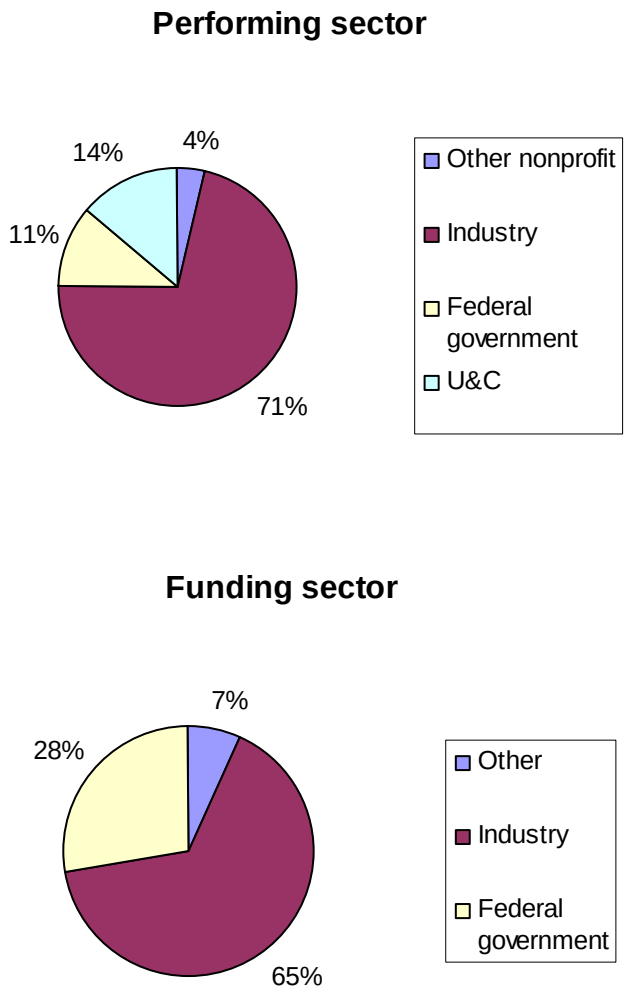
[4] *Chesbrough (2006) p xxiv.*

2.2 Industry – university collaboration develops

One aspect of this new open innovation paradigm is the closer cooperation and collaboration between academia and industry. These ties have traditionally been stronger in the U.S. compared to Sweden, but also in America changes are taking place.

Similar to the situation in Europe, there is a growing concern in the U.S. about the lack of funding in particular for long-term research and how the "valley of death" between basic research and commercialization should be bridged. Due in part to the increasing cost of financing the wars in Iraq and Afghanistan, available resources in other areas of the federal budget have decreased. This has meant that industry financing of R&D has become increasingly important. Today, approximately two thirds of overall R&D funding originates from industry as seen in figure 1 below. However, most industry research is geared toward more near-term R&D rather than long-term, discovery-oriented research.

Figure 1 Shares of National R&D expenditures by performing and funding sectors (2006). U&C=Universities& Colleges.



Source: NSF (2008), Science and Engineering indicators 2008.

In the report *Rising Above the Gathering Storm* (2006), the National Academies point to several explanatory factors. First, the Bell Laboratory model was based upon the telecom monopoly that has since been dismantled and replaced by a competitive market, leaving fewer incentives to fund long-term research. Second, the financial markets are to a greater extent focusing on quarterly financial results, placing little value on long-term and more risky research investments. Third, it is not always possible to capture the return on long-term research, instead results and benefits often spill over to other researchers and companies. Fourth, globalization means that research is more fragmented and takes place at many different locations around the world.

The relative lack of federal funding means that universities need to look for financing elsewhere, in particular from industry. At the same time, industry performs less R&D in their own labs and more in university settings. An example is a recent announcement by Microsoft and Intel that they together will finance two labs at University of California at Berkeley and University of Illinois at Urbana-Champaign focusing on parallel computing.[5] Together, the companies will invest 20 million USD over five years in the two university centers.

Another example is Intel's lablets (see also section 5.1 on Intel lablets) which are labs owned and funded by Intel but located at universities, where industry researchers are working side by side with university researchers and students. Much of the research is published and shared widely. Intel has such laboratories at University of California at Berkeley, Carnegie-Mellon University (Pittsburg), University of Washington (Seattle), Santa Clara (California) and in Israel (Haifa and Jerusalem).[6]

A third example is IBM's work with collaborative research initiatives where different models for collaboration have been developed.[7] In the IBM model, research cooperation range from completely open, where all results are publicly shared and royalty-free to sponsored research (or "research-for-hire") and hybrids in between. In December 2006, IBM announced that a number of universities would participate in the Open Collaborative Research (OCR) program to support open-source software research. The participants include Carnegie Mellon University, Columbia University (New York), Georgia Institute of Technology (Georgia), Purdue University (Indiana), Rutgers University (New Jersey), the University of California at Berkeley and the University of California at Davis. All parties must agree that any software developed in an OCR project will be made available as open source. Other intellectual property stemming from OCR collaborations will also be openly available.[8]

Increased industry – university collaboration may also pose some challenges. If academic research labs mainly become "job shops" for industry, the academic independence may be challenged and threatened. It is therefore important to thoroughly discuss how to set the research agenda. Another challenge may be intellectual property rights.

2.3 Research is becoming more multidisciplinary

One of the important trends is that research, high-level education and development are becoming more multidisciplinary. Where it used to be enough to have only engineers

[5] *www.berkeley.edu/news/media/releases/2008/03/18_parlab.shtml*
[6] *techresearch.intel.com/articles/Exploratory/1504.htm*
[7] *www-304.ibm.com/jct09002c/university/scholars/ur/collaboration/index.html*
[8] *domino.research.ibm.com/comm/research.nsf/pages/d.compsci.ocr.html*

working on a problem, today there are advantages in bringing in other scientists, economists, educators and anthropologists. This trend is for instance clearly evident at the cross-section of information technology and biomedicine.

An example of this multidisciplinary trend is the initiative that the former Governor of California took in the year 2000 when four California Institutes for Science and Innovation (CISI) were established. These centers conduct multidisciplinary research in biomedicine, IT and nanotechnology at two or more University of California campuses. California Institute for Telecommunications and Information Technology (Calit2) is one of these centers and is located at two campuses, Irvine and San Diego, and it conducts broad multi-disciplinary research to address large-scale societal issues. The state of California originally financed these centers with 400 million USD and industry has co-financed the institutes by an equal or larger amount.

2.4 Innovation in a networked world

That innovation usually is the result of several individuals' efforts and perspectives rather than the lone work of an individual is well-known. The development of new technologies during the last few decades is now also providing new tools for innovation processes.[9] We live in a networked world where the Internet is ever present, giving us new opportunities and means to communicate and collaborate independent of time and distance. Tools such as instant messaging, video conferencing, virtual worlds such as second life, Wikis and blogs are becoming more and more common.

The National Science Foundation (NSF) last year launched a new initiative, Cyber-Enabled Discovery and Innovation (CDI). It is a five-year initiative to create revolutionary science and engineering research outcomes made possible by innovations and advances in computational thinking. NSF is planning to finance the program with approximately 50 million USD per year. Projects that are transformative and multidisciplinary within the following three broad areas will be considered for financing:

- *From Data to Knowledge*: enhancing human cognition and generating new knowledge from a wealth of heterogeneous digital data,
- *Understanding Complexity in Natural, Built, and Social Systems*: deriving fundamental insights on systems comprising multiple interacting elements,
- *Building Virtual Organizations*: enhancing discovery and innovation by bringing people and resources together across institutional, geographical and cultural boundaries.

Another example of how technology changes innovation is the World Community Grid.[10] This is an initiative by IBM, launched in 2004 to use idle computer time and direct this computing power to large scale humanitarian research projects. Only non-profit and public research organizations may use the grid. Today there are almost 400 000 members with a total of over one million devices that donate their computer time for research projects on aids, cancer and climate change.

[9] *Rodriquez and Solomon (2007).*
[10] *www.worldcommunitygrid.org/*

3 Rankings of academic environments

Universities are important collaborative partners for industrial companies, a source for new companies and ideas as well as a recruitment ground for qualified personnel. Universities that are highly ranked are likely to be attractive to companies and it is of interest to follow rankings of academic environments. All types of rankings of academic environments should however be interpreted with caution as they often are limited. For instance, the measure of academic merit may be dependent on very few but successful scientists or the research performed may be in a relatively new area which has not yet reached journals with high citation indices. However, we still believe that it is useful to study the different rankings that have been made as they often give at least an indication of how successful the environment is and also because of their impact. For instance a high ranking of an educational program will most likely attract top students to that school.

3.1 Rankings

In this section we present some rankings that we deem to be of importance because of their impact. We also present the results from a search of the most cited researchers within the computer science area. Those universities that are located in the two clusters looked at (Austin, Texas and the Research triangle Park, North Carolina) have been marked in bold.

US News & World Report presents rankings in many fields and has a relatively strong impact as it is well-known. According to the publication, Massachusetts Institute of Technology (MIT) has the top **graduate program in engineering** in the U.S. The ten highest ranked (2008) schools[11] are:

1. MIT, Massachusetts
2. Stanford University, California
3. University of California-Berkeley, California
4. Georgia Institute of Technology, Georgia
5. University of Illinois – Urbana Champaign, Illinois
6. California Institute of Technology, Calfornia
7. Carnegie Mellon University, Pennsylvania and California
8. Cornell University, New York
9. University of Michigan – Ann Arbor, Michigan

11. University of California – San Diego, California

11. University of Texas – Austin, Texas

US news & World Report has also ranked **the graduate programs**[12] in Computer Science as follows.

1. MIT, Massachusetts
1. Stanford University, California
1. University of California – Berkeley, California
4. Carnegie Mellon University, Pennsylvania
5. University of Illinois – Urbana-Champaign, Illinois
6. Cornell University, New York
6. Princeton University, New Jersey

[11] *grad-schools.usnews.rankingsandreviews.com/grad/eng*
[12] *grad-schools.usnews.rankingsandreviews.com/grad/com/search*

6. University of Washington, Washington
9. Georgia Institute of Technology, Georgia
9. University of Texas – Austin, Texas
11. California Institute of Technology, California
20. Duke University, North Carolina
20. University of North Carolina-Chapel Hill, North Carolina

Yet another ranking by the **Shanghai Jiao Tong University** rates world universities. This ranking is to a large extent based on funding/expenditures and publication analysis. Within the engineering, technology and computer science field[13] the results (2008) are as follows below:

1. MIT, Massachusetts
2. Stanford University, California
3. University of Illinois – Urbana Champaign, Illinois
4. University of California-Berkeley, California
5. University of Michigan – Ann Arbor, Michigan
6. University of Texas-Austin, Texas
7. Carnegie Mellon University, Pennsylvania and California
8. Georgia Institute of Technology, Georgia
9. Pennsylvania State University – Univ. Park, Pennsylvania
10. University of California – San Diego, California
25. North Carolina State University – Raleigh, North Carolina

The highest ranked non-US university is Cambridge University (UK, rank 15)

In addition to the above mentioned rankings, a number of others have been made by other organizations with similar results.

Finally, a search of the ISI Thompson Web of Knowledge shows that universities with the **highest numbers of "highly cited researchers"** within the computer science field are:

1. Stanford University, California (14)
2. MIT, Massachusetts (13)
3. University of California San Diego, California (7)
3. University of Massachusetts Amherst, Massachusetts (7)
4. California Institute of Technology, California (6)
5. University of Texas Austin, Texas (5)
5. University of Maryland, Maryland (5)
5. Carnegie Mellon University, Pennsylvania and California (5)
5. Cornell University, New York (5)

3.2 Conclusions

The lists reflect various points including education programs, research quality and output volume. Although rankings, in general, should be viewed with some skepticism they are an important tool to assess various academic qualities and are also to some degree self-fulfilling. Researchers and students will often be attracted to highly ranked environments resulting in an increased competitive admittance procedure and recruitment which in turn may result in that only the most merited individuals are admitted. A number of universities

[13] *www.arwu.org/ARWU-FIELD2008/ENG2008.htm*

are present in the top ten on all lists presented here, and the two top-universities are in all cases MIT and Stanford University. The stability of the lists and the similarity between them suggest that those institutions present on multiple lists indeed are of particular importance. We note that University of Texas at Austin also was in the top ten on all lists.

4 Innovative regions

4.1 Introduction

In this chapter we first describe how the 50 States are performing with regard to the implementation of some IT-related factors of importance for the "new economy". Next we describe four important geographic clusters of which two are described and discussed in more detail – Austin, Texas and the Research Triangle Park in North Carolina, with a focus on how the companies innovate and the interactions within the clusters.

4.2 The States

4.2.1 State rankings in IT-factors relevant for the "new economy"

Rankings are often difficult to interpret due to the exact factors measured. Furthermore, the quality of the studies may vary. However, rankings are also often useful and may provide important information.

A high-quality publication, the 2007 State New Economy Index,[14] which is published by the Kauffman Foundation and the Information Technology and Innovation Foundation illustrates the heterogenity of the United States, while providing an overall ranking of the states in the "**new economy**" – a compound ranking of factors such as the number of knowledge jobs, globalization, economic dynamism, transformation for a digital economy and technological innovation capacity – and it indicates that the following states have advanced the furthest:

1. Massachusetts
2. New Jersey
3. Maryland
4. Washington
5. California
6. Connecticut
7. Delaware
8. Virginia
9. Colorado
10. New York

Texas is found in the 14th place and North Carolina in the 26th. Massachusetts' lead is, according to the report, large and can be illustrated by the software-, hardware- and bio-tech-companies concentrated along Route 128 (Boston) and the nearby presence of world-class universities such as MIT and Harvard University.

ITIF/Kaufmann also investigated the **innovation capacity** of the states by studying the share of jobs in the high-tech sector, scientists and engineers as a share of the workforce, the number of patents (normalized to workforce size), industry R&D as a share of workforce earnings and venture capital invested as a share of workers' earnings. Again the leading state was Massachusetts followed by California, Maryland, Delaware and New Jersey.

[14] *www.itif.org/files/2007_State_New_Economy_Index_Small.pdf*

How far the states have moved into the digital economy was measured using indicators such as the percentage of the population online, the number of internet domain names, the use of IT in public schools, e-government services, percentage of farmers online and the deployment of broadband telecommunications. In the compound ranking the following states ranked the highest:

1. Alaska
2. Massachusetts
3. Washington
4. New Jersey
5. Florida
6. Virginia
7. Connecticut
8. California
9. Arizona
10. Nevada

Below the subcategories population online, jobs in the IT-sector, computers and internet in schools, broadband adoption and e-government adoption are listed.

Percentage of population online

In this category the top states were:

1. Alaska (72 %)
2. New Hampshire (70 %)
3. Utah (70 %)
4. Minnesota (69 %)
5. Wyoming (68 %)

National average (59 %)

Fraction of jobs that are in the IT-sector

The number of jobs in the IT-sector is of interest as the IT-evolution continues which is a powerful driving factor in the new economy. The states with the highest percentage of jobs in IT occupations were:

1. Virginia (2.36 %)
2. Maryland (2.06 %)
3. New Jersey (1.94 %)
4. Massachusetts (1.86 %)
5. Connecticut (1.83 %)

National average (1.30 %)

Usage of computers and internet in schools

The states in which IT has been incorporated the most in public schools were:

1. South Dakota
2. Maine
3. Wyoming
4. Kansas
5. West Virginia

Broadband adoption

The top five states when it comes to the deployment of broadband for residential and business use are:

1. Georgia
2. California
3. New Jersey
4. Florida
5. Nevada

E-government

E-government, i.e. the use of IT for services by the state for the citizens as well as for intragovernmental improvement of the efficiency and security, is important. E-government is used on both the federal and the state levels. The states that according to the ITIF-study are most developed in this respect are:

1. Michigan
2. Utah
3. Indiana
4. Texas
5. Ohio

Interestingly, another study[15] from Brown university (West, 2007) rank the best e-government states:

1. Delaware
2. Michigan
3. Maine
4. Kentucky
5. Tennesse
6. Massachusetts
7. Maryland
8. Texas
9. New Jersey
10. Utah

Furthermore, the study claims that 54 percent of federal sites and 46 percent of state sites meet the World Wide Web Consortium disability guidelines and that 86 percent of state and federal sites have services that are fully executable online, compared to 77 percent in 2006. 17 percent had a user fee. Very few are accessible through PDAs or mobile phones. The differences in between the two rankings described clearly show their dependency on the exact factors measured and the relative weights the factors are given.

Federal e-government services and initiatives are discussed in section 5.8.

4.2.2 Conclusions

Similar to rankings of academic environments, rankings of states should be interpreted with caution. Rankings may give different results depending the exact methodology and factors measured. However, it is interesting to note that the Milken Institute's, a

[15] *news.brown.edu/pressreleases/2007/07/american-e-government*

California-based think tank, Science and Technology index 2008[16] put Massachusetts as the top Science and Technology state. ITIF/Kaufmann ranks it as number 1 in the new economy and in innovation capacity. The sparsely populated and cold Alaska is at the top in the digital economy and population online categories which is perhaps not surprising. However, it is also interesting to note that none of the states that are normally considered as the most dynamic and innovative like California and Massachusetts are in the top-5 concerning the use of IT in schools. The difference in results between the two rankings of e-government clearly demonstrates the dependency on the exact factors measured.

4.3 Innovation clusters

4.3.1 Silicon Valley is still the leader

In this project, we have studied two innovation regions in detail; Austin, Texas and RTP, North Carolina. However, any description of IT innovation in the U.S. would be incomplete without mentioning Silicon Valley (California). Silicon Valley is still seen by most as the leading area for IT innovations and has been described in many texts.[17] Another important cluster that has been referred to earlier in this report is Route 128 in Massachusetts. Route 128 is important not least because of Massachusetts' strong position in research and innovation. For a comparison of the two regions see e.g. Saxenian (1994).[18]

4.4 Silicon Valley

Silicon Valley is an area located in the western part of the San Francisco Bay south of San Francisco and it is considered as one of the leading regions in high-tech due to its large number of engineering companies and outstanding access to venture capital. The name of the valley has its origin from silicon chip innovators in the area. In 2008, the 3888 km/sq area of Silicon Valley has a population of 2.5 million people.

During the post-war era, Stanford University grew fast. As a result of economic problems that arose when trying to finance the growth, Stanford University decided to lease part of the university land to high-tech companies. The goal was to create a center of high-technology close to the university and it was quickly suggested that the lease should be limited to companies that could be beneficial to Stanford University.

In 2006, the Wall Street Journal found that 10 of the 20 most innovative towns in America were located in Silicon Valley. Thousands of high-technology companies are headquartered either in or near Silicon Valley. Some of the companies in the Valley are Google, Yahoo, Apple, Cisco, Oracle, Microsoft, Intel, Hewlett-Packard and Sun Microsystems.[19]

Silicon Valley has a solid network of industries and the world's highest concentration of venture capital, which makes it clear why the area nurtures entrepreneurial activity and is considered to be a global center for creativity in technology. A number of top universities that are engaged in innovative research and development are located in the broader San Francisco Bay and Northern California region. Examples of these are Stanford University, University of California (Berkeley), University of California San Francisco, San Jose State

[16] *www.milkeninstitute.org/newsroom/newsroom.taf?cat=press&function=detail&level1=new&ID=142*
[17] *e.g. Kenney, M. Understanding Silicon Valley (Stanford university press 2000).*
[18] *Saxenian, A.L. (1994) Regional Advantage: Culture and Competition in Silicon Valley and Route 128 Cambridge, MA: Harvard University Press.*
[19] *www.siliconvalley.com/*

University, University of California, Davis, Northwestern Polytechnic University (Fremont), University of California, Santa Cruz (NASA Ames UARC & UC Extension) and Carnegie Mellon University West.[20] The share of patents granted to Silicon Valley inventors increased at a faster rate during 2003–2004 than any period since 1997–1998. Patents per capita have more than tripled between 1994 and 2004[21] and around 10 percent of all patents issued in the U.S. are granted in Silicon Valley.[22]

4.5 Boston

Boston (Massachusetts) started its success in technology in the 1950's and has thereafter been considered as one of the major cities in the U.S. when it comes to technology.[23] The Boston cluster is strongly connected to Route 128.[24]

In 2001, Boston was ranked only after Silicon Valley in the United Nations Human development report which identified major world hubs for technology innovations. This ranking was based on factors such as the ability of local universities to develop new technologies and to train skilled workers, the availability of venture capital and the presence of established companies.[25] The area is considered as a very strong industry cluster and has the highest R&D expenditures in the U.S. In addition, it is an area considered to be among those that are most competitive and fastest growing. [26]

Companies like EMC, IBM and HP is a part of the 250 technology companies that employ approximately 90 000 people in the Massachusetts technology cluster.[27]

Furthermore, the Boston area has a number of top universities including MIT and Harvard University. The different universities in the area have taken action in order to respond to the demand of technology skills with new technology programs and have a great impact on the economy by attracting high-tech industries. The companies that are expanding in Boston often also have ties to Silicon Valley. However, Boston is commonly considered as number two after Silicon Valley.[28]

4.6 Austin

Austin prides itself with being unlike any other city. "Keep Austin weird" is an unofficial slogan used to emphasize that Austin's relative success in recent years in high-tech computer science, software development and telecom establishments and research is regarded as dependent on a mix of creative people, a tolerant attitude and strong cultural and musical influences. Austin is furthermore the self-proclaimed "Live Music Capital of the World". People in Austin generally cite the quality of life and Austin's hip character as reasons, besides a strong university and pro-business government, for the successful IT cluster that has emerged, something that became evident during a site visit in April 2008.

[20] *Innovation Center Denmark.*
[21] *Innovation Center Denmark.*
[22] *www.siliconvalleyonline.org/profile.html*
[23] *www.bostoninnovation.org/bostoninnovation/informationTech.htm*
[24] *www.businessweek.com/2006/34/b354197.htm*
[25] *www.tbf.org/indicators/technology/overview.asp?id=265*
[26] *www.innovasjonnorge.no/Internasjonale-markeder/Kontorer-i-utlandet/USA/In-English/Our-Offices/Boston/*
[27] *www.innovasjonnorge.no/Internasjonale-markeder/Kontorer-i-utlandet/USA/In-English/Our-Offices/Boston/*
[28] *www.businessweek.com/2006/34/b354197.htm*

4.6.1 Austin quick facts

Austin is the state capital of Texas. As everything is "big" in Texas, it comes naturally that the State Capitol is the largest in the U.S., except for the federal Capitol building in Washington D.C. The city is located on the Colorado River, south of Dallas and west of Houston.

Austin is the fourth largest city in Texas, the 16th largest in the U.S. and the third fastest growing in the country.[29] Three quarter of a million live in the city, and in the greater Austin metropolitan area there are some 1.6 million people. About one third of the inhabitants are Hispanic or Latino.

There are a number of higher education institutions in Austin. The prestigious University of Texas (UT) occupies a large downtown area, and has around 50 000 students enrolled and is one of the most distinguished research universities in the U.S.

4.6.2 Austin in rankings

Austin does well in different rankings where creativity is one of the key parameters. Richard Florida's, in his bestseller "The Rise of the Creative Class"[30] ranks Austin as number two behind San Francisco in the U.S. (interestingly and flattering for Sweden, Florida ranks Stockholm as number one in the world). In 2000, Forbes Magazine ranked Austin as number one of all U.S. cities in terms of entrepreneurship, and two years earlier Fortune attributed Austin a first place for doing business in the U.S. It is however worth noting that Fortune together with CNN this year (2008) did not even rank Austin among the 100 best places to live and start a company in the U.S., citing growth-related problems like rising house prices and traffic congestion, but instead promoted Austin's "suburb" Georgetown 26 miles north of the city as number two in the country.[31]

In Milken Institute's ranking of best-performing cities 2007, Austin is in 20th place, having risen from 56th place in the ranking 2005.[32] Low housing prices for a tech center, coupled with below-average business costs and a high quality of life are factors that influence the ranking.

Moreover, Austin was for several years ranked among the top three of the world's knowledge regions in the annual study by Robert Huggins Associates.[33] The magazine Business 2.0 named Austin one of four "Boom Towns" among 318 U.S. metro areas in 2004, and more recently the Wall Street Journal placed Austin as number one for economic vitality, and in 2006 as number three for most inventive city measured by patent activity.[34] Finally, Microsoft Networks (MSN) rates Austin the Greenest City in the U.S.[35]

---

[29] *U.S. Census Bureau 2007.*
[30] *Richard L. Florida, "The Rise of the Creative Class : and How It's Transforming Work", 2002.*
[31] *See money.cnn.com/galleries/2008/fsb/0803/gallery.best_places_to_launch.fsb/2.html*
[32] *Milken Institute, Best Performing Cities 2007.*
[33] *Robert Huggins Associates "World Knowledge Competitiveness Index" years 2002 and 2003, reports available at www.cforic.org*
[34] *The Austin Chamber of Commerce, "Greater Austin Regional Guide" at www.austinchamber.com/DoBusiness/GreaterAustinProfile/GreaterAustinRegionalGuide.pdf, see also article in Business 2.0 at money.cnn.com/magazines/business2/business2_archive/2004/03/01/363548/index.htm*
[35] *cityguides.msn.com/citylife/greenarticle.aspx?cp-documentid=4848625*

4.6.3 Austin – from sleepy town to high-tech metropolis

Not many years ago, Austin was a small quiet town, dominated by the campus of the University of Texas in the center next to the Texas State Capitol building, and with a cowboy and ranching culture. In the late 50's, a blueprint from UT calling for IT manufacturing led to two very important establishments near Austin – Texas Instruments and IBM both built plants in the region, which in a way marked the beginning of a new priority for the city, trying to benefit from the growing IT industry. However, it still concerned mostly manufacturing at the lower end of the value chain.

It was really in 1983 when things started to happen. A research consortium, Microelectronics and Computer Technology Corp. (MCC), chose Austin as the location for its headquarters, in a "beauty contest" with 57 competing cities. MCC was financed by 12 high-tech companies, and the mission was to ensure that the U.S. kept its lead in supercomputing, before upcoming Japan and other nations, by investing in top notch research. A group comprised of "Austinites" from the private and public sectors and from academia worked intensively to secure the localization to Austin by presenting an incentive package, including more than 20 million USD worth of research labs, endowed chairs at universities and benefits to MCC employees and their families. This put Austin on the map as a place for research and high-tech business.

MCC gave birth to some 14 spin-off companies (many of which are still in business today) and the nick-name "Silicon Hills". MCC itself was dissolved in 2004, which made it one of the most long-lived technology incubators. More importantly, MCC gave Austin a boost resulting in that many other companies chose to set up research labs in Austin.

In 1988, there was once again a national competition, this time for the national research consortium SEMATECH, grouping most of the U.S. semiconductor industry players. Austin was chosen among 137 sites. The same group that had worked to get the MCC contract now succeeded in getting the SEMATECH site as well. In May 2007, SEMATECH decided to establish its International headquarters in Albany, New York where a new R&D center will be constructed. SEMATECH's corporate office remains in Austin.

Today, more than 2 200 technology companies call Austin home. World famous Dell started as a small business in Michael Dell's dorm room when he was a student at UT. Dell is now competing with Hewlett Packard (HP) for the first place in PC sales. IBM, Freescale, 3M and AMD all have headquarters or important operations in Austin, and many foreign companies including Samsung and Siemens have established a presence there.

The catalyst for Austin was clearly MCC's choice of headquarters, but what have since then been the driving forces that explain Austin's high-tech attraction? Opinions vary, but there are some common denominators that many different players emphasize.

An excellent supplier of talent such as the different university systems, with UT as the most important in Austin seems to be a prerequisite for any successful high-tech region. High-tech companies need skilled employees, and they try to recruit the best and brightest from the universities through collaborations, internship programs and research projects besides sheer marketing. With over 50 000 students enrolled every year at UT in Austin, there are plenty of resources for the companies to tap from.

Other often cited reasons are Austin's collaborative spirit, its welcoming attitude towards new-comers, the geographical proximity between the parties involved (the Capitol lies next to the UT campus and the business district) and overall a high quality of life. The soul of the city and Austin's relaxed style, beautiful surroundings and good climate attract all sorts of creative people that contribute to the continued growth, are emphasized by a number of stakeholders. Texas tax structure and Austin's relatively low cost of living are important factors as well.

The collaborative spirit shines through, there are several important initiatives and organizations that gather the stakeholders around a cause and promote entrepreneurial and innovative efforts. IC2 ("Innovation Creativity Capital", or I C square), which is an interdisciplinary research unit at the University of Texas at Austin that hosts the Austin Technology Incubator (see further below) is a prime example of this. The Austin Chamber of Commerce as well as the Emerging Technology Fund, a 275 million USD fund created by the Texas legislature to improve innovation, commercialization of research and to recruit research talent, are other good examples involving several stakeholders.

Many of the people interviewed emphasized the importance of some role models, some "champions" that lead the way and passionately work for the common cause. The local government as well as the state government are important players and have e.g. focused on ameliorating the infrastructure and a pro-business tax structure. They are also praised by players outside of the public sector, for instance for the strategy to involve industry experts in advisory and review groups for tech projects and funding.

It is important to consider the capital formation infrastructure. Even though Austin cannot match the venture capital market in Silicon Valley, a number of VC firms are present in and around Austin, which provides a source of funding for start-ups and spin-offs from the universities and labs.

When visiting Austin in the spring of 2008, signs of the continuous development were easily observed. In the downtown area several tall buildings are being constructed, creating a new skyline. Traffic jams are frequent due to construction and a growing population. However, the impression is still that Austin has a small town atmosphere, which the city tries to preserve while at the same time profiting from having a bustling town's attractions that cater to a younger workforce.

4.6.4 How to improve the innovation and business climate – Stakeholders' perspectives

As was mentioned above, a contributing factor to Austin's success as a dynamic region is the collaboration that exists among different stakeholders. A number of players are focused on the same sectors and issues and are heading in the same direction. In the section below we give an overview of trends as well as initiatives that these stakeholders currently work with.

State of Texas and City of Austin

The State of Texas and the City of Austin both have a number of initiatives aimed at economic development and there is often collaboration between them, as well as with other partners.

In 2005, legislation was passed by the Texas legislature creating an Emerging Technology Fund.[36] A total of 200 million USD, which was later increased by another 75 million USD, was channeled to the fund. As part of the innovation eco-system, the purpose of the Fund is to:[37]

- expedite innovation and commercialization of research;
- increase higher education applied research capabilities;
- attract, create, or expand private sector entities that will promote a substantial increase in high-quality jobs;
- keep emerging technologies in Texas.

Examples of emerging technology industries include aerospace, biotechnology, computer & software technology, defense, energy including clean energy, information, life sciences, manufactured energy systems, medicine, nanotech, petroleum refining & chemical processes and semiconductors.

The program works through a partnership with the academic and private sectors and is thus another example of the collaboration that often takes place in Austin. To get the regional perspective, a network of eight Regional Centers for Innovation and Commercialization, RCIC, has been created where the Austin Chamber of Commerce is the Central Texas RCIC.[38] The Fund also has a 17-member advisory committee consisting of top industry and university leaders which is seen as an important strength.

To date, the Fund has invested in 83 projects, approximately half being industry-projects and the rest e.g. research grants and sponsoring of university projects. The 275 USD million is expected to last approximately ten years. After that, the expectation is that it will be self-financed from returns on previous investments as well as from exits.

Industry-projects for commercialization that are funded must fulfill a number of criteria: it must show a demonstrable economic impact in the state which includes committing to commercialize and/or have manufacturing within the state (the company's headquarters must be and remain in Texas for ten years). They must also raise matching funds from outside investors. This need not be done before applying to the ETF. It should however happen within 18–30 months and must be in capital funding, not in-kind. The terms that the companies negotiate with these private parties will also be the terms of the ETF funding. Grants from federal programs such as SBIR or STTR do not qualify as matching funds.

The Fund is also used for attracting top research talent to Texas. Texas institutions of higher education can apply for Research Superiority Acquisition Funds which, in the form of a grant, help to finance individuals with both very high academic qualifications as well as significant commercialization experience. In order to guarantee that this particular competence is valuable also for industry, the university is required to have matching funds from industry as well as from the academic institutions (the three parties, academic institution, industry, ETF, will thus finance a third each).

[36] *www.texasone.us/site/PageServer?pagename=tetf_homepage*
[37] *Texas Emerging Technology Fund – presentation material dated March 25, 2008.*
[38] *Among CenTex RCIC's partners are Austin Technology Incubator, SEMATEC, University of Texas, Texas State University www.centexrcic.org*

In addition to the ETF, the Governor of Texas, Rick Perry, has undertaken a number of initiatives in order to make Texas' universities more "user friendly". There are currently 13 different university systems in Texas, making it very hard for an entrepreneur coming to the state to know which institution that is appropriate to contact. The Governor is launching four actions related to the academic sector:

- commercialization should be included in the universities' mission statements;
- commercialization should be part of academic tenure reviews;
- tech transfer programs should be properly staffed;
- common templates for licensing will be provided in order to facilitate commercialization of research at *all* Texas universities.

The City of Austin is naturally an important stakeholder when it comes to economic development. Currently the Mayor has four broad priority areas; a fit city, live music, downtown development and green city – green industries.

A few years ago, the City Council established a committee for emerging technology issues. In relation to this, the Emerging Technology Program was established.[39] The objective of the program is to attract, retain, and facilitate growth of emerging technology firms in Austin and to act as a central clearinghouse of information about opportunities and resources for networking, financing, market development and business development. The target industry sectors for the program are: Clean Energy, Digital Media, Wireless, Biotechnology and Life Sciences and Early-Stage Technology Commercialization. As an example, within the program, the city is financing the creation of a bioscience part of the Austin Technology Incubator (ATI, see below).

Another example of work that the city is doing is a study on the economic impact of the digital media industry in Austin that was commissioned a few years ago.[40] One of the main challenges that the study identified was skills supply and workforce development. As a result of the study, the city worked with stakeholders to improve education in fields relevant for this industry. Today, there is a two-year gaming program running at the Community College and there is collaboration with University of Texas with the aim of developing a four-year program.

University of Texas

The University of Texas in Austin is widely considered to be the core, the key and the motor of Austin's high-tech economic development. It was founded in 1876, has 14 colleges and 333 degree plans and a strong focus in computer sciences, engineering, mathematics and the physical sciences. More than 90 research units are tied to the university. UT enrolls more than 50 000 students each year, and hosts some very respected research facilities that attract some of the best and brightest to the region, be it students, researchers or companies. It also leaves an imprint in the local population, nearly 40 percent of which has attained a college degree or higher compared to the national average of 27 percent.[41]

As mentioned earlier, commercialization and entrepreneurship activities will be considered at reviews for tenure. The goal is to encourage faculty members and researchers to create

[39] *www.ci.austin.tx.us/redevelopment/emergingtech.htm*
[40] *The economic impact of Austin's entertainment software/digital media industry*
[41] *"Austin Regional Overview", Austin Chamber of Commerce, 2008.*

spin-offs (and ultimately jobs and an increased tax base for the region). Even though this was generally seen as a step in the right direction by the people we met, we also heard voices raising a concern over the measure as this could influence negatively on the idea generation as "non-commerciable" ideas would be discarded, and because some researchers do not feel comfortable being forced into the entrepreneurial world.

However, change has already been thorough. Open innovation models are being widely used at the university, the collaboration with companies is intense, and research programs and groups are established by a demand-driven approach. For instance, a wireless research program (Wireless Networking and Communication Group) was set up some years ago, and features corporate sponsored research programs. Another program focuses on the digital media market with applied research projects in digital content and interactive technologies.

Finally, the already mentioned IC2 must be highlighted in this context. It was started in 1977 by Dr. George Kozmetsky, then Dean at UT (even though UT was not a contributor from the beginning as IC2 was initially financed by Dr. Kozmetsky's own funds), as a trans-disciplinary virtual think tank, and it is a collaboration between academia, business and government. Today, it is a part of the UT. It describes itself as a catalyst for accelerated technology-based growth, and it has several international programs with foreign incubators, universities and companies participating. Among its own initiatives are the well-known Austin Technology Incubator (described in more detail in sub chapter *Incubators and Venture Capital* below), the Global Commercialization Group and the Bureau of Business Research. IC2 supports action oriented research programs, where participants come from different disciplines like for instance engineering, liberal arts, information sciences and communication. There are programs in econometrics, creative and innovative management, knowledge-based benchmarking, high-tech marketing, regional economic development and more. IC2 also gives incubator education in such places as Shanghai, Moscow, Mexico and Poland, and receives scholars from all continents which ultimately is considered to benefit Austin as well.

Chamber of Commerce

Austin Chamber of Commerce, working for the greater Austin region (five counties) is an important partner in a number of initiatives. It has approximately 2 600 business members in the region. The chamber was a driving organization during a time when Austin started to attract a large number of companies and it coordinated many initiatives. On a monthly basis, the chamber would take representatives of the Austin business community on marketing trips. In the words of Angelos Angelou, one of the leaders from that time: "Austin is a community-based economic development marketing machine." Today, the Chamber still has a central role in many of the programs that take place in the region. The Chamber runs an initiative for economic development called Opportunity Austin, and another important program is called AustinHumanCapital.com which aims at recruiting top technology talent to Austin. Other programs include education on venture capital funding for entrepreneurs and an initiative to increase higher education enrollment.

Incubators and Venture Capital

Often referenced as a prime example of insightful leadership, The Austin Technology Incubator (ATI) was founded as early as 1989 by the IC2 Institute. It was an initiative supported by a group of government, university and industry leaders, in cooperation through the City, the County and the Chamber of Commerce. It started out as a three year experi-

ment to create wealth and jobs in the then struggling economy. Its focus is on supporting high-tech companies that have high growth potential. It turned out to be a success, and was therefore prolonged. It is today a self-contained entity, with connections with various universities besides UT. Since the start, more than 3 000 direct employments have been created through ATI, as well as 1.5 billion USD in revenue.[42]

The key success factors behind incubators in general and ATI specifically seem to be the tight ties to an excellent higher education institution, in this case UT. It has also in ATI's case been important to have some large technology companies in the region, and that all stakeholders (industry, VC, public sector and academia) have a long-term strategy which is not drastically changed due to politics or passing conjuncture trends.[43]

Other more specific parameters that have proved to be ground for success in ATI's case include clear metrics, a rational selection process and the development of value-added member services.[44]

The venture capital industry in Austin is fairly important in size. During the dotcom years around year 2000, more than two billion USD were invested by some 30 venture capitalist firms in Austin. Since then, the number of VC firms has been slashed to half, and the funding has hovered around half a billion USD per year.[45] However, in 2006 venture capital placement rose 50 percent in 2006.[46] The most important industry in Austin in terms of investments is semiconductors, followed by software. For these two areas, the Austin marketplace has a quite significant share of the U.S. total (in 2007, it was 7.6 percent of total U.S. investments for semiconductors). Now, the importance of these areas is giving way to upcoming sectors like (clean) energy, networking and medical devices.

For the local VC industry, important drivers have been the overall pro-business climate in Texas, with a very competitive state and local tax structure. There is for example no individual income tax and no corporate income tax in the state of Texas. Other parameters cited were Austin's ability to accept and integrate newcomers, besides the recurring statement about the quality of life. The good collaboration and understanding between public and private sector and academia is also a selling point for investing, as it provides stability and trust in future development. One key issue brought forward was the fact that the local government sees and emphasizes the importance of industry experts being part of public initiatives such as the ETF, which augments the likelihood of positive results.

Industry – Dell and IBM

Dell and IBM are two large companies with a long time presence in Austin, Dell of course being founded in Austin when Michael Dell was a student at University of Texas at Austin. In the following section we will discuss the main features of these companies' innovation processes as well as current developments.

[42] *"Building the Austin Technology Cluster : the Role of Government & Community Collaboration in the Human Capital", Pike Powers, 2006.*
[43] *"Creating the Technopolis : High-Technology Development in Austin, Texas" Dave Gibson, 1988.*
[44] *"Overview of US Incubators and the case of the Austin Technology Incubator", Dave Gibson and Joel Wiggins, 2003.*
[45] *The 2008-2009 Economic & Technology Forecast, AngelouEconomics.*
[46] *Milken Institute (2007) p. 29.*

Dell was founded in 1984 and today has some 80 000 employees worldwide. Approximately 18 000 of these are located in Austin (headquarters in Round Rock). Already from the start, Dell applied an innovation model based on openness and collaboration which means that much innovation at Dell stems from activities outside of the company. Most projects are based on open standards – "that's what the customer wants" and Dell is active in a number of standardization activities. As most companies today, Dell has design centers located around the globe. Products both for the global market (the target being business customers with a need for globally interoperable solutions) as well as regional markets (targeting mainly the consumer market). Dell is also moving from having partners mainly in the EU and the U.S. to having more partners in Asia, thus breaking the traditional model where innovation mostly happened in the EU and U.S. and manufacturing mainly took place in Asia.

Dell evidently strives to influence and control this process through a number of actions. Among these are the following:

- Dell tries to influence how its partners are spending their resources. For new innovations, the company can function as the "rabbit" to get quick access to market. The CTO's (Chief Technology Officer) office is continuously involved in a dialogue with partners and VCs to gather intelligence, catching trends and influencing the development of solutions that Dell can use. Speed is an important factor.
- Limiting the number of strategic suppliers.
- Securing large conduits for other innovation inputs, e.g. cooperation with universities, start-ups etc.

Dell is also investing in some of these start-ups. The company has an extensive cooperation with four other universities; among them are University of Texas at Austin and University of Minnesota. Of importance for this cooperation is naturally that the universities are excelling in areas relevant for Dell and that they are progressive when it comes to industry partnerships. As an example, when UT Austin declared that they would create the wireless research group mentioned above, being local was not sufficient for Dell to support such an initiative. But the person recruited to head the initiative was a person with strong entrepreneurial background who stated that he wanted very close cooperation with industry and hence, the initiative became of interest to Dell.

Speed to market is important in today's fast-paced technology market. Product development cycles of 12–18 months have been reduced to 6–9 months. Dell's product groups, their engineering teams, need to work so fast that they face difficulties that arise when integrating new technologies. This has led Dell to create "advanced engineering teams". These are small units that work within the product groups and that create solutions that can more rapidly be integrated in the products.

When it comes to the supply of talent and competence, Dell sees no immediate problems in Austin. Since Dell pursues the open innovation model, the company argues that it is not as affected by the difficulties in obtaining visas for foreign staff that some other companies in the U.S. are.

Looking at long-term trends when it comes to R&D, the declining federal funding will most likely create problems even though Dell is not affected today. In an open innovation model, there is less room for fundamental research and since there are no more Bell labs around, federally funding for basic research is of importance.

IBM opened up a manufacturing center (electrical typewriters) in Austin in 1967 and Austin has since then become an important IBM site. Austin is one of IBM's eight world-wide research labs and the site is very important when it comes to creating patents. IBM is the largest patent holder in the world and Austin is the site that creates most patents for IBM.

The transformation of IBM both from being a manufacturing company to being a service producing company as well as going from a closed innovation system where everything was created in-house to an open innovation model is well-known.[47] A shift in focus from the consumer to the business market has also taken place. A few of the changes that have been made are the following:

- *Collaboration* There is more emphasis on having different perspectives on a problem or a challenge. In simplified terms; IBM used to show the customer what the customer should want to have. Today, there is a much clearer customer perspective, where the customers as well as other partners take an active part in the innovation processes. "Innovation jams" is one instrument. The innovation jams can be described as online brainstorming sessions. In 2006, an innovation jam took place where 150 000 people from 104 countries and 67 companies participated.[48]
- *Global Innovation Outlook (GIO)* IBM has opened up what was earlier an internal, closed process of technology and business forecasting, to players outside the company. Open, collaborative, multi-disciplinary and global are key words. In the GIO process, participants from academia, industry, government, non-profits etc are gathered to have discussions called "deep dives".[49]
- *Use of technologies enabling innovations* Different forms of collaborative tools are used to a greater extent in the innovation process, e.g. Wikis and Second Life.

Engineers and scientists are naturally a main feature of IBM's innovation team. The company has a model with Fellows and Distinguished Engineers. To be a Fellow is the most prestigious honor at IBM and the title was introduced in the 1960's. Today there are approximately 50 active Fellows. IBM Fellows are given freedom and flexibility through a fellowship to pursue creative achievements, and typically work on special projects or research initiatives that lead the company in new directions. The Fellows are appointed by the chairman of IBM. The Distinguished Engineer program (DE) was introduced in 1995 as a way to recognize the top technical professionals. There are approximately 600 DE's today and they are appointed by the chairman's committee. The DE's receive their funds via business funding. There are also a third category, Senior Technical Staff Members, STSM, who are elected by their peers. There is a constant demand on IBM R&D staff to provide output of their efforts, e.g. to publish papers, make conference presentations, teach at universities and file for patents.

IBM is naturally working closely with the academic sector and has a partnership executive program with a number of universities. Elements of such a program could include matching grant programs, shared university research and teaching. In Austin, a Center for Advanced Studies, CAS, has been created.[50] The Austin CAS is an IBM research-based

[47] *See e.g. Chesbrough (2006), chapter 5.*
[48] *www.collaborationjam.com*
[49] *domino.research.ibm.com/comm/www_innovate.nsf/pages/world.gio3.html*
[50] *domino.research.ibm.com/acas/w3www_acas.nsf/pages/index.html*

institution dedicated to promoting and cultivating university relationships and collaborative research between IBM organizations in Austin and universities across the U.S. and beyond. In partnership with IBM business units dedicated to research, development, and services, Austin CAS provides universities with a window that spans a relevant cross-section of the company. The center is a focal point for an efficient, coordinated approach to university relations. Within the program, students (mainly graduate students) can be funded for internships and work in joint research projects.

4.6.5 Conclusions

The success story of Austin going from a small town dominated by agriculture and low end manufacturing to a thriving and praised high-tech region known for its creative and cultural scene, seems to depend on a few key elements.

The enabler is the higher education infrastructure, especially University of Texas at Austin but also other colleges and universities, which forms the basis for the talent supply. Its excellence and reputation in areas like computer science and telecommunications attract top students, and they, in turn, attract high-tech companies and researchers. The workforce in Austin is very well educated. There are well-developed partnerships between academia and industry where both sectors have a strong interest in cooperation and collaboration. Often, an open innovation model is pursued. The initiative from the State Government to make the universities more "user friendly" and to actively influence commercialization and entrepreneurial efforts is worth noting.

However, UT existed well before the dynamic cluster developed; hence, there are other important reasons as well. A committed leadership and collaborative spirit in local government, academia and industry, topped with some "champions", extraordinary people that were passionate about Austin's future opportunities, appear to have ignited the process. The most tangible milestones were the establishment of IT manufacturing in the late 50's thanks to UT efforts, but most importantly, the joint regional work that lead Austin to becoming the selected site for MCC in 1983. The marketing efforts undertaken by a number of stakeholders to get these establishments were of crucial importance. Marketing is still an important factor and Austin was described as a "community-based economic development marketing machine".

The spirit of co-operation remains strong today. Organizations like the Austin Chamber of Commerce, the City of Austin, the State Government, different venture capitalists, the universities and industry all meet regularly at different venues. The distances between different stakeholders are short in the small city, both geographically and mentally.

As stated above, the region is very proud of its active and lively cultural community, and leverages from it. Young professionals are attracted by the activities and the relaxed and liberal attitude that reigns in the city, quite different from the rest of Texas.

4.7 Research Triangle Park

4.7.1 North Carolina

North Carolina is located on the east coast in the U.S., and has a GDP of 375 billion USD. The state has a population of more than 8.8 million people and its labor force consists of 4.5 million people, with an unemployment rate of 4.7 percent. North Carolina was primarily an agricultural state in the 19th century but has since then emerged as a major industrial centre. This chapter focuses on the region that is located in the heart of the state; the region

Raleigh-Durham-Chapel Hill, with a current population of 1.3 million people. With state efforts in building a good infrastructure and business climate, the region has become competitive and has generated a strong economic growth for the state. This region is the home to the Research Triangle Park (RTP).

Figure 2 North Carolina and RTP.

Source: Research Triangle Foundation (2008).

4.7.2 Research Parks

Research Triangle Park

The Research Triangle Park (RTP) was established in 1959 by North Carolina leaders from business, academia and industry. It is the largest research park in the U.S. based on the number of employees and geographical size.

RTP was founded as a model for research, innovation and economic development with hopes for a change in the economic composition of the region and the state. At that time, North Carolina faced a number of negative economic trends; having one of the lowest per capita incomes in the nation, an economy dominated by manufacturing industries such as textiles and furniture, and a brain-drain of graduates from the state's many higher education institutions. The effort to change these trends started in 1956 by state leaders, and soon thereafter the Research Triangle Development Council was formed. The vision was to attract research companies to its environment with excellent infrastructure and intellectual assets. A decision was also made that the park should be a private effort together with the three surrounding universities, instead of an effort by the state government. Much of the funds needed came from corporations and institutions from all over the state.

As a result of these efforts, the Research Triangle Foundation was established. The foundation, a non-profit organization, owns and operates the park and is responsible for building and maintaining it as well as for attracting and retaining companies. The Foundation is not pressured to sell the land,[51] but is rather interested in finding the right companies. The main selling points when the Foundation approaches companies are the universities, RTP

[51] *As a matter of fact, only a few lots remain which means that RTP is entering a new phase.*

(the brand), and the location. RTP does not offer incentives to locate within the park, but the state does. The state and the local (city) government also assist the park with services (water, roads, sewer, and police protection) and decided in 1985 that companies within RTP should not have to pay city tax, only county tax. This tax law makes it more attractive for companies to locate its R&D facility to the park.

Figure 3

RTP Quick Facts

- Land area 7000 acres
- Land available for Development 630 acres +/-
- Tenants 157 companies
- Employees 39000
- Developed Space 20 million square feet
- Capital Investment 2.8 billion dollars
- Total payroll 2.7 billion dollars
- Industry Clusters: Biotechnology/Agricultural Biotechnology/Biological Agents, Chemicals, Electronics/Nanotechnologies, Environmental Services, Financial Services, IT/Informatics/Telecommunications/Pervasive Computing, Materials Science, Non-profit organizations/Associations, Pharmaceutical/Biopharmaceutical/Medical Devices, Professional/Business Services

Source: Info@rtp: 2007 quick guide, The Research Triangle Foundation of North Carolina.

In 1965, IBM decided to establish a presence in the RTP. IBM's decision, together with the U.S. Department of Health, Education and Welfare's decision to locate within the park, gave the park credibility as a place where to conduct research and development, and an increased growth was the result. Today, there are several large companies at RTP. The initial idea was to attract larger companies that would create a culture in which smaller companies could thrive.[52] The majority of companies within the park are small businesses and there have been 1 800 spin-off companies since 1975 within RTP.

The largest industry sector in RTP is the Pharmaceuticals/Health Services/Medical Devices with more than 35 companies and 7 000 employees. The second largest is the IT/Pervasive Computing/Telecommunications sector with more than 25 companies and over 20 000 employees. Important for the IT industry's decision to locate here are the engineering schools at North Carolina (NC) State University, Duke University, and the computer-science department at UNC-Chapel Hill. Nearly 90 percent of the companies within the park have some kind of relationship with the surrounding universities. Access to the talent source at the universities (students and faculty) is considered important to the companies.[53] IBM is the largest employer with approximately 10 800 employees. Cisco and Nortel Networks are third and fourth in number of employees. Industries within the park interact and learn from each other through best practices. The Research Triangle Foundation tries to facilitate the interaction by hosting networking events.[54]

Today, there are four incubators within the park, which are managed by separate companies and organizations. Its main incubator, Park Research Center, is owned by a subsidiary to the Research Triangle Foundation and managed by an outside firm. The companies at

[52] *Research Triangle Park: Evolution and Renaissance, The Research Triangle Foundation, June 2006.*
[53] *Hardin (2008) Pathways to High-tech Valleys and Research Triangles, Chapter 2: North Carolina's Research Triangle Park, Springer.*
[54] *A complete list of all RTP companies can be found at www.rtp.org/files/Maps/rtp_map_and_company_list__august_2007.pdf*

the incubators have to be affiliated with one of the three universities and many of them locate in the incubator to gain access to the different business networks. The Foundation assists the incubator companies with a first introduction to investors.

The state of North Carolina (North Carolina Board of Science and Technology) has a couple of grant programs that assist entrepreneurs. In its NC Small Business Program, the state offers a matching funds grant to small businesses that have been granted a federal SBIR and/or STTR Phase I grant. The program is in its third year and has not been evaluated, but shows strong evidence of success so far.[55] One third of these matching grants are awarded within the biotech sector; National Institutes of Health (NIH) awards most SBIR/STTR grants, followed by the Department of Defense. NC Department of Commerce also supports small businesses with a grant that covers costs affiliated with SBIR/STTR applications called North Carolina SBIR/STTR Phase I Incentive Program.

The North Carolina Green Business Fund Program is a new competitive program to support small businesses and government entities in developing green technologies. It is in its first year and has had 50 applicants. The program is run by the North Carolina Board of Science and Technology and will issue approximately 25 grants per year.

Success factors for RTP

The key success factor for RTP is the mentality of the region and a group effort to achieve excellence.

To create good clusters one needs to locate around knowledge centers and natural and transportation assets. RTP has three nearby universities and one central airport. That is at the core according to many of the people that we met in North Carolina. A working environment and policy framework enabling entrepreneurship and innovation is vital. However, a cluster also needs to offer quality of life; a safe community, access to healthcare, affordable housing etc. Furthermore, a region cannot offer only one employment opportunity but should be able to offer multiple jobs, thus, a critical mass of organizations and companies is needed. Quality of life, diversified industries and a low cost of living are considered by many to be the key elements in the success of RTP. However, it would be difficult to duplicate RTP somewhere else as each cluster has its own features and has to build from these.

To continue the growth and success, the park and state will select new areas in which to expand in the future such as gaming, energy, and clean tech. RTP cannot compete in everything but tries to focus on the areas that it already has competence within.

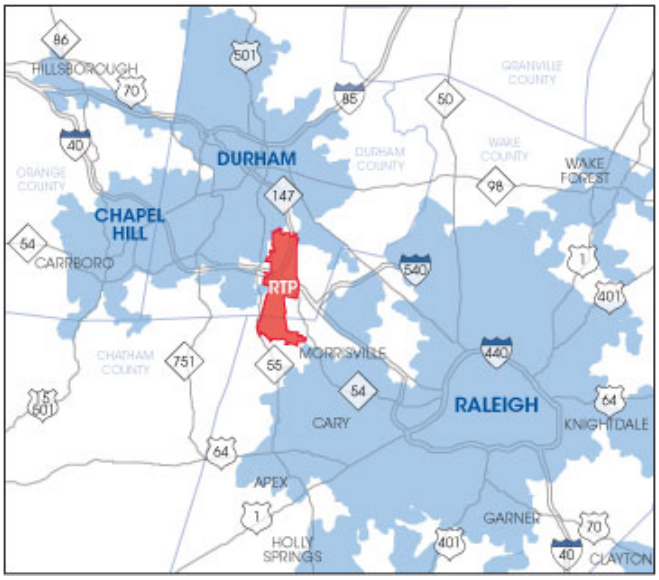
As mentioned earlier, RTP is a private/public initiative that has benefited from assistance from the state of North Carolina. The government will continue to work on infrastructure issues, water and tax issues. There has been a major regrouping effort the last five years within the region in order to use land more wisely. One of the biggest weaknesses is the lack of an urban life, but efforts are being made on state and city level to make the area "more urban" in order to cater to younger professionals and "creative people".

[55] *Interview with John Hardin with the North Carolina Board of Science and Technology.*

4.7.3 Universities

RTP was named after the triangle that is formed by the geographic location of three universities; the University of North Carolina at Chapel Hill, Duke University in Durham and North Carolina State University in Raleigh.

Figure 4 RTP.



Source: Research Triangle Foundation (2008).

Raleigh, the state capital is in the far east corner of the triangle. This is the home to North Carolina State University (NC State). NC State is a large public-grant research university with approximately 30 000 students and 1 800 faculty members. The university offers five levels of degrees in 125 fields of study.[56] The university, which was founded in 1887, is well-known for its strengths in agriculture and engineering and for its efforts in building a sustainable environment in the surrounding Centennial Campus. Therefore, NC State and Centennial Campus have been selected for a closer look and are further discussed below.

Discoveries at NC State University have resulted in over 550 patents and dozens of companies employing more than 13 000 people. Among the research developments is statistical software that led to the creation of SAS Institute. NC State University invests close to 325 million USD in research annually. Over 70 percent of the faculty is engaged in sponsored research and over 2 500 graduate students are supported in research and teaching appointments. Faculty members work proactively with industry to get funding for their research. The industry often turns to NC State thanks to the good reputation of the university.

Duke University, a private university at the northern point of the triangle in the city of Durham, was founded in 1924. The university has approximately 12 000 students, half of which are enrolled as graduate and professional students, and 2 500 faculty members. It is mostly known for its medical center but has also strength in biomedical sciences and engi-

[56] *Hardin (2008) Pathways to High-tech Valleys and Research Triangles, Chapter 2: North Carolina's Research Triangle Park, Springer.*

neering. Duke has strong financial resources; many large companies choose to invest in the school.[57]

In the southwest corner lies Chapel Hill, a small town of 50 000 people, home of the University of North Carolina (UNC) at Chapel Hill. This is North Carolina's oldest public university, founded in 1789. There are currently approximately 27 000 students enrolled, and more than 3 100 faculty members. UNC is known for its biomedical and computer science strengths, and is, with the exception of engineering and agriculture, the state's primary centre for graduate education and research at doctoral levels.[58] UNC at Chapel Hill has the largest endowment of the three universities in the park.

In addition to the three universities mentioned, there are several other public and private universities. The region is in total home to more than 111 000 university students.[59]

According to NC Department of Commerce, universities are becoming more involved in economic development initiatives in the region. There is a memorandum of understanding (MoU) between the state and universities on how they can work together. One example is the efforts within the Research Triangle Park. Academia has been important to the park from its beginning and is the core of RTP. Faculty at the three universities actively recruited new companies to the park at the start. In 1974, the Triangle Universities Center for Advanced Studies (TUCASI) was formed. TUCASI's purpose is "*to assist in and facilitate the planning and execution of non-profit research and educational programs that utilize and enhance the productivity of the intellectual and physical resources of the University of North Carolina at Chapel Hill, Duke University, and North Carolina State University*"[60]. The RTP Foundation that administrates TUCASI has set aside part of the land at RTP for a TUCASI campus where park scientists and university faculty can meet. Today, there are four organizations at this campus: The National Humanities Center, MCNC (initially Microelectronics Center of North Carolina), the North Carolina Biotechnology Center, the National Institute of Statistical Sciences, and the Burroughs Wellcome Fund.[61]

According to the Foundation, the universities work very well together. However, they do compete for students even though with somewhat different attractions and competences. Also, state universities like NC State and UNC compete for state funding.

Just like the companies view the universities as crucial, the universities consider RTP companies as very important. Companies are regarded as a prime source for jobs for their graduates, internships for students and training for faculty. In addition, RTP companies are seen by the universities as an important source for visiting faculty/lectures, endowments, and research funding.[62]

---

[57] *Hardin (2008) Pathways to High-tech Valleys and Research Triangles, Chapter 2: North Carolina's Research Triangle Park, Springer.*
[58] *Hardin (2008) Pathways to High-tech Valleys and Research Triangles, Chapter 2: North Carolina's Research Triangle Park, Springer.*
[59] *Hardin (2008) Pathways to High-tech Valleys and Research Triangles, Chapter 2: North Carolina's Research Triangle Park, Springer.*
[60] *Research Triangle Park: Evolution and Renaissance, The Research Triangle Foundation, June 2006.*
[61] *Hardin (2008) Pathways to High-tech Valleys and Research Triangles, Chapter 2: North Carolina's Research Triangle Park, Springer.*
[62] *Hardin (2008) Pathways to High-tech Valleys and Research Triangles, Chapter 2: North Carolina's Research Triangle Park, Springer.*

Centennial Campus/ NC State University

The Centennial Campus is owned by NC State University and was started in the 1980's. The university saw an increase in enrollment and turned to the governor at the time, Jim Hunt. The Governor gave state land to the school to build classroom and laboratories. The purpose was to stimulate economic growth in the region, and companies and government entities were invited to move in. The campus was inspired by the RTP. Today the Centennial Campus has 70 companies, of which Red Hat is the largest with 450 employees. Approximately 40 companies are active within the IT-sector. The campus is committed to diversity and do not focus on a particular sector, but rather believes that diversity, of both size and sector, is needed for the park's sustainability.

Figure 5

Centennial Campus Quick Facts

- Land area 1,344 acres (1,130 Centennial Campus + 21 Centennial Biomedical Campus)
- Tenants 71 corporate and government partners
- Employees 2,070 corporate and government
- Faculty, staff and post-docs 1,350
- University students 3,400
- Middle school students 600
- Housing residents 60
- NC State research Centers, institutes, laboratories and department unit 75
- Students 250 and Faculty 200 involved with Centennial Campus Partners
- Investments in facility and infrastructure 620 million dollars
- Industry Clusters: Advanced Materials, Bioscience/Biotechnology, Information & Communications Technology, Education

Source: NC State University (2008) http://centennial.ncsu.edu/overview/quickFacts.html

In order to be located at the campus, the companies have to interact and cooperate with the NC State University. Centennial Campus does not sell the land to the companies, which is different compared to RTP that sells or leases land to companies and also does not require cooperation with the three universities. Centennial Campus is much smaller in scope. There is no obvious competition with RTP according to Leah Burton at the NC State University between RTP and the Centennial Campus; mainly due to very different missions. Furthermore, there is no formal agreement between RTP and Centennial Campus in terms of cooperation but they will cooperate on an up-coming conference in 2009 (International Science Park Conference 2009).

The majority of the companies has learned about the campus by word of mouth and chooses to locate here due to the possibility of partnership with NC State University and access to its talent pool. Only a minority of the companies are spin-offs from the university. Besides word of mouth, the business development office works with precision marketing and tries to locate companies with an interest in the profiled research that is carried out at the campus.[63]

According to Burton, the main reason for companies to be attracted to the campus is the talent pool. Many students work as interns at the companies, where the companies can

[63] *A complete list of companies at Centennial Campus: centennial.ncsu.edu/directory/corporate.html*

evaluate them, and the students are later often hired and work with projects that the companies sponsor. Senior students receive 5 000 USD plus mentoring time by working on a problem announced by a company in something called a senior program at NC State University. In joint ventures with industry, the results are owned jointly. Should the company sponsor a project at the university, the university owns the rights but the companies can license it. At NC State University, all faculty members are required to disclose any new discoveries. An intellectual property (IP) committee is reviewing what can be patented and commercialized. If the faculty member has no interest in commercializing his findings, the IP committee calls upon entrepreneurs/companies for commercialization. It is vital to the Centennial Campus that the idea in the minds of the faculty is kept on exploring new ideas, collaboration and innovation.

The Centennial Campus has an incubator with 28 offices and 10 laboratories. Today the incubator is filled and some of the companies receive SBIR awards (se section 5.2 on SBIR). If so, the state of North Carolina matches these grants (see above). In the state, there is also something called "NC Idea Grant", mainly to do "proof of concept". Due to increased number of proposals, these grants have moved from seed stage financing to financing for later in the development.

NC State University is a public university and receives state funding. The campus is self-sustaining. Money received from developing (buildings and leasing) are put in a trust fund to be used for infrastructure. In addition, NC State University receives research funding and is among the top five public universities in terms of receiving industry funding. The university receives only small amounts of federal funding.

There are several research centers on the campus; one is the Center for Advanced Computing and Commercialization. Companies join the center as members for 15 000 USD per year. They are then entitled to vote two times a year on research proposals, the results of which they can benefit from. The center was started with federal funding from NSF. Another center example is the Secure Open System Institute. This institute was also started by federal funding and the facility given to the institute by Red Hat. The institute is focusing on open source security.

Success factors according to Centennial Campus representatives

- Focus on collaboration
    - The campus collaboration with the university is the key and differentiates it from other parks. Many of the companies that do join the campus decide to stay and grow. This is not the fastest model to expand, but the campus has no pressure to grow quickly.
- Community involvement.
    - The campus starts many projects within the community. Sometimes the projects fail but the mentality is that not everything has to be perfect the first time. The campus learns and gets better as it goes along.
- Recruitment and Retention
    - An important factor is talent. Companies that are located within the companies are offered many of the same benefits as the students at the university, which is a great incentive.

4.7.4 Company views

Red Hat – a "small" North Carolinian company at the Centennial Campus

Red Hat was established in 1993 by Mark Ewing and Bob Young. Mark Ewing was a student at a university in North Carolina and developed the software. Mark was a "computer geek" and knew more about computers than any other person at his university. Whenever other students had computer problems, they were directed to the guy in a red baseball hat, Mark; therefore the name "Red Hat".

Red Hat has been profitable since 2003, and has grown steadily in both people and number of offices. The company headquarter is at the Centennial Campus in Raleigh, but Red Hat has offices worldwide. There are currently 2 200 employees. Today, 50 percent of its revenue comes from the U.S. market, and the company believes the future growth is stronger outside the U.S.

The core business is open source software, built on Linux. The company revenue comes from subscriptions that large enterprises have with Red Hat for business critical software based on Linux that Red Hat has tested and certified. The company uses customer driven innovation with a system called Fadora, which opens new software products to the public, who in turn uses it, reports errors and thus minimizes the bugs. They rarely buy ideas from the outside, but sometimes acquire companies.

The company's success is based on its understanding of the customers according to company representatives. The excellent innovation comes from the fact that many of the best Linux "geeks" works at Red Hat According to the company, Red Hat has seven out of the top ten Linux developers as employees. The founder Mark Ewing is a legend within Linux development ("rock star in Linux"), which has enabled the company to attract great talent.

Red Hat has located to North Carolina because "it is good to do business here". Most of the office locations are close to universities; a second office is in Massachusetts because of the proximity to MIT and Harvard, a third in California, another in India because of the Indian Institutes of Technology (IIT) etc. The benefit of being a part of the Centennial Campus is the access to great talent. However, many employees are recruited from universities all over the world where the company proactively visits universities and markets itself. At Centennial Campus the company offers internship programs. Access to the university is also granted them by having adjunct professors on staff. Red Hat does not believe in software patents and does not hold many patents except for some with a defensive purpose. IPR issues are therefore not problematic in its relationship with the university.

Red Hat's advice to local government includes building a healthy ecosystem with a competitive tax situation, strong education system, support of labor, interest in public education (primary, secondary and university). North Carolina does this right according to Red Hat.

Cisco – a large Californian company at the Research Triangle Park

Cisco has been located in the RTP for 10–15 years. The reason that Cisco decided to locate at the park was simply that IBM was here. Jokingly, the purpose was to "steal IBM's engineers". The company soon realized the role of the university. Other companies like Nortel were also here, creating a critical mass of tech people. There is also an ecosystem of small companies at RTP that do a lot of design, which benefits the larger companies.

Cisco's innovation strategy includes what they call "Core vs. Context":

- Core – what we do to create value.
- Context – around the core, outsourcing a lot of context, manufacturing and simple design.

Cisco spends 4.2 billion USD on R&D per year of which the vast majority is development (lifecycle of products are only 18 months). Research is kept within Cisco. Research is mostly in software and the company has started to work with "open source". Some parts of software the company does give out for free. However, Cisco is very protective, and would never open up the source code for their routers. The company plans to put routers on Linux in the future.

Cisco innovates by partnering and collaborating or buying companies. If Cisco is buying a company, it is seen as vital to retain the employees, which is done by stock options (locked in for a period of five years). In total Cisco employs around 20 000 engineers and is working hard to keep them innovative. According to a deployment model, engineers start in the "invent" zone with a project and often follows it all the way to the "offload zone". Cisco has started to pressure team leaders to let go off engineers that are in the offload zone, also push engineers to find another project at Cisco within 90 days. The low performing bottom 5 percent engineers get pushed out in the annual evaluation procedure. The company hires people into the invent zone and would like to keep them there. Everybody within Cisco changes job position in approximately 2–3 years.

Cisco was started by two professors at Stanford University and has always had a good relationship with academic institutions. The company hires engineers from NC State University and recruits many interns and support students. It is involved in a formal program with the surrounding universities for research projects and invests several million USD. However, for tax reasons, Cisco has to donate money without dictating the exact field of study as it otherwise would be contract research and not deductible. The collaborative research is general in nature; for instance research on new communications protocols that may become a standard.

Ideas that can be patented are explored internally. If an employee finds a patentable idea, he/she will receive 5 000 USD, and if patented, the employee will receive yet another bonus.

A large and complicated issue for Cisco is Intellectual Property Rights and the company works actively through lobbying to influence on the legislation. However, IPR is a federal issue and Cisco therefore seldom applies for federal grants. Instead, the company relies on smaller companies getting federal grants for discoveries that Cisco later may benefit from. Reductions in federal investments in R&D thus affect Cisco indirectly.

All new company products are used internally before they reach the market. Recently, Cisco developed its own video conferencing system, "TelePresence", a new product type for internal use. It has proven so successful that it will now be sold on the external market. Telecom conferencing is a new business sector for Cisco which will be part of the future. Communication at Cisco is mainly done by video and internal websites, besides email.

Another trend is "collaboration" which brings challenges such as sharing and security issues – it is complicated to let people into closed networks. The complexity has generated a new business area for Cisco – security products, but also tools and networks that enable collaboration.

Cisco has less employee turnover at RTP than at any other Cisco location. The RTP region is relatively family oriented and the cost of living is low which may be part of the explanation. Cisco is however missing the attractions of a large city and they see that many young graduates want to go to the Cisco office in San Jose. However, many of them return to RTP.

Cisco would like to see the state help financing a better broadband at RTP. It does exist but not at the capacity that the companies need. Better broadband would facilitate communication with other companies in RTP and enable more virtual meetings.

4.7.5 Conclusions

The key success factors for RTP seem to be a decisive state and regional leadership, a collaborative spirit with stakeholders from government, industry and academia, a strong higher educational system and a good quality of life. Other important policy measures are the tax system, substantial investments in education and favorable conditions for the "ecosystem" of venture capital. It is furthermore crucial to facilitate the life for entrepreneurs. The universities in North Carolina are among the best when it comes to entrepreneurship and spin outs, as faculty members are strongly encouraged to work with industry to commercialize research.

One example of how RTP's success was founded was an insightful leadership at the time that understood that marketing would be key. A catalogue of the aggregated competences and research areas from the three universities was compiled and then used when marketing the region.

Some of the challenges for RTP are keeping a sustainable growth without too many of the nuisances of a the urban areas, how to come winning out of the war for talent and attract a younger and "creative" workforce, and how to create a critical mass of employment opportunities so that people can move to the region with the prospect of getting different interesting job positions.

5 Initiatives to improve innovation and innovation capacity

In this chapter we describe a particularly interesting example of open innovation between Intel and a number of universities. The chapter also describes a number of federal initiatives and agencies that are of importance for IT-research and innovation. Finally, we describe two government initiatives of special interest – e-health and e-government.

5.1 Intel research labs (lablets) –An interesting example of open innovation

Representatives for the National Science Foundation (NSF) and other organizations point out the Intel "lablet initiative" that was briefly described in section 2.2 as being particularly successful and interesting and we have therefore looked at these specifically. In 2002 Intel established small research labs (lablets) at a number of universities. At the lablet, which consists of up to 50 scientists and engineers, explorative research is made by university and Intel scientists in collaboration. The staff consists of researchers and students from both the university and the company and the lablet is led by a senior scientist from the university (who is on leave from his/her ordinary position). Usually the head of the lablet will be in the position for 2–3 years before returning to his/her normal position. Graduate students are often sponsored by Intel.

The most interesting aspect of these labs is most likely the fact that ideas are allowed to flow freely within the university-company collaboration and that much of the results are published openly. This has been made possible by an open collaborative agreement. Projects in the lablets are funded on a milestone basis, reviewed quarterly and are seen as an important link between "pure" university research and proprietary internal research projects.

The Intel website gives the following listing for the lablet research[64] areas:

Berkeley Lab
Networks as databases & technology for developing regions, Sensor Networks, Internet-Scale Services, IT for Developing Regions.

Israel, Haifa and Jerusalem Lab
Bio Sensors, Intelligent Grid Management, Vision systems: Object class recognition and detection, DPR Catom Fabrication.

Pittsburgh Lab
Software for widely distributed systems, Internet Suspend Resume, Diamond, Open DHT.

Seattle Lab
New usage models for ubiquitous computing, Digital Home, Healthcare, Activity Inferencing, Location.

[64] *http://techresearch.intel.com/articles/Exploratory/1504.htm*

Santa Clara Lab
I-Wireless, Integrated Biosystems Lab, Every Day Sensing and Perception, Dynamic Composable Computing.

5.2 Federal research and innovation

The American Competitiveness Initiative (ACI)

In the past few years, several reports on the future of U.S. competitiveness have been published. The most attention came to *Raising Above the Gathering Storm* by the National Academy of Sciences (2005), a Congress initiated report, and *Innovative America* by the Council on Competitiveness (2004). As a response to the debate, President Bush announced a new initiative – The American Competitiveness Initiative (ACI), in his State of the Union 2006. The President stated that *"Federal investment in R&D has proven critical to keeping America's economy strong by generating knowledge and tools needed to develop new technologies"*[65]. The initiative was created *"to encourage American innovation and strengthen our nation's ability to compete in the global economy"*.[66] In short, the President committed to doubling investments over 10 years for agencies that support basic research in mathematics, physical sciences and engineering. The agencies that would benefit from the doubling are the National Science Foundation (NSF), Department of Energy's Office of Science (DoE SC), and National Institute of Standards and Technology (NIST). In addition, ACI supports universities that have word-class education and research opportunities, and encourages additional private investments in innovation by creating favorable business and innovation environments and more.

With the initiative, the President has committed to allocating 50 billion USD of new funding for NSF, DoE SC and NIST. Also, the President wants to make the Research and Experimentation (R&E) Federal Tax Credit permanent. This would require 86 billion USD over ten years. A permanent tax credit would enable the companies to have certainty in their tax planning and be bolder in R&D investments.[67] Furthermore, ACI proposed 380 million USD in new federal support for math, science and technology education in K-12 schools[68] and the establishment of new programs in education such as professional development for teachers, and adjunct teacher corps program.

ACI received widespread support from the Congress through the America COMPETES Act and other bills. However, problems with funding later surfaced (see below).

The America COMPETES Act

As mentioned above, ACI in turn led to the *Americas COMPETES Act*, passed by the House and Senate and signed by the President in August 2007. However, funding to support this law fell short in the FY 2008 budget and it is currently uncertain if funds will be available for 2009.[69]

[65] *White House news release "State of the Union: American Competitiveness Initiative", January 31, 2006.*
[66] *White House news release "State of the Union: American Competitiveness Initiative", January 31, 2006.*
[67] *White House (2006) American Competitiveness Initiative.*
[68] *K-12 is the abbreviation for the school system from kindergarten to Grade 12.*
[69] *AAAS (2007) Report XXXII Research & Development FY 2008.*

The COMPETES Act is one of the latest innovation and competitiveness efforts in the federal government and is set to invest in long-term science and research and short-term technology development and innovation. Probably the most important part is a doubling of the funding of three physical sciences agencies over ten years. These are NSF, DoE SC, and NIST (similar to ACI). The Act also supports education in math and science to secure a leading pool of engineers and scientists.

The COMPETES Act does not explicitly mention investments and initiatives in information technology, but increased funding in the above mentioned agencies will benefit the IT-sector due to the widespread importance of IT within the targeted areas and agencies.

NSF, DoE and NIST's IT R&D FY 2009 budgets would increase by 17 percent, 13.4 percent and 8.1 percent respectively compared to the FY 2008. For example, NSF has requested increased funding for its Computer and Information Science and Engineering (CISE) division in the FY 2009 budget (From 535 (2008) to 639 million USD). NSF also requested increased funding for its engineering program, including electrical communication and cyber systems; likewise for its Office of Cyber infrastructure.[70]

Another example which is part of the COMPETES Act is the new program to be managed by NIST, the Technology Innovation Program (TIP). TIP was established to stimulate high-risk projects between academia and industry (see below) and replaced the former Advanced Technology Program (ATP). In addition, those agencies and department mentioned in the COMPETES Act are also involved in IT-research through the Networking and Information Technology Research and Development Program (NITRD).

Networking and Information Technology Research and Development Program (NITRD)[71]

The High-Performance Computing Act of 1991 and the Next Generation Internet Act of 1998 are the basis for the NITRD program (see figure below). These two legislations have authorized federal agencies to act together within networking and information technology research and development. Today, the program involves 13 agencies – among them are National Science Foundation (NSF), Office of the Secretary of Defense/Department of Defense (OSD/DoD), National Institutes of Health (NIH), Defense Advanced Research Project Agency (DARPA) and Department of Energy (DoE), being the top five agencies of the 13 in terms of budget requests for research programs within the eight program component areas (see figure below).

NSF's requests constitute approximately one third of the budget. The total budget request for FY 2008 estimated approximately three billion USD. A third of the budget was requested for the program area of High-End Computing Infrastructure and Applications (mainly within NSF, OSD/DoD, and DOE/SC). The second largest program area within NITRD in terms of budget request is the Human-Computer Interaction and Information Management program (767.3 million USD) while the third largest is the Large Scale Networking program (416.5 million USD).[72] The budget request for FY 2009 would be an increase of 6.2 percent compared to 2008.

[70] *AAAS (2008) Report XXXII Research & Development FY 2009.*
[71] *For an overview of US R&D investments in IT including the NITRD, see ITPS (2008), Chapter 4.*
[72] *PCAST (2007) Leadership Under Challenge: Information Technology R&D in a Competitive World, An assessment of he Federal Networking and Information Technology R&D Program.*

Figure 6

The NITRD Program

The NITRD Program provides a framework and mechanisms for Federal agencies to set goals and coordinate their activities in NIT R&D. The Program has 13 member agencies with an annual aggregate budget of NITRD investments that now exceeds $3 billion. The goals of the NITRD Program are to:

- Provide research and development foundations for assuring continued U.S. technological leadership in advanced networking, computing systems, software, and associated information technologies
- Provide research and development foundations for meeting the needs of the Federal government for advanced networking, computing systems, software, and associated information technologies
- Accelerate development and deployment of these technologies to maintain world leadership in science and technology; enhance national defense and national and homeland security; improve U.S. productivity and competitiveness and promote long-term economic growth; improve the health of the U.S. citizenry; protect the environment; improve education, training, and lifelong learning; and improve the quality of life.

The Program comprises eight subject-based Program Component Areas:

- High End Computing Infrastructure and Applications (HEC I&A)
- High End Computing Research and Development (HEC R&D)
- Cyber Security and Information Assurance (CSIA)
- Human-Computer Interaction and Information Management (HCI&IM)
- Large Scale Networking (LSN)
- High Confidence Software and Systems (HCSS)
- Social, Economic, and Workforce Implications of IT and IT Workforce Development (SEW)
- Software Design and Productivity (SDP)

Source: Leadership under Challenge: Information Technology R&D in a Competitive World (PCAST 2007).

In 2007, the President's Council of Advisors on Science and Technology (PCAST)[73] published an assessment of the NITRD program. In short, PCAST concluded that so far, the program has been effective but need changes to meet the future need of NIT capabilities. Specifically, PCAST concluded that "the most critical need is to rebalance the NITRD investment portfolio to include more long-term, large-scale, multidisciplinary NIT R&D and more visionary R&D".[74] Furthermore, NIT education, the NIT workforce, the technical areas, the rate of tech transfer, and the planning and assessment process all need changes. Concerning NIT education and securing a NIT workforce, the report proposed that the federal government should ease the visa process for non-us students admitted to accredited graduate degree programs in NIT areas. The report also recommends to make it a routine for foreign nationals after graduating with a NIT degree at a U.S. university to be allowed to work and gain citizenship in the U.S.

Furthermore, PCAST recommends increased investments in the following areas: NIT systems connected with the physical world, software, digital data, and networking. The Federal Plan for Advanced Networking Research and Development, expected in late 2008, was also endorsed by PCAST. Finally, the report stressed the importance of continued support for: High-End Computing (HEC), Cyber Security and Information assurance

[73] *PCAST was established by President Bush in 2001, and it functions as an advisory body on matters concerning science and technology policy. The Council consists of 34 council members from industry, academia, and other non-governmental organizations. (http://www.ostp.gov/cs/pcast)*

[74] *Leadership under Challenge: Information Technology R&D in a Competitive World (PCAST 2007).*

(CSIA), Human-Computer Interaction (HCI) and, NIT and Social Sciences.[75] Few adjustments based on the recommendations have so far been seen as a result of this report.

Technology Innovation Program (TIP)

The Technology Innovation Program was created by the America Competes Act and is managed by NIST. TIP, as mentioned previously, replaced the Advanced Technology Program (ATP). The program was established "to support, promote, and accelerate innovation in the United States through high-risk, high-reward research in areas of critical national need"[76]. Defining these areas of critical national needs is still a work in progress. At a recent (May 2008) workshop, organized by the National Academies, discussions focused on potential such areas presented so far; infrastructure, energy, manufacturing, water, communications, complex networks and personalized medicine. Opportunities within information technologies were one of the topics and cyber security, multicore computing, and sensors were among other needs discussed.[77]

TIP received 65 million USD for FY 2008[78]. However, as of today, no awards have yet been granted. NIST hopes to issue the first awards by end of September 2008.[79] Funding can be issued to industry (small and medium-sized companies), universities, and consortia. Large companies can not receive funding but they may participate in a project funded by TIP. The research should be transformative and of high-risk in NIST's area of technical competence and awards will be made on the basis of merit competitions. Awards are to be limited to three million USD over a period of three years for a single company project, and limited to 9 million USD over a period of five years for a joint venture. TIP should not provide funding for more than 50 percent of the total cost of a project. In addition, TIP will continue the support of awards granted under the Advanced Technology Program (ATP was run by NIST, but cancelled and replaced by TIP in the Americas COMPETES Act).[80]

NIST requested 638 million USD for FY 2009 (FY 2008 = 755.8 million USD). However, no funds for TIP were requested. According to its Director, in setting the budget NIST prioritized its core program, which was disappointing to the U.S. Congress.[81] The President has tried before to eliminate TIP, but the U.S. Congress has saved it, and will most likely try to do the same at this year's appropriations season.[82]

---

[75] *PCAST (2007) Leadership Under Challenge: Information Technology R&D in a Competitive World, An assessment of he Federal Networking and Information Technology R&D Program.*
[76] *Public Law 110-69, SEC. 3012 Technology Innovation Program, Aug 9, 2007.*
[77] *The National Academies, Symposium: Critical national Needs in New Technologies: Opportunities for the Technology Innovation Program, April 24, 2008.*
[78] *Jackson (2008) House questions NIST budget priorities, Government Computer News, March 12, 2008.*
[79] *Marc Stanley, Director of TIP, NIST, Presentation at the National Academies, Symposium: Critical national Needs in New Technologies: Opportunities for the Technology Innovation Program, April 24, 2008.*
[80] *NIST, www.nist.gov/tip, February 2008.*
[81] *Jackson (2008) House questions NIST budget priorities, Government Computer News, March 12, 2008.*
[82] *AAAS (2008) Report XXXII Research & Development FY 2009.*

Small Business Innovation Research Program SBIR/Small Business Technology Transfer Program STTR

SBIR and STTR are programs that are administered under the U.S. Small Business Administration (SBA). SBIR was enacted in 1982 as part of the Small Business Innovation Development Act. The program is a competitive program that invests in small businesses so that entrepreneurs can invest in R&D. It funds the startup and development stages and encourages commercialization. SBA coordinates the program, but the program is carried out by eleven federal departments and agencies. These federal agencies all have extramural R&D budgets in excess of 100 million USD, and are required by SBIR legislation to set aside 2.5 percent of their extramural R&D funds for SBIR. The eleven agencies and departments are: Department of Agriculture, Department of Commerce, Department of Defense (DoD), Department of Education, Department of Energy, Department of Health and Human Services (HHS), Department of Homeland Security, Department of Transportation, Environmental Protection Agency, National Aeronautics and Space Administration, and National Science Foundation. Five agencies administer 96 percent of the SBIR funds; DoD and HHS (incl. NIH) are the two major granting agencies.[83]

Proposals for a SBIR award are submitted to respective agency/department, after they choose R&D topics. Based on small business qualification, degree of innovation, technical merit, and future market potential, the proposals are then accepted. Companies that receive a SBIR award start a three-phase program. The third phase is not funded by SBIR, but requires private investors or other federal funding.

Statistics available for SBIR awards are from 2004. In 2004 6 348 SBIR grants were awarded for a total of approximately 2 billion USD. Small businesses in Texas received 293 awards and small businesses in North Carolina 108 awards, which place Texas as the seventh state and North Carolinas as the 20th state in state rankings. More awards are given each year to phase I than phase II. However, since the phase II awards are larger, more money is invested in phase II.[84] STTR is somewhat similar in nature to SBIR. The significant feature of the STTR program is the expansion of the public/private sector partnership to include the joint venture opportunities for small companies and nonprofit research institutions. Assistance from laboratory to marketplace is in focus. Five federal department/agencies announce R&D topics and award proposals. These five are: Department of Defense, Department of Energy, Department of Health and Human Services, National Aeronautics and Space Administration, and National Science Foundation.

Statistics available for STTR awards are also from 2004. In 2004, 842 STTR grants were awarded for a total of approximately 200 million USD. Small businesses in Texas received 45 awards and small businesses in North Carolina 17 awards, which place Texas as the fifth state and North Carolinas as the 14th state in state rankings. There is a similar ratio between phase I and phase II awards in the STTR program as in the SBIR program.[85]

SBIR and STTR have been evaluated a number of times and the common opinion is that they are effective federal programs. In a recent report, *An Assessment of the Small Business*

[83] *Wessner (2008) An Assessment of the Small Business Innovation Research Program by NRC, NAS.*
[84] *SBA (2008) SBIR Awards and Statistics, www.sba.gov/SBIR/indexsbir-sttr.html*
[85] *SBA (2008) SBIR Awards and Statistics, www.sba.gov/SBIR/indexsbir-sttr.html*

Innovation Research Program, the National Research Council[86] concludes that *"the SBIR program is sound in concept and effective in practice. It can also be improved"*. The assessment found that the SBIR program is *"stimulating technological innovation, linking universities to the public and private markets, increasing private sector commercialization of innovations, using small business to meet federal research and development needs, providing widely distributed support for innovation activity; and fostering participation by minority and disadvantaged persons in technological innovation"*. The report made several recommendations; one was to conduct regular evaluations of the program, another to help bridge the "valley of death" between phase II and phase III by working with prime contractors. [87]

Advanced Research Projects Agency – Energy (ARPA-E)

The America COMPETES Act established ARPA-E within the U.S. Department of Energy. ARPA-E is modeled by and similar to the DARPA program (called ARPA before and led to the development of Internet). This was part of the recommendations from the National Academy of Sciences' report "Raising above the gathering storm". ARPA-E's mission is to pull together cross-disciplinary research teams focused on the nation's urgent energy need.[88]

5.3 National Science Foundation (NSF)

At the National Science Foundation, the Directorate for Computer and Information Science and Engineering (CISE) is the IT-arm. NSF does not operate any labs or institutes on its own, but finances research through grants to different organizations all over the U.S. in different sectors. The directorate has the following goals:

- To enable the U.S. to uphold a position of world leadership in computing, communications, information science and engineering;
- To promote understanding of the principles and uses of advanced computing, communications and information systems in service to society;
- To contribute to universal, transparent and affordable participation in an information-based society.

CISE supports research in all areas of computer and information science and engineering, helps develop and maintain cutting-edge national computing and information infrastructure for research and education and is engaged in education and training efforts. To get an idea of current NSF priorities it is often useful to study current funding schemes[89]. It should however always be remembered that NSF primarily is a "bottom-up" organization that largely funds researcher-initiated research in wide scientific areas.

---

[86] National Research Council was asked by the U.S. Congress to evaluate the SBIR program when the program was reaching its 20th anniversary. This assessment report is one of a series published as a response to the U.S. Congress' request.

[87] Wessner (2008) An Assessment of the Small Business Innovation Research Program by NRC, NAS.

[88] US House of Representatives, Committee on Science and Technology, "Establishing the Advanced Research Projects Agency-Energy (ARPA-E) Act, Legislative Highlights: January 10, 2007.

[89] For a current listing see http://www.nsf.gov/funding/pgm_list.jsp?org=CISE

CISE is organized in three divisions:

- Division of Computing & Communication Foundations (CCF)
- Division of Computer and Network Systems (CNS)
- Division of Information and Intelligent Systems (IIS).

Figure 7 NSF CISE budget 2008[90].

Computer and Information Science and Engineering Funding
(Dollars in Millions)

	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Request Amount	Percent
Computing and Communication Foundations (CCF)	$105.30	$122.82	$149.15	$26.33	21.4%
Computer and Network Systems (CNS)	141.07	162.98	191.98	29.00	17.8%
Information and Intelligent Systems (IIS)	103.78	119.30	154.63	35.33	29.6%
Information Technology Research (ITR)	146.20	121.59	78.24	-43.35	-35.7%
Total, CISE	$496.35	$526.69	$574.00	$47.31	9.0%

Totals may not add due to rounding.

The CISE division of NSF has a budget of over 527 million USD and hands out 86 percent of all federal funding for computer science research. Many different initiatives exist including some that are new for 2008. These are: CreativeIT, Cyber-Enabled Discovery and Innovation (CDI), Expeditions in Computing, Foundations of Data and Visual Analytics, and Software for Real-World Systems. Below we have described a few of NSF's most important current initiatives.

5.3.1 Collaborative efforts between IBM, Google and NSF

An important new private-public initiative is the new partnership between the National Science Foundation, Google and IBM.[91] In this collaboration academic researchers and students will get access to new resources including large scale cluster computing facilities with more than 1 600 parallel processors. This will enable academic scientists to pursue exploratory data intensive research using internet-scale computing. The effort will according to NSF help to bridge the gap between the industry and academia. The role of NSF will to a large degree be to issue proposal calls and select which research proposal that shall get access to the resources.

Related to the above, in October 2007 Google and IBM announced their collaboration.[92] The two companies will collaborate to promote new software development methods to help students and researchers to respond to the challenges of future Internet-scale applications. For web software such as search, social networking and mobile commerce to run fast enough, the computational tasks may often need to be broken down into a large number of smaller pieces that are processed in parallel. The initiative aims to improve computer science students' knowledge of advanced parallel computing. IBM will support hardware,

[90] *www.nsf.gov/about/budget/fy2008/pdf/19_fy2008.pdf*
[91] *www.nsf.gov/news/news_summ.jsp?cntn_id=111186*
[92] *www.google.com/intl/en/press/pressrel/20071008_ibm_univ.html*

services and software to augment university curricula and research. Universities that have joined the initiative include the University of Washington, Carnegie Mellon University, Massachusetts Institute of Technology, Stanford University, The University of California at Berkeley and the University of Maryland. The system will be accessed over the Internet and the servers will run open server software including Linux and XEN system virtualization as well Apache's Hadoop project, which is an open source implementation of Google's published computing infrastructure.

5.3.2 NSF supports TeraGrid computing in Tennessee

NSF has recently awarded 65 million USD in a grant to the University of Tennessee (Knoxville) to develop a state of the art supercomputer, "the Kraken".[93] The computer will enhance the computational power of the TeraGrid which, according to NSF, is the world's largest, most powerful and comprehensive distributed cyberinfrastructure for open scientific research.

5.4 Defense Advance Research Project Agency (DARPA)

The proposed 2009 Research and Development budget for the Department of Defense amounts to 80 668 million USD (2008: 77 782 USD). However, Science and Technology is proposed to receive 11 669 million USD compared to 13 215 million USD in 2008. The Defense Advance Research Project Agency (DARPA) is of special importance as the agency has been closely linked to development in the ICT-sector. Not least is it known for its involvement in the development of the personal computer and the Internet.

Information technology is part of many projects at DARPA and it is therefore difficult to assess the total expenditures within the area. However, DARPA's total budget for research, development, and testing is 2 959 million USD for 2008 and the appropriations indicate an increase to 3 286 million USD in 2009. The DARPA part of the NITRD program (FY2009 budget) is planned to be 570 of a total of 3 500 million USD.[94]

According to DARPA,[95] DoD is undergoing a "transformation within network-centric operations – to turn information superiority into combat power". DARPA's information technology programs are "*built on traditional and revolutionary computing environments to provide the kind of secure, robust, efficient, and versatile computing foundation that they believe the network-centric future requires*". DARPA plans[96] to create new computing capabilities for their forces. One of the key areas in information technology is embedded systems – special purpose computer systems contained in devices, enabling advanced functionality. According to DARPA, embedded computing is critical across a broad range of military applications.

Among present DARPA projects connected to the IT-sector are:

- **Networks**: self-forming, robust, self-defending networks at the strategic and tactical level are important to network-centric warfare.
- **Chip-Scale Atomic Clock**: miniaturizing an atomic clock to fit on a chip to provide accurate time as required, for example, in network communications.

[93] *www.nsf.gov/news/news_summ.jsp?cntn_id=111367&org=NSF&from=news*
[94] *www.nitrd.gov/pubs/2009supplement/NITRD-09Supp_FINAL-budget.pdf*
[95] *www.darpa.mil/body/news/2007/2007StrategicPlan.pdf*
[96] *www.darpa.mil/body/news/2007/2007StrategicPlan.pdf*

- **Air Vehicles**: unmanned air vehicles that quickly can arrive at their mission station and can loiter there for very long periods.
- **Space**: The U.S. military's ability to use space is one of its major strategic advantages. DARPA works to ensure the United States maintains that defense advantage.
- **High Productivity Computing Systems**: supercomputers are fundamental to many military operations such as weather forecasting, cryptography and design of new weapons; DARPA is working to maintain the U.S. lead in this technology.
- **Real-Time Accurate Language Translation**: real-time machine language translation of structured and unstructured text and speech with near-expert human translation accuracy.
- **Prosthetics**: developing prosthetics that can be controlled and perceived by the brain.
- **Quantum Information Science**: exploiting quantum phenomena in the fields of computing, cryptography, and communications, with the promise of opening new frontiers.

Among current strategy thrusts are "Robust, Secure Self-forming Networks" aimed at enabling the distribution of large amounts of information quickly and precisely across long distances. The networks are supposed to be able to form, defend and repair themselves and work at very high speeds. Another strategic thrust is the "Increasing the Tooth to Tail Ratio" (Tail=support function, Tooth=operational unit). The main themes within the initiative are:

- **Cognitive Computing** – Reducing manpower by providing computers that "know what they are doing" and that can learn.
- **High Productivity Computing Systems** – Speeding up development and deployment of new weapon systems by more complete and rapid design and testing.
- **Language Processing** – Improving the U.S. global operations by providing local knowledge, and interaction with local populations by removing language and culture barriers through machine language translation, thereby reducing the need for human translators.

5.5 National institute of Standards and Technology (NIST)

National Institute of Standards and Technology (NIST)[97] is an agency within the Department of Commerce and one of the member agencies in the NITRD program. NIST is involved in seven of the eight program component areas of NITRD. The program areas "High Confidence Software and Systems and Cyber Security and Information Assurance" are the two main areas which stand for more than half of the IT budget. The President's request for FY 2009 includes 67.0 million USD for the funding of NIST's participation in the NITRD program, an increase of five million USD over FY 2008. The agency's R&D efforts within IT include making IT-systems more useable, secure, scalable, and interoperable. These efforts are made in close cooperation with industry, educational, and government organizations. Furthermore, NIST works to apply IT to areas such as biotechnology and manufacturing. In addition, NIST works to encourage industry to accelerate develop-

[97] *http://www.itl.nist.gov/*

ment of IT innovations.[98] Much of these IT R&D efforts take place within NIST's Information Technology Laboratory (ITL).

5.6 National Institutes of Health (NIH)

NIH is the largest federal civilian research organization in the U.S. with an annual budget of around 29 billion USD. Modern biomedical research is strongly dependent on IT to create research tools and to manage data. In addition, the new large biomedical informatics databases, high throughput screening centers and national centers for technical development that are being built up need a strong IT infrastructure. NIH is one of the leading agencies within the NITRD program and contributes with approximately 14.4 percent [99](509.6 million USD) of the requested budget for 2009. The sub-areas that NIH contributes most to are "High End Computing Infrastructure and Applications" and "Human-Computer Interaction and information Management". The NIH Roadmap is a plan that contains a number of initiatives deemed to be of special national importance. Among these are a number of programs within computational biology, structural biology, nanomedicine and clinical sciences that requires very large IT resources.[100] The Center for Information technology (CIT)[101] is NIH office for IT efforts and resources.

5.7 Department of Homeland Security (DHS)

The Department of Homeland Security (DHS) works to protect the United States against many types of threats. The Homeland Security Advanced Research Project Agency (HSARPA) engages industry, academia, government, and other sectors in innovative research and development, rapid prototyping, and technology transfer to meet the needs of the agency. DHS collaborates with universities on a variety of threats including agricultural, chemical, biological, nuclear and radiological, explosive and cyber terrorism, as well as the behavioral aspects of terrorism.

The University Affiliate Centers to the Institute for Discrete Sciences (IDS) are led by Rutgers University, the University of Southern California, the University of Illinois at Urbana-Champaign and the University of Pittsburgh. The universities collaborate with IDS, based at Lawrence Livermore National Laboratory, to conduct research on advanced methods for information analysis and the development of computational technologies.

5.8 E-government

5.8.1 Overall picture

E-government concerns the use of IT and in particular Internet technologies to make the government's communications less bureaucratic, more efficient and more user-friendly. E-government may concern both intra-governmental communications for instance in between different departments, communications between the public sector and citizens, and communications between the public sector and businesses. It should be noted that e-government initiatives are important on both federal and state levels.

In 2001, President Bush initiated several government reforms that were known as the President´s Management Agenda (PMA), to make the government more efficient and

[98] *AAAS REPORT XXXIII RESEARCH AND DEVELOPMENT FY 2009.*
[99] *http://www.nitrd.gov/pubs/2009supplement/NITRD-09Supp_FINAL-budget.pdf*
[100] *http://nihroadmap.nih.gov/grants/relatedactivities.asp*
[101] *http://www.cit.nih.gov/*

citizen-oriented. One of the elements was to expand the "electronic government". The federal government took a two-pronged approach by attempting to modernize IT investments within agencies and by integrating IT investments across agencies. The Congress recognized the importance of e-government with the e-government act of 2002 which was signed into law by the President during the same year. In 2001, the e-government task force called the "Quicksilver Task Force" was formed to identify e-government initiatives and unresolved e-government challenges.

The e-government initiative taken in the 2003 budget included parts such as:

- FirstGov.gov – Government services,
- To enable 60 percent of taxpayers to file their taxes for free electronically,
- GovBenefits.gov – Access to more than 400 government benefit programs,
- Regulations.gov – Enable finding, reading and commenting proposed regulations,
- GoLearn.gov – Provides affordable training primarily for government employees,
- E-Payroll – Consolidation of payroll processing centers,
- Department of Veterans affairs (VA) and Department of Defense (DOD) integration of online patient medical records,
- Department of Education (ED) transactions with the public electronically,
- BusinessLaw.gov – Provides small businesses access to legal and regulatory information, compliance and assistance tools and the possibility to do online transactions.

Another initiative is fedbizopps.gov (www.fbo.gov) which is a central website for public procurement.

It should be made clear that the above initiatives only constitute a part of the total. The extensive list of initiatives and the work leading up to the plan formed in 2003 will not be described here but can be found in the US e-gov strategy (2003).[102]

In the budget proposal for 2009, the President has allocated approximately 71 billion USD for investments in IT (+3.8 % from 2008) in total. From the budget proposal it is clear that IT security is a prioritized area (6.8 billion USD, 2009) as it is suggested to receive a 68 percent increase in funding compared to 2008. 2008 also marks the first time that an official federal document, in this case the 2009 budget proposal, was electronically submitted from the executive to the legislative branch.

5.8.2 Department of the Interior (DOI)

Out of 24 e-government initiatives identified in 2003, ten are managed by the Department of the Interior (DOI).[103] DOI is presently actively involved in 20 of the initiatives. The DOI is therefore a very important player in the federal investments of e-gov services and has recently formulated an e-government strategy for the period 2008–2013 (The previous one was for 2004–2008). In total DOI has a one billion USD e-gov/IT investment portfolio. The e-gov strategy goals are supported by other programs such as: Enterprise Architecture,

[102] *The website www.whitehouse.gov/omb/egov/ is the homepage for the federal investments in e-government.*
[103] *www.doi.gov/e-government/index.html*

IT Security, Enterprise Infrastructure, e-gov initiatives, IT Investment management, Information and Records Management and IT workforce.

The 20 e-gov initiatives that DOI is involved in are:

- E-Authentication (General Services Administration, GSA)

Government to citizen:

- Recreation One-Stop (DOI)
- GovBenefits.gov
- USA Services

Government to Businesses:

- Federal Asset Sales (GSA)
- E-Rulemaking (Environment Protection Agency, EPA)
- Business Gateway (SBA)

Government to Government:

- Geospatial One-Stop (DOI)
- Disaster Management (DHS)
- SAFECOM (DHS)
- Grants.gov (HHS)

Internal Effectiveness and Efficiency:

- E-training (Office of Personnel Management, OPM)
- Recruitment One-Stop (OPM)
- EHRI (OPM)
- E-Clearance (OPM)
- E-Payroll (OPM)
- E-Travel (GSA)
- Integrated Acquisition
- Environment (GSA)
- E-Records Management (National Archives and Records Administration, NARA)

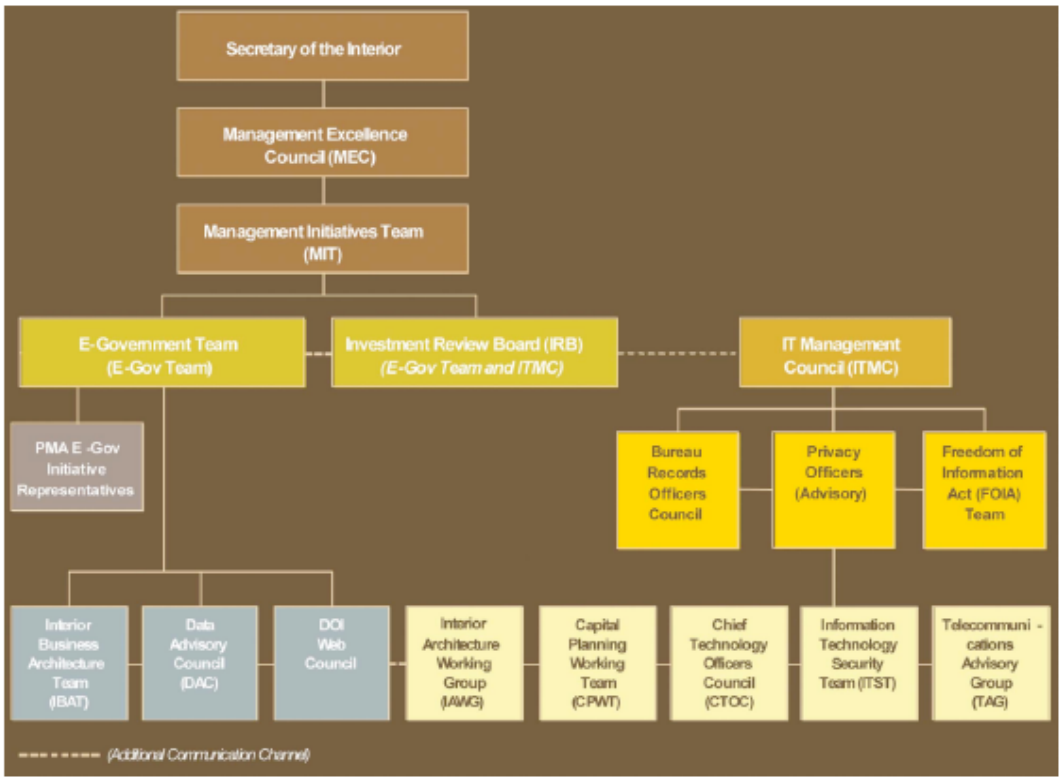
DOI has identified four e-gov "customer-centric objectives" (CCOs) that are aimed at the improvement of e-gov initiatives, the relations with customers, customer satisfaction, the investments delivery of DOI e-gov initiatives and information sharing and reliability. The four CCOs are:

- to promote e-gov customer awareness, engagement and training to strengthen the relation between the DOI mission delivery and e-gov services,

- to achieve a high level of customer satisfaction as a managing partner and shared service provider,
- to improve the management of e-gov investments including customer relationship management,
- to Improve e-gov information sharing and reliability.

Figure 8 shows the e-gov framework that has been implemented at DOI.

Figure 8 DOI e-government framework



Source: DOI.

The DOI Information Technology Strategic plan (2007–2012) identifies IT-focus areas and strategic goals. These include:

- to ensure that private and sensitive information is protected. This includes developing a strategy for identity management,
- to provide a reliable IT infrastructure for e-gov services,
- to improve the Enterprise Architecture,
- to improve the efficiency in e-gov mission delivery, investments, customer relations, information sharing and reliability,
- to institutionalize the management of data needed for emergency alerting and management of emergency incidents,
- to ensure that DOI has an Office of the Management of the Budget (OMB) -approved plan to meet communication requirements during and after a disaster,

- to ensure that IT investments meet business goals, objectives and plans including schedules and budgets,
- to ensure the availability of IT human capital capable of meeting IT goals and DOI mission needs.

5.9 E-Health/Health IT

E-Health or Health Information Technology (Health IT) involves the management of medical information and includes secure exchange between health care consumers and providers. In 2004 the President highlighted Health IT including electronic health records and formulated a goal that all Americans should have access to secure electronic health records by 2014. According to the Department of Health and Human Services (HHS) Health IT usage will:

- improve health care quality,
- prevent medical errors,
- reduce health care costs,
- increase administrative efficiencies,
- decrease paperwork,
- expand access to affordable care.

HHS believes that Health IT also will benefit public health in the following ways:

- early detection of infectious disease outbreaks around the country,
- improved tracking of chronic disease management,
- evaluation of health care based on value is enabled by the collection of de-identified price and quality information that can be compared.

Barriers to the adoption of Health IT appear to be a mixture of financial, legal, technological and organizational reasons. Some of the obstacles are that most practices are small, that there is not a coherent healthcare system, confidentiality concerns and that unique identifier numbers for individuals (such as the Swedish personal numbers) can not be used. A coherent system with standards must also be developed to ensure interoperability. Physicians are concerned about the legal exposures and/or the burden to be compliant with regulations. The protection and disclosure of patient data is one of the issues. An interesting new development is the collaboration between Google and a hospital group in Cleveland.[104] In this collaboration Google will manage health records under the control of the patients. However, questions concerning compliance with the HIPAA act of 1996 (Health Insurance and Portability act) has been raised as a third party is involved.

Some physicians and practices are concerned about the ease of use and costs to install Health IT systems and the culture and manpower of the organization concerned may be important. Small practices may find it hard to find the resources and time to install the

[104] *www.networkworld.com/news/2008/022108-google-to-manage-health-records.html*

systems. It should be noted that a number of ways to overcome the above issues have been suggested. These include e.g. education of physicians and health administration professionals, clarification of legal rules and requirements, administrative support etc.

A number of comparative studies concerning the adoption of Health IT have been made. However, the quality of the surveys varies and it is therefore difficult to assess the situation correctly. One survey (2005 National Ambulatory Care Survey, NAMCS)[105] claims that approximately 75 percent of physicians and community health care centers do not use electronic health records (EHR) while only around 10 percent use EHR fully. The results also suggest that the use of electronic medical records (EMR) is more common in metropolitan areas. In general, it appears that the use of EMR is more common in the mid west and western parts of the country. EMR usage is also more common in multi-speciality practices and at practices owned by an organization (in contrast to those owned by the physicians themselves). It is not surprising that it is more common to use EMR at larger practices and that practices that receives over 20 percent of the revenue from the Medicaid program are less likely to use EMR. Finally, it appears that younger physicians are more prone to use EMR.

5.9.1 Organizations involved in Health IT implementation

The Office of the National Coordinator for Health Information Technology (ONC) provides counsel to the HHS Secretary for the development and implementation of a nationwide Health IT infrastructure. The coordinator also develops, maintains and directs the implementation of the strategies employed. Furthermore, the coordinator provides comments and advice regarding specific federal Health IT programs.

The American Health IT Information Community (AHIC) is a federal body that acts in an advisory capacity to the Secretary at HHS on how to accelerate development and adoption of Health IT. AHIC will be reformed during 2008 as a public private-public partnership. The process will be led by the Brookings Institute and LMI, a not-for-profit strategic consultant firm that specializes on the government sector. AHIC has workgroups for biosurveillance, consumer empowerment, chronic care, electronic health records, quality personalized health care and a confidentiality, privacy and security workgroup.

The Nationwide Health Information Network (NHIN) intends to provide a secure, nationwide, interoperable Health IT infrastructure that will connect providers, consumers, and others involved in supporting health and healthcare. NHIN will enable health information to follow the consumer, be available for clinical decision making, and use of healthcare information to improve health.

The NHIN aims to:

- develop capabilities for standards-based, secure data exchange on the national level,
- improve coordination of health care information among hospitals, laboratories, physicians offices, pharmacies and others,
- ensure that appropriate information is available at the time and location of care,
- ensure that consumers' health information is confidential and secure,

[105] *www.rwjf.org/files/publications/other/EHRReport0609.pdf*

- to give consumers new capabilities for managing and controlling their personal health records as well as providing access to their health information from for instance EHRs,
- reduce the risks for medical errors and support delivery of evidence-based medical care,
- lower costs resulting from inefficiencies, medical errors, and incomplete patient information,
- promote a more effective market with greater competition and increased choice. As part of this information on healthcare costs, quality, and outcomes should be easily available.

The Agency for Healthcare Research and Quality (AHRQ) funds Health IT research and development with 166 million USD in grants and contracts.

Many other agencies are involved in Health IT initiatives. Some examples are the National Institutes of Health (NIH), the Indian Health Services (IHS) and the Center for Medicare and Medicaid Services (CMS). Furthermore, the Department of Defense (DoD) as well as the Veterans Health Administration (VHA) within the Department of Veterans affairs (VA) are involved in e-health. ALTHA, the DoD system for EHRs is used by many military healthcare providers and health records will in the future be electronically transferable to the VHA systems. The VHAs electronic health record system is called ”My HealtheVet” and allows patients to refill prescriptions online and provides access to health information.

A number of companies such as Google and SUN Microsystems are involved in e-health and the global market is estimated to be between 73 and 88 billion USD.[106] The Open e-Health foundation is an interesting initiative to provide Open Source tools that may be used for commercial applications (www.openehealth.org).

[106] *eHealth task force report, 2007, http://ec.europa.eu/information_society/activities/health/docs/lmi-report-final-2007dec.pdf*

6 Technology trends

While studying innovation and innovation processes in the IT-sector it is important to be aware of what products and services trends that are current and believed to become important in the future. Many companies and journals investigate technology trends and it is impossible to cover all here. CIO (Chief Information Officer) Insight[107] is an influential journal targeted to IT-professionals and decision makers and has asked IT-professionals about trends in technologies. These surveys are of value to identify overall trends. In one investigation, CIO's were asked which technologies that help drive their own company revenue. The following technologies were identified:

1. A **service-oriented architecture** including service-oriented device architecture (SODA), service-oriented business architecture (SOBA) and standards like the simple object access protocol (SOAP). Small, medium sized and big companies ranked a service-oriented architecture highly.
2. **Rich Internet Applications** such as Adobe flex and flash and Microsoft Windows Presentation Foundation were ranked highly for all sizes of companies except for the absolutely largest.
3. **United Communications** (telecom tools) ranked highly with all sizes of companies.
4. **Smart Phones and Mobile Clients** ranked highly with small and medium sized firms.
5. **Asynchronous Javascript XML (AJAX)** was interesting for companies of all sizes.
6. **Application Virtualization** was in particular interesting for larger companies.
7. **Storage Virtualization** was interesting but not so much for the very largest firms.
8. **WIKIs** got most support from the largest firms.
9. **RFID/Wireless Technologies** got most interest from medium sized firms.
9. **Social Networks** were interesting but not so much for the very largest firms.

In another survey, 280 IT-leaders were asked about their interest in a number of emerging technologies. The survey resulted in the following list:

1. **Storage Virtualization**
2. **Application Virtualization**
3. **Unified Communications**
4. **802.11n Wi-Fi**
5. **Hosted products Apps**
6. **Browser-based data visualization**

[107] *http://www.cioinsight.com/*

7. **RFID Wireless Sensors**
8. **Linux on the Desktop**
9. **Social Networking Analysis**
10. **Cloud Computing**

A survey of the fastest growing technologies indicated that these were:

1. **Virtualization**
2. **Customer Self-Service Technologies and Applications**
3. **Open Source Applications and Systems**
4. **Collaborative Software**
5. **Storage Equipment**

CIO Insights has also tried to identify some trends for 2008 by interviewing executives in IT-firms. Among the trends are an increased focus on e-services on the web as well as increased commercial services for mobile phones (M-commerce). Cyber security will be high up on the agenda as will virtualization. Web video is predicted to be used more as a business tool. Furthermore, the need of large storage capacity is predicted to grow. New technologies to reduce the power consumption will become more important.

The use of business modeling and management is also likely to increase according to the survey. In addition, business will become more international with a higher number of IT-companies becoming active outside the U.S. and more foreign companies entering the U.S. markets. An increased foreign outsourcing is likely. One serious problem seen by many IT-executives is the shortage of personnel. According to the survey, the downwards trend in the number of U.S. graduates in computer science will continue during the coming years.

Some of the individuals interviewed also predict that business will be more inspired by consumers, youths and users in general. Open Source initiatives will become more important. The dominance of Microsoft Windows is likely to persist but become weakened.

Studies performed by Gartner Inc.[108], an IT research and consulting firm, also indicate that Open Source initiatives will become more important and also suggest that user influence, green technology and 3D-printing will grow significantly as will software and IT infrastructure services. Among other trends Forrester Research Inc.[109], a company dealing with technology and market trends, believes that Social Networks, blogs, Wikis and RSS-feeds will grow in importance.

[108] *http://www.gartner.com*
[109] *http://www.forrester.com*

7 Discussion

This report describes current innovation trends, technology trends, public initiatives, progressive geographic areas and maps excellent academic environments in the IT-sector in the U.S. One of the most important trends described in this report is a movement towards more open innovation. Although the trend largely appears to be universal, some industrial sectors including the automotive and airline industry use less "open" strategies than others. Special circumstances also apply for the defense industry due to security concerns. However open strategies are to some extent also used by defense-related companies. The concept of open innovation has been described in many texts including some by ITPS[110] and a recent report from Vinnova.[111]

In this study, we have partly focused on a number of companies, public authorities, universities and other organizations and how they interact in cluster structures. We have specifically studied this in two academic/industrial/public clusters – Austin, Texas and the Research Triangle Park, North Carolina. One observation is that companies need to be located close to where qualified people are available for recruitment purposes as well as close to good universities for R&D collaborations. In addition, universities want to be connected with innovative companies and there is much collaboration between the two types of organizations. Sometimes public authorities and other entities are also involved.

A number of stimulatory initiatives are available on the federal level including for instance the SBIR and TIP programs and on the state level e.g. the Texas Emerging Technology Fund. The states also use the tax structure to create good conditions for individuals, companies and academic institutions. The U.S. states have a large degree of freedom to form their own policies and are therefore important players with regard to innovation stimulation.

At both clusters described, efforts are ongoing to increase the economic outcome of research performed at universities. An example on how this affects work at the universities is that, at Texas state universities, patents and generated spin-off companies are now taken into account at tenure reviews. It is worth remembering that U.S. universities own the IPR in contrast to their Swedish counterparts. The venture capital sector is mature and competent at both locations studied, however small when compared to the sector in Silicon Valley. In addition, marketing to attract capital and companies is an important factor. Furthermore, the need for personnel with many competences including business and marketing is at both locations.

The two clusters that we have focused on are both of particular interest but for somewhat different reasons. Austin is a strong cluster for IT innovation with companies such as Dell and IBM as well as a top university – the University of Texas at Austin. One of the important factors that have enabled Austin to succeed appears to be a high quality of life (weather, music etc.) combined with the presence of innovative companies and good universities. However, the Research Triangle Park is also very successful although it appears to have a different character. The park was formed in 1959 in a deliberate effort to improve the economy of North Carolina. RTP contains three universities of which University of North Carolina at Chapel Hill and North Carolina State University seem to be most

[110] *e.g. Karlsson(2004) and Karlsson (2006).*
[111] *Managing Open Innovation –Present Findings and Future Directions, Vinnova 2008:02.*

important for the IT-sector. Many well-known companies including Cisco, Nortel, Red Hat and Sony Ericsson are located in the area. In contrast to Austin, RTP lacks an urban character which is seen as a disadvantage by some.

A common denominator is also the collaborative spirit between local government, academia and industry, often working together toward jointly identified goals.

While both Austin and RTP are very important it should be noted that Silicon Valley (California) has not lost its importance and still is seen as dominant and as the most innovative IT-region in the country. One of the persons interviewed expressed this as *"Nothing else comes even close to Silicon Valley"*. The ability to "fail" with a project but still be given the chance to "start again" is seen as one of the crucial factors for the Valley's successes as well as the abundance of venture capital and closeness of top universities. As Silicon Valley has been described in many other reports[112] we have not covered it here in detail.

In addition to the cluster descriptions, we have looked at some research and innovation strategies that we believe are of particular interest. Among these is a tendency that some companies including Intel have established joint laboratories with top universities such as University of California (Berkeley) and Carnegie Mellon University (Pittsburg). In the Intel so called "lablets" most or all results are "open domain" and therefore possible to publish, which is essential for the academic researcher. On the whole, we see a clear trend towards more open innovation in pre-proprietary industry R&D phases although companies do it in different ways. For instance, IBM works much with internships aimed at the very best university students. Many of the results from the student projects are publicly available. The trend towards open strategies has been amplified by the increased availability of IT tools such as Wikis.

In this report, we have also described the results from a number of ratings of computer science research and educational programs at U.S. universities. On the four lists studied or compiled, four universities were in the top ten on all rankings. These were MIT, Stanford University, Carnegie Mellon University and University of Texas at Austin.

Federal involvement and funding for research is very important. The America Competitiveness Initiative and the America COMPETES Act contain many interesting stimulatory initiatives relating to the IT-sector. However, as full funding for these initiatives have not been secured[113] from Congress they have fallen short of their expectations so far. The Networking and Information Technology Research and Development-program is also of special importance for the IT-sector.

Government agencies and departments that are particularly important for information technology include the National Institute for Standards and Technology, the National Science Foundation (NSF), the Department of Energy, the National institutes of Health the Defense Advanced Research Projects Agency, the Department of Homeland Security and the Department of the Interior (DOI). While NSF is particularly important as the largest IT-research funding agency through its CISE-department, DOI is important not least for many of the initiatives within e-government. While e-government appears to have picked up speed, e-Health/Health IT-initiatives seem to be implemented relatively slowly. Some of

[112] *e.g. Kenney, M. Understanding Silicon Valley (Stanford university press 2000).*
[113] *www.aaas.org/spp/rd/aboutrd.htm*

the reasons for this include many small medical practices, implementation costs and concerns over personal integrity.

Finally, we have looked at technology and service trends and it is clear that among the most important current trends are cyber-security, virtualization, communications, web services and interactive software and services.

References and selected readings

Note: Please also see footnotes.

Documents, books and presentations

AAAS (2008) Report XXXII Research & Development FY 2009

AAAS (2007) Report XXXII Research & Development FY 2008

Bridging the Gap- DARPA-Powered by ideas, 2007

Chesbrough, H. W. *Open Innovation: the New Imperative for Creating and Profiting from Technology,* Harvard Business School Press, Boston, 2006

DOI *e-government strategy* 2008-2013

DOI *Information technology Strategy Plan* FR 2007-FY2012

Hardin, J. *Pathways to High-tech Valleys and Research Triangles, Chapter 2: North Carolina's Research Triangle Park,* Springer, 2008

Info@rtp: *quick guide, The Research Triangle Foundation of North Carolina,* 2007

ITPS (2008) *IT-forskning i Sverige och i omvärlden,* Institutet för tillväxtpolitiska studier rapport A2008:006, Östersund, 2008

Jackson, *House questions NIST budget priorities,* Government Computer News, March 12, 2008

Karlsson, M. Företagens förändrade FoU-investeringar I USA och Sverige ITPS Tillväxtpolitisk utblick, 2, 2004

Karlsson, M. (Ed.) The Internationalization of Corporate R&D Leveraging the Changing Geography of Innovation. ITPS A2006:007, 2006

Stanley, M. Director of TIP, NIST, Presentation at the National Academies, Symposium: *Critical national Needs in New Technologies: Opportunities for the Technology Innovation Program,* April 24, 2008

National Academies *Rising Above the Gathering Storm,* The National Academies Press, Washington D.C., 2007

PCAST Leadership *Under Challenge: Information Technology R&D in a Competitive World, An assessment of the Federal Networking and Information Technology R&D Program.* 2007

Public Law 110-69, SEC. 3012 *Technology Innovation Program,* Aug 9, 2007

Research Triangle Park: *Evolution and Renaissance, The Research Triangle Foundation,* June 2006

Rodriguez, D. and Solomon D Leadership *an Innovation in a Networked World, Innovations: Technology, Governance, Globalization* Summer 2007, Vol. 2, No. 3: 3–13, 2007

Saxenian, A.L. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128* Cambridge, MA: Harvard University Press, 1994

The 2007 State new Economy index. The Information Technology and Innovation foundation and the Kaufmann Foundation, 2007

The National Academies, Symposium: *Critical national Needs in New Technologies: Opportunities for the Technology Innovation Program*, April 24, 2008

US *E-government Strategy Plan* 2003

US House of Representatives, Committee on Science and Technology, "Establishing the Advanced Research Projects Agency-Energy (ARPA-E) Act, Legislative Highlights: January 10, 2007

Vinnova *Managing Open Innovation – Present Findings and Future Directions*, Vinnova Report VR 2008:02

Wessner, C.W. *An Assessment of the Small Business Innovation Research Program by NRC*, NAS, 2008

West, D.M. *State and Federal E-Government in the United States*, 2007

White House *American Competitiveness Initiative*, 2006

White House news release "State *of the Union: American Competitiveness Initiative*", January 31, 2006

Websites

American Association for the Advancement of Science http://www.aaas.org

DARPA website http://www.darpa.gov

Department of the Interior website http://www.doi.gov

Google website http://www.google.com

National Science Foundation http://www.nsf.gov

NSF (2008) National Science and Technology Indicators http://www.nsf.gov/statistics/seind08/c0/c0i.htm

NIST, www.nist.gov/tip, February 2008

North Carolina State University http://centennial.ncsu.edu/directory/corporate.html

NC State University (2008) http://centennial.ncsu.edu/overview/quickFacts.html

PCAST http://www.ostp.gov/cs/pcast

RTP http://www.rtp.org/files/Maps/rtp_map_and_company_list__august_2007.pdf

SBA (2008) SBIR Awards and Statistics, *www.sba.gov/SBIR/indexsbir-sttr.html*

SBA (2008) STTR Awards and Statistics, *www.sba.gov/SBIR/indexsbir-sttr.html*

Shanghai Jiao Tong University rankings http://ed.sjtu.edu.cn/ARWU-FIELD2008.htm

US News and world Report rankings http://grad-schools.usnews.rankingsandreviews.com

White house egovernment website http://www.whitehouse.gov/omb/egov/

Interviews

Randall Kempner, Vice President, Regional Innovation, Council on Competitiveness

Robert D. Atkinson, President,Information Technology and Innovation Foundation, ITIF

Interviews - Austin

Angelos Angelou, Principal, AngelouEconomics

Sanjay Banerjee, Director, Microelectronics Research Center, University of Texas at Austin

Jim Butler, Creative Industries Development Manager, City of Austin

Adriana Cruz, Vice President Global Corporate Recruitment, Austin Chamber of Commerce

Susan Davenport, Vice President, Austin Chamber of Commerce

Erin M. Defossé, Director, ATI Wireless, Austin Technology Incubator

Sandy Dochen, Manager, Corporate Citizenship & Corporate Affairs, IBM

Sheldon Ekland-Olson, Director, Division of Statistics and Scientific Computation, University of Texas at Austin

Richard Friedman, Associate Director – Licensing, Office of Technology Commercialization, University of Texas at Austin

David V. Gibson, Associate Director, IC2 Institute, University of Texas at Austin

John Goodenough, Dr., Professor, Virginia H. Cockrell Centennial Chair in Engineering, University of Texas

Henrik Johansson, Boundless Network

K. Alan Kirchhoff, Deputy Directory, Emerging Technology, Office of the Governor

Katie Kizziar, Director, Technology & Education Executive Council, Skillpoint Allicance

Thomas Milner, Professor, School of Engineering, University of Texas at Austin

Mortada Mostafa Mohamed, Regional Director Europe/Middle East/Africa, Office of the Governor

Anders Nilsson, Vice President, Swedish American Chamber of Commerce, Texas

Pike Powers, of Counsel, Fulbright & Jaworski L.L.P.

Ben Ramirez, III, International Program manager, City of Austin

Coby Shorter, III, Deputy Secretary of State

Neeraj Srivastava, Director, Technology Policy, Office of the CTO, Dell

Scott L. Winters, Distinguished Engineer and Director of Development WW Tech Sales Enblement, IBM Software Group, IBM

Bill Wood, Silverton Partners

Michael W. Young, Senior Manager, State Government Relations, Dell

Interviews – RTP

Ted Abernathy, Executive Vice President & COO, Research Triangle Regional Partnership

Leah Burton, Partnership Developer, North Carolina State University, Centennial Campus Partnership Office, Raleigh

Dave Buster, Director, Product Marketing, Global Government Solutions Group, Cisco, RTP

Melanie Chernoff, Public Policy Manager, Corporate Affairs, Red Hat

Dallas Hardenbrook, European Investment Manager; NC Department of Commerce

John Hardin, Acting Executive Director, State of North Carolina, Office of Science and Technology, NC Department of Commerce

Kevin Johnson, Vice President, Business Development, Research Triangle Foundation

Martyn B. Johnson, European Investment Director, NC Department of Commerce

Vivian Powell, Economic Development Representative, NC Department of Commerce

Tom Rabon, Executive Vice President, Corporate Affairs, Red Hat

Tina Valdecenas, Vice President, Corporate Strategy, Research Triangle Foundation

David Hudson, Portfolio Management, Nortel Networks

Kelly Kanellakis, Strategic Planning, Governance & Operations, Nortel Networks

The Swedish Institute for Growth Policy Studies (ITPS) is a Government Agency responsible for providing policy intelligence to strengthen growth policy in Sweden. ITPS primarily provides the Government Offices, Members of the Swedish Parliament, other state authorities and agencies with briefings based on statistical material, policy papers and key analyses. Business policy and regional development policy are areas given high priority.
Changes in policy should be based on:

- Statistic data and analyses of the structure and dynamics of industry – to obtain an up-to-date view of future challenges and opportunities.
- Evaluation of results and effects of policy measures and programmes – to provide benchmarks and learn from measures implemented earlier.
- Policy intelligence in order to look outwards and ahead – what issues are likely to come on the growth policy agenda in the future?

These represent the principal missions of ITPS.

ITPS, Swedish Institute for Growth Policy Studies
Studentplan 3, SE-831 40 Östersund, Sweden
Telephone: +46 (0)63 16 66 00
Fax: +46 (0)63 16 66 01
info@itps.se
www.itps.se