SOFTWARE INNOVATION AGENDA

This agenda describes how to get Sweden to be one of the top countries by the year of 2020 when it comes to software development.

1 THE VISION

Software means business in Sweden. Keeping the country at the forefront of this strategic, dynamic industry is key, and we need to make sure this happens.

There's no denying the importance of software. It's part of everyday life, from the individual – and business – level to society as a whole. And it's mostly happened in the past four decades, which have seen remarkable growth in this sector.

It's becoming the key industrial differentiator and is indispensible when it comes to innovating – meaning that it is of key importance when it comes to growing the economy and staying competitive – and no more so than for a country like Sweden, which has ploughed considerable time and resources into becoming a leader in the software and IT industries.

It's a big part of Sweden's economy, accounting for 11% in terms of product and service production3 – more than twice the EU average. It's had a hugely positive effect on job creation, with at least 15,000 new jobs in both small and large companies2. During the downturn, the sector actually saw a significant rise – almost 13% in employment in Sweden. Not only is it an important part of the country's economy – it's becoming more and more so.

Sweden's position as a software leader is particularly notable in several key sectors – notably automation, aviation, entertainment, telecom and transportation. It's also noted around the world as having a forward-thinking approach in the public sector and in the development and rolling out of new internet services to the Swedish public. Its dominance in the software development industries is increasingly being challenged, however, as other countries have come to realize the importance of the sector and are catching up.

The last ten years has seen more and more software development being outsourced, mainly due to bring costs down. Recently, however, companies have felt the need to outsource development in order to find people who can handle both the volume and the degree of skill necessary.

To keep a leading position and to maintain Sweden's competitiveness, Sweden must continue to invest in the software and IT area. We must identify our competitors and their unique strengths, such as India and Silicon Valley, and position our expertise.

Software is a fact of life, and is part of every product or service out there. To maintain Sweden's competitive edge, and to be at the forefront of

SOFTWARE MEANS BUSINESS!

15.000

NEW JOBS ONLY IN 2012!

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THE VISION

the advancement of this industry, every facet of development needs to be considered. Innovation and research is needed, to further develop technologies, including algorithms. We need to innovate in the processes of creating and producing software too. This agenda will focus on the production aspect of software – while other areas are as important, they are dealt with elsewhere. Software engineering is a particularly Swedish specialty, especially in the country's skill of building complex software systems, which need to be both dependable and robust. This well-known strength will be an advantage in attracting investment.

There have already been several high-profile succeses – Rovio, the Finnish startup of Angry Birds fame, opened their first international office in Stockholm, and Sony Mobile Communications will keep its software development based in Lund while it relocates other parts of the company to new overseas locations.

It is clear that software development is a key to Swedish growth during the next decade with the potential to create thousands of jobs in Sweden. The industry needs to improve, however, not only in terms of how it innovates and creates new products, but also in how it is able to improve productivity in research and development – the focus of this agenda. The vision of this agenda is to make Sweden the innovation centre for software development by 2020. It aims to do this by focusing on a number of strategies:
- defining areas of strength & competitive advantage
- boosting collaborations between industry-academia
- allowing more 'cross-domain exchanges'
- creating test beds and meeting places
- increasing resources

We expect the outcome of this to be a country that is recognised throughout the world as an innovator

of new products and a leader in productivity. This will, in turn, encourage more inward investment and act as a base for long-term economic growth. Not only will this policy be beneficial for the specific software production industry, it hopes to contribute to the overall success of software intensive companies in Sweden. It should make it possible to:

ADVANCE
- Advance software technology by re-aligning existing efforts – and their resources and facilities – into new joint ventures, which can advance the needs of the Sweden and its industries.
- Spread the results across the stakeholders to ensure that everyone benefits

BOOST
- Strengthen Swedish development skills, and the supply of competent software engineers
- Increase interest in software development education at all levels

CREATE
- Create 1000 new Swedish software companies, each with at least 100 employees, by 2020.
- Double the number of software developers by 2020.

Based on Strategic Research Agenda by Swedsoft1, this agenda aims to ensure that Sweden stays at the forefront of software development, maintaining and developing world-class competencies, technology and methodology in software development. Recognising the strengths of the Swedish software industry – including our system development tradition, non-hierarchical management structures, lead user communities, internationally renowned research, industry-academia collaboration and education – it aims to build on these.

IN 2020:
1000
NEW SOFTWARE COMPANIES

IN 2020:
100000
NEW JOBS IN THE SECTOR

2 THE FACTS

Software systems are becoming more and more central to our lives and therefore becomes a national concern for future growth and welfare.

Currently Sweden ranks highly in terms of software and IT innovation, something that INSEAD's global innovation index supports – the country is ranked second in the use of IT2. Many Swedish businesses demonstrably embrace software and IT to enhance their products and services, and on a personal level, the Swedish population is highly computer literate and also embraces the use of IT.

In the following section we will look at the importance of software from a variety of perspectives – the industrial, societal and individual. We'll also show how these perspectives coincide, and what this means for software as a national concern for future growth and welfare.

THE INDUSTRIAL PERSPECTIVE

Not only do Swedish companies rely on innovation and software development to maintain their competitiveness, but around 20% of Sweden's exports in 2012 consisted of IT related products and services5. In addition, software counts for 80% of the innovation in the telecommunication and automotive industries.

Almost every company in Sweden needs technology – particularly software – to be moving forward and in 2009 these companies invested around 60 billion SEK in new software. The market keeps on growing, as systems become ever-more complex and greater product functionality and services are implemented in software.

It's clear that software represents a significant amount of investment – which means return in terms of innovation, increased revenue and growth. For example:

- **Aerospace** develops safety critical systems such as flight control and vehicle systems, which require high levels of system and software complexity. In addition, better human-

machine interface for displays and controls are becoming more and more important.

- **Automation** Software is increasingly replacing mechanical systems, which are more and more complex. At the same time, there is a demand for safer systems with better usability. This requires competence and innovative thinking to meet these challenges.

- **Automotive** Software controlled functions are the basis for 90% of innovation in this industry. They are paving the way for green propulsion, active safety and additional in-vehicle services. New architectures, methods and techniques, as well as competencies are required to deal with these improvements – in functional growth, safety and in configuration management.

- **Telecom** Current, large-scale development, including managing legacy systems, continuous deployment and enhanced performance by means of multi-core technology are all aspects of the telecom industry's need for innovative software solutions

- **Media** With an increasingly integrated landscape of internet, TV, radio and newspapers, the industry faces an increasing reliance on software in their production and distribution of image, text and video. This development has triggered needs for effective development and management of heterogeneous distributed systems.

- **Music, film and gaming** industries rely heavily on advanced software and communication systems for production, marketing and distribution of their products and services in a fast changing environment. These cutting-edge industries constantly demand improved

technology, processes and methods to support their lifecycle and its management.

- **Emerging non-traditional ICT** dependent industries such as mining and forest industries, with an increased need for automation and decision support systems, are also finding themselves increasingly software-reliant.

Many of the issues that these industries are facing are common – or at least similar – to those in other sectors, meaning that there is a great deal of cross-sector knowledge transfer and innovation.
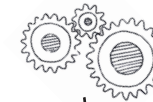
Sweden has also been remarkably successful in exporting its software successes to the wider world. Klarna AB, for instance, founded in 2005 and employing 800 people in 2012 hopes to double that workforce in the coming few years. Spotify, founded a year later, doubled its workforce – from 177 to 300 – between 2011 and 2012 and boasted an annual turnover of 1.1 billion SEK.

There are also several newsworthy acquisitions of Swedish firms that show how Swedish solutions are valued by overseas tech companies. Deals such as TAT by RIM/Blackberry, Scalado by Nokia and PolarRose by Apple, to name but a few, give an idea of the reputation of Swedish software design and development.

It is also firms and deals like these that prove the economic impact of the industry – creating over 2000 jobs and close to 3 billion SEK in revenues in a sector that did not exist 10 years ago.

TOP RANK OF ICT USE

01.	KOREA	78.50
02.	SWEDEN	75.49
03.	LUXEMBOURG	72.41
04.	FINLAND	71.08
05.	JAPAN	70.83
06.	DENMARK	68.49
07.	NORWAY	66.00
08.	ICELAND	65.83
09.	AUSTRALIA	65.71
10.	HONG KONG	64.64

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OUR CIVILIZATION RUNS ON SOFTWARE.

BJARNE STROUSTRUP, CREATOR OF C++

THE SOCIETAL PERSPECTIVE
The importance of software isn't limited to industry – it has implications for every aspect of society.

As society develops and the economy grows, it is crucial that resources be used to create maximum value for everyone, now and in the future. Software is a key driver for this and as different public institutions and sectors rely on it more, it needs to be made more robust. This can be seen in the following examples:

- Health care needs extensive software systems, especially for an aging population, where more and more treatment takes place in the patient's homes. Improved software systems are important, both for cost and convenience reasons.

- Public services of all kinds are supported by software systems, enabling self-service via the web, which provides higher accessibility at lower costs – savings on, for example, personnel.

- Publicly funded data – demographic, metrological or financial – is a source for new services in public-private partnerships.

VINNOVA, the Swedish Governmental Agency for Innovation Systems, has identified four social challenges relevant to the task of promoting sustainable growth in Sweden: future health and medical care; developing sustainable and attractive cities; developing the 'information society 3.0'; and fostering competitive industry. Given the advantages that software and IT have in meeting

these challenges, it seems that there are definite opportunities for the country to stay competitive, when developing solutions to these problems. Continent-wide, the EU has identified global warming as the most important challenge of our time. Software can play a key role in combating climate change by reducing carbon emissions in two ways:

- Software enables sustainable development across industries – and society – through the introduction of new business models, services and support, which monitor and control various activities and processes, which can provide insight into their environmental impact.

- Reduction of the software and IT industry's own carbon footprint. This currently accounts for a relatively small but growing part of global energy consumption. New technology and infrastructure solutions can be developed to bring energy consumption into consideration. To develop a society that makes full use of technology means that expertise in software – both in development and maintenance of systems – needs to be very high. From a practical standpoint it means that large, dependable systems need to be created. This means that the government and scientific/tech communities need to align their views, policies and ambitions. Public funding can create further employment opportunities by encouraging Swedish companies to develop systems for the public sector, and by encouraging innovation in the domestic market, these novel uses can be

exported. By opening up government information and knowledge for use, Swedish companies can benefit as they develop innovative products.

Society can also contribute by training future software developers – and end users – and providing access to tech-based skills at every step along the road. Research is a key factor, and is the basis for becoming – and remaining – a center for innovation. Thanks to 20 years of top-ranked research at Swedish universities (paid for by research funding agencies and industry-academia collaboration) Sweden has a well-established research community, with industrial centers at Blekinge Tekniska Högskola, Chalmers, Kungliga Tekniska Högskolan, Lund University and Mälardalen University. Technology transfer institutes, which allow for research to be passed on to innovators, are a key part of the chain.

THE INDIVIDUAL PERSPECTIVE
From software developers to end-users, individuals are the cogs that drive the Swedish innovation system.

As users and consumers, our daily lives become increasingly dependent on software, both privately and professionally. More and more we interact socially and in business through computers, and even personal communication is moving this way.

We also rely on safety software, for instance when traveling by train, car or aircraft, increasing the importance of technology as we move forward. We expect that these systems should be robust against interference. These developments mean that we encourage people to become advanced software users, or even developers. This boosts the industry, creating a domestic market at the forefront, where early adopters help predict the needs of the masses tomorrow. Access to these users gives Sweden's software

industry an advantage in identifying and developing products that can reach an international market.

Getting young people involved is crucial to developing the country as a center for innovation. It's important to involve, encourage and enthuse them – to explain the creativity and to demonstrate this – on order to get them on board.

Software development offers considerable competitive advantages for entrepreneurs – investment costs in new businesses have been reduced thanks to tech innovations and the internet has created a global marketplace. . Important trends, such as software ecosystems and open innovation allow the industry's products to open up and benefit fromoutside modding. Here, small and innovative ideas can establish themselves in niches that are not attractive to a larger company. The open source movement also opens opportunities for SMEs to make contributions and innovations in ways that were previously the domain of large companies.

Society also has much to offer individuals through advanced software. Enhanced services that can help us with what we need more efficiently, along with new services such as home care, can improve the quality of life. Similarly, society can offer quality education that leads to well-paid and attractive jobs in software development.

The benefits to society that a thriving software industry can provide increases the chances of attracting people to live and work in this industry in Sweden, even further improving the country's reputation as an innovation center for software development. A positive spiral is started, where we attract high-paying jobs to the country, which contributes to high tax revenues that further strengthens the possibility of investment and growth.

INNOVATION CENTRE SWEDEN

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③ CHALLENGES

While Sweden has a head start and can use its existing reputation as an innovation center to attract new talent, there are a number of other countries that are starting to understand the value of a developed software industry, meaning that the global climate is much more competitive. Software development today also faces considerable technological challenges.

A CHANGING LANDSCAPE OF TECHNOLOGY AND APPLICATIONS
The evolution of hardware platforms, from single to multicore, along with the enormous amount of connected sensors and devices, services moving to the cloud and the emergence of 'Big Data' are all drastically changing the way we need to educate, research, innovate and utilise.

INCREASING SCALE AND COMPLEXITY OF APPLICATIONS AND SYSTEMS
The opportunities of connectivity and software allow us to develop more and more advanced, complex systems. Developing, producing and managing these systems, however is becoming increasingly challenging. Proposed solutions are at present not able to deal with this increasing complexity, resulting in late deliveries, quality problems and product recalls.

INCREASING DEMANDS AND RELIANCE ON SOFTWARE INTENSIVE SYSTEMS
Widespread adoption of software leads to an increased societal reliance on it, resulting in greater demands on such systems to be cost-efficient, secure and safe. Development and verification of critical software-intensive systems is a challenge, and requires substantial resources – and time – which can sometimes delay or even block market introduction.

BIG AMOUNTS OF DATA

COMPLEX SYSTEMS

DEMANDS FOR SECURE SYSTEMS

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COMPLEXITY DEPENDABILITY USER EXPERIENCE

SWEDEN

4 STRATEGY

To achieve the aim of making Sweden a software hub by 2020 means that everybody – from government to academia, businesses, the industry itself along with the individual, needs to be invested.

However, it is of utmost relevance to emphasize that software development is an extensive area. Sweden cannot do everything. To ensure that the investments will result in the desired effects requires a clear prioritization and specification of the scope of work. Hence, Sweden must make strategic choices in what areas to focus its efforts and investments.

Sweden is a world leader in the development and research of certain classes of software. A class of software is distinguished by the fact that it is applied in many areas that have similar demands. For instance, safety-critical software is a class of software that is found in a variety of computer systems and products, regardless of trade, industry or sector, e.g. aerospace, automation, automotive, and healthcare. Clearly, synergies between the many areas of application are achieved if the expertise is collected in ways that enable effective cross-domain knowledge transfer.

The strategic choice naturally identifies the classes of software in which Sweden is an established actor as a starting point for prioritizing excellence areas. However, there are also classes of software indicating high future potential, primarily justified by a changing computer landscape that has triggered a growing worldwide demand of expertise. As such, they are

candidates of new excellence areas. Recognizing their potential is crucial to support renewal, evolution and innovation in the software development domain.

To identify the areas where Sweden should excel, a number of workshops, meetings and conversations were organised throughout Sweden during 2012-2013 to collect the ideas of the various stakeholders of this agenda. This dialogue covered discussions about Swedish challenges, opportunities and areas of strength. As result of this dialogue with business representatives, policy-makers, experts, scientists, and end-users, three prioritised areas of excellence were identified: complexity, dependability, and user experience.

COMPLEXITY
New infrastructure allows heterogeneous systems to be connected to each other. Therefore, there is an urgent need for systematically derived knowledge on how to develop and maintain systems, based on integration of other systems, possibly provided by other actors in various forms, such as suppliers, subcontractors, or open source communities. The life cycle of systems and components may be counted in decades, surviving technological generation shifts. Important aspects of knowledge required for these systems of systems involve decision support for make/

borrow/buy decisions, knowledge of distributed systems, refactoring of deteriorating legacy systems and quality assurance. On the other end of the scale, knowledge is needed for start-up companies, building their software systems to be adaptable and possible to integrate with other systems, without spending effort on developing features that are not needed at the moment.

DEPENDABILITY

Safety critical implies systems where errors can be highly interruptive or even harmful. Consequently, developing such systems involve care for correctness, redundancy, reduction of complexity, and a significant amount of conservativeness regarding technologies and processes. In short they need to be dependable. Verification should also be considered an important area that needs to be addressed. Safety critical parts of a system are traditionally physically and logically separated from other parts of the system to reduce the complexity and the need for costly safety assessment of the complete systems. However, as demands grow for more advanced features, more integrated systems of systems, and faster pace of change, also for safety critical software, the technology and engineering practices must advance to ensure competitiveness. Although different industry domains, e.g. aerospace, automation, robotics, automotive are regulated by different safety standards, the standards share certain core properties that enable joint research and development across domains of new development practices for safety critical software-intensive systems. Dependability will also address the need to make systems secure from cyber-attacks and other aspects of securing data, be it personal or other.

USER EXPERIENCE

For market driven software systems, the user experience is a key selling point for many customers.
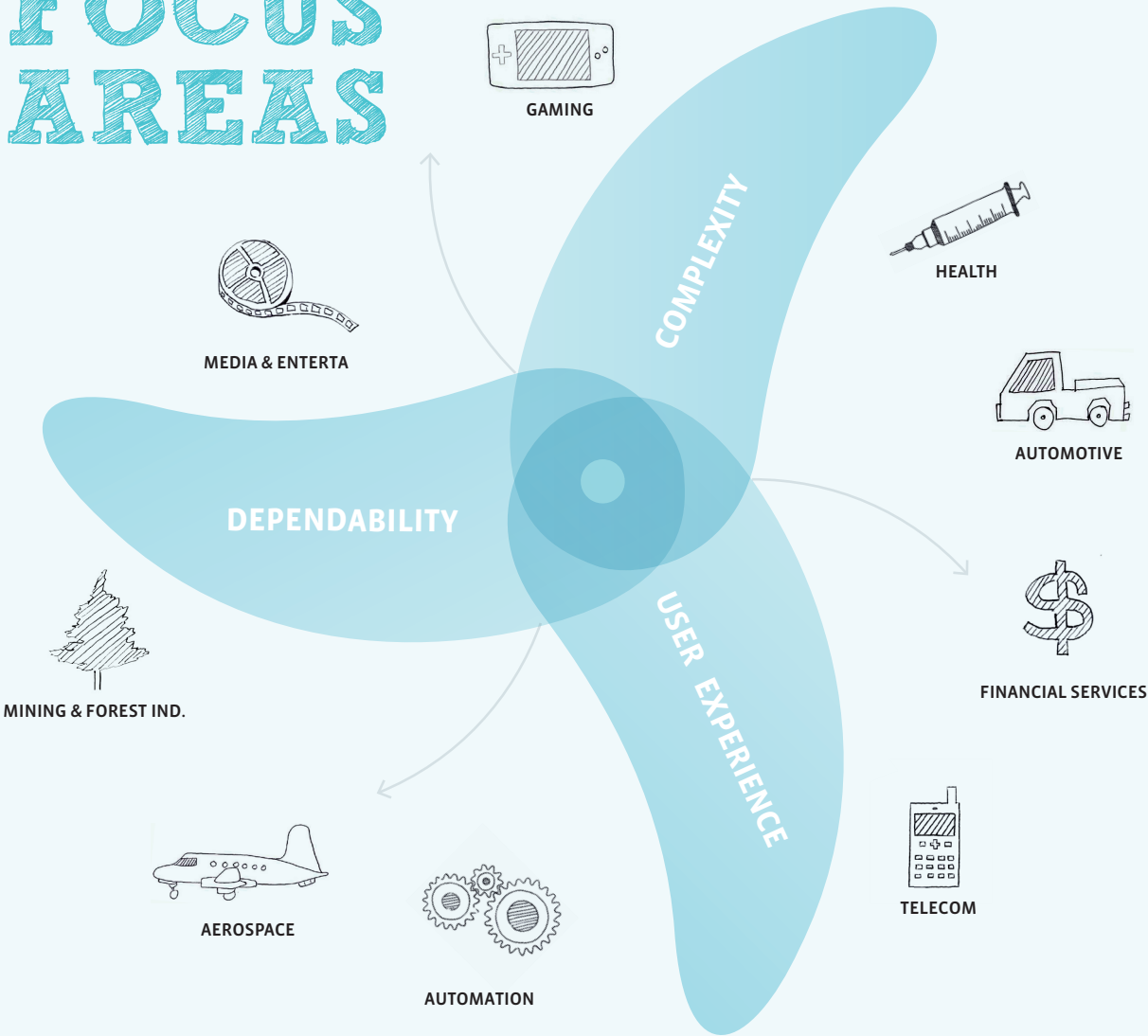
In gaming and other entertainment systems, it is the selling point. However, for in-house systems, and industrial type systems, the user experience may be a key contributor for the productivity gain expected by the system, and also a safety aspect in e.g. medical systems. As many systems are developed based on new technology push, rather than user pull, there is a significant risk that they are designed from a technical rather than a design perspective. User experience goes beyond user interface and user interaction design; rather it is about the conceptual models for interaction with the system and, when considering systems of systems, the modes for composing and configuring such systems, whether it be conducted by system integrators, or the users themselves.

At the intersection between traditional industry domains and the entertainment sector, and influenced by the "Scandinavian design" tradition, there is a potential to develop new user experience models. This may also include simulation systems for training to handle complex systems of systems. However, because this in not only an interface and interaction issue, deep architectural design competencies must be involved in this exploratory endeavour.

BENEFITS TO SWEDISH INDUSTRY AND INNOVATION

When looking at how these prioritized areas can be applied to innovation in the industry it is clear that the investment can be amortized and applied to all domains.

INDUSTRY FOCUS AREAS

- GAMING
- COMPLEXITY
- HEALTH
- MEDIA & ENTERTA
- AUTOMOTIVE
- DEPENDABILITY
- FINANCIAL SERVICES
- MINING & FOREST IND.
- USER EXPERIENCE
- TELECOM
- AEROSPACE
- AUTOMATION

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⑤ ACTION PLAN

The Swedish software community is ready for action. However, it requires that the area of software development have to be acknowledged as a cross-domain discipline that deserves its own focus, instead of being a sub-field of traditional industry domains.

The focus of this agenda is to enable innovation. Traditionally, the most common way to improve performance and commercial success has been to focus on technological product and process innovation. Today, it's not enough. Successful companies must combine their product and process innovations with marketing and organisational innovations and address customer needs. Basically, successful innovation requires a combination of new solutions in four areas, product, process, marketing and organisation .

A product innovation is the introduction of goods or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.

A process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.

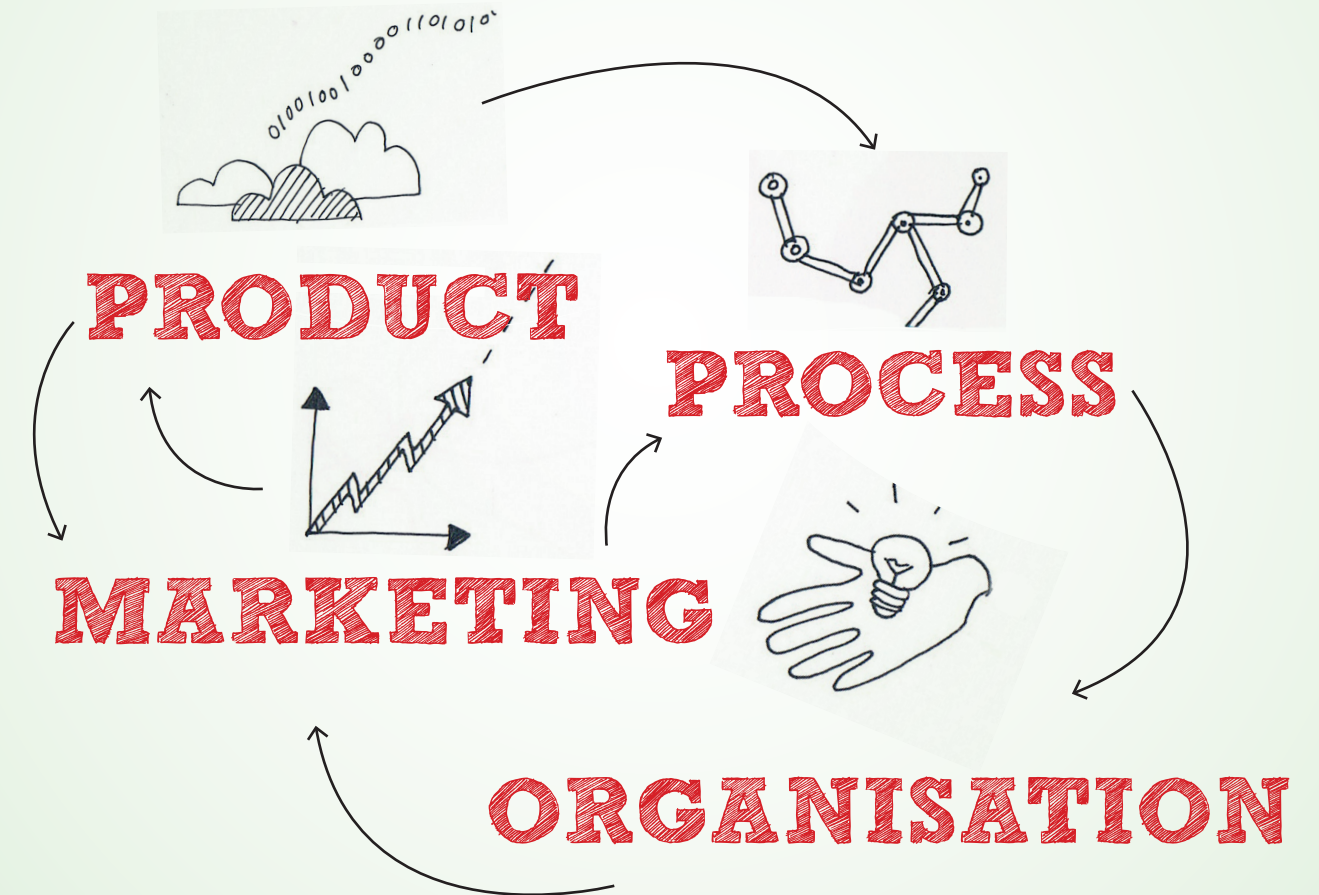**A marketing innovation** is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

An organizational innovation is the implementation of a new organizational method in the firm's business practices, workplace organisation or external relations.

Innovation in any one of these four areas is always of importance, but the truly new and exciting opportunities are created when combining the individual innovation in new ways!
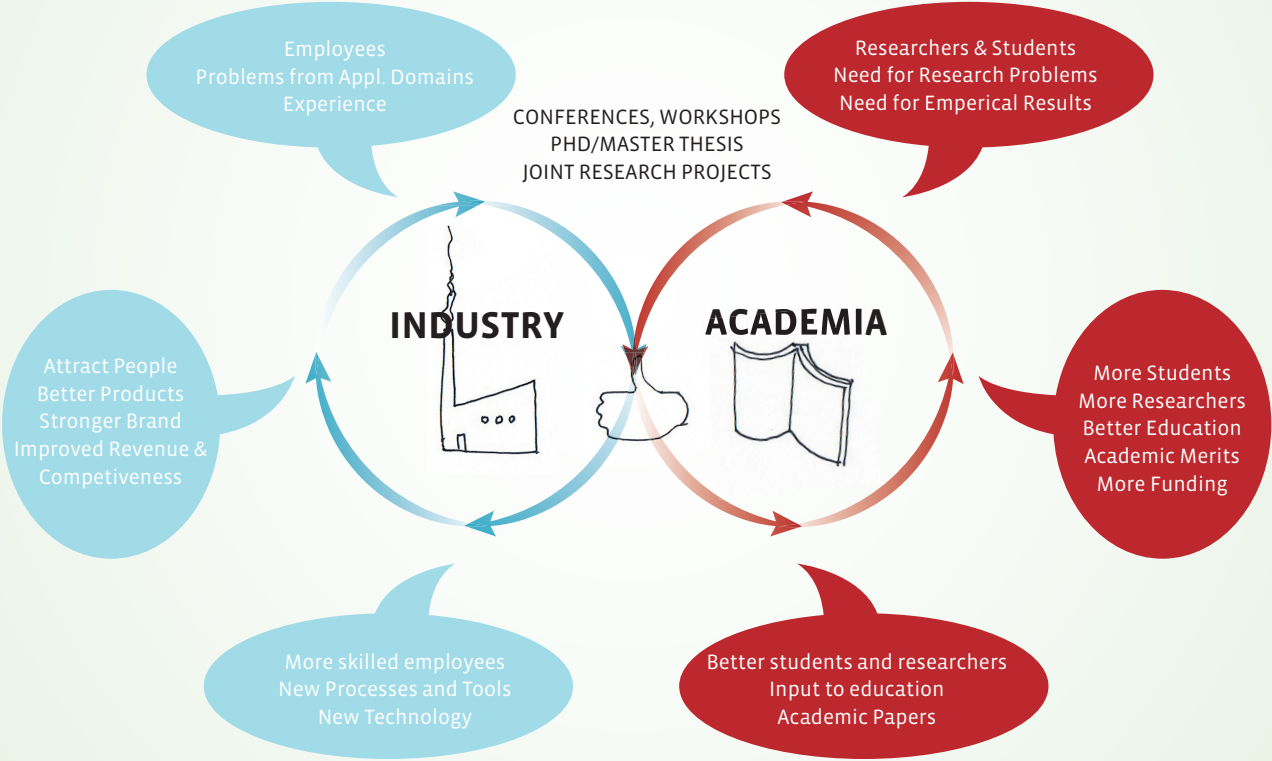
Software is the technology that is uniquely positioned to enable this mode of innovation. Software acts as glue between these different areas. For instance, Klarna AB has combined software algorithms and technology (Erlang) to introduce a new business model for e-commerce payments. Skype is another example. The technological solutions provided by Skype for calling over the Internet combined with a new business model, where users can use the base service free of charge and buy additional services for reasonable rates, is illustrative for software, as a key enabling technology, being the glue across the areas needed for innovation.

AREAS OF INNOVATION

PRODUCT

PROCESS

MARKETING

ORGANISATION

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KNOWLEDGE IS KEY

Industry (blue speech bubbles):
- Employees / Problems from Appl. Domains / Experience
- Attract People / Better Products / Stronger Brand / Improved Revenue & Competiveness
- More skilled employees / New Processes and Tools / New Technology

Center:
CONFERENCES, WORKSHOPS
PHD/MASTER THESIS
JOINT RESEARCH PROJECTS

INDUSTRY

ACADEMIA

Academia (red speech bubbles):
- Researchers & Students / Need for Research Problems / Need for Emperical Results
- More Students / More Researchers / Better Education / Academic Merits / More Funding
- Better students and researchers / Input to education / Academic Papers

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HOW SWEDEN WILL BECOME AN INNOVATION CENTER

To reach the position of Sweden as the innovation center for software development, requires that the area of software development have to be acknowledged as a cross-domain discipline that deserves its own focus, instead of being a sub-field of traditional industry domains to ensure vital knowledge transfer.

The Swedish software community is ready for action. Internationally recognized research in software development has been built up at several Swedish universities during the last two decades. For instance, several Swedish academic researchers are among the most cited in the field. This position of strength could be utilized as a backbone for competence development. Several major industrial players have also established cross-sector collaboration, as well as industry-academia collaboration through the organisation Swedsoft, which through its members organise a majority of Swedish software intensive companies. Swedsoft is ready to be extended to cover other stakeholders, both within industry and public domains, where software is a central part.

MAPPING OUT ACTIONS TOWARD THE INNOVATIVE FUTURE OF SWEDISH SOFTWARE DEVELOPMENT

To successfully implement the strategy of this agenda activities and actions will be organised, specifically aimed at addressing the identified strategic areas. Increasing industry disruption and fast change is transforming the software business towards agile and lean ways of working, which also need to be recognised in this agenda requiring that we organise its activities accordingly. A critical part of this is the ability to present results that facilitate continuous evaluation of progress, e.g. by demonstrators.

The following activities are identified to stimulate cross-domain knowledge sharing and innovation.

- Creating meeting places and networking opportunities across industry such as ICES, SIGRUN, Software Center and Swedsoft and other regional actors.
- Provide technical incubators for start-ups, providing software competence for new and growing companies.
- Competence supply through making the field attractive to students, and with increased efforts to create high-quality education including continued training and education. Such efforts will be supported by an increased emphasis on research, and networking efforts.
- Investigate the need for demonstrators and testbeds that can be used across programs.

In addition to the actions and plans presented above, there are other factors that influence a successful execution of this agenda. To list a few relevant factors, these include:
- Immigration laws affecting PhD students
- Visas and work permits for experts
- Business climate in Sweden, including taxes and seed capital
- Education in grade school

For Sweden to remain in a leading position requires world class software development, both for innovation of new products, services and business models, and for continuously improved productivity in product research and development. This agenda shows that there is significant potential to achieve this and that software is also a key enabling technology for sustainable national growth.
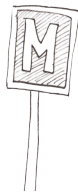
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Swedsoft is a cross-boundary Swedish
industry initiative to strengthen our
country's competitiveness with
regards to software.

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