The Information Driven Society

SIO programme description

Content

1 The strategic innovation area

1.1 Definition of the strategic innovation area

Information is power - those that fail in the information race will be left behind. At the same time, ICT is becoming increasingly data- and service centric. Application focus is steadily shifting towards extracting value and creating services from the massive amounts of data created, and compute, storage and communication resources are more and more viewed as services rather than hardware platforms. This puts huge demands on a combined analytics and communication infrastructure. It constitutes a paradigm shift in the way ICT systems are viewed, and in how information is handled and valued in society. Managing and extracting value from data is the crucial competitive advantage for the future.

New winning ICT infrastructures will need to combine data analytics (distributed and stream-based), cloud services and networks in a sustainable way and meet new service requirements. Those that can achieve this will be in an advantageous position to create innovative and highly relevant services and solutions for businesses and end users alike. The potential gain while great, will only be fully realised if the cost of obtaining and processing the data can be made clear and affordable as well as energy efficient for both existing needs and for future scaling up.

This programme will put Sweden at the forefront of this paradigm shift. Driven by the need from industry to address this opportunity and challenge, the Big Data Analytics Network has developed an Agenda to guide the creation of this programme. The proposed SIO office intend to ensure substantial competitive advantages both in traditional industry (such as communications and automation) and in the fast developing digital services area (largely built on completely new value chains) by taking a complete overview on how to address the following key areas: the data-driven services themselves, the infrastructures supporting them, the end-user interactions with them and their overall impact on society[1].

The information driven society

An unprecedented growth of data (fed by novel technology, user behaviour and business models) constitutes a dramatic development in both ICT and society at large. Most of this data is Big Data, characterized by vast volumes, high velocities, and a large variety. We are rapidly moving towards real-time Big Data analytics applications that will serve as enablers for both smarter end-user applications and efficient management of large scale systems such as transportation networks or energy grids. They are key components in the push towards autonomics in future large, heterogeneous, and complex information and communication technology systems.

At the same time, novel Cloud technologies have not only become fundamental in the creation of these Big Data applications, but they have changed our perspective on how we view compute, storage, and network resources, as well as the business around them. In the changing landscape for how new business is created, ICT resources are increasingly provided as elastic services, enabling small actors[2] to quickly build large-scale services with global reach. Today mostly confined to large data centres, these technologies will spread to smaller scale clusters and individual, end-user devices. As this happens, services will let go of their ties to specialized hardware and move into these distributed and heterogeneous clouds - clouds which by providing functions for data processing and analytics as abstract processing layers drastically will lower the barriers to entry for new service developers.

In short, next-generation computing and communication systems are becoming both pervasive and increasingly data- and service-centric. The impact will be profound. Health services such as real-time prediction of epidemics and data-driven diagnostics will make for an efficient and personalised health care when needed. By enabling better traffic control combined with autonomous vehicles and smart, autonomous energy grids, society can reap the benefits of a low emissions and increased energy efficiency. Industrial production and maintenance will become dramatically more efficient and reliable. Real-time information on global environmental changes will be effectively derived from Big Earth Observation. Democracy will be enhanced by better decision support and citizen access.

The business opportunity is huge. Forecasts vary between analysts but all agree that Big Data is growing rapidly[3]. IDC predicts that Big Data revenues will hit $32.4 billion by 2017[4] , which is conservative compared to the over $47 billion forecast by Wikibon. It is sometimes hard to grasp the magnitude of the change further ahead. The best comparison, and one that is often made, is that it is of the same magnitude as the industrial revolution.

Topics and work areas

With the goal of supporting innovation within information-driven services using Big Data analytics techniques and cloud technology, we will structure work into four interconnected thematic areas: A: Extracting value from data, B: End-user involvement, C: Cloud services and infrastructure, and D: Data access and networking. While the core focus of the programme will be on information driven services, Big Data, and analytics, we will also develop and apply key technologies in supporting areas such as Cloud computing and Networking, data centre management, and the Internet of Things to both build the ICT infrastructure of the future and to successfully integrate it into Swedish society. Each programme initiative is expected to span across several areas to ensure relevance and possible involvement of all affected actors

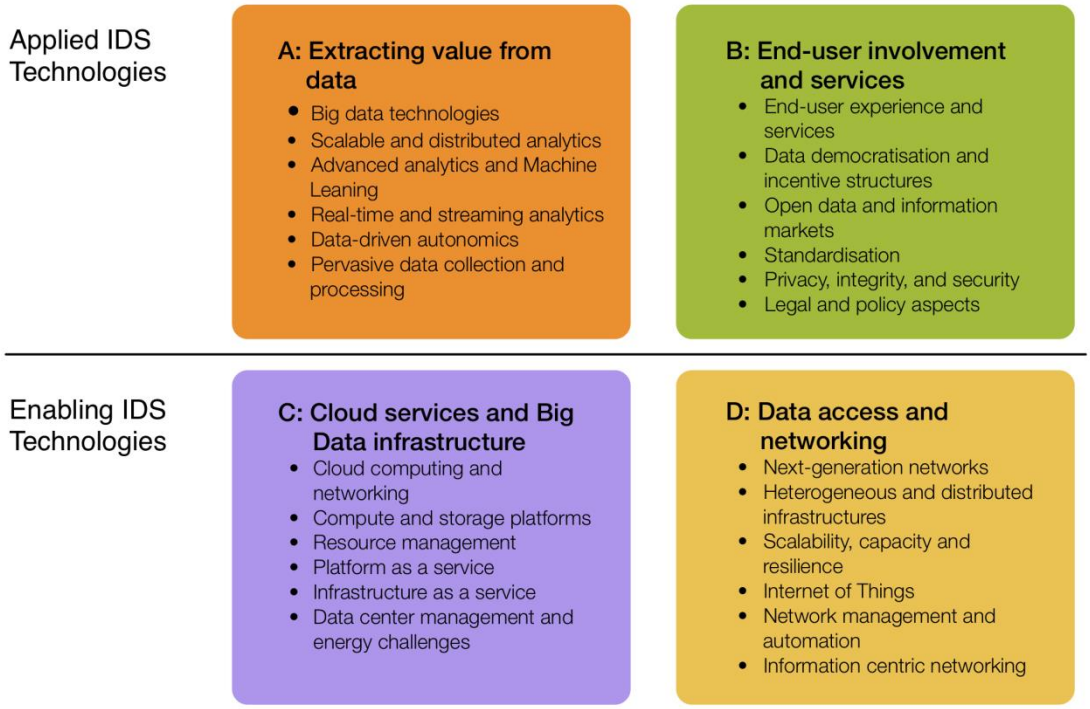

Figure 1: Thematic areas of the SIO programme

1.2 Current position of the innovation area

Sweden is a world leader in ICT, with more than 100 000 employees within the industry and 100 000 more in directly related areas such as the automation and automotive markets[5]. Ericsson is regarded as the fifth largest software company in the world[6]. Currently, the ability to use and refine data is changing the innovation lifecycle, and is acknowledged to be one of the most important competitive factors in the future [1, 4]. At the same time, service exports have grown faster than commodity trading over the past twenty years and the service content of export goods is increasing rapidly in Sweden[7]. These developments create enormous opportunities within information driven technologies and services for both i) established Swedish industries like Ericsson, Vattenfall, ABB, Sandvik, and Volvo, and ii) new ICT-oriented businesses and value chains such as Recorded Future, Gavagai, Findwise, King.com, Klarna, iZettle, KnCMiner and for iii) the Swedish society through organizations such as SCB, The Swedish Transport administration, the Swedish National Land Survey, and the Swedish Environmental Protection Agency.

Sweden has a unique position in this shift in ICT perspective that can be leveraged to provide gains in competitiveness well beyond the investment level. More specifically,

- Sweden is a world leader in ICT, with a relatively small but highly digital population. This makes Sweden a very good testing ground for new applications and services, both for end users and in society and industry.
- There are world leading companies in Sweden to build on: for example, Ericsson is in an excellent position to provide cloud and connectivity products and services, as well as cloud and in-network analytics solutions, ABB is at the forefront of automation, Volvo is equipping all trucks with telematics gateways, and there is a growing digital service industry with companies such as Narrative and Spotify.
- Traditional Swedish industry is relatively mature from an ICT perspective, which means that the uptake of data-driven solutions is drastically simplified.
- Sweden is an innovation leader[8] , developing large numbers of technology patents and new ICT solutions each year. This innovation climate will be essential in bringing data-driven services into use throughout society.
- Sweden has a long tradition to gather, store, and analyse data on its citizens - This register has been kept since 1631 and was computerized 1964[9].
- Swedish companies as well as the Swedish public sector generate and collect large data sets of high quality today, e.g. in healthcare, from the Swedish Land Survey data, and Swedish Statistical Offices (SCB). In many respects, Sweden is a world leader in data quality.
- Sweden has a strong research tradition in fields such as data analysis, statistics and computational frameworks. High quality applied research is another national strength, enabling industrial actors to leverage further on large data sets in collaboration with research institutes and academia.
- Sweden has a unique tradition in the public-private collaboration that is necessary to successfully implement a fully information-driven society, where industry, public, and policy actors can join forces to ensure data availability, a functioning infrastructure and long-term access to competence.
- Sweden is a military stable region, renowned for its stability in political and legal issues, its neutrality in conflict and its egalitarian ambitions. This leads to a safer home for innovators in the future information society.

- Sweden stands out as an ideal destination for data center infrastructure operations, climbing from eighth in 2012 to a third place in 2013 in the latest rankings[10]. Sweden performs especially well in sustainability due to a high percentage of renewable energy, and has mission-critical infrastructures and a fitting cold climate that attracts large companies such as Facebook and entrepreneurs like KnCMiner.

All in all, we believe that these advantages make Sweden an ideal place to implement the first fully information driven society.

Supporting this Sweden has world-class research and innovation within Cloud, Big Data, and communication technologies and close ties to world-leading universities and companies such as UC Berkeley, MIT, Stanford, and Google. Outstanding examples include:

- KTH, with world class research, notably in distributed systems, Big Data platforms, analytics, visualization, and applications in sustainable cities, smart transport, global land cover mapping and monitoring. PDC as an excellence centre for HPC.
- SICS, with research efforts throughout the Big Data analytics stack, from data collection through to storage and compute platforms and data analytics.
- Chalmers research is in the international front line of Big Data, analytics and visualization, and has an industry driven initiative around Big Data.
- Stockholm University carries significant research weight in the areas of data and text mining and in various application areas in like healthcare and transportation.
- Linköping is a world leader in visualizing Big Data sets, and performs research within several relevant areas such as networking, optimization, and statistics.
- The Karolinska Institute (CMM) combines research excellence in molecular biology and bioinformatics with software engineering and Big Data analytics.
- Umeå research excellence centres on for example data centre and cloud management and control.
- Luleå excels in applied research and particularly within areas pervasive and mobile systems and data centre management. A major actor in the LivingLabs network.
- Lund's research specialities cover for example cloud management and the associated newly started MAPCI, working in the area of distributed cloud services.
- Högskolan i Skövde has a long research track record in machine learning and data fusion both of which are increasingly used in Big Data.
- Halmstad University's research strengths lie within data analysis machine learning and have a focus on streaming data applications.
- Victoria Institute excels in applied research on data-driven service innovation.
- Uppsala University conducts world-leading research for example within the Internet of Things, grid-, and cloud computing.

Many public funding opportunities and related initiatives currently exist that can be leveraged to create critical mass. In Sweden, these include:

- EU Horizon 2020, primarily in the LEIT ICT programme with a 2014 budget of around 700 MEUR, but also in the societal challenges where six out of seven challenges contain ICT-related topics. EU ECSEL, more specifically ARTEMIS, is relevant for data acquisition. Further, there is national funding through EUREKA, with ITEA3 and Celtic Plus.

- The European Institute of Technology (EIT) and specifically EIT ICT Labs is significant source of funding for related activities funding of about 10.5 MEUR in Sweden per year. EIT InnoEnergy could provide funding from its annual budget of 69 MEUR, along with EIT calls within the area of Health.
- Other Vinnova programs such as FFI, VinnVäxt, and already running SIO programmes are potential contributors to Big Data research and innovation.
- The Swedish Energy Agency funds research that can contribute towards a more sustainable society where cloud, Big Data solutions and their energy footprint reduction are becoming increasingly important.
- The Swedish Foundation for Strategic Research funds research with about 550 MSEK per year, part of which is applicable to this area.
- The Knowledge Foundation (KKS) funds research with about 350 MSEK per year. Part of this funding is likely to be highly relevant for this programme.
- The Research Council (VR) allocates around 1500 MSEK per year to research within natural and engineering sciences, part of which is likely to fund research related to this programme.
- The Wallenberg foundation funds research and research infrastructure with about 1400 MSEK per year, applicable to Big Data infrastructure and applications.

A major source of research funding within this area however is expected to come directly from industry not solely from public funding agencies. A lot of possible research themes directly influence the competitiveness of the companies involved. This often involves the retention of sensitive data that cannot be disseminated outside of the organisation. Such issues are increasingly driving directly financed research within the area, either at universities and institutes or internally.

1.3 International competition for the strategic innovation area

Competitiveness of Sweden

The stability of the Swedish political, business climate and interest in new ideas contributes to a healthy innovation region. Stockholm is renowned for being internationally competitive and is often named when the top ten cities of the world for start-ups, the number of Swedish tech meetups, TEDx conferences, and gaming and hacker meets are referenced. Sweden is also in the top five nations when it comes to the speed of being able to register a new business, with any legislation changes being less disruptive than for those of its neighbouring countries. We as a nation also have a relatively non-restrictive immigration policy, with good access to finance, some available tax support and relatively simple digital administration for new start-ups. Recent PISA study results have prompted very large funding for educational attainment, including SEK 100 million per year in the next five years for mathematics and applications of it, in a national synchronised effort.

There are numerous Swedish companies in the area at hand, with a distinctly Swedish approach to Big Data analytics. Established companies include Ericsson, Sandvik, SKF, SCB, Volvo, Vattenfall, SCA, LKAB, Boliden, Swedish Land Survey, and others. A vibrant start-up scene has produced new companies. For example, QlikTech was founded in 1993 in Stockholm and today has 28.000 customers in 100 countries, branching out to Big Data in recent years. Expertmaker, founded in 2006, has branched out to Silicon Valley, rather than the other way around. Narrative is an example of a Swedish start-up with vast crowdfunding ($550,000 on a pledge for $50,000) complementing other capital (including $3 million from True Ventures) and other assets - it builds on an existing data innovation community of life-loggers and those interested in the Quantified Self. The most explosive growth in a Swedish company within the area is most likely Spotify, currently

with six million subscribers and 24 million active users, each leaving daily digital trails for analysis.

International innovation clusters

Silicon Valley - the mother of all ICT clusters Silicon Valley is home to thousands of technology-related start-up companies and some of the world's largest technology corporations, including Apple, Google, Yahoo!, linkedIn, Facebook, eBay, Facebook, and Amazon. Ericsson employs 1100 people in Silicon Valley. Innovation in Big Data analytics and data centre technology is today, to a large degree, driven by companies based in and around Silicon Valley. The SIO has established connections to this cluster through Chalmers, KTH and Ericsson's Silicon Valley office.

Silicon Alley - The high-tech cluster in New York City, which is trying to reinvent itself as a tech and start-up hotspot, has been dubbed "silicon alley". It is one of the fastest growing clusters in the US. There are 262,000 workers in the growing New York tech and info sector. With a tradition in data-intensive industries such as media and financial services the area is uniquely positioned to attract investment in Big Data analytics. As an example, IBM is investing $1 billion to create a Watson business division located on Silicon Alley. Established connections to this cluster are through SICS and IBM.

MassTLC - The MassTLC Big Data Cluster is located in Massachusetts, USA. It is dedicated to sharing knowledge, fostering innovation and expanding the Big Data ecosystem in Massachusetts where over 100 Big Data companies are located. It is a cluster with expertise in database, infrastructure, and application software, as well as communications and storage technologies. Through events, research, and policy initiatives, the MassTLC community has a strong voice in the Big Data revolution. Connections lay with Recorded Future and SICS.

Tech City - Launched in November 2010 with generous tax breaks and start-up grants, Tech City, a five-square-mile slice of east London, is the UK's biggest high-technology hub. According to the Department for Business (Innovation and Skills), Tech City has doubled the number of technology businesses in this run-down area of London and created more than five hundred new jobs. The area has attracted Google and Microsoft to set up business incubator units near Tech City's epicentre, the Old Street roundabout, appropriately dubbed "silicon roundabout". BT is a connection via EIT ICT Labs.

Other - There are also strong clusters with focus on Big Data in Israel (Tel Aviv, Haifa), Singapore and Russia (Skolkovo) all with connections to the Big Data Analytics Network.

Relevant research groups internationally

UC Berkeley AMPLab - AMPLab (Algorithms, Machines, and People Lab) is a five-year collaborative effort at UC Berkeley addressing Big Data analytics problems. Software components built by AMPLab is integrated in the open source Berkeley Data Analytics Stack (BDAS). It has already been used in Swedish projects, e.g. a joint work between SICS and Ericsson for mobile phone traffic modeling. AMPLab works with several companies and start-ups, e.g. Databricks, founded by the creators of Apache Spark.

TU-Berlin DIMA - The Database Systems and Information Management Research group (DIMA) conducts research in the field of information management on cloud through the Stratosphere project. Stratosphere is the European counterpart of Spark and exploits the power of parallel computing for complex information management applications. In 2012, eight Universities and research institutes started a consortium to productize Stratosphere through the Europa-EIT project. SICS and KTH are contributing to Stratosphere.

MIT Big Data - The MIT Big Data Initiative launched in May 2012, aims to develop scalable systems and platforms across multiple application domains.

MSR Distributed Systems (Silicon Valley) - MSR distributed systems conduct research activities ranging from protocols and algorithms to decentralized architectures and services.
Imperial College LSDS - The goal of the Large Scale Distributed Systems group (LSDS) is to support the design and implementation of large-scale distributed systems. The research areas covered by LSDS are distributed systems, software systems, networking and databases.
EPFL DIAS - The Data Intensive Applications and Systems lab (DIAS) handles challenges in database software and data-intensive applications.
Cambridge University Computer Laboratory - The research in this group is mostly concentrating on large-scale graph processing. GraphCam, as a joint project between Computer Laboratory and EPFL, aims to understand the difficulties and bottlenecks in large-scale graph processing.

Related international research and innovation initiatives

At the European level, Big Data analytics and cloud technologies are recognised as critical development areas[11]. The Horizon 2020 work programme stresses Big Data and Cloud, which are also important in EIT-ICT Labs and in the Advanced 5G Networks PPP. Nationally, running projects such as End-to-End Clouds and Information-Driven Secure Business Intelligence pull in the same direction. Related regional initiatives include the CloudBerry data centre initiative in Luleå.

In US the NSF and the department energy has many initiatives. A consortium with Rutgers University, University of Chicago and University of California at Santa Barbara is leading in renewables and cloud.

In UK the Minister for Universities and Science has announced the release of £14 million to fund the second phase of the ESRC's investment in Big Data. This step to strengthen the UK's competitive advantage in Big Data will be used to support the establishment of the ESRC Business and Local Government Data Research Centre's at Essex, Glasgow, University College London (UCL) and Leeds Universities. Several other national initiatives are also being formed in European countries - examples including the Italian Trento RISE Association Open-Big Data National Initiative and the recent French allocation of 11.5M EUR to Big Data projects[12].

1.4 Contributions to solutions to global societal challenges

The main global challenge to successful adoption of Big Data analytics is access to automated and open tools, methods, and algorithms for intelligent data processing. While some U.S. companies, like Walmart, have since long declared an influence of Big Data analytics on their logistics chain, there are parts of the world (certainly including parts of the U.S.) that are less open in their support and their use of analytics. Economy of size and political support are drivers for industry, whereas societal values can arguably be seen as coming from critical thinking, and of more careful adoption of widespread use of intelligent data processing and data innovation. Such views would include privacy, personal integrity, and smart use of anonymization techniques.

There is a lack of best practice in managing intelligent data analytics as a corporate asset, including data quality, data provenance, data governance, and security platforms and tools. By contrast, modern science (like the SETI project and the largest semantic Web projects) has moved to hands-on employment of intelligent stream analysis, clustering, and many other forms of practical use. The promise for societal value - including the democratization

of information and ubiquitous access to ICT services - includes drivers for transparency and promoting bottom-up engagement in society and business, reducing the gap between rich and poor, between men and women. The move towards an information- and service-oriented society is a global challenge in itself however, and any such promises must be scrutinised, regardless of whether tax payer's money or industrial investments are at stake.

A number of megatrends have been identified by the Oxford Martin Commission for Future Generation[13]. These trends are interacting and global and include: Demographics (the world's population is drastically growing with the fastest group being the large ageing populations of the age of 60, a trend for which intelligent data analytics is vital for prevention and for understanding well-being and chronic diseases) and Mobility (urbanisation is occurring rapidly and there is a growing middle class, relevant because mobility generates massive amounts of mobile phone traffic and positional data). The report indicates that we collectively need to rethink corporate governance so that owners and boards embrace longer-term mind-sets and responsibilities to society at large. For this to be achieved, forecasting, back-casting, and strategic planning based on massive data analytics must be implemented and used, thus in general adhering to the principles laid out in this document.

1.5 Vision and future potential for the strategic innovation area

Our vision is that in ten years Sweden will be the first fully information-driven society, where policy decisions are made based on up-to-date information on the state of the community, where industry works with exceptional efficiency and competitiveness through efficient use of data and cloud services. We see a large number of new Swedish services and products based on information refinement in use all over the world. We envision Sweden having a cutting edge infrastructure supporting these developments, providing ubiquitous connectivity and compute resources; world-class expertise and utilization of information- and service-driven ICT; and an agile business ecology supporting exchange of information and development of new services. To reach maximum energy efficiency and user performance, data is transported instead of energy, i.e. the largest part of energy consumption is only transported to data centers while refined data is transported to end users. The excess heat of these data centers is re-used and the application latency is solved with distribution of the cloud and network infrastructure. This SIO program will be a critical catalyst in the realisation of this vision.

In the light of related international efforts - the US government funded a Big Data initiative with $200 million in 2012 with similar goals and the US ICT industry is investing billions - a Swedish SIO program may seem small. However, Sweden is in the fortunate position of being able to provide an excellent level of available ICT infrastructure and technology readiness is generally very high in industry and the public sector. Furthermore, Sweden has a very strong tradition in data availability and quality both in industry and public sector, between whom an excellent climate of collaboration exists. In total, this means a well-coordinated effort could provide gains in competitiveness well beyond any investment. Through coordinating our efforts with other funding opportunities a strategic collaboration and internationalization effort to quickly leverage international developments and the application of novel technologies in Swedish industry from day one, we believe that Sweden will be able to be at the forefront of the developments towards an information-driven society.

Industry Potential

Based on a report "Data equity - Unlocking the value of Big Data" from the Centre for Economics and Business Research Ltd (Cebr) in UK[14] , an industry estimate on economic benefits has been formulated. The bottom line of the estimate is an annual economic benefit for Sweden of almost 100 billion SEK by year 2020.

The Cebr reports for 2012-2017 an accumulated economic benefit of £216 billion in the UK. That number takes into account business efficiency in current industries other than ICT, business innovation in current Big Data and cloud ICT industry and the creation of new business in the Big Data & cloud ICT industry. Based on the assumption that Sweden implements this SIO program, that we can match the UK and that the industry benefits are similar, we arrive at the GDP-scaled version of the UK economic benefits.

The estimate includes business efficiency in current non-ICT industries like retail, banking, manufacturing, process industry, and transport. Big Data and cloud will be key enablers for value enhancement and operational benefits in the range of about 500 billion SEK accumulated for the period 2012-2020, see table below. New companies in the Big Data and cloud area will create an economic benefit of around 20 billion SEK annually. Job creation totally including all industries and indirect job creation is envisioned to reach 4 000 annually and around 35 000 accumulated over the period.

Benefits (Billion SEK)	Accumulated 2012-2020	Annually 2020
Efficiency in other industries	511	75
Efficiency in current Big Data and cloud companies	81	11
New Big Data and cloud companies	142	20
Total economic benefits	734	107
Total jobs created	34 800	4 000

Table 1: Economic benefits of the SIO programme

Part of its potential is the unique position to enable data centre infrastructure operations. It is estimated that growth for this specific area will be huge with 30 - 40 mega data centres spread all over Sweden. The vision for the zettabyte era is extreme efficiencies in sustainable data centers. The total accumulated job creation, including indirect jobs, is expected to be 8000-9000 jobs with an accumulated infrastructure investment of 25 billion SEK.

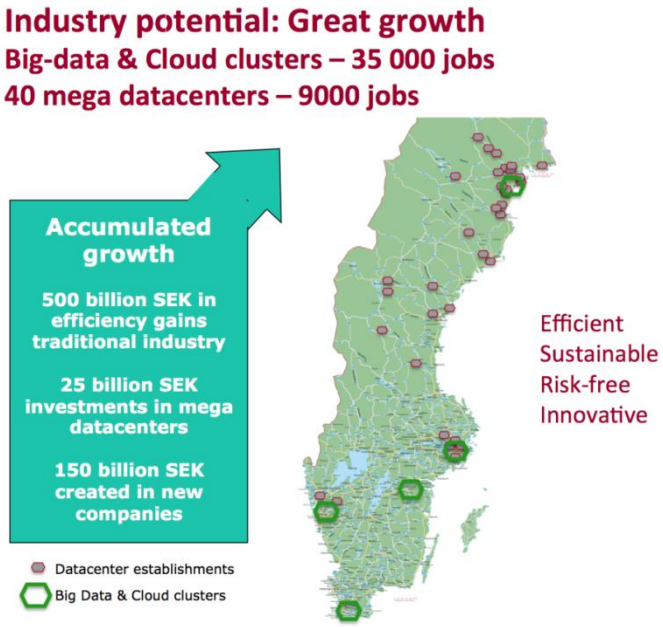

Figure 2: Growth potential of the Big Data and cloud industry

1.6 Most important needs to fulfil within the strategic innovation area

Sweden is in an advantageous position in data-driven services from an international perspective. The real potential lies in combining data from various sources over long periods of time and integrate public and private data in new innovative services on top of enabling cloud infrastructure and networking technologies. In an environment like a modern city, for example, all kinds of information is interconnected and should be treated as such. Wearable sensors whose primary purpose today is measuring performance during sport activities can also provide crucial information to doctors many years later. Travel data collected on city buses for diagnostic purposes today can be used tomorrow to improve traffic planning.

To realize such applications competence in analytics must be increased and widely disseminated to companies and public actors that can drive innovation, prompting knowledge transfer between academia and industry and a neutral, connecting party to achieve critical mass. To increase competence in the cloud infrastructure area and enable reference evaluations of new technologies, products and services an open large-scale infrastructure test environment is required. The technical innovation in this area is currently driven by large US companies including Google, Twitter, Facebook, and Amazon with their hundreds of millions of users. The US has invested significant amounts into this area and the EU plans to do the same. This SIO is broader and focuses more on future technologies (convergence of analytics, cloud, IoT and infrastructure) and includes a broader range of industries and public sector actors. Building on Sweden's inherent strengths in communication, energy and automation technologies as well as systemic innovation and environmental capabilities Sweden can with this proposed SIO leap-frog and take a lead in this broader process

2 SIO programme

2.1 Goals of the SIO programme

The overall goal of the programme is to make sure that Sweden has an excellent position at the forefront of the global transformation, developing an information-driven and ICT service-oriented society and where traditional Swedish industry, the developing digital services industry and the public sector are all included.

More specifically, we envision that

- *By 2024, Sweden will be the first fully information-driven society*. In ten years, Sweden will be the first country to fully utilise the information potential for end-users, industry and the society at large.
- *Within 10 years, Sweden will be established as the most attractive region for data-driven services*. Through a combination of available infrastructure, competence, and healthy innovation climate around data-driven services, Sweden will continue to attract a very large amount of foreign investment.
- *Within 5 years, Sweden will have a world-leading innovation rate within data-driven services*. Measured by the number of patents, papers, and new start-ups, Sweden ranks top 5 worldwide in data-driven service, cloud and networking infrastructure product innovation.
- *During the next 10 years, Sweden will have developed world-leading energy efficiency for data-driven services*. Within 10 years, Sweden will have a number of large data centers operating at world leading (top 100) energy efficiency.

- *Within 10 years, data-driven services and infrastructure will be employed on massive scale in traditional industry and new start-ups*. Data-driven services and cloud & networking infrastructure will be used in many new digital service and product start-ups as well as on large scale in traditional industry such as mining, manufacturing, automation, and transportation.
- *By 2019, the strategic innovation area will result in 300 MSEK per year in related funding*. Using the SIO program as catalyst, the area will have attracted the significant funding effort needed to achieve critical mass in Sweden.

Achieving these goals will put Sweden at the front not only of ICT development but also significantly increase competitive advantage in industrial and public sectors and see Sweden as a world leader in tackling global societal challenges.

2.2 Contributions for renewal of the strategic innovation area

Currently, the ICT landscape is shifting towards extracting value from the massive amounts of data produced, while compute, storage, and communication are viewed as elastic services rather than physical devices. This is a paradigm shift within ICT, a shift that Sweden must manage efficiently both to stay competitive as a provider of ICT infrastructure and services, and to realise the enormous potential gains in efficiency and new services in industry and public administration.

This programme will be an important catalyst in realising this shift within Sweden. While providing innovation within ICT services and infrastructure, this SIO will connect industrial and academic actors that have cutting edge competence within these new data-driven systems with traditional industry and public actors to create innovative and novel services.

2.3 Energy relevance

One of the most obvious benefits of Big Data analytics is the possibility of process optimisation and avoiding inefficiencies. This directly corresponds to energy savings across many domains. For example, the "smart grids" concept relies on collecting and analysing Big Data, which for transportation can save fuel by optimising logistics, whilst in manufacturing and retailing, a more accurate demand predictions can lead to significant savings as well.

A report[15] by GeSI demonstrates how the increased use of ICT could cut the projected 2020 global greenhouse gas (GHG) emissions by 16.5%. This is equivalent to more than seven times the ICT sector's emissions over the same period. The SMARTer2020 report evaluates GHG abatement potential from ICT-enabled solutions across six sectors of the economy: power, transportation, manufacturing, consumer and service, agriculture, and buildings. Still, with the Swedish data centre operations opportunity in mind, the increased use of Big Data and ICT services will increase the energy use in data centres both globally and in Sweden. A recent study[16] shows that the growth rate is 7% during 2013. The total power use is 40 GW globally and will increase.

Using the IDC data growth predictions and applying the improvements, there is still a doubling of data centre infrastructures to 2020 combined with a less than acceptable doubling of the energy use. More research in energy efficiency is a must, requiring Sweden to get involved in several new areas such as design and construction of facilities, cooling, hardware, building automation and smart grid for data centres.

Sweden is in a unique position being able to combine environmental, energy and ICT technology research with Big Data and Cloud infrastructure technology development to address these many challenges. Sweden can take responsibility within Europe to improve

the environmental impact of data processing and storage by hosting more mega data centres in Sweden, combining the natural cold climate with local hydropower.

2.4 Other areas affected by the SIO-programme

In the informations Driven Society envisioned by this SIO program is hard to find areas that are not affected. The Information Driven Society is a fundamental change that will open up opportunities but also put new demands on governmental agencies, new and established companies in all industries. The SIO program will reach out and be both a catalyst and resource that can enable Sweden to be the leader in this transformation.

Sector or Actor	**Implications**	**Effects**
Other SIO programs		
Production and PiiA (Process Automation)	Large data sets can be collected from sensors (IoT) in machines and processes and analysed in real-time. Data can be correlated with other information.	Less product defects; Boosted quality; Improved supply planning, control and automation.
Light weight materials and metallic materials	Data collection in situ in experiments, no need for reduced data volumes for analysis.	Better materials using less resources for sustainability and durability; Faster time to market.
Mining and metal production	The ability to use and analyse geodata for prospecting; Sensors (IoT) in drilling and other equipment provide real-time data streams that can now be handled.	Improved profitability for companies like LKAB; Less resource usage and waste in extraction of raw material.
Other areas		
Healthcare and pharmaceutical	A broader view whereby clinical, financial and administrative data as well as patient behavioural, population and medical-device data plus other related health data, all can be combined and used for retrospective, real-time and predictive analysis. Ability to collect and analyse data from clinical trials and adverse drug reactions.	Health care more accessible at lower cost and at home; Aiding an aging population; Enabling preventive health care; Better and more cost-effective medication.
Governmental services	Methods and tools to follow the guidelines from “E-delegationen”, coping with and the ability to analyse the data generated.	More agencies providing open data; Better services for citizens; Better decision support for agencies to create sustainable solutions to societal challenges.

Forestry and agriculture	Near real-time monitoring of environmental conditions; Visualization of data.	Sustainable farming and harvesting of forest resources.
Government	Collection and analysis of data from citizens wishes, elections, referendums, and other democratic tools.	Inclusive governance where citizens feel understood and can influence decisions.
Transportation	The ability to combine and do mash-ups of relevant data sources to compute optimal resource use.	Lower consumption of fuel; Faster delivery of goods; Better planning.
Climate science	Tools to do whole earth science.	Ways to mitigate the effect of a changing climate.

2.5 Global challenges or developments that effect the SIO-programme

Industry and government have to cope with an exponential increase in data volume, velocity, and complexity. This creates challenges for operators and public bodies, institutions like the Swedish Royal Library (which has a full text archive obligation for publications), and individuals who are affected by personal integrity and privacy issues. It requires competence in ICT management and Big Data-related skills - something that every nation currently lacks - and to be able to explain to citizens the added (and potentially huge) value of using their anonymized data for extrapolating knowledge and providing new services for their benefit, naturally also linked to legal and policy challenges. The move to open or accessible data by governments and industry is set to be key but access and sharing remain challenges. Private initiatives like Google Public Data can be seen both as a driver and a threat to this development.

Data and information is increasingly interconnected and machine-interpretable. This holds for social networks, but also to an increasing extent for machine-to-machine (M2M) communication. We are moving into a world where all data is linked, constituting a global engineering challenge. The increase in energy use by technologies for refining and distributing this information is another challenge.

Risks that affect the program include:

- The relevant and important pieces of information deduced from massive data sets, and even massive data sets in their own right, constitute a costly resource of considerable value, which places it at the risk of theft.
- Since a large part of the data amassed concern technological and socio-technical systems, there is a risk for strong and difficult to interpret bias in the analytics. This risk increases in view of the fact that much of the methodology of intelligent data analytics is still under development and test.
- During the last 15 years, there has been increasing interest from governmental and private organisations in using data outside its normal uses for surveillance and marketing purposes. This has generated discussion of privacy and data protection issues, and comes with a risk of policy or legislation blocking responsible use of massive data sets.
- The gap between European and U.S. Big Data and cloud research and development is increasing. Legislation, commercialization, and the engineering cultures are different, but the means to measuring innovation and progress also deviate, making

success measurements difficult. The risk is that KPIs and simple measurements obscure true progress and disruptive innovation.

Challenges for the area include:

- Understanding data (text, images, sound/video, 3D objects). The volume and complexity of data requires new methods to present and to interact with data.
- Data integration and dissemination. The large number of actors, platforms, and tools result in inefficiencies. Silos must be broken and standards agreed upon.
- The creation of new value chains for data and analytics
- Scalability and energy efficiency: The creation of cost-efficient solutions that can handle the increased data volume and complexity at an acceptable energy cost.
- Accelerating time to insight and the validation of intelligent analytics.
- How to monetise on new types of data. Societal value is often easy to grasp, but how does industry introduce this into their revenue models?
- Lowering the cost of data collection. While the value of data is significant, the cost involved in obtaining it using current technology is often inhibitive.
- Shifting from legacy systems (SQL vs. NoSQL as an example) and scaling in engineering efficiency. Data-driven services and Big Data applications must be easier to develop and maintain compared to using today's tools.
- Policy and legal uncertainties. What we can and cannot do with data must become clearer.
- To enable the information-driven society with data collection, aggregation and analytics, a new fully scaled network infrastructure beyond current 4G system is needed.

Finally, examples of opportunities within the area include:

- The open source community is strong and growing. Large companies and universities are taking proprietary methods into the open.
- Real-time stream data mining. The need to store data is reduced, meaning that real-time services operating on high-velocity data can be created.
- User-controlled privacy can address privacy concerns at the individual and NGO level, in part propagating to industrial and governmental levels. This may also solve some surveillance issues.
- The data visualisation boom will bring new ways of presenting and interacting with information.
- Cooling technologies in the cold Nordic climate using air, water, snow and ice combined with closely located Hydro and wind power availability for clean energy operations.

2.6 Expected results and effects

Vision and goals of strategic innovation area	Results and effects	Actions and activities
By 2024, Sweden will be the first fully information-driven society	*Results:* New knowledge, competence, innovation, and collaboration opportunities *Effects:* Drastically improved international competitiveness and societal efficiency	*All*

Within 10 years, Sweden will be established as the most attractive region for data-driven services	*Results:* Excellent industrial, public, and academic networks; person and competence mobility *Effects:* International investment in Sweden, new services and product & service companies	*Business and policy, Information Academy, Collaboration and internationalization*
Within 5 years, Sweden will have a world-leading innovation rate within data-driven services	*Results:* Infrastructure and platform innovations, implementations across industrial and public sectors *Effects:* Increased exports and attractiveness for capital and talent	*I-combinator space, 360 Collaboration and development, Megawatt challenge*
During the next 10 years, Sweden will have developed a world-leading energy efficiency for data-driven services	*Results:* Innovations in data centre and infrastructure efficiency, collaboration between ICT actors and energy providers *Effects:* International investment in Sweden, a sustainable ICT infrastructure and services	*Megawatt challenge, I-combinator space*
Within 10 years, data-driven services and infrastructure will be in use on a massive scale in traditional industry and new start-ups	*Results:* Competence supply and transfer, collaborative application and infrastructure development *Effects:* Increased competitiveness, industrial efficiency and exports	*360 Collaboration and development, Information Academy*
By 2019, the strategic innovation area will result in an extra 300 MSEK per year in related funding	*Results:* Enabling a number of Horizon 2020, EIT-ICT labs, and other EU projects; alignment with US (e.g. NSF) projects; coordination of national funding; attraction of direct investment from companies *Effects:* Sweden will be a lead innovator in these areas	*Programme office, Collaboration and internationalisation, Business and policy*

2.7 Actors

The developers of the Agenda and the actors behind the SIO programme are Ericsson, IBM, AB Volvo, Vattenfall, Novartis, SKF, Sandvik, NCC, ABB, Bahnhof, Spotify, Narrative, HiQ, Findwise, Future Position X, TIBCO Spotfire, SWECO, SAS Institute, CSC, Teknikföretagen, Volvo Cars, Recorded Future, Gavagai, Lincube Group, Findwise, MTC, Swedish Standards Institute, Tullverket, eGovLab, National Library of Sweden - KB, KTH, Stockholm University - DSV, Karolinska Institutet - Computational Medicine, Chalmers University, Uppsala University, Luleå University of Technology, Linköping University, Högskolan i Skövde, Lund University - MAPCI, Halmstad University and SICS. All these actors intend to participate in the programme activities or board.

The main target groups of the programme are i) established Swedish industries, ii) new ICT-oriented businesses and value chains, iii) public administrations, iv) universities and research institutes, and v) consumers and citizen groups.

i. Established Swedish industries. Within process, automation and manufacturing industries, an increased ability to analyse data will provide not only a better basis for business decisions, but also open up the possibility for much more efficient and

autonomous operations as well as new service offerings. Telecommunications are currently witnessing an integration of cloud and data analysis services into the network, while network functionality is rapidly moving to virtualised processes in a cloud. It is imperative that Swedish actors, most importantly Ericsson and other telecom operators, can achieve this shift and stay ahead of the competition.

ii. New ICT-oriented commercial players. Sweden has a strong ICT sector, employing at least 130,000 people (a figure due to rise)[17]. Several participating actors are already at the forefront of information-driven services, such as Spotify, Narrative, King.com, Klarna, and iZettle; and further establishments are likely to provide support. New start-ups and entrepreneurs must be able to focus on their advantages and innovations, and trust the infrastructure to provide basic processing and analytics layers. This programme will provide interfaces to such processing layers and concrete baseline implementations for analytics methods. With Facebook's establishment of a data centre in Luleå and a second site now approved, and KnCMiner building a center in Boden, we are also seeing the beginning of a service ecology consisting of both smaller and larger companies.

iii. Public Administration. There is an enormous untapped potential in employing analytics in the public sector, e.g. for data-driven socio-economic planning. Extracted relevant information can provide policy makers with detailed descriptions of society in order to make better-informed decisions in both operational situations and at strategic crossroads e.g. for planning cities based on the mobility and behavioural patterns of the residents, as well as electricity grid investments based on trends in energy usage behaviour. The Swedish government has declared in its public administration strategy that it should be more open and innovative through the use of open data and open solutions[18].

iv. Universities and research institutes. Universities and research institutes are increasing their focus developing tools and methods for pervasive data collection, advanced cloud technologies, and Big Data analytics. Corporations with data streams of interest are today unable to share the data thus reducing the relevance and effectiveness of research. This programme will make possible the informed study of big data by non-commercial actors and by making data available through direct collaborations.

v) Consumers and citizen groups. Big Data is also collected by observations of the public at large, such as usage data from services, information shared on social networks, and data mined from such sources as electronic patient records. With the advent of more efficient analytics, such data offers a formidable tool for understanding populations. This will increase the information imbalance between those with access to analytics and those who are being analysed. Proposed legislation such as "the right to be forgotten"[19] is of little use unless data are contextualised so that the individual can assess their impact. This programme will develop information access tools for the public at large and contribute to legislation protecting the individual.

Participants from all groups will be invited to participate in the programme. To ensure that all relevant actors are able to influence and participate in the programme, the Big Data Analytics Network will be open to all interested actors. Through continuous development of the research and innovation agenda in cooperation with all partners, both old and new, the relevance for all actors will be ensured.

The programme office will actively seek engagement from actors in areas where participation is currently low, such as smart grids, retail, transportation, health and from new start-ups. The programme office will also coordinate additional funding for the area,

within Vinnova programmes such as FFI, Vinnväxt and Forska&Väx; national funding programmes from KKS, VR, SSF, and Wallenbergstiftelserna; European initiatives within Horizon 2020 and related calls; and the alignment with US programs when possible.

3 Coordination of SIO-programme

3.1 Organization and leadership

The Information Driven Society is a vision that will be realised through a number of concerted efforts. These efforts will be guided by the strategic research agenda, which will be continuously updated through the open actor association behind this programme. Given the number of instruments (projects, conferences, meeting places), the heterogeneity of the area, and the speed with which the development in this area moves, this will be a formidable task. The proposed governance structure takes this issue as its starting point.

Orchestrating all activities will be a programme office lead by a dedicated Director, who will be the primus motor of ensuring that the goals will be achieved. This person is not merely an administrative person, but rather an initiator, mediator, and facilitator of actions in the programme.

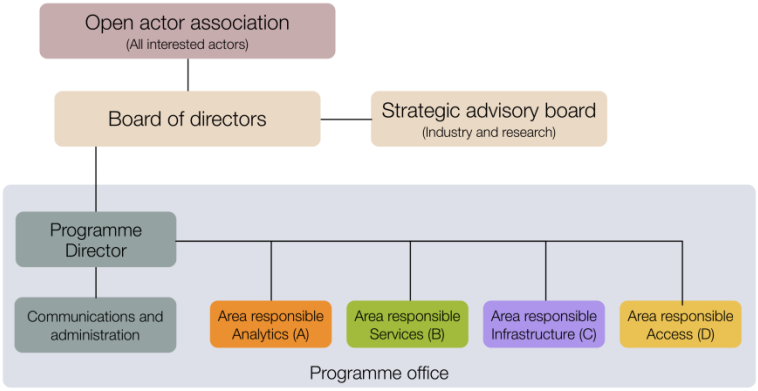

Figure 3: Governance structure of the SIO programme

The Director will be supported by a communications manager to help manage contacts, dissemination and call preparation. Furthermore, the director will be supported by four area responsible players, corresponding to the programmes thematic areas. These will be people working in each area with a relevant contact network, and will make sure that the programme can reliably follow developments and introduce relevant actors. They will be appointed by the programme director and will work part time at the programme office.

Above the Director there will be a Board with representatives from industry and academia. This Board will set the goals of the programme and makes decisions based on principles and indicators for the programme. It will also provide strategic advice to Vinnova on calls.

The Board will be elected by an Association created for this purpose and will comprise of the companies and research organisations listed in this document. The Association will provide rules for adding and removing member organisations, and will be open to all organisations that wish to participate. It should be noted that the programme is for the good of every organisation in Sweden, but that the stewardship of the programme needs to be handled in a practical manner. In particular, the Association must ensure that SMEs are promoted in the programme.

The Director will also be assisted by a Strategic Advisory Board, appointed by the board of the programme. This advisory board will comprise of experienced academic and industrial representatives. Key tasks of the Advisory Board will be ensuring a proper balance between academic and industrial focus, balancing dissemination and the search for new solutions and to ensure that the programme stays relevant, given trends and changes.

3.2 Project plan for the coordination of the SIO-programme

Priorities

In order to get operational quickly, the first four actions of the programme are to:

- Establish the organisational framework, i.e. the Association and the Board, and appoint staff.
- Establish goals, principles and indicators.
- Produce the first call, initiate pre-studies and activities.
- Create early visibility e.g. through events.

As much as possible, these four will be handled in a parallel lean manner, to avoid unnecessary delays. With this type of approach, constant feedback and communication within the team and leadership is key. Other tasks important while running the programme:

- The continuous creation of road-maps.
- Portfolio and network management, to ensure a reasonable coverage of the area.
- The participation and engagement in the creation of national and European policies and initiatives.

The start-up phase

The start-up phase will run between 2014-07-01 and 2014-12-31 and focus on the first four actions listed above. In collaboration with Vinnova and the other involved actors, a research and innovation programme will be developed that can start all major initiatives in January 2015. During the start-up phase, the consortium will be consolidated and expanded to cover all needed relevant actors. This will be managed through both bilateral communication between the programme directors and individual actors, and during open workshops and meetings.

Deliverables and milestones for the start-up phase are:

- An interim board of directors and advisory board in place on 2014-08-31.
- Candidates for all positions and the boards by 2014-11-30.
- An elected board of directors and advisory board finalised by 2014-12-19.
- An updated research and innovation agenda to guide the start of the programme finalised no later than 2014-12-15.
- Contacts and initial cooperation agreements made between the programme and the most important international actors, 2014-12-31.
- A plan for educational programmes in collaboration with universities and EIT-ICT, available 2014-11-28.
- An open Information Driven Society kick-off in November 2014.
- Communication and collaboration infrastructure in place on 2014-09-30, including printed materials, a website, a discussion forum, and a presence on social media platforms such as Twitter and LinkedIn.

Continuous operation

The detailed plan for the continuous operation of the SIO programme will be defined during the start-up phase. The initial plan is to have a yearly cycle, based around a creation of road-maps that drive the work of creating two calls and two major events per year. There will also be a regular overview of the portfolio and partnership structure, and of the goals and indicators of the programme.

3.3 Budget for coordination of the SIO programme

3.3.1 Budget for start-up phase

The start-up phase will require considerable effort to correctly set the goals, procedures, and structures of the programme, meaning a higher cost per month for the coordination than during the continuous operation.

Activity	Cost (SEK)
Programme director	400 000
Area responsible	400 000
Programme administration	50 000
Premises	20 000
Travel	30 000
Marketing and communication	20 000
Meetings and conferences	10 000
Total	930 000

Table 2: Budget for the start-up phase of the SIO programme

3.3.2 Budget for operating the SIO-programme

Activity	Cost (SEK)
Programme director	1 200 000
Area responsible	600 000
Programme administration	800 000
Premises	100 000
Travel	100 000
Marketing and communication	60 000
Meetings and conferences	80 000
Total	2 940 000

Table 3: Budget for operating the SIO programme 2015-2017 (per year)

4 Proposed actions and activities in the SIO programme

Six initial initiatives are proposed that will create innovation towards the vision of the information-driven society. Because of the revolution ahead, it is imperative that this programme reach new as well as established actors. This SIO therefore proposes actions where unexpected actors should be expected and strategic activities are the major focus instead of a traditional, research led, call based approach. It is in this mix of experience, the will to learn new things and create that innovation blossoms. Emphasis is also on learning and expanding the required competence level in Sweden, and produce value through exploitation in the short and long term.

4.1 Existing actions and activities to be used within the SIO-programme

We will exploit synergies with ongoing and planned projects and activities in all programme actions, and the bulk of the financing will in many cases come from these external activities (Please refer to section 4.2 for an overview of programme actions). In general, the listed examples of existing actions and activities will contribute to the area as a whole, not only within the action it is listed under.

I-combinator space - For this action we will build on projects and initiatives already providing data, computational resources, and next-generation platforms such as

- The *Nordic Information for Action eScience Center* (NIASC), led by Karolinska Institutet and funded by NordForsk with 40 MNOK aims to exploit the Nordic infrastructural advantage in health data registries, biobanks and advanced eScience tools to achieve progress in population-based cancer screening programmes.
- The *Swedish National Infrastructure for Computing* (SNIC), a national research infrastructure with a mission to provide a balanced and cost-efficient set of resources and user support for large-scale computation and data storage.
- End-to-End clouds (see below).

360 collaboration and development - Here, we will coordinate with and leverage on results from other research and collaborative projects such as

- The *High-Performance Data Mining for Drug Effect Detection* project (SSF, 19MSEK) at Stockholm University, developing techniques and tools to support decision making and the discovery of drug effects by analysing patient records, drug registries, case safety reports and chemical compound data in the form of both structured and unstructured (free text) data.
- The *Data-Driven Secure Business Intelligence* project (SSF, 25MSEK), developing scalable system architectures, algorithms, development methods, and working demonstrators for temporal analysis of large data sets harvested from open sources (web, social media, etc.) as well as corporate databases (customer data, business intelligence data), to enable new forms of collaborative innovation.
- The *Towards a Knowledge Based Culturomics* project (VR, 18 MSEK), combining machine learning and language technology techniques to mine large scale text documents with applications in digitized data ranging from old archival data to new forms of social networking data such as Twitter.
- The *Strategic innovation program for process industry IT and automation* (PiiA), representing a natural collaboration partner and application area for the IDS program within all four PiiA focus areas of efficient resource utilisation, availability, process control and simulation, and future technologies.
- The Vinnova *FFI* program, set to launch a Big Data initiative for transportation. Already, projects such as *IRIS* (Integrated Dynamic Prognostic Maintenance Support 11.6MSEK) and *DOIT* (Data-Driven Optimization for Intelligent and Efficient transport, 11MSEK) have been initiated within the FFI programme.
- End-to-end clouds, a five-year research project financed by SSF and carried out by researchers at KTH and SICS. The aim is to enable the orchestration of wide-scale distributed computing and network resources from multiple organisations to serve as an integrated utility infrastructure for data-intensive services and applications.

Business and policy - Examples of existing actions include

- *SUP46,* gathering start-up people in a Stockholm based meeting and co-working space, with the vision to make Stockholm the #1 start-up city in the world.
- *Digitaliseringskommissionen* develops the Swedish digital agenda which is of direct relevance to this programme.
- *IT-standardiseringsrådet,* run by SIS, created to ensure that Sweden can utilise standardised ICT solutions and lead the development in the EU. Efforts to standardise Big Data and services are currently being initiated.
- Relevant policy initiatives from EU, including *DG Connect* and *Futurium*.

Information Academy - Examples of existing or planned actions include

- The *University educational programmes* within cloud, Big Data, and Data Science at both graduate and undergraduate levels that are currently being developed will be a cornerstone of the Information Academy.
- *EIT-ICT Labs*, educating students in top class ICT programmes, with a strong focus on entrepreneurial skills. The Information Academy action will provide additional funding, resources, and connections to the Information Driven Society programme.

Collaboration and internationalisation - Several existing initiatives will help the Information Driven Society programme with international contact networks and collaboration opportunities. Examples include

- *EIT-ICT Labs*, driving European ICT innovation by accelerating the market introduction of research-based innovations. The current EIT ICT Labs ecosystem consists of seven core nodes (Stockholm, Helsinki, Paris, Eindhoven, Berlin, Trento, and London), two associate partnerships (Madrid and Budapest) and provides an excellent contact network for the IDS programme.
- The *5G Public-Private Partnership*, initiated by industry manufacturers, telecommunications operators, service providers, SMEs and researchers investing in R&D and innovation in Europe. The initiative will "drive the future networked society" and provide industrial and academic connections in Europe and beyond.
- *NESSI*, a European Technology Platform active contributing to the research and innovation space of software and services, have launched the bigdatavalue.eu initiative providing networking and collaboration opportunities.

Megawatt challenge - Addressing the energy consumption of the growing data center industry is done in for example

- The *Cloudberry* initiative, creating an innovation arena with a focus on resource efficiency and green technologies in data centres. From an initial focus on software-defined ICT, Cloudberry will expand into related fields such as buildings, energy production and recycling, with a focus on resource-efficient methods.
- *Cloud control* (VR, 20MSEK), taking a controlled theoretical approach to a range of cloud management problems. The objective is to transform today's static and energy consuming cloud data centers into self-managed, dynamic and dependable infrastructures.

A complete mapping of all existing and planned activities to be used within the SIO programme will be performed during the start-up phase.

4.2 Summary of actions and activities

Our overall strategy for this SIO programme is to (i) ensure the supply of cutting edge expertise and innovations in data science and cloud technologies, (ii) develop and assess high-value, high-impact information-driven applications in digital services, traditional industry and the public sector, and (iii) provide a scalable communication, cloud, and analytics infrastructure to support research and innovation at new and existing companies, as well as education. This strategy is developed from the underlying Agenda and will be implemented through the activities described below.

Action/ Activity	Description	Targeted Groups	Duration	VINNOVA Financing (MSEK/Y)	Other financing (MSEK/Y)
1	I-combinator space	Ind, NewICT, Univ	2014-17+	12	15
2	360 collaboration and development	all	2014-17+	22,5	26
3	Business and policy	Ind, NewICT	2014-17+	5	5
4	Information Academy	Ind, NewICT, Univ	2015-17+	7,5	4
5	Collaboration and internationalization	all	2015-17+	6,5	0
6	Megawatt challenge	Ind, Pub, Univ	2015-17+	9,5	13

Table 4: Actions and activities within the Information Driven Society SIO programme

4.3 Action/activity 1: I-Combinator space

4.3.1 Description

In order to answer the needs from both established actors and new entities, and to grasp the opportunities in this important new area that is transforming both business and society, we will use a novel approach for collaboration and knowledge sharing, making it available to a wider set of players than normally would take part in traditional calls. The intent is to create a *meeting space* and *development resource* open to all interested actors for the development of both new applications and the technologies enabling them. Here, industry can meet SMEs, have open data available for experimentation, attract international businesses, and depend on compute resources being in place, with experts on hand and co-located with business development such as a start-up incubators like SUP46. This should be a place for Open Innovation in Practice.

Swedish ICT and RI.SE work together with VINNOVA to develop the I-combinator space to evaluate new services and technology developed in this initiative. Computational resources will be developed in collaboration with the Megawatt challenge action.

4.3.2 Expected results and effects

Vitalisation of established industry; Open test-bed and demonstrators to evaluate and showcase the technology; exploitation of results within participating actors and industry; new businesses that provide infrastructure services; Creation of research-based novel technology; New products and services companies. Number of new products introduced, number of new companies started and other relevant KPIs TBD.

4.3.3 Time plan and budget

A workgroup established by the SIO office will do a pre-study in the fall of 2014 (budget 500 KSEK) for site selection; compute resources needed and recruitment of staff. The I-combinator should open in early 2015 and staffed by a Director (1,6 MSEK) and using subject matter experts for each part of the activities on a rotating schedule depending on need – 4 FTE (6,4 MSEK). Resources and services has an annual budget of 4 MSEK.

4.3.4 Targeted groups

ICT-oriented industry, established industry, start-ups, SMEs and Universities and research institutes. Other group affected are governmental agencies and other SIO areas.

4.3.5 Communication and knowledge transfer

Communication should reach as many actors as possible using the Big Data Analytics Network members, Incubators, SMEs through the RI.SE outreach program, Swedsoft and info channels (PR, web) and social media. Results will be spread through the publication of lab notes from participants, workshops, demos, LivingLab tests and info channels.

4.4 Action/activity 2: 360 collaboration and development

4.4.1 Description

Today, there is a huge amount of potential applications of information- and service-driven technologies in industry. This creates an immediate innovation potential - for the largely new digital services area, where this would involve development of completely new consumer and business services; for the traditional Swedish industry, such as in increasing efficiency within forestry and mining; and in novel enabling technology and infrastructure.

To realise this potential, we need to address a number of issues that currently limit development:

- New services, applications, and infrastructure within the area often involve many different actors as data and service providers as well as new policy and business models, a complexity hindering development of truly novel and large impact applications.
- Universities, research institutes, and start-ups in the digital service industry that possess the capability to develop the foundation of new data-driven services lack access to data and exact problem definitions.
- The state-of-the-art within heterogeneous cloud services and information extraction from large data sets must be improved to provide an open, flexible infrastructure for data-driven services.

To solve this, we will target application and enabling technology development by organising open calls for collaborative projects. These projects are expected to result in new services, products, and engineering processes, helped by coaching from experienced business developers provided by the programme.

The initiative will take a 360 perspective on data-driven service applications and infrastructure, spanning and enabling collaboration between all types of actors. The programme will strive for strong engagement from traditional industry, new ICT-oriented industry and public administrations, with support from academia, business incubators, and policy influencing bodies. The development of strong showcase demonstrators and applications will be encouraged.

The initiative will have two yearly recurring calls, one in spring and one in autumn synchronized with Vinnova. Three types of project applications will be considered:

- Smaller pre-study, viability and demonstration projects.
- Collaborative projects for targeted application development.
- Larger strategic efforts aiming at large scale demonstrators and applications.

Smaller projects are expected to last less than one year, collaborative projects between one and three years, and larger strategic efforts between two and four years.

4.4.2 Expected results and effects

Creation of information-driven applications and services for industry, SMEs, and public administrations; showcase demonstrators; involvement of consumers, and citizens'. Follow-up: Through normal Vinnova procedures measuring goal attainment for each call.

4.4.3 Time plan and budget

The SIO office and Vinnova will drive this action. The first call text will be drafted during autumn 2014, to be announced in January 2015. The action will have two calls yearly, closing on March 31 and October 31 and sharing the same call text, which will be updated yearly. Each project must have an industry co-funding of at least 50% to be eligible. Call budget for 2015 is expected to be at 12 MSEK for a total project budget of at least 24 MSEK, and the call budget for 2016 onwards is expected to be 22,5 MSEK for a total project budget of at least 48,5 MSEK.

4.4.4 Targeted groups

Established industry, ICT-oriented commercial actors, public administrations, universities, and research institutes.

4.4.5 Communication and knowledge transfer

Calls will be communicated through Vinnova or other participating funding agencies, as well as within the Big Data Analytics Network. The programme office will provide coaching and networking opportunities through e.g. meetups and workshops for anyone interested in the programme. Each project will provide dissemination plans including industrial uptake, public and academic dissemination of results, and networking activities.

4.5 Action/activity 3: Business and policy

4.5.1 Description

In order to build a business- and service ecology around information driven services, business models and practices for sharing data and information, as well as computation as a service, must be developed. We need to consider the larger impact on society from this technology shift. The impact will be profound and is a fast on-going process with cross-sector, public, and private participation.

Embracing the future - The SIO will through structured meeting processes (based on research, analysis and expert knowledge) with multiple stakeholders create new knowledge and enable new co-operations. The process includes steps such as identifying the larger structures in the ecosystem that will be affected, understanding important core actors, identifying key drivers of change as well as obstacles and visualizing possible future outcomes. Industries and actors will be able to benefit from the changes through acquiring and mobilizing broader competences as well as understanding the changes due to the technology shift. This understanding is generated through insights in an open learning process with multiple stakeholders.

Securing advantage through information based business models – Data-driven services need to be applied and implemented successfully. Companies face different challenges if they for example focus on automation/efficiency, new offerings based on data-driven services/innovation platforms or solutions based on open data/multiple sources. On-going round-tables and structured interactive meetings will address these challenges, and by aggregating the outcome of these meetings new insights can be spread and knowledge gaps be identified. A two-way interaction model for working with SMEs will be employed.

Dissemination of results to SMEs and requirements from SMEs regarding venture support will both be given attention.

Specific actions to be taken include embracing the future processes, establishing methods for long-term cross-disciplinary cooperation and development, and an annual conference and publication, "Information Society Conference for business opportunities". Further, we will establish two to four on-going round tables with the involvement from various industries and initiate and visualize new business opportunities (described through storytelling or scenarios in meetings, publications and reports). We will develop an open-minded and creative platform for cross-disciplinary dynamic relations and connections; policy proposals for information access and privacy; and business cases on increased efficiency, new markets, platform innovations, and successful transformations due to data-driven services.

4.5.2 Expected results and effects

By 2016, 10 areas where the SIO has had impact in the massive use of data-driven services in an industry segment or societal challenge; Enabling of a business ecosystem around information driven technology and services. By 2018, The SIO program methodology is used regularly by actors in the strategic innovation area. Follow up: Number of relevant publications, Number of attendees at meetings, and other KPIs TBD.

4.5.3 Time plan and budget

The Program office initiates processes to best support the development of the SIO program and its activities/actions. This activity will be most important and in the beginning of the program, but needs constant monitoring for updates and development of policy questions. The program will be initiated in 2015 and a total yearly budget of 5 MSEK is estimated covering work of 3 FTE (4,5 MSEK) and travel cost (300 KSEK) and dissemination (200 KSEK). It will most likely be spread over 5-6 experts working part time.

4.5.4 Targeted groups

ICT-oriented commercial actors, public administrations, consumers and citizen groups.

4.5.5 Communication and knowledge transfer

Invitation will be both be targeted to key influencers as well as open to interested actors. The results will be communicated through publications that each process defines.

4.6 Action/activity 4: Information Academy

4.6.1 Description

Gartner [4] predicts that the global demand just for Data Science-related jobs will reach 4.4 Million by 2015, with two thirds of the positions remaining vacant. At the same time, a large number of ICT professionals will have to update their knowledge to match this direction. As the area develops and gains in importance, these issues must be addressed.

To tackle these issues, we will set up an *information academy* combining initiatives around

- Professional education
- Personnel exchange and internships for undergraduates
- A Bachelor and technical college program
- A Masters programme and a PhD programme

The first two of these will ensure that current and future professionals can stay on top of current developments, while the others will address the general lack of educated personnel.

Within professional education, we will start an initiative with continuous education activities for professionals in form of short courses and workshops, which will be offered on a periodic basis by universities and new ICT actors. These activities will provide the basic background in cloud services and analytics techniques for professionals from related fields, and it will update experts with the newest technologies and methods. For personnel exchange, we will couple projects from 360 collaboration and development with an exchange program. In the case of SMEs, coaches will be offered in these activities. In association with the I-combinator initiative, we will provide a summer job program, internships and master thesis projects. This will provide university students with critical experience and business perspective, while providing industry with a talent pool.

As a joint effort between this SIO programme, EIT-ICT labs and participating universities we will set up a Master program that provides graduates with a complete foundation within cloud technology and management, applied experience with next-generation analytics platforms such as Spark, Stratosphere, and GraphLab, and advanced analytics and machine learning in a Big Data context. In addition, we will set up a program for industrial PhD students, complementing similar efforts by SSF. Participating academics will provide supervision while industry provides relevant application areas and the main part of the funding. The SIO programme will offer courses and joint summer schools for participating students, where they can exchange experience and ideas.

To support the operation of the growing ICT infrastructures, networking equipment and data center infrastructures a support technician education program will be set-up jointly with universities and technical colleges. Basic skills to operate sensors, compute nodes, networks, servers, UPS's, coolers and DCIM software is in focus.

4.6.2 Expected results and effects

A significantly increase in the number of young engineers and researchers in information-driven technology and applications; the achievement of knowledge transfer between actors through joint projects and exchange of personnel; the renewal of education programs at universities.

4.6.3 Time plan and budget

The detailed programme for this action will be drafted during autumn 2014. The activity will have a start-up phase during 2015 and then be fully executed during the following years. 7,5 MSEK/year from VINNOVA will be required to fully fund the activity, while complementary effort from universities, companies, and EIT-ICT labs will likely be in the order of 4 MSEK/year.

4.6.4 Targeted groups

Universities and research institutes, established industry and ICT-oriented actors.

4.6.5 Communication and knowledge transfer

The programme for the action and opportunities for participation will be continuously disseminated to the IDS open actors association, through web and social media, and through all participating funding agencies (Vinnova, EIT ICT labs etc.). Results will mainly be disseminated by personnel mobility and publications.

4.7 Action/activity 5: Collaboration and internationalization

4.7.1 Description

The full value of this programme can only be realised through effective collaboration between actors and full participation in international developments in the area. To achieve this, we intend to provide and enable

- An active and open national network
- Support for European project proposals and collaboration
- Personnel exchange and collaborative projects with actors in the United States
- Liaisons in major innovation clusters

We will create a strong, open and active national network for all actors in Sweden, which will serve as the backbone for 360 collaborative projects and the information academy. The starting point is the consortium behind this programme, but this should be continuously extended to new actors and areas. We plan to fully exploit the synergies with H2020 and EIT ICT Labs, and will create a support program for European contacts within the open network mentioned above.

Collaboration with key actors outside Europe, primarily the US as a world leader in the area, will be critical for the development of the IDS programme. We will enable personnel exchange for PhD students, PostDocs, and professionals between Sweden and the US based on the already excellent academic and industrial contacts available within the IDS consortium. These contacts will also be used to align proposals within the IDS sphere with e.g. NSF proposals by US partners to set up collaborative projects. To help with internationalization efforts, we intend to set up technical liaisons connected to the programme in major clusters with an initial focus on Silicon Valley and Silicon Alley. These will typically be located at participating partners' premises, and expand on existing strong connections and collaboration.

4.7.2 Expected results and effects

Creation of a National Network in Cloud and Big Data Analytics, Strengthening and exploitation of EU-funded collaborative projects, primarily, in the context of Horizon 2020 and EIT ICT Labs, joint projects with actors outside Europe, and personnel exchange with leading actors from outside Europe. Follow up: Number of professional exchange programs, study trips, and US/Swedish collaboration projects.

4.7.3 Time plan and budget

The detailed programme for the action will be drafted during autumn 2014. The activity will have a startup phase during 2015 and then be fully executed during the following years. 6,5 MSEK/year from VINNOVA will be required to fully fund the activity.

4.7.4 Targeted groups

All actors will be involved, i.e., established Swedish industries and business, new ICT-oriented commercial players, public administrations, universities and research institutes, consumer and citizen groups.

4.7.5 Communication and knowledge transfer

Knowledge transfer will be achieved through collaborative projects, exchange of personnel, networking opportunities, and publication of joint strategy documents whitepapers through the programme board.

4.8 Action/activity 6: Megawatt Challenge

4.8.1 Description

Virtualization has been a major trend for a number of years, being driven by a desire for greater flexibility, elasticity, operating efficiency, lower capital costs, better use of physical space, and reduced energy consumption. Technology developments directed toward the same goals are new processor technologies, dense server architectures, free-air cooling, in DC bioenergy production, AC/DC transformations and automation, operation and management technologies. Currently Sweden has industry involved in parts of the development, but the competence level in a wide perspective in academia and industry is low compared to US and other European regions. Sweden needs to increase research in the data centre energy efficiency area, both to make sure that we leapfrog to the forefront of the technological developments and to ensure that academia and industry can position itself in an expansive market.

We will have open *Megawatt Challenge* calls for technology development within energy efficient data center infrastructures including green buildings and building practices, smart-grid for data centres, energy production, building and resource management & automation and hardware and software data centre infrastructure technologies. The call will also address analysis of life-cycle management and macroeconomics of data centres. There will be two open calls per year, coordinated with the 360 collaboration and development programme.

To enable the uptake of research results and to improve industry solutions we need a large-scale national test environment, driven by industry needs but also to be used as an open environment for research projects in this SIO and related programs. The investment is assumed to be made by regional and national governmental funds supported by industry investments from e.g. Vattenfall, ABB, NCC, Coromatic, and Enaco. In case the large-scale common national test environment is not realised, all tests, experiments, analytics implementations and demonstrators will be spread out at the smaller-scale test environments of participating organisations.

4.8.2 Expected results and effects

New businesses based on providing data center infrastructure technology, an industry leadership in green data centre technology, and an open large-scale test-environment. International businesses will invest and develop services, technologies and operations. Enhanced competence in the industry and a centre of excellence for data centre operations and technology to be used by industry when designing new facilities.

4.8.3 Time plan and budget

Open call 1 in 2015 focusing on basic infrastructure concepts 9,5 MSEK. Open call 2 in 2016 focusing on advanced concepts and future technologies 9,5 MSEK. Further calls will follow yearly with revised focus. Other financing will be around 13 MSEK/Y.

4.8.4 Targeted groups

Established industry including SMEs together with Public administrations, Universities and research institutes.

4.8.5 Communication and knowledge transfer

Support an industry association to perform evaluations and produce publications with recommendations for technologies, design, construction and procurement.

5 Risk analysis for the SIO-program

Strengths	**Weaknesses**
• Size and breadth of engaged consortium and actors • Good international position in ICT • Very good collaboration climate between e.g. public and private actors • Ideal (energy, sustainability, climate, competence) place for datacenters	• Sweden follower in key technologies • Limited funding compared to larger countries • Limited competence supply • Decision processes slow in Sweden • SMEs find it hard to grow in Sweden
Opportunities	**Threats**
• Sweden is attractive for data centers and data-driven services • Services and knowledge can be distributed worldwide • Innovation amongst *all* actors through collaboration • Energy, environmental and mobile technology leadership • Efficient, mature ICT-supported public administration	• Many actors affected by the SIO area makes the area complex • Changes in legal and/or political landscape • Possible significant change in ICT related technology paradigms (very low risk) • Energy taxation competition from other countries

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