DIGILE

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Authors (in alphabetical order):

Petri Ahokangas, Christian Engblom, Lauri Frank, Dr. Tua Huomo, Dr. Jouni Huotari, Dr. Janne Järvinen, Dr. Petri Kettunen, Aulis Koivisto, Dr. Pauli Kuosmanen, Dr. Raija Kuusela, Dr. Pasi Kuvaja, Dr. Marja Känsälä, Prof. Casper Lassenius, Dr. Pekka Lehtovuori, Sami Lilja, Joonas Lyytinen, Prof. Satu Miettinen, Prof. Tommi Mikkonen, Prof. Jürgen Münch, Prof. Tomi Männistö, Prof. Markku Oivo, Daniel Pakkala, Jari Partanen, Juan Pinoargote, Prof. Ivan Porres, Ahmad Qureshi, Jurka Rahikkala, Prof. Kari Smolander, Matti Sommarberg, Jari Still, and Prof. Pasi Tyrväinen

Organisations involved:

F-Secure, Ericsson, NSN, Vaisala, Elektrobit, Nokia, Tieto, Metso, Huawei, Polar Electro, Digia, Saab Systems, CSC, Inno-W, Sofigate, Consultia ICT, Mfore, Packet Video Finland, Luoda, User Intelligence, Datamania, Context learning Finland, Actidio, Whatamap, Gosei, Qvantel Business Solutions, Ubifirm, Eday solutions, Richardi International Trade, Reaktor, Futurice, Vincit, Geniem, Infotripla, Vaadin, Nomovok, Leonidas, Green Peak, Deveteam, Reactive-Technologies, Pepron, Vivid Works, Tracker, Kilosoft, Tivit, Tekes, Hermia, Helsinki City Library, Tax administration, FISMA, Culminatum Innovation, Tampere University of Technology, Tampere University, Haaga-Helia, VTT, Aalto University, Lappeenranta University of Technology, Metropolia, Åbo Akademi, University of Turku, Turku University of Applied Sciences, Jyväskylä University of Applied Sciences, University of Jyväskylä, University of Oulu, Centria, University of Lapland, University of Helsinki, Kajaani University of Applied Sciences, Finnish Institute of Occupational Health, Cargotec, Oulu Business School, and DIGILE.

1 EXECUTIVE SUMMARY

The aim of the Need for Speed (N4S) Strategic Research and Innovation Agenda (SRIA) is to create the foundation for the success of the Finnish software intensive businesses in the new digital economy. During the program we will see the global digital services business growing in Finland and totally new Finnish brands in digital business introduced, together with a new flavor of organizational culture where executing business experiments continuously -- enabled by technical infrastructure as well as everyday practices and mindset -- is embraced.

The Internet is and increasingly will be the first truly global platform for the digital economy and will enable significant new business, economic and social opportunities. Consequently, we are facing a fundamental systemic transformation towards a world where digital resources are constantly available on-line, and available for all to use. This document describes the position and intent of the Finnish software intensive industry and research in the context of the transformation as well as the critical research areas that should be tackled in order to ensure that the Finnish industrial organizations and society can build a successful growth strategy for an unpredictable future. The vision of the SRIA is as follows:

By 2017 the Finnish software intensive industry is the recognized leader in business innovation and fast implementation of products and services in the digital economy.

This has been achieved by adopting a real-time experimental business paradigm, providing instant value delivery based upon deep customer insight.

The N4S breakthrough targets have been defined as follows:

1. Paradigm Change - Delivering Value in Real-Time:

The Finnish software intensive industry has renewed their existing business and organizations towards a value-driven and adaptive real-time business paradigm. Technical infrastructure and required capabilities have been established to support the transformation.

2. Deep Customer Insight – Better Business Hit-Rate:

The Finnish software intensive industry is utilizing new technical infrastructure and capabilities as well as various sources of data and information for gaining and applying the deep customer insight. This will significantly improve the return of investments in service and product development.

3. Mercury Business – Find the New Money

A new “Goal Driven Hunting Culture” has been created and applied by the Finnish software intensive industry with several successful examples of adjacency towards the new markets and business areas. The new form of business is enabled by the continuous and active strategy as well as the new leadership style. The two above breakthrough targets further support this target, as they are prerequisites of rapid, systematic experiments in new business domains.

2 INTRODUCTION

The state of the global economy has been turbulent during the last several years. Governments and enterprises continue to struggle to inject a positive momentum and effectuate growth. One particular and significant trend to note is the ever-increasing impact of the Internet on the global economy. The Internet has rapidly become far more pervasive than it was only a few years ago and even hyper scalable business models are emerging. Furthermore Internet's transformational effects are spreading into several sectors of the economy and society via new innovations, services, and the emergence and quick success of new companies. The complexity and competition around the new Internet infrastructure, services and business environment will increase dramatically which will fundamentally change the way software will be developed, deployed and used to reach business goals. The Internet is and increasingly will be the first truly global platform for the digital economy and will enable significant new business, economic and social opportunities. Consequently, we are facing a fundamental *systemic transformation* towards a world where digital resources are constantly available online, and available for all to use.

Increasingly, products and services are not developed by a single company but rather by a network of collaborating companies. This network contributes to the ecosystem through different elements from existing and established products as well as newly developed elements forming new, even more compelling entities. Even domains such as embedded software and complex cyber-physical systems are increasingly being opened for more networked development, agile creation, testing, integration, and deployment of new features and services in the Internet. New, still partially emerging ecosystems and new competitors will alter industry structures, the public sector, supply chains and many other aspects of today's businesses. Similarly, ICT infrastructures, approaches and processes have changed dramatically over the last years - increasingly fast networks, cloud, social media and web technologies, open source, IoT (Internet of Things) and big data approaches are reshaping the digital economy.

As a result, many businesses are starting a major shift on how they define their next-generation competitive strategy, new leadership approach and operating processes that would form a strong basis for changing economic conditions. *The key question is how the companies could adapt to radically new business conditions and opportunities in real-time or even, proactively.* The dimensions of the new digital business revolution go broad and deep, even to the traditional industry sectors, and will require that the companies begin to perform in significantly different ways than before. The Finnish ICT (Information and Communication Technology) and digital services sector have an excellent technical basis for the change; however, they lack the capabilities and competences needed for a systemic business transformation.

This document – the Need4Speed (N4S) Strategic Research and Innovation Agenda (SRIA) – describes the position and intent of the Finnish software intensive industry and research in the context of the transformation as well as the critical research areas that should be tackled in order to ensure that the Finnish industrial organizations and society can build a successful growth strategy for an unpredictable future.

The aim of the N4S SRIA is to create the foundation for the success of the Finnish software intensive businesses in the new Internet economy. The vision of the SRIA is as follows:

By 2017 the Finnish software intensive industry is the recognized leader in business innovation and fast implementation of products and services in the digital economy.

This has been achieved by adopting a real-time experimental business paradigm, providing instant value delivery based upon deep customer insight.

The transformation and radical rethinking which takes companies into totally new markets and enables them to benefit from the most viable business opportunities, are built on the concepts such as new strategic thinking and leadership, rapid development cycles, validated learning, scientific live experimentation, iterative releases with minimum viable services. Most importantly, *deep customer insight* is rapidly being integrated into the strategy and business operations. All services and products in digital economy are software-based. The quantum leap in software development speed by incrementally building and deploying software with real-time customer feedback will facilitate the speed and flexibility needed in these new types of business competencies. The central concept in the new Internet economy is the idea of a *minimum viable product or service*, which aims at defining the smallest possible implementation that brings added value to customers. Upon delivering the product or service, the focus shifts to creating incremental improvements, so that development cycles can be shortened, progress can be evaluated, and customer feedback and insight can be used to measure the value of the improvement and fed back to development in real-time.

The main goal of the ongoing business transformation is to create a foundation for the next-generation competitive strategy and operating processes that together, form a response to the changing economic conditions. Companies must be able to *deliver value in real-time* and *in-time* and to adapt to the radically new business conditions and opportunities also outside their existing business domains. This approach requires new leadership approaches and styles as well as fundamental rethinking on how the companies continuously improve and develop their existing model of business. In this SRA, we call the approach as *Mercury Business*, which briefly means the capabilities to adapt to new business conditions and aggressively go to new business areas searching for new opportunities with the best skills and minimum effort. All employees in Mercury Business are actively searching new business attractions and money like mercury is sensing with its whole surface pervasively flowing towards attraction of gravity. Immense speed of software development is the business component that provides the liquid metal type of properties of mercury business. Implementing *Mercury Business* target requires *deep customer insight* and *delivering value in real-time* as they are prerequisites of rapid, controlled experiments in new business domains.

One of the key bottlenecks of the new culture is the *new technical infrastructure for real-time value delivery*. Increasingly the companies need advanced technical infrastructure, tools, methods, interfaces, APIs, etc. in order to be able to deliver value in real-time. This requires a mix of heterogeneous technologies in implementing dynamic and adaptive service execution environments that fulfil the quality requirements in an on-demand and personalized way and are flexible enough for the introduction of new features and removal of obsolete ones. Continuous integration and deployment tools, methods and processes are a necessity to support a new digital ecosystem in the networked and fast-cycled multi-organization environment. In addition, tools and methods that

enable e.g. a new version release as automatically as possible for large scale or for a (trial) use among certain user groups are needed. To make such experimentation a daily practise, also organizational culture must change to support the transformation towards new ways of working.

The key prerequisite for the *better business hit-rate* in the new real-time digital economy is the companies' ability to *gain deep customer insight*. In the new global markets companies must better understand not just what features, functions or user interface solutions their products and services should have but, even more, how they could provoke, delight, gratify, shape or touch the users in a totally new way and with totally new products and services. The feedback and insight should be collected from multiple sources (e.g. in order to cover gender, age, racial, and cultural differences) and the companies should be able to utilize heterogeneous data and information including market trends and weak signals in order to predict future and impact to the markets. This requires methods and tools to improve innovation as well as co-production with the users; including both the direct customers as well as existing and potential end-users. Technical infrastructure includes topics such as feedback mechanisms to automatically collect, analyze, and visualize data and information of the experiences and needs of the users.

Future businesses take more and more place in *ecosystems* where different players have different roles and the ecosystems are constantly evolving. For a single enterprise point of view this means that it needs to learn to utilize increasingly resources beyond its enterprise boundaries in all phases and areas from opportunity identification and foresight to software development, parts of system functionality, experimentation, etc.

Finally, to meet the above goals, *a new kind of leadership*, where vision plays a central role instead of more traditional command and control, is needed. Employees can take decisions regarding their work independently in a fashion that fosters co-creation between different stakeholders. Such stakeholders include other individuals and companies, some of which may even be competitors, as well as customers. Working in this fashion requires emergence of an organization that has no hierarchy (or is very flat), and where trust is a key issue focus in all its operations.

3 BACKGROUND

The landscape of this SRIA has already been influenced by the Finnish ICT 2015 report (http://www.tem.fi/files/35440/TEMjul_4_2013_web.pdf). The concrete actions suggested in the report include the development of enabling technologies for the needs of the digital economy. The report also highlighted the necessity to change the Finnish business mindset towards the era of the digital economy and services. Special attention was put on two particular areas: digital services to the global markets and the need to speed up the deployment of new and refined services. These two areas, critical for economic growth in Finland, are both included in the Need4Speed SRIA. As pointed out by the Finnish ICT 2015 report, the Internet was creating up to 20% out of economic growth between 2004-2009 in developed countries, and for each job that disappeared due to the Internet 2.6 new job opportunities emerged.

3.1 N4S as a Horizontal Enabler for Other Industry

The N4S SRIA is geared towards the needs of the software intensive industry, in the widest possible sense. While software is a necessary tool and software companies play a major role in the transition towards Internet enabled businesses, the real impact is in the digital services business and the transition towards digital services will happen everywhere. Consequently digital service brand owners will gain the majority of the value. Hence, the research themes proposed in the SRIA range from co-creation of hardware and software to digital services that are constantly online and real-time.

Besides being a technology in its own right, software intensive industry also fuels other fields, including; for instance, biotechnology, medicine, and other fields of engineering. Therefore, it should also be noted that the goals of the program are far more outreaching than the software ecosystem itself. We foresee that as the importance of the software keeps increasing, the benefits of the SRA will also be available in other fields of the businesses and the society at large.

3.1.1 Finnish Market

The importance of ICT is considerable for Finnish economy. OECD Factbook 2011-2012: Economic, Environmental and Social Statistics gives the following overview:

“In 2008, the ICT sector accounted for between 3.7% (Switzerland) and 13.9% (Finland) of value added in the manufacturing and business services of 28 OECD countries with available data. The average share for the OECD was 8.2%. Over 1995-2008 the ICT share in value added has increased in all OECD countries except Austria (-1.3%), Australia and Canada (-0.8% both).

In 2010, the narrow definition of ICT employment (ICT specialists) accounted for between 1.7% (Turkey) and 5.4% (Sweden) of total employment of the OECD countries with available data. Over 1995-2010 this share has been rising in most countries, despite the stagnation of employment in the ICT sector. The broader group of ICT-using occupations (specialists, advanced and basic users) accounts for over 20% of total employment in most countries, ranging from 10.9% (Turkey) and 35.3% (Luxembourg).”

While these numbers overlook other industries that benefit from ICT, they alone demonstrate the importance of the field in all OECD countries. Based on Statistics Finland, the Finnish software and IT services sector grew over 11 percent in 2013. Finnish software firms have adopted cloud

computing platforms quickly, as half (50.3%) of the firms report employing the platforms in their software development in 2013. Cloud computing is used for cost efficiency by enhancing the IT services provisioning and for new business opportunities (www.softwareindustrysurvey.fi, 2014). Also, more than one third (38%) of respondents offer platform or interface to other software firms for development. This progress can be seen as positive, because these firms report more flexibility than companies on average. (www.softwareindustrysurvey.fi, 2014).

Another essential aspect to consider is introduced due to the fact that in the realm of software, it is common that a dominating design emerges, which is used almost universally. The monetary value of companies that own the IPR of such designs can be excessive in relation to the normal indicators of business performance.

3.1.2 Global Market

The global software market is one of the prominent fields of industry, with several different domains included in it. In general, defining the global size of the ICT market is difficult, since as already pointed out the software-intensive industry stimulates numerous other fields. Thus, the horizontal nature of the SRIA complicates the precise calculation of the global market.

According to EITO, the compound annual growth rate (CAGR) for global software market (defined as part of global IT industry) between 2011 and 2015 will be 6,6 %, resulting in the total market size of €336 Billion in 2015[1]. Another estimate comes from MarketLine Research. According to them the global market for all types of software was $554.5 Billion in 2013, with a CAGR of 11.3 % between 2009 and 2013. The performance of the market is forecast to decelerate, with an anticipated CAGR of 9.2 % for the five-year period 2013 - 2018, which is expected to drive the market to a value of $860.9 Billion by the end of 2018[2].

In addition, OECD Communications outlook published in 2013 contains:

- Labor figures in 2011:
  - OECD total 3,7%, Finland with highest figure with 6,4% of employees in ICT
  - “Information and communication technology (ICT) refers to both different types of communications networks and the technologies used in them. The ICT sector combines manufacturing and services industries whose products primarily fulfill or enable the function of information processing and communication by electronic means, including transmission and display. The ICT sector contributes to technological progress, output and productivity growth. Its impact can be examined in several ways: directly, through its contribution to output, employment or productivity growth, or indirectly, as a source of technological change affecting other parts of the economy, for instance.”
- value added in 2011:
  - OECD average 6,0% of value added in 2011 coming from ICT. In Finland 6,4%. Ireland has top value with 11,9% of value added coming from ICT.

To summarize, in the global scale, the role of software is still increasing dramatically. Currently “every business is a software business”. For example, 2/3 of the added value of Mercedes-Benz

[1] Source: EITO (European Information Technology Observatory), ICT Market Report 2014/15 Update
[2] Source: MarketLine Research: Software - Global Industry Guide, http://www.marketresearch.com/MarketLine-v3883/Software-Global-Guide-8174771

comes from software. The size and complexity of the software is increasing dramatically also in the future.

3.2 Global State-of-the-Art

Many of the elements proposed in this SRIA have been presented previously in books such as, the Lean Startup (http://theleanstartup.com/) and the Elastic Enterprise (http://theelasticenterprise.com/). In both contexts, the main message is that in order to make breakthroughs, companies need the strategic capability for systemic transformations. This capability is gained through the three breakthrough targets of this SRIA.

Even on the global scale, there are only a few companies that have been able to constantly execute systemic transformations of their businesses. The most prominent examples are Apple, Amazon, and Facebook, and these companies can also be used as examples when explaining how such systemic transformations take place. As a concrete example, the Facebook release process allows a single engineer to deliver added value to 1 Billion Facebook users links:

- http://www.infoq.com/presentations/Facebook-Release-Process
- http://arstechnica.com/business/2012/04/exclusive-a-behind-the-scenes-look-at-facebook-release-engineering/

In general, the global state-of-the-art largely consists of the integrated use of topics described later on in Section “3.3 Global Trends”. Top companies are able to perform continuous development and deployment, to the extent that a single developer can manage releasing a certain improvement to all potential customers. The ability to do so fosters pride over one’s work, which in return results in increasing job satisfaction and pro-activeness to perform even more upgrades to products and services.

In the field of using real-time data on customer behavior, recommendation engines that aim at increasing the business of the service provider have become the norm. They help companies in identifying what kinds of products or services users are interested in accessing. This business intelligence data can then in turn be harnessed also for other uses when aiming at even more compelling services.

3.2.1 Finnish Position with Respect to the Global State-of-the-Art

To serve markets in the new digital economy the business strategy must be active and continuous in pursuit of new opportunities that emerge real-time. The Finnish software intensive industry has an excellent technical basis and resources to develop products and services for the existing business domain. However, the majority of software intensive companies in Finland have been following technology driven release-focused approach, where a lengthy sequence of actions is taken to produce a new release. In other words, the business models most of the companies are following are traditional and do not support the new needs and speed of the digital economy.

The recent changes in the Finnish software economy are also challenging Finland’s position in software research. Moreover, the challenging situation of the global economy degrades the interest of companies to invest in new approaches, and stick to old ways of working and old customer bases. This is leading to a situation, where a thorough renewal of the Finnish software industry is becoming

imminent. The main issue will not be whether there will be major changes, but rather whether the renewal takes place in a proactive, controlled manner or in a destructive fashion.

However, there are some companies that are at the forefront of the change towards faster development approaches and more elaborated business models. One example is Supercell, a game development company, whose products are available online for free, but certain benefits can only be gained with real money. This model, commonly referred to as freemium, has been gaining a foothold globally for some time, but only few Finnish companies have been able to enter the field. Even in the global market, Supercell is presently one of the few companies to combine fast delivery and close monitoring of customer behavior. In general, game industry in Finland is still blooming and leading the way towards understanding the customer and end user, despite the first signs of problems in some established companies. There are a lot of opportunities to reuse existing competence regarding the setup of customer databases, data collection procedures, modeling customer behavior and so on.

To demonstrate the benefits of such mode of operation, they presently have two games in the Top iPad top grossing apps (Figure 1):

Figure 1: Top grossing IPad apps in Apple appstore
(http://www.iosappstats.com/stocks/apptops.php, April 10, 2015)

This is a phenomenal achievement considering that Apple appstore is extremely competitive - there are hundreds of thousands of IOS apps available (http://en.wikipedia.org/wiki/IOS).

To summarize, the companies that have reached the global state-of-the-art are numerous in global scale, and some of them even operate and do research and development in Finland. However, the transition towards real-time business has not been shrink-wrapped in a form that could easily be transferred from one company to another. Moreover, when a company starts to develop its tools and methods towards the practices described in this SRIA, a considerable amount of working hours will be invested in finding the available components and fitting them in in the ways of working within the

company. It is an explicit goal of this SRIA to create methods, tools and guidelines to assist in the paradigm shift and to simplify gaining deep customer insight, which are prerequisites of implementing systemic transformation real-time business.

A special theme that is central in the Finnish software ecosystem is the networked character of many of its operations. Unlike the examples that have been used to demonstrate the success of global software giants, in Finland cooperative way of working implies that introducing new facilities and capabilities takes place across the whole network. As different domains follow different practices, such as open source and closed source software development, this is a central challenge that has not been conclusively studied, and in many ways true pioneering business and business model research is needed.

Finally, while the necessary actions and ideals have been documented in textbooks, the books are most commonly focusing only on one single theme at an abstract level, and do not present how technology is harnessed to support real-time business. Instead, it is up to the individual companies to take actions as they see fit, and to select the best possible tools independently of others. While there is a lot of research that focuses on individual components, some of which pose considerable research problems as such, it is the total systemic transformation that will be a unique research challenge.

3.3 Global trends

There are numerous trends associated with the Internet era that affect this SRIA. In the following; we list the main trends that have been recognized to impact this SRIA:

- Almost all products and services are software-based or contain important software components that provide most of their features and differentiation
- Everything is intelligent and connected
- Recommendation engines help to find the right content and services

In order to successfully compete in a market dominated by these trends we believe that the Finnish industry must understand and benefit from the following developments:

- Software everywhere
- Everything is intelligent and connected
- Fast and effective software development with continuous deployment
- SW/HW co-development and co-deployment
- DevOps and ServDev
- Cloudification
- Open Data and Mashups
- Consumerization
- On-line collaboration
- Crowdsourcing
- Recommendation engines
- Hyper-scalable businesses
- Platformization

In the following, we briefly discuss these in more detail.

Software Everywhere

"More and more major businesses and industries are being run on software and delivered as on-line services—from movies to agriculture to national defense. Many of the winners are Silicon Valley-style entrepreneurial technology companies that are invading and overturning established industry structures. Over the next 10 years, many more industries are expected to be disrupted by software, with new world-beating Silicon Valley companies doing the disruption in more cases than not." (Marc Andreessen, Why Software is Eating the World, The Wall Street Journal, August 20, 2011).

This change is already plain to see in several trends. Everyday items that can be accessed in digital form - e.g. photos, music, and videos - are widely available on the web and on-line banking and stock trading have changed the style of how transactions take place. Entire industries, with photography and music distribution being the prime examples, are being radically reshaped.

The change will also affect the software industry and ICT as a whole. So far, the change is best reflected in the fashion we create scalable services using cloud technologies, which have been gaining a lot of research interest and industry focus. As a result, software is increasingly made available as a service instead of the traditional business model where licenses are used as the basis for transactions.

Everything is Intelligent and Connected

The increasing amount of computing power in our everyday environment is also an emerging trend. We are surrounded by several "smart spaces", i.e., systems where our environment is controlled and monitored with computers and software running in them. Cheap computing devices, such as Raspberry Pi (http://www.raspberrypi.org), have become widely available. This enables fast and low-risk experiments but also provides evidence that low-cost, Internet connected and powerful computing nodes are coming close to us. The same trend is also visible in the recent increase of the importance of software as well as connectivity with respect to all industry domains, covering in particular automobiles but also e.g. work machinery, home appliances, and factories.

Continuous Deployment

The push towards Continuous Deployment will be a major driving force during the SRIA period. Based on a survey of over 130 of the top 500 Fortune organizations conducted by XebiaLabs in March 2013, organizations are:

- Actively seeking to automate "the last mile" of the release process.
- Looking for solutions that can help unify the process to make release management a coordinated activity.
- Researching solutions that can help them move away from expensive, error prone "big bang" releases.

Key factors identified were as follows;

- Almost 75% of respondents give their deployment process a failing grade.
- Errors, deployment failures and reliance on expensive experts are the main drivers for automating application release.
- The majority of respondents reported that deployments failed between 10 and 30% of the time.

- Increased efficiency and release acceleration were ranked as the top benefits of deployment automation.
- Improvement initiatives are driven by pressure to achieve a key strategic business goal - deliver more features to the market faster and more reliably.

The identified major projects needed fell into the following categories already in 2013, Figure 2 below.

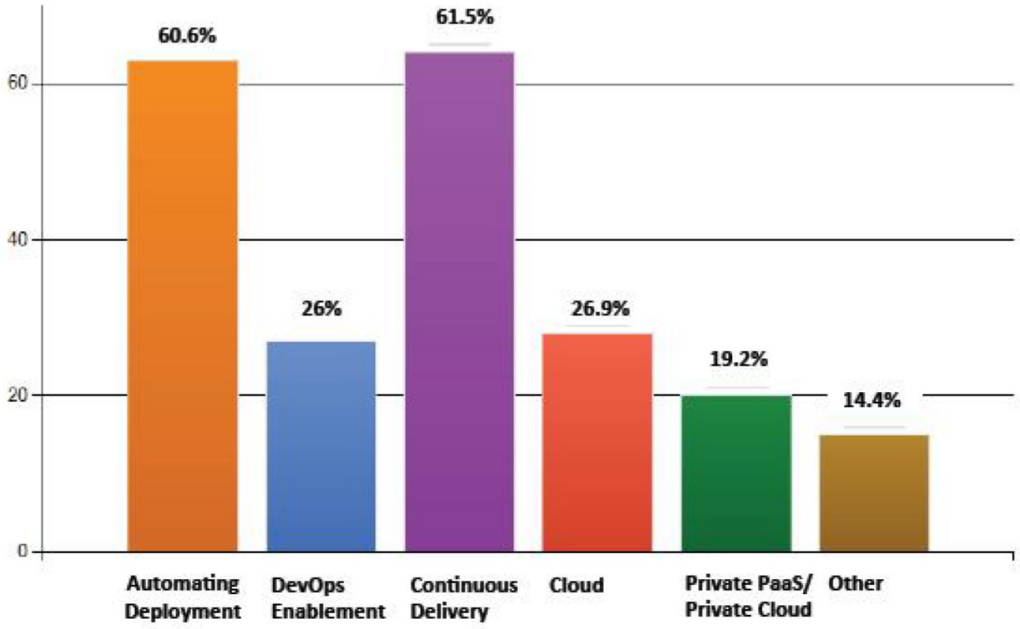

Figure 2: Major development projects 2013 identified in the XebiaLabs study (Application Release automation Trends, March 2013)

Need to Improve SW and HW Co-development and Co-deployment

SW and HW co-development and co-deployment are major trends and the focus of the research will be the following;

- Creation of models for the co-development of immature integrated HW and SW
- Optimize the use of Lean and Agile principles for the use of HW and SW respectively
- Optimize the test and integration time and improve dramatically the test and integration lead and cycle times with HW and SW in order to improve efficiency and find ways to shift resourcing focus more into actual development

The expected business benefits are high due to increased efficiency and opportunities to capture new business opportunities due to dramatically reduced cycle time.

From DevOps to Emerging ServDev

DevOps is a software development approach, where special focus is placed on communication, collaboration and tight integration between software developers and information technology. With an explicit goal of bridging the gap between the above stakeholders, the goal of DevOps is to support

the rapid production of products and services. This is particularly useful when extensive requirements on the deployment capability of the software development organization are set.

DevOps is commonly closely associated with continuous deployment mentioned above and in general with agile and lean development. Moreover, also the ideals of so-called lean start-up methodology are reflected in DevOps.

The DevOps phenomenon is identified as a major driver towards changing the way to deploy applications and when enhanced, emerges to a ServDev phenomenon - where a single developer can understand the need, create the requirements for and deploy a new feature.

Cloudification

The already strong trend towards “Cloudification”, i.e. the migration of data and functionality to the Cloud will continue during the time period of the SRIA. Increasingly, corporate systems and data will also be handled in the Cloud, and many functions traditionally handled by in-house systems will be migrated to use Cloud services. However, moving business critical data to the Cloud will still be considered a risk.

Open Data and Mashups

The trend to make public data, as well as company specific data that might be of interest for other parties, available for other developers is rapidly opening up new opportunities for developers. Traffic data on trains, buses, and airplanes is increasingly made available for developers. Map data is available via multiple services with various features that are automatically provided by the services. Access to internal data of e.g. flight prices makes it possible to create recommendation systems where consumers can select which airline to choose.

The availability of an increasing amount of data is encouraging the development of mashup applications, or systems that leverage data from existing services, but make it more appealing to consume the data. For instance, a brokerage service could be extended from simply displaying the features of a real estate to a more complex application that shows tax records, crime rate, and schools, and so on of that particular neighborhood to help a consumer with decision making. When using mashups, the consumers quickly learn to expect new features that provide an even richer user experience. For the developers, this means that mechanisms for experimenting with new ideas provide an opportunity to eliminate those ideas that are not interesting for the users in a fashion that does not risk the service.

Consumerization

Everybody is a consumer, all the time. It does not matter whether you are on your own time, or in the office. In the old days of the IT industry, products were first designed for enterprises and then pushed to consumers. Today, most great products are first built with consumers in mind and then adopted by businesses, as in many cases we have similar needs and wants for the hardware and software, regardless of whether it is for personal or professional use. The “bring your own device” (BYOD) and “bring your own application” (BYOA) movements are becoming more apparent, and corporate policies no longer restrict the usage of devices in the workplace to the ‘officially approved’ ones.

On-line Collaboration

The increasing popularity of the web has enabled numerous new forms of collaboration. Wikis have made it possible to create numerous systems that have previously been monetized by different parties. Examples include Wikipedia (http://www.wikipedia.org), Wiktionary (http://www.wiktionary.org/) and Wikitravel (http://wikitravel.org/), all of which are results of on-line collaboration. Social media, with systems such as Facebook and LinkedIn, is changing the way we define friends and colleagues. On-line editors such as Google Docs (http://docs.google.com) are changing the fashion people interact when creating joint documents. Blogs have made it possible to share experiences in a fashion that can be commented on by others. All these demonstrate the feasibility of on-line collaboration and cooperation even by people who might not even know each other.

Finally, it is obvious that open source movement is still a trend in its own right. Within the scope of this SRIA, we foresee that numerous already existing systems can be benefited from, and that numerous others will be made available for participating companies.

Crowdsourcing

Crowdsourcing is the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people. While crowdsourcing is not per se associated with computing at all, its value in web-based industries and on-line communities can help in e.g. taking care of laborious tasks or even the implementation of complex software systems, as is the case in open source communities. While each participant handles a small portion of a complex task, a collaborating group of individuals have huge potential. In the field of software development, an obvious example is the Linux operating system, which is to a large degree a community project. For businesses of the web era, crowdsourcing is an interesting concept, since it seriously challenges existing organizations where traditional employees, suppliers, and so on are no longer needed, or are replaced by motivated individuals.

Crowdsourcing can take various forms. In addition to development-related crowdsourcing, almost any electronic service is being rated by its users, which in essence is crowdsourcing process for evaluating the usefulness of the service. Similarly, crowdfunding provides opportunities for creating new funding models based on individuals willing to invest.

Recommendation Engines

With virtually all digital information within reach, the role of recommendations and systems producing recommendations is increasing. Recommendation engines seek to predict the rating that a particular user would associate to an item that he or she has not considered. The rating is based on a model where the characteristics of the item, the user's social or physical environment, or demographics are considered. Examples of using recommendation engines include various web shops, with Amazon leading the way in its system that recommends additional items based on what other shoppers bought along with the currently selected item, and content providers such as NetFlix, where additional content can be offered based on already consumed content.

Hyper-Scalable businesses

Recently, traditional business models have been challenged by peer-to-peer type of businesses. Companies such as WhatsApp, Uber, and AirBnB operate with small personnel but are able to serve the global consumer base by connecting producers and consumers online. Completely powered by

software, super-scalable businesses are emerging, where one company takes up to 99% of available market on a particular domain, often disrupting the business of existing players.

Platformization

Platformization refers to engineering techniques and methods needed to enable traditional standalone software applications to be offered on the cloud. Software platformization includes the development of new techniques to harvest software architectures, functions and processes from existing large code bases instead of defining and coding them separately for every set of business requirements. Main benefits of platformization include significant reductions in development effort, cost, and time.

3.4 Strategic challenges & opportunities

In the rapidly changing world of ICT, it has become increasingly important to bring new compelling features available for the largest possible customer base. The Web plays a paramount role in the distribution of products and services, and therefore, in a relatively short time, the Web has become the platform for all types of applications that enable real-time collaboration in forms and scale that would have been difficult to imagine a few decades ago.

As the Web enables instant worldwide deployment at virtually no cost, traditional distributor-driven business models and processes are being challenged. Applications and services can be distributed over the public Web without middlemen, distributors or app stores. Once a web page or application is deployed on the Web – be it in Tampere (Finland), Dar-es-Salaam (Tanzania), Kyoto (Japan), or in Menlo Park (California, USA) – it is instantly available to everyone connected to the Web. The *worldwide deployment* aspect is incredibly powerful, especially when combined with the notion of "*zero-installation software*", i.e., software that does not require any manual installation or upgrades. Such software can evolve at a pace that is almost beyond imagination to conventional software developers, with "*nano releases*" – upgrades of the software occurring on a daily or perhaps even on an hourly basis. This in turn enables changes in businesses at a pace that were unimaginable only few years ago.

There are many challenges associated with the new, elastic businesses and associated systemic transformations. In order to deliver new features at the pace required by users, a number of phases in software development need to be further automatized, to the extent that a single developer can handle design, implementation, testing and deployment of a new property in one day, or even more rapidly. This calls for tools, techniques and methods to support different versions of a service or a product that are deployed at any given time. In addition, facilities are needed for managing massive scaling when a service becomes a global hit, as well as to enable developers to notice this via different feedback mechanisms. Detailed descriptions of these have been defined later on in this SRIA, and here, we only conclude that there are numerous technical and organizational hurdles that must be overcome.

A further challenge that should not be overlooked is the fact that in the systemic transformation, technical artifacts and advances go hand in hand with business opportunities. For instance, modifying a service that was created for a certain group of users for another requires an understanding of the technical limitations as well as associated business aspects. This requires new forms of cooperation and flexibility between different functions inside a company.

As confirmed by global giants, such as Google, Amazon, Facebook, and Apple, as well as Finnish examples, such as Supercell, the benefits of the web and the ability to grasp them are what makes the difference between the successful and mediocre companies. Based on recent history, it seems that the dominating companies will gain an even bigger share of attention and revenues than before, whereas other companies will struggle over leftovers. Consequently, the ability to play by the rules of the web era, including continuous deployment of compelling features, rapid changes in businesses and business models, are essential for long-term survival of any ICT company. While gathering data from actual users, companies can adapt to the changes in customer base more rapidly than when using e.g. living labs, which have become popular for extracting customer feedback, but only give partial answers - only a limited view can be collected. Based upon the above, the creation of feedback systems that operate real-time on real customer data, and even visualize the results on the fly as more data becomes available, enables entering new markets that are partially unknown. In other words, it is possible to do business experiments in domains that are not familiar beforehand, and adapt to their needs based on the feedback.

The increasing level of automation is an important factor, which can be considered as a challenge and an opportunity. Systems can learn from e.g. human behavior, and when combined with data that is available on-line or from recommendation systems, increasingly complex conclusions can be made. The different components that enhance the automation of software deployment, feedback gathering and analysis have been studied earlier in DIGILE programs Cloud Software (cloud-based services, user experience), Internet of Things (wireless connectivity of different appliances), and Data to Intelligence (data analytics). Therefore there is a strategic opportunity that is based on the results these programs. The forms of cooperation will be specified later on.

Finally, this SRIA has the potential to act as a forerunner in *catalysing systemic transformations in different industries*. The breakthrough targets of this SRIA - paradigm change to deliver value in real-time, deep customer insight to improve business hit-rate, and mercury business, where rapid business moves are taken to gain new revenues - provide profound enablers for such change. Having the opportunity to observe how such a transformation takes place will then help in understanding its dynamics and, in the long run, assist in similar transformations in other contexts.

4 BREAKTHROUGH TARGETS

The aim of the N4S SRIA is to create the foundation for the success of the Finnish software intensive businesses in the new Internet economy. During the program we will see the global digital services business growing in Finland and completely new Finnish brands in digital business introduced.

The breakthrough targets have been defined as follows:

1 Paradigm Change - Delivering Value in Real-Time:

The Finnish software intensive industry has renewed their existing business and organizational ways of working towards a value-driven and adaptive real-time business paradigm. Technical infrastructure and required capabilities have been established to support the transformation.

2 Deep Customer Insight – Better Business Hit-Rate:

The Finnish software intensive industry is utilizing the new technical infrastructure, new capabilities as well as various sources of data and information for gaining and applying the deep customer insight. This significantly improves the return of investments in service and product development.

3 Mercury Business – Find the New Money

New "Goal Driven Hunting Culture" - Mercury business approach expanding beyond existing business has been created and adopted by the Finnish software intensive industry with several successful examples of adjacency towards the new markets and business areas. The new Mercury Business approach is enabled by the continuous and active strategy and the new leadership style. What is important to note that the two breakthrough targets above are enablers and prerequisites for meeting the Mercury Business breakthrough target, as well as key elements of the real-time business system.

The key goals and measurements related to the breakthrough targets are defined below.

Paradigm Change - Delivering Value in Real-Time	N4S: lead time decreases 20% annually (yr2->)
Goal	**Measurement**
Continuous deployment infrastructure and new capabilities will enable fast release cycles with minimum effort	# of deployed services/products updates increase # of service/functionality launches increase developer/staff ratio will increase Quality of products or services increases (e.g. less bugs or better customer satisfaction)
Technical infrastructure and capabilities to allow organizations to deliver new features significantly faster without compromising the quality	lead-time decreases annually towards right-time, real-time value delivery targets # of minimum viable services launches increase annually # of new, methods and tools enabling faster development and release cycles

Deep Customer Insight – Better Business Hit-Rate	Active user base of affected services is doubled by 2017. Finnish digital businesses have entered into entirely new markets, customer segments and several completely new brands are introduced.
Goal	**Measurement**
Technical infrastructure and capabilities in gaining and analysing the deep customer insight have been established in the organisations	How often do we use data in new feature development decision making? Percentage of affected organizations that have the technical and human capabilities to run live experiments in their software services How often do we collect systematic customer satisfaction data for our products? Percentage of affected organizations that have used deep customer insight for product development decisions
Organisations are using several sources of the heterogeneous information and data to predict the future and impact to the market	# of business opportunities identified and systematically considered/analysed ROI of products and services improves significantly

Mercury Business – Find the New Money	N4S: revenue growth from 10% annually to > 50% by 2019 Finland will be a new innovation and investment hotspot - Several new businesses have been established based on Mercury Business approach.
Goal	**Measurement**
Organisations scout actively new business opportunities outside the existing business.	# of new opportunities identified and utilised # of persons in scouting new opportunities in an organisation
Organisations will introduce new products and services outside the existing business	# of new products and services outside existing business
New start-ups (also within the existing companies)	# of start-ups emerged from Mercury Business approach

The N4S results will be packaged as capabilities that can be disseminated and exploited widely in the Finnish economy to enhance global competitiveness that will attract foreign investments in Finland.

5 RESEARCH STRATEGY

The research approach in the SRIA combines the scientific goals of basic research by aiming to gain fundamental understanding of the complex phenomena related to the paradigmatic changes taking place in the development of software intensive services and products with the considerations of use of the new methods, tools, and processes. The scientific results will then be applied empirically in the industry to validate them in practice, thus creating new knowledge.

5.1 Introduction

The research is organized into two tracks, one focusing on basic research activities that go beyond the most burning industry issues, and another where close cooperation between academia and industry takes place. The former category of research will be funded via fully academic means, such as Academy of Finland and European Science Foundation, with academic institutions taking the lead. In contrast, the latter will be organized in the form of a Tekes project, with an option to include auxiliary projects that collaborate with the N4S program. Following the practices that have been established on numerous other DIGILE programs, the effort will be guided by industry needs and led by an industrial participant.

Research approaches that will be used are selected based on their adaptability to the current situation. At the level of SRIA, the main principles applied in the research include the following:

- Build the research baseline with state-of-the-art and state-of-the-practice reviews.
- Review of the industrial pain points and business goals in the participating companies and industries carried out jointly in the beginning.
- Start experimenting with fast creation of services using e.g. the “hackathon approach”
- Create new tools, methods, and processes for supporting real-time deployment of services and for collecting and analyzing feedback at real-time; analyze the outcome in the context of companies
- Study and create new business models and their mechanisms
- Focus research to create approaches, methods, tools and techniques to areas with key impact.
- Evaluate and improve approaches with appropriate means such as analytic or empirical methods.
- Move the emphasis gradually to work on business cases.
- Common cross-theme and cross-topic repository and working environment for research material.
- International cooperation principles that are commonly applied in joint research.

World-class research will be carried out in the following fields:

- Software engineering technologies, tools, competences and processes that enable frequent delivery of improved products and services which can be reused over multiple industrial sectors;
- Feedback and analytics systems that can be used to study the true needs and expectations of the users;
- Mechanisms for fostering Internet-era businesses and business models;
- Sustainable dynamics for massive scalability of products, services, and businesses.

The academic partners implementing this SRIA will be selected from prominent academic institutions in Finland in the areas of software engineering, information sciences, user experience, and data science. The participation in the research provides a unique opportunity for advancing and stabilizing the research and education at the top level in the world, leading to excellence in research.

Forward-looking companies will participate in the research. They will define the industrial needs of the research together with academic partners. The companies will take the results of the program into use and provide an empirical environment for carrying out the research.

Strategic target

A specific strategic target for the remaining time of this SRIA regarding the research results shall be to document the obtained results of the results into packages, so that they are easy to use by anyone interested.

Consequently, project plans addressing this SRIA needs to include a clear dissemination plan that ensures:

- Proper information distribution internally and externally during the project
- Definition of Package of concrete tools, guidebooks and processes for future dissemination, consultation enterprises and enterprises in general.
- Definition of a place where Package is available for future use, e.g., a DIGILE hosted storage.

5.2 Research Methods

In the research program, a variety of research methods will be applied, as determined by the focused research objectives and questions for the various studies. The fact that the program has academic partners from a variety of disciplines creates the possibility for innovative interdisciplinary research.

Research methods that will be applied in the project include Qualitative, Quantitative and Mixed Methods Approaches (Creswell JW. Research Design --. 3rd ed.: Sage Publications; 2009) and (Systematic) Literature Reviews. The empirical approaches include in particular the following:

- Software engineering experiments and quasi-experiments both in laboratories and in industrial contexts
  - Claes Wohlin, Per Runeson, Martin Höst, Magnus C. Ohlsson, Bjorn Regnell, Anders Wesslén. Experimentation in Software Engineering. Springer, 2012. 248 pages.
  - Pekka Abrahamsson, Petri Kettunen, and Fabian Fagerholm. 2010. The set-up of a software engineering research infrastructure of the 2010s. In Proceedings of the 11th International Conference on Product Focused Software (PROFES '10). ACM, New York, NY, USA, 112-114.
  - Fabian Fagerholm, Nilay Oza, Jürgen Münch. A Platform for Teaching Applied Distributed Software Development: The Ongoing Journey of the Helsinki Software Factory, Proceedings of the 3rd International Workshop on Collaborative Teaching of Globally Distributed Software Development, 2013.
  - Natalia Juristo and Ana M. Moreno. 2010. Basics of Software Engineering Experimentation (1st ed.). Springer Publishing Company, Incorporated.

    - Shadish WR, Thomas CD, Campbell DT. Experimental and quasi-experimental designs for generalized causal inference: Houghton Mifflin Company; 2002
- Software Measurement
    - V. Basili and D. Weiss. A Methodology for Collecting Valid Software Engineering Data, IEEE Transactions on Software Engineering, vol.10(3): 728-738, November 1984
    - Victor Basili, Jens Heidrich, Mikael Lindvall, Jürgen Münch, Myrna Regardie, Dieter Rombach, Carolyn Seaman, Adam Trendowicz. “Linking Software Development and Business Strategy Through Measurement”, IEEE Computer, vol. 43, no. 4, pp. 57-65, 2010.
- Case study
    - Yin RK. Case study research: design and methods. 5th ed.: Sage Publications; 2013.
    - Runeson, P. & Höst, M., 2009. Guidelines for conducting and reporting case study research in software engineering. Empirical Software Engineering, 14(2), pp.131–164.
    - Seaman, C.B., 1999. Qualitative methods in empirical studies of software engineering. Software Engineering, IEEE Transactions on, 25(4), pp.557–572.
- Surveys at a firm level and at the industry level
- Qualitative Studies
    - Tore Dybå, Rafael Prikladnicki, Kari Rönkkö, Carolyn B. Seaman, Jonathan Sillito: Qualitative research in software engineering. Empirical Software Engineering 16(4): 425-429 (2011)
    - Myers, Michael D., and David Avison. "Qualitative research in information systems." *Management Information Systems Quarterly* 21 (1997): 241-242.
- Business experiments and other experiments in real-world contexts using Action Research, Action Design Research (ADR) or another suitable research methodology. These experiments can include, e.g. adopting new practices for business, innovation or software development and analysing their impact, shortcomings and new novel complementary directions needed.
    - Baskerville, R. & Wood-Harper, A., 1996. A critical perspective on action research as a method for information systems research. Journal of Information Technology.
    - Avison, D. et al., 1999. Action research. Communications of the ACM, 42(1).
    - Davison, R., Martinsons, M.G. & Kock, N., 2004. Principles of canonical action research. Information Systems Journal, 14(1), pp.65–86.
    - Stringer ET. Action research 3rd ed., Sage publications; 2007.
    - Sein, M., Henfridsson, O., Purao, S., Rossi, M. & Lindgren, R., 2011. Action Design Research. MIS Quarterly, 35(2).
- Design Science
    - E.g construction of new methods and tools
    - Use of common tools for process support and analysis will be investigated
    - Hevner, A. et al., 2004. Design science in information systems research. Management Information Systems Quarterly.
    - Gregor, S. & Jones, D., 2007. The anatomy of a design theory. Journal of the Association for Information Systems, 8(5), pp.312–335.

    - Van Aken, J., 2007. Design science and organization development interventions: Aligning business and Humanistic Values. The Journal of Applied Behavioral Science.
- Research and analysis of public and proprietary databases, including open source repositories and software development databases of participating companies.

5.3 International Cooperation

Within the scope of the SRIA, we foresee that a number of already existing international relations will be further strengthened and a number of new ones will be created. Researcher exchange to and from Finland is also planned.

In addition to the opportunities listed below, please contact DIGILE with new collaboration proposals.

- European research projects - Horizon 2020 and ITEA3 will be the main targets for future projects.
- European Institute of Technology ICT Labs, which acts in a similar fashion as proposed in this SRIA, and aims at consistently bringing together researchers, academics and business people.
- A number of international academic partners, with whom the N4S partners have existing relationships, including
    - Universidad Politecnica de Madrid, Spain, with which the foreseen research partners have already established close cooperation, supported by a FiDiPro professor visit to Finland.
    - Fraunhofer Institute for Experimental Software Engineering (IESE) carries out empirical research in collaboration with industry. N4S partners have close collaboration with IESE.
- Lero - the Irish Software Engineering Research Centre
- A number of conference communities that have already been used for publishing research results related to the scope of the project. These include at least the following conference series and other venues listed in the following:
    - International Conference on Software Business (ICSOB)
    - Product-Focused Software Development and Process Improvement (PROFES)
    - Software Engineering and Advanced Applications (SEAA)
    - IEEE / IFIP Working Conference on Software Architecture (WICSA)
    - European Software Architecture Conference (ECSA)
    - IEEE International Conference on Global Software Engineering (ICGSE)
    - International Conference on Software and System Process (ICSSP)
- Co-operation with the ISERN network in empirical co-studies will allow for world-class joint research. ISERN is a global network of over 50 top research and academic organizations in empirical software engineering.
- IFIP (International Federation of Information Processing Science) Working Group 2.10 Software architecture.
- Stanford University, USA (visiting professor and research collaboration)
- Research on software engineering theory and practice with University of Lund (Prof. Per Runeson)

- Research co-operation with Chalmers University of Technology and Malmö University in replication study of “Stairway to Heaven” model and development of new version for the model (Prof. Jan Bosch and Prof. Helena Holmström-Olsson).
- Collaboration with the leading elastic enterprise organizations to form a “Elastic Enterprise Network”
- Norwegian University of Science and Technology (Prof. Pekka Abrahamsson)
- Free University of Bolzano-Bozen (Daniel Graziotin and Xiao Wang)
- Istanbul Technical University (Dr. Ayse Tosun)

6 RESEARCH THEMES

The SRIA is built around three main research themes that have already been addressed at the beginning of the document. These are:

1. Delivering value in real-time - how do we rapidly provide value to customers? Which technology, tools, methods, and organizational cultures are needed? How can these be aligned with business goals and in particular support the creation of new business?
2. Deep customer insight - how do we enhance “data-driven” organizational culture and capabilities in order to increase business hit-rate and create new, successful business while rapidly terminating efforts that are expected to be dead-ends in the long run?
3. Mercury business - how do we identify and leverage new opportunities for emerging businesses beyond those that are already being harvested?

In the following, we will give a detailed introduction to all of these themes, together with the most important goals for research.

6.1 Theme 1: Delivering Value in Real-Time

The research theme ‘Delivering Value in Real-Time’ focuses on providing both techniques, methods, and tools as well as cultural changes that allow organizations to deploy products or services with extreme speed. The goal of the theme is to enable organizations to rapidly provide value to customers as real-time as possible. Some organizations, especially in the area of web applications, are currently able to do this and even deploy many new versions per day. However, we understand that this goal is still a formidable challenge for many types of systems and services in various domains and organizations, for example in the field of embedded systems.

To deliver value in real-time, an organization operating in DevOps or more traditional mode has to explore opportunities amongst their potential customers continuously as well it needs to have an culture and architecture that supports the incremental development of systems, where features can be added and removed easily. The architecture must be supported by a continuous integration system that can build and test new versions of a system without delay. This requires the automatic and incremental generation of test cases and interpretation of test results. Deployment must also be automated with mechanisms to minimize or remove downtime or inconveniences for the users. These technical solutions must be adequate to develop and deploy both digital services and embedded systems. To top it off an organization needs to have capability for deep customer insight that improves the odds for creating the best customer value. It is envisaged that in some areas new value creation may even be automated, e.g. recommendation engines can provide new value unattended. These changes require also profound changes to the organizational culture and human issues. It must be remembered, however, that value is something that each person experiences for themselves. For example, a minor change in service is easy to accept and therefore brings value, but too radical a change can cause frustration.

It is also important to distinguish between *delivery capability* and *delivery frequency goals*. Different businesses and customers have different needs with respect to delivery frequency, and the organization’s delivery capability should match or exceed this — the organization should aim for **“in-time” value delivery**. While real-time value delivery can be an important goal in certain businesses, e.g. SaaS, in many others, full real-time delivery capability might not be needed. As the investments

when building delivery capability can grow exponentially when building e.g. the necessary infrastructure, the capability need, investments and expected benefits must all be weighed from the point of view of the expected competitive advantage gained. The work package aims at addressing this through understanding the cost-benefit of real-time/in-time value delivery capability and the market/customer needs and help companies understand how close to real-time value delivery capability they should aim for.

Once technical solutions and methods are in place, an organization can change the way it internally generates value. Traditionally, organizations have carried out planning, development and operations as different activities. However, with new technical solutions proposed in this theme an engineer can single-handedly deliver a new feature to the users. The question is how should the organization and the ecosystem around this individual function? For example, there may not be a need to keep separate departments for sales, marketing or R&D but to organize people according to customer value streams overlapping organizational boundaries. Alignment of business, assets and skills can be dramatic and may require major changes not only in development and deployment processes but also in the way businesses are run in more general.

6.1.1 Focus areas

Beyond DevOps, Organizational Culture and Human Factors

DevOps has been identified to be an important aspect in continuous deployment paradigm in practitioners' community and academic research. DevOps is a blend of two words Developers and Operations that builds a living bridge between development and operations and gives them an opportunity to work and collaborate effectively and seamlessly in software development and deployment. To be successful DevOps needs a cultural change on a company level. DevOps requires company culture supporting new ways of working and mindsets like DevOps including the co-existence of DevOps and traditionally organized development culture (sub cultures). One of the challenging questions is how to empower individuals to deliver value in real-time while being aligned with the goals and objectives of an organization? By enhancing DevOps with product management and engineering (aka ProDev) we will be able to move to so called ServDev or supercells which will provide more sophisticated ways of working. The background is that organizations have a long tradition of being structured according to the division of duties, but that is not enough. As value creation gets faster there is less time to wait for specific expertise. In parallel with technical infrastructure enabling the high speed of system and service creation and deployment there also needs to be an adequate infrastructure in place for the non-technical aspects of value creation. In ServDev approach value creation must be taken into account by all members of the ecosystem, and thus, individuals need to be multi-talented and proactive to understand very fast what is required for creating the value for the customers. Organizations need to foster a culture that facilitates the real-time value creation at all levels. Finnish culture supports this with high respect for knowledge of individuals and little fear for authority. Externally, organizations need to embrace and exploit suitable ecosystems and networks to enable capability the fastest possible overall value creation.

Architectures, Methods and Tools Supporting Real-Time Development and Deployment

This theme area focuses on flexible software, HW/SW product and system architectures, development methods and tools that enable engineers to provide new value to customers in significantly less time than what is required currently. These architectures, methods and tools allow for designing, implementing, integrating, and deploying new features and products with minimal

extra effort. Adding and removing features to existing products and services is performed with minimal downtime or inconvenience for the users. Features can be selected and configured at run-time allowing an organization to offer customized products and services to different customers without overheads. HW revisions and modifications can be done with minimal change to product architecture and product structure or SW. There is support to develop minimum viable products and services rapidly, using ready-made templates and components. Experimentation approaches are supported in system architecture and development tools, for example in the form of easily replaceable features for A/B testing, measurement collection and reporting. Finally, this theme needs to provide answers for the challenges for developing the multiple capabilities required for ServDev people and teams.

From Continuous Integration towards real-time, Continuous Deployment or R&D as experiment system paradigms with real-time Quality Assurance

To achieve the necessary high development and deployment speed there is a need for methods and tools to reduce the time required to build, test and remove defects from the new versions of software or hardware system. To build such capabilities in organisations, research is needed in methods for continuous integration with fast delivery and deployment. These capabilities require the mastery of test automation, coping with the architectural challenges enabling the flexibility required, and feature management practices for maintaining the dynamically evolving product offering. Development and build times can be improved by the better integration of the methods and tools. Test effort and time can be reduced by automating test generation and test result interpretation, and using distributed testing and incremental testing approaches that only test what has changed from the previous version. Some organizations are currently capable of deploying several versions of a system in a single day. However, this is still not the norm for many organizations in Finland or for certain domains, such as embedded systems. We also propose to study the use of crowdsourcing in quality assurance, for example to obtain feedback on the user experience of a new version. Organizations must also assess if continuous deployment is a suitable business model for them. It needs to be analyzed when it makes sense to invest and transition to a continuous deployment model and when to change the business model to benefit from the continuous deployment capability. In relation to this code-generation, automated testing, open source coding and COTS (components-of-the-self) should be noted as important approaches to learn with in perspective how it impacts to real-time value delivery. Learning from experiences of game and other industries like automotive software in building development environments like game engines and AutoSar standards based automated code generation is seen also worthwhile.

Co-development and deployment of hardware and software

Products and services typically consist of elements from different disciplines, e.g., mechanics, electronics, and software. Continuous deployment requires, therefore, that these components are developed and integrated in a highly synchronous way utilizing best development principles. There is a need for a better understanding on the applicability of continuous development and deployment methods for different kinds of products within each discipline, but perhaps even more importantly for products combining components from several disciplines. It is important to find out and understand the boundaries, potential limitations, and most importantly the characteristics of products, companies and other contextual parameters that offer the best opportunities for fast deployment capabilities. Further it is important to optimize need for prototyping of HW in terms of maturity, sample size, prototype rounds within a project and cost based on lean principles. Advanced analytical models are

needed to analyze all the previous to guarantee required quality, manufacturing and supply performance and to minimize time, number of prototype rounds per project and cost involved.

6.1.2 Goals

- Renewal of existing businesses, organizations and organizational cultures towards a real-time business paradigm
- Provide methods and tools to quickly and inexpensively create mockups, prototypes of new products and services, including also hardware-based products, so they can be evaluated by potential customers before investing heavily in actual development.
- Study how flexible co-existence of ServDev, DevOps and traditional way of organizing e.g. program organizing coexist as subcultures
- Provide the technical and non-technical infrastructure and capabilities to allow organizations to deliver new minimum viable products and services significantly faster.
- Provide the technical and non-technical infrastructure and capabilities to allow organizations to deliver new features in existing products and services significantly faster and without compromising quality.
- Apply the designed techniques, tools, and methods in multiple industry sectors.
- Evaluate the developed technology with respect to increase in delivery and deployment speed
- Apply customer feedback and other relevant data, which is guiding the development as important as the original requirements
- Study Model-based software development approaches in light of delivering value in real-time.

6.1.3 Results

- As a result a dream state is the following; “User starts development by taken into use virtual development and deployment environment which is linked to organizations Way of Working like DevOps, related tools and methods and community”.
- Renewal of existing businesses and organizations towards real-time business paradigm
- Technical infrastructure and methods for DevOps enabling real-time value delivery approaches including in-time, continuous deployment or R&D as experiment system approaches in addition to SW approaches also HW/SW co-developments; this can include
    - New methods and tools to quickly and inexpensively create mockups and prototypes of new products, services and features to be evaluated by potential customers before actual development.
    - Methods, tools and best practices for feature prioritization and feature management, versioning, run-time configuration and customization of products and services to individual customers.
    - New methods and tools for elastic, scalable and automatic design, implementation, management and deployment of digital services.
    - New testing methods and tools that reduce the effort and time to validate new features and enable continuous integration and deployment in practice.
- New design and development methods and tools to facilitate continuous development and deployment of large embedded systems containing software and hardware components.
- Culture and human aspects require approaches to support cultural changes in companies for example in DevOps and other subcultures in continuous deployment.

- New architectures, design and development methods and tools supporting fast and continuous development and deployment of new features in software-intensive products and services for several application domains and technologies including web, mobile and embedded systems.
- Templates, stencils, blueprints and skeletons that can be used as starting point to develop new minimal products and services.

6.2 Theme 2: Deep Customer Insight

The research theme 'Deep Customer Insight' focuses on quickly gaining information about the true customer value of potential services, product features, and other possible aspects of user interaction with a service or a product. The goal of the theme is to enable data-informed design decisions, focus development resources on new opportunities, and create competitive advantage from deep customer insight. The deep understanding of the customers, usage of products and rapid feedback are gathered and exploited continuously from the live use of the products.

This research theme requires as a prerequisite a very good understanding of customer contexts and development opportunities, the ways how customers live and work. This is essential for inventing value-creating solutions, i.e., the source of inspiration for new products, features, or services that create customer value will typically stem from the customer contexts and not from the engineering domain. Appropriate methods and approaches such as problem interviews or collecting demographics from the software domain but also from other domains need to be identified and used for capturing these contexts.

In order to efficiently utilize the methods of gathering and analysing customer data for gaining deep customer insight, the organizations need to develop and improve their capability for identifying questions and business problems that could be answered using customer observation, data analytics and live experimentation. This process includes identifying the stakeholders, and their data needs, to whom the insights are provided in order to understand and guide management and R&D work better. Furthermore, organizations need the ability, culture, and mindset to transform the insights gained into concrete actions that affect the development priorities, product roadmaps and backlogs and other related fields such as marketing and sales.

There is a thriving demand for advancements in automatic and efficient feedback systems, analytics and visualization for companies that want to do be competitive on the global market. The potential of efficient feedback systems, less advanced and advanced analytics is huge as companies and organizations have gained a better understanding of the importance of knowing their customers' cultural differences and behaviour in different situations i.e. they want to have deep customer insight.

Conducting live experiments is a means to trying to understand customer behaviour with a service or a product. However, before running the experiments, one should understand what would be the target of the experimentation. One can start the experimentation from simple features and interactions. Starting an experiment, i.e. releasing the features for experimentation and instrumentation for data collection, should be made simple and fast. The ultimate goal would be to experiment and test ideas and concepts early in the development - not only after the product or service or hardware for the product exists. This addresses not only testing single features, but

testing all kinds of customer interactions with services, products, and ecosystems that are expected to generate customer value.

The successful collection of usage data requires understanding regarding what data to collect. Data that is readily available and simple to collect does not necessarily lend itself to meaningful interpretation, for example, in terms of what can be related to the user value of the features or true needs of the user. Thus, instrumentation, data collection and the analysis of the data to be collected must be designed properly for effective results. Finally, privacy and security concerns that can be overlooked in a single, proprietary company like Google, Facebook, or Amazon must be treated differently when considering a networked software economy such as Finland.

Data management and exploitation within organisations needs to be improved to enable organization level data and analytics results sharing and reuse, as well as learning from data and insights. Customer insight data management solutions may also need to support semi-automated data analytics and visualization to provide continuous and reliable insights to support decision making in different parts of organisations. In order to provide relevant decision support, an important aspect to consider in data and insights management is quality and reliability of the data.

The goal of running the experiments requires two kinds of main capabilities from the company. Firstly, the software development process requires the basic capabilities for understanding customer needs, flexible architecture, and continuous deployment with automatic testing so that the features to be experimented can be released effectively without the risk of breaking the real product or service in the process. In addition, however, advanced capabilities are needed for the management of the features, with the ability to release features at will and remove the obsolete features after the experiments so that they do not obscure the code base.

Once a company has the capabilities needed in place and have gained the understanding on how to target and design the experiments, the software can be developed in an extremely fast pace to match the real needs on a factual basis.

6.2.1 Focus areas

Business Hit Rate of New Products and Features

Innovative products, services, features, or ecosystems typically stem from vision and intuition of entrepreneur-style thinkers. In order to reach high business hit rates, the vision and intuition need to be directed towards the most value-creating solutions with appropriate means. The first ideas should already have a high probability for business success. However, due to the inherent risk of intuition-guided work, mechanisms need to be in place to quickly test if the ideas should be continued or whether a change in direction is needed. Ideally, it should be feasible to test value propositions before the solutions are implemented or in an early stage of the implementation. In addition, the value-creating solution needs to be linked to the operational activities that constitute this solution. Agile and lean development approaches already support the visualization of working software and hardware. However, links from working software or hardware towards user stories and higher-level solutions customers are needed. Often, these links are not explicit, i.e. specific features provide functionality but it is unclear how they contribute to the final solution for customers and if they really create value. Therefore, it is necessary to elicit these links and make them explicit. These links are usually assumptions. Such an assumption could be that the existence of a specific feature increases the customer satisfaction with a service by a certain percentage. This improvement, in turn, might

improve customer loyalty, and in consequence the ability of the organization to secure or expand their position in the marketplace. In order to improve the business hit rate links of such kind need to be established and continually reviewed and adapted. In addition, the underlying assumptions need to be validated continuously. It is necessary to continuously review and evolve these links and to validate the underlying assumptions. This promises to significantly increase the business hit rate of organizations.

In addition to making assumptions and testing them during product development, information about the value of any set of features and services can be gained through observations and interviews of future users and customers and other service design methods.

Infrastructure for Continuous Experimentation

The focus of this research area is to create an experimental infrastructure consisting of the mechanisms, tools, processes, and methods for efficiently running experiments. Innovative features, for instance, that are not familiar to customers need to be tested as early as possible in order to better understand their real value. The experimental infrastructure needs to be easily adaptable to the needs of different organizations so that they can effectively customize it for their purposes. As a prerequisite it is necessary to analyze which experimental designs and testing methods are appropriate for different goals and contexts. Based on this, decision support should be provided for selecting appropriate designs. In addition, the selection of experimental subjects needs to be better understood and guidance needs to be developed. Due to the overall goal of rapidly getting customer feedback by continuous experimentation, the experimental setup including the measurement instrumentation needs to be highly automated. Appropriate mechanisms and tools for this kind of automation need to be identified or developed. Concepts for storing and packaging results from conducted experiments will be part of the experimental infrastructure. Experimental results could, for instance, be stored in a company-specific “experience base” that captures the gained knowledge and allows advanced analyses of customer behavior and customer expectations. Facilities and laboratories such as Software Factories could be established to create experimental objects (such as prototypes or minimum viable products). Note that companies like Facebook are using the live production system as the base for their experiments, and use techniques like geographical throttling to conduct experiments so separate infrastructures may not be needed. Finally, the experimental platform needs to be integrated with the technical infrastructure for continuous integration and deployment.

Data Collection, Real-time Feedback from Real Customers

The focus of this research area is to create the mechanisms, tools and methodologies for collecting usage data and feedback. As the starting point, it is important to gain understanding on what data to collect, for example, whether the primary interest is the usage of a single feature, the particular combination of features or an entire new service or product. Appropriate measures need to be derived from measurement goals. This also involves business-related measures such as innovation accounting (i.e., what has been learned about the customer value). The main focus is to collect usage data or other value-related data without interfering with the actual use. However, other, complementary means of collecting user feedback should be utilised. Such means include, among others, traditional usability tests, interviewing and observing users, user surveys, active user feedback directly from applications as well as different social media channels where the users discuss, evaluate and critique services and products they use. The data collection should be based on the rigorous scientific principles of data collection and experimentation, but clearly adapted to the

needs of industrial practice, for example, the data collection should not distract other development activities.

Data Analysis, Visualization and Interpretation

The primary purpose of experimentation and data collection is to provide a factual basis for decision making. This requires that the collected data is properly analyzed and correctly interpreted by the respective stakeholders. The proper methods and tools need to be readily available and built in to the overall experimentation setup. This includes the availability of Open Source Software (OSS) for analytics and other tool support on top of OpenStack and other OSS platforms. In the interpretation of data, the potential differences in the context of usage must be understood and taken into account in order to avoid the serious misinterpretation and danger of wrong decisions. Finally, the data needs to be visualised and provide a clear link to customer value and business goals with clearly interpretable answers as the basis of decision making.

6.2.2 Goals

- Create and enhance “data-driven culture” in organizations. Make them better in identifying questions and business problems that could be answered with data and use it in decision making at all levels of the organizational hierarchy.
- Significantly improve the business hit rate by linking product-, service- or an idea related activities to the business level using live customer feedback and validated knowledge about customer value.
- Provide multi-disciplinary mechanisms that companies can use proactively and early for validating innovative idea, feature, product, service and business models as well as future customer needs
- Provide support to organizations for making data-informed design decisions for evolving or creating new software-based products and services.
- Build robust and automated feedback systems both for new and existing products and services.
- Develop a tool-based infrastructure for continuous experimentation and live customer feedback to be efficiently used by organizations in different domains.
- Conduct cost efficiently massive scale experiments with users and customers, together with the necessary analytics tools for studying the real use of products and services.
- Explore advanced mechanisms, such as recommendation systems, to predict customer behavior based on existing data or mimic real customers based on validated models.

6.2.3 Results

- Processes and guidelines for making data based product development decisions and to transform customer insight to concrete actions
- Means to understand customers and markets with greater depth to be able to assign investments earlier with radically improved accuracy
- Methods, laboratories, and tools for running live experiments for software intensive services, SW/HW products and features.
- Simple and advanced data and text mining methods in order to extract deep customer insight, e.g. dynamic customer segmentation models, predictive models, recommendation systems, and early warning system models.

- Deep understanding about the benefits and limitations of live experimentation as a means to understanding customers in different domains and contexts as well as when combining different industrial disciplines.
- Networks of Software Factories that support the experimentation with customer value.
- Reusable and scalable experimental infrastructure that can be applied in multiple industry sectors.
- New business opportunities in the form of technology and tools that are needed to support the defined activities.
- Strategic ability to enter the new promising fields of businesses at a speed that is beyond that of current organizations.
- Detailed processes and tools of collecting information, analyzing information and experimenting are defined in a reference system that is easy and convenient to take into use.
- Defining feedback loops so that continuous feedback process can be implemented at various stages of the process with appropriate stakeholders and clients (internal/external).

6.3 Theme 3: Mercury Business

The research theme “Mercury Business” focuses on how companies and societies can behave like “mercury” finding new grooves where to flow. The goal of this theme is to enable companies and societies to actively seek new ways in their existing business, but also ways to transform themselves to completely new business areas. Research themes 1 and 2 contribute heavily to Mercury Business theme as they contain many of the prerequisites, e.g. ability to deliver value in real-time and infrastructure for continuous experimentation.

The research will study ways to create capabilities and practices to identify, initiate, and grow new business initiatives flexibly utilizing internal and external resources following a mercury approach. This includes research on what Mercury business requires from the company culture, structure, and leadership and from the external ecosystem. This research both collects and adapts best practices from other business domains and countries and also generates new revolutionary ways of conducting business (models, tools and methods) that stem from the strengths of the Finnish culture and society.

The first four focus areas below represent the main flow of activities in a company from internal and external Foresight through Opportunity Identification and Experimentation to Business Modelling. The fifth focus area addresses Capability identification and creation including tools, methods, employee competences, new business hunting and organization culture as well as resource and coordination flexibility. The last area Mercury Management Model identifies variation of business models and management models according to the phase of business initiative.

Most of the focus areas already exist in companies, but not the Mercury way of creating new businesses. With the Mercury approach it is essential that all the focus areas form a network of interconnected activities that make the capabilities and opportunities to meet leading to evolving business and renewal of the company.

The Mercury business model may change the existing products, product portfolios – but, perhaps more importantly – it can totally convert the company into a new business domain. Google, with its custom to release new services as beta to a selected set of consumers, is an example of this when it has entered totally new application domains with radically new business models.

6.3.1 Focus areas

Foresight

Foresight includes external foresight recognizing weak signals, behavioral patterns, and trends as well as internal foresight analyzing asset knowledge and discovery and mapping them against market trends.

Often, new emerging trends and new customer segment's needs or habits are not visible for organizations and are detected too late. Research should provide both customer data analysis capabilities as well as new ways to reach the existing and potential customers and actively communicate and elicit feedback from them. The focus of this research is to establish mechanisms to early identify weak signals that indicate potential future customer needs, potential growth opportunities, and new problem areas that might be attractive for business creation. One example could be that certain customer groups with specific characteristics use certain features more than others. A more detailed qualitative analysis of these new customer groups could lead to uncovering the reason for this behavior and lead to ideas for new business. In addition, other mechanisms for identifying trends with respect to customer needs and behavior as well as for new customer discovery (e.g., by qualitative means) need to be explored and combined with customer experimentation. In addition, the early acquiring of customer understanding can be utilized, for example, by the means of the service design approach that responds to the new needs of service production where value is created together with the customer or an end-user. The research should study how Finnish companies could improve their understanding about the surrounding and evolving world partly in their existing context and beyond. Such research would lead to methods and capability to follow and to predict the future evolution with improved accuracy. Research should aim to provide concrete means for understanding ongoing and evolving trends better. This research can utilize the existing studies in megatrends and weak signals, future research, research in human motivation and behavior and existing analysis methods.

The internal foresight research on asset knowledge and mapping against market trends should generate methods how to reflect market trends against assets and capabilities of a company or society and vise a versa. Special attention should be on hidden assets (including employee insights and tacit knowledge), not typically used in the company's existing business. In optimal case such mapping would provide a clear picture of opportunities that a company or society is capable to approach if so decided. Also it would provide clear understanding of areas where a company or society is required to improve in the future to stay competitive. To get an understanding of current assets a basic practice is to benchmark company assets against potential competitor assets to identify strengths. This is clearly not enough and one should also compare the market trends, new initiatives and evolution against their own assets. This would help to identify potential new opportunities where one's assets could be utilized or indicate areas of existing business where future improvement is needed. Generic framework of competences can support the identification of relative strengths of a company. Both the resource-based view to strategy and the dynamic competences are relevant for this analysis. At a company level the mapping will partially shift from strategy boards to individual level.

Opportunity identification

The project should study and define factors that typically help to identify opportunities. Further project should study improved means to search, analyze and observe factors to be able to identify

the nature of potential opportunity. The opportunity identification section should include the concept of right-time or just-on-time value delivery. The value delivery principle should be optimal in the context as well as made available in right window of opportunity.

As a research target, the opportunity identification will include new kind of practices to evaluate the assets, capabilities and shortcuts/workarounds taken when accessing the market and developing a new business innovation, product or service. Real options and other evaluation techniques for opportunity can be applied. The knowledge of the assets, capabilities and shortcuts/workarounds is important for creating a sustainable business out of new opportunity.

Business Modelling

Research will study new ways to identify customers and understand their needs matching the paradigm shift. Further research should provide means and guidelines how deep into "customer" business (or customer chain) a company or society should familiarize in order to identify appropriate customer segments and allocate different players into those segments. It is important that this model is scalable to provide methods between the short and long chain of "customer" cases. One potential method for this is the scouting mentality where people go to actual usage situations and dig for the otherwise invisible information and business opportunities. The research should not look only "logical" customers and segments, but also those which are not known nor related to the existing domain a company or society operates in. Research will focus on studying current and future channels of business realization or activity realization. Research will study, and provide means how a company or society could come to an optimal business model for the intended new business or activity. The means to identify an optimal business model will take into account the relation and impact of the new business on the existing business. It is necessary to understand how a company or society could create completely new business models and channels not tried before, should be one of the questions answered in the research. Another method for finding new markets is to enable 3rd parties, both firms and consumers to innovate on applying the services to new targets. Crowdsourcing techniques can be combined for example with requirements engineering.

Continuous and Cross-Domain Business Experiments

The research will study ways to enable "success based on voting" on an ongoing basis to bring market input for new ideas. Basic question is about how to test different business ideas with the potential customer base in the most realistic way, yet cost efficiently and with short cycle time. Experiments will be scalable to the purpose and size of the business in question. Without them it is not possible to operationalize Mercury business model. Research will provide tools, approaches and environments (e.g., sandboxes) for different companies and societies to find optimal frequency and scale of conducting "continuous experiments" to have a good representation of "market feedback" available to support business decisions. One important role of research is to validate the results although the cycles are fast, which means fast validation embedded in the experimental methods and infrastructure. In case that companies from different domains work together for creating new offerings there is a need to perform cross-domain experiments to test these offerings. Here, an ecosystem is generating joint innovations and activities potentially leading to new business opportunities with the principles described above. Important challenges address the following questions: How do different players identify each other? How to secure the interest of each party, yet keeping things simple and agile? How to communicate the results and experiences with others?

Enterprise flexibility capabilities

Enterprise capability development includes developing tools, methods, competencies, attitudes, and organization culture to support mercury business approach. They create business hunting culture and strategic flexibility. Strategic flexibility includes resource flexibility referring capability to use resources for multiple purposes and coordination flexibility needed to apply internal and external resources to the chosen business goals. Means to gain these targets include ecosystems, platforms, and resources outside the organization boundary providing scalability, as well as other ideas from elastic enterprise and other related models.

One important factor in extreme organizational flexibility is to make activities culturally as easy as possible. This model requires changes in leadership, company culture and organization starting from individuals and going all the way to organizational structures. The ways of working may also change dynamically regardless of the existing organizational structures. These changes are possible in the Finnish individualistic culture which enables very dynamically changing the ways of working. This part of the research will provide means to build a culture in a company or society and to help transformation in a controlled, yet flexible manner. What is important is to find ways on the one hand to secure existing business if that is seen as important, but on the other hand secure the capability to transform swiftly to new when opportunity arises. The opportunity here is often still a very immature prospect that is not yet proven, thus the risk is high. One important challenge is to balance the security of the existing business but to optimize capturing the opportunities.

Mercury Management Models

Mercury management models includes identification of appropriate business models and management models for each phase of an idea in flow from exploration, experimentation, expansion, evolution of new businesses. That is, the identifying minimum viable management supporting an internal start-up evolving to a wider set of functions in an expanding business.

Mercury management models shall utilize simple and fast decision making principles typical to the start up scene. Decision making should address capabilities, value added and company strategic intent. Mercury management models shall include a set of scalable decision making guidelines.

In addition to managing new business initiatives with different models during their evolution, the enterprise should be able to evaluate and build appropriate capabilities to get flexibility relevant for the business domain. That is, how fast the real-time value creation cycle should be, the scope of foresight performed, the approaches for acquiring external resources etc.

6.3.2 Goals

- Scout for new business opportunities and execute continuous business experiments.
- Use Mercury foresight to detect the trends (small or large) and predict the future of the world around the company business or areas where the assets of the company can be used.
- Capture new business ideas internally and externally (from the ecosystem) and to verify their viability before market realization.
- Build Mercury business capabilities including a company or society culture where new opportunities are looked at every level and structural slowness is eliminated from renewing the business.
- Validate the experiment results in case real customers cannot be used for experimenting.

- Create new business via tool support that is needed for executing the experiments and analytics.

6.3.3 Results

- Processes, ways of working and tools for changing the whole culture of the company or society towards an opportunity hunting culture.
- Tools and methods for detecting and analysing trends globally within a particular business domain.
- Means to find a good balance of smooth yet swift transition to new business opportunities when appropriate.
- Means to analyze when to focus on improving existing business or to seek new domains. With the model, a company or society would flexibly work with other companies or societies to evolve in the business.
- Means to operating business experiments also without real customers and validation methods for validating the results by different means.
- Technology, tools, and methods for executing business experiments in multiple industry sectors.

Tool support that is needed for executing the business experiments and analytics.

7 WHAT WILL BE CHANGED?

While it is difficult to provide precise, directly measurable changes at the point of defining the SRIA, there are numerous changes that will be spurred by the research work. They are listed in detail in this section, together with their rationale and justification.

7.1 Paradigm

The proposed SRIA will act as a catalyst for a new way of working, where companies are able to systematically identify forthcoming systemic transformations and harvest them for applying existing and new digital services created on-demand. This will mark a quantum leap from agile and lean development to real-time value delivery using continuous deployment and market experimentation, and support software and business development alignment leveraging research, development, and business as an experimentation system.

Founded on Finnish cultural strengths, empowered self-directed individuals and esteem to create proactiveness, the results will take different forms in different domains. In some business domains, the paradigm change implies empowering individuals to exploratively deploy services based on their capability to interpret and amplify weak signals, changes in organizational culture and behavior, changes in the ways of providing process and infrastructure enablers, and changes in competences of individuals and small groups. In other businesses, the paradigm change could mean enhancing consumer devices with new software features, e.g. updating car infotainment systems during the night.

In general, in order to take new paradigms into use in organisations, their culture and priorities needs to change as a part of this process. For instance, very risk averse culture (priority) can effectively prevent experimentation. To this end, the effect that organizational culture has on artefacts and organizational behavior must be made visible.

In practice, the required new competencies and capabilities will result in new sustained value-add for the Finnish software industry and help to keep and increase jobs in Finland.

7.2 Business ecosystem

As a result of the SRIA, it is expected that Finland will be recognized as being within the top 3 countries in the world identifying new market opportunities, deploying business experiments, and market initiatives in the Digital business.

The challenges that the business ecosystem development aims at solving include the following issues:

- The “Mercury” business approach is emerging creating a profoundly new type of doing digital business with new types of business ecosystems across domains that are based on digital businesses. Mercury business, most likely, will create new customer channels and even cannibalizes current ones.
- The DevOps approach is identified as a major driver changing the way applications are deployed, and further enhanced to a ServDev approach. ServDev refers to a way of working in which a single developer can understand a market need or opportunity, create requirements, implement, and deploy a new feature, all in a single working day.

Cultural change of the business ecosystem thinking is extreme – Skills needed for ServDev requires profound understanding of multiple disciplines. Moreover, changes in the mindset are needed to enable business experiments as daily practice.

- Systematic transformation of the business domains creates new types of cross-fertilized business ecosystems utilizing continuous business experiments and continuous deployment or other similar methods for the deployment of the product or service in multiple domains. This also enables experimental business ecosystems with a very light setup. Every transformation will bring a new set of digital services and this is accelerating the total transition towards service driven business and world.

The competitiveness of the participating partner companies will increase when they are able to serve their customers in a fashion that is faster by a magnitude than present approaches. Moreover, the competitiveness is also increased by the fact that results from the individual experiments can be validated with real users, which increases the confidence in delivering the right product/service at the right time.

The SRIA aims at the restructuring of old business models. This requires business process re-engineering, creating new business models, new areas of business, and new kinds of services. In accordance with the Internet business era in general, these will be created in fashion that new products and services are experimented early on. This creates opportunities for SMEs and ecosystems involving them, thus strengthening SMEs and their role in supporting larger corporations.

New revenue streams will be generated from a number of different directions, which are enabled by the systematic transformation and its reflections. The directions include at least the following:

- Tool vendors who provide tools for managing the complexity of Mercury business and analyst companies that help in understanding the results from experiments.
- New business opportunities, which are beyond the businesses of companies today, but which can be entered due to the new facilities of development, experimentation, and business proposed in this SRIA.
- New start-ups that generate revenues earlier on than when applying more traditional development approaches.

7.3 Research Ecosystem

The research ecosystem forged by the SRIA will lead to a number of research results that increase and deepen both the knowledge and collaboration of the Finnish software research organizations. Joint and replicated experiments will offer opportunities for aggregating data and creating understanding from different viewpoints. The results that we foresee at this point include the joint collection of empirical research data as well as the integration and aggregation of empirical results. Another result will be a next-generation virtual and real-life networks for experimenting with researchers, students and industry. Further research results include the investigation of the availability of OSS for analytics and other tool support on top of OpenStack and other OSS platforms.

A mini doctoral program (N4S Doctoral Consortium) will accompany the research activities and lead to the in-depth investigations of key research questions. The proposed SRA will create closer links between software-related research, business research and industry and thereby promote closer

collaboration between industry and academia. With the growing relevance of software for nearly all kinds of products and services and the power to transform the business of complete industry sectors, there is an urgent need for industry to better understand and benefit from the latest software research results. Vice versa, research needs to consider that successful research results are applied in the context of industrial projects, i.e., specific constraints such as process requirements, the capabilities of the workforce, and economic constraints need to be considered. These constraints cannot be neglected by researchers and require a better understanding. In particular software design decisions are nowadays not only based on technical considerations but also highly influenced by economic facts and assumptions. Resource decisions, for instance, need to consider cloud cost models and design decisions on new features need to consider the provided customer value in order to make efficient use of development and maintenance effort. Approaches to jointly access international firms at the leading edge need to be considered, e.g. through globally operating firms and local universities to expand research networks.

7.4 Curricula Development

The proposed SRIA will influence the curricula development in different areas. Probably the biggest impact will be in software engineering discipline. There is a need to change the traditional way of teaching by starting with requirement specification and subsequent development towards a proactive requirements identification process based on continuous experimentation, live customer feedback, validated learning, and approaches for launching businesses. As a consequence, software engineering will need to deal with experimentation not only on the technical and process levels, but also on the business level.

In order to account for the changes in the environment, new guiding principles for curricula development should be considered:

1. Emphasizing fast value creation over implementation of the full specification. Minimum viable product (MVP) should be used as a starting point for all projects.
2. Integrating courses not only in one field but interdisciplinary. This means that teachers must collaborate over the department and school boundaries to create interdisciplinary courses, representing real-life setups. Ideally the courses would be implemented in cooperation with companies and including students both from business schools and from IT units.
3. Customer feedback and cooperation should be acknowledged as one of the driving factors of the software process. Experimenting should be presented as one option to visualize the results, to test the value of the product and to collect feedback.
4. Entrepreneurial skills.

7.5 Multidisciplinary Development

Most of future innovative software-enhanced services and products will have contributions from different partners from different disciplines. This requires that these partners need to be aligned. Boundaries between different disciplines need to be identified and techniques, methods, and models need to be created that overcome barriers between different disciplines. An example is the integration of electrical engineering and software engineering. Creating solutions from these two domains requires, for instance, the integration of continuous and discrete models and the integration of quite different engineering cultures (including aspects such as different terminologies as well as different daily practices and mindset). It is expected that scattered resources from industry and

research will be combined to reach a critical mass and to tackle greater challenges. The proposed SRIA promises to contribute to the integration of different disciplines and to raise the degree of multidisciplinary collaboration on higher levels.

Multidisciplinary nature of the development should be reflected also in the corresponding curricula (see 7.4)

7.6 International visibility and collaboration

The SRIA will increase the international visibility of the Finnish industry by improving the ability to deploy services and solutions globally and by better collaboration with industrial partners to identify and provide new solutions. In addition, it is expected the the Finnish industry will better understand customer profiles from different geographical and cultural regions and in consequence can gather more international business opportunities. International visibility and collaboration focuses on different methods, tools and actions to improve and increase the impact of the Finnish industry and research community globally. The focus areas are as follows:

7.6.1 Focus areas

Business impact and growth of Finnish Software intensive industry

This area focuses on increasing the business impact of the program by improving the visibility of the results and companies' new or improved products/services/solutions. In addition the goal is to establish or contribute to the relevant business ecosystems or networks that support the expansion of the program's impact globally.

Academic visibility and impact

The aim of this area is to increase the visibility and impact of the academic results. This goal is accelerated by systematic and coordinated collaboration between the program partners and with the selected key external partners and networks. This area also includes activities that enhance researcher exchange (e.g. FiDiPro) to and from Finland.

Program's academic results dissemination and further development is also strengthened by active contribution to the Tekes, H2020, Eureka, ECSEL, EIT ICT Labs and other research and innovation programs and relevant dissemination events of such organisations.

7.6.2 Goals

- Significant results (business, academic) visibility in the different international publications, conferences, journals, magazines etc.
- Excellent visibility and recognition of the program's events, web-pages, social media news and other activities by the different actors, organisations, press, funding organisations and other key stakeholders.
- Active collaboration with the relevant networks and ecosystems. This is realized by the successful research exchange, ecosystem and network expansions, new research and innovation projects as well as the business growth.
- Researcher exchange to and from Finland.

7.6.3 Results

- Several high-level articles in TOP journals and conferences

- Global results adoption and/or utilization by relevant companies, programs, networks and ecosystems
- Both longer (at least a year) and a few weeks or a few months visits of researcher to and from Finland at all career levels. Also a few months or part time visits of top researchers to Finland.
- Key stakeholders well informed of the international impact of the program
- Greater awareness of activities and results by the wide external audience by using the different methods and tools such as
    - N4S tutorials, key-note speeches, presentations, training workshops, doctoral symposium series, etc.
    - Books, book chapters, whitepapers, guide-books, etc.
    - Social media and other web presence (e.g. series of videos, Research Gate, LinkedIn, Twitter)
    - N4S Workshops, flyers and promotions in various events
- Better quality of incoming students.