GOVERNMENT'S ANALYSIS,
ASSESSMENT AND RESEARCH ACTIVITIES

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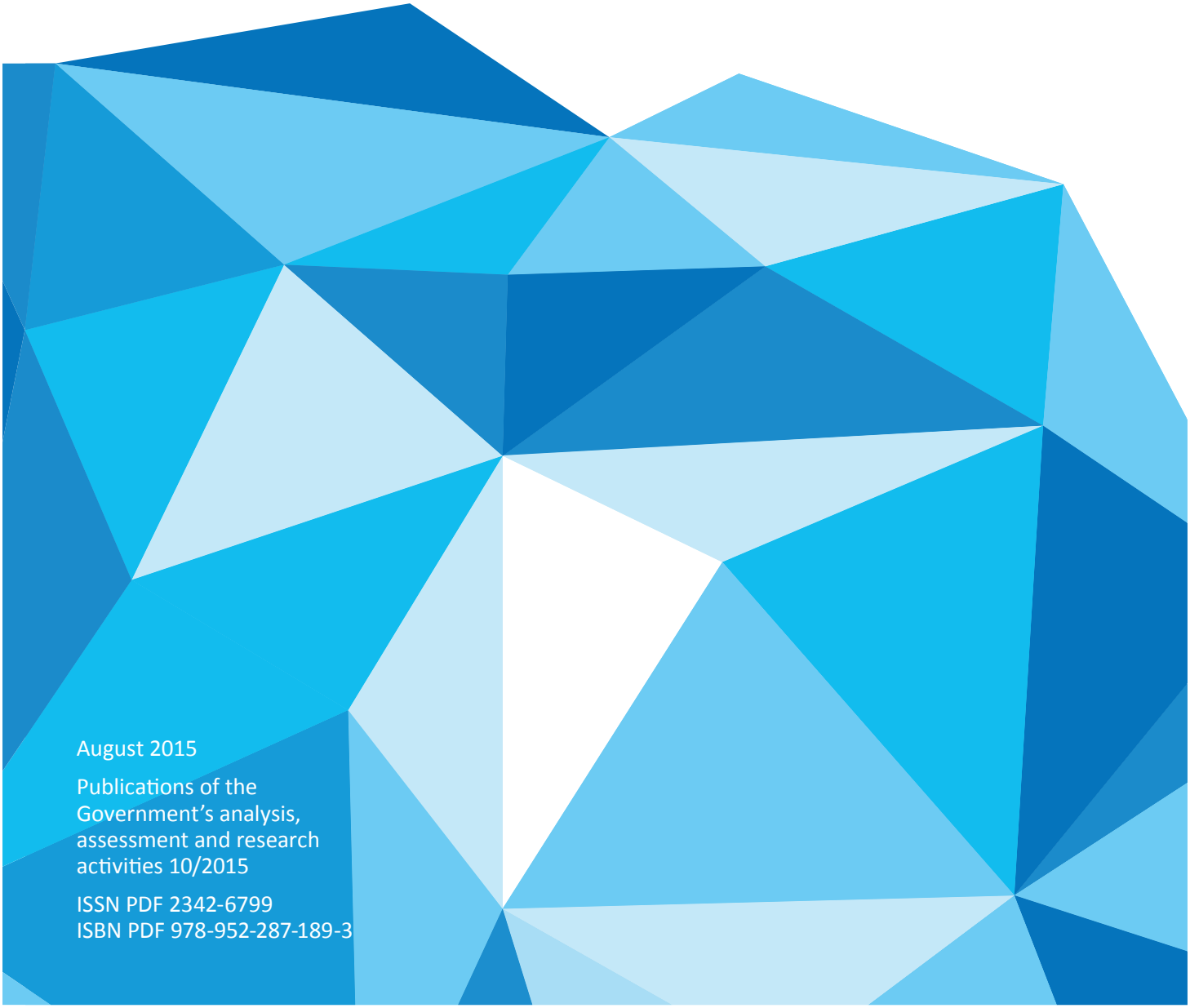
Finland—The Silicon Valley of Industrial Internet



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Introduction

The industrial internet (II) is one of greatest disruptions in contemporary economy globally. By making best use of the opportunity provided by industrial internet, Finland hopes to grow and become more competitive. The Prime Minister's Office (PMO) has chosen it as one of its leading strategic research iniatives and decided to carry out an assessment themed "*The Finnish Industrial Internet—From Challenge to Opportunity*". The assessment was carried out by a designated research team from Technical Research Centre of Finland Ltd (VTT), Aalto University and The Research Institute of the Finnish Economy (ETLA).

The aim of *The Finnish Industrial Internet—From Challenge to Opportunity* project was to identify the potential and threats, development incentives and bottlenecks, and employment impact of the industrial internet on the Finnish economy. The assessment comprises of four work packages: 1) background summary, 2) scenarios and impact, 3) Finland's strengths and weaknesses and 4) recommendations for actions. The central emphasis of the project is on Finland's manufacturing industry but it also touches on other key areas of business, such as energy, transportation and logistics, trading, buildings and infrastructure, and the activities of the public sector.

The report offers a number of recommendations for action to promote the success of companies in Finland in the disruption brought on by the industrial internet and to make Finland an attractive location for various business functions. The final goal is to increase the value creation that takes place in Finland.

The recommendations apply mostly to the public sector, but they are also relevant to other interest groups to some extent. As the public sector creates favourable premises, it is hoped that companies, particularly their boards and executive management, will provide growth-seeking leadership and foster an active dialogue in order to generate a positive investment and growth cycle.

Helsinki, 20 April 2015

Olli-Pekka Heinonen, State Secretary

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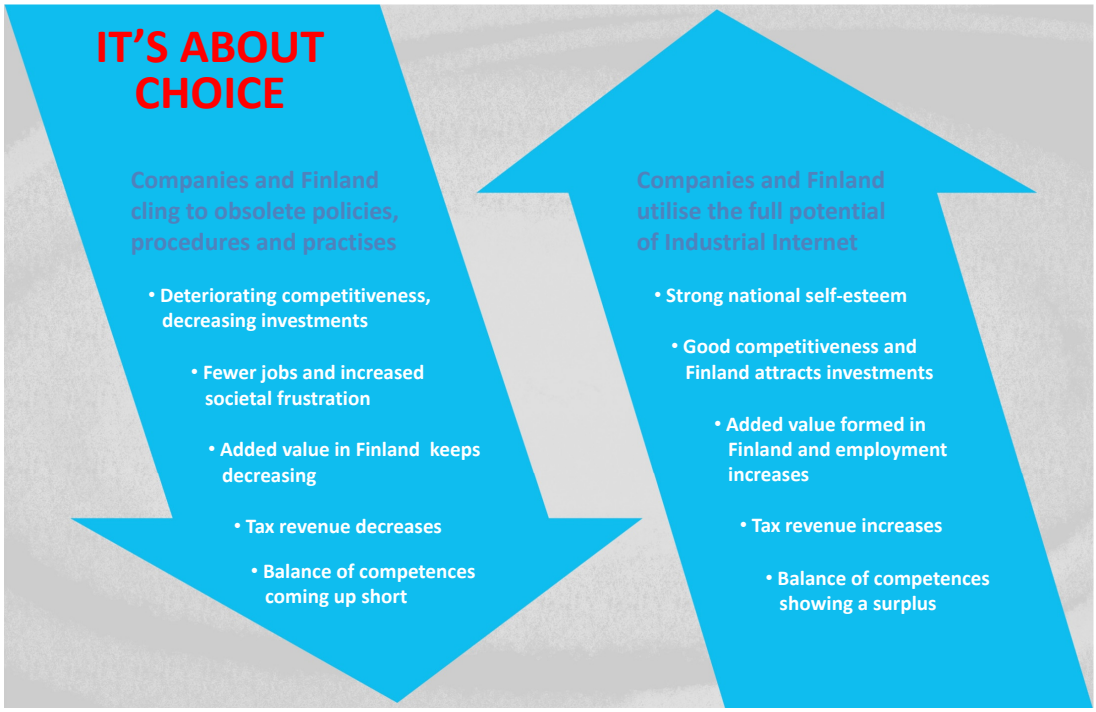
1 Abstract and Key Recommendations

The industrial internet is part of the new wave of digital disruption where connected products and services enable the intelligent use of tied-up capital and knowledge of products and services. It brings about significant changes to the productivity of the public economy and companies, various management practises, business models and general competition on new markets and customer relationships. It is likely that changes in different fields have a highly significant impact, comparable, for example, to the digitalisation of the banking sector in the 1990s or the media revolution of the 2000s. In some areas, there may be changes similar to the creative destruction associated with the travel business, as web-based services partly replaced traditional travel agencies. What is essential is the question of how the joint impact of digitality and the industrial internet will be manifested more broadly in the fields and institutions of the various actors.

The disruption is a threat to those who stick to the old operating ways for too long, while it is an opportunity for those who utilise the new technology, offering products and services that interest customers, methods that increase performance and new profit-making business solutions and models. It is a matter of choice (see figure 1.1). Navigating the choppy waters is a challenge for the existing institutions and economic actors, existing structures of organisations and management practises. Unfortunately, many actors perceive the disruption as a threat to their present position and, particularly at companies, to their turnover, profitability structures and levels. This, in turn, leads them to staunchly defend their current position and repeatedly reduce costs, the 'spiral of death'.

Figure 1.1 Success requires vision and courage



The revolution caused by the combination of digitality and industrial internet must be seen as a positive opportunity to increase the well-being and productivity of our society. With these, we can create new jobs and establish a framework for new investments, offering new and existing companies in Finland a global operating environment and promoting the success of companies on the rapidly changing industrial market. In order to make justified decisions on what course to take in the future, we must understand the present.

This report offers a number of recommendations to promote the success of companies in Finland in the upheaval brought on by the industrial internet and to make Finland an attractive location for various business functions. The final goal is to increase the value creation that takes place in Finland. The value is comprised of salaries with statutory expenses, profit entered as income in Finland, depreciation and rents that the whole society benefits from, for example through taxes but also by means of productivity and a rising gross domestic product.

The recommendations apply mostly to the public sector, though also to interest groups to some extent. The impact of the measures on the decisions of companies and individuals is consequential: with the public sector creating a favourable environment for investments and growth through correctly targeted measures and its active industrial and owner policy, companies and people make choices that are positive not only for them, but for the whole country as well.

As the public sector creates favourable framework conditions, companies, particularly their boards and executive management, are now required to show growth-seeking leadership and dialogue in order to create a positive investment and growth cycle. Now is the time for companies to invest in the development of digital abilities in order to conquer new markets.

Digitalisation and the disruption caused by the industrial internet affect the day-to-day realities of many people, as certain livelihoods become obsolete while others thrive. This increasingly requires initiative and independent effort from more people who are required, for instance, to get a new education to stay at the top of the game. We are not too late. By seizing the opportunity and acting boldly, Finland could become the Silicon Valley of the industrial internet.

Figure 1.2 Vision, main themes and measures of Industrial Internet

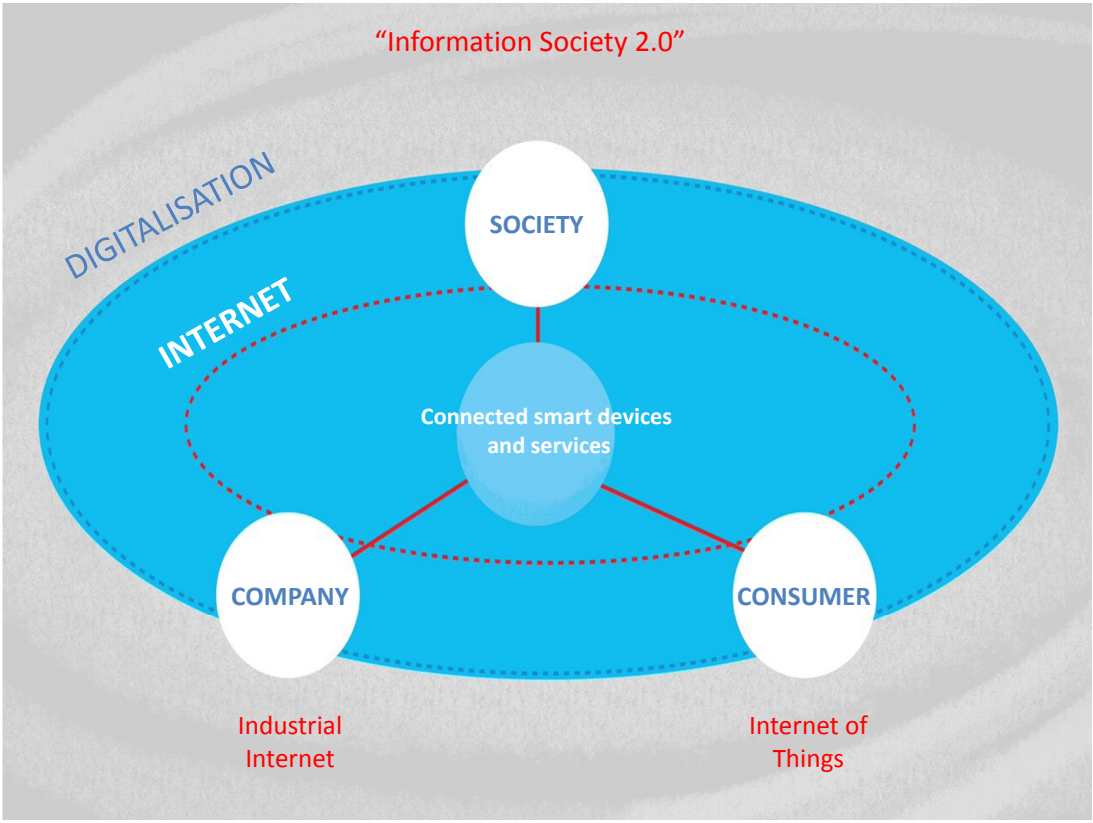
Figure 1.2 describes the vision of the industrial internet, the main themes and fifteen recommendations, after which the report continues in the following way. Section two explores the topic of the industrial internet—what it is about and where we are headed. In addition, the section discusses data and information ownership and management. As this question is very central to the operation of the industrial internet, we have dedicated the box 2.1 for it. In section three, we will expand on three factors of breaking the structures of industrial branches: 1) platforms and the related business networks, 2) global value chains and fragmentation of work and 3) companies, productivity and renewal in the digital age. Section four describes the vision of the Finnish industrial internet and two positive development paths for Finland. Section five discusses the fifteen recommended measures in more detail.

2 Industrial Internet—What Is It About and Where Are We Headed?

2.1 What?

The industrial internet is part of a broader digitalisation that has gradually affected the economy and industry dating back to the 1950s. Today, at the core of the most recent wave of development we can see increasingly smart, connected products and services that produce up-to-date information on their status and features in the customer's real-time environment. In addition, new technology allows for real-time monitoring and optimisation of how the customers can best make us of the products and services provided to them. Focus will shift from the (one-time) delivery of products and services to customers to the optimisation of their (continuous) use in the customer's real-time environment. This digitalisation of the products and services is rapidly shaping traditional business models, breaking the

Figure 2.1 The society, companies and consumers have their own actor-specific view on digitalisation



prevailing sector boundaries in business life and the public sector alike. At the same time, interfaces among society, companies and consumers will become closer, which enables altogether new types of data-based service innovation (see figure 2.1).

The **industrial internet** is the companies' view on connected smart products and services. Once the business processes of companies and their sold products and services are connected, the business significance of data is further emphasised, and new, data-based, smarter service innovations are produced. In the past, software (intelligence) were integrated to physical products, while in the future, products and services will also be integrated with software (intelligence).

With the industrial internet, sensors, machines, processes and services continuously produce information that can be refined to anticipate and automate work. This requires that all things related to the production and service process have a digital identifier that uses the internet to relay data to the different actors of the delivery and value chains but also creates new business models.

> *Rolls-Royce plc is considered one of the first industrial companies in the world to have adopted an output-based business model, where airliners are invoiced according to the Power by the Hour principle.*

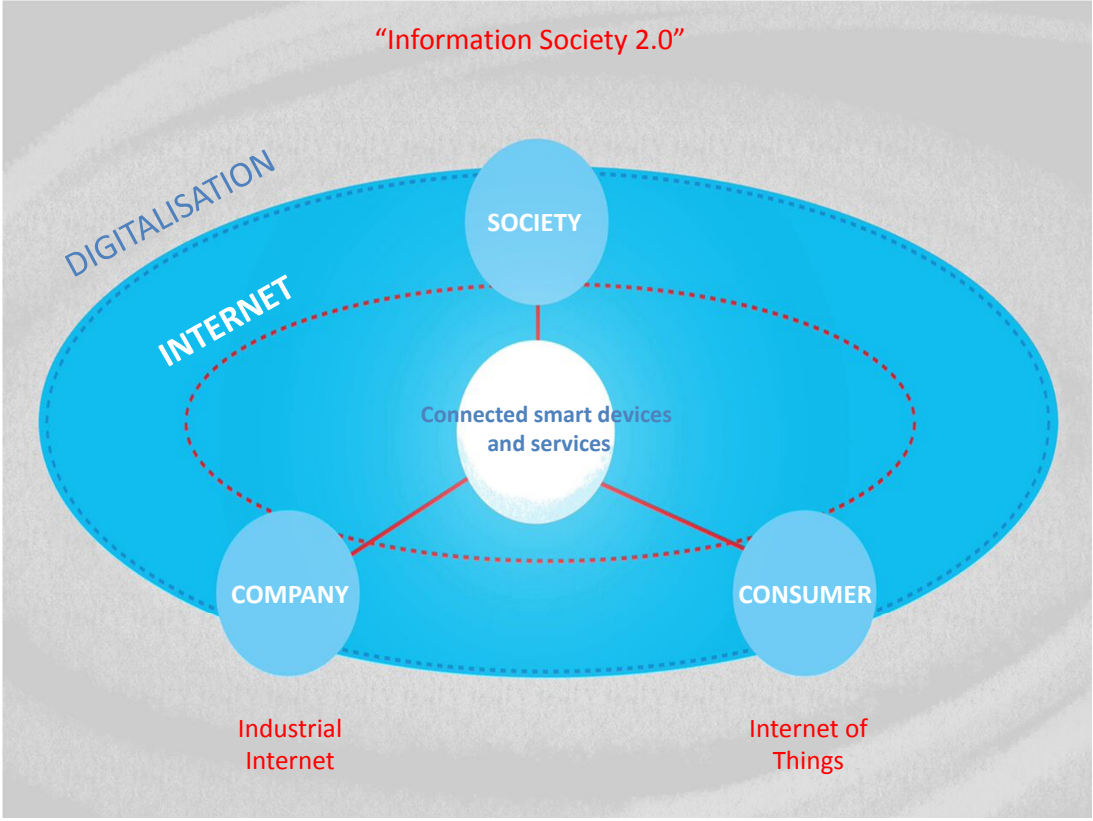
The Internet of Things (IoT) is the consumers' view on the digitalisation of products and services. All things have a digital identifier with which their use, features and added value can be optimised for all consumers. New product features may, for example, be based on richer additional information offered to a consumer or better user experience. For instance, services may promote consumer health, energy savings when heating the house or converting the business model by selling light as a service instead of selling just lamps.

> *The consumer's smart and connected electric toothbrush collects information on teeth brushing and sends this to a cloud service. Analysing the data may reveal that the consumer should pay more attention to the left upper jaw, and this information can be sent further to the bathroom mirror's embedded screen where the consumer otherwise reads the news headlines each morning. The information is also shared with the consumer's dentist, who can then invite the patient in for tartar removal, if necessary. Since this service entity reduces the total cost of dental care, social insurance will subsidise the cost of implementing the service.*

Information Society 2.0 refers to the situation where a citizen is connected as an actor of a national digital service architecture. All actors have a digital identifier with which they connect to the internet and will be offered services adjusted to their needs. In Finland, all citizens have the right and possibilities offered by society to utilise and equally participate in the digital services, offered to citizens throughout Europe in Finnish. These services offered to the citizens are being entirely shifted to the Internet and adopting a digital form.

> *When a child is born, she will be assigned a digital personal identifier and a private data cloud, rendering every citizen an actor who can safely interact and participate in society, the Internet of Things and the industrial internet. In other words, anonymous internet use will cease, and users will become so-called trusted actors. The trust of the actors is a key theme in the future digitalisation to Information Society 2.0. Digital identification and information security will be emphasised.*

Figure 2.2 Smart, connected products and services will form a shared digitalisation core for the different actors



The digital revolution of the industrial internet is now becoming reality. In it, society, industry and consumers are converging into a larger entity where connected smart devices, services and the related software, application and content stores and cloud services work as a shared, central and possibly open platform (figure 2.2).

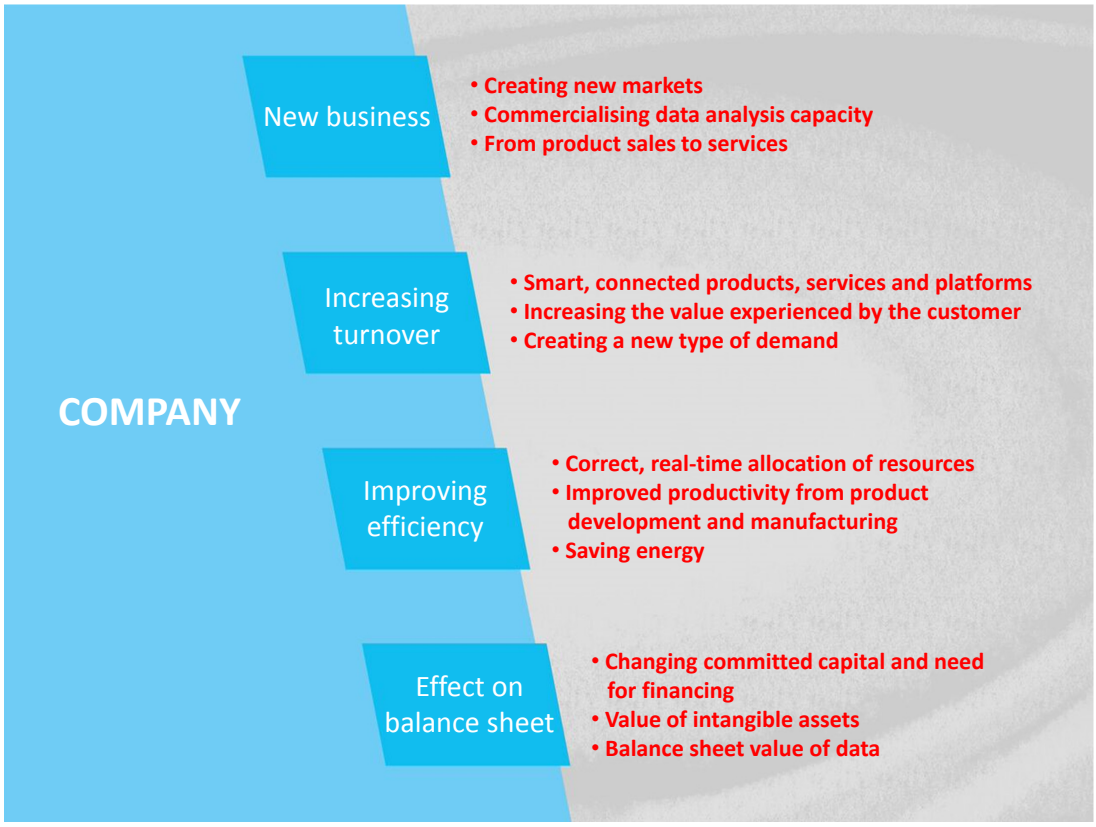
2.2 Why?

Connected smart products and services allow companies to work more efficiently, as the real-time visibility of internal and the customer's actual needs is improved. Thus, enhancing the efficiency of existing business and the use of capital are the first key objectives or applications of the industrial internet, the impact of which can clearly be seen in the company's expenses and balance sheets. Another significant way of applying the industrial internet is to develop existing products and services into smarter ones by including new features, adding customer personalisation and improving the usability. This is a way to increase the value the existing business provides customers, subsequently achieving increased turnover and profitability. These, however, are still just incremental ways of developing the existing business.

The greatest potential for the application of the industrial internet lies in creating new markets, new competition and growth parallel to, above and between the present business models. These digital online-type business models will replace, or at least radically supplement, traditional product and service businesses. With these, we will see new types of customer-centric markets and value networks built around smart physical products and services.

In the new market of the future, the actors will no longer be tied to a physical location but can produce and manage services globally regardless of their location. This is a great opportunity for Finnish companies to create new international growth. Companies need a completely new type of thinking and management in order to build new, digital business on top of traditional products and services. For now, many Finnish companies are lacking a clear, communicable public strategy that establishes future guidelines. To companies, the benefits are manifested as new business, increased turnover, improved productivity or more efficient use of capital in value chains (figure 2.3).

Figure 2.3 Making use of the industrial internet requires strategic and operative choices and their implementation from actors



New business models will alter the present sector structures and create new markets. It is likely that, as a result of the new business models, the balance sheet values of companies will increase, as "products become services" (the hardware supplier retains ownership). With increased capital-dependence, this will create challenges for Finnish industrial companies.

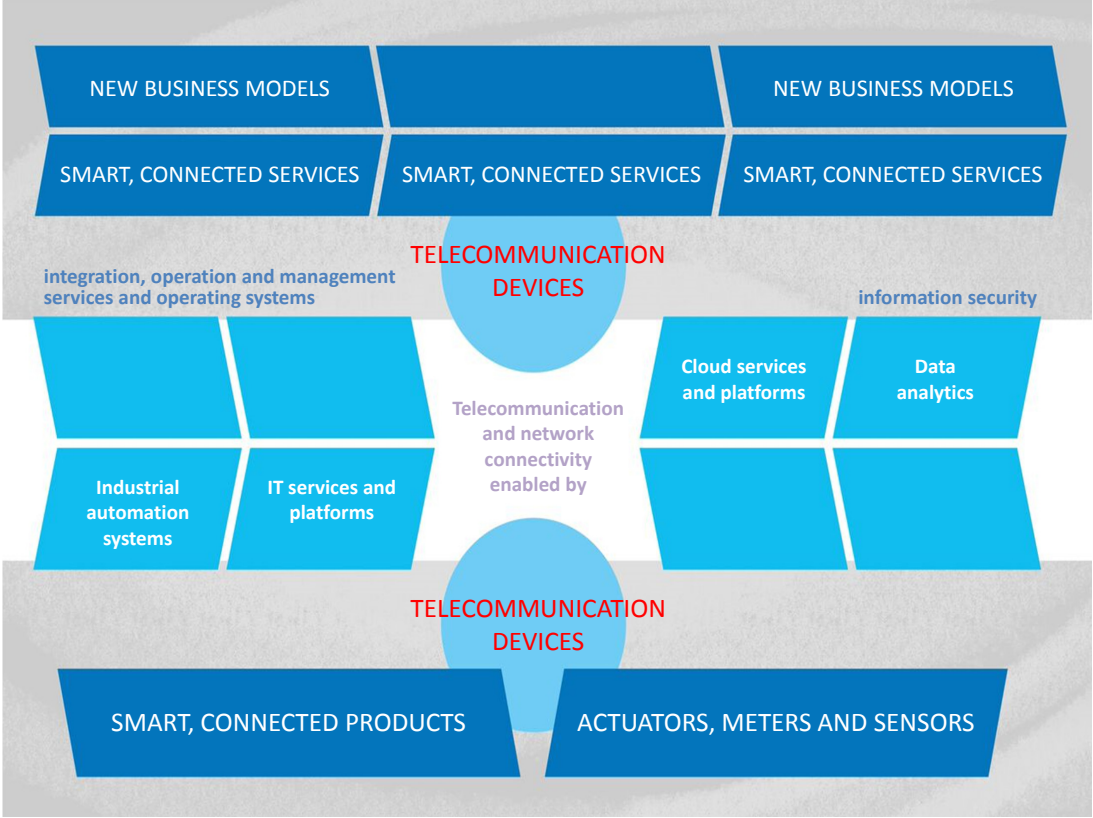
2.3 How?

To provide smart, connected products and services, companies must build a whole new, multi-layered technology stack. This infrastructure comprises multi-threaded software, applications, networks, hardware, product cloud, platforms, operational regulations, etc. The majority of the required technology already exists but building new infrastructure that combines them requires significant investments and new competence that companies must take into account in human resources planning. New expertise is required particularly in the areas of monitoring, analysis, optimisation and autonomic actions related to new products and services.

Thus, it cannot be said that the industrial internet has a single technology or platform but its activity spans a broad spectrum of technologies, which will be discussed next. Figure 2.4 describes the technology and operating levels essentially related to the industrial internet. The top business models in the figure are connected to the actuators and sensors at the bottom level through the intermediate levels. Data is produced at the bottom of the figure, and it is refined and shifts toward business. The technology stack must also take into account vertical service entities, such as information security, standards, integration, operation and management services and operating systems.

The information refined from the data is utilised increasingly at various levels of business. From the processing perspective, data analysis significant to the benefits of the industrial internet may take place both locally and also remotely in an Internet cloud service. At larger companies, data analysis expertise lies in the hands of specialised in-house personnel but, owing to the scale of the change at hand, there is more demand for this expertise than is currently available. There is thus an increased need for the services in this area and ICT companies offering these services.

Figure 2.4 Technology and operating levels essentially related to the industrial internet



The area of focus of the Finnish industrial internet is to enable new business that produces significant added value to customers through the technologies and methods of the industrial internet. Above all, the approach should emphasise the development of industrial businesses based on the industrial internet so that they can seek new business opportunities as suppliers, operators and maintainers of overall systems and solutions (figure 2.4). In particular, it is worth noting that in this context, platforms do not refer only to building technological capacity but the majority can be attained through entirely new business models built on technology solutions.

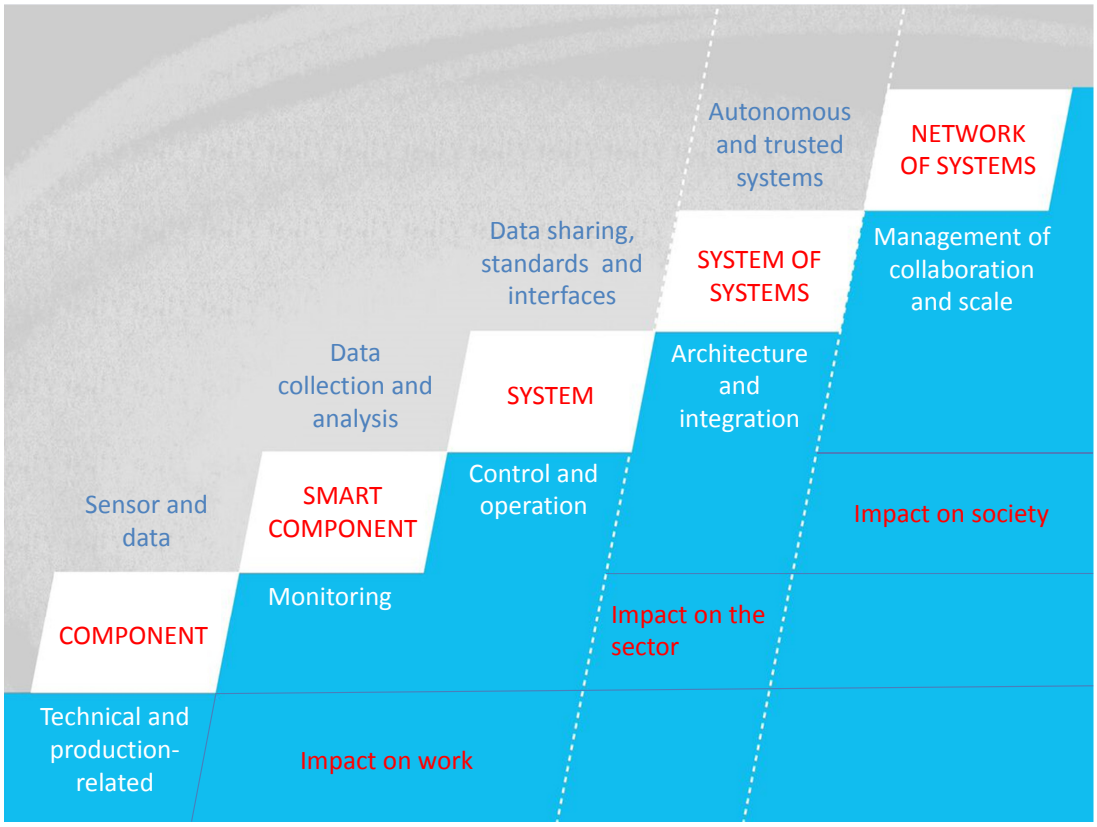
Smart products, smart services and real-time interaction between them are needed in order to build new business and new business models. The possibility for growth is often produced on top of existing business and on traditional business and sector boundaries. It can be seen that generic technology platforms may emerge on the market for the bottom of the above stack, and on top of these, there can be specific business models with industry-specific characteristics. At the same time, it is important to note that the branches and their boundaries are constantly changing. De facto platforms such as Linux and Android have still not emerged for implementing smart products and services from the perspective of the industry and society. However, the race to create such platforms is now underway.

The global platform game is not over yet!

2.4 Where?

The value creation of the industrial internet is based on the fruitful utilisation of existing elements and the supplementing new features. The hierarchical system levels of connected, smart products and services can be described using the stairs shown in figure 2.5. The steps in the stairs are the product or service concepts: 1) component, 2) smart component, 3) system, 4) system of systems and 5) network of systems. The potential for value creation increases when climbing up one step.

Figure 2.5 Levels of connected smart products and services, their typical feature and impact on different actors



Getting to the next step requires certain new features from the elements of the preceding levels and the incorporation of the associated abilities. These properties are described here as drivers of change, the implementation of which enables the transition to the next step. The positioning of a company on these stairs should be a strategic choice. However, in practice, the relative strengths of the various actors define how freely this choice can be made. In particular, going up a step typically requires moving to a new area and competing or collaborating with completely new actors.

It must be noted that the market and innovation potential grow when moving from a closed environment to an open one. Utilising the potential and the distribution of the benefits among the various actors significantly depends on the role that the actors in the environment can adopt. Clear rules of the game and trust among the actors are emphasised when migrating from the manufacture of products in closed environments to the implementation of services in open, networked business models. At the same time, an agreement will be reached on the ownership of intangible assets (patents, licensing, trademarks, brands, copyrights) and data.

Many Finnish companies operate at levels one, two and three, either as a component or a system supplier. There are few open interfaces here. Instead, data transfer is implemented in closed systems. New, growing business opportunities should be identified on levels three, four and five where the share of networks in doing things and innovating is emphasised. It is the duty of society to lay out the premise for all sizes of businesses so that they can move up the stairs in a planned, rapid way with as few risks as possible. Moving up a step requires new strategic and operative business abilities from companies (processes, information systems, data and competence), vision and, in particular, the courage to seize upon new opportunities. A possibility alone will not create success.

The role of society as an innovation platform is emphasised when moving to the steps of system of systems or network of systems, as in most cases society manages and operates these levels of the system.

Box 2.1

Information and data ownership and management

As a general rule, information and data cannot be owned. Information and data may belong to various actors but they cannot be owned in the legislative sense. Information can, however, be managed. The most natural view of information and data management is that the actor is the one who owns the device and the service where the information and data are. The ownership of a device or service is the default situation of data management when no contractual arrangements or the like have been made. In this case, the owner of the device and service usually have a natural ability to prevent others from accessing the data by preventing access to the device or service.

On the other hand, every actor, such as the device and service owner, device and service providers and the software manufacturer has their own interest in managing the information and data produced in smart devices and services. This can sometimes involve excluding other parties through the life cycle of the product or service. In addition, it can be stated that a party has ownership-like administration of information and data when it has the ability to deny other parties the use of the data even when it does not have actual ownership.

Another aspect of information and data ownership is intellectual property rights. On the one hand, they do not concern the ownership of information and data (Section 1(1)(4) of the Patents Act). In general, intellectual property rights can be administered and agreed upon. On the other hand, there is plenty of (compelling) legislation pertaining to intellectual property rights: for example, the Patents Act, Copyright Act and Trademarks Act and the related Unfair Business Practices Act.

Intellectual property rights are divided into copyright and industrial property rights. Both establish how the rights are utilised in business but they are also valid for a limited time. From this perspective, intellectual property rights constitute stronger ownership specifically because they contribute to the factual ability to prevent others from using the data indirectly through a court.

It should be taken into account that intellectual property rights emerge at the stage when information and data are used for specific purposes, for example as part of new products and services. From a future perspective, autonomous smart devices, services and networks and the information and data produced there should be taken into consideration in the same way. Even at present, companies administer the new information and data produced through research and development projects and their intellectual property rights.

When great amounts of information or data are produced (big data), data protection may be involved (Copyright Act section 49: catalogue and database protection). On the other hand, the protection of catalogues or databases is not related to how the information and data ownerships are determined—the database protection does not protect individual information elements or a non-essential part of the database—but the information entity and the data contained in it is protected.

A third view on the ownership of information and data is the data protection related particularly to personal data, i.e., at the stage when the data could lead to the identification of a person, when the data is personal data and involves certain statutory obligations. An actor who administers information and data related to a person, i.e., a register of personal data, must

safeguard the data as necessitated by data protection, for example pursuant to the Personal Data Act and Information Society Code.

Legislators then could enact a law providing for the ownership of information and data. Such ownership-related legislation could have various effects on the competitiveness of Finnish industry or on the country's ability to attract foreign investments. There are certain international examples of legislation pertaining to the ownership of data: for example, China and Russia have already begun regulating issues related to the location of data servers, i.e., limiting the regional processibility of data. On the other hand, European data protection legislation, which is being reformed along with the new EU data protection regulation, contains restrictions on the transfer of personal data to other countries.

The fourth view on information ownership and management is agreements. Within the freedom of contract, it can be specified who data belongs to, what kinds of access rights there are to the data, whether they are exclusive, parallel, etc. It is aimed at agreements between parties on the ownership of data and use restrictions even when no one owns the data and only restrictions on any contractual partner. The restriction of contract comes, however, from the fact that the contract cannot be binding on a third party.

From the perspective of contract law, the reliability (or correctness) of data will be an increasingly significant element, one which will fundamentally shape contract policies between parties as information and data are moved through different interfaces between the various actors. However, even in long information and data transmission chains, it must be possible to contractually establish causality of liability. Even if such direct and indirect legal means of prevention could be created, they would probably not be enforceable everywhere in the world, i.e., it may not be possible to use the local legal system to prevent the users of data from doing so.

The factual management of information, IPR, data protection and agreement policies are the four aspects which information and data management and ownership involve and where the present legislation sets certain marginal conditions. In the end, the contractual policies between the actors will define the relative strengths of information and data ownership between parties, for example how the ownership of information and data will be established in the autonomous smart device and service entities of the future.

3 Contributors to disruption of structures

In this section, we discuss three themes arising from earlier research, related to the convergence of the computer, mobile phone and Internet sectors. All three have affected or presently affect the breakdown of the structures of other industrial branches. These three themes are platforms and networks, global value chains and work fragmentation and how the companies in the digital age break down industrial structures and create new competition.

3.1 Platforms and Networks

When inspecting the strategies and success of global companies in recent years, it has been noted that the companies have achieved the highest profits by opening their platform up to the technologies, products and services of third parties, to supplement it and create added value for the customer. In addition, it has been established that these opened platforms have benefited from the direct and indirect effects of the created networks. By participating in the network, the value of the platform itself grows. For example, when other users are active on the platform, all users will directly benefit from the possibility of sharing files and compatible software and indirectly from the use of commodities supplementing the platform (products and services, such as software and supplies). One of the key indicators of the platforms is how they can attract different parties to work as part of the shared platform and network.

Another important thing about the platforms is that when they reach critical mass, the internal and external network effects cease to work or work in reverse, limiting external competition and market access. In addition, the owners of these technology platforms may, with their own management policies and property, control the policies of the networks, such as patents and cash flows, while at the same time being very dependent on the innovation, technologies, products and services produced by third parties to the network. It should be noted that often the platforms involve common earnings logic for the sale of technologies, products and services. In addition, the platforms provide incentives for innovations produced by third parties. The owners of the platforms also commonly offer legal protection, for example, against the attacks of patent trolls.

> *Where the final assembly in factories "controls" the value chains of physical products, platforms are becoming the assembly line of the digital future that "controls" the value chains of services.*

3.2 Global Value Chains and Work Fragmentation

Global value chains bring their own significant features to industrial development. Global value chains can be described and understood at the micro level by inspecting three key factors: the changes of the structures of different industrial branches, the economic geography of multinational companies and the global supply chains of products and services, sometimes even digital ones. The role of different states as a producer of added value and their ability to attract jobs and foreign direct investment (FDI) are the result of these three key factors. It is also important to understand how a multinational company designs and implements its strategy as part of global supply chains and production networks. In addition, when inspecting the principles of the companies' transfer pricing and their operative strategies in recent years, it has been found out that the economic geography of tangible and intangible added value batches have become detached from each other.

At present, global value chains also involve the global upheaval of the structures of present work tasks, brought about by digitalisation, which has only just begun. Work and work duties are expected to fragment into increasingly small entities across the planet. This change is led by multinational actors chasing state-of-the-art competence. In the future, the manufacture of products and the rendering of services will have fewer national borders. However, in the heat of global value chains and digitalisation, it is important to consider that the Internet is just a channel for communicating information, and the smartness of products and services must be built into the devices and services. Earlier, the disruption of global value chains and the structures of work tasks would only apply to certain fields of business, while now, with digitalisation, it affects almost all tasks in almost all fields. On the other hand, in the era of global value chains and digitalisation, top competence will be created where the education system produces the best resources.

> *In the future, work, companies and value chains will fragment into increasingly smaller pieces, value networks. This speeds up the change of the existing institutions and branches and their business models and logic of value formation.*

3.3 Companies, Productivity and Renewal in the Digital Age

In the past three years, thousands of companies have been founded across the world. Offering their own digital product and service business, these companies break down the value and supply chains of different actors into more resource-efficient chains. Here, resource efficiency refers to the added value of a product and/or service that remains the same or grows with new markets opening but, on the other hand, the absolute amount of work required for the production of the product and/or service decreases. Instead of resource efficiency, this same phenomenon can be described as productivity enabled by new technology platforms.

Collaboration and alliances between companies and their mergers and acquisitions can be seen as two central columns of business growth strategy and reform. Collaboration should be seen as a means of altering the company's present strategy, organisation and business models. Only a few Finnish companies have made use of these possibilities, as often the established actors are too concentrated on their existing business instead of trying something new. In the digital, rapidly changing world, companies should pay more attention to rising companies "in their own field" and prepare a business acquisition and collaboration strategy for the missing elements required by digitalisation. The goal of this strategy should be to supplement the companies' digital expertise in a holistic way.

> *Start-ups and SMEs should be seen as a tool for supplementing the present strategic and operative toolbox of established companies.*

4 Toward the Silicon Valley of the Industrial Internet in Finland

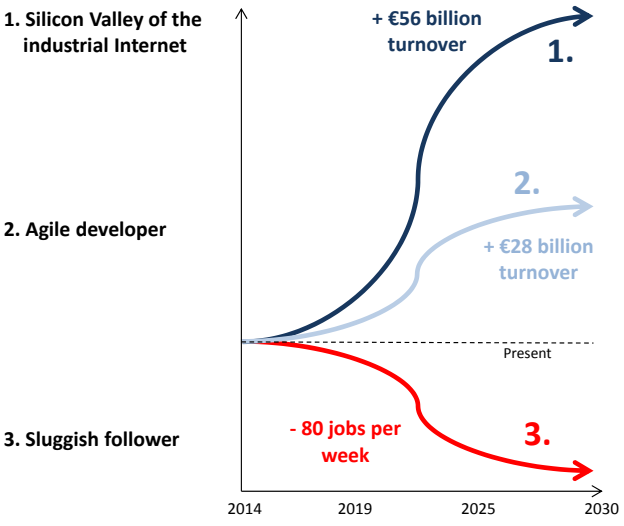
Over the past seven years (2008–2014), the development of Finland's industry has been poor by all indicators. The direction of investments, productivity and creation of added value has been declining. If nothing is done, this development will continue, and in the next four year period we will lose approximately 16,000 factory jobs (figure 4.1, development path three). This does not need to be our path towards the future—we can choose otherwise!

Based on the analysis produced during the assessment, together with the various interest groups, we prepared the **Finnish Industrial Internet Vision**.

> ***Silicon Valley of the Industrial Internet*—Thanks to our know-how, production and service investments in Finland will increase and create jobs.**

Figure 4.1 outlines two different positive development paths that would help Finland realize the vision. In both development paths, investments and jobs in Finland will grow and more added value will be created.

Figure 4.1 Three future paths for Finland



Impact area	2023
Added value (€ billion)	+9
Jobs	+48,000
Investments (€ billion)	+12
Impact area	**2019**
Added value (€ billion)	+3
Jobs	+16,000
Investments (€ billion)	+4
Impact area	**2019**
Added value (€ billion)	-3
Jobs	-16,000
Investments (€ billion)	-4

Development Path 1: Finland as the Silicon Valley of the Industrial Internet On this future path, Finnish companies assume the role of key actors of the industrial internet's platforms and ecosystems. Here, platform must be understood broadly, not just as a technological platform, for example an operating system, but also as a business platform. In this role, Finland will attract investments, companies and experts.

The development path is only possible if the executive management and boards of companies as well as the public sector commit to this goal. This development path is the best possible future, where the industrial internet is the "New Nokia".

Development path 2: Finland as a agile applier. In this future path, companies and other actors will quickly and efficiently utilise the new possibilities technology enables in their business. Strong engineering companies will utilise ICT experts in their operations, thus gaining a competitive advantage. One example is the collaboration between Konecranes and ICT start-ups. New companies are dedicated to the service business of the industrial internet or to applying new technologies in traditional fields. As an example of this, we can mention Data Rangers, a companies that does data analytics, and Enevo, which improves the efficiency of waste management.

What, then, should be changed for Finland to get up on the positive development path? Both development paths involve five important areas, where the public government, companies and other interest groups must work with determination in order to achieve a cycle of growth. The areas are *Leadership and implementation, Market access, Markets and business models, Competence and Technologies and platforms*. With respect to these areas, we have prepared 15 recommendations, described in detail in section 5.

4.1 Leadership and Implementation

The industrial internet is an innovation platform that provides the possibility for new types of business models and earnings logics. Thus the industrial internet is also an enabler of change that affects the growth or fading out of companies, the rise of new actors and the fall of old ones. The industrial internet is effective at three levels:

- Within companies ("intranet"), where the effects are managed by the companies and relatively restricted. In this case, it is often a matter of enhancing the efficiency of existing methods and processes in a search for savings or other benefits.
- Within a network of companies ("extended intranet"), where a key company in the network can still aim to plan and manage the changes. This will involve not only improving the efficiency of existing processes but also new processes and operating methods.
- Open field ("internet") where the actors are not known in advance, great and relatively fast changes are possible, and the growth and destruction of companies will take place.

Finland's weakness can be considered to be the lack of vision and shared story and the inflexibility of the labour market and communities in changing tasks and processes. Strong interests and interest organisations defend the old structures and operating models. The government platform is not taken to the level of action. Finland's strength can be considered to be a scale that enables collaboration, trust and a corruption-free business environment. Global challenges will also bring possibilities and the Finns are problem-solvers. For Finland to benefit from the upheaval, we must have the courage to seize the new and, reciprocally, let go of the old and secure. This requires leadership in both the public and private sectors. Visions and manifests are not sufficient, however. What is needed is long-term commitment and strong implementation.

4.2 Market Access

In particular, the challenge of new and growing companies is their market access. A good product or service alone will not suffice. Financing and references are also needed. The threat is that the fear of change will prevent companies from taking a risk and prevent investments. The culture of joint development of large and small companies has yet to be developed, and the skill to utilise the potential of the start-ups and SMEs is lacking. Established larger companies can strengthen their position in the

upheaval by supporting new actors in their ecosystem with financing—that is, direct investments—and with reference-producing orders. At the same time, the established companies can obtain experience and information with which to reform their own business.

The public sector makes sizeable investments annually. One of Finland's strengths mentioned is the public sector, which actively utilises ICT. By directing part of the orders to so-called innovative procurement, both the orderer and the companies provide new products and services benefit. The digitalisation of society and the development of the related standards is, as it happens, an opportunity brought about by the industrial internet. The orderer receives a more affordable or better product and/or service and the supplier receives a valuable first reference. Lifespan expenses must always be taken into account in project bidding.

The significance of international competition and collaboration in the upheaval of the industrial internet is decisive. All products and services compete with international offering, and this also occurs on the Finnish market. On the other hand, the creation of most products and services requires international collaboration. Finnish actors should seek collaboration with the leading actors in Germany, the United States and China, for example. Such collaboration also permits an adequate level of comparison and hard targets. Sweden and Swedish companies can also be useful to collaborate with because of both proximity and the similarity of their industries.

Global business policy trends should also be taken into account. In simplified terms, there is talk of the return of industrial policy, which refers to the states' stronger guidance of the economy and particularly their attempt to affect the structures of business life and industry by means of the new industrial and owner policies. China and South Korea, neither of which ever gave up strong industrial policy, are investing heavily in the industrial internet. Germany is also carrying out an industrial policy with its Industrie 4.0 programme that emphasises the joint significance of the manufacturing industry and digitalisation. The United States has also implemented a policy with the aim of strengthening the country's industry and bringing back jobs lost to Asia and elsewhere. In this context, the industrial internet is seen important. There is a question as to whether Finland should also prepare for the "return of the industrial policy" in the field of the industrial internet as well.

4.3 Markets and Business Models

The upheaval of the industrial internet depends not only on technological development but also on the emergence of a new market. Finland's strengths are a strong basic industry, which could serve as an applier of the industrial internet, and broad ICT competence, which establishes good premises for the implementation of industrial internet solutions. The threat is that the industrial internet could lead to the change of business models in a way that does not promote Finland's national economy. Weaknesses pointed out include product-centricity, branch-connected taxation that favours sector thinking and the fragmentation of legislation, which does not support digitalisation. Various measures can speed up—or slow down—companies' ability to seize on opportunities brought about by the upheaval. Some of the measures will affect the market in Finland, some affect the companies' possibilities directly in Finland and indirectly abroad, some primarily affect the companies' possibilities abroad and some may have a direct impact in the EU area or globally. The growing European and global markets are an opportunity, as is the transformation of business earning logic from products to services and the acceleration of collaboration between companies. Opportunities can also be created, getting investments on the move through taxation, for example by taking value creation into account when calculating taxation.

Discussions and interviews regarding the topic have clearly pointed out that questions related to data ownership and the lack of contract models satisfactory to the various parties are a significant factor that slows development. The threat is that contract law issues cannot be solved. It is important to consider that companies which can provide a solution to data ownership and contract matters that are acceptable and understandable to the customers will gain a significant competitive advantage. It is likely that the major actors will offer models beneficial to themselves, as Apple, Facebook and Google have done in their fields. More balanced models could bring a competitive advantage to the companies offering them.

Legislation pertaining to the ownership of data can be actively promoted in Finland and maybe also at the EU level. Contract models can also affect the companies' competition at a global level. The contract models can also bring to bear the ownership of the data.

The activity of the market can be affected by introducing new actors or structures on the market, as presented in recommendation #6 (Making a focused market intervention).

4.4 Competence

The competence and initiative of employees constitute important productivity factors and thus significantly impact the companies' choice of location. Therefore, it is important for Finnish expertise to be competitive. As Finland's strengths, we can identify high employee education and competence level, particularly broad ICT expertise, and an efficient and collaboration-encouraging innovation system. The reform ability and productivity based on the employees' competence are naturally the most important factors: they contribute to the chance of getting a job and are the foundation for a relatively high level of income.

> *Finnish engineering competence is one of the most important reasons of being able to keep R&D activities and part of the manufacturing in Finland.*

The revolutionary nature of the industrial internet also challenges the expertise of business executives and experts. There are also narrow fields of expertise, both in companies and at universities. Strengthening the experimentation and collaboration culture creates possibilities for broadening these fields. The question is not only about shaping a digitalisation strategy suitable for a company but also, first and foremost, implementing the strategy and managing change so that the change can take place on a sustainable basis.

The expertise required by the industrial internet must be developed at least at the following levels: enhancing management's understanding of the technological and business upheaval, renewing the product development professionals' technology competence and educating graduating university engineers and mechanics on what is actually occurring in the field. In addition, because of the industrial internet and the big data phenomenon, investment is needed in analytics education and industrial information security.

4.5 Technologies and Platforms

Finland can provide the possibility of piloting industrial internet solutions, in other words experimenting with them in a real environment before they go to market. Our strengths include skilled operating methods, which enable rapid application, but the culture of experimentation must be strengthened. The society's digitalisation and the related standards and innovative solutions in public procurement are a fruitful environment for piloting.

A working infrastructure is an unquestionable requirement for competitive business activities in the areas of the industrial internet. Key basic infrastructure factors, such as the reliable availability of electricity, public utility services, working logistics connections and, importantly, telecommunication are at a good level in Finland. However, there is still room for improvement: the telecommunication infrastructure is not up to par with the requirements of the Internet of Things. Therefore, we concentrate on the factors where the infrastructure could be a positive differentiating factor for Finland. We highlight two such factors in the discussion: information-secure industrial internet and piloting possibilities.

In the field of the industrial internet, information security is even more important than in areas previously brought to the scope of the internet, as the potential threats do not involve the protection of privacy, stealing secrets and the refusal of services alone. A cyber attack on systems that rely on the internet may rapidly paralyse vital functions of society (like the distribution of electricity) or the shut-

down or damaging of an individual factor or machine. Finland must create methods and technologies to create a persevering industrial internet resistant to attacks. This generates both national security benefit and competitive advantage for companies.

The benefits of the experimenting environment (the demonstration platform) can be summarised as follows. It provides favourable conditions for demonstrations, gets users to be involved as the testers of a new solution and supports the implementation of the changes required in the implementation environment. In addition, it supports the preparation of the implementation and the procurement of the new solution, presents the implementation of the solution to potential implementers and lays the foundations for the dissemination of the solution.

5 Necessary Decisions and Concrete Measures

The industrial internet is both a challenge and an opportunity for Finland. It is a challenge because the industrial internet will in any case profoundly change the conditions in which Finnish companies and all Finnish society must operate in the next few years. Business customers, partners and competitors will adopt the technologies and principles of the industrial internet. New operators who do not respect the former boundaries between sectors or their established rules may also appear on the market.

The industrial internet is an opportunity for the country because Finland's starting points for using and adopting it are excellent when assessing many important factors. In terms of technological expertise, pioneering companies in a good position and institutions supporting success, we are still in the vanguard. The potential for achieving the vision described in this report genuinely exists and it is worth aspiring to.

However, meeting the goal requires determined and sufficiently ambitious measures among various public operators and individual companies, networks and the ecosystems surrounding them. Users, consumers, citizens and employees must also be enabled to adapt their activities to the objective both individually and separately. This means we need a national programme for the industrial internet and concrete contents for the programme.

This chapter describes the measures created during the study that may serve as the foundation of the national programme. We have attempted to formulate measures that create preconditions and remove obstacles instead of direct support measures. Managing the set of measures according to the principles of a good technological policy is an essential part of the proposal.

Table 5.1 provides a summary of the proposed measures (see p. 32). They have been divided into five sections: 1) Leadership and implementation, 2) Market access, 3) Markets and business models, 4) Competence and 5) Technology and platforms.

Measure #1: Create a Finnish story and wake-up

A common vision and an idea of the path towards the vision will help set focal points and achieve the goal. First, we must encourage the companies and other operators to see the turning point and then catalyse them to act on it.

At companies, it is particularly important that board members understand the turning point and be committed to supporting the senior management in the process of change which may result in smaller profits during the transition period.

Responsible parties: Finnish Industrial Internet Forum (FIIF), Technology Industries (TI), Prime Minister Office (PMO)

Time range: 2015–2018

Benefits and costs: A common vision and story will help achieve the objective. The direct costs are EUR 0.2 million/year, e.g. to support the FIIF communication activities.

Measure #2: Lead change as part of the government platform

The proposed measures are intended to function as a whole where individual measures support and reinforce each other. Therefore, they should be controlled and managed as a whole according to the principles of a good industrial policy. These include e.g. clearly communicating of the goals of each measure to the parties concerned; monitoring the effectiveness of the measures; adequately assessing the role of public operators (to ensure it is relevant); establishing timelines (to avoid the loss of morale) of the measures, communicated in advance, and formulated into a clearly communicated 'exit plan'. The entity must be flexible according to the potentially changing situations and needs, and also take the new emerging parties into account: it must not be exclusively based on the needs and priorities of the established companies already operating in the area. Measure #3 also supports accelerating the implementation of the entity.

Responsible parties: A policy program covering and coordinating the actions of various ministries (Ministery of Employment and Economy (MEE), Ministery of Education (MoE), Ministery of Foreign Affairs (MFA)).

Time range: 2015–2020

Benefits and costs: The benefits will be created through the effects of the entity of measures. Costs (max. EUR 100,000/year) mainly consist of implementing effectiveness analysis, e.g. by means of various competition projects.

Measure #3: Appoint a person in charge to co-ordinate the implementation of the industrial internet

Publicly funded RDI activities include many operators. Though the sponsoring parties, Tekes and the Academy of Finland, co ordinate their activities and use the programmes to outline the field of study, the research organisers, SHOK Centres, in particular FIMECC, Digile and CLEEN; the parties carrying out research and development activities, Technical Research Centre of Finland (VTT), universities and universities of applied sciences, operate relatively independently, which may result in the lack of coordination, overlap and competition. At the same time, we can see that similar activities have been better coordinated in countries such as South Korea, China and Germany. These countries have created national programmes of action.

An II coordinator should be appointed in Finland. The coordinator could have a relatively strong mandate to coordinate the publicly funded RDI activities, promote the national II agenda and give it a public face. This person would be in charge of channelling the national research, development and teaching activities for the industrial internet in close cooperation with the industry (FIIF), the universities and other research institutions. This person would be in charge of establishing features such as a nation-wide pilot network for the industrial internet in Finland to include regional operators (companies, municipalities, universities, research institutions), each of which would focus on the strengths of their region, supplementing the strengths in other areas. The II coordinator would report on its activities to the policy programme proposed in measure #2.

Responsible parties: MEE, MoE, Ministery of Transportation and Communications (MTC)

Time range: 2015–2020

Benefits and costs: The benefits would include the coordination of RDI activities and avoiding overlap. The direct intensification impact would be EUR 10–20 million/year, and the indirect impact would amount to several billions once the objectives of the agenda are met. In practice, no cost; targeting existing resources.

Measure #4: Make use of innovative public procurement: 5% obligation

In the 2010s, the public sector service procurements and investments totalled approx. EUR 35 billion a year, and they form approx. 20% of the GDP[1]. Public procurements may provide new products and services using the industrial internet technology and data-based business activities 1) a pilot client who will at the same time provide income to fund the product and service development as well as 2)

[1] http://www.tem.fi/files/33155/TEMrap_18_2012.pdf

valuable client references. This resource has not been used effectively in Finland as a tool of trade and technology policy, though the EU procurement directive reforms attempt to favour innovative procurements. At the same time, the measure encourages the reform of public services and the establishment of operating models for agile development in public administration.

We consider the excessive emphasis on the price as a procurement criterion to be the main obstacle to the growth of innovative procurements. The second reason is the desire of the parties making decisions on procurements to avoid the real or imaginary risk related to innovative procurements. This is why we suggest the following:

- where possible, planning public procurements so that they take into account the application of the industrial internet and its methods as a way to reduce costs or produce better quality services.
- in public procurements, 5% minimum requirement for innovative procurements (EUR 1,750 million/year)
- innovation should be more distinctly and transparently included in the procurement scoring
- the starting point for competitive procurements will be life cycle costs
- pooling should occur in the public sector (municipalities, the state, other public operators)
- the procurement criteria scoring should be reviewed so that the potential of the innovative projects to be selected will improve, for instance by emphasising the value of the procurement throughout its life cycle instead of its price.

Responsible parties: Prime Minister and PMO (legislation, 5% requirement, life cycle model); Ministery of Finance (MoF) and Association of Finnish Local and Regional Authorities, pension insurers (pooling arrangement implementation)

Time range: To be included in the government programme, entry into force in 2016

Benefits and costs: The investments in innovative procurements and services must be more profitable during the normal amortisation periods than the alternative solutions. If we estimate that the value of the productivity and other benefits is 15% of the value of the investments, EUR 1,75 million of annual procurements will result in benefits of EUR 262 million for the public sector. The risk costs will be estimated on a 10% risk level, EUR 175 million per year. The public sector net benefits are EUR 87 million.

The benefit through the references given to the companies and the related increasing added value can be assessed as follows: if the references help the companies triple their sales, Finland will have EUR 5.25 billion of new added value per year.

Measure #5: Support the partnerships of different types and sizes of companies

Finnish companies do not make sufficient capital investments into start-up companies as part of their own innovation activities, whereas large American companies are currently responsible for approx. 10% of all capital investments made in start-up companies.

For taxation purposes, capital investments into start-up companies should be considered as part of the companies' additional deductions from their research and development activities. The networking of small and large companies can be further accelerated by means of the Finpro programme supporting the internationalization of growth companies in the footsteps of large companies and with their support.

Responsible parties: Company boards, MoF, Finpro

Time range: 2015–2018

Benefits and costs: The rapid development of an innovation ecosystem and the determined productification of innovations

Measure #6: Carry out focused market intervention

Both the public sector and the business world produce big data which cannot be directly used in their own activities. However, this data may serve as the foundation pillar of more extensive community innovations. Along with their products and services, the business operation models based on data analysis create new markets where Finnish expertise provides excellent preconditions for Finland to become a worldwide forerunner. This will be utilised by all operators in Finland: companies, society and consumers. It will also benefit all these parties.

One way to accelerate the utilisation of data might be to create a neutral intermediary, 'Data Bazar Finland', which would distribute the data delivered to it according to previously agreed rules (developed in measure #7) and agreement models to the parties utilising the data.

Responsible parties: Companies, universities, research institutes

Time range: 2016–2018

Benefits and costs: The benefits of the measure can be directly measured by the number of transactions taking place through the 'data bazar'. Its costs should be shared by the parties responsible, for instance according to the cooperative principles. Public fixed-term initial funding would accelerate the launch and scaling of the project.

Measure #7: Clarify the rules of game for data ownership and management

The lack of clear rules and agreement models often slows down the implementation of new technologies and business operation models. On the other hand, the party introducing usable and acceptable agreement models will derive benefits from this, and this may result in a leading position in the network (cf. the role of Apple and Google in their own ecosystems). By creating general rules and agreement templates for Finland, companies operating in Finland could achieve a global competitive edge, particularly if the various platforms of networked business activities can be used to support the procedures under these rules. The intervention suggested in measure #9 is an example of such a platform.

Responsible parties: MEE, MoE, TI or FIIF, universities, the Data Protection Ombudsman

Time range: 2015–2017

Benefits and costs: The measure may be implemented as an RDI project involving universities, research institutions and key law firms as developers and companies as the utilisers. The ministries are mainly in charge of ensuring that the subject area will be regulated in a way that does not unnecessarily impair the progress of the measure. The costs will be approx. one million euros per year between 2016 and 2017.

Measure #8: Reduce regulation and reform taxation

Regulation may promote or deter the implementation of new technologies and business operation models. Good examples of the effects of regulation or reduced regulation includes the positive effect of the Nordic NMT mobile phone standards on the rise of Nokia and Ericsson as business and technology leaders in the field of mobile phone technology in the early 1990s as well as the liberation and partial cancellation of air traffic regulation in the 1980s and 1990s, which led to plummeting flight ticket prices and increased mobility among the citizens.

For the industrial internet business operations, it is important to assess regulation not only on a general level (rules on business activities and working life) but also in the field of privacy protection and data security. Finland should be able to develop its global status as a pioneering 'laboratory' for new data-based business operation models and a pilot market where companies will find it easy to create and test innovative industrial internet service concepts in a limited production environment. For instance, the progress of smart road traffic and cars without drivers could be piloted in Finland, which would ultimately lead to the creation of an automotive industry in Finland.

Equal Company Taxation on a Global Level The revenue logic and construction of data-based (and digital) business operation models based on products is not bound to any physical location. For companies, this means that digital business operations need not be carried out in the same country where the physical product itself is manufactured. Digital business operations enable the benefits created in the value chain and also the transfer of the entire digital business operations to a country with a more favourable tax system. In this respect, companies operating locally in Finland are not in the same position as companies operating globally.

Responsible parties: Prime Minister and MoF

Time range: To be included in the government programme, entry into force in 2016

Benefits and costs: The benefits may be significant (cf. the examples on mobile phone business activities and air traffic) if companies do not have to leave Finland due to tax planning, but instead, they may operate from Finland throughout their life cycle. Direct costs related to legislative work are not significant. The construction of pilot environments does not require large social investments if the

preconditions for creating 'laboratories' at companies are created in conjunction with local companies, universities and research institutions. Supporting innovative activities also refers to an abstention from new regulation. However, indirect costs may be incurred due to incorrect choices or the materialisation of risks related to the clearing of regulation.

Measure #9: Specify common platforms and standards at the EU level

Improving competitiveness requires both national measures and measures covering the entire European domestic market. On a national level, using our own strengths, Finnish operators must be more competitive than countries such as Sweden or Germany. In a global economy, strong cooperation on EU level must be carried out to create joint platforms and standards in order for the European way of operating to be successful in relation to Asia and the United States. We need a European network of teaching, research and cooperation to coordinate the European model (cf. EIT ICT Labs). Finland must be an active operator on all levels in order for the Finnish way of operating to be approved as a (de facto) standards and to reinforce Finland's possession as a forerunner.

Responsible parties: Ministers, MEE, MFA, 'idea leaders' for various operators

Time range: 2016–2018

Benefits and costs: The potential benefits are formed through the scale benefits received through EU level operator networks, and more concretely, through the channelling of EU funds to targets that fit Finland's priorities. The credibility of Finland and Finnish companies as industrial internet operators will also improve thanks to their activity. The costs mainly consist of the direct costs incurred by preparing the initiative and lobbying and by coordinating the preparation measures of various operators.

Measure #10: Start adult education at different organisation levels

The digitalisation of products and services will change business operation models at an increasingly rapid pace. The importance of managing business architecture is emphasised since an ability to react and to quickly scale the operations or services up or down is required. Training programmes that target Finnish companies and focus on the application of the industrial internet from a business point of view are required. Instead of the internal operations of companies, their focus should be the operations between companies (intranet => internet).

The industrial internet training programme for companies will be launched. There is need for training on various company levels: middle management and experts, senior management (including board members) as well as officers. The eMBA and PD programmes may be tailored for the needs of various sectors, and they answer the question about how products and services linked to a network may bring new growth for the companies involved and increase the efficiency of their existing business activities. The objective should be to understand the potential of the industrial internet for the company's business activities and to apply it over the traditional (internal and external) organisational boundaries both for adding customer value and for producing products and services. It is useful for the participants in the training programmes to have different functions and/or operate in different sectors whose different point of view supplement the global image of the new business opportunities in the company.

Responsible parties: Professional training units in universities and universities of applied sciences

Time range: 2015–

Benefits and costs: Companies will benefit from this and pay for the training themselves. In connection with the training sessions, valuable research material is acquired.

Measure #11: Reform the education programmes at universities

The application of the industrial internet requires a multidisciplinary, systemic skills and an ability to connect the software with products and services. In the future, physical products and services will be integrated to the intellect (software), not the other way around. This requires an entirely new type of thinking. The importance of software skills is increasing, and in the future, it should be included in the teaching provided in basic and upper secondary education. In university education, more emphasis on a phenomenon-based education as well as phenomena and complexity management is required. Programmes should be planned and implemented in order to also attract talented foreign students to Finland.

Scaling is the largest challenge to ensuring the measure is effective: how can it be implemented so that it truly reaches a sufficiently large part of the students in the field? The effect of this bottleneck may also be reduced by contributing sufficiently to the production of electronic educational contents and its distribution to everyone, for instance in the form of open online courses. This comment also applies to measures #12 and #13 which may also achieve scaling benefits through electronic educational materials with a suitable content and through their efficient distribution. It is particularly important that the electronic training material will be created and distributed in a way that also supports the effective implementation of measure #14.

Responsible parties: MoE, universities, universities of applied sciences and other educational institutes

Time range: 2015–2020

Benefits and costs: The benefits of the measure consist of improving companies' ability to change and the resulting renewed products and services. These are all enabled by the improved skills, Though the greatest benefits are achieved in the longer term, benefits may be rapidly achieved through actions such as redirecting theses and project assignments from suitable educational programmes to deal with the relevant industrial problems. As for universities, the measure may be implemented as part of the profiling programme launched in 2015. In this case, no permanent additional costs would be incurred. Measure #16 should be implemented so that the infrastructure it creates also serves the modernised educational programmes.

Measure #12: Support self-initiated education

In a rapidly changing business environment, individual skills and labour force needs do not meet. A tax break on training costs is currently intended to additionally reduce the income tax of an employer in independent trade or agricultural activities. The possibility of benefiting from this reduction should be extended to an individual level and it should also be applicable in the personal taxes paid by individuals seeking to educate themselves at their own initiative.

Responsible parties: MoF, MoE and labour market organisations

Time range: 2015–2019

Benefits and costs: The ability of the labour force to regenerate itself, such as its mobility from one sector to another, will improve, which will significantly reduce the problems otherwise caused by the passage to the industrial internet. In addition, it should support the company's own measures for reorienting their activities as required by the application of the industrial internet. In addition, the right to a tax reduction may also be seen as a way to accelerate the entry into working life and to extend working careers.

Measure #13: Derive best practices from business models

Companies may learn from each other's experiences, and as a result, they will enter the market at an earlier stage and benefit from increased sales and revenue due to these experiences and good practices. This may be promoted not only by means of increasing networking (e.g. through the activities of FIIF) but also by developing and providing educational programmes designed and intended for the senior management of companies.

Responsible parties: FIIF, TI, Finpro, professional training units in universities

Time range: 2015–2018

Benefits and costs: Companies will benefit from this and pay for their costs themselves.

Measure #14: Ensure a cyber-safe industrial internet

In the concrete industrial internet applications, the ecosystems developing around it play a central role. They gather various operators within the ecosystems and in their close proximity. In this regard, the ecosystem's 'security architecture' is a significant factor: who will be in charge of ensuring that the operators, software, installations, maintenance etc. are cyber secure. This requires system-internal rules and control which will concretely promote the cyber secure activity of the ecosystem.

Standards should be applied within the possibilities and limits of the industrial internet use case concerned. On a national level, the standards should be monitored, and it is necessary to assess which of them are becoming de facto standards and which standards are suitable for which use case and sector. Good international and national practices and models should be shared and utilised. This work should be supported on a national level so that operators are prevented from developing their own procedures which may cause confusion as the cooperation depends or expands. The development of cyber security awareness for the various II area operators will also likely require a national contribution.

Technical platforms must be evaluated in the future as well, and in various ecosystems, the platforms that are strongest and safest from the competitive point of view as well as their effects on the architecture and dependencies of II applications (such as software libraries, software developers etc., and the related threats) should be identified.

Technical solutions should take into consideration the openness of the industrial Internet by providing an integrated architecture within products and services, allowing an open, semi-open (confidence networks) and an entirely closed interface.

Responsible parties: National Emergency Supply Agency (NESA), National Cyber Security Centre Finland (NCSC)

Time range: launched –2019

Benefits and costs: Cyber security is an essential requirement for the extended application of the industrial Internet. A credible level of cyber security that is distinguished from others would give (Finnish) companies a competitive edge. Costs of the basic procedures described above will be in the public sector three to five million euros per year between 2016 and 2019.

Measure #15: Produce a rapid-testing environment

Applying the principles of industrial internet will require an ecosystem of rapidly testing various technologies and business operation models which will decrease the risk level of experimentation and balance its costs. The laboratories and experimentation environments of universities, Technical Research Centre of Finland (VTT) and willing companies may be gathered into an 'IoT Pilot Network Finland' group through which companies can access ready-made laboratory and piloting resources and cooperation networks at reasonable costs. In this versatile network of operators, services are provided for all questions requiring a solution and applications, such as technology, business activities, agreement templates, law, networking etc. In addition to companies, universities and research institutions, the network of operators must also cover innovators and start-up entrepreneurs who may take up emerging ideas and develop them towards a market entry. The promotion of a culture of experimentation will foster the creation of innovative products and services, preparing for the disruption caused by digitalisation. Depending on the possibilities, laboratories should network with features such as the corresponding platforms on an EU level (e.g. Industrie 4.0 pilots).

Responsible parties: FIIF, universities, VTT

Time range: 2015–2019

Benefits and costs: The benefits of the measure depend on the increase in the amount of concrete experiments and developed innovative pilots and on their transfer for use by commercial operators. The costs of the measure can be largely covered either by the individual contributions of the various parties or by existing financial instruments (Tekes programme funding, the Academy of Finland infrastructure funding). However, setting an additional fixed-term incentive would accelerate the implementation of the measure. The suitable level is approx. ten million euros per year between 2017 and 2019, after which the ecosystem should be able to continue on its own.

Table 5.1 Measures, objectives, responsible parties and time range

Area	#	Measure	Main objective of the measure	Responsible party	Time range
Leadership and implementation	1	Create a Finnish story and wake-up	The vision will help set the focal point and achieve the objective	PMO, FIIF, TI	2015–2018
	2	Lead change as part of the government platform	The implementation of the program of measures as a clear entity, effectiveness assessment, flexibility	Interministerial policy programme	2015–2020
	3	Appoint a person in charge to co-ordinate the implementation of the industrial internet	Coordinated and effective activities	MEE, MoE, MTC	2015–2020
Market access	4	Make use of innovative public procurement: 5% obligation	References and technological head start	PMO, MEE, MoF, other stakeholders	2016–2020
	5	Support the partnerships of different types and sizes of companies	Company growth accelerates => value for Finland	Company boards, MoF, Finpro	2015–2018
	6	Carry out focused market intervention	Empowering cooperation: start ups and industrial clusters	Companies, universities, research institutes	2016–2018
Markets and business models	7	Clarify the rules of game for data ownership and management	The uncertainty factor preventing business activities and investments is removed; this leads to increase in export	MEE, MoE, FIIF, TI, universities, Data Protection Ombudsman	2015–2017
	8	Reduce regulation and reform taxation	Predictable and fair taxation; an agile and favourable operating environment for innovative business	Prime Minister, MoF	2016–2020
	9	Specify common platforms and standards at the EU level	European competitiveness and employment, reinforcing the pioneering qualities of Finland	Ministries, MEE, MFA, 'idea leaders' for different stakeholders	2016–2018
Competence	10	Start adult education at different organisation levels	Reinforcing the management and experts' II skills	Universities and educational institutions	2015–2020
	11	Reform the education programmes at universities	Phenomenon based training => phenomenon management	MoE, educational institutions	2015–2020
	12	Support self-initiated education	Increasing digital expertise, employment, ability to change	MoF, MoE, labour market organisations, tripartite	2015–2019
	13	Derive best practices from business models	Scalability, predictable and continuous flow of income	FIIF, TI, universities	2015–2018
Technology and platforms	14	Ensure a cyber-safe industrial internet	Methods of operation, standards, procedures, technical platforms	NESA, NCSC	2015–2019
	15	Produce a rapid-testing environment	Piloting possibilities, cooperation networks, agility, limitation of risks	FIIF, universities, VTT	2015–2019

6 Summary

The industrial Internet is a revolutionary turning point. It is a threat to those who stick to old working methods too long, but an opportunity for those who seize upon it. Unfortunately, many actors perceive the upheaval as a threat to their present position and, particularly at companies, to their turnover and profitability structures and levels. An attempt may be made to maintain the profitability by means of cuts and savings. This approach has led to the loss of 16,000 industrial jobs during the last four years.

However, Finland has a good opportunity to choose an entirely different path of development. We have industrial companies that are the leaders in the sector and world-class ICT skills. However, this is not enough: companies must have the courage to give up the old and make large-scale investments in the new, a willingness to become internationalised and to find the best partners near and far; the public authority must see the importance of the turning point, reform pertinent education and procurement methods, remove obstacles to the operation and growth of companies and make long-term investments into research and development. In addition to companies and the public authority, representative associations and all employees, decision-makers, consumers and citizens are expected to seize opportunities and be willing to change.

This report suggests a set of concrete measures which Finland can use to redirect the negative course of development described above and receive its share of the value produced by the industrial internet. The measures proposed are a good starting point and framework and when the operators—companies, the public authority and the other parties—are committed to the vision, we can achieve good results for the future of our nation.

We can turn Finland into an attractive target for placing company functions and creating new jobs. It will be the Silicon Valley of the industrial internet, spreading new innovations to the rest of the world!

Appendix: Work Process

The 'Finnish Industrial Internet—from a Challenge to a Possibility' project was carried out according to the process presented in Figure A.1.

Figure A.1 The 'Finnish Industrial Internet—from a Challenge to a Possibility' project work process

A short description of each work stage is presented below.

1. Background compilation

To provide a comprehensive view, a compilation on the background of the present state of the industrial internet and related (global) development was initially drafted. The material used for the background report included the literature databases of Technical Research Centre of Finland (VTT), Aalto and the Research Institute of the Finnish Economy (ETLA) which provided access to extensive scientific, financial and statistical materials. The expertise on the subject within the working group and the steering group was also used for the report. The group that drafted the background report consisted of researchers for the organisations mentioned above.

The background report was published in the Research Institute of the Finnish Economy ETLA publication series, and it may be downloaded in Finnish from the Research Institute's website at http://www.etla.fi/julkaisut/suomalainen-teollinen-internet-haasteesta-mahdollisuudeksi-taustoittava-kooste/.

2. PESTE drivers

To form a vision, the research group assembled the drivers related to the industrial internet according to the PESTE (Political, Economic, Social, Technological, Environmental) factors. The materials used included the background compilation, literature and the expertise of the researchers in the working group. The initial PESTE table was supplemented and discussed at workshops. The PESTE driver table for the vision work is presented in table A.1.

3. Vision workshop and vision

A vision workshop was organised with the objective to create a vision of the industrial internet in ten years; the question was how could the industrial internet become the strength of Finland. The other reason for the workshop was to identify the central challenges, possibilities for achieving the vision and operators related to the industrial Internet. For identifying the vision, the ME-WE-US method was used. The identification of the challenges and possibilities was carried out at the World café where the challenges and possibilities were examined from the PESTE perspective (politics, economy, society, technology and the environment). The workshop was organised on 6 November 2014 at the Research

Table A.1 PESTE driver table used for the vision work

Politics	Economy	Society	Technology	Environment
Harmonisation of legislative and institutional systems in Europe (e.g. cyber security, privacy protection, communication)	Globalisation, global business activities and delivery chains	Privacy protection	Digitalisation	Carbon footprint: Reduction of CO2 commissions
Data transparency	Trans-European labour market	Increasing competition for jobs	Technology maturation (communication, probes, sensors etc.) and reduction in costs	Energy efficiency and sustainable energy solutions
Education/skills (challenge)	Loss of jobs and changes to work tasks	Urbanisation	Technology platform spectrum and lack of compatibility	Scarcity of resources
Investment strategies	The share of company-internal trade in world trade has significantly increased	Changes in user needs (such as individualisation)	Technology may be used to replace legislation (control; ignition interlock device; business cases missing)	Climate change
Tax policy	Separation of real and financial economy Geography of profit separated from jobs and investments Tax exemption for corporate profit abroad (USA) => competitive edge for American companies	Increase in employee know-how, consumerisation Cooperation of operators over sectoral boundaries, consumer producers Ageing Appreciation of health and quality of life	Cyber security Differences in patent systems (USA vs. other countries)	

Institute of the Finnish Economy ETLA in Helsinki, and experts of the industrial internet from various organisations were among the invited participants.

Based on the workshop outcomes, the working group created a draft vision. Skills, the society, business and infrastructure were identified as important aspects in forming the vision. Eventually, the

Table A.2 Strengths, weaknesses, possibilities and threats

STRENGTHS	WEAKNESSES
ICT skills	No joint story, general lack of prospects, short-sightedness
Strong basic industry applying Industrial Internet (II)	Bottlenecks in skills and fragmentation both in universities and companies
The scale of Finland allows rapid cooperation	
Confidence in institutions and corruption-free business environment	Undeveloped culture for the cooperation between large and small companies
Innovation system encouraging cooperation	Strong interests and interest organisations defend the old structures and business operation models

POSSIBILITIES	THREATS
Growing European and global markets	II is hyped up, and no real incentive exists
Global challenges create new business opportunities Pioneering companies, niche leadership	II leads to business operating models which will take the possibility to create value away from Finnish operators
Reinforcement of experimentation and cooperation culture and developing ecosystems	II and IoT will render some jobs unnecessary, which will lead to objections
Digitalisation of society and related possibilities (including innovative public procurement)	Legal questions related to agreements cannot be solved, shortcomings of II infrastructure

vision was recorded as ‘In Finland, jobs and investments are created by intelligent products and services connected to the Internet by means of our know-how and skills’.

4. SWOT workshop

The objective of the SWOT workshop was to examine the strengths, weaknesses, possibilities and threats related to the industrial internet in Finland. The workshop was organised on 11 November 2014 at the facilities of the Technical Research Centre of Finland (VTT) at Espoo.

The outcomes of the project launch meeting and vision workshop were used as the background material for the workshop. SWOT was carried out at the workshop, and the measures that should be implemented in Finland were also discussed. After the workshop, the outcomes were grouped in the four sections of SWOT (see Table A.2).

5. Roadmap workshop, interviews and strategic roadmap

The objective of the Roadmap workshop was to share a joint vision of a Finnish industrial internet, identifying its enablers and bottleneck and forming ideas on the necessary measures (and the associated development paths) in order to reach a vision. The roadmap workshop was organized on 20 January 2015 at the Aalto University School of Economics in Helsinki. Representatives of the industry, Parliament, various ministries, representative associations and research institutions were invited to participate.

The work was carried out in five groups under the guidance of the instructor. The PESTE driver table and outcomes of the vision work were available as background materials. Initially, each group was entrusted with identifying the effective factors, enablers and bottlenecks of the industrial Internet. The results were recorded on colour-coded stick-it notes based on a roadmap template provided, with a division according to the themes of the vision aspects (business activities, infrastructure, skills, society and ‘other’). The factors, enablers and bottlenecks identified were prioritised using a simple voting method.

In the project, semi-structured interviews were carried out with the goal of creating a more detailed image of the effects of the industrial internet on Finnish companies on the scope of utilising the industrial internet and the expectations and objectives related to the industrial internet applications. In addition, the interviews were used to map the views of companies on the risks related to the industrial internet, its possibilities, and views on Finland as an investment environment. Some of the interviews were more concise, focusing on the legal questions and other questions related to data ownership.

6. Suggestions for measures and the FIIF event

Based on the enablers and the bottlenecks, the working group identified initial suggestions for measures in order to reach the vision. These initial suggestions for measures were commented on and modified in various connections, such as interviews, the Finnish Industrial Internet Forum (FIIF) event on 9 February 2015, and the steering group meetings. In the FIIF event, the mandate of the project and the initial suggestions for measures were submitted for comment. More than a hundred people participated in the event, the majority (approx. eighty) from the business world. The real-time feedback mechanism of the screen.io service was used in the event, allowing the users to score and comment on the suggestions in real time using their own smartphones. They were also able to make new suggestions. The participants were very active, which had a strong impact on the suggestions. For instance, two suggestions originally made at this event later developed into measures.

The suggestions for measures were refined and specified so that the party in charge of the measure, a schedule and the benefits and costs of the measure could be determined.

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