Information and Communication Technology Sector's Vision of Estonian Information Society in 2020

Tallinn 2014

Vision of Estonian Information Society in 2020

Information and communication technology (ICT) sector's vision 2020: by 2020, Estonia's primary catalyst for welfare generation will be grounded in innovative ways of applying ICT solutions to managing economic and societal affairs.

The following document represents a vision of Estonia's IT sector as envisioned by the Estonian Association of Information Technology and Telecommunications (ITL).

Open Society

By 2020, Estonia will have established itself as a globally recognized authority in applying innovative IT solutions for the purposes of developing a free and democratic society in the information sphere – a process, which could be tentatively called the onset of "e-democracy". Estonian experts on developing such systems will be much sought after throughout the world. As time passes, the cumbersome "e" will be dropped as IT systems become an integral part of modern democracies.

In the spring of 2020 the Estonian President will give an interview to the New York Times, citing his reasons why he is proud of Estonia's acumen in developing e-solutions that instil democratic principles to a society that has undergone fundamental technological transformation. The President will recognize the fact that the transition has not been easy for Estonia – following the realization that unmoderated anonymous internet comments, for instance, proved to be a vehicle that was ill-suited for democracy building.

Estonia has recovered from scandals that accompanied the divulging of secrets, an inevitable concomitant to rapid opening up of information streams, and made amends with past legacies that have served as a basis for making future adjustments. Public records are widely available in unified formats on the open domain, with uniform accessibility fostering more effective decision-making processes in the economic sphere as well as the society in general.

Latest models of telephones and computers have long since ceased to be important, with information and communications technology being embedded in everyday life. Yet despite the deceptive ubiquity of ICT solutions in all spheres of society, the changes brought about by the implementation of these solutions have been profound in altering ways in which Estonians do business, engage in politics, study and network with the community.

Although the novelty of new technologies will soon wear off, discussions on how to best implement IT based solutions will inform decisions directed at making the best use of ICT for making life more prosperous without encroaching on democratic

principles and individual liberties. Thus the process will be directed at making technology cater to human needs and not vice versa.

Estonia has become a world-renowned ICT hub that stands at the forefront in developing a number of IT technologies. This in turn will mean that Estonia should attract talents from different parts of the world. Such a process will be accompanied by a consensus within society, which recognizes that instead of being a burden, the migrant workforce is actually a net contributor to the economic growth by virtue of value added know-how and expertise. Thanks to such policies Estonia will attract an increasing volume of foreign investment, and is in a strong position to compete as a potential location for setting up multinational corporations' regional R&D centres.

"Smart" state

Even prior to 2020, Estonia will find itself among a number of nations facing the ageing of population accompanied by labour shortages. This will place an unbearable burden on the national health care system, which has a rigid infrastructure that is unfit to meet the expectations of the changing society. The aforementioned challenges will be compounded by increases in the prices of energy.

Social services will be in a situation where demand will outstrip supply, with budgets unable to cover all the liabilities associated with financing the pension system. As finances run short, dissatisfaction with state policies will increase.

Old challenges will be exacerbated by new problems. A large number of service sector jobs will become surplus to requirement with the arrival of automated payment systems. This will add further pressures to the unemployment situation. Increasing automation of manufacturing processes will further diminish the demand for human labour. Following 2020 many workers in the transport and logistics sectors will be made redundant as auto piloted transport achieves unseen levels of efficiency and safety.

By working together with other sectors of the economy, the solutions provided by the ICT sector can help remedy the situation by offering new ways to retrain the labour force. For instance, by adopting the concept of smart specialization, the healthcare sector can be transformed into an exporting segment of the economy, which will employ large amounts of workers coming from downsized (in terms of labour usage) industries, thus creating added value for the economy and society.

In order to adapt to the changing environment the state needs to embrace flexible solutions to re-invent rigid systems. This requires a more holistic approach to conceptualizing human activity within the societal structure. Above all, it requires an understanding, which considers every stage of life as valuable. In 2020, the concept of lifelong learning will be firmly entrenched within society.

The state will use the opportunities provided by the ICT sector to optimise its structures and public utilities. Administrative reforms will be completed. Diminishing the number of regional administrations will not necessarily translate into a

diminishing of the quality of the public services provided that person-centric e-solutions working in conjunction with conventional best practices will ensure that the state continues to function in the sparsely populated areas of Estonia.

Intelligent communities will be established where the generation gaps are overcome by providing an opportunity for young and old to work together in order to create new products and services that are demanded by local communities and markets abroad. Such undertakings will include healthcare and social services, energy and environmental technologies as well as manufacturing based on novel principles.

The opportunities provided by various well thought out "e-democracy" solutions will enable grass-roots participation in managing the affairs of state. This will find expression in joint interfaces, set up to garner the input of specialists, as well as in public discussions in the open forum – both virtual as well as actual.

By 2020, villages, towns and the state as a whole will have adopted novel solutions for involving the general population in decision-making processes. Each individual will reserve the right to request access to information pertaining to his/her person that has been collected by state institutions and local authorities. This will further promote grass-roots participation and greater efficiencies in the execution of governmental functions.

Easily accessible personalised healthcare solutions

For quite some time the full diagnostic of a person's state of health has existed in handwritten form, buried deep in the hospitals' filing systems or alternatively stored in the recesses of the family physician's memory. In the future, data recording a person's state of health will be easily accessible to everyone the individual in question deems privy to such information. Such a principle will open up a wide range of innovative service solutions. Individual fragments of information (i.e. blood pressure readings, sleep cycles, pain, mood alterations, etc.) will fit into a pattern that can be readily analysed, not only by doctors, but also by computers operating based on well-formed algorithms. The results of the analysis can be interpreted in ways that provide multiple outputs – each one optimally suited for use by the patient, nurse or doctor respectively. Medical institutions are witnessing a steady increase in demand for services evaluating business operations, measuring efficiency and providing personalised healthcare solutions.

Such solutions will enable people to keep track of their health condition and make informed decisions much in the same way they do with regard to their career management. This will foster a more conscientious appreciation of one's medical condition and setting long-term goals, as people will no longer take health matters seriously only in cases of illness. Minor health concerns can be addressed by active autonomous measures, whereas serious ailments will involve the patient playing an enhanced role in being a part of the solution. The peoples' expectations with regard to health care services will rise in proportion to increases in their active input.

Most health concerns will be attended to online (teleconferencing consultations combined with analysis of pre-recorded medical data). Cases which require physical contact and appointments with specialists can also be arranged from home using electronic means (smart phones, digital television interface, etc.) or by making the necessary arrangements from the local health centre, pharmacy, self-service centres located at malls, etc.

Estonia has at least 20 internationally acclaimed medical institutions which use secure data sharing and teleconferencing-medicine capabilities in order to service patients abroad, thereby becoming an integral part of the foreign clients' service base (including the use of medial data in national health information databases). All Estonian health IT services' developers co-operate with foreign healthcare institutions. Product development will be pursued in a manner, which takes into account the needs of both domestic and foreign clients.

Smart Energy

Overall energy consumption levels have dropped since energy generation, enterprise management and electricity consumption solutions all employ ICT extensively. Such devices will offer scope for making economies by synchronizing operational patterns of different parties and devices, thereby decreasing energy consumption in domestic households, industry and the public sector alike. As a consequence, Estonia's cumulative energy consumption will decrease by 20% compared to the levels seen in 2010.

By 2020, Estonia will have a range of fully functioning renewable energy cooperatives with easy access to energy grids. The individual electricity consumer will find its counterpart in micro-providers who are willing to share the surplus energy generated, thus balancing the general energy production balance. Preference will be given to local production and consumption of energy in order to secure guaranteed supply and to diminish the amounts of energy lost as a result of long-distance delivery via stretched supply lines. Innovative business models will define the market and a general leaning toward green, renewable energy sources at the marketplace. As a result of this renewable energy supplied by micro producers will account for 20% of households' overall energy balance.

Grid administration systems will make the management of complex energy supply networks straightforward, with control, monitoring and resource allocation optimization functions coordinated by Estonian designed ICT systems, which are exported in large volumes to customers abroad

1. Foreword

Information and communications technology has taken centre stage in reshaping the global socio-economic order during the past couple of decades. In order to have a plan, which could set the development of Estonia's ICT sector on a sustainable footing, ITL decided to formulate a vision outlining our concept of Estonian information society in 2020 together with a roadmap, which could be used as a blueprint on how to get there. Our vision, along with associated national development plans make up the framework that conceptualises the idea of Estonian information society in 2020 and is thus usable as an input for EU's financing plans for the upcoming budgetary cycle.

The subsequent exposition titled "ICT sector's vision of Estonian information society in 2020" consists of the following chapters:

Vision of Estonian Society in 2020
1. Foreword
2. Introduction
3. ICT sector's four objectives for 2020
4. Roadmap

This segment of the document, encompassing the vision and tentative objectives, was compiled by a working group (participating members from ICT companies and other sectors) led by Taavi Kotka and administered by Marek Tiits (IBS).

The roadmap was formulated by four working groups led by Pirko Konsa, Kalev Pihl, Toomas Veersoo and Seth Lackman. The working groups worked under the active guidance of Kristjan Rebane. The document has been edited by Jüri Jõema. ITL wishes to thank everybody who contributed toward formulating the vision document.

2. Introduction

Information and communications technology (ICT) lies at the heart of a number of global socio-economic developments that have taken place during the past decades. Personal computers, mobile phones, the internet and other devices and systems have played an important role in reshaping the way people organise their daily lives. During the early 2000's around half of the gains in productivity that occurred in OECD countries originated from the ICT sector or were the result of ICT solutions being adopted throughout the society.

When examining global ICT trends it becomes apparent that technologies with the highest growth potential are to be found among technical solutions, which will remain relevant as socioeconomic enablers for at least 10–20 years down the line. The preceding period in IT systems development was primarily focussed on efforts directed toward creating computing technologies with maximum data processing outputs in conjunction with the rapid spread of IT infrastructure. The upcoming decade will likely witness a shift in focus toward developing solutions, which can make the most of the infrastructure already in place.

The spread of ICT technologies in Estonia has been rapid, as the northernmost Baltic state already possessed considerable acumen in IT technologies as early as the 1970's. This know-how proved to be fertile ground for the upcoming informatization of Estonian society that occurred in the 1990's. As the fledgling state had to establish several of its systems and infrastructures from the ground up, it had the benefit of the "latecomer advantage", which meant that Estonians could employ the latest systems and solutions necessary for addressing the challenges facing Estonian society without having to replace legacy systems.

The engines for growth of Estonia's ICT sector in the upcoming decade can be found in two perspective challenges. Firstly, there is the task of employing the latest technologies in all spheres of activity, especially in order to give Estonian companies the advantage when competing on international markets. The second avenue consists of a unique opportunity for Estonia, which lies in the possibility of turning its distinctive experiences and innovative solutions into an ICT discipline in its own right, which could help boost exports and create new jobs in the IT sector. It would be most imprudent for Estonia not to make use of its distinctive advantages.

It is clear, however, that the magnitude of the changes required to implement such plans requires the participation of more than one enterprise or government agency.

In order to be successful it is critical that a united vision and course of action is agreed by all the stakeholders in the project – entrepreneurs of different sectors, educational institutions, ministries, etc. During the last 15 years the public sector has been outstanding in acting in the role of an initiator and promoter of various e-services initiatives. The central government of the state is in a very good position for continuing in this role.

Estonia's ICT sector possesses the knowledge required to fully exploit available technologies. We hereby assume the obligation and responsibility to support the implementation of pioneering ideas in Estonian society. The support will be made manifest primarily through discussing novel ideas put forth on the open forum as well as providing smart solutions to associated problems.

The following document outlines Estonian IT and telecommunications companies' vision of information society as it should transpire in Estonia by the year 2020. The document includes the following:

➢ Overview of Estonian society as it should look in 2020;

➢ ICT sector's four objectives set for 2020;

➢ A roadmap detailing our desired destination and intermediate stages for getting there.

On behalf of the Estonian ICT sector

Estonian Association of Information Technology and Telecommunications

3. ICT sector's four objectives for 2020

As the networked society of the future should connect people, devices and information in a way which facilitates the development of economic prosperity combined with individual and societal attainment, we put forth the following four strategic objectives for Estonia's ICT sector:

1) ICT has an impact on Estonians' way of life

Networked societies are more effective in mobilizing and demobilizing resources as circumstances require (i.e. energy, democracy, healthcare, education).

➢ 50% of initial contacts and 75% of subsequent contacts with healthcare or social services institutions will be made via ICT systems.

➢ Estonia's overall ranking in OECD's "Better Life Index"* will rise. The survey's "Life Satisfaction" indicators will rise considerably lifting Estonia from its current 31st position to a place among the top 10 countries. Estonia will also improve its standing in the "Civic Engagement" category where it currently holds 31st place among OECD members.

➢ Estonian households will consume 20% less energy than in 2010.

➢ Renewable energy coming from micro producers amounts to some 20% of households' overall energy balance.

➢ ICT systems are used to support education (ICT support will cover the entire spectrum of the education system) – e-curriculums make up 25% of the total educational programme and 40% of the working-age population has received refresher and/or retraining courses in any given year.

*OECD's "Better Life Index www.oecdbetterlifeindex.org

2) Estonia ranks first in the world in terms of use of secure and reliable ICT services

➢ The concept of data single entry is implemented throughout Estonian society and Estonia stands at the forefront of using automated business procedures. All routine transactions with companies or state agencies can be executed without using physical written forms;

➢ Estonia holds the leading position in Europe when it comes to developing, introducing and implementing electronic ID based solutions. Estonia is recognized throughout the world as a leader in implementing such technologies;

➢ Estonia ranks as a net exporter of IT solutions. It is a country where software licensing systems and turnover from the sale of intellectual property is on the increase. Export of ICT products and services makes up at least 20% of Estonia's net export volumes (in 2013 the figure stood at 12.5%).

3) Doubling the number of experts engaged in the Estonian ICT sector

➢ In Estonia at least 500 students receive Master's degrees in subjects related to the ICT sector annually;

➢ Estonia will recruit at least 1500 foreign ICT sector specialists annually;

➢ The period of 2014–2020 will witness some € 6 billion worth of foreign direct investments coming to Estonia's ICT sector.

4) Implementation of ICT solutions will account for half the surplus generated in targeted sectors

➢ The ICT sector will account for at least 15% of Estonian GDP (2013 figure – 8%);

➢ ICT sector's productivity per worker will correspond to at least 2/3 of the respective figure in Nordic countries;

➢ Estonia's economy will employ at least 50 000 workers who possess ICT or e-business skills (i.e. ICT practitioner skills).

4. Roadmap

2020 objectives that envision attaining higher standards of welfare, economic prosperity and levels of efficiency can be reached in case the results achieved so far (i.e. the provision of public sector services) are put to best use and focussed on ventures that hold out the best promise of success (i.e. private sector undertakings which benefit from solutions provided by ICT applications).

Reaching the objectives outlined in the vision is contingent upon the following enablers:
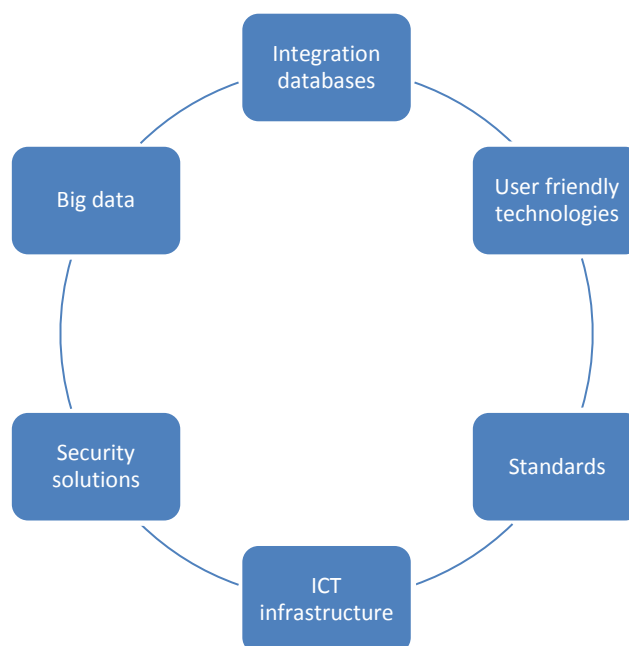
- **Integration of databases** – in order to avoid duplication of data entries and provide better services, there is an increased tendency towards data sharing between individual databases. Data sharing increases as machine to machine (M2M) communication protocols become standardised, enabling more efficient use of information while at the same time placing additional requirements on data security and protection of sensitive personal information.

- **"Big data"** – digitization of information and replacing analogue devices with digital ones (i.e. in the medical sphere). The growing use of sensors and IT devices creates a profusion of diverse data streams in all disciplines. Combined with increasingly cost-efficient data storage technologies and data analysis systems the aggregation and analysis of data feeds into more efficient decision making processes in the public sector together with new services in the private sector.

- **Security solutions** – the rapid pace of changes in ICT technologies combined with its ever-increasing field of application means that the demand for the provision of IT security services remains high. The development and spread of

biometric systems (e.g. used for the purposes of authentication in the services sector) creates favourable conditions for Estonia to become a pioneer in integrating biometric and electronic identities. Secure and user-friendly identification and authentication methods will in turn lead to the creation of an integrated and flexible user interface that will be used by multiple technical devices and software platforms.

- **User-friendly technologies** – just as recent history has seen the advent of touch-screen panels to augment the ubiquitous mouse and keyboard solutions, the future will witness the introduction of even more intuitive and user friendly interfaces that are able to recognize and respond to voices, gestures, glances, etc.

- **Standards** – standards will play a crucial role in integration of databases as well as in making individual devices compatible. The role of unified standards will increase further during the course of regional and pan-European integration, and will encompass such spheres as financial data, personal medical records, identification and authentication standards or even the compatibility of Estonian language technologies with imported devices.

- **ICT infrastructure** – for obvious reasons modern software and hardware solutions are a necessary precondition for meeting any of the development objectives outlined in the present document. Both cable and wireless networks (incl. broadband solutions) must maintain adequate throughput capacity in order to meet the challenges presented by increasing data streams. Public key infrastructure and other security infrastructures are there to guarantee the security and reliability of ICT systems. The role of data centres will increase as they will be used for both data storage and cloud computing purposes.

The roadmap describes the most important intermediate stages that must be reached in order to achieve the four goals outlined in Chapter 3. Using ICT solutions to advance the respective spheres of life requires necessary acumen on part of the users as well as the reliability and usability of technologies employed. Enhancing the fields of application by applying and developing ICT solutions demands that a far greater number of IT specialists are employed. Only then can the target areas yield the expected growth in the coming years. The process is affected across the board by several key technologies which act both as enablers and enhancers – technologies such as integration of databases, big data and secure IT solutions.

The following contains a description of landmarks outlined in the roadmap, which are given as a list of keywords or activities related to the attainment of goals set in the vision. By encompassing the socioeconomic sphere in its entirety, the keywords tie into numerous fields, which are nonetheless connected by the common denominator in the form of ICT solutions that are becoming an inseparable part of both everyday life as well as economic undertakings. The following sections are meant as a backgrounder elaborating on the landmarks described on the development chart.

1. SOCIETY

ICT impacts the entire fabric of life in Estonia.

This will come about as ICT solutions help to increase the quality of life of each individual together with helping people to engage with the society at large. For this to happen it is crucially important that the knowledge regarding the opportunities provided by new technologies does not remain the prerogative of a privileged circle within society. The society must learn to make use of new technologies to maximise its benefits for the greatest number of people. For this reason the creation of new services and products is directly proportional to the proliferation of ICT know-how in the society at large. Considering that education and health care services affect the greater part of individuals, the problems (i.e. problems related to the changes in demographic situation) are foreseeable, and solutions time-consuming, it is self-evident that changes require **increased resource allocation to health and education spheres today.**

Today, the proliferation of e-services is widespread in Estonia and the growth of associated know-how (incl. teaching clever use and best practices of ICT solutions) will soon make the use of e-services a routine procedure, which will help increase efficiency and economic growth through ICT solutions. This is evidenced by the fact that as time goes on fewer references are made to "e-services" as a distinctive group set apart. Rather it is the case that e-services have become the norm, which can be used in all channels of interaction. Application of new technologies together with constant improvements to the ICT solutions user-friendliness helps with the **creation of personalised e-learning and medical services environments**. Children and parents are no longer content with traditional education and expect to have access to the benefits offered by contemporary (i.e. ICT enhanced) teaching methods, which grant access to the best that Estonia and the world can offer in terms of scholarly talent. In order to meet their elevated expectations it is important to develop and facilitate access to methodological materials and e-learning environments. In much the same way e-solutions in medical services play a similar role in constructing a modern personalised health care environment. Areas of e-medicine that will most notably improve patient welfare include: access to personal medical records and other information that is relevant from the point of view of medical treatment, medical services accessible by means of remote telecommunication and real-time monitoring and treatment of the patient's condition. A strategically important effect that accompanies ICT enhanced medical services lies in the decentralization of medical centres.

ICT know-how will increase in importance with regard to people's ability to manage their daily affairs besides becoming a vital part of workers' skill set that is sought after in virtually all segments of the labour market. Widespread ICT know-how will also play a key role in determining whether the goals set in the present vision document are to be fulfilled. The aforementioned situation dictates that **ICT skills are included in all curriculums** at least in the capacity of a vital auxiliary discipline. ICT training must also be included in all retraining courses that are formulated by keeping in mind the requirements of the future labour market.

The training of ICT specialists in other fields besides IT will help those sectors become more effective by virtue of adopting ICT solutions, until eventually all economic sectors will have their own specific ICT competences. Thus it is important to propagate the training of sector specific IT systems developers in diverse fields (i.e. construction, education, medical services) by initiating relevant support mechanisms (i.e. training a labour force that has in-depth knowledge of industrial and technological processes). **The society's trust toward e-solutions will likely grow** with the systems becoming ever-more widespread **regardless of location or types of hardware used.**

Estonia's experience in building the e-state and introducing e-learning solutions will soon make it possible to **open up the first internet university dedicated to developing electronic state administration solutions** which will enrol over half a million students from all over the world. This would be a landmark occasion signifying the merging of ICT solutions with everyday life as **IT know-how would become an integral part of all economic sectors. Lifelong e-learning would become common practice, remote working the norm and personalised medicine services commonplace** (as opposed to traditional formal education, office work and standardised mass-medical services). Innovative IT solutions are woven into the fabric of primary, basic and secondary school as well as college education so that students will have the opportunity to "breathe in" IT from an early age.

Refresher and re-training courses would transfer to the concept of individual electronic learning which would offer better opportunities for personalised information sharing, automated evaluation and certification procedures so that the knowledge base spreads to a wider population, thereby freeing up the teachers and students time for questions and discussions.

By the end of the decade the paradigm shift in lifestyles and ways of doing business through the spread of reliable IT services will be marked by the **launching of a common user interface for all e-services**. This will relieve the user of the need to focus on the specifics of the institution or company whose services he/she is currently using.

2. SERVICES

Estonia stands at the forefront of using reliable services provided by the information society.

This can happen only in case solutions developed in Estonia are reliable everywhere!

Increasing the usability of services requires that a political decision be made, insisting that the principle of **data single entry** is adhered to at the early stages of systems development together with ceasing the practice of duplicated entry of identical data. This means that once a public sector institution has gained information about a citizen, it is up to the institution to collect the data from the domains where such data is stored instead of requesting that the individual re-

submit the data in question. In conjunction with this, efforts must be directed towards wider use of open data in the private sector.

In order to ensure that **extant and perspective e-solutions developed** and used in Estonia can compete on the world markets, it is important to guarantee that such solutions are compatible with international standards. For instance – EU's regulation on trusted services can have a positive impact on Estonian economic growth through an increase in export volumes only on condition that the IT systems security solutions developed in Estonia have been taken into consideration when drafting the regulation at least in part. In sectors where the standards are only in the nascent developmental stages, the public sector must strive together with the private sector in order to ensure that the development takes into account Estonia's pioneering solutions. The adaptation of the electronic identity (e-ID) system used in Estonia by at least one European country is a step toward adopting at least some of the solutions developed in Estonia to serve as the basis for **European-wide standards**. On the other hand, it is equally important that solutions designed in Estonia are compatible with extant international standards. Estonia's experience in using ICT solutions for performing state administration functions and fostering civil participation in state affairs is a persuasive argument for **Estonia's emergence as an international think tank focussed on e-governance related issues**.

Companies intensify international bilateral and cluster type cooperation by using domestic experience beyond national boundaries and networks, offering Estonia's services as a potential cluster focussing on provision and development of ICT services. Interdisciplinary international co-operation between clusters is especially important here since such formats offer chances for IT specialists/scientists to collaborate with specialists from diverse fields, working together on joint projects in fields such as medicine, machine building, robotics, agriculture, energy, etc.

Use of e-solutions irrespective of locations and hardware means being free from constraints imposed by specific devices and platforms. This permits trouble free access from domestic TV sets, work desk computers or portable "smart" devices. Integration of individual devices (TV, mobile, computer, home appliances) is supported by cloud-computing based mobile services. Such a diversity of services **increases trust toward e-services in society as a whole.**

Use of reliable e-services provided by the public and private sector institutions again requires that the customer base is ICT literate and that there is a sufficient base of IT developers readily available. This in turn depends on **ICT modules being integrated into all specialized curriculums throughout the education system**.

The development and widespread use of reliable and user-friendly public services will have propelled **Estonia to the forefront in e-state systems development**. An important element in this and the transformation of our way of life **lies in the use of a common user interface** connecting all individual e-services. Usability and ease of use must go hand in hand with systems security and reliability.

3. WORKFORCE

Doubling the number of ICT specialists working in Estonia

This will happen if Estonia becomes the best place for developing and using IT services.

Estonia requires a competitive workforce in order to generate more added value and to attract more international businesses to set up their operations in Estonia, especially when it comes relocating profitable headquarters and establishing competence centres here. This necessitates the doubling of ICT sector's worker base by drawing on both domestic and external labour pool.

The goals set demand that the **resources allocated by the state education system for the purposes of training ICT specialists be increased immediately**. With the founding of the Tiger University, IT Academy and launching of the ICT programme there is already a solid basis on which to improve on (incl. paying full time faculty members a salary that is at least double the Estonian average) and which can be augmented with additional measures (i.e. by ensuring that **at least half of the lectures can be available online** – a measure that would enable the **doubling of the number of graduates** without placing excessive strains on the universities physical infrastructures). **The use of e-services becomes increasingly widespread** as new products are used by the private and public sector alike. This in turn increases the demand for IT specialists on all levels, including sectors that act as intermediaries. Special emphasis should be placed on training product developers (i.e. persons responsible for product management throughout its life cycle) with international experience. Working as prime contractors instead of sub-contractors increases the levels of responsibility within the framework of international co-operation (i.e. focussing on foreign partners) and thus helps Estonia to diversify its range of ICT products to include higher value services.

Besides strengthening the domestic educational framework, **Estonia's ICT acumen is further improved** by creating conditions for foreign students to remain in Estonia by passing relevant legislation, which would also facilitate simplified movement of highly qualified workforce. In order to **improve the influx of talents from third countries** it is necessary to simplify mandatory procedures for hiring qualified foreign employees. In order to attract foreign professionals even on a temporary basis it is important that the initiative is not restricted to the aforementioned measures. It is equally important to have a welcoming and amicable social environment together with multi-lingual kindergartens and schools.

Experience accounts for as much as academic achievement. For this purpose it is imperative **to ensure that fully functional apprenticeship programmes** are set up together with arrangements that **allow faculty members to improve their qualifications by observing work carried out in companies.** Such initiatives would help create an educational policy framework, which connects theory and practice besides laying down concrete guidelines regulating the rights and obligations between apprentices and companies. Estonia should be more actively promoted as a place where foreign students can receive working experience. This would include

solving the problems foreign students employed by companies can come across with regard to language, living, etc. in advance. On the other hand, letting faculty members work at companies will enable them to keep in touch with the latest challenges the companies are facing (both technological as well as economic), tie academic work more closely with economic matters and help **spread ICT know how to all educational disciplines**. Apprenticeship models are designed to combine job experience and academic work in a way which ensures the attainment of skills most relevant and also serves as a signal, which helps to guide the course of academic studies. Studies will be made easy and practical by designing and applying educational models that combine academic and working endeavours.

As an alternative to physically relocating from post to post, the **spread of ICT skills** will usher in the onset of remote working in many science-intensive sectors of the economy. This process will be further buttressed by **use of e-solutions that are autonomous from specific locations and hardware sets**, **and which gain more popularity as trust towards such systems grows.** Distance working enables greater **flexibility for working arrangements** domestically (with respect to time and place), and makes it easier to employ foreign specialists who can work for Estonian companies without changing their place of residence. However, such solutions depend on implementing and propagating part-time and cluster centric work models.

4. VALUE ADDED

Implementing ICT solutions will account for half the increases in productivity in targeted sectors of the economy.

This only takes place as IT transforms the world one sector at a time!

Smart specialisation creates the necessary preconditions needed to focus on our true strengths by combining research and development with entrepreneurship in areas that show the greatest scope for growth (presently represented by ICT, health care and resource allocation). In addition to improved coordination of targeted state funds aimed at supporting entrepreneurship, the prioritisation helps concentrate resources toward smart solutions developed by focus groups. This will give further impetus to the **transfers of know-how** from research institutes to university spin off companies and start-ups (which will be facilitated by involving academic IT personnel in the process).

Increases in productivity must be accompanied by the **use of ICT throughout the cycle of generating economic value**. This requires the use of user-friendly production technologies and techniques of automation (i.e. production that has a special focus on programming automated systems). Additional investments (incl. FDI **directed at the technology sector**) are to be supported by specialized **motivation packages,** which encourage technological investments in sectors deemed a priority in Estonia.

Funds directed at improving education and business environments will have yielded results in case **Estonia becomes a developer of smart products and acts as leading participant in international clusters**. This in turn means taking on additional project management responsibilities, developing Estonian products and services, which necessarily involves outsourcing work abroad. The latter process depends on creating a regulatory framework supporting overseas subcontracting together with creating necessary capabilities, implementing best practices, etc. As a general principle, entering foreign markets usually entails co-operation between individual companies. Clusters and other co-operative undertakings must involve more foreign actors in order to produce workable solutions aimed at the EU market.

ICT competence spreads through all sectors, creating a rapid increase in the **demand for ICT training in all fields of education**. By 2020, IT studies have become an integral part of other disciplines. The proliferation of information technologies in other industries picks up as increasingly user-friendly manufacturing technologies are employed (for instance as the intelligibility of machine to machine communication increases). This in turn means that all economic spheres will have their own cadre of specialized IT personnel.

"Big data" and the "internet of things" are just some of the trends that facilitate the creation **of new business models** in production, subcontracting, logistics, etc. The execution of such models will increase the demand for specialists who are proficient in data analysis, implementing data mining technologies, etc.

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