CERTUS
Policy Think Tank

ICT Industry: Breakthrough Scenario

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Summary: ICT Industry in Latvia and Around the World

Infrastructure

Latvia's infrastructure is among the best in the world. However, the intensity of use of existing infrastructure in many segments could be higher, thereby creating additional opportunities for the development of new products and services.

91%

of households have the opportunity to connect to the next generation of access networks (at least 30 Mbit/s download speed)

16.6 Mbit/s

Average IPv4 connection speed

5 Gb

Average mobile data flow per connection per month

8%

of Latvian companies purchase cloud services

Human capital

IT specialists are in demand throughout the world. Latvia's higher education institutions have taken on students almost solely from Latvia in its IT study programmes.

500,000

is the forecast shortage of IT specialists in the EU in 2020

45%

of those who have commenced studies in the IT field are excluded during the first year of study

25,219

are employed in Latvia's IT services industry

19,700

IT professionals were employed in Latvia in 2016

656

Graduates from IT basic study programmes in 2016

984

Maximum number of graduates of IT basic study programmes in 2022, if the participation of local inhabitants only is increased

Global IT services market

The customers of global IT companies are located mainly in developed Europe, Asia, North America and Australia. Latvia is attractive to providers of services due to the skills of the workforce and its comparatively low costs. In turn, IT services are well remunerated against the background of other sectors of the Latvian national economy and have a relatively high added value.

283.5 billion USD

market value of global IT outsourcing in 2016

32%

of new outsourcing centres opened in 2016 are located in nearshore Europe (mainly in Poland, Ireland and Romania)

13.8 EUR/hour

Average wage in the ICT sector in Latvia in 2016

31%

Average wage in Latvia compared to Germany

3,000

ICT study programme graduates a year required to ensure the development of the ICT sector and satisfy the demand of other sectors for ICT specialists

162%

Average wage in ICT services sector as a percentage of the average wage in the national economy in 2016

Start-ups

Start-ups are a career development opportunity for IT specialists wishing to concentrate on the creation of new products and business development. It is important that a well-functioning start-up ecosystem is established in the country, thus allowing promising minds to develop their business ideas and increase opportunities for society as a whole to gain from the knowledge and expertise of these specialists.

240

Latvian start-ups

77 transactions and **44.2 million EUR**

worth of investments in Latvian start-ups in 2016

60 million EUR

Predicted investment from EU financed risk capital funds in this planning period

15 million EUR

Predicted investment from EU funded acceleration funds in this planning period

Introduction

Many countries rely on the strong growth of the information and communications technology (ICT) sector as part of their development strategy. The potential of ICT seems attractive to high income countries and to those who have been less successful in terms of economic development. This chapter highlights the most important resources that power the ICT industry and examines the industry's main business models. The offer of Latvian ICT industry is positioned within this resource and activity space and compared with the situation in other countries.

Global Development Trends

The last fifty years (following the digital revolution) have produced enormous improvements in ICT that, in turn, have changed our daily lives, changed the operations of enterprises, and enabled new business models. However, it is more difficult to forecast how the ICT industry will develop in the future and what its impact will be on productivity, employment and quality of life.

Technology optimists think that we live at the beginning of a second machine age and that the creation of functional and applicable artificial intelligence combined with connection of a large part of the world population to a single digital network are the preconditions for innovations that, in the near future, will turn much of what has been science fiction into everyday reality.[1] It seems, though, that the progress of ICT until now has had a limited impact on measures of productivity. The productivity in manufacturing sectors that have adopted ICT based solutions more intensely have not increased more than in the rest of manufacturing.[2] Based on such evidence, the sceptics argue that ICT based innovations have exhausted their potential and in terms of impact cannot be compared to innovations that came before (especially the internal combustion engine and electrification) and lead to improvements of productivity up until 1970s.[3]

The sceptics point out that since the 1970s, technological improvements have been concentrated in entertainment, communication and data processing and that it has minimally impacted the rest of the economy outside of those activities. The optimists counter by listing several possible explanations for the absence of productivity gains starting from mismeasurement problems and ending by citing difficult to eliminate bottlenecks in the production process that prevent companies from capturing the productivity gains in other parts of the process. However, all agree that nowadays ICT not only supplements and allows the skills and competencies of the workers to better manifest, but increasingly enables to replace workers.[4] Although it is difficult to predict the path of the development of technology, and the further into the future we look, the more surprises we can expect, we have summarized some of the most important ICT developments with particular focus on technologies that are changing the current state of the industry and application of which is likely to increase substantially in near future.

[1] Brynjolfsson, E. and McAfee, A. 2014. The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. New York: W.W. Norton & Company.
[2] Acemoglu, D., Autor, D., Dorn, D., Hanson, G. and Price, B. 2014. Return of the Solow Paradox? IT, Productivity, and Employment in US Manufacturing. American Economic Review: Papers & Proceedings, 104(5), 394–399.
[3] Gordon, R. 2016. The Rise and Fall of American Growth: The U.S. Standard of Living since the Civil War. Princeton, NJ: Princeton University Press.
[4] Frey, C. B. and Osborne, M. 2013. The Future of Employment: How Susceptible are Jobs to Computerisation? University of Oxford; Arntz, M., Gregory, T. and Zierahn, U. 2016. The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis. OECD Social, Employment and Migration Working Papers, No. 189.

Development Tendencies of ICT Industry[5]

Figure 1

The Importance of ICT Development Tendencies for Latvia

Clearly, ICT development tendencies affirm the existence of new opportunities, but technology advances also put additional pressure on public institutions that will face many new challenges starting with public procurement of ICT and ending with data security. To seize the opportunities that have arisen and to ensure equitable distribution of the potential benefits, the government of Latvia and municipalities will have to raise their ICT competence level. The success of procurement processes and adoption of ICT solutions depend on client knowledge of supply and their ability to adequately communicate their needs.

[5] Data Sources: Stone, P. et al. (2016). Artificial Intelligence and Life in 2030. One Hundred Year Study on Artificial Intelligence: Report of the 2015-2016; Briggs, B. (Ed.) (2017). Tech Trends 2017. The Kinetic Enterprise. Westlake, TX: Deloitte University Press; Carley, D. (2016). Gartner's Top 10 Strategic Technology Trends For 2017; Evans, P. and Gawer, A. (2016). The Rise of the Platform Enterprise. A Global Survey. New York: The Center for Global Enterprise.

Currently public institutions in Latvia are not among the digital pioneers, and several public ICT projects have produced useless or poorly functioning ICT products. It can also be expected that, just as Uber offered services in the transportation market, ICT based solutions will disrupt existing business models in other markets. Public players will have to distinguish when the disruptions lead to general welfare improvements for the whole society and when they only benefit the disruptors. Moreover, it will not be possible to amass all of the necessary expertise in one centralized agency as can be done in the case of public procurements. Instead all the regulating institutions (construction, food, competition and other agencies) will have to improve their ICT competencies. Finally, public institutions are in the position of owning large amounts of potentially beneficial data that with the progress in data analysis have opened opportunities for development of welfare improving ICT solutions, but have also imposed the responsibility to ensure that the benefits are justly distributed among data owners, solution developers, and society in general. Latvia's progress in this area so far has been slow and insufficient.[6]

Although it will be delayed, automation will also affect the labour market in Latvia. The highest automation potential is exhibited by predictable physical activities and operation of machinery. Current estimates show that technically it would be possible to automate 81% of the time spent on these activities. High automation potential is also displayed by such activities as data collection (64%) and processing (69%). For comparison, presently it is much harder to automate people management and development tasks. In turn, sectoral analysis shows that most opportunities for automation of different activities are in accommodation and food services, manufacturing, transportation and warehousing sectors, while comparatively fewer in educational services, enterprise management and healthcare sectors. Of course, technical potential does not mean automation will take place. Scenarios for currently demonstrated automation technology adaptation show that, time-wise, there could be substantial shifts. Considering a number of preconditions (technical, economic, legal, etc.), complete adaptation may be accomplished by 2055 but it could also drug on for at least 20 more years. Also, because of differences in labour costs, automation will first take place in the economically most developed countries.[7]

However, while evaluating the opportunities for economic development at the state level, the automation potential should be taken into account. The scarce resources at the state's disposal should be invested where the returns are the highest and most sustainable. Most likely automation does not create restrictions in terms of economic sectors, but adaptation of potentially dispensable technologies and accumulation of human capital in activities that are susceptible to automation should be avoided. In turn, workers who will lose their jobs due to automation will have to be retrained. Therefore, road maps for acquisition of new knowledge and skills should be produced and trajectories for changes of careers should be outlined in a timely fashion. It is especially important because interdisciplinary planning, creative solution seeking, and efficient decision-making skills that are in high demand might also be difficult to learn.

Even though ICT solutions diminish the significance of distances, they are more likely to contribute to worldwide urbanization and agglomeration processes than to limit them. Many of ICT solutions are closely connected with the city environment and the possibilities for replicability ensure that there is a potentially huge global sales market. At the same time, to come up with new solutions it is important to have the possibility to experiment in a limited local market. In Latvia, Riga is an option to become a centre for testing and experimentation that could be attractive not only for local but also the foreign companies. Of course, this option is available for other cities as well and many try to fulfil it. To a large extent the success of the cities is determined by the ability to establish a competitive legal framework and to create a physical environment that attracts companies while at the same time guarantees security and privacy for cities' inhabitants.

At the company level ICT development tendencies show many opportunities for specialization and some Latvian companies are among the world leaders in their specific market segments. In this respect, it is crucial to cultivate the local start-up ecosystem where the most successful industry representatives help promising newcomers thus reproducing itself and growing.

[6] The State Audit Office. 2017. Lietderības revīzijas ziņojums "Vai valsts pārvalde efektīvi rīkojas ar uzkrāto informāciju?" (Does the state administration effectively use the stored information?) Audit No. 2.4.1-12/2016.
[7] McKinsey Global Institute. 2017. A Future That Works: Automation, Employment and Productivity.

1. Infrastructure

This section contains descriptions of ICT infrastructure development projects envisaged and country level comparisons of different existing ICT infrastructure components.

International and National Goals

The presence of modern, accessible, high quality ICT infrastructure is a precondition for the dynamic development of the ICT industry and the whole globally connected economy. The importance of ICT infrastructure is recognized by international organizations and national governments that set goals for the development of an internationally competitive ICT infrastructure. For example, one of the flagship initiatives of the EU growth strategy Europe 2020 is the Digital agenda for Europe. The EU is using the agenda framework to ensure European households and companies have access to fast and high-quality connectivity. In 2016 European Commission set out strategic objectives to be achieved by 2025:

- 1 Gb connectivity for all main socio-economic drivers such as schools, transport hubs, and the main providers of public services as well as digitally intensive enterprises;
- Uninterrupted 5G coverage for all urban areas and all major terrestrial transport paths;
- Access to Internet connectivity offering a downlink of at least 100 Mbit/s for all European households.[8]

In turn, researchers point out that creation of ICT infrastructure has a positive effect on different socioeconomic indicators. For example, broadband network development projects, similar to traditional electrification or road infrastructure building projects, create value and new work places that are directly linked to the construction of infrastructure objects. They also stimulate the economy indirectly by opening up opportunities for development of new services and by improving the efficiency of companies using the infrastructure. Therefore, during the last economic crisis several countries (Singapore, Finland, Portugal, USA, Australia, Germany, etc.) made broadband network investments worth several billion USD.[9]

According to the next generation broadband network development strategy, Latvia, by 2020, plans that all households have access to internet connections with at least 30 Mbit/s download speed and to achieve that at least 50% of households have subscribed to internet access services with a download speed of at least 100 Mbit/s.[10] To fulfil these goals, Latvia has chosen to provide access to fast internet in regions that are relatively far away from the capital. The Latvia State Radio and Television Centre (LVRTC) that is responsible for implementation of the strategy has mainly worked on construction of optical network and optical network access points in territories where internet access services are not offered by any commercial service provider. Thus, backbone network is being connected to potential local access networks (last mile), which in turn will be constructed by commercial service providers. During the first stage of the project (from 2012 to 2015) LVRTC built 1,813 km of optical fibre lines and constructed 177 access points. The first stage of the project cost 26.4 million EUR of which 87.18% was financed by EU funds. The second stage of the project that should be completed by 2020 will see construction of a further 3,000 km of optical fibre lines and 220 access points. The expected costs are 46.7 million EUR and 85% of funding should come from the EU funds.[11]

In the meantime, several private telecommunication service providers have developed networks for the Internet of Things (IoT). For example, Lattelecom completed the set-up of a specialized IoT network for Riga in the summer of 2017. It utilizes Low-Power Wide-Area Network (LPWAN) that is well suited for remote and automatic management of urban infrastructure.[12]

[8] European Commission Communication "Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society", 14 September 2016, COM (2016) 587.
[9] Katz, R. L. and Berry, T. A. 2014. Driving Demand for Broadband Networks and Services. Cham: Springer.
[10] Latvia Ministry of Transport. "Nākamās paaudzes platjoslas elektronisko sakaru tīklu attīstības koncepcija 2013. - 2020. gadam". Approved by the Cabinet of Ministers on December 7, 2012 with Order No. 589.
[11] Latvia Ministry of Transport. "Informatīvais ziņojums par "Nākamās paaudzes platjoslas elektronisko sakaru tīklu attīstības koncepcijas 2013. - 2020. gadam" izpildes gaitu". Published on July 27, 2016.
[12] Labs of Latvia. 2017. Lattelecom launches the first internet of things network in Riga. http://ej.uz/ansj

Mobile service providers in turn work on establishing 5G networks that could be accessible in 2020. For example, LMT is cooperating with telecommunication network infrastructure producer Nokia and is testing prototype equipment for 5G network introduction.[13]

Comparisons

In general ICT infrastructure can be defined as a set of devices, networks and procedures that ensures connectivity of the participants involved in communication. However, components of ICT infrastructure and their evaluation are constantly evolving and it is hard to pin down which are the most important. First, technological progress leads to some components of ICT infrastructure being replaced by others. Therefore, to understand how those changes affect overall ICT infrastructure, international organizations have to adjust the principles of ICT infrastructure accounting by introducing new or changing the existing indicators. Second, the evaluation of ICT infrastructure at country or regional level is performed by different organizations and they illuminate different aspects of the ICT infrastructure, often overlapping and supplementing each other.

ICT infrastructure also contains public and private elements. To establish connections, users typically need specific devices or equipment (for example, a mobile phone or a personal computer). Users have to make sure that they have the equipment and that it is compatible, but in its totality, aggregated at the national level, to some extent those privately held devices characterize the nation's ICT infrastructure. In turn, the public element of ICT infrastructure is not characterized by the ownership, but rather by access. It is the element of ICT infrastructure that, subject to certain payment, is publicly accessible. The following comparisons are mostly associated with the public element of ICT infrastructure.

Since the 1990s, the International Telecommunication Union (ITU) formed under the auspices of the United Nations maintains a database of ICT indicators that is periodically updated and upgraded. One of the ITU's goals is to harmonize the ICT data collection process at international level and the ITU database is the most comprehensive ICT data source in the world. Each year the ITU publishes the ICT development index that, along with other statistics, includes several ICT infrastructure indicators. In 2016, Latvia ranked 40th, and that was 3 places lower that previous year. Latvia's index value actually increased, but the index values for some of the countries (for example, Greece and Barbados) that are closely ranked to Latvia grew even faster. Overall, Latvia lags behind the more advanced countries of Western Europe and slightly also behind the closest neighbours of Estonia and Lithuania, but is ahead of several direct competitors from Central and Eastern Europe (Slovakia, Hungary, Poland, Romania, Ukraine, etc.). The ICT infrastructure indicators used by ITU mostly show the proportion of subscriptions of different network technologies. In this respect, the situation in Latvia has improved during the last couple of years – subscriptions relative to population has increased.[14] In turn, data on households and enterprises collected by *Eurostat* show that the situation in Latvia is uneven. For example, in 2016 most Latvian households (75%) had broadband internet connections, but it only ranked Latvia 23rd among European countries. At the same time 30% of Latvian households had ultrafast broadband internet connections (with at least 100 Mbit/s download speed) that ranked Latvia 5th in Europe. Likewise, 39% of enterprises in Latvia had fixed fast broadband internet connections (with at least 30 Mbit/s download speed) and the situation was better in only 11 European countries (see comparison of indicators in the figure).

However, the number of subscriptions is only indirectly linked to infrastructure. The decisions of customers to subscribe for network connections are influenced by many factors. Another aspect of ICT infrastructure is illustrated by the coverage of different services. Data collected for European Commission show that network coverage in Latvia is relatively good – most households have the opportunity to connect to the fixed Next Generation Access (NGA) and mobile 4G LTE networks and optical fibre cable (FTTP) coverage is one of the most complete in the EU.[15]

[13] Dienas bizness. 2017. Binde: 5G Latvijā varētu parādīties jau 2020.gadā. http://ej.uz/r2hm
[14] ITU. 2016. Measuring the Information Society Report 2016. Geneva: ITU.
[15] IHS Markit. 2017. Broadband Coverage in Europe 2016.

Comparison of Indicators Characterizing Latvia's ICT infrastructure[16]

Figure 2

INDICATOR	YEAR	RANKING	CHANGE IN RANKING	COUNTRIES	VALUE	[MIN; MAX]	DISTRIBUTION	SOURCE
Coverage								
Households that can connect to Next Generation Access Network (NGAN) (%)*	2016	**10**	-	**31**	91	[45; 100]	Greece – Malta	IHS Markit
Households that can connect to optical fibre line (FTTP) (%)**	2016	**2**	-	**31**	85	[0.4; 86]	Greece – Portugal	IHS Markit
4G (LTE) mobile network coverage (% of households within the coverage territory)***	2016	**15**	-	**31**	91	[45; 100]	Romania – Denmark	IHS Markit
Subscriptions								
Fixed (wired)-broadband (≥ 256 Kbit/s) subscriptions per 100 inhabitants	2016	**49**	**+ 2** ↑	**205**	25.64	[<0.01; 46.27]	Congo – Switzerland	ITU
Mobile-cellular telephone subscriptions per 100 inhabitants	2016	**50**	**+ 9** ↑	**201**	131.16	[7.29; 233.99]	Eritrea – Honkong	ITU
Active mobile-broadband (≥ 256 Kbit/s) subscriptions per 100 inhabitants	2016	**19**	**+ 1** ↑	**37**	84.12	[42.62; 146.44]	Hungary – Japan	OECD
Households with broadband internet connection (≥ 256 Kbit/s) (%)	2016	**23**	**- 1** ↓	**31**	75	[63; 97]	Bulgaria – Luxemburg	Eurostat
Households with ultrafast broadband internet connection (≥ 100 Mbit/s) (%)	2016	**5**	**-2** ↓	**31**	29	[<0.1; 36]	Greece – Romania	COCOM
Enterprises with fixed fast broadband internet connection (≥ 30 Mbit/s) (%)	2016	**12**	**+ 3** ↑	**31**	38.6	[14,4; 63.6]	Cyprus – Denmark	Eurostat
Unique IPv4 addresses per 100 inhabitants	2017	**14**	-	**74**	45.42	[0,12; 61.9]	Nigeria – Sweden	Akamai
Other indicators								
International internet bandwidth (bit/s per internet user)	2015	**38**	**-1** ↓	**175**	111,881	[28; 421,237]	South Sudan – Luxemburg	ITU
Average IPv4 connection speed (Mbit/s)	2017	**17**	**-2** ↓	**149**	16.6	[<4; 28,6]	South Korea	Akamai
Average monthly mobile data usage per SIM (Gb)	2016	**3**	-	**33**	5	[0,5; 8,3]	Belgium – Finland	Tefficient

Data Source: ITU, OECD, Communications Committee (COCOM), Eurostat, Akamai, Tefficient, IHS Markit
* NGAN (Next Generation Access Network) includes different technologies capable of delivering services with download speed of at least 30 Mbit/s.
** FTTP (Fibre to the Premises) is a broadband network architecture with optical fibre cable laid all the way to the customers' premises thus creating optical fibre access points.
*** 4G LTE is the 4th generation (Long Term Evolution) high-speed wireless communication technology.

[16] Distributions of countries are based on rankings, not on values of indicators. They show countries with the highest and the lowest indicator values. Latvia's place in the rankings is highlighted (for comparison so is the rankings of Poland and Netherlands).

The number of subscriptions is determined by other factors, especially service prices. In this respect the situation in Latvia is also relatively good. In the autumn of 2016 the cheapest fixed broadband (with at least 12 Mbit/s download speed) monthly subscription price in Latvia was 12.82 EUR (by purchasing power parity). For comparison, the cheapest offer of 11 EUR (PPP) was in Sweden, while the average price in Europe was 21.33 EUR (PPP).[17] According to 2016 data, subscriptions to mobile broadband connections in Latvia are also relatively cheap compared to the rest of Europe, 14 EUR (PPP) for 1 Gb data and 300 calling minutes in Latvia as opposed to 30 EUR (PPP) on average in other European countries.[18]

Connection speed and quality are another important set of ICT infrastructure indicators. Cloud service and content delivery network company Akamai Technologies uses its internet traffic data to regularly publishe assessments of average connection speed in different countries. According to their data in the first quarter of 2017 average IPv4 connection speed in Latvia was 16.6 Mbit/s – a drop of 0.6 Mbit/s compared to last quarter of 2016. Nevertheless, it still ranked Latvia number 17 in the pool of 149 countries that were compared.[19] In turn, connection quality indicators are not internationally harmonized and thus are hard to evaluate. In Latvia the quality of telecommunication services is overseen by the Public Utilities Commission (SPRK). In its annual report, SPRK says that in 2016 almost all evaluations of proportion of unsuccessful connections, average connection times, repair times, etc., made by SPRK and by service providers were in line with targets set by SPRK and values advertised by service providers.[20]

Finally, to some extent, the infrastructure is also characterized by its utilization. In this respect Latvia's performance varies in different segments. For example, 5 Gb average monthly mobile data usage per SIM in Latvia is among the highest in the world. In 2016, Finland and Taiwan were the only countries that outperformed Latvia in this regard.[21] Likewise 78% of Latvia's population have used online banking services, which is the 6th highest rate in the EU. At the same time, only 8% of enterprises in Latvia have paid for cloud computing services, which is one of the lowest rates in Europe and well below the EU average of 21%. Further, the Latvian government has not created an open data portal, and, in terms of open data use, Latvia lags considerably behind other EU countries.[22]

Overall, Latvia's ICT infrastructure is internationally competitive and provides good international connectivity. By itself it will most likely not be sufficient to attract global ICT service providers, but it also will not create limitations for those ICT companies that already operate in Latvia or will choose to do so in the near future. In turn, the intensity of infrastructure utilization in most segments could be higher, thus creating more opportunities for the development of new products and services.

[17] Empirica. 2016. Fixed Broadband Prices in Europe.
[18] Van Dijk. 2016. Mobile Broadband Prices.
[19] Akamai. 2017. State of the Internet Q1 2017 Report.
[20] SPRK. 2017. Elektronisko sakaru pakalpojumu kvalitātes pārskats par 2016. gadu. Rīga: SPRK
[21] Tefficient. 2017. Mobile Data Industry Analysis 2016.
[22] European Commission Staff Working Document "Europe's Digital Progress Report 2017", 10 May 2017, SWD 2017 160.

2. Start-ups

In the last fifty years, some ICT companies have achieved enormous growth and transformed from start-ups into multinationals worth several billion EUR. Therefore, the ICT sector has attracted many new and ambitious entrepreneurs. However, start-ups may also represent career options for upcoming ICT professionals who choose to focus on creation of new products and business development. In this environment, it is crucial that a country establishes a well-functioning start-up ecosystem that, on one hand, allows the brightest minds to develop their business ideas, and, on the other hand, ensures that the society as a whole benefits from their knowledge and expertise. A dynamic start-up community primarily provides support for its members, but can also have positive side-effects that benefit the whole economy. For example, intensive exchange of information and knowledge transfer as well as improvements in matching of skills and needs in the labour market are some of the positive externalities.

Case of Latvia

A start-up typically has some or a combination of the following characteristics – an idea of innovative solution, limited resources to develop it, a potential for rapid growth, scalability, etc. Many start-up founders emphasize the importance of the mindset of those involved in it – their commitment and readiness to sacrifice certain stability for enormous growth opportunities and satisfaction of working on a product that might change the current order of things. In 2016, the Latvian parliament approved the Law on Aid for Start-up Companies that came into force on January 1, 2017. According to this law, a start-up company is a capital company possessing a high growth potential and its main economic activity is related to design, production or development of scalable business models and innovative products.

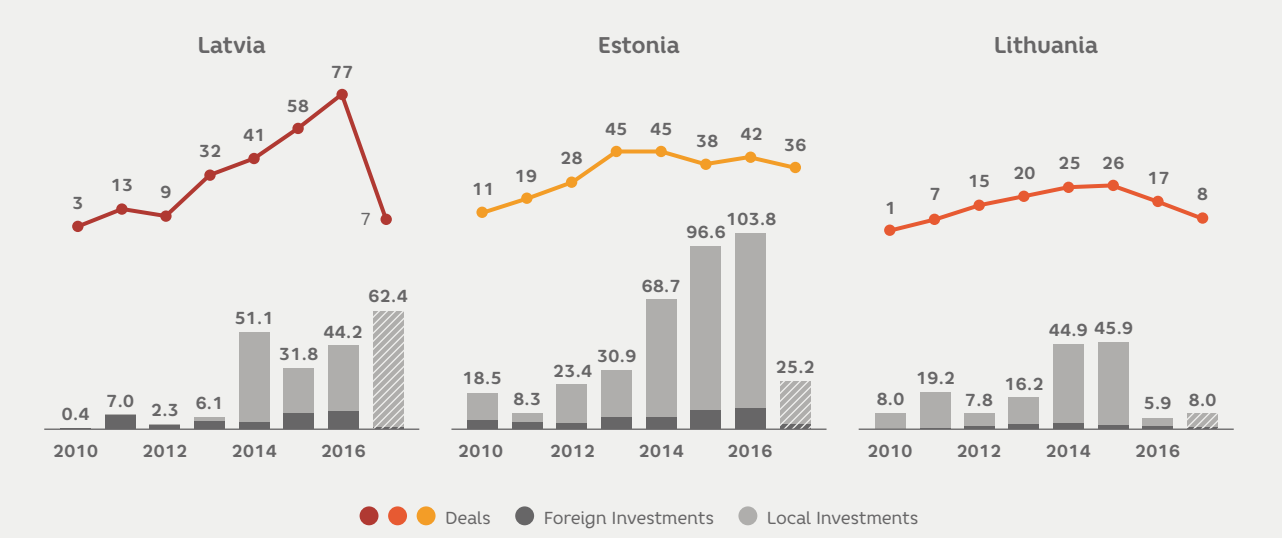
The Latvian start-up association reports 240 companies in Latvia that currently fit this definition.[23] In 2016 Latvian start-ups attracted 77 investments in total amount of 44.2 million EUR, 75% of which came from foreign investors. Most of the investment deals did not exceed 1 million EUR. The following steep drop in investments in the first half of 2017 can be explained by the end of the investment periods of the local venture capital funds. Currently Latvia is in the process of selecting the future administrators of the EU seed and early development funding for the next period.

The bulk of the capital has been invested in *BitFury*, which is a world leading producer of Application-Specific Integrated Circuit chips (ASICs), data centres, and servers for mining of *BitCoin* and other cryptocurrencies. More recently, *BitFury* has positioned itself as a full-service blockchain technology company. Valerijs Vavilovs, CEO and a Co-founder of *BitFury*, started his professional career in Riga. Today *BitFury* is a global company with its main office in San Francisco, California and annual sales of 100 million USD. Since 2014 the company has attracted at least 90 million USD in capital investment.[24] Ten other start-ups from Latvia have attracted more than 1 million EUR in investments, and eight have moved beyond start-up status and have been sold. For comparison, the situation in Lithuania is slightly worse – fewer investment deals and lower amount of attracted investments. Whereas, Estonia surpasses both Lithuania and Latvia, especially in the number of start-ups that have attracted more than 1 million EUR in investments.

[23] Startin.LV. 2017. Latvian Start-up Magazine. February, 2017.
[24] Coindesk 2017. Think Bitcoin Is Small Business? Bitfury Is Making Almost $100 Million Annually. http://ej.uz/8sm4 ; Forbes (2017). Valerij Vavilov. BitFury Group. Blokchain - industrija na trilioni dollarov. http://ej.uz/amoh

Number of Investment Deals and Capital Raised by Baltic Start-ups, million EUR

Figure 3



Data Source: Open crowdsourced data collected by the start-up communities of the respective countries (Latvia: http://ej.uz/vqnm ; Lithuania: http://ej.uz/1xjh ; Estonia: http://ej.uz/cqkb)
Note: Data for 2017 is for the time period from January to August

The engagement of the state in strengthening of the start-up ecosystem has increased in the past few years. The 2016 start-up law provides various tax reductions, as long as a start-up attracts at least 30 thousand EUR of venture capital investment per year. If this condition is fulfilled, the start-up is only responsible for paying a fixed social insurance payment (currently about 260 EUR per month) for each of its employees as well as a contribution to their state pension insurance. The start-up is exempt from personal income tax and corporate income tax. In 2017 the Ministry of Economy initiated changes in the Immigration law that relaxed immigration procedures for highly qualified employees and founders of start-ups. In addition, start-up companies can apply for up to 25 thousand EUR worth of innovation vouchers – a 60% government co-funding to cover costs of new technology or product development. On top of that, if a company has managed to attract investment from a business angel, but lacks co-funding for implementation of the project, it is eligible for a loan from the state development financial institution ALTUM that covers up to 60% of total project costs, but usually not more than 150 thousand EUR. In summer 2017, Latvia chose three administrators of acceleration funds, each of which will have an opportunity to grant funding in amount of 15 million EUR for pre-seed investments (up to 50 thousand EUR) and seed investments (up to 250 thousand EUR for companies that have successfully completed the pre-seed stage). The acceleration funds will be able to invest in equity and quasi-equity or give out loans. Administrators are soon to be selected also for venture capital funds that will receive 60 million EUR of EU funding. These funds will provide early development investments and development capital investments. It is estimated that about 80 projects will receive support through these financial instruments.

Potential Gains

Start-ups are a kind of entrepreneurial experiment. It is clear that a certain number of such experiments will not succeed. For example, in the USA only one in every 500 start-ups attracts first stage venture capital funding and only very few from those develop into thriving enterprises, such as Google. However, it is impossible to predict which projects are going to be successful without making the investments. Therefore, a multi-tier financing system serves as a sieve that separates out areas of investment with less potential.[25]

Latvia institutionally is involved only in the initial stage of this start-up development system. It is possible to improve the situation by continuous upgrading of the local start-up ecosystem, by adjusting the regulatory environment, i.e., but any progress will take time. Estonia has been improving its start-up ecosystem for at least five years and therefore surpasses the other two Baltic states today, yet, even Estonia is far behind the 20 most appealing start-up locations in the world.[26] Besides, the start-up ecosystem is global in its nature and the perspective companies cannot and should not be nationally bound. For example, links of aforementioned *BitFury* to Latvia are rather symbolic. Its data centres are located in Iceland and Georgia, its administrative offices – in Amsterdam, London, and elsewhere around the world. We can be pleased that print on demand company *Printful*, a part of the *Draugiem Group*, has decided to build its European production centre (a 1 million EUR investment project that will create 150 new jobs) in Latvia, but this choice cannot be taken for granted.[27]

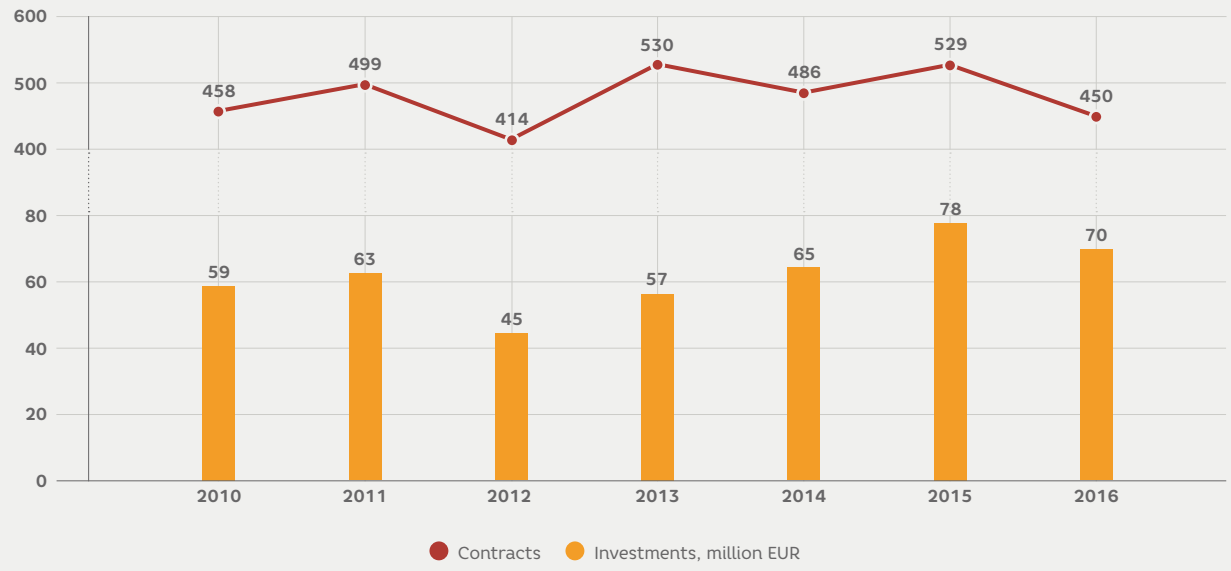
For any state, it is important to understand how to maximize gains from start-ups, irrespective of the maturity of its start-up ecosystem. Start-ups, their employees, investors, accelerators, associations, etc. form interconnected networks. There are two types of ties in these networks that are particularly important. First, the more tightly the start-up environment is linked to the rest of the economy, the grater the benefits for the economy as a whole are. The people involved in the start-ups with their specific knowledge, competences and creative potential are the start-ups' most valuable assets. How much society in general gains from these activities depends on the type of projects start-up employees are involved in and on the kind of problems they are trying to solve. In this respect initiatives of Latvian telecommunications companies are truly celebratory. For example, in 2016 *Lattelecom* in a cooperation with *Startup Wise Guys* implemented the first B2B accelerator program in Latvia. More recently the company together with Danish partners have become a co-administrator of one of the EU acceleration funds. *Lattelecom* agrees that its involvement with start-ups has led to changes in its working environment and lines of thought.[28] *LMT* has a different approach – it cooperates with a few selected start-ups in a new partnership of innovations and development. For example, in the spring 2017 the company announced its partnership with a machine vision technology company *4SmartStreets* in development of an AI parking location solution.[29] While engagement of start-ups in the telecommunication sector might seem logical, other sectors of economy can equally benefit from ICT innovations. Therefore, building ties between start-ups and companies in all sectors of national economy might prove profitable for society at large, even if the specific relations do not result in immediate new projects or profits.

The public sector can benefit from networking as much as the private sector. Data from the Procurement Monitoring Bureau (IUB) show that from 2010 to 2016 state and municipal institutions made about 480 ICT procurement contracts per year and spent annually about 63 million EUR.

[25] Nanda, R. and Rhodes-Kropf, M. 2015. Financing Entrepreneurial Experimentation. NBER Working Paper Series. No. 21278.
[26] Startup Genome. 2017. Global Startup Ecosystem Report 2017. http://ej.uz/3n42
[27] Dienas bizness. 2017. Printful atver ražotni Latvijā. http://ej.uz/5w25
[28] Dienas bizness. 2017. Sadarbība ar start-up palīdz mainīt domāšanas veidu. http://ej.uz/bt4w
[29] Labs of Latvia. 2017. Latvijas startup uzņēmuma 4SmartStreets mašīnredzes risinājums brīvo stāvvietu meklēšanai. http://ej.uz/jpfn

Number of ICT Procurement Contracts and Amount of Investments, million EUR

Figure 4



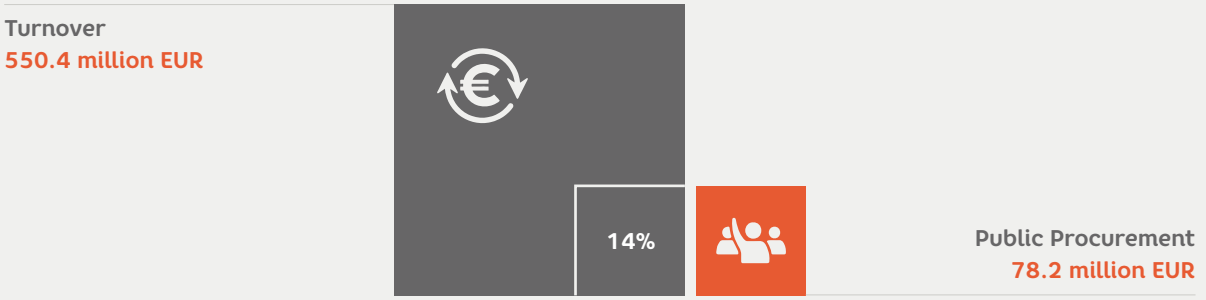
Data Source: IUB
Note: ICT sector consists of IT consulting, application development, internet and support services (CPV code 72000000-5)

The overall turnover of the ICT sector is much bigger, but public procurement constitutes a significant part of it. In 2015, the sales of ICT sector even in a very narrow meaning of ICT were 550 million EUR. 14% or 78 million of 2015 sales were public procurement. Thus, the state and municipalities are important actors in the ICT market. However, the results of ICT public procurements in Latvia have not always been successful. Public institutions frequently overpay for ICT services and end up with poorly functioning or even utterly useless ICT solutions. Construction of some public procurement contracts in a framework of innovation and industrial policy and engagement of start-ups in this process might be a way out of this problem. This would not be effective in all cases[30], but it might work in sectors with an already existing critical mass of start-ups. The public sector would benefit from innovative partners, while start-ups would get another source of public support unhindered by the EU de *minimis* regulation.

[30] Cepilovs, A. 2013. Public Procurement for Innovation in Small States. The Case of Latvia. Rivista di Politica Economica, 2, 99-136.

ICT Turnover and Public Procurement in 2015, million EUR

Figure 5



Data Source: CSB, IUB
Notes: ICT turnover includes services of computer programming, consultancy and related activities (NACE division J62), but public procurement - IT consulting, application development, internet and support services (CPV code 72000000-5)

The second type of ties that should be noted are international connections. Access to global knowledge, advice and financial flows is crucial for local start-ups to realize their full potential.[31] Therefore, connections of local ecosystem to similar systems elsewhere in the world must be strengthened by all means.[32] Start-up founders and employees that have already reached international success and have left the local ecosystem are instrumental in this. They should not be viewed as minds lost in the global brain drain, but rather as the modern-day Argonauts whose networks and connections can be utilized by those left behind. Public actors must work on creation and maintenance of such connections and should support these new Argonauts if any one of them is ready to invest their time and energy to foster global network building.[33]

[31] Andersson, M. and Wernberg, J. 2016. State of the Digital Region 2016: Cities Connecting the Digital Economy in the Baltic See Region. Copenhagen: Baltic Development Forum
[32] Saxenian, A. 2007. The New Argonauts: Regional Advantage in A Global Economy. Cambridge: Harvard University Press.
[33] Leitarts, U. 2017. Ko Latvijai darīt Silīcija ielejā? http://ej.uz/qm14

3. Out-sourcing Providers

Companies working as out-sourcing providers to other companies constitute a large segment of the ICT sector. The ICT out-sourcing market situation is described briefly in this section with the most important sources of competition being identified.

The IT Out-sourcing Market

The value of the global IT out-sourcing market increased in 2016 by 4.6% and reached 283.5 billion USD.[34] Whereas, the value of IT out-sourcing provided by other countries (i.e., outside the developed Western European countries, USA, Japan, Australia et al.) was approximately 67 - 69 billion USD.[35] International players like *IBM*, *Accenture*, *Cognizant*, *HP Enterprise* etc., which maintain geographically diversified global agency networks for satisfying customer needs as cheaply and effectively as possible, are involved in the provision of IT out-sourcing. The customers for these companies are located mainly in developed Europe, Asia, North America and Australia, but company employees throughout the world are involved in fulfilling orders, using the advantages provided by various geographic locations in relation to service delivery costs and the availability of a suitably qualified workforce. Similar agency networks are also maintained by global IT and associated sector companies which take care of their own needs for IT services in most cases (for example, *Microsoft*, *SAP*, *Siemens*, *Morgan Stanley*, *ExxonMobil et al.*).

The most popular and most frequently used locations in other countries that provide IT out-sourcing are located in Asia and in the Pacific Ocean region (India, the Philippines, China et al.). This region's market share is about 60-70% of the IT outsourcing provided by other countries. But, in recent years, the market share of the so-called nearshore Europe (Ireland, Northern Ireland, Scotland, Portugal, and the Central and Eastern European countries) continues to grow. For example, 32% of the new service centres opened in 2016 are located in nearshore (mainly in Poland, Ireland and Rumania). It is significantly more than five years ago, when the balance of newly opened centres in this region was only 17%. Overall, nearshore Europe's market share of all the IT outsourcing provided by other countries is about 12-17%.[36]

Mutual Competition

Costs (especially workforce costs, which form the largest part of operation costs), the availability of the workforce and their qualifications, as well as the overall business environment are usually compared when analysing the attractiveness of different countries and places from the perspective of out-sourcing providers. According to an evaluation of the global out-sourcing market made by *A.T. Kearney*, Latvia took 18th place in 2016, which is 5 places higher than in 2014. Latvia's main advantages are linked to its low costs when compared to its direct competition in nearshore Europe, as greater savings for companies can only be offered by Ukraine, Bulgaria and Romania. However, the workforce and business environment available in Latvia is rated lower. Latvia's climb in the ranks too, compared with 2014, is associated with more marked advantages in the sense of costs, while the evaluation of the remaining index components has decreased. Since 2014, comparative costs have reduced markedly in Ukraine, which has allowed it to climb 17 places up the ranks. Meanwhile, the drop in the rankings by Lithuania, Estonia and Slovakia is connected with a reduction in the evaluation of all components.

[34] Gartner. 2017. Market Share Analysis: IT Outsourcing Services, Worldwide, 2016. http://ej.uz/o34j
[35] Everest Group. 2017. Demand for Digital Technologies Will Fuel Continued Growth of IT Services in 2017. http://ej.uz/8f1z
[36] Everest Group. 2016. Global Locations Annual Report 2016 (Preview Deck). http://ej.uz/dxgg ; Everest Group. 2016. Asia Pacific Share of Global Delivery Center Set-ups Continues Its Decline. http://ej.uz/aiyg

Global Services Location Index in 2016

Figure 6

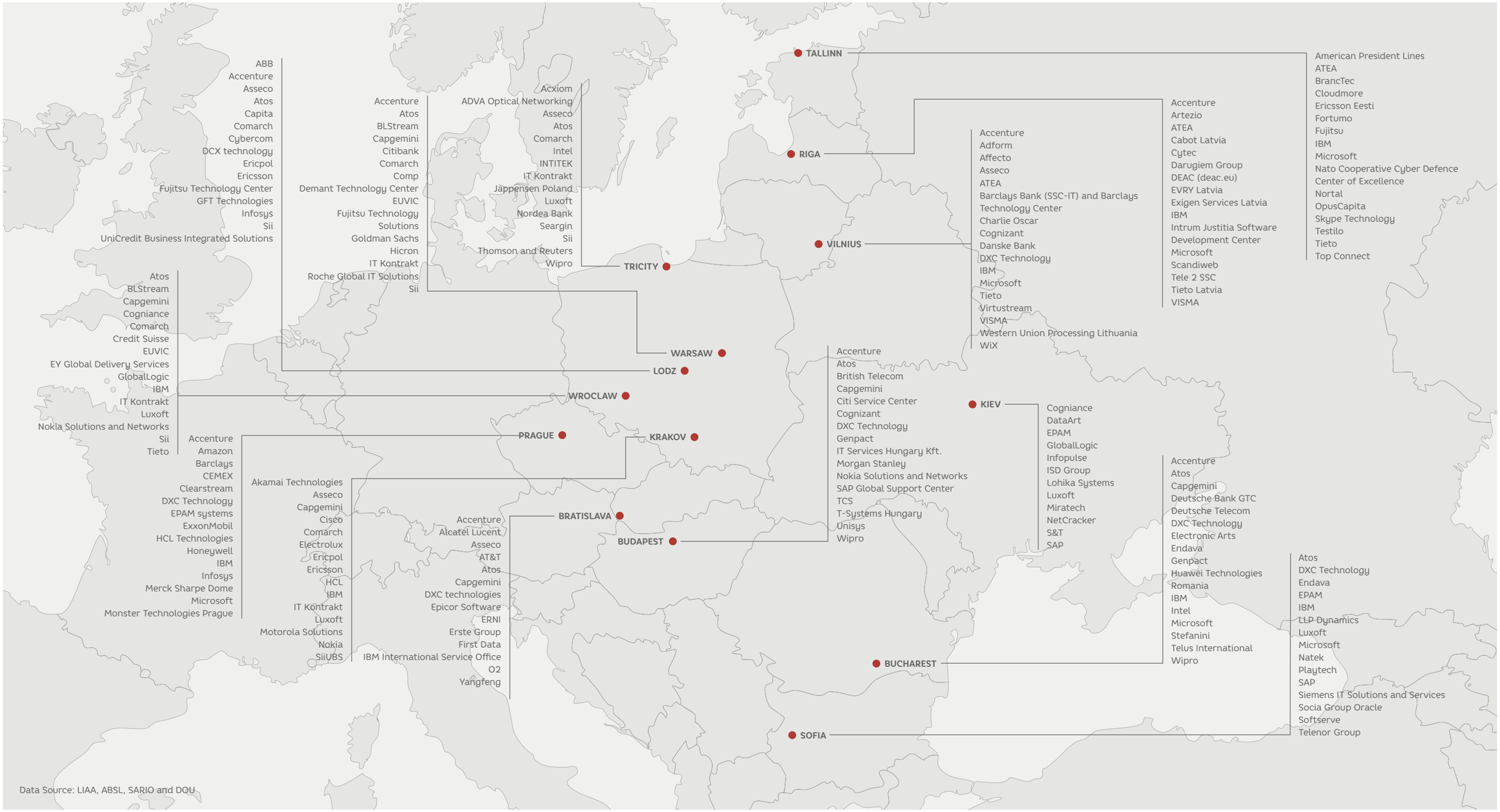
COUNTRY	RANK	CHANGES CF. 2014	FINANCIAL ATTRACTIVENESS	PEOPLE SKILLS AND AVAILABILITY	BUSINESS ENVIRONMENT	OVERALL EVALUATION
Poland	10	+ 1 ↑	2.41	1.37	1.90	5.68
Bulgaria	12	- 3 ↓	2.99	0.94	1.66	5.60
Romania	13	+ 5 ↑	2.79	1.16	1.64	5.59
Latvia	18	+ 5 ↑	2.70	0.99	1.64	5.33
Ukraine	24	+ 17 ↑	3.03	1.14	1.12	5.29
Czech Rep.	26	+ 7 ↑	2.19	1.14	1.94	5.27
Lithuania	27	- 12 ↓	2.59	0.93	1.73	5.24
Hungary	32	- 1 ↓	2.28	1.14	1.71	5.14
Estonia	33	- 11 ↓	2.29	0.94	1.87	5.09
Slovakia	49	- 14 ↓	2.03	0.97	1.74	4.74

Data Source: A.T. Kearney (2016). Global Services Location Index: On the Eve of Disruption.
Note: The overall evaluation is calculated using 38 indicators that form three index components. The weight of "Financial Attractiveness" in the overall evaluation is 40%, while the "People Skills and Availability" and "Business Environment" components each constitute 30% of the overall evaluation.

Poland can be earmarked against the background of other countries if we look at specific places in the CEE region, where international IT and associated sector out-sourcing providers have decided to locate. First level centres have been created in Warsaw and Krakow, which currently offer the most competitive package in relation to costs, workforce and business environment. Meanwhile, second level centres have developed in Lodz, Wroclaw and the combined Gdansk, Gdynia and Sopot agglomeration [Tricity], where there is a more limited workforce supply, but cheaper operational costs compared to Warsaw and Krakow. The majority of the out-sourcing providers in the other places examined are located in capital cities and significant second level centres have not yet been able to develop. Brno and Ostrava in the Czech Republic, as well as Cluj-Napoca in Romania have occasionally been mentioned as places with future potential.

Location of Individual International Service Providers

Figure 7



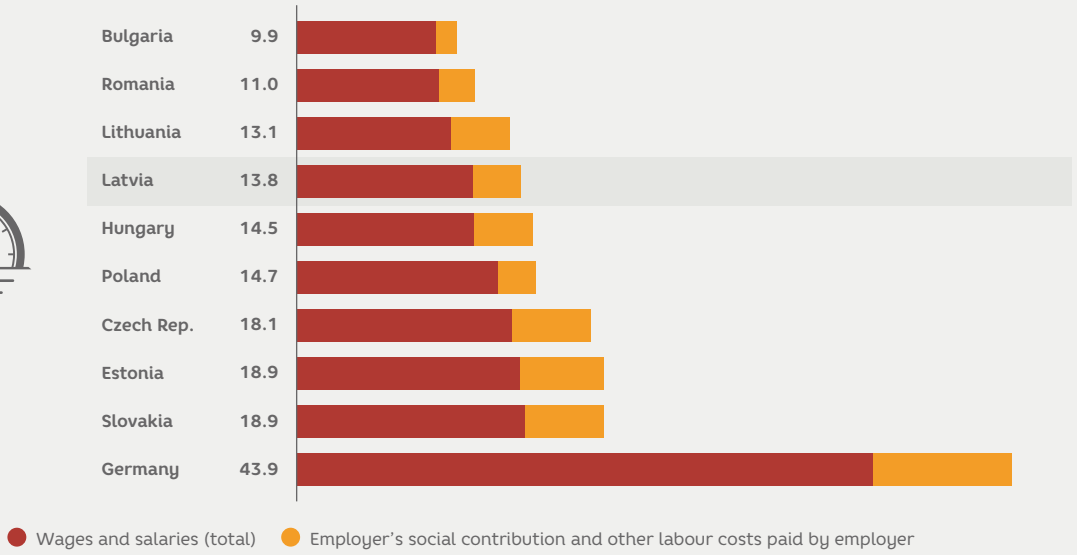
Data Source: LIAA, ABSL, SARIO and DOU

Labour Costs

The main incentive to set up IT and other out-sourcing centres in other countries is, and remains, the relatively low workforce costs. Out-sourcing providers often point to market development, which forces them to increasingly operate as strategic partners, offering companies not only reduced costs, but also organizational improvements and contributions in the creation of new products and services.[37] However, company surveys reveal that out-sourcing providers have not fared so well up till now specifically with strategic partnership and 48% of customers have been unsatisfied with the performance of out-sourcing providers.[38]

Eurostat data shows that Bulgaria and Romania offered the greatest savings in the sense of average labour costs in the CEE region in 2016. For the purposes of comparison, the average salary in the IT sector in these countries was 77% and 75% lower, respectively, than that in Germany. Whereas, the average labour costs in Latvia were 69% lower. A comparison of average salaries only provides a general evaluation though, as differing levels of productivity and purchasing power, as well as the salary structure, which is specifically characteristic to international competing IT out-sourcing providers is not taken into account. But, the overall trends concur with *A.T. Kearney's* evaluations. In the sense of cost savings, the leaders are Bulgaria and Romania (and definitely Ukraine as well, though Eurostat data is not available on it). The labour cost levels in the IT sectors in Slovakia, the Czech Republic and Estonia are also low compared to Western European countries, but savings for out-sourcing providers here, in the sense of costs, are lower in comparison with other CEE region countries.

Average Wage in ICT Sector in 2016, EUR per hour Figure 8



Data Source: Eurostat

[37] Peck, J. 2017. Offshore: Exploring the Worlds of Global Outsourcing. Oxford: Oxford University Press.
[38] Everest Group 2017. Nearly Half of All Sourcing Investments Leave Enterprises Unsatisfied. http://ej.uz/2paw

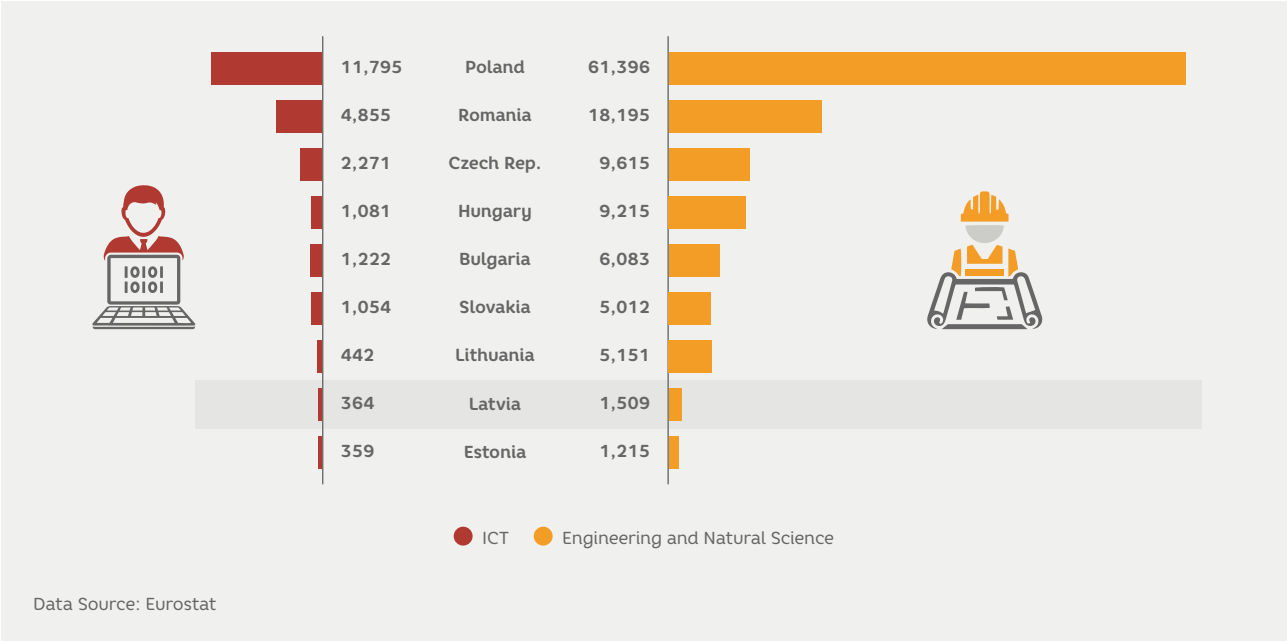
In turn, the average level of remuneration in Poland hides differences between first and second level service centres. The survey on the out-sourcing industry in Poland published in 2017 reveals that the salary for a software developer with 3 years of experience in Warsaw could be about 20% greater than in Lodz.[39]

Workforce Availability

Usually, the number of graduates of bachelor level study programme are looked at when evaluating workforce availability. The primary candidates for work in companies that provide out-sourcing, will obviously be from amidst IT study programme graduates, but an analysis of the workforce market shows that about a third of IT employees gained their education in related engineering and science study programmes. In this sense, Poland's out-sourcing provider centres have considerable advantages, which despite the many level structure, have substantially larger opportunities in choosing new employees than other CEE countries. Proportionally, the first level centre universities in Warsaw and Krakow, together, prepare about one third of all graduates, and the workforce is sufficiently mobile to provide a suitable supply for the first and second level centres mentioned. On the other hand, in the Baltic states, despite their relatively high numbers of bachelor level IT study programme graduates in relation to the overall number of inhabitants, comparatively fewer new employees, in absolute numbers, end up in the labour market each year.

Number of Bachelor Level Graduates in CEE Countries in 2015

Figure 9



Data Source: Eurostat

[39] ABSL. 2017. Business Services Sector in Poland 2017.

4. Human Capital and Education

The ICT sector and its component in other sectors are comparatively open to newcomers. The countries, companies and individuals who wish to get involved can find lucrative niches which do not require disproportionately large capital investment, access to raw materials or a specific location for entry. Public infrastructure does play a certain role. However, when it conforms to internationally acceptable standards, the sector's main competitive driver is human capital. This section is devoted to the evaluation of the availability of human capital in the Latvian IT sector and opportunities for its further accumulation.

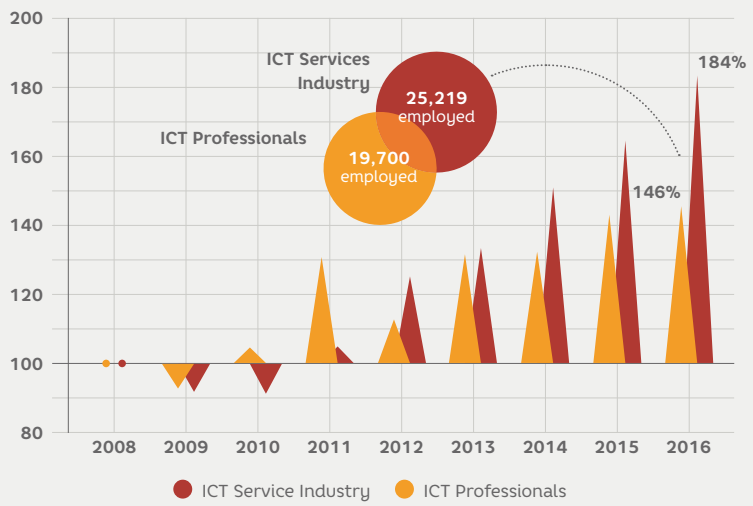
Demand for ICT Skills

Digitalization and ICT is changing our everyday lives and creating new opportunities for both businesses as well as employees, but specific skills and abilities are required to take advantage of them. Recently undertaken OECD research shows that the acquisition of digital skills pays off and is valued in the labour market. For example, employee ICT skills help to explain different rates of pay, while improvements in ICT skills allow people to secure better paying work positions.[40]

Demand for ICT professionals is also increasing. EU predictions reveal that by 2020, the shortage of ICT specialists in the EU could reach 500,000 employees.[41] If the current situation is maintained, it is predicted that only Finland, Estonia, Portugal and Greece will be able to prepare sufficient numbers of new ICT specialists to satisfy the growing demand.[42] Since 2008, employment in the ICT service sector in Latvia has increased by 84%. Whereas, the number of ICT professionals employed in the national economy, as a whole, has increased by 46%. In 2016, 25,200 employees were employed in the ICT services sector, with most of them being in computer programming and consultancies or associated areas, but the number of ICT specialists employed in the national economy, as a whole, reached 19,700 employees. These two indicators overlap and together describe employment in the ICT sector.

Employment in the ICT Sector 2008-2016, % against 2008 (2008 = 100%)

Figure 10



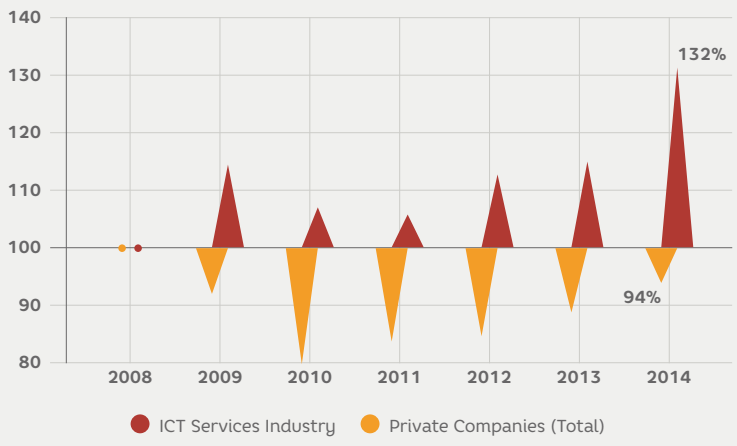
Data Sources: Eurostat, Central Statistical Bureau
Note: The ICT services industry includes telecommunications, data programming and information services (NACE subgroups J61-J63.); ICT specialists, according to the Eurostat definition are ICT sector leaders, senior specialists and technicians (ISCO-08 subgroups 133, 25 and 35), as well as other professionals, whose work is mainly ICT services (individual ISCO-08 four-character subgroups).

[40] Falck, O., Heimisch, A., Wiederhold, S. 2016. Returns to ICT Skills. OECD Education Working Papers, No. 134.
[41] Empirica. 2017. High-Tech Leadership Skills for Europe: Towards an Agenda for 2020 and beyond.
[42] Cedefop skills forecasts. 2016.

For a number of years now, ICT sector companies have indicated tension in the labour market and have been complaining about the difficulties that they encounter in looking for new employees. The ICT sector is no different to others in this regard, as employers in all sectors would enjoy a situation where they could easily find required manpower, with appropriate qualifications, comparatively cheaply within the market. But, statistical data reveals that real remuneration in the ICT services sector in relation to productivity increased by 32% in the period between 2008 to 2014. At the same time, the relationship mentioned has decreased by 6% within private sector companies. Consequently, it can be maintained that the situation in the ICT sector's labour market really is strained, and is restricting the sector's further development.

Real Wages in Relation to Productivity in the ICT Sector and in the National Economy Overall 2008-2014, % against 2008 (2008 = 100%)

Figure 11



Data Sources: Eurostat, Central Statistical Bureau
Note: The ICT services industry includes telecommunications, data programming and information services (NACE subgroups J61-J63).

According to calculations by Certus, the number of graduates from ICT study programmes needs to be increased to 3,000 per year in coming years to ensure the development of the ICT sector and satisfy the demand of other sectors for ICT specialists.[43]

Opportunities for Increasing the Number of ICT Specialists

Countries use varying strategies to increase the number of ICT specialists. Long-term solutions are associated with developing ICT competencies at school age already by, for example, introducing the teaching of the basics of computing from the first grade.[44] Whereas, the attraction of foreign ICT specialists could be attempted in the short-term. For example, in Singapore, one of the superpowers in the ICT field, more than a third of people currently employed in the ICT industry are foreigners.[45] In Europe though, the dominating migratory flow of ICT specialists is from CEE nations to developed Western European nations, and this is unlikely to change in the coming years.[46] Therefore, Latvia must bear in mind that it will have to develop its own ICT specialists.

An undoubtedly attractive option is the re-qualification of employees. On the one hand, nations are battling with unemployment created by various structural changes, but on the other hand, the ICT sector is ready to employ more specialists. Unfortunately, the learning of ICT professional skills requires a certain level of readiness and grounding, which groups of people that are in need of re-qualification rarely possess. A well-thought-out student selection process is often the basis of a successful re-qualification programme. For example, 18,000 people per year are trained at coding boot camps in the USA and data shows that after the completion of the training, the income for graduates of the programme increases by 64%, or about 26,000 USD per year.

[43] Rozīte, K. 2017. Latvijas Konkurētspējas Ziņojums 2016. Informācijas un komunikācijas tehnoloģiju nozare Latvijā. Rīga: Domnīca Certus.
[44] Start IT Education Project. https://startit.lv/about
[45] Tan, K. S. and Tang, J. 2016. New Skills at Work: Managing Skills Challenges in Asean-5. http://ej.uz/xb4b
[46] Barslund, M. and Busse, M. 2016. How Mobile is Tech Talent? A Case Study of IT Professionals Based on Data from LinkedIn. CEPS Special Report, No. 140.

The programmes are not free, costing 11,500 USD per participant for the 13-week course.[47] Consequently, students from the programme are highly motivated to acquire new skills and abilities which are required in the labour market. Whereas, the Seattle-based (USA) *Ada Developers Academy*, which focuses on increasing the number of women in ICT industry, can boast that 97% of women who complete the programme, find work in the ICT sector during their period of study, or afterwards. But not everyone who wants to study in the programme is accepted. Admission takes place in three stages, and only 8% of the women who indicated interest commenced the learning of the basic programme.[48]

These examples reveal that a requalification programme will work best if its organizers carefully consider and select those who will take part, in advance. For example, in the reformation of Latvia's school network, a re-qualification programme for teachers could be offered, supported by the state and the ICT sector. In the same way, there should also be opportunities for clients of the State Employment Agency of Latvia to re-qualify as various types of ICT specialists. However, there should be an awareness that not all representatives of various professions, whose skills are in less demand in the labour market, will want to, or be able to, go through a re-qualification process.

Higher Education in the ICT Field

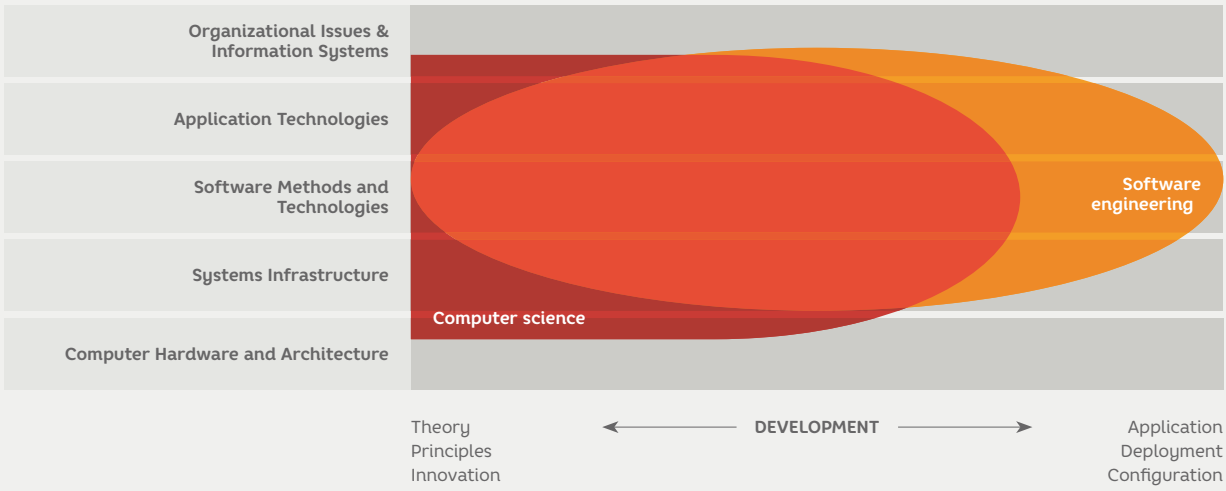
The majority of specialists employed in the ICT field have higher education (the EU average is 61%). Therefore, it is no surprise that countries focus special attention on higher education study programmes.

Since the 1960s, *Association for Computing Machinery* (*ACM*), which brings together IT sector professionals, researchers and teaching staff, has developed standards and suggested programme curricula in the ICT study field. The ACM currently identifies five sub-disciplines of computing, two of which we will compare in more detail: computer science and software engineering.[49] The computer science study programme is general in its nature. It includes all types of software development methods and technology, but the focus is more on theoretical aspects, and less on application and software development practice. Instead, the ACM's curriculum for the software engineer study programme foresees for the coming software developers to be taught as engineers, not scientists. Therefore, it is more like a classical engineering programme, for example, electrical engineering, not a science programme like physics. Engineers are trained to create and service products which are required by society, while the role of a scientist is to question, examine and expand knowledge as a whole, which can then be used in product development. These differing roles also determine the differences in the content of the education and the process. Both programmes provide for a theoretical knowledge base in the acquired education, and that the students must also be prepared for working in the industry. Therefore, the students need work experience in parallel with their theoretical studies. In relation to the study process, experts suggest that software engineer training should approximate software development projects which young specialists will have to undertake after the completion of studies, as much as possible. Students should be given opportunities to participate in project implementation, allowing them to work in groups and to become familiar with the various roles associated with software development (for example, demand analyst, project manager, programmer, tester et al.).[50]

[47] Course Report. 2016. 2016 Course Report Alumni Outcomes & Demographics Study. http://ej.uz/29hr
[48] Ada Developers Academy. https://adadevelopersacademy.org/
[49] The remaining three sub-disciplines examined by the ACM are computer engineering, information systems and information technology. The computer engineering study programme concentrates on hardware development. Whereas, information systems and information technology study programmes specialize more on organizational aspects and the application of IT respectively.
[50] ACM. 2005. Computing Curricula 2005; ACM. 2013. Computer Science Curricula 2013; ACM. 2015. Software Engineering 2014.

Localization of ICT Study Programme Graduates in the Problem Space of Computing and Labour Market

Figure 12



Data Source: ACM
Note: The horizontal dimension indicates differences between the IT field's theoretical and practical aspects. Whereas, the vertical dimension indicates the significance of equipment and people in the particular IT field's specialization opportunities.

Companies are also getting actively involved in defining educational content. For example, *Google* has published guidelines for computer science students who plan to get work experience or work at this company in the future. The guidelines provide suggestions and offer academic and non-academic resources for the development of required technical skills through self-education. *Google* expects that up-and-coming software developers will learn the object-oriented programming paradigm, using one of the programming languages (for example, *Java*, *C++*, *Python*). In the same way, *Google* suggests future employees to familiarize with at least one more programming language, as well as to gain practical knowledge in the development of mobile and internet apps, software testing and debugging. *Google* considers that, in parallel with studies in programming language and technology, potential employees need to develop logical thinking, develop a knowledge base in discrete mathematics, understand algorithms and data structures, as well as gain basic knowledge about virtual reality, machine learning, cryptography and other areas associated with IT. Finally, *Google* points out that gaining skills in team work, collaboration with other programmers and experience within companies, is important for future software developers.[51]

A comparison has been made in this section of what is being offered by several foreign and Latvian universities, to get an idea about the content of bachelor level study programmes in computer science. Cambridge University, Stanford University and the National University of Singapore, as well as Switzerland Federal Institute of Technology in Zürich (ETH Zürich), have been selected for analysis as they are frequently mentioned among the leading higher education institutions in the ICT field. Whereas, De Monfort University in Great Britain has also been included, because, in contrast to the previously mentioned foreign universities, it concentrates mainly on teaching local young people and does not compete at the international level. Some specific universities in neighbouring countries (Vilnius University and Tallinn Technical University (TTU)) and study programmes offered by the largest Latvian universities in terms of IT student numbers (the University of Latvia (UL), Rīga Technical University (RTU) and the Transport and Telecommunication Institute (TTI)) have also been examined.

[51] Google. 2017. Technical Development Guide. http://ej.uz/9ei5

The study programme structure at all of them was similar. Future IT specialists spend most of their time learning computer science and mathematics courses. All of the study programmes reviewed, also include general education study courses, and the majority of university students were offered work experience opportunities. The length of studies did vary. Some were three-year, but others four-year, study programmes. Stanford University and the National University of Singapore, which offer four-year study programmes, provide students with more opportunities to attend courses that are not connected with computer science. The National University of Singapore stands out for the fact that the general education courses that it provides are markedly interdisciplinary. Whereas, optional courses can be used within the framework of the USA education system, to continue the acquisition of extended computer science or to develop competence in some other field.

Structure of Bachelor Study Programmes in Computer Science (credit point break-down) Figure 13

		COMPUTER SCIENCE	MATHEMATICS	GENERAL EDUCATION COURSES	ELECTIVES	COURSE WORK, BA THESIS	INTERNSHIP, WORK EXPERIENCE
TTI	4 years	162	30	21	12	15	
UL	4 years	144	24	18	9	21	24
De Monfort University	3 years	135	15	15			15
Vilnius University	4 years	120	45	35		25	15
TTU	3 years	117	24	18	6	9	6
ETH Zurich	3 years	116	38	16		10	
RTU	3 years	108	27	24	6	15	
Cambridge University	3 years	105	15	30		15	15
National University of Singapore	4 years	102	30	48	42		18
Stanford University	4 years	72	40	32	84	12	

Data Source: Higher education institutions
Note: Credit points have been shown in the ECTS System, where 60 credit points are attained in one academic year.

Alternative Training Programmes

The majority of leading universities in the IT field currently offer computer science courses for free on the internet. Therefore, online studies are a real alternative for acquiring and improving ICT professional skills. Confirmation of the successful completion of such courses, in the form of a certificate, is usually for a fee though, and many students do not end up finishing their studies. Some industry representatives consider that the proportion of those finishing courses could be improved by attracting companions and advisers who would motivate and help people continue their commenced study. As a result, at the moment, internet courses will most likely work in specific cases, but not as a primary option in the preparation of new ICT specialists.

Some other private initiatives in preparing new ICT specialists are also gaining greater popularity. One of the most striking examples is the Coding School 42 that has been created in France. The basis of its operation is peer-to-peer training. The school has no lecturers and students learn technology and programming through self-education by solving practical tasks, communicating among themselves and sharing knowledge. Candidates must be aged from 18 to 30 years. Programming knowledge is not necessary, and the admissions committee is not interested in the applicants' high school exam results. The selection of candidates takes place during a four-week long marathon of logic and programming tasks. For those who are successful in the tests, studies are free, and a scholarship can also be obtained during the period of study. The length of the studies is from 3 - 5 years, during which time students gain the skills which are needed for a successful career as a software engineer. By opening a new affiliate in the USA, the school plans to teach 10,000 students over the next five years.[52]

A large proportion of ICT professional skills have to be continually renewed as they quickly lose their currency. For this reason, most ICT companies are involved with the training of their employees to a certain degree. Firstly, companies can utilize their knowledge to develop training content and in this way, ensure that the skills of new ICT specialists conform more to the needs of the company. But, some skills can be acquired more successfully specifically within a company, which is why companies often provide novice and trainee positions. The state can get involved in the co-funding of such novice/trainee training systems, through partly transferring the publicly supported training process, which is useful for society at large, from educational institutions to individual companies. They can then develop the competence of those studying in the corresponding field and also use this in training their own new specialists or those of other companies. For example, 18 training standards for apprenticeships in the ICT field (software developer, systems network engineer, data analyst, cybersecurity specialist et al.) have been endorsed in Great Britain. About 15,500 trainees commence training within this framework every year, of which 55% also complete their training and receive corresponding certification.[53]

[52] Crunchbase. 2016. Coding school 42 plans to educate 10,000 students in Silicon Valley for free. http://ej.uz/2h95
[53] UK Further Education Data Library: Apprenticeships. http://ej.uz/h5nr

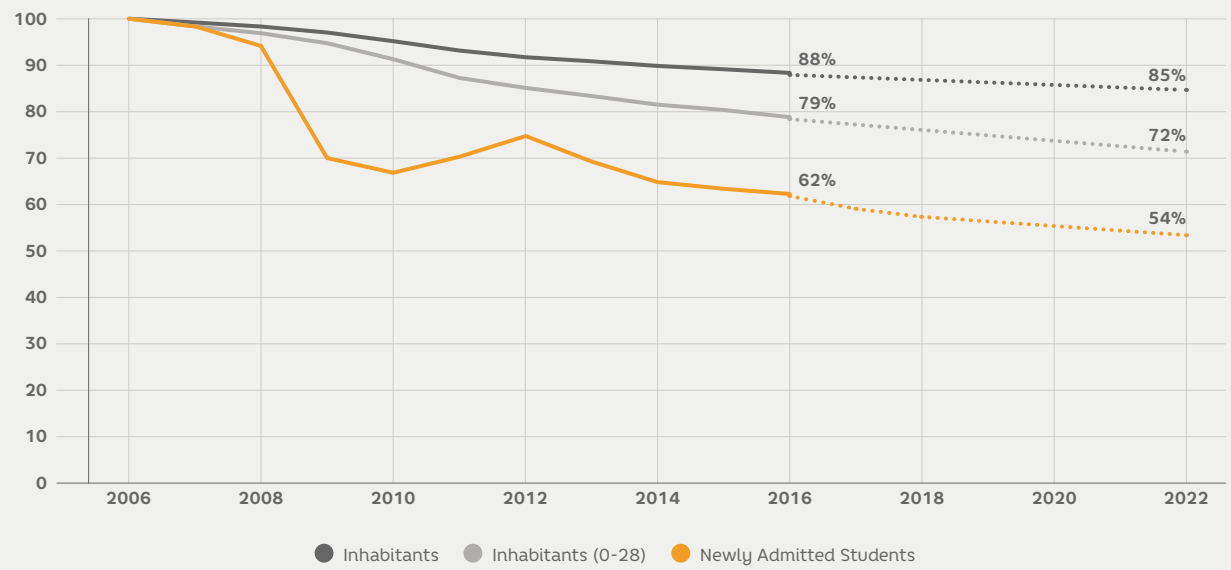
Preparation of IT Specialists in Latvia

In the last 10 years, there has been a substantial decrease in the number of inhabitants of Latvia. Projections by Certus show that this trend will continue in the period up till 2022. In addition, the average inhabitant of Latvia is getting older. It is the young people who mainly choose to study at universities. Almost 75% of all Latvian university students are younger than 29 years. The number of inhabitants within this age group has decreased and will continue to decrease faster than the overall number of inhabitants. Even though the number of newly admitted students is influenced by various factors, 38% fewer students commenced studies in Latvian higher education institutions in 2016 than in 2006, to a large degree as a result of demographic trends.

At the same time, the proportion of people who have attained higher education in Latvia has increased, and statistical data shows that 43% of inhabitants in the 30 to 40 years age group had higher education in 2016. This is higher than the EU average (39%), and also exceeds the goal set by the Europe 2020 strategy (40%). Consequently, Latvia is amongst the leading EU countries in this field, and it would be problematic to markedly increase the proportion of those studying. Therefore, assuming that the age structure of admitted students does not change, we can expect that the number of admitted students will continue to decrease.

Changes in the Number of Inhabitants and the Number of Students Admitted to Basic Study Programmes (Index, 2006 = 100)

Figure 14



Data Source: CSB, Ministry of Education, Certus calculations
Note: Basic study programmes include college, professional basic study and bachelor study programmes (Latvia's education classification second level codes: 41, 42 and 43).

IT Basic Study Programmes: Students Admitted and Graduates

IT basic study programmes were offered by 19 Latvian institutions of higher education in the 2016/2017 study year, and students could choose from 33 full time study programmes. The state universities UL and RTU as well as the private TTI, were the leading universities in the IT field in 2016 and together they took on 66% of all new students and issued 63% of all basic study diplomas issued in Latvia in the IT field.

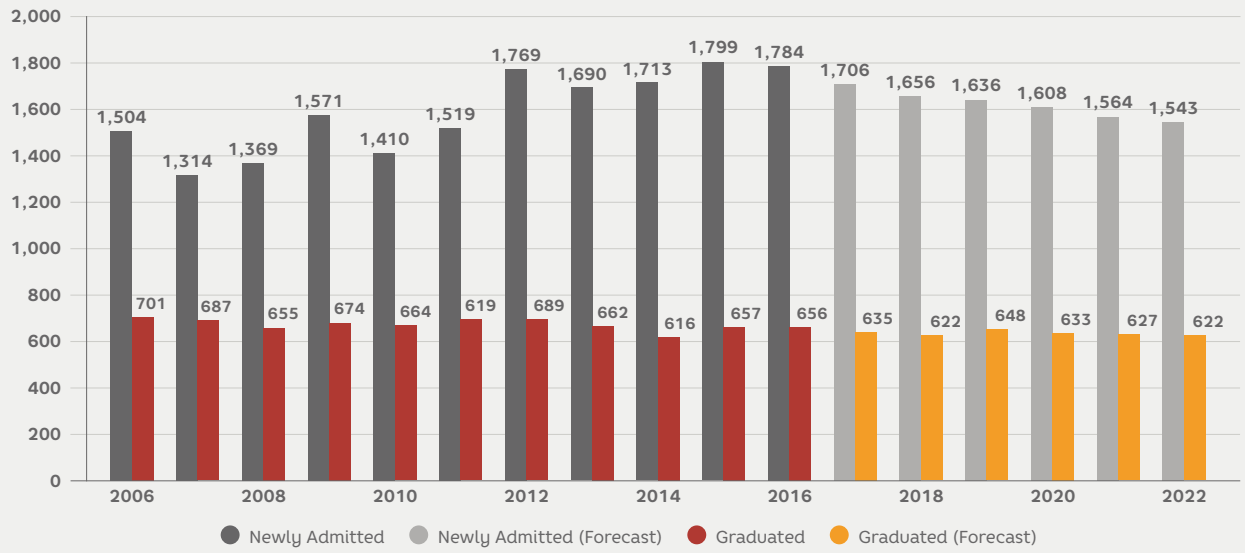
The number of young people who wish to study in IT basic study programmes has not decreased as is the case for basic study programmes in general. Actually, over the past 10 years the number of newly admitted students in IT programmes has even increased a little. In 2016, the proportion of students taken on in IT study programmes was 8.2% of the overall number of newly admitted students, which was almost 4 percentage points more than in 2006. Whether this trend will continue is to a large degree dependent on the field's comparative popularity and the preparedness of young people to commence studies in the IT field. Currently, there is only competition at UL and RTU for funded study places in IT study programmes, which could indicate a conditional downturn in the enthusiasm connected with the popularity of the IT field. In recent years too, there has been a tendency for centralized mathematics exam results to become poorer, and there are consequently fewer young people whose level of knowledge permits them to commence studies in IT programmes. To finish, calculations by Informatics Europe, the European computer science research and higher education association, show that the number of newly admitted IT students in Latvia per million inhabitants is one of the highest in Europe[54], which points to potential restrictions on an increase in future newly admitted IT student numbers. Consequently, assuming that the proportion of IT students among overall student numbers does not change, we can expect that this study direction will also experience a decrease in student numbers.

The annual number of graduates of IT basic study programmes does not increase in proportion to the number of newly admitted students. Firstly, this is linked to the length of various study programmes, which vary from two-year college level study programmes to five-year part time study bachelor level programmes. Controlling for the length of the programmes, fluctuations in the number of newly admitted students explain about 70% of changes in the number of graduates. However, the number of graduates is also affected by the number of students who have abandoned studies, which is, in turn, dependent on the level of student preparedness and other factors. The results from each study programme up till now were analysed, and forecasts about the number of newly admitted students were used to predict the overall number of graduates, on the condition that the proportion of IT students remains at the 8.2% level. Based on these evaluations and assuming that the education process remains unchanged, it can be predicted that the number of diplomas in the IT field issued by higher education institutions will decrease from 656 diplomas in 2016 to 622 diplomas in 2022.[55]

[54] Informatics Europe. 2016. Informatics Education in Europe: Institutions, Degrees, Students, Positions, Salaries. Key Data 2010 – 2015. Zurich: Informatics Europe.

[55] It should be noted though that the number of diplomas issued is greater than the number of new specialists entering the market, as some students receive a college (1st level professional higher education) diploma and then continue studies in bachelor level study programmes. For example, the UL admits about 40 students every year in a college level programme, but issues about 100 college diplomas, which can be explained by the fact that some bachelor level students, who later continue their studies and also receive a bachelor diploma, also choose to receive a college diploma.

Newly Admitted Students and Graduates of IT Basic Study Programmes Figure 15



Data Sources: Ministry of Education, Certus calculations
Note: The IT study field includes Latvia's education classification fourth-level codes 48 (Computing) and some fifth-level codes 523 (Electronics and Automatics) and 526 (Other Engineering).

Prospects for Increasing the Number of Graduates

Two target groups need to be looked at for increasing the number of graduates. Firstly, the number of graduates can be increased by reducing the number of students who do not complete their studies. Secondly, the number of people who choose to study in IT study programmes could be increased. At least a number of them would complete their studies later, and increase the number of graduates in this way.

The target group of existing students is much more promising, as it includes people who have already made a choice and invested effort to get through the selection process. Therefore, by devoting special care to this group one could expect that successful policies could produce gains already in the short-term period. Some students terminate their studies due to personal circumstances, and a common solution for those cases would be difficult to identify. However, the majority of students drop out already during the first semester. This is mainly due to insufficient preparedness for the study process or a change in the choice of study programme.

Different levels in the state education system are dependent on each other, and a large proportion of responsibility for the level of preparedness of new students must be assumed by secondary education institutions. Data shows that most potential IT students are prepared by a small number of schools and technical colleges, which thereby restricts opportunities for increasing the number of new specialists in the IT field.

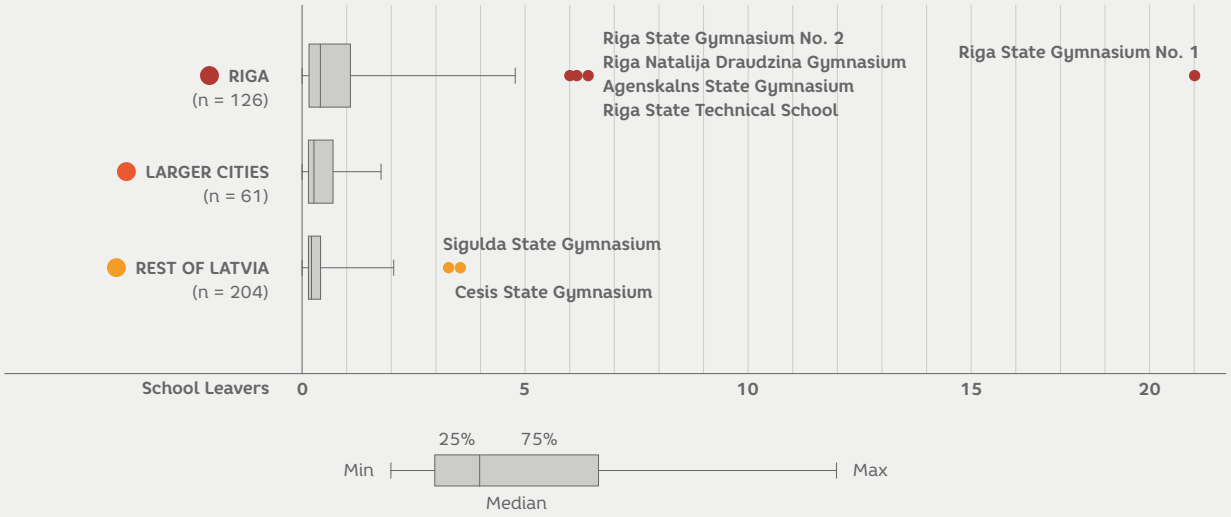
The UL's Faculty of Computing has collected data on secondary schools that its students have attended prior to entering UL. In the period from 2007 to 2013, an average of 57% of the newly admitted students each year were from Riga, 11% from larger cities (Daugavpils, Jelgava, Jekabpils, Jurmala, Liepaja, Rezekne, Valmiera and Ventspils) and 32% from the rest of Latvia. The number of foreign students was insignificant. Riga State Gymnasium No. 1 stood out against the background of other schools, as it provided 21 school leavers or 8% of the number of students taken on in the UL IT basic study programmes per year.

Several other large Riga schools also had comparatively good results, but Cesis and Sigulda State gymnasiums should be noted among the schools located outside of Riga. However, each year there are a large number of schools from which not a single school leaver joins the UL Faculty of Computing. It is partly due to secondary school specialization and transfer of next IT students to State gymnasiums after the 6th grade. Nevertheless, the data also indicates that quality of secondary education differs and some secondary schools are not able to provide education that enables their students to continue their studies in the IT field at the higher level of education.

Unfortunately, a resolution to the situation in this field is not possible in the short-term. Changes are required here in both the school network, as well as in the teaching of required competencies for IT studies. Even if such changes were introduced relatively quickly (for example, within a year), the return on this would only come in the long-term. Improvements in high school mathematics teaching which would reduce the load in the first study year, when many new students spend time repeating or learning high school mathematics for the first time, could help results in the short-term most of all.

The Average Number of Students Per Year Entering the UL IT Basic Programmes from Secondary Education Institutions in the Period from 2007 to 2013

Figure 16

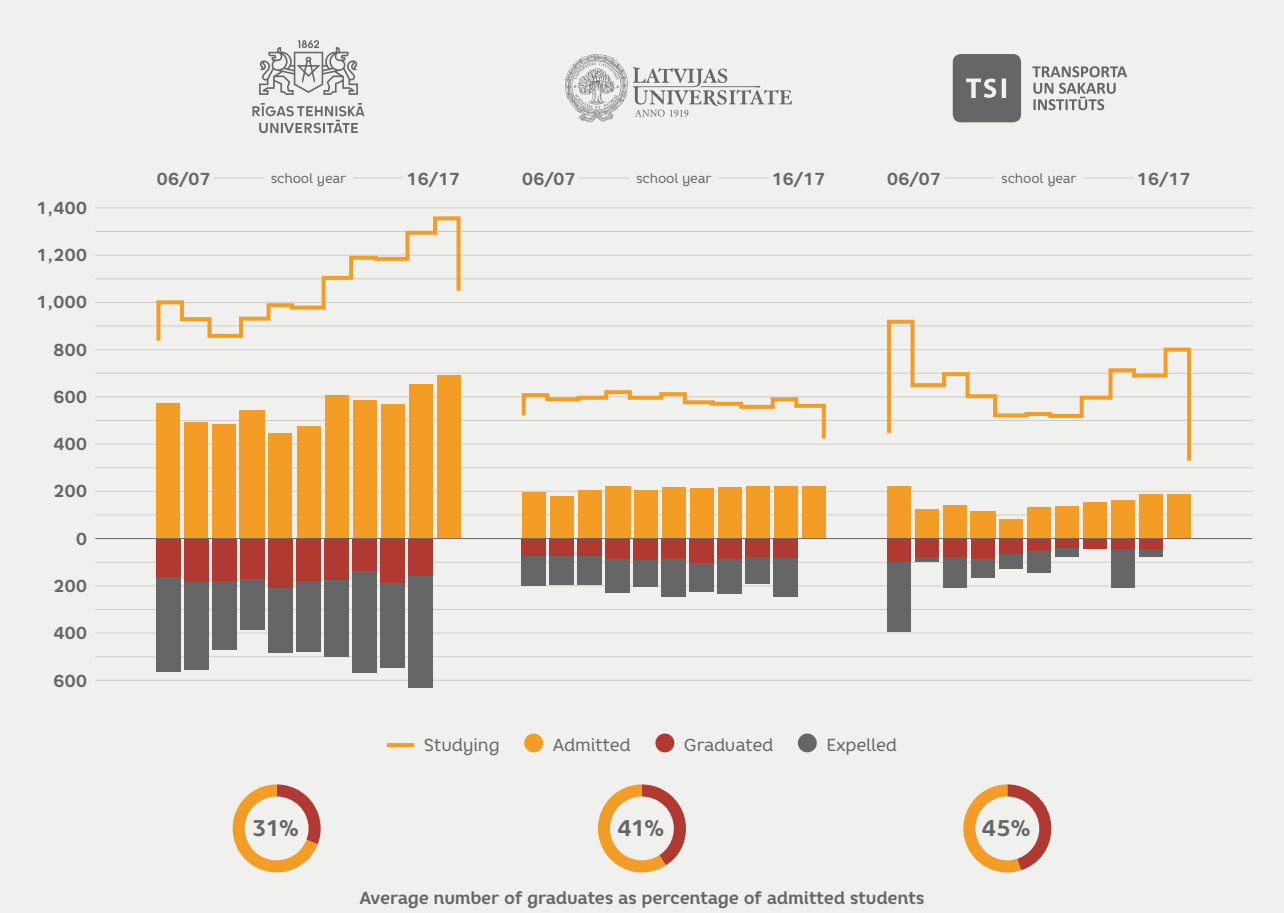


Data Sources: UL Faculty of Computing, CSB, Certus calculations

Universities are aware that a large proportion of students who commence studies in the IT field do not complete them. Ministry of Education data shows that in the time period from 2006 to 2016 graduates of the bachelor level IT programmes at Latvian universities with most IT students constitute only 31% to 45% of admitted students. TTI was the best performer, while RTU had the most for improvement. Not all the students who fail to attain a bachelor degree in the IT field are lost to the sector. Some students who terminate their studies in their final study years do this so that they can concentrate fully on their work or projects in the IT field. Such a choice can negatively influence a young person's later career, but they will, most likely, remain and continue to work in the IT sector.

Bachelor Level Study Programmes at Some Universities in Latvia: Students Admitted, Studying, Graduated and Expelled from 2006/2007 to 2016/2017 School Year

Figure 17



Data Source: Ministry of Education
Note: For a school year n students expelled are calculated as $expelled_n = studying_n - graduated_n + admitted_{(n+1)} - studying_{(n+1)}$

The situation differs where studies are abandoned in the first study year. UL data shows that about 30% of students accepted in the UL IT basic study programmes are expelled after the first semester. Those expelled can, in turn, be divided up into about three equally sized groups: those who did not commence their studies, those who were not able to pass the tests in catch-up mathematics course and those who were not able to pass the tests in the first year introductory courses (algebra and programming). Additional 15% of students are axpelled after the second semester.[56] Consequently, 45% of the students who commenced studies at UL have acquired little knowledge or skills that would be of use for ICT companies. They constitute a target group, by reducing of which, the number of new ICT specialists could be increased. Unfortunately, there are no data on students expelled during the first year of study from other Latvian institutions of higher education, but the number of students expelled during the entire study period shows that the situation at all institutions of higher education is similar.

[56] Borzovs, J., Niedrite, J. un Solodovnikova, D. 2015. Factors Affecting Attrition among First Year Computer Science Students: The Case of University of Latvia. Environment. Technology. Resources. Vol. III, 36-42.

Institutions of higher education have tried to find various solutions to improve the situation, but they have not always been successful. The UL offers a mentor and curator support programme to the first-year students, within the framework of which, later course students and faculty lecturers do additional work with the new students. In addition, about half of the first-year students attend a catch-up course in mathematics, which is meant to assist those whose knowledge of mathematics falls behind the required level to continue studies. The course helps some students, but some are unable to cope with the load and after falling behind, abandon their studies.

At the university level it may be possible to reduce the number of students who upon registering do not end up commencing studies by creating an alternative list of candidates, but it is hard to believe that it would substantially affect the overall number of graduates in the country. In turn, flexible initial stage training options could be offered to help students who are unable to pass the first tests. First, students who are not adequately prepared to start studies could begin catch-up training courses in the summer. Second, students who fall behind during the first semester, could be presented with an option to devote the whole first year to catch-up courses. In this way, the training process would be more flexible and could provide students with opportunities to at least continue studies in the initial stage at varying pace. For this solution to work, special attention needs to be focussed on the progress of insufficiently prepared students. A small group (2-3 students) or individual training programme could be utilized within the framework of the mentor programme where the role of mentors could be performed by advance students. The new students would then attend individual learning sessions regularly and their progress could be followed each week. Of course, some students may not complete their studies and would not remain in the IT sector anyway. It would not be efficient to spend valuable resources just to drag out this process. That is why, support programmes should provide a variety of additional options on the one hand, but, on the other, the individual progress of students should be monitored.

It is more problematic with students whose level of preparation is sufficient, and who abandon their studies to study something else. But, here too, it may be possible to keep some of the students who have been lost, by regularly highlighting career opportunities and involving students in the informal ICT community with the assistance of various events and gatherings.

The involvement of ICT community is also important for attracting people who for various reasons do not wish to currently study in the IT field. Firstly, people who consider the IT field to be too technical, could be addressed with the assistance of sector specialists by focussing people's attention, for example, on the attractive final products.

There should be an awareness here though, that additional efforts will have to be made to ensure the progress and completion of studies of potentially technically insufficiently prepared students. In a similar way, the ICT skills could be positioned as an inseparable component or even a pre-condition for many of today's professions and jobs, and in this way, attract students, who wish to delay the choice of their final profession. Both these activities would be mainly connected with popularizing the IT studies among high school students.

The importance of ICT skills in a wide range of professions could be pointed out to attract students who initially selected other study programmes. A good introductory course in computer science with a focus on the development of abstract and algorithmic thinking, data structuring and programming could be open to all university students. At Stanford University, 90% of the students register for such a course, while at many other US universities it is at least 50% of students.[57] Completing such a well-prepared course might provoke some students to reconsider their study programme and switch to IT studies.

Last, special attention could be focussed on groups in the population that choose IT study programmes comparatively rarely. It has been well documented that compared to men there are few women in the IT field. In 2016, females made up only 17% of IT specialists employed in the EU, and an IT specialist's career was associated more with men than with women. For example, in Great Britain, the proportion of women whose knowledge corresponds to the required qualification for an IT specialist's career, decreases rapidly with the commencement of the formal education process.

[57] Lohr, S. 2017. Get with the Programming. New York Times, Late Edition. 9 Apr 2017: ED.20.

Consequently, among bachelor level applicants there are only 15% of women. It is interesting to note that during the school-age period (from 9 to 18 years of age) females develop a specific dislike for the IT learning process, but their interest in issues associated with IT, for example, programming, increases. In 2016, females made up only 18% of the newly admitted students in IT basic study programmes in Latvia, even though the proportion of females among the total number of admitted students in all study programmes exceeded 50%. However, there was a slightly greater number of females among IT basic study graduates in 2015 at 21%, which possibly points to their better preparedness for the study process.

To increase female interest in technology in the USA, the *Girls Who Code* commune organized a 7-week summer training programme for female high school students. The programme included a programming course, as well as work experience in such companies as *Accenture*, *IBM*, *Facebook*, *Pixar*, *Pfizer*, *Microsoft* and others. Participants had a female IT specialist allocated to them from the respective company, who undertook the role of mentor and continued to collaborate with them after their summer work experience as well. After the training, 93% of the females noted that they had the desire to choose computer science as their future study programme due to the commune's initiative. A similar programme could also be introduced in Latvia.

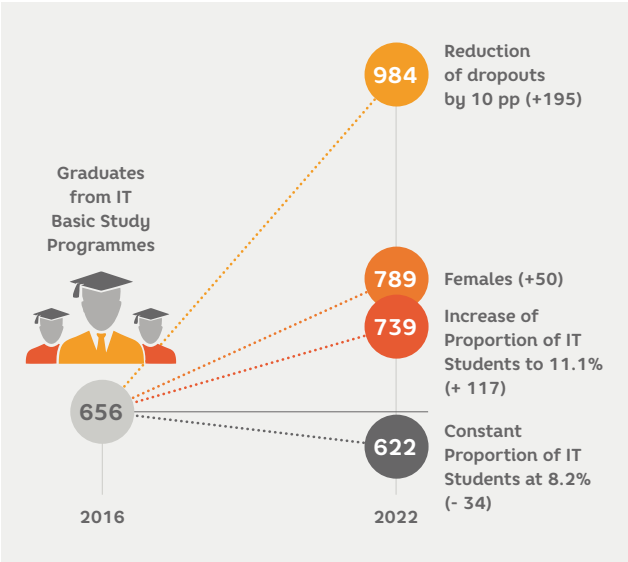
Three important directions can be discerned by collating the abovementioned information. An increase in the number of IT basic study graduates would be possible by working with and introducing the totality of specific activities in a focussed way. First, an attempt should be made to increase the number of young people choosing IT study programmes. If the tendency for the proportion of IT students to increase could be maintained and increased to at least 11.1% by 2022, then the number of newly admitted IT students in absolute numbers would reach 2,088 students by 2022, and the number of graduates, instead of decreasing, would increase to 739. Such an increase could only be achieved by making significant investments in the popularization of the sector, and even in this case, it will be complicated due to the comparatively high proportion of IT students that has already been achieved.

Second, positive discrimination-type instruments could be used in relation to females. Additional 50 women could graduate from IT study programmes (an increase of 5 percentage points), if mentors, financial assistance and individual study support is made readily available for the female students.

It should be recognized that the increase of students will mainly attract young people, who on average will be more poorly prepared for the study process than current students. Therefore, an increase in ICT graduates will, to a large degree, depend on the ability to reduce the number of students abandoning studies. In this respect Latvia's results lag behind, for example, Estonia where during the first study year only 32% of newly admitted students in IT basic study programmes choose to drop out.[58] Ireland shows similar results. On average, one third of bachelor level students in the IT field are expelled during the first year of studies.[59] If Latvia's higher education institutions were able to reduce the proportion of students who drop out in the first year by 10 percentage points (this would allow the UL to achieve Estonia's and Ireland's level of performance), then an additional 195 graduates could be gained on a national level.

Consequently, in the best-case scenario, the number of IT graduates from local candidates could be increased to 984 graduates a year by 2022.

Opportunities for Increasing the Number of Graduates from IT Basic Study Programmes Figure 18



[58] Kori, K., Pedaste, M., Tõnisson, E., Palts, T., Altin, H., Rantsus, R., Sell, R., Murtazin, K. and Rüütmann, T. 2015. First-year Dropout in ICT Studies. Proceedings of 2015 IEEE Global Engineering Education Conference, 437-445.
[59] Higher Education Authority. 2016. A Study of Progression in Irish Higher Education. http://ej.uz/e3v7

Offers of Neighbouring Countries and Opportunities for Latvia

Review of study programmes offered by Latvian higher education institutions, dynamic of newly admitted IT students and demographic trends together suggest that it will not be possible to increase the number of those completing a basic study programme in the IT field to 3,000 per year using only internal human resources.

One of the possibilities for improving the situation is to develop education export and attract IT students from neighbouring countries. This section briefly describes the situation in the IT education field in Latvia's closest neighbouring countries outside the EU.

Russian Federation

The IT industry is one of the most promising sectors of the Russian economy. According to statistical data, about 350-400 thousand IT specialists work in the IT sector in Russia. Despite this, the country faces a shortage of IT specialists which is restricting the development of the IT sector. In 2016, the Russian Ministry of Communications and Media made an announcement that for IT industry to develop successfully the number of programmers in the country needs to reach 1 million by 2018. Russia has increased the number of funded places for new students in the IT field to 42,500 per year, is funding re-qualification courses for specialists from other fields and is making investments in the promotion of children's interest in IT issues, to try to achieve this goal.[60]

In addition to state initiatives the IT industry itself is also playing a significant role in the preparation of new specialists. Such companies as *Yandex*, *Mail.ru*, *Kaspersky Lab*, *1C*, *Microsoft*, *Intel* and *Acronis* are taking on trainees, teaching, and holding competitions and events to popularize the IT sphere. On-line learning platforms are particularly attractive. For example, the Geekbrains learning platform maintains that the number of its registered users in 2017 reached 2 million and the 2-week free of charge introductory programming course has already been completed by 885,000 people. The platform's course content was created in collaboration with IT companies. The platform currently offers 59 specialized coursesfor a study fee of about 180 EUR per month. These fee-paying courses are completed each year by about 4,000 students.[61]

Ukraine

The IT sector is considered to be one of the most dynamic and innovative national economic spheres in Ukraine as well. The number of specialists in the IT sector in Ukraine is one of the largest in Europe and could reach 200,000 by 2020. In 2014, 11,500 young people enrolled in the IT study programmes at higher education institutions. This is still insufficient, as according to assessments, the deficit of IT specialists already reached 100,000 people in 2015, but only about 15,500 new specialists enter the workforce each year.[62]

The Ukrainian government has doubled the state order for new IT specialists, but several higher education institutions find it difficult to increase the number of students due to a shortage of lecturers. Like in Russia, the IT industry is also involved in the training process, arranging programming schools and courses alongside higher education institutions. These types of programming courses were completed by almost 30,000 young specialists in Ukraine in 2015.[63]

[60] Tjournal. 2016. S uma s IT: budut li v Rossii vostrebovony programmisty v blizhajshee desjatiletie. http://ej.uz/b6hs
[61] To find out more about GreekBrains see greekbrains.ru/company
[62] Shubnaja E. V., Pechenaja T. A. 2016. Sovremennie problemy i perspektivy razvitija IT-otrasli v Ukranie. Nauchnij Vestnik DGMA. No. 2 (20E), 203-209.
[63] DOU. 2016. Rynok IT-obrazovanija: kursy i uchebnie centry podgotovili pochti 30 tysjach studentov v 2015 godu. https://dou.ua/lenta/articles/it-schools-rankings-2015/

Belarus

In 2013, about 34,000 specialists worked in the IT sector in Belarus. There are 55 universities in the country which prepare new specialists for the IT sector and 2,500 to 4,000 students complete their studies there each year.[64] Like its neighbouring countries, Belarus also has a deficit of professionals. Since 2011, the government has been implementing a development strategy in the IT sphere with the goal of increasing the number of IT specialists and the sector's contribution to the nation's GDP.[65] One of the strategic steps was to develop a High Technology Park, which concentrates Belarus' IT companies in one place and participates in the preparation process for new specialists together with the universities.[66]

Potential for Latvia's Higher Education Institutions to Attract Students from Neighbouring Countries

Despite the funding of the Russian, Ukrainian and Belarusian governments and the IT industry to increase the number of students and new specialists, more and more students from these countries wish to study abroad. According to UNESCO data, more than 60,000 students from Ukraine and about 56,000 from Russia are studying abroad, while the number of students abroad from Belarus has reached 30,000. Consequently, students from neighbouring countries are quite mobile, and the possibility of getting them to choose to study in Latvia depends on what is offered by local higher education institutions. Currently, the most popular countries where students from Russia, Ukraine and Belarus are choosing to study are Germany, Poland, the USA, France, Czech Republic, Italy, Hungary, Austria and Great Britain.[67]

Most likely to attract students from neighbouring countries, Latvia's higher education institutions must primarily focus on students from Belarus, Ukraine and the border regions of Russia. It may be more difficult to attract Russian students, particularly from Moscow and St. Petersburg, as the offers from several local higher education institutions are comparatively competitive. Several leading global IT companies (for example, Intel, *Samsung* and *Microsoft*), as well as local IT industry leaders *Yandex* and *Mail.ru* offer new IT specialists broad work experience and career opportunities.

Consequently, the capacity of Latvia's higher education institutions to attract foreign students is to a large degree depends on how education attained in Latvia will promote the carer development of the young IT specialists, will it ensure employment, and will the IT industry representatives regard it as corresponding to market demand.

An equally important factor in the competitiveness of higher education institutions is the tuition fee. For example, the current cost of studies in Poland is 800 – 3,000 EUR, whereas Czech state higher education institutions offer studies for free. Studies in Germany and Scandinavian countries are also free. However, studies in Germany take place mainly in German, while living expenses in the Scandinavian countries are comparatively high. In turn, leading higher education institutions in the US and Great Britain compete for the most talented young students by offering scholarships. These institutions are also open to candidates who can afford to pay, but this could be too expensive for a large number of young people in the region. The niche for Latvia's higher education institutions is most likely linked to the comparatively low study costs, and their direct competitors would be other Central and Eastern European countries.

In considering potential foreign students from Russia, Ukraine and Belarus, one of the advantages of Latvia's higher education institutions could be the opportunity to commence studies in the Russian language. This would significantly facilitate the initial study process for some candidates, and would allow attract students, who for now do not consider studying abroad due to their poor knowledge of foreign languages.

[64] UDF. 2013. Nesmotrja na vysokie zarplaty, v Belarusi serjeznij deficit kvalificirovannih IT-specialistov. http://ej.uz/ys45 ; BELBIZ (2012). IT-rynok v Belarusi: kadrovij golod budet narastatj. http://ej.uz/k5r9
[65] To see more about strategy, visit it-strana.by
[66] UNITER (2014). IT-rynok. http://www.investinbelarus.by/docs/-21948.pdf
[67] For more detail see the UNESCO database Global Flow of Tertiary-Level Students. http://ej.uz/adus

Computer Science Study Programme to Attract Foreign Students

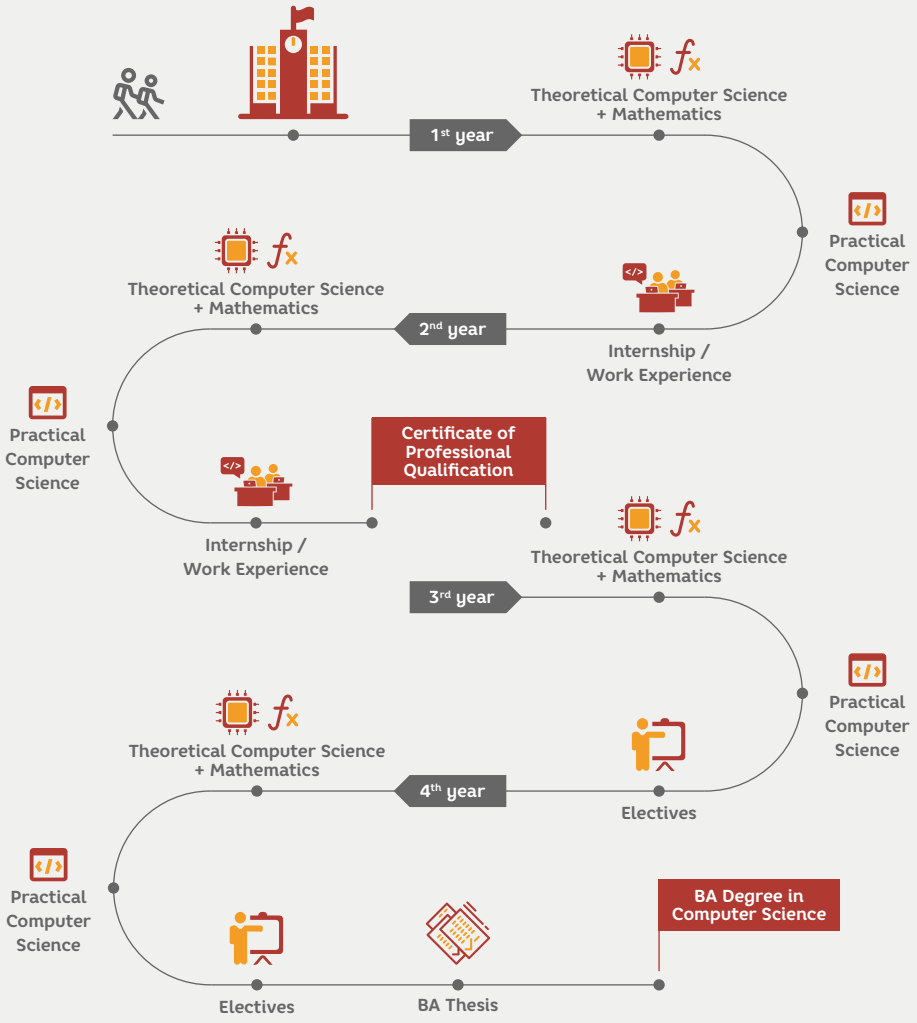
Based on examples of good practice in the training of IT specialists, as well as the guidelines developed by the ACM for the curriculum of bachelor level study programmes in computer science, we have outlined the suggested content of an IT study programme. The programme has been structured by combining several study modules within study courses. Firstly, mathematics and theoretical computer science module courses are introduced and their task is to create a base of primary knowledge. To reduce drop-out rates, students, who have an insufficient level of knowledge, would have an opportunity to take a catch-up course in mathematics, as well as an introductory course in computer science. Similarly, the opportunity to commence studies in Russian would be offered with language teaching provided, which would allow the continuation of studies in Latvian and/or English during the later years.

In turn, practical computer science module includes the basics of programming, system modelling and analysis, as well as other courses which are necessary for a professional career in the IT sector. Practical computer science courses are implemented in collaboration with industry. IT professionals are involved in the development process of the content and practical work takes place at companies. This provides higher education institutions with the opportunity to refresh course content in line with the latest industry development trends and requirements, incorporating the latest technology and software in the learning process.

Over the first two years students are provide with work experience opportunities and during this period students must additionally have the opportunity to gain a certificate of professional qualification that would allow them to enter the employment market as junior specialists. The third and fourth year are partly devoted to specialization – development of competencies in some IT sub-sector or application of a specific technology which is required for the development of academic work and the receipt of a bachelor degree.

Suggested Model of IT Programme Structure

Figure 19



Strategy

3,000 graduates programme

To ensure further development of ICT industry and to meet the demand for ICT professionals in other sectors of the economy, there is a need for 3 000 graduates from ICT study programmes every year

- **1,000 from local candidates:** promotion of ICT studies, with positive discrimination to raise the proportion of women, mentoring and individual study programmes for struggling students
- **2,000 from foreign students:** study programme that correspond to labour market demand, is financially attractive and accommodates special needs of the students

World class ICT infrastructure

To remain among the countries with the world leading ICT infrastructure, state, municipal and ICT service providers should continue ICT infrastructure investments and upgrading process.

ICT start-ups fro local economy

Fostering the cooperation between ICT start-ups and other sectors of the local economy including the public sector representatives, will increase the probability that local companies create globally competitive products.

- **Advancement of cooperation promoting ecosystem**

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