empirica Working Paper

E-skills and e-leadership skills 2020

Trends and forecasts for the European ICT professional and digital leadership labour market

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Abstract

The ability to become innovative and remain competitive in the market strongly relies on the competences of the workforce and the efficiency of exciting policies and other relevant mechanisms to fine – tune retention of skilled workers in line with rapidly evolving market trends. The speed digital transformation is influencing today's economy requires hasty actions from companies to rapidly and efficiently adopt new technologies for driving innovation and business growth.

Parallel to arising technologies and digital transformation, there is also a wave of transformation in the way of doing business, which at the same time, reshapes the set of e-skills and competences essential in the digital economy. The mismatch between the skills available and those demanded for digital transformation of the economy concerns all Member States and their policy makers.

This paper provides insights into ICT workforce development in Europe, within both core and broad definition of ICT jobs, looking also at changes in ICT graduates over years as a major inflow into this workforce. It analyses trends of e-skills demand and supply in Europe and develops foresight scenarios and forecasting until 2020. Furthermore, the paper shares the latest forecasts on the demand of e-leadership skills, the necessary set of skills for exploiting IT for innovation and business development.

Content

1   Introduction

ICT skills and e-leadership skills are a major policy concern in Europe in order to become more innovative and competitive. Apart from domain skills in ICT as it is traditionally expected to be the area of expertise of ICT practitioners, there is an urgent need for also other workers with a portfolio of skills that includes but is not restricted to ICT – both in non-ICT occupations that evolve into digital jobs and in leadership positions which more and more require e-leadership skilled experts having a T-shaped portfolio of skills, expertise in new technologies and the development of successful and efficient organisations.

The gap between the demands for digital transformation of the economy on the one hand, and the knowledge, skills and competences of the workforce on the other is widely reported and agreed upon in the public and academic realm, although notions of its actual size remain vague. In the current economic situation, there is also widespread hope that a successful policy to foster the skills needed for this digital transformation can regain Europe's technological edge and resilience in global competition.

But what digital skills exactly will Europe need to educate to its current and future digital workforce in order to be as sustainable as possible in this fast changing tech environment? Form mining deeply into the Labour Force statistics of the past years, it emerges that there have been strong patterns in very recent years that can give hints as to the actually massive structural changes that are ongoing within the ICT workforce.

Looking at such patterns alone, however, will certainly not suffice to calibrate forecast scenarios, but stakeholder engagement needs to inform forecasting as much if not more than analysing quantitative trends in the statistics. It is this stakeholder engagement that empirica can build upon specifically for our analytics, having been involved in innumerable and invaluable interactions with CIOs, professional bodies, Higher Education, policy makers and social partners over the past years.

There is an urgent need to quantify and forecast the demand and supply for e-skilled work phenomena in order for policy action to be grounded in empirical evidence[1]. While the concept of an ICT practitioner is relatively well captured in official statistics and can rely on an established language to describe and communicate phenomena, for concepts like e-leadership skills and digital jobs, which genuinely are about how ICTs are becoming a more and more important part of non-ICT jobs, this is not yet the case . Therefore the forecast of ICT practitioners can rely on established statistical notions, on a comparably better developed common language between employers, educators and policy makers than the e-leadership forecast. The efforts of establishing the notion of e-leadership skills in business, both SME and corporate, policy and academia are ongoing and first progress is visible already, but measurement remains difficult. The results of the e-leadership forecasting are therefore less elaborate and should be understood as order-of-magnitude estimations rather than exact measurements.

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1   For the European e-Skills conference 2014 in Brussels (http://eskills2014conference.eu/), we have prepared an analysis of e-skills trends that become visible in official statistics and reported on an experimental pilot survey we had carried out earlier as a proof of concept of e-leaderhisp measurement. These efforts were carried out in relation to two ongoing serice contract work assignments for the European Commission ("New curricula for e-leadership (GUIDE)", www.eskills-guide.eu, and "E-leadership skills for SMEs (LEAD)", www.eskills-lead.eu), but they were not part of the contractual obligations and hence not reported in detail in project deliverables. We received many requests for the figures reported at the conference and would hence like to present them in this working paper.

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2   E-Skills supply and demand in Europe

2.1   ICT workforce

The ICT workforce in Europe in 2013 comprises 7.3 million workers, or 3.4% of the European workforce. Broadening up the definition further, ICT mechanics and manual workers skills would add 1.4 million ICT workers, to a European Labour Force of 8.7 million ICT workers.

The ICT workforce is here defined according to occupational categories from the ISCO – International Standard Classification of Occupations 2008 and quantifications are made using data from the Labour Force Surveys (LFS) of the EU-27 Member States provided by Eurostat.

Figure 1: ICT professional workforce in Europe 2013 by ISCO-08 skills clusters
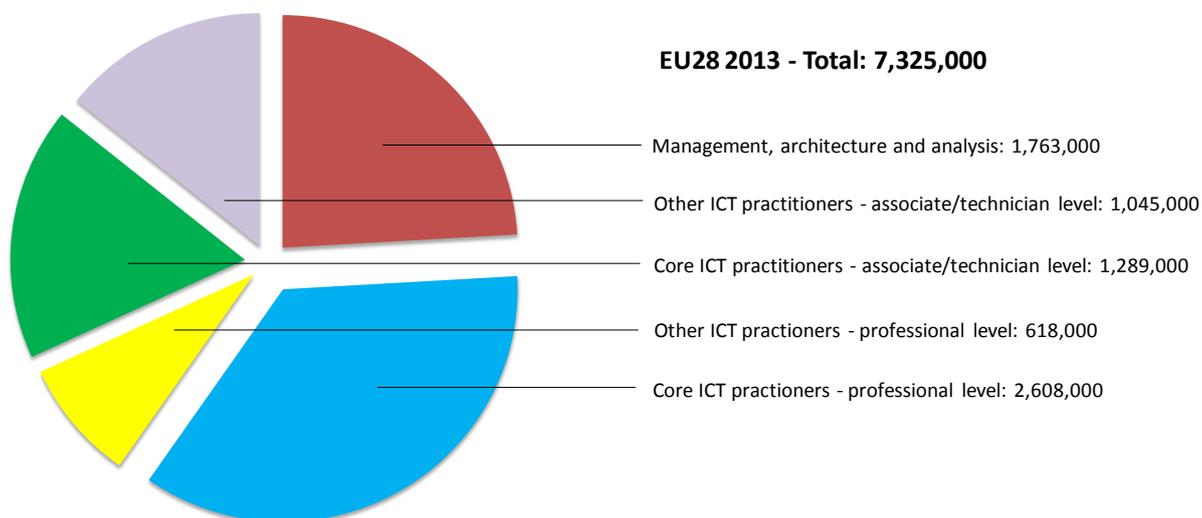
EU28 2013 - Total: 7,325,000

Management, architecture and analysis: 1,763,000

Other ICT practitioners - associate/technician level: 1,045,000

Core ICT practitioners - associate/technician level: 1,289,000

Other ICT practioners - professional level: 618,000

Core ICT practioners - professional level: 2,608,000

Source: empirica calculations based on LFS retrieval by Eurostat. Some further estimates apply.

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Table 1: ICT practitioner workforce in Europe 2013

ICT PRACTITIONER WORKFORCE (1+2+3+4+5)	ISCO-08	7,325,000
1) Management, architecture and analysis		**1,765,000**
-Information and communications technology service managers	1330	407,000
-Management and organization analysts*	2421	638,000
-Systems analysts	2511	720,000
2) Core ICT practitioners - professional level		**2,608,000**
- Software developers	2512	721,000
-Web and multimedia developers	2513	127,000
-Applications programmers	2514	853,000
-Software and applications developers and analysts not elsewhere classified	2519	220,000
-Database designers and administrators	2521	91,000
-Systems administrators	2522	426,000
-Computer network professionals	2523	124,000
-Database and network professionals not elsewhere classified	2529	46,000
3) Other ICT practitioners - professional level		**618,000**
-Electronics engineers	2152	245,000
-Telecommunications engineers	2153	205,000
-Information technology trainers	2356	35,500
-Information and communications technology sales professionals	2434	133,000
4) Core ICT practitioners - associate / technician level		**1,289,000**
-Information and communications technology operations technicians	3511	245,000
-Information and communications technology user support technicians	3512	205,000
-Computer network and systems technicians	3513	35,500
-Web technicians	3514	133,000
5) Other ICT practitioners - associate/technician level		**1,045,000**
-Electronics engineering technicians	3114	202,000
-Process control technicians not elsewhere classified	3139	219,000
-Air traffic safety electronics technicians	3155	6,500
-Medical imaging and therapeutic equipment technicians	3211	210,000
-Medical records and health information technicians	3252	23,600
-Broadcasting and audio-visual technicians	3521	207,000
-Telecommunications engineering technicians	3522	176,000

*Source: empirica calculations based on LFS retrieval by Eurostat. Some further estimates apply. * Note that ISCO group2421 was multiplied by 50% in order to allow for ICT consulting.*

Table 2: ICT mechanics and assemblers in Europe 2013

ICT mechanics and assemblers		1,402,000
- Electronics mechanics and servicers	7421	331,000
- Information and communications technology installers and servicers	7422	475,000
- Electrical and electronic equipment assemblers	8212	596,000

Source: empirica calculations based on LFS retrieval by Eurostat. Some further estimates apply.

ICT practitioners are working in almost all industries of the economy and not just in the ICT industry sector.

Figure 2: ICT professional workforce in Europe 2013 by ICT and Non-ICT industry
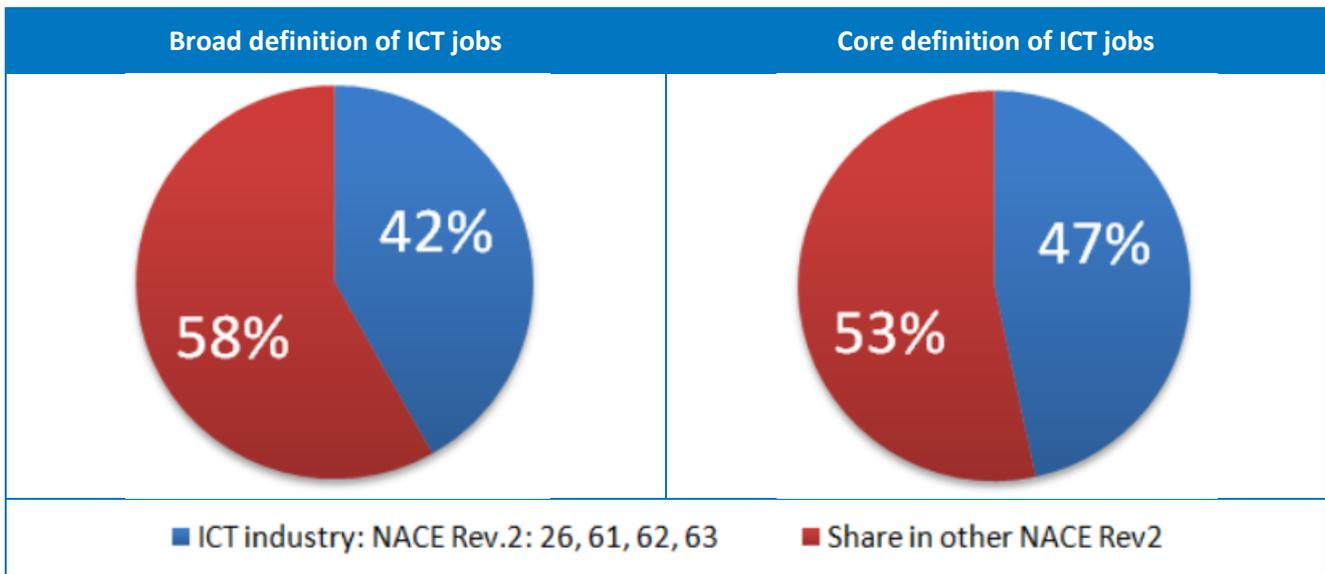
Source: empirica calculations based on LFS retrieval by Eurostat.

Looking at the European ICT professional workforce as a whole, it becomes apparent that three countries already account for half of today's jobs, namely the United Kingdom, Germany and France. Adding Italy, Spain, Poland and the Netherlands already this group of seven would reflect already three quarters of the European ICT professional workforce.

**Figure 3: ICT professional workforce in Europe 2013**
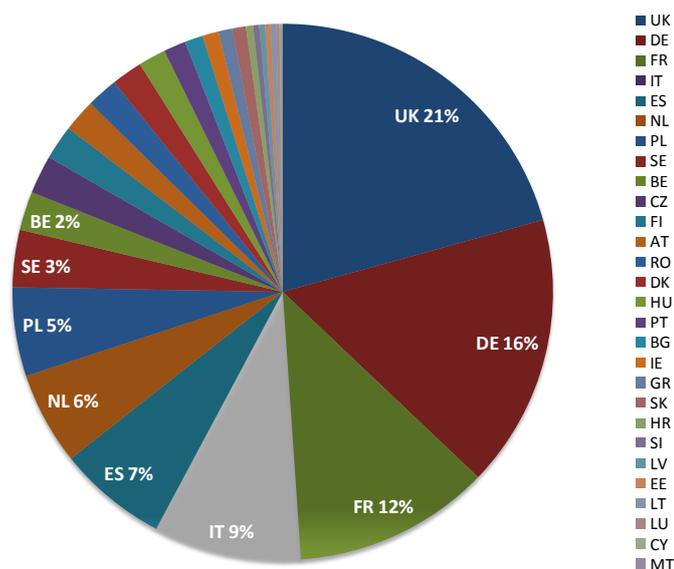
Source: empirica calculations based on LFS retrieval by Eurostat.

The share of the ICT professional workforce within the total workforce is 3.4% in Europe and varies significantly across the European countries. Sixteen EU Member States show shares below the EU-27 average with Greece, Lithuania and Romania below 2% and Portugal, Cyprus and Croatia at levels below 2.5%. The other extreme includes the United Kingdom, Luxembourg, Sweden, Finland and Denmark with a share of above 5%.

There is a slightly positive correlation between the share of management levels skills among professionals and the share of ICT professionals in the workforce. While on average one in four ICT-professional jobs (24%) is in ICT management, architecture and analysis, countries with an overall large ICT workforce tend to have seen a trend towards higher-level skills in the ICT workforce, although some exceptions to this rule appear. In the Netherlands which features the largest share of management, architecture and analysis jobs, their share is 39%, followed by Germany (35%), Sweden (34%), Belgium (33%), Finland (32%), Lithuania (32%), and Latvia (30%). Countries with a share below 15% are, in ascending order, the Slovakia, Hungary, Czech Republic, Croatia and Italy.

Figure 4: The Structure of the ICT Workforce in European Countries (EU27) in 2013
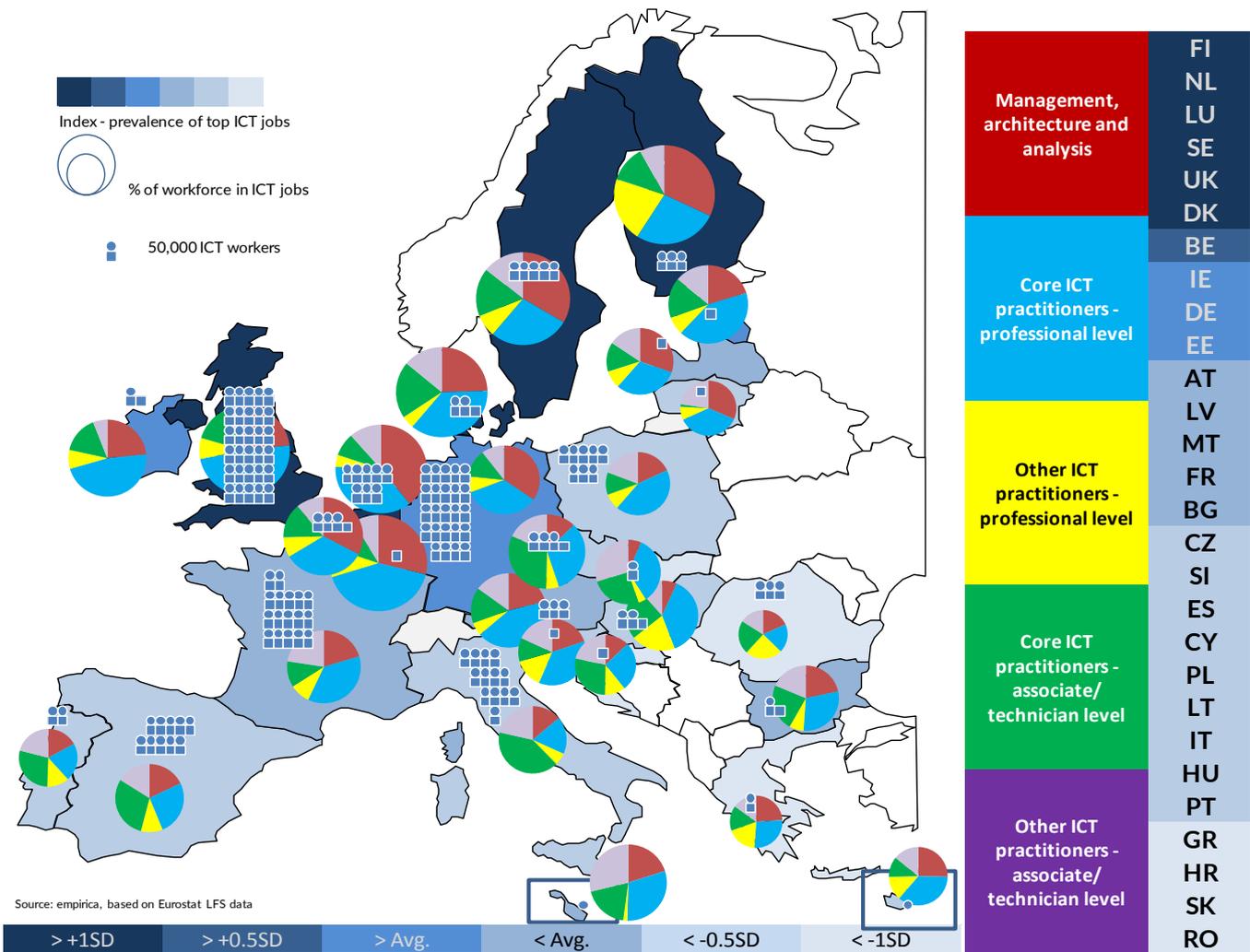
Source: empirica calculations based on LFS retrieval by Eurostat.

The worker segments that have been growing massively over the last years (compare next section) can be a metric of ICT innovativeness or maturity. Empirica has produced an index of the maturity of the ICT workforce which is represented above by the different shades of blue. The darker, the more ICT management and advanced ICT professionals in architecture and analysis as well as in core ICT practitioners

there are in a country relative to its total workforce. The ranking of countries is given in the right hand column of the picture above. The index is a combination of the structure and the relative size of the ICT workforces.

The size of the workforce is represented by the blue worker icons, each representing 50,000 ICT workers, across job families. As to the size of the workforce, half of Europe's ICT workers work in three countries: 21 % can be found in Britain, 16% in Germany and 12% in France. Add Italy (9%), Spain (7%) NL (6%) and PL (5%) and 7 countries cover 75%.

The share of ICT workers as percent of the total workforce is represented by the diameter of the pie charts per country. The largest shares in the workforce can be found in Finland, Luxemburg, Sweden and the UK.

The structure of the ICT workforce can be read from the segments of the pie charts. The colour coding is displayed in the column which is second from the right. The largest share of management, architecture and analysis jobs can e.g. be found in the Netherlands.

If we compare the seven largest ICT employing nations, we see significant differences in the workforce structure. There is an especially large share of top ICT jobs in the Netherlands and in Germany. The UK has the largest workforce, with a huge professional segment as well as management. France and Poland have a similar structure with many professional level workers.

Spain and Italy on the other hand have far more associate level ICT workers and less highly skilled employees.

**Figure 5: ICT professional workforce as share of employed Labour Force in Europe 2013**
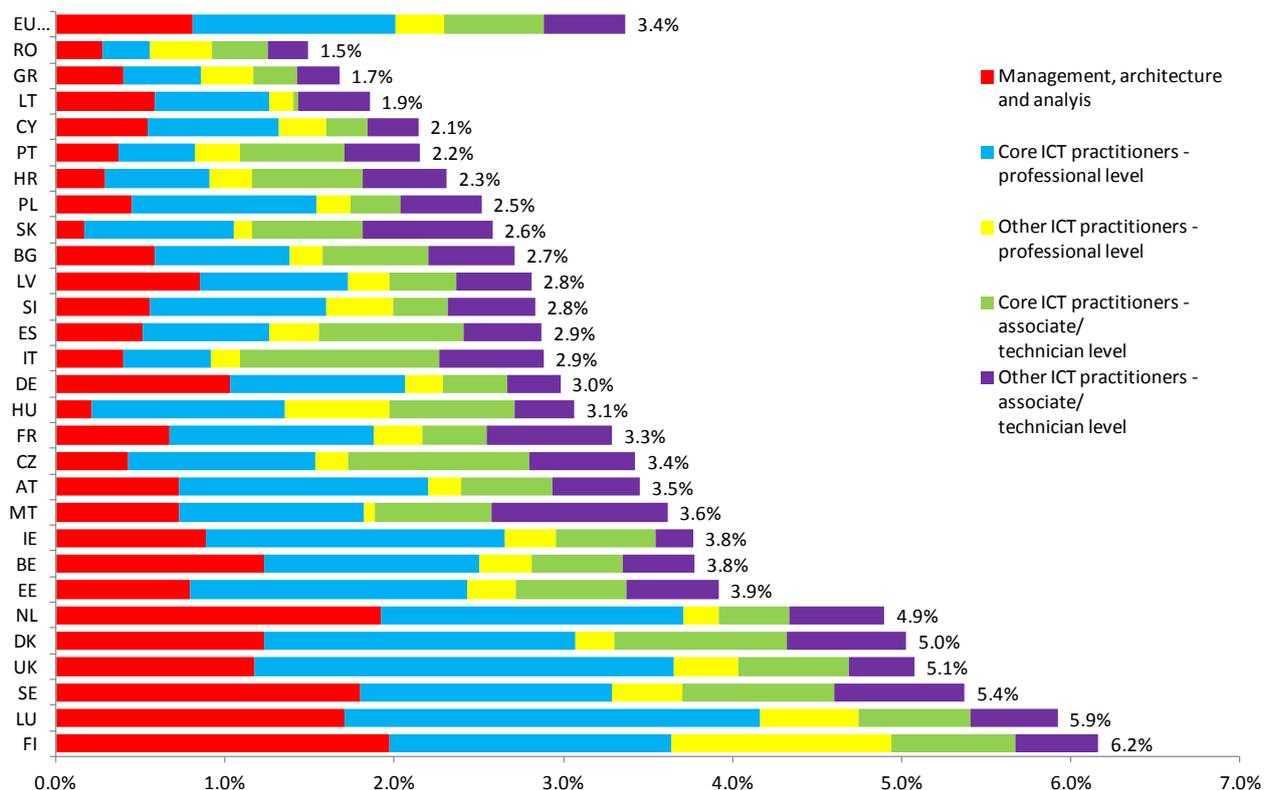
Source: empirica calculations based on LFS retrieval by Eurostat.

2.2   Developments

The development of the ICT workforce in Europe between 2000 and 2013 has been very dynamic. The size of "ICT workforce" naturally depends on the definition used. If using a minimum definition, that only includes a core set of practitioners, in the first decade of the millennium, from 2000-2010, we have seen an average compound growth rate of 4.26% and of 3.33% between 2011 and 2013 (with a break in series 2010/11).

Figure 6: Development of ICT employment and average annual growth rates in Europe 2000 – 2013
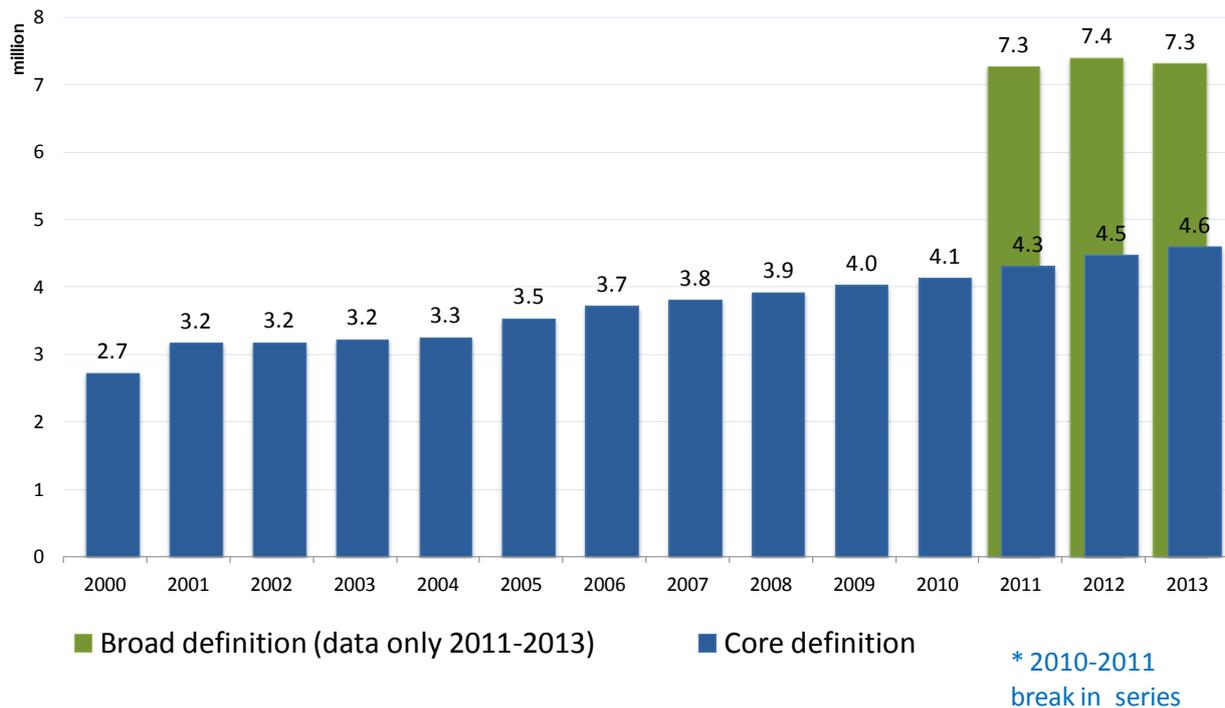
Source: Eurostat LFS. Narrow definition: 2000-2010 ISCO-88 groups 213, 312: "Computing professionals" and "Computer associate professionals". Break in series 2011: ISCO-08 groups 25 "ICT professionals", 35 "Information and communications technicians". Broad definition: see elsewhere in this document.

In a broader definition, today's ICT workforce in Europe amounts to 7.3 million workers[2], the growth of workforce according to this broader definition has however been on average 0.3% between 2011 and 2013[3].

A growth rate of 4.26% means a doubling of stock every 17 years, (3.3%: 22 years). It is arguably the case that continuous percentage growth (exponential growth) cannot be taken as trend-extrapolation in the longer to very long term, but for the short term horizon it will be a good heuristic to compare to.

Europe and the world have seen two major economic crises in the first decade of the millennium. After the dot-com bubble burst in 2000, many firms in the ICT sector went bankrupt, were slashing employment or at least putting on the brakes in terms of new hiring. Consequently, ICT employment suffered as can be seen in the above diagram with only marginal increases for the years 2001-2004.

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[2]   See definitions in the previous chapter.

[3]   There are no data available before 2011 for the broader definition.

The banking crisis began to show in 2008, evolved into an economic crisis and sovereign debt crisis Europe is still trying to cope with today. Unemployment has been building up in many countries after 2009. In terms of ICT employment, however, nothing similar seems to have happened. Between 2008 and 2010, ICT employment increased by on average 2.65% per year. Between 2011 and 2012 we see rapid job growth, with different segments of the ICT labour market benefiting more than others.

From 2011 on, when statistical institutes switched to a new taxonomy, we were able to produce a broader statistic of the ICT workforce, including many more ICT jobs, as is depicted by the „Broad Definition" containing all of the jobs listed in the box below. This definition includes more than the core development and operations jobs. In general, one has to be a little more cautious about this statistic than the core jobs statistic, because some of the data for some countries had to be estimated.

In the broader definition there is more variance but more or less stagnation for the three years of measurement available.

The question arises, whether this can be interpreted as a uniform trend, as opposed to perhaps a compound of different trends at disaggregation level? Another question is whether, when the sum total stays at a given level, whether that is an expression of a stagnant demand for ICT workers or it is the result of supply side bottlenecks.

In more detailed data, one sees that massive changes in the structure of the workforce are happening right now. There is a surge in "Management" and "Plan/Design" positions: IS management and governance, architecture, analysis. Europe has added 400,000 jobs in this category in only two years.

There is also obviously a high demand for "core ICT jobs", such as Software and Application developers, Web and Multimedia experts, Database designers and administrators, system administrators and network and operations practitioners.

The open vacancy data that is available from different sources for several countries shows that there is also a severe excess demand for these core jobs. From vacancy data it emerges that the most sought after IT positions currently are software engineering and web development jobs, and application administrators. These jobs are in high demand with many unfilled vacancies reported.

At the same time we see a decrease in the number of jobs for some other jobs, such as peripheral, enabling and maintenance occupations. This includes

- Telecoms and electronics engineers
- Sales and training professionals
- Technology specific maintenance and operation technicians

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Figure 7: Growth of ICT professional workforce (EU27) 2013 compared to 2011

Management, architecture and analysis	ICT managers
	Management and organization analysts (partly)
	Systems analysts
Core ICT practitioners - professional level	Software developers
	Web and multimedia developers
	Applications programmers
	Other software and applications developers and analysts
	Database designers and administrators
	Systems administrators
	Computer network professionals
	Other database and network professionals
Other ICT practitioners - professional level	Electronics engineers
	Telecommunications engineers
	IT trainers
	ICT sales professionals
Core ICT practitioners - associate/ technician level	ICT operations technicians
	ICT user support technicians
	Computer network and systems technicians
	Web technicians
Other ICT practitioners - associate/ technician level	Electronics engineering technicians
	Process control technicians not elsewhere classified
	Air traffic safety electronics technicians
	Medical imaging and therapeutic equipment technicians
	Medical records and health information technicians
	Broadcasting and audio-visual technicians
	Telecommunications engineering technicians

Source: empirica calculations based on LFS retrieval by Eurostat.

2.3   ICT graduates

The major inflows into the ICT workforce would obviously come from the ICT graduates from Higher, and in some countries Vocational, Education. The e-skills supply in Europe in 2012 from ICT graduates from Higher Education can be estimated to sum up to 111,000 ICT graduates[4]. A closer look at the developments over the past 10 years shows a trend indicating decreasing numbers throughout Europe for the past years, but especially in the United Kingdom and Sweden. After a continuous increase and a peak of 129,000 ICT graduates leaving universities in 2006 the figures went down.

Figure 8: Enrolment in and Graduates from Computer Science studies (ISCED 5A and 5B) in Europe (EU28)

Computer Science graduates
(first degrees / qualifications in ISCED 5A and 5B)

Enrolment in Computer Science
(in ISCED 5A and 5B)
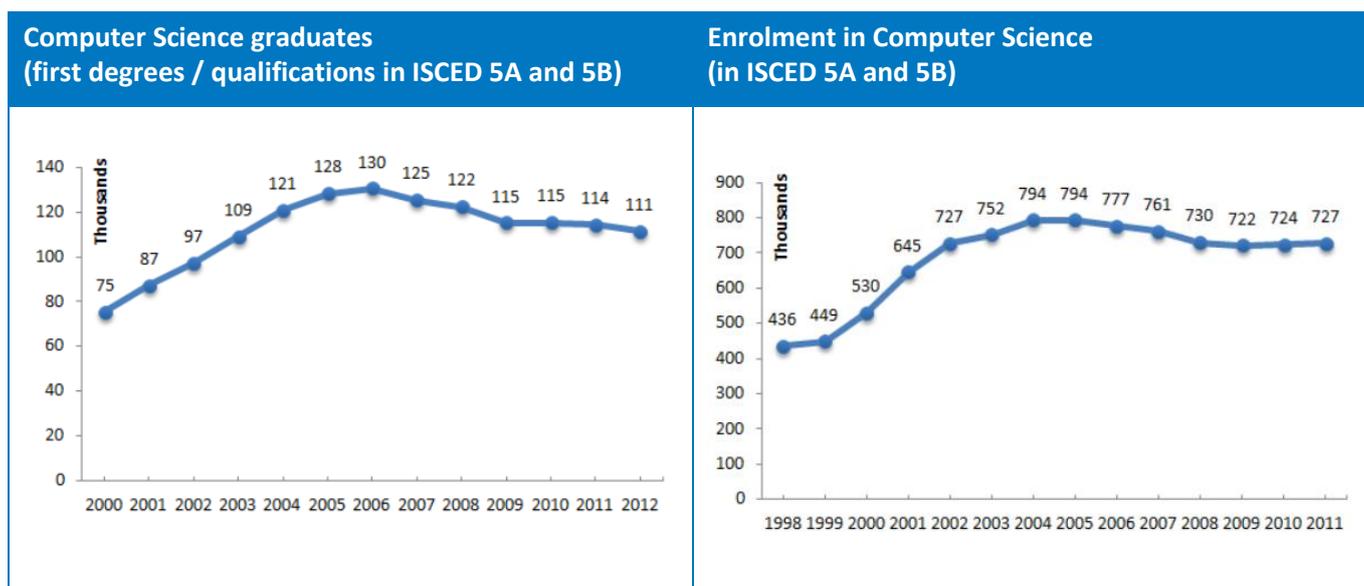
Source: Eurostat, some imputations and assumptions apply

The interest in pursuing ICT careers seems to have been diminishing since the middle of the last decade, when the number of graduates had reached a peak. The number of computer science graduates grew even after the dot com bubble burst, but has been in decline in Europe since 2006.

The effect of the decrease in the number of graduate entrants to the ICT workforce is intensified in Europe by an increasing number of retirements and exits, as ICT practitioners leave the workforce.

The most dramatic decrease of graduate numbers can be observed in the UK, where the number of graduates today is down to just 63% of the number it used to be in 2003. Decreases can also be observed in the other countries except Germany and France.

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[4]   This figure represents a count of first degrees in ISCED 5A and first qualifications in 5B. The number of students entering the labour force in a given year does not equal but is approximated by this number of graduates, as many will go on to second or further degrees (master, PhD). However, also counting second degrees would mean that every student is counted more than once, even if in different years.

By counting only first degrees/qualifications, every graduate will be counted only once (except the supposedly very rare cases of doing both a 5A and 5B degree), even if labour market entry may be at a later point in time. However, there may be an issue of double counting with initial vocational degrees (ISCED 3 and 4), to which individual learners may later add an ISCED level-5 degree.

Another issue with this method lies in a poor representation of those graduates who earn a second (master's) degree but switch subjects. On the one hand, ICT related bachelors may switch to other subjects and not enter the workforce as ICT professionals, while on the other hand there are numerous ICT related masters that are addressed to non-ICT bachelors.

France has meanwhile overtaken the United Kingdom in terms of ICT graduates from university and now contributes 18% of all European graduates. The UK comes in second with 17%, and Germany third (15%) of the European computer science graduates to the labour market. The shares have changed dramatically, if compared to ten years earlier when the UK produced almost a third of Europe's Computer Scientists (30%) and Germany just 7%.

Enrolment has also reached a peak in 2004 and 2005, but figures have stabilised recently and a slight increase is visible since 2009.

Figure 9: ICT graduates (first degrees in ISCED 5A and first qualifications in 5B) in Europe 2012
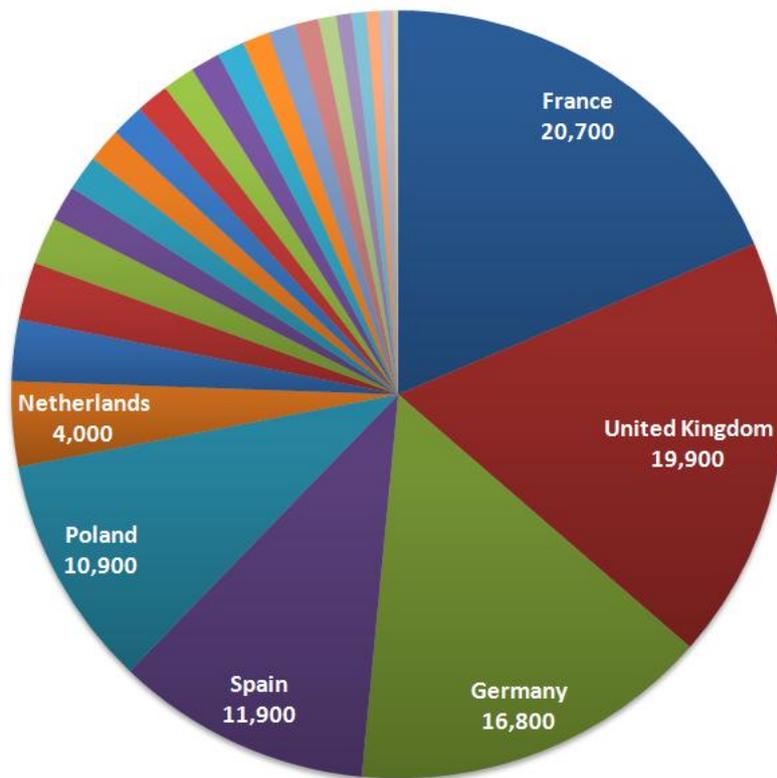
Source: empirica, based on Eurostat educ_grad5

Figure 10: Tertiary level computer science graduates in EU28 countries in 2003 – 2012
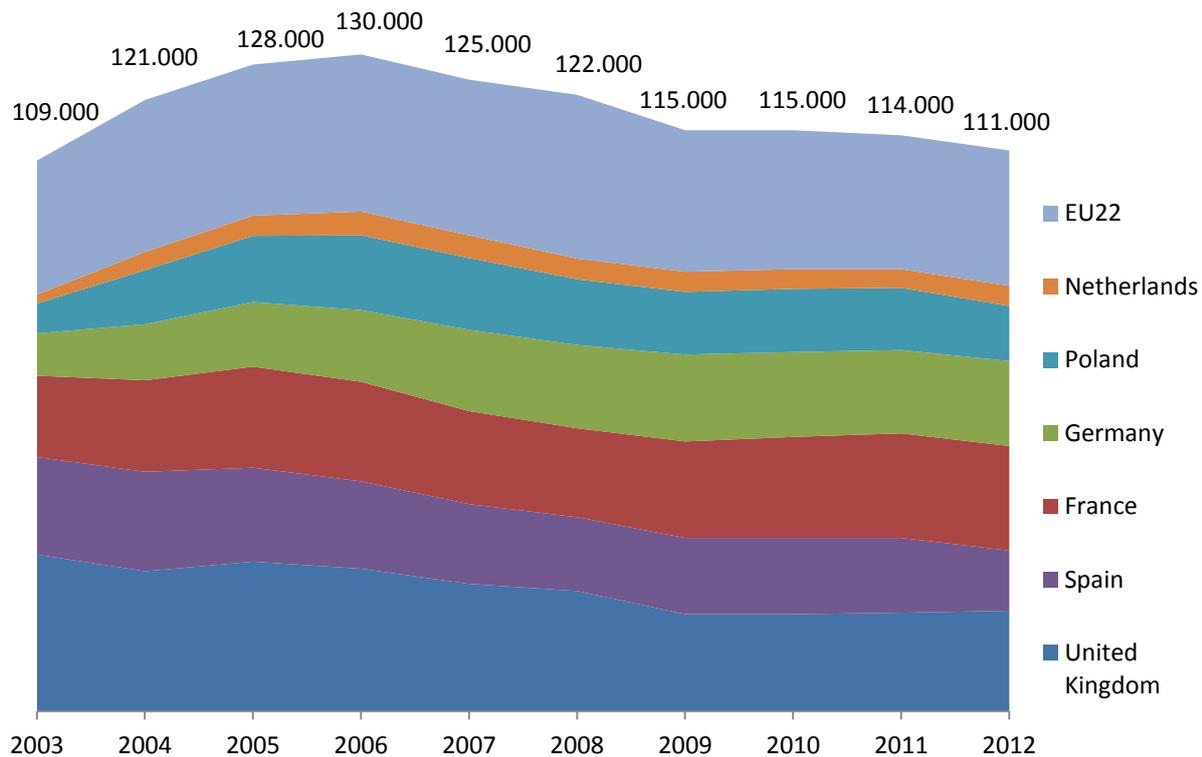
Source: empirica, based on Eurostat educ_grad5

2.4 E-skills demand

2.4.1 ICT skills shortages

Today, like in almost all recent years except for the aftermath of the dotcom-bubble bursting, the demand for ICT workers is outstripping supply. The results of a representative empirica survey of CIO's and HR managers in eight European countries in 2012 showed that the demand for e-skills, i.e. ICT professionals and practitioners, extrapolated to the whole of Europe (EU-27) can be estimated at around 274,000 in 2012. This is based on the numbers given by CIOs and HR managers in European organisations for the number of vacancies in ICT-related occupations.

Among these, we find a demand of about 73,000 vacancies for the EU-27 for "ICT management and business architecture" skills and about 201,000 for "Core ICT practitioners" and "Other ICT technicians" jobs.

Of these vacancies, 82,000 are reported in Germany, which exhibits the by far largest excess demand of all countries. With the economic situation currently differing as it does between Member States, differences are visible with regards to national levels of demand.

With 201,000 open posts, the number of vacancies is significantly higher for ICT Practitioners compared to the ICT management and business architect level professionals with around 73,000 vacancies. As percentage of existing workforce, there are 3.4% open positions for practitioners and 5.0% for management and architecture jobs.

2.4.2   Extrapolation to 2013

As no new surveys could be carried out, vacancy data for the baseline year 2013 had to be estimated. This was done using 2012 percentage applied to the new known job totals.

2.5   ICT professional workforce forecasts

The main forecast scenario represents the most likely future as we foresee it for the time horizon of 2013 to 2020. The forecasting models differentiate between stocks and flows, or between a baseline market and dynamic entries and exits. The baseline basically consists of a number of existing jobs, number of vacancies and number of unemployed ICT practitioners. Flows are modelled as entries of graduates and exits of professionals.

Supply side model

The availability of individuals with the different types of e-skills who are either gainfully employed or seeking employment is termed e-skills supply to the labour market. As mentioned above, the e-skills supply **stock** includes individuals in ICT practitioner positions and unemployed ICT practitioners. The scope of e-skills supply depends on the scope of the e-skills definition used and is obviously not static.

The supply total for 2013 is estimated at 7.7 million, of which 7.35 million are in employment and 376,000 unemployed.

E-skills **inflows and outflows** to/from the labour market need to be identified and statistically measured and future developments modelled to gain a comprehensive and complete picture of e-skills supply in the market. To capture market dynamics, i.e. the inflows and outflows of individuals in the pertinent e-skills categories, specific approaches need to be developed.

New market entrants typically are **computer science graduates** of **tertiary education** entering the labour market. In many countries (Germany and Poland in particular) also (post-) secondary **vocational training** plays a major role as supply pool.

Anecdotal evidence supports the observation that the share of computer science graduates has increased in ICT recruitment over the last decade[5], yet **other graduates**, from mathematics, natural sciences, engineering or social sciences who possess the IT skills demanded still today fill ICT positions that would otherwise remain vacant.

While it is relatively easy to approximate an adequately accurate annual supply of university leavers and vocational school leavers with a major in ICT, any attempt to distil a supply pool from the official statistics about natural science, maths, or social sciences graduates has to rely on evidence based assumptions and auxiliary hypotheses about the share of outsiders entering the ICT workforce.

Also **career changers** originally coming from a non-ICT background may take on ICT positions, furthermore re-entrants who had been out of the labour market previously. While recent research (e-skills QUALITY Study: www.eskills-quality.eu) shows that certification has become crucial for ICT practitioners across all backgrounds, it can be assumed that especially for "educational outsiders" certification and re-skilling programmes play a crucial role in adapting the workforce skills to the demand side requirements.

Finally, **immigration** is a source of additional supply to the market.

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[5]   A UK study of 2001 still found that „the majority of graduates working in ICT jobs do not hold a degree in an ICT related subject. While the most common degree subject is maths or computing (40 per cent), others include engineering and technology (21 per cent), physical sciences (11 per cent) and business studies (nine per cent). Graduates employed as computer analysts/programmers display the greatest range of degree subjects. Also, female graduates working in ICT occupations are more likely to have degrees in non-ICT or non-technical subjects (e.g. social sciences). (THE INSTITUTE FOR EMPLOYMENT STUDIES (2001): An Assessment of Skill Needs in Information and Communication Technology.) http://dera.ioe.ac.uk/15250/1/An%20assessment%20of%20skill%20needs%20in%20ICT.pdf)

Certifications and re-skilling programmes play a crucial role in adapting the workforce skills to the demand side requirements.

Supply side **exits** may be due to **retirement, temporary leave** (e.g. parental leave) and **emigration** of ICT workers as well as promotion or other **career change** to non-ICT jobs (– or jobs at least not statistically captured as ICT jobs).

The necessary statistical data regarding university graduations is available from Eurostat (see annex and chapter 2.3). Further inflow indicators of relevance - which could be considered subject to availability of the necessary data - include data from immigration and career changers or market re-entrants.

Outflow data would mainly include statistics on retirements, emigration, career changers or re-entrants. This kind of data is hardly available across countries and estimates have to be based on analogies.

Demand side model

Conceptually, demand given as a specific figure, i.e. not as a function of wage (as in textbook economics), is the size of the workforce that the market would absorb shortly given that the current wage level prevailed. Markets tend to adjust via the price or quantity offered of the commodity. However, certain limitations apply in the labour market in the short term as regards the availability of skills, and obviously also with regards to the wages employers are willing to pay.

While a short-term demand can be computed by adding existing and open posts, future demand will be highly path dependent. A planned demand that cannot be satisfied today and over a longer period and where prospects of filling it are meagre will eventually lead to evasion on the demand side, i.e. changes in the production structure. Therefore it is crucial to understand the concept of future "**demand potential**" which will be a demand given the supply available is not actually too distant from the plans of the enterprises. It should therefore be noted that **an extremely high projected number of vacancies in a distant future will probably not actually be realised**, but derives from a demand potential for potential jobs which could be created if Europe manages to produce the skills needed for these jobs.

Demand potential up until 2020 is calculated and estimated using the following observations:

- The long term trend of ICT workforce growth over the past decade

- Annual growth of ICT employment has remained very robust throughout the crisis

- The correlation between the ICT workforce growth rates, GDP growth rates and IT investment growth rates have been disappearing somewhat during recent years

- There seems to be less influence of economic cycles and a stronger indication of a "mega-trend"

- Consequence for foresight: Heavier weighting of "trend" in favour of "economic situation"

- The approach contains the following inputs:

- Market insight data on enterprise IT spending

- Market insight data on hardware, software, services: IT Budgets

- Market insight data on Consulting Budgets

- (Semi-) Official Statistics on IT spending / IT investment (EITO, Eurostat)

- An evidence based estimate on the split of IT budgets into hardware, software, services

- Estimation of Labour costs, internal and external

- Correlation with GDP growth, IT investment and IT labour market

- Scenario outputs on the assumptions of GDP growth, IT investment which leads to estimations of IT labour demand (costs)

- Assumptions on wage developments and IT labour costs result in an estimation of IT labour headcount

Technological trends are included to take effect from 2015 on, together with a beginning maturity of some markets in terms of outsourcing and offshoring. Other major markets yet are still catching up through this period.

Scenarios furthermore deliver assumptions on the distribution of IT labour costs into a) management / business architecture level, b) core ICT practitioners and c) ICT technicians. Technological trends mainly put pressure on lower skilled ICT practitioner demand, while lifting demand for management / business architecture type of skills.

As is inherent in the concept of demand *potential*, adjustments to supply shortage need to be made in the scenario.

Assumptions for forecasting future e-skills developments

Several assumptions for forecasting the future e-skills developments in Europe have been developed which build the basis for the calculation of e-skills demand and supply for the period up until 2020. These relate to the:

- Entry rate of ICT graduates, both from tertiary and vocational education (ISCED 3-5) into the ICT workforce;

- Development in the numbers of ICT graduates from tertiary education from 2013 to 2020

- Development in the numbers ICT graduates from vocational education from 2013 to 2020;

- Entry rates of STEM graduates entering the ICT workforce;

- Upgrading of skills of outsiders and career changes through training and further education (estimated number of awarded industry-based ICT training certifications);

- Replacement demand of ICT practitioners and ICT management staff leaving the workforce annually (Cedefop based);

- Expansion demand according to a baseline based on applying historical correlations of GDP and ICT investment and a trend component;

- ICT Management recruitment[6] (ICT managers, enterprise architects, ICT consultants) specifying a percentage of individuals from the ICT practitioner pool getting promoted to management level and those coming from the business management pool;

- Excess demand baseline 2012 based on empirica CIO / HR manager survey on ICT vacancies, 2012;

- Intra-EU migration from excess supply to excess demand countries (only in those years and from those countries where excess supply exists).

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[6] Advanced positions, especially ICT managers, can be recruited from the pool of ICT practitioners or through side entries of non-ICT practitioners (e.g. managers from other departments). In both cases, there are no statistical concepts of the pools of suitable candidates available, as is the case with university or vocational graduates for practitioner labour market entries. Seasoned practitioners are an obvious source for management jobs, but both working experience and life-long learning credentials have to match with the position. While bottlenecks are reported to exist by employers who claim to have a hard time finding good e-leaders, it is hard to model exact evidence-based parameters for these bottlenecks into our labour market model. We finally resorted to assuming external side entries to be 33% of new demand for management positions (with an unlimited pool), and 67% to be tried to recruited from the existing practitioner pool. For practitioners, a bottleneck of no more than 1.25% of existing practitioner workforce annually was introduced into the model. The breakdown of total number of vacancies into management and practitioner positions therefore has to be taken with a pinch of salt, as it is likely to underreport management vacancies and over report practitioner vacancies.

Main forecast scenario

The main scenario features an economic growth scenario based on ECFIN forecasts until 2014 and a slow recovery afterwards. GDP growth across Europe is assumed at an average of 1.0 % compound annual growth rate between 2012 and 2015 and increases to 1.7 % on average annually between 2015-2020.

We expect moderate IT investment growth around 2% per year until 2015, and slightly increasing afterwards.

In the education domain, and this is assumed for all scenarios alike, we will see an increase in the number of ICT graduates (**2% increase per year on average**). Labour mobility increase to on average 18.000 cross border movements per year, from countries of low demand to countries with excess demand.

Table 3: 'Main forecast scenario': Real GDP growth

	2013	2014	2015	2016	2017	2018	2019	2020
France	-0.1%	1.1%	1.4%	1.6%	1.2%	1.3%	1.5%	1.7%
Germany	0.4%	1.8%	1.5%	1.6%	1.3%	1.4%	1.6%	1.8%
Italy	-1.3%	0.7%	1.0%	0.8%	0.8%	0.9%	1.1%	1.3%
Poland	1.1%	2.2%	3.8%	3.6%	3.5%	3.6%	3.8%	4.0%
Spain	-1.5%	0.9%	1.5%	1.9%	1.2%	1.3%	1.5%	1.7%
UK	0.6%	1.7%	1.9%	1.5%	1.3%	1.4%	1.6%	1.8%
EU21	-0.1%	1.5%	2.0%	2.1%	1.8%	1.9%	2.1%	2.3%
EU 27	-0.1%	1.4%	1.7%	1.7%	1.4%	1.5%	1.7%	1.9%

Source: IDC Europe

Table 4: 'Main forecast scenario': IT spending growth

	2013	2014	2015	2016	2017	2018	2019	2020
France	1.0%	2.5%	2.8%	3.0%	3.4%	3.8%	4.2%	3.8%
Germany	2.2%	2.6%	2.7%	2.8%	3.3%	3.6%	3.7%	3.7%
Italy	-2.9%	1.1%	1.7%	2.2%	2.1%	2.8%	5.1%	5.1%
Poland	2.5%	2.6%	4.7%	4.9%	5.1%	5.2%	5.3%	4.6%
Spain	-8.4%	1.0%	1.5%	1.9%	2.7%	4.3%	4.1%	3.1%
UK	1.6%	2.2%	2.3%	2.7%	2.5%	2.1%	1.7%	1.2%
EU21	1.8%	4.0%	4.4%	3.4%	2.9%	2.3%	2.3%	2.1%
Total	0.9%	2.7%	3.0%	2.9%	3.0%	2.9%	3.1%	2.9%

Source: IDC Europe

Results

In the 'Main Forecast Scenario', the ICT workforce in Europe will grow from 7.3 million in 2013 to 8 million in 2020, of which 5.8 million will be ICT practitioners and 2.2 million ICT management and analysis level employees.

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Table 5: e-Skills Jobs – 'Main forecast scenario':
Development ICT Professional e-skills Jobs in Europe 2013 – 2020

EU28 (millions)	2013	2014	2015	2016	2017	2018	2019	2020
ICT Management	1,765,000	1,778,000	1,827,000	1,888,000	1,959,000	2,040,000	2,127,000	2,219,000
ICT Practitioners	5,560,000	5,660,000	5,702,000	5,710,000	5,727,000	5,740,000	5,754,000	5,765,000
Total	7,325,000	7,437,000	7,529,000	7,598,000	7,686,000	7,780,000	7,881,000	7,984,000

Source: empirica model forecast.

Demand is increasing despite the modest economic circumstances, to over 8 million in 2015 and 8.9 million in 2020.

Table 6: e-Skills Demand Potential - 'Main forecast scenario':
Development of ICT Professional e-skills Demand Potential in Europe 2011 – 2020

EU28 (millions)	2013	2014	2015	2016	2017	2018	2019	2020
ICT Management	1,936,000	2,018,000	2,114,000	2,221,000	2,331,000	2,440,000	2,548,000	2,651,000
ICT Practitioners	5,658,000	5,682,000	5,752,000	5,839,000	5,939,000	6,032,000	6,102,000	6,158,000
Total	7,594,000	7,700,000	7,866,000	8,060,000	8,270,000	8,471,000	8,650,000	8,809,000

Source: IDC Europe

The **excess demand** or shortage (calculated as the number of open posts)[7] amounts to **337,000 in 2015** and **825,000 in 2020**. This figure can best be described as **'demand potential' or 'job potential' for ICT jobs**. It should be seen as a (theoretical) figure describing the demand potential for new ICT jobs which – under the above assumptions – could theoretically and additionally be created in Europe due to an e-skills demand likely to occur especially in the years closer to 2020.

Recalling the definition of demand potential, by 2020 the labour market would be able to absorb **825,000 additional workers, if demand is not hampered by supply bottlenecks.** Of these 825,000 there are 393,000 potential additional jobs in ICT practitioner occupations and around 432,000 at ICT management level.

Table 7: e-Skills Vacancies Estimate- 'Main forecast scenario':
Summing-up of National ICT Professional Excess Demand in Europe 2011 – 2020

EU27	2013	2014	2015	2016	2017	2018	2019	2020
ICT Management	171,000	240,000	287,000	333,000	372,000	400,000	421,000	432,000

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[7] This model simply adds up the national balances of supply and demand, but only where they reveal an excess demand. It should be noted that this is still a very conservative estimate, as within countries a perfect geographical match is assumed. Mismatches thus only occur between countries. Migration, which alleviates the geographical mismatch, is already built into the model, as described in the assumptions section. Apart from geographical mismatches, skills mismatches only exist between management and practitioner level skills, but the assumptions on management level recruitment out of the pool of practitioners are also conservatively estimated, rather overestimating the mobility between these categories.

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EU27	2013	2014	2015	2016	2017	2018	2019	2020
ICT Practitioners	99,000	22,000	50,000	129,000	212,000	292,000	349,000	393,000
Total	270,000	262,000	337,000	462,000	584,000	692,000	769,000	825,000

Source: empirica model forecast. Note: this is a summing up of national excess demand figures, not balanced with oversupply in other countries, but after migration.

While currently a relative majority of vacancies exists in Germany, the comparably lower graduate figures in the United Kingdom and in Italy suggest that the problem of skills shortages will severely aggravate in these countries. While in absolute figures increasing from 84,000 (2015) to over 145,000, the share of German vacancies in the European total decreases from 25% in 2015 to 18% in 2020. By contrast, the number of vacancies grows immensely in the UK from 55,000 to 171,000. In Italy, the number of vacancies is expected to rise from 30,000 to 154,000.

This figure of course strongly depends (of course among other factors) on the cross border mobility of IT workers into countries of highest demand.

Figure 11: e-Skills Vacancies Estimate- 'Main forecast scenario': Distribution of vacancies per country ('000s)
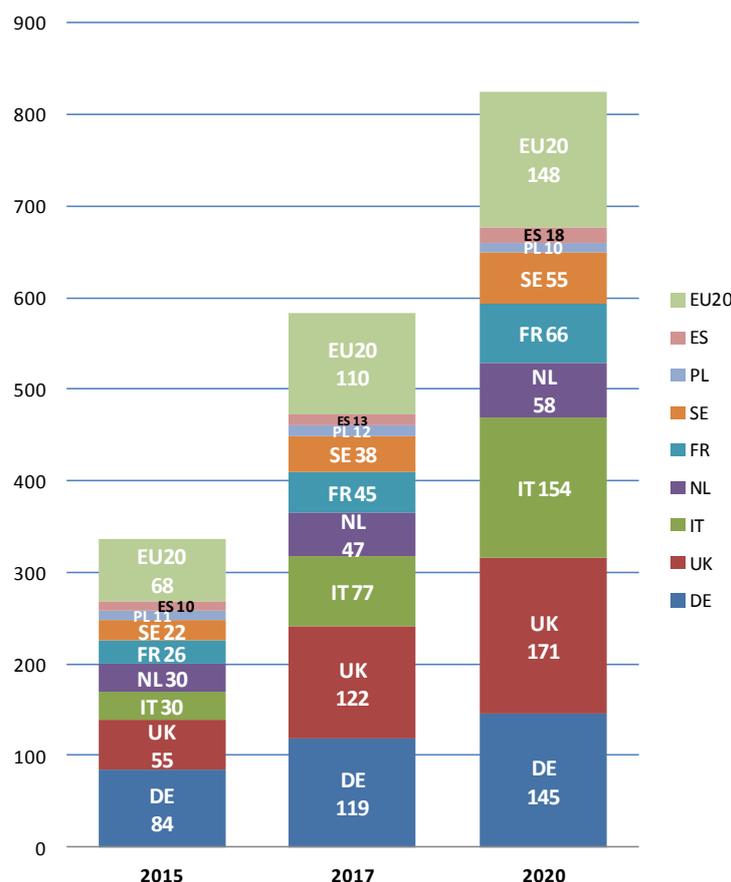
Source: empirica model forecast.

The model has been built cautiously to include some migration, but figures by no means contribute strongly to alleviation of shortages. We foresee a net immigration of ICT workers into the UK in the order of magnitude of 42,000 over eight years and 35,000 to Italy. Poland and Spain are the main countries of origin, the reason being that the supply outstrips demand in these countries. While in Poland the reason is a

Figure 12: Main Forecast Scenario: ICT Professional Jobs and Demand in Europe (EU-27) 2012 – 2020

EU28 - Main Forecast Scenario

Source: empirica model forecast

comparatively strong supply, in Spain it is rather a very cautious new demand as the country slowly experiences recovery from the economic crisis.
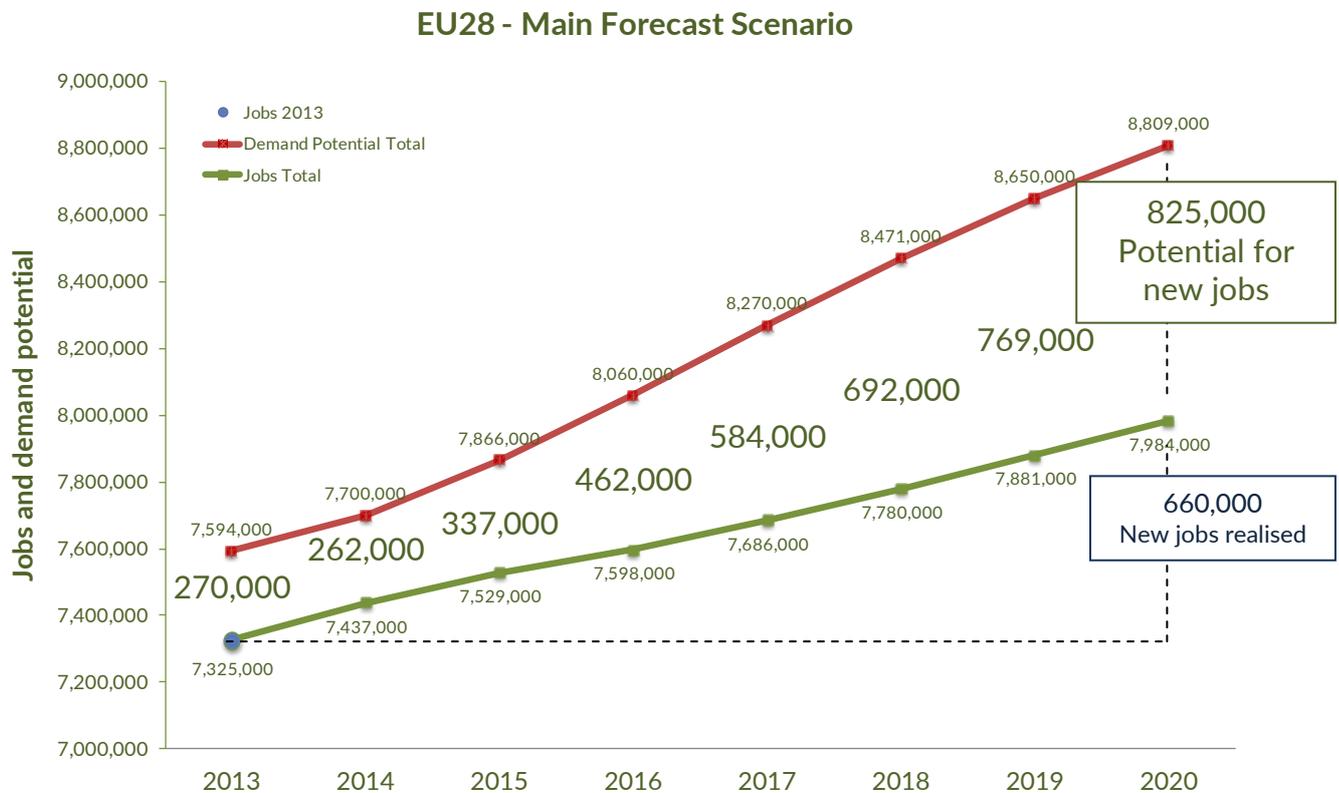
Interpreting the results

The Main Forecast Scenario features a modest but steady job growth of on average 94,000 ICT workers per year until 2020, a figure which is heavily restricted by supply. More than 800,000 more jobs could be created if the skills were available. The bottlenecks are largest in the UK and Germany, but also Italy. Taken together, these three countries will account for almost 60% of all vacancies in Europe.

Some caveats need to be formulated when interpreting these results. The **first one** concerns the notion of **demand *potential*** again. It should be stressed that we do not expect anything like over 1 million vacancies to actually realize. The projection is a demand potential and as such is to be seen as a fragile construct. Vacancies that cannot be filled year after year will go away – projects cannot be realised, tenders not submitted, innovations will simply not be made. The effects of a persisting skills shortage will probably include

- increased outsourcing and offshoring
- untapped innovation potential
- unwanted/enforced productivity gains but also
- wage increases
- changes of the production structure

The **second caveat** concerns the workarounds that have existed in IT as long the sector and occupations exist. Our approach is prudent insofar as that it accounts for **a limited number of side entries & non-ICT**

graduates. In the Main Forecast Scenario, almost 1 million side entries and non-ICT graduates over the eight years enter the workforce, compared to 1.4 million graduates.

In recent years, however, the number of new jobs was up to more than twice as high as the number of available graduates. Assuming this ratio to pertain, the number of vacancies would be considerably lower. However, CIOs we have talked to in the process of modelling have told us that side entries at the entry level happen much less recently than it used to be for example in the Nineties.

This caveat that sees excess demand potentially significantly lower contrasts with the **third caveat** that would entail a much higher shortage: our **demand estimate is in fact very conservative.** The model still relies on a relation of ICT workforce growth and GDP/It spending growth of the 1990's and the first decade of the 2000's. Nevertheless, we have seen the workforce increase significantly even through the crisis years 2008-2012. The level of ICT workforce growth in 2011-12 has been much stronger than expected. Therefore we assume that we still underestimate the long term trend in favour of the independent variables GDP and IT spending.

A **fourth caveat** concerns new and emerging jobs which are not part of the forecasting model yet. There are and will be numerous jobs around third platform technologies that have not yet appeared in job statistics – or if they have, as people on these jobs will for sure be counted in the statistical systems, it is not yet clear where in the existing categorisations they would appear. Big Data, cloud computing, social media, mobile platforms and other megatrends will deliver new capabilities and jobs – and taken together this "3rd technology platform" will require new skills.

Many third platform jobs that are not genuinely IT jobs will be at professional level, for instance in finance, marketing, or consulting. New business processes need to be defined and implemented as the third platform is adopted, and many people engaged in these tasks will never appear in statistics as ICT workers.

A **fifth caveat** finally is about the impact of the Grand Coalition for Digital Jobs. Being a huge joint effort of industry, policy and other stakeholders, the Grand Coalition and the entirety of its pledges aggregated is certainly going to have some effect on the statistical picture across Europe.

2.6   Outlook

Demand for ICT skills keeps growing at a tremendous pace. The trend in core IT jobs has been up to 4% growth p.a., the growth in management jobs up to 8% growth p.a. However, demand for medium level skilled associate and technician jobs is declining. In total, despite the crisis, we have seen new jobs being created in Europe continuously. There is thus a need to continuously increase the quality and the relevance of e-skills. At the same time, although graduate figures seem to stabilise, supply from universities does not seem to keep pace.

Job growth is largest in highly skilled jobs, such as management, architecture and analytics positions, and this reinforces the need for more and better e-Leadership skills. The fact that these positions are usually recruited from pool of seasoned practitioners and other (non-ICT) managers, together with a presumed lack of entry level jobs at medium level skills may evolve into recruitment bottlenecks in the longer term.

However, at the same time the pace of change seems to be still increasing in ICT jobs, and new job profiles pop up which naturally cannot yet be fully covered in statistical classification, such as Big Data and Cloud computing specialists. Many of these jobs are not genuinely ICT jobs but will be at a professional level, for instance in finance, marketing, or consulting – helping new business processes be defined and implemented.

This is a huge opportunity for creation of new jobs generated in all industry sectors, beyond the traditional pathway of ICT studies, but with a strong imperative for ICT to permeate other and new educational trajectories.

ICT has traditionally been a field in which outsiders – in terms of formal education or career trajectory – play a crucial role. However, recently increased endeavours are made to reach a higher level of

professionalisation of the profession, which increasingly includes formal education requirements. These are not necessarily to be sought in a traditional first university or vocational education, but may still be acquired later in the career, a workaround that the ICT profession has maintained like perhaps no other profession for decades. Nevertheless, increasing requirements of formal education make continuous professional education, lifelong learning and executive education even more important. There is an immense opportunity today for new education approaches, new modes of delivery, better curricula and learning outcomes.

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3   Quantification of the e-leadership workforce

Previous estimates[8] at e-leadership demand and supply in Europe came to the conclusion that Europe sees a demand of about 683,000 e-leaders and a supply of 661,000. Demand estimation was based on the sector and size structure of businesses in Europe, simply assuming that an enterprise of a certain size and in a certain, more or less ICT intensive sector needs on average a certain number of e-leadership skilled employees. Supply estimation was based on occupational data and assumed that a certain percentage of several occupations (such as ICT and R&D executives) are e-leaders.

While the estimations presented a reasonable stab at establishing an order of magnitude of e-leadership in the workforce, its weakness lies in the fact that some of the assumptions made simply rely on educated guesswork. They were discussed at various workshops with experts and stakeholders, but not empirically tested.

To amend this shortcoming, empirica undertook to survey enterprises of the business economy and public sector with the intention to estimate the number of employees that could be seen as e-leaders.

A survey of CIOs carried out in the summer of 2013 was used to pilot methods for exposing e-leadership problems in today's organisations, i.e. a focus on an organisation's competence in identifying and addressing opportunities for business innovation using ICT.

As a yet not fully defined phenomenon, e-leadership had to be operationalised so as to be able to communicate to survey respondents whom we look for. Operationalisation of e-leadership was decided to follow the proposition that e-Leadership manifests in successful innovation.

The survey was carried out in the UK, Germany and the Netherlands – the first being the two biggest economies in Europe with the largest ICT labour markets, the Netherlands as regionally close and with a high level of educational activity in the e-leadership domain. Together, these three countries account for 38% of the business economy employment in the EU.

In total 901 interviews were carried out, across the three countries and across sectors and size classes. The respondent was the head of the IT function in the organisation, in larger organisations usually a CIO. The following tables show the composition of the sample:

Table 8: Sample e-leadership survey

		Sample	Percent
Sector	Manufacturing and Construction	220	24%
	Distributive services	231	26%
	Other services incl. Finance	240	27%
	ICT	138	15%
	Public sector	72	8%
	Total	**901**	**100%**
Size of firm	10 – 19	73	8%
	20 – 29	67	7%
	30 – 49	92	10%
	50 - 99	96	11%
	100 - 249	142	16%
	250 - 499	151	17%

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8   Hüsing, Tobias et al (2013).: e-Leadership: e-Skills for Competitiveness and Innovation Vision, Roadmap and Foresight Scenarios. Final Study Report http://eskills-vision.eu/fileadmin/eSkillsVision/documents/VISION%20Final%20Report.pdf

		Sample	Percent
	500 - 999	116	13%
	1000 - 2499	88	10%
	2500+	76	8%
	Total	**901**	**100%**
Country	Germany	300	33%
	The Netherlands	301	33%
	United Kingdom	300	33%
	Total	**901**	**100%**

The methods were directed at organisations employing ICT staff. Therefore an interview was only carried out if at least one ICT practitioner was employed in the organisation. Incidence of ICT employment is shown in the following table.

Table 9: Incidence rate in e-leadership survey

	Incidence Rate
Sample Total	18%
Sample Germany Total	19%
Sample Netherlands Total	16%
Sample UK Total	19%
Sample Total 10 to 49	9%
Sample Total 50 to 249	20%
Sample Total 250 plus	34%

Though incidence rates appear low, these levels were reconfirmed by the survey organisation as being in line with results from other surveys.

3.1   Addressing innovation opportunities

Key questions in the survey address an organisation's success in detecting innovation opportunities, both by ICT staff and by business staff. The main issue was whether overall CIOs thought their organisation was performing well in addressing innovation, and whether innovation projects were allocated sufficient resources. Some reports suggest that business innovation projects are left to the IT department, with the implication that these suffer from lack of access to resources in user departments. Furthermore, since many opportunities for innovation require understanding of both business and ICT, innovation opportunities could be detected by business executives, if these have enough understanding of ICT. Two questions therefore looked at the CIO's view of the innovation capabilities of their organisation as a whole and as identified by their fellow non-IT executives in particular.

Though most CIOs (77%) report that the opportunities for IT-based innovation open to their organisation are being addressed in time and with appropriate resources, a significant minority report that this is not the case. Problems are somewhat more acute in smaller organisations, though the difference perhaps surprisingly small: the proportion of organisations experiencing problems drops from over a quarter of the smaller organisations to under 20% in the largest enterprises.

A significant part of the problem in grasping ICT based innovation opportunities appears to be due to skills deficits in business departments. From the perspective of their CIO, only about half of organisations today have business executives who have a level of understanding of IT sufficient to identify innovation

opportunities in their sector or area of activity. This is more or less constant across all size categories – there is just as large a proportion of the largest enterprises organisations reporting this problem as among quite small organisations.

3.2   E-Leadership roles in innovation

Ensuring ICT-based innovation opportunities are identified, grasped and guided to fruition requires e-leadership at the different stages in the innovation life cycle. It is seen as particularly critical not only to be able to envision an innovation, and to assess its likely success in the organisation, but also to communicate this vision to executive colleagues controlling the resources impacted by the proposed organisational change. This was operationalised as the performance of two key component e-leadership roles. The first is the role of proposing an innovation project. The success of a proposal was conceptualised as an innovation project resulting from the proposal. Making proposals not leading to a project can be taken as an indicator of failure in e-leadership, having arisen either from inability to assess business outcome appropriately or inability to persuade business colleagues of the probability and value of the business outcome.

A second key component of an e-leadership role is seen as that of guiding an innovation project to success. This is not implementation of an IT solution, nor even managing its implementation, but acting as the client for the innovation project - assessing proposals, monitoring conformance to requirements, accepting results etc., including acting as client for delivery of solutions from outside organsations.

Both these e-leadership component roles are required ensure that innovative IT applications and services are identified and successfully deployed to improve performance and competitiveness.

To investigate this complex, it was first necessary to ask the respondents to report on recent ICT-based innovation. CIOs were asked about the number of such innovation projects their organisation had engaged in in the recent past, phrased for simplicity as "innovative IT projects".

Of the organisations surveyed, nearly three quarters reported having initiated / carried out at least one innovation project within the previous year. A further 10% had at least one such project within the last five years. Those unable to report on a project - 7% reported no project at all, while 11% were unable to tell – had to be excluded from further questions and analysis, due to the methodological focus adopted. The average number of innovative ICT-based projects in the previous year is 5.1, the median is 2.

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Table 10: Staff involved in proposing and as clients of IT projects

Size of enterprise	Average number of employees	Innovative IT projects have been proposed by			Number of persons involved in proposing innovative projects using IT			Number of persons acting as project clients		
		Staff from the IT depart-ment	Staff from other business units	External organi-sations	In the IT depart-ment	In other business units	In external organi-sations	In the IT depar-t-ment	In other business units	In external organi-sations
Okt 19	13.8	51%	54%	39%	1.5	2.1	1.6	1.3	1.4	0.8
20 - 29	23.2	59%	52%	21%	2	1.8	1.3	1.3	1.3	0.4
30 - 49	37.3	58%	60%	25%	1.4	2.1	4.4	1.4	1.4	0.8
50 - 99	69.2	53%	65%	12%	1.9	2.5	0.7	1.5	1.8	0.5
100 - 249	153	56%	64%	22%	1.9	2.9	1.1	1.4	2	0.5
250 - 499	342	65%	76%	24%	2.9	5	0.7	1.7	2.7	0.4
500 - 999	667	72%	73%	27%	3.9	4.5	0.8	2.4	3.6	1.1
1000 - 2499	1420	65%	83%	14%	4.9	5.5	1.5	2.3	4.3	0.5
2500+	9633	75%	77%	34%	5	13.7	7.3	4.2	8.7	1.2
Total	**1030**	**62%**	**68%**	**23%**	**2.7**	**4**	**1.8**	**1.8**	**2.7**	**0.7**

The second feature addressed was the locus of proposed innovation. Are successful innovation proposals flowing in from business units – a sign of at least adequate understanding of the options for ICT exploitation alongside business understanding – or are such proposals mainly generated from the CIO or IT staff working under the CIO? Or does the organisation respond to vendor proposals, proposals coming from outside without direct access to organisation-specific demand detail

The picture is surprisingly mixed. Successful innovation project proposals are balanced in origin between business and ICT executives. Successful proposals have been proposed equally from within and outside the IT department. About two thirds of organisations with recent ICT-based innovation state each origin. Vendor or other external impetus is also very prevalent, being mentioned by about a quarter of innovative organisations.

The number of persons involved increases only slightly with enterprise size, so that a much higher share of employees in the enterprises are actually involved in smaller enterprises(up to 25% in the smallest class), while larger ones have a specialised innovation labour force:

Table 11: Staff involved in proposing and as clients of IT projects

Enterprise size class	% of staff involved in proposing IT projects	% of staff involved as project clients
10 - 19	25.40%	19.50%
20 - 29	16.50%	11.50%
30 - 49	9.60%	7.50%
50 - 99	6.30%	4.90%
100 - 249	3.10%	2.20%
250 - 499	2.30%	1.30%
500 - 999	1.30%	0.90%
1000 - 2499	0.70%	0.50%
2500+	0.20%	0.10%
Total	**0.60%**	**0.40%**

It is interesting to see that the relation between IT staff and non-it staff involved in driving IT based innovation is rather constant at 40/60, both in terms of initiation (proposing, 2.7 IT staff and 4.0 Non-IT staff) and implementation (acting as client, 1.8 IT staff and 2.7 Non-IT staff).

While the survey only addressed three countries, we experimentally applied the results of the three countries to the known business structure according to size class (but not industry) of the whole of Europe (EU28)[9]. The following e-Leadership quantification emerges from grossing up from DE, NL and UK to EU28.

Figure 13: e-Leadership quantification
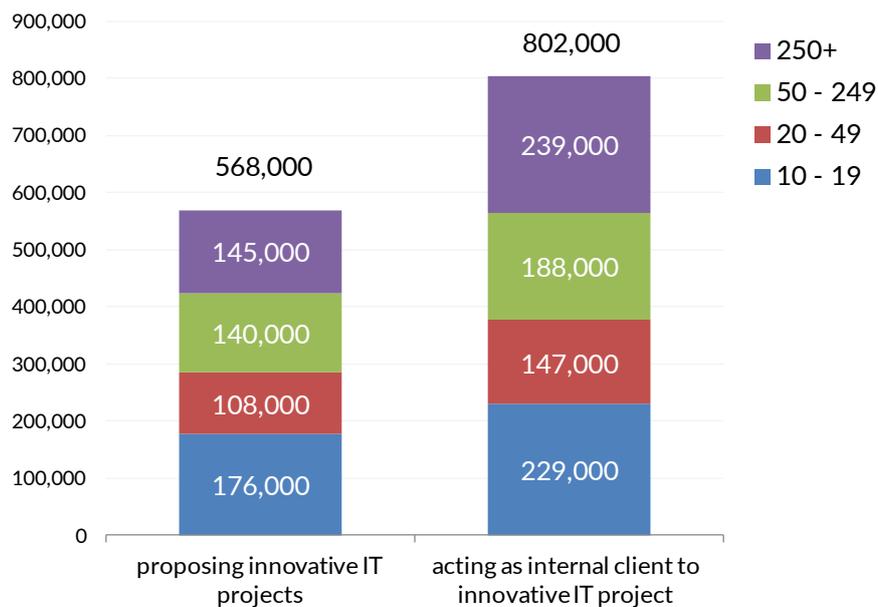
EU28 estimation based on data in NL, DE and UK

The order of magnitude of the European e-Leadership workforce can thus be estimated to lie between 570,000 and 800,000 workers. The previous estimate of 660,000 to 680,000 e-leaders has not been out of range.

3.3   Forecasting demand

IDC and empirica have forecast demand for highly skilled ICT occupations[10] to rise by on average 4.6% until 2020. It seems reasonable to assume that demand for e-leadership is closely coupled whit highest skilled ICT jobs. Applying a 4.6% growth rate to the lower bound of the range results in a demand potential for 776,000 e-leaders in 2020.

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9   The countries in the survey account for 38% of the employment in the European Union. Scaling up the result to the European Union should also require taking account of sector differences between these countries and the remaining 25 Member States but due to the limited number of cases and inconclusive variance between sectors and it seemed reasonable to restrict adaptation to size class structure only. Given the sector structure difference between the whole of Europe and the countries covered, the true value might be somewhat lower.

10   ICT management, architecture and analysis skills. Demand for these jobs is forecast to rise from 1.94 million (2013) to 2.65 million (2020).

Figure 14: e-Leadership forecast, lower bound and upper bound scenario
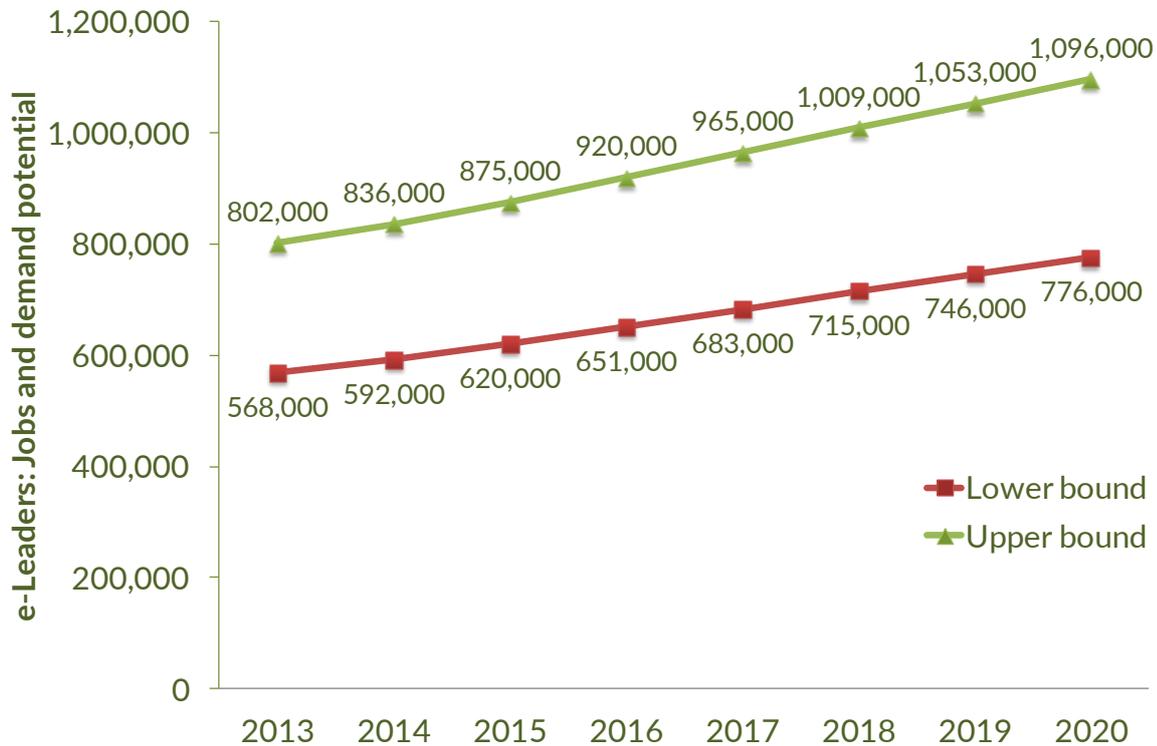
Europe will thus need 215,000 additional e-leaders by 2020. Together with a replacement demand until 2020 of 100.000[11], this would mean that the education system has to be capable of supporting 40,000+ seasoned practitioners and managers turn into new e-leaders each year.

In the upper bound scenario, 1.1 million e-leaders will be needed in 2020, which means that the education system needs to produce 73,000 e-leaders per year.

3.4   Summary and Outlook

Experts agree that for effective e-leadership, people need very strong ICT skills and must lead qualified staff from ICT and other disciplines towards identifying and designing business models and exploiting key innovation opportunities. Their success is defined as making best use of developments in ICT and delivering value to their organizations.

Recent research - further described in the document - demonstrates that there is a significant shortage of e-leaders in Europe. First attempts to quantify the existing e-leadership workforce based on company's involvement in ICT based innovation activities result in some 568,000 e-leaders in European enterprises. If we take the implementation of ICT-based innovation as basis for the definition of e-leadership, we can conclude that there could be around 800,000 e-leaders in Europe. Around 70% of e-leaders are found in SMEs and interestingly enough, we see 59% of e-leaders outside the IT department, coming from lines of business, and 41% being IT department inhabitants.

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[11]   Replacement demand rates of 3% are not uncommon in senior position type occupations which would equal 17,000 of the current 568,000 e-leaders. In six years this adds up to >100,000.

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When coupling the e-Leadership demand and supply with the known demand and supply of ICT management, architecture and analysis skills with an average rise of 4.6% we can assume the Europe would need 215,000 additional e-leaders by 2020. An additional more than 100,000 would be required due to replacement demand.

In order to compensate for this European higher and executive education system needs to be capable of supporting 40,000+ seasoned ICT practitioners and managers to be turned into new e-leaders each year which constitutes a huge challenge.

It is against this background that the European Commission e-Leadership initiative aims to support the development of e-leadership skills through the strong practical instrument of a curriculum profile and the development of quality criteria that evaluate the programmes provided by higher educational institutions matched to curriculum profiles and demonstrate these at different business schools and universities in Europe. This should lead to encouraging the development of attractive, adapted, up-to-date educational offers able to increase the supply to the economy of experienced and highly qualified leaders in ICT-based innovation

Closing this skills gap requires an ecosystem perspective, connecting the demand and supply side stakeholders of e-leadership skills. Responding to the inadequacies in the skills market flagged by stakeholders across the EU, the European Commission has launched the "e-skills strategy" and the "Grand Coalition for Digital Jobs". After responding to requirements for increased professionalism among ICT practitioners, and developing strategies and instruments to bridge the gap between e-skills demand and supply at that level, the new focus is on the skills gap in the e-leadership domain. The first pan-European initiative on e-leadership was launched in 2013 (www.eskills-guide.eu).

In order to close this skills gap, the e-leadership initiative has applied an ecosystem perspective and identified techniques to improve information flows between demand and supply side stakeholders in e-leadership skills. The improved transparency and timely flow of knowledge about developing skills requirements will enable institutions of higher and executive education to respond. A key practical instrument in communicating skills requirements are the new e-leadership curriculum profiles, which specify core skills, learning outcomes, understanding and competences required by e-leaders today, whether they lead innovation teams bringing specialist understanding of topics such as enterprise architecture or take full responsibility for enterprise innovation at C level. A key element of these curriculum profiles and the guidelines is the requirement for mapping existing programmes onto the skills and competences of the e-Competence Framework (http://www.ecompetences.eu). The e-leadership curriculum profiles and guidelines use and applicability has been demonstrated by the universities and business schools directly participating in this initiative in several European countries. Response by the education community is picking up with already more than 20 universities and business schools having evaluated their programmes against the new e-leadership profiles. Further dissemination and substantial stakeholder engagement was achieved through 10 regional cluster events throughout Europe reaching out to more than 1200 stakeholders and experts. The initiative continues to be open to education institutions, industry and associations understanding e-leadership skill requirements in the workplace.

The European Commission DG Enterprise and Industry launched the complementary e-Leadership Skills for Small and Medium sized Enterprises action in January 2014. This Commission initiative is complementary to the above one on 'New Curricula for e-Leadership' and focusing on entrepreneurs, managers and advanced ICT users in SMEs, start-ups and gazelles (www.eskills-lead.eu).

Annex

Table 12: ICT workforce in Europe in 2013

	Management, architecture and analysis	Core ICT practitioners - professional level	Other ICT practitioners - professional level	Core ICT practitioners - associate/ technician level	Other ICT practitioners - associate/ technician level	TOTAL	Share of workforce
UK	351,000	739,000	115,000	194,000	116,000	1,514,000	5.1%
DE	418,000	417,000	90,000	155,000	126,000	1,206,000	3.0%
FR	176,000	316,000	77,000	99,000	195,000	863,000	3.3%
IT	90,000	116,000	38,400	264,000	139,000	647,000	2.9%
ES	86,000	125,000	49,400	144,000	77,000	481,000	2.9%
NL	161,000	150,000	17,500	34,300	47,400	410,000	4.9%
PL	70,000	170,000	31,800	44,900	75,000	392,000	2.5%
SE	85,000	70,000	19,600	42,500	36,200	253,000	5.4%
BE	56,000	58,000	14,100	24,400	19,200	171,000	3.8%
CZ	21,100	55,000	9,300	53,000	30,900	169,000	3.4%
FI	48,500	40,900	31,900	18,000	12,100	151,000	6.2%
AT	30,500	61,000	8,200	22,400	21,600	144,000	3.5%
RO	25,300	26,300	33,600	30,900	22,000	138,000	1.5%
DK	33,200	49,500	6,000	27,600	18,900	135,000	5.0%
HU	8,200	45,200	24,200	29,300	13,800	121,000	3.1%
PT	16,600	20,700	11,900	27,800	20,300	97,000	2.2%
BG	17,300	23,400	5,600	18,400	14,900	80,000	2.7%
IE	16,600	33,300	5,600	11,100	4,200	71,000	3.8%
GR	14,500	16,400	11,200	9,400	9,100	61,000	1.7%
SK	3,900	20,700	2,400	15,300	17,900	60,000	2.6%
HR	4,100	8,600	3,500	9,000	6,900	32,200	2.3%
SI	5,100	9,400	3,600	2,900	4,700	25,700	2.8%
LV	7,600	7,800	2,100	3,600	3,900	25,100	2.8%
EE	4,900	10,200	1,800	4,000	3,400	24,300	3.9%
LT	7,600	8,800	1,900	300	5,400	24,000	1.9%
LU	4,100	5,900	1,400	1,600	1,200	14,300	5.9%
CY	2,000	2,900	1,100	900	1,100	8,000	2.1%
MT	1,300	1,900	100	1,200	1,800	6,400	3.6%
EU28	1,765,000	2,608,000	618,000	1,289,000	1,045,000	7,325,000	3.4%

Source: empirica calculations based on an LFS data retrieval done by Eurostat.

Table 13: ICT graduates (first degrees in ISCED 5A and first qualifications in 5B) in Europe 2012

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Increase since 2003
EU28	109,000	121,000	128,000	130,000	125,000	122,000	115,000	115,000	114,000	111,000	+2%
France	16,100	18,100	20,000	19,700	18,400	17,600	19,100	20,000	20,700	20,700	+29%
United Kingdom	31,000	27,700	29,600	28,200	25,200	23,800	19,200	19,200	19,500	19,900	- 35%
Germany	8,400	11,100	12,800	14,200	16,100	16,500	17,200	16,800	16,500	16,800	+100%
Spain	19,300	19,700	18,600	17,300	15,800	14,600	15,100	15,100	14,800	11,900	- 39%
Poland	5,900	10,700	13,100	14,800	14,200	13,000	12,400	12,500	12,300	10,900	+85%
Netherlands	1,770	3,600	4,000	4,700	4,500	4,100	4,000	3,900	3,700	4,000	+127%
Czech Republic	1,220	1,500	1,640	2,100	2,400	2,900	3,000	2,900	2,800	2,900	+141%
Greece	1,210	1,330	2,900	2,000	1,100	2,200	2,200	2,300	2,300	2,700	+119%
Italy	2,800	3,200	3,500	3,500	3,400	2,900	2,900	2,800	2,400	2,200	- 22%
Hungary	640	1,290	1,330	2,900	3,000	2,600	2,200	2,200	1,970	1,670	+162%
Sweden	2,200	2,200	2,100	2,000	1,630	1,430	1,360	1,400	1,620	1,660	- 25%
Romania	3,800	4,400	4,400	4,500	4,400	4,600	2,800	2,100	2,000	1,600	- 58%
Denmark	1,390	1,520	1,220	1,000	840	870	900	1,240	1,430	1,540	+11%
Austria	560	1,080	1,500	1,970	2,000	1,820	2,000	1,630	1,560	1,520	+174%
Croatia	460	360	450	470	630	1,150	1,250	740	1,120	1,500	+229%
Belgium	2,700	2,800	2,700	2,500	2,600	1,840	1,140	1,340	1,370	1,380	- 48%
Slovakia	960	1,100	1,060	1,090	1,370	1,480	1,580	1,500	1,380	1,270	+33%
Ireland	4,000	3,400	1,080	1,160	1,240	1,330	1,410	1,630	870	1,250	- 69%
Bulgaria	640	730	710	760	750	760	800	980	1,100	1,240	+94%
Finland	1,610	1,780	1,810	1,720	1,750	3,000	1,060	1,230	1,120	1,110	- 31%
Lithuania	610	780	910	1,200	1,160	970	910	970	820	840	+38%
Portugal	890	1,030	1,100	910	1,180	1,240	1,010	770	780	700	- 21%
Slovenia	120	140	180	200	270	290	340	430	540	690	+497%
Latvia	520	540	560	610	610	600	580	580	620	610	+17%
Estonia	300	360	540	500	560	380	380	400	410	410	+37%
Malta	40	50	50	130	90	150	150	150	230	210	+393%
Cyprus	190	210	210	180	230	220	190	180	300	210	+14%
Luxembourg	60	110	110	140	70	30	30	30	30	30	- 50%

Source: Based on Eurostat, some estimates.

Table 14: ICT graduates (Higher Secondary vocational ISCED level 3) in Europe 2012

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
EU28	11,477	5,610	64,026	43,921	35,999	33,583	36,412	44,295	:	59,383
EU27	11,477	5,610	64,026	43,921	35,999	33,583	36,412	44,295	48,551	59,383
Poland	258	314	18,051	255	363	1,237	8,997	13,498	16,283	17,706
Spain	:	28	898	3,335	4,387	3,955	7,011	9,814	11,088	11,525
Germany	19,114	19,955	17,867	17,605	17,227	14,513	9,591	9,704	9,481	8,740
Portugal	:	:	:	:	:	:	:	:	:	6,378
Netherlands	6,532	7,919	8,078	6,175	5,371	5,430	5,495	5,523	5,830	5,509
Greece	:	8,159	8,985	:	:	:	:	:	:	3,320
Finland	2,299	2,479	2,175	2,024	1,950	1,766	1,696	1,636	1,496	1,482
Bulgaria	240	301	360	433	569	517	665	701	755	1,019
Belgium	1,444	:	834	764	791	692	745	1,061	1,045	930
Austria	:	:	:	:	516	546	621	840	892	872
Slovenia	189	334	248	373	423	589	605	590	615	594
Latvia	:	325	444	515	506	511	436	535	525	521
Estonia	110	172	166	137	139	72	89	152	237	303
Malta	:	:	:	47	364	571	363	175	227	227
Czech Republic	:	:	:	:	:	:	:	:	:	148
Luxemburg	:	56	70	46	66	37	50	46	58	56
Lithuania	:	:	:	:	:	:	:	:	:	30
Hungary	568	332	338	613	674	965	:	:	:	19
Sweden	:	4	203	22	28	5	5	19	19	4

Source: Eurostat educ_grad5

Table 15: ICT graduates (Post Secondary vocational ISCED level 4) in Europe 2012

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
EU28	23,053	16,967	31,424	31,188	26,128	16,214	24,159	17,757	:	12,565
EU27	23,053	16,967	31,424	31,188	26,128	16,214	24,159	17,757	14,271	12,565
Poland	17,305	15,900	16,019	16,559	11,705	3,759	8,332	6,343	4,191	3,517
Germany	3,437	4,045	3,733	3,031	3,801	3,239	7,258	4,729	4,688	3,028
Hungary	4,566	4,799	4,818	4,148	3,704	2,977	2,171	2,313	2,529	2,460
Austria	:	:	:	:	1,269	1,251	1,015	1,018	1,019	963
Greece	:	3,604	5,355	2,753	3,745	3,330	:	1,246	:	691
Portugal	:	:	:	81	:	279	427	437	284	623
Romania	1,089	975	804	684	363	141	374	449	384	400
Sweden	:	15	:	33	29	84	:	175	247	224
Malta	:	:	:	256	200	:	:	186	212	212
Estonia	540	304	325	207	146	116	123	121	146	161
Lithuania	:	:	28	46	45	46	73	77	124	134
Belgium	285	:	79	86	231	218	227	245	245	66
Netherlands	:	:	:	427	438	344	338	183	157	23
Latvia	12	39	26	22	:	:	:	:	:	12
Slovenia	:	:	:	:	:	15	30	18	5	8
Bulgaria	5	:	43	69	27	48	47	47	1	6
Finland	39	27	10	23	7	17	4	12	3	6

Source: Eurostat educ_grad5