THE SUPPLY AND DEMAND OF E-SKILLS IN EUROPE

September 2005

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Prepared for the European Commission

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Preface

As Information and Communication Technologies (ICT) have become such a crucial element in the working lives of many European citizens and for the competitiveness of enterprises, so has the demand for e-skills. Consequently, concerns about the supply of these skills have become an important element of policy – a smoothly operating ICT jobs market is expected to increase industrial efficiency and economic gains. In its synthesis report "e-Skills for Europe: Towards 2010 and Beyond" (September 2004) the European e-Skills Forum called for the development of a long-term strategy and the improvement of data availability about the ICT labour market.

In this context, the European Commission selected RAND Europe in December 2004 after an open call for tenders to conduct analysis of the situation of demand and supply of e-skills in Europe. Our contact point was André Richier (Principal Administrator, Enterprise and Industry Directorate-General, Innovation Policy Directorate, Technology for Innovation, ICT industries and e-Business). This report covers work performed between January and September 2005. It considers different approaches used when studying supply and demand of e-skills; it describes and analyses the current situation relating to the supply and demand of practitioner skills in the European Union and its Member States and provides data on the position in the United States for comparative purposes. The RAND Europe team was supported by a large number of experts. First of all, Matthew Dixon (Labour Market Adviser to CEPIS and SEMTA Visiting Research Fellow, SKOPE, University of Oxford), Hanne Shapiro (Danish Technology Institute) and Cathy Stasz (Research Leader at RAND) provided extensive comments and suggestions during the different phases of our research. In addition, an ad hoc steering group consisting of representatives of the European e-Skills Forum commented on the deliverables that were produced. These experts are mentioned in Appendix C.

The primary audience for this report are policymakers in the field of ICT industry and ICT skills at the European Commission and the EU Member States. The report may also be of interest to a wide variety of stakeholders, such as major European employers, ICT Professionals' Associations, social partners and national policy makers in the field of social, employment and education policy. For more information about RAND Europe or the work reported in this document, please contact Erik Frinking.

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Glossary

APO	German Advanced IT Training System
BISER	Benchmarking the Information Society: e-Europe Indicators for European Regions (EU funded project)
CEDEFOP	European Centre for the Development of Vocational Training
CEPIS	Council of European Professional Informatics Societies
CompTIA	Computing Technology Industry Association
EF	Field of education classification (ISCED)
EITO	European Information Technology Observatory
EUCIP	European Certification of Informatics Professionals
EUQuaSIT	European Qualification Strategies in Information and Communications Technology
FISTERA	Foresight on Information Society Technologies in the European Research Area
ICT	Information and Communication Technologies
IPTS	Institute for Prospective Technological Studies
ISCED	International Standard Classification of Education
ISCO	International Standard Classification of Occupations
ITAA	Information Technology Association of America
LFS	Labour Force Survey
NACE	*Nomenclature generale des Activites economiques dans la Communaute Europeenne* (Nomenclature of economic activities in the EC)
NeDAP	Northern eDimension Action Plan
NSO	National Statistical Office
OECD	Organisation for Economic Cooperation and Development
SFIA	Skills For the Information Age
SOC	Standard Occupational Classification

Executive Summary

The report documents an in-depth study into the supply and demand of e-skills within the European Union, summarises current understanding of the state-of-play within 2004, in particular in relation to ICT Practitioner skills, and presents an analysis and proposed framework for building Foresight Scenarios in this area. The study's approach is presented through the following steps:

- A review of existing supply and demand studies, expert interviews, and the development of a taxonomy of e-skills research;
- A presentation of different approaches to estimating e-skills supply and demand, and their advantages and disadvantages;
- An analysis of the situation in 2004 relating to the supply and the demand of e-skills in Europe, based on the most recent statistical data available; and
- An overview of recent future-oriented studies on e-skills on the basis of which a framework for conducting e-skills foresight studies is proposed.

The study has found that there is comparatively very little consistent, reliable quantitative evidence available in relation to clarifying the factual situation of the supply and demand of e-skills at the European level. However, for the best understanding of supply and demand within these constraints, the report recommends combined use of the seven following complementary indicators, in particular in relation to ICT Practitioner skills:

(1) Unemployment in e-skilled occupations;
(2) Number of graduates in educational fields of relevance to e-skills;
(3) Number of issued training certificates for training of more than a minimum amount of days;
(4) Current employment in e-skilled occupations;
(5) Unfilled or hard-to-fill job vacancies in e-skilled occupations;
(6) Replacement demand; and
(7) Replacement of jobs by off-shoring activities.

Detailed recommendations are made of ways in which data gathering for these key indicators might be strengthened and improved, together with information on any current work being undertaken in that direction.

A wide range of data is shown for the development over recent years of key relevant employment and education indicators for all Member States, both types of data provided by Eurostat, and these results allow a considerable amount of interpretation and comparison in support of e-skills policy analysis. The employment data, based on the occupation proxy for skills, is differentiated into IT Practitioner and the broader ICT Practitioner areas.

- The best evidence available confirms that there were, in 2004, no widespread significant shortages of ICT (or IT) Practitioner skills within the EU, although the growth in demand for skills for certain ICT Practitioner occupations (both computing professionals and optical and equipment operators showed considerable increase in 2004) was greater than for others (for example continuous decline since 1998 in the group of electrical and electronic equipment mechanics and fitters), and it also appears that employment was comparatively high in some of the new Member States (such as the Czech Republic, Latvia, and Malta)
- The under-representation of women in ICT Practitioner occupations (compared to men as well as to women in other occupations) continues to be an issue.
- There are some indications that this situation has changed in 2005, during which overall employment has begun to grow (Belgium, Spain), and notably in some Member States (Latvia, Lithuania, Malta, and Slovak Republic)

In considering how best to undertake the estimating of future e-skill needs in Europe, the report lays the foundations for a consistent EU-level approach to the development of Foresight Scenarios.

In particular, it explains how a foresight process can facilitate multi-actor policy analysis and policymaking: foresight brings together a range of relevant stakeholders each of whom can provide different and valuable insights on the future development of e-skills. Instead of attempting to "squeeze" these viewpoints into the same framework, a foresight process recognises differences of opinion and aims to find a common ground for decision making.

To achieve adequately robust understanding, the possibility of structural changes needs to be addressed with the use of a set of scenarios. This analysis and discussion would need to be an ongoing process, with reviews increasingly possible of differences between previous forecasts and actual developments.

Overall, the report provides a significant amount of important information on which future EU e-skills analysis and foresight development can be built.

CHAPTER 1 Introduction

1.1 The role of ICT skills in the economy

Over the last two decades, the rapid and continuous uptake of new information and communication technologies (ICT) has resulted in many changes in the way we work. It is generally acknowledged that, when effectively implemented, the introduction of new ICT contributes to economic productivity and growth. As such, European policy makers see innovation in the ICT sector, and increased take-up of ICT in other sectors, as an important means of attaining the Lisbon goals[1] and have addressed this in detail in the eEurope action plans and the recent i2010 initiative. [2]

As ICT has become such an important element in the working lives of many European citizens, so has the demand for ICT-related skills, both in terms of the "ICT practitioners (or professionals)" who design, build and maintain products and systems, and of the (very much larger numbers of) "ICT users". Consequently, concerns about the supply of these skills have become of considerable interest to policy makers – a smoothly operating ICT jobs market is felt likely to increase effective ICT use and so to increase industrial efficiency and economic gains. In hindsight, we see that around the year 2000 the expected need for skilled ICT workers was overestimated[3] and partly exacerbated by the anticipated problems of the millennium transition. Despite the economic problems in the ICT sector, expectations about future gaps, shortages, and mismatches remain high, as the supply of properly qualified personnel has been perceived as lagging behind the demand.

To get a grip on the extent of the e-skills gap, several approaches have been undertaken to measure demand, supply or both. These efforts have run into methodological difficulties, definition questions and incomparable results. Furthermore, the ICT 'bubble' – the period of inflated expectations about the growth of the ICT market – still influenced forecasts based on projections made in the first years of this decade. As we now know that these expectations were exaggerated, it is time for an objective effort to measure the current and future demand for e-skills in the European Union (EU) and compare the outcomes to

[1] The EU's aim "to become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable growth with more jobs and greater social cohesion", as formulated in March 2000.

[2] See http://europa.eu.int/information_society/eeurope/i2010/i2010/index_en.htm

[3] A good example of this was the IDC/EITO 2001 study expecting millions of unfilled vacancies.

developments in the United States (US), which remains a crucial point of reference for ICT developments. This effort will provide an important base on which foresight scenarios can be built at the European level – something of growing interest to policymakers and experts.

1.2 Objectives of the study

Based on the growing interest in this field, RAND Europe was commissioned by DG Enterprise and Industry of the European Commission to undertake a study of the supply and demand of e-skills in Europe. The study had a two-faceted character.

First, the study aimed to provide an in-depth analysis and assessment of the situation of e-skills in 2004 based on various published studies, collected data, and interviews with experts and relevant stakeholders. This analysis also led to recommendations on definitions, use of indicators, and improvements for (statistical) data collection.

Second, the project examined existing forecasting activities and foresight scenarios in the Member States. Based on this, concrete proposals for the establishment of foresight mechanisms and the establishment of a European network of experts were developed.

For the exact terms of reference, please see Appendix K.

1.3 Outline of the report

This report covers work performed between January and September 2005. It considers different approaches used when studying supply and demand of e-skills; it describes and analyses the current situation relating to the supply and demand of ICT practitioner skills in the European Union and its Member States, together with comparable information from the US as contrasting nation.

The steps in our analysis are presented as follows:

- Selection of existing supply and demand studies, expert interviews, and developing a taxonomy of e-skills research publications (Chapter 2).
- A presentation of different approaches and their advantages and disadvantages (Chapter 3).
- An analysis of the situation in 2004 relating to the supply and the demand of e-skills in Europe based on the most recent statistical data available (Chapter 4).
- An overview of future-oriented studies on e-skills on the basis of which a framework for conducting a foresight study on the future of the ICT skills market is proposed (Chapter 5).

CHAPTER 2 Scope and methodology of the study

2.1 Definitions of e-skills

The term "e-skills" is often used as the encompassing concept of all skills related to ICT-activities. This concept, however, is not uniformly applied or understood. E-Skills are defined in different ways across different studies. Most often, e-skills are interpreted more directly as (synonymous with) ICT skills.

The European e-Skills Forum (2004) discussion on e-skills has resulted in definitions for three *different* types of skill.

- **ICT user skills**: the capabilities required for effective application of ICT systems and devices by the individual. ICT users apply systems as tools in support of their own work, which is, in most cases, not ICT. User skills cover the utilisation of common generic software tools and the use of specialised tools supporting business functions within industries other than the ICT industry;
- **ICT practitioner skills**: the capabilities required for researching, developing and designing, managing, the producing, consulting, marketing and selling, the integrating, installing and administrating, the maintaining, supporting and service of ICT systems.
- **e-Business skills**: the capabilities needed to exploit opportunities provided by ICT, notably the Internet, to ensure more efficient and effective performance of different types of organisations, to explore possibilities for new ways of conducting business and organisational processes, and to establish new businesses.

Although there are a considerable number of different definitions and types of skills distinguished (e.g. the OECD (2002; 2004) differentiates three types of ICT skills[4] that cover different domains of e-skills although some of these overlap), this study has taken the European e-Skills Forum definitions as the starting point for its analysis.

[4] The OECD (2002; 2004) distinguishes: 1) basic skills (using generic tools like word processors, internet browsers and email clients); 2) advanced skills (using advanced and often sector-specific tools for the administration and manipulation of data and digital media); and 3) specialist skills (developing, maintaining and operating ICT systems). Thus, compared to the European e-Skills Forum definitions, *ICT user* skills have been separated out into *basic* and *advanced*, while "specialist" is preferred to "practitioner" for those whose work is fully dedicated to ICT activity for the benefit of others.

To avoid any misunderstanding, we point out that ICT practitioners do not only work in the ICT sector. Furthermore, more than half of ICT practitioners work in different types of ICT-support functions in all sectors of the economy (both private and public). In addition, it should be recognised that ICT practitioners also require ICT user skills in carrying out their work and ICT users can "progress" into ICT practitioner work (and very many do).

E-Business skills are said to play an increasingly important role in a company's competitiveness; they are strategic in nature and are related to innovation management. It should be noted, however, that these skills are not the same as ICT skills but represent an intersection between ICT skills and (other) business skills.[5] Basically, ICT skills focus on the question of how to deploy (practitioner) and use (user) ICT, whereas e-business skills focus on the question of what to do with ICT (for an organisation).

The distinctions between these three types of e-skills are important in a number of ways, and especially in relation to the attempts to track and measure their supply and demand that will be the focus of the report in following sections. In particular, many aspects of ICT Practitioner skills can be tracked through (the proxy of) ICT Practitioner ***occupations***, while this is not possible for ICT User or e-Business skills (because there are no "ICT user" or - currently – "e-Business" occupations). Tracking occupations brings considerable advantages, since there is a comparative wealth of continuing data (publicly) available on occupations in official statistics from "general" – regular – surveys (both household and enterprise). Where analysis cannot benefit from such databases, specific primary research is required – (new) surveys involving questions specifically about (different aspects of) e-skills. This study reports on a number of these, although there have been very few at the European level (or even beyond the national level). Eurostat has been working to increase the coverage of e-skills within its annual enterprise and household surveys, and this data will become increasingly valuable in supporting objective analysis of e-skills at the European level.

Shortage, mismatch, gap

As indicated in the introduction of this report, a smoothly operating labour market requires a balance between the supply and demand of these various sets of skills. The expectations are, however, that the supply will not be able to keep up with the demand for a variety of reasons. An important element in this discussion is to describe what problem(s) lie(s) at the heart of any discrepancy between supply and demand for an e-skilled workforce. This discrepancy may carry qualitative or quantitative characteristics. The European e-Skills Forum (2004) has defined the various deficiencies as follows:

- **Shortage**: a quantitative lack of skilled people in the labour market; in other words: there are not enough people in the workforce that can perform ICT jobs;
- **Gap**: a competence shortfall between current and needed competence levels of (employed) personnel; in other words: the ICT practitioners do not (as perceived by their employer) have the complete set of required competences to an adequate

[5] In practice, this could either be a person with predominantly business skills and some ICT skills, or an ICT practitioner with some business skills.

level. This shortfall would require one of the following responses: retraining, on- or outsourcing, or work reorganisation;

- **Mismatch:** a difference between the competence of the trainee or graduate and employers' expected competence needs. Mismatches are assumed to arise from 'inappropriate' training or "mis-aligned" course curricula, 'unrealistic' requirements of employers or rapid technological advances (and learning providers' required time to adapt to these changes)

These definitions can help clarify problems of the labour market, but can lead to semantic misunderstanding: discrepancies between demand and supply could either be due to a quantitative lack of skilled people (shortage) or to the qualitative discrepancies gap and mismatch. Figure 1 attempts to clarify the differences. If there are not enough people with ICT skills available when employers attempt to recruit, it is called shortage (1), if the ICT workforce has skills that are not adequate, it is characterised as a gap (2) and if education (and training – the term is less used in relation to training, although it is indeed possible that some training is felt not to have been very well aligned with employer skill needs) provision does not lead to an adequately skilled set of new recruits to the ICT practitioner workforce this is a mismatch (3).

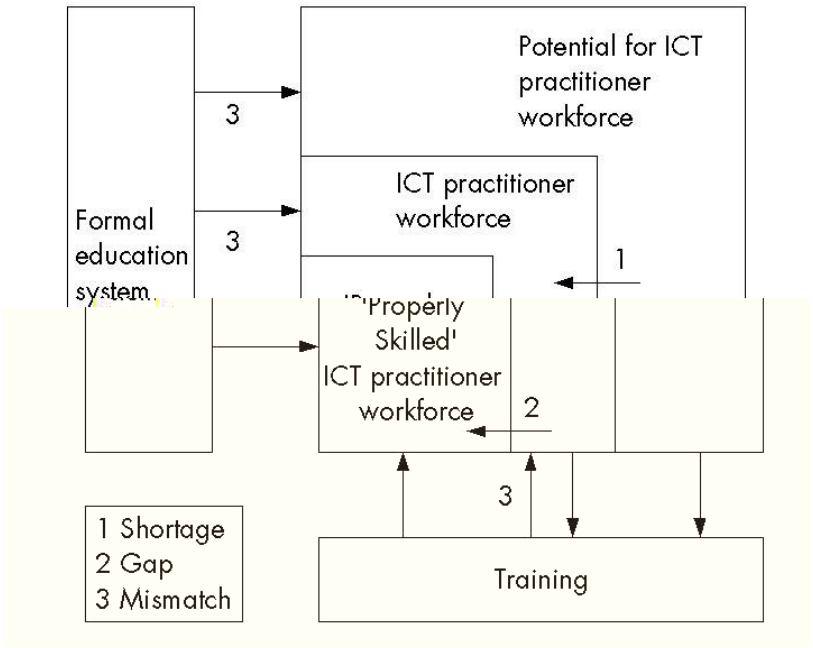

Figure 1. Shortage, gap and mismatch in the ICT labour market

Dynamics play an important role in workforce requirements: new developments in ICT require new skills and may also lead to the devaluation of older skills (and lead to gaps). Furthermore, periodical updates of learning provision are required in order to mitigate mismatches; for the individual, life-long learning is required to mitigate skill gaps.

2.2 Focus of our study

The potential scope of a study considering all e-skills can be very large and may interest various groups of stakeholders. An increasing number of studies focus on (basic and advanced) user skills, as participation of citizens in the knowledge society is an important policy issue.[6] There are implications for productivity here, and this is obviously an important element in the goals that are formulated under the Lisbon agenda.

At the same time, the competitive and innovative positions of various economic sectors remain dependent on the supply of practitioner skills and the rapid development of e-business skills. Thus, without neglecting the importance of user skills and the social inclusion objectives, **this study focuses on *ICT practitioner and e-business skills*.**

As indicated before, many aspects of ICT Practitioner skills can be tracked through (the proxy of) ICT Practitioner occupations, while this is not possible for ICT User or e-Business skills (because there are no "ICT user" or - currently – "e-Business" occupations). Therefore, when discussing e-skilled occupations, in the context of this report, we primarily target those occupations that require *practitioner* skills. Where available, we include findings that focus specifically on e-Business skills as well.

As we have emphasised in the previous section, ICT practitioners do not only work in the ICT sector. ***Therefore, in this study we focus not only on the ICT sector specifically, but also consider other economic sectors with considerable needs for ICT practitioner skills.***

2.3 Data sources used for analysis

The study was not intended to conduct primary data collection. As a result, two different types of secondary data sources were used.

First, the most recent studies on the supply and demand of e-skills – with a focus on ICT practitioners and e-business skills – were an important basis for the analysis. We identified a large number of studies describing the ICT practitioner job market that were undertaken just before or just after the millennium change. Some of these reports were considered, but the focus was particularly on studies from 2002 to 2005, as these are likely to shed light on the newest developments and issues. Second, large data sets on ICT and IT practitioner employment and education (as collected in large, regular, general surveys by statistical agencies primarily) were analysed. The next sections provide a more detailed breakdown of these information sources.

2.3.1 Studies and reports

In addition to purely official statistical sources, there are a number of organisations that collect and analyse information concerning e-skills. On the national level these include ministries of information or economic affairs, national planning offices, organisations of ICT practitioners, organisations of ICT (service) suppliers, job agencies (public and private), business associations or academics in the field of information technology or

[6] This has recently been reinforced by the i2010 initiative, with 'inclusion' as one of its three pillars. (See http://europa.eu.int/information_society/eeurope/i2010/index_en.htm)

labour studies. In order to identify all these potential sources, we contacted the members of the European e-Skills Forum and the Northern eDimension Action Plan (NeDAP) e-skills working group and asked them for pointers to national studies.

At the European and trans-national level, we looked at the work of major (ICT) technology, education and practitioners' organisations: the Career-Space project (an industry consortium aimed at describing the roles, skills and competencies required by the ICT industry in Europe), Cedefop (European Centre for the Development of Vocational Training), CEPIS (Council of European Professional Informatics Societies), CompTIA (Computing Technology Industry Association), EITO (European Information Technology Observatory), the EUCIP programme (European Certification of Informatics Professionals), and IPTS (Institute for Prospective Technological Studies).

In order to address the second, future-oriented perspective of the study, we performed a systematic review of recently conducted future-oriented studies on e-skills, including some of the reports identified in the first phase. In addition, we searched the literature using the search terms "foresight", "forecast", and "e-skills" and examined databases containing foresight related data such as the Dynamo system (a

2.3.3 Interviews

In addition to the literature search, we contacted more than 30 experts in the field of ICT (skills), mainly from the previously mentioned organisations, to further identify data and sources. With some 15 experts we had extensive contact to clarify a number of questions, including:

- What is the current state of the art concerning studies on the demand and supply of e-skills?
- Which areas are most problematic concerning the skills match? Where do gaps occur and in which areas does demand exceed supply?
- Which type of studies do policy makers use?
- Which definitions of e-skills are currently used?
- Which indicators have proven to be feasible, valid and reliable?
- In which direction are e-skills studies currently developing?

2.3.4 Meetings and workshops

Finally, a number of meetings and workshops were organised to reflect on intermediary findings of this study and to collect ideas about, among others, improvement of data collection.

First of all, we met with representatives of Eurostat (12 April 2005) to address ongoing initiatives with respect to the possibilities of the various surveys (Labour Force Survey, Household Survey on ICT usage, Enterprise Survey, CVTS, Job vacancies survey) that Eurostat has set up, and improvements or changes that were foreseen with respect to these surveys, in particular the development of new indicators. Eurostat officials present were: Ana Franco (Labour Force Survey), Christophe Demunter (Household Survey), Birgitta Andrén (Education and Culture), and Fernando Reis (Enterprise Survey).

Second, on 13 April 2005, we talked with two OECD officials, Graham Vickery and Desirée van Welsum, both of the Information, Computer and Communications Policy Division within the Directorate for Science, Technology and Industry. During this meeting several issues were discussed:

- focus of analysis of OECD activities,
- projections of ICT employment
- composition of the ICT skill requirement within the workforce
- definitional issues related to e-business skills
- feasibility of data analysis at a more detailed level

In addition to these meetings, two workshops were convened to discuss the interim and draft final report. The first meeting was organised in Brussels (4 April 2005) and focused on the intermediary findings of the study. The second meeting took place at Cedefop in

Thessalonica (23-24 June 2005)[8]. This workshop resulted in a very useful exchange of views and an extensive list of comments and suggestions that were subsequently incorporated in the final report. The list of participants in both workshops is incorporated in Appendix C.

2.4 Framework for classification / taxonomy

The body of research and literature on e-skills is vast and varied. In order to structure the material, we applied a taxonomy that could provide a quick overview of the key issues while preserving the empirical richness of the different sources. This taxonomy was used to summarise the following factors:

- Definition of e-skills: one general definition of e-skills, or several definitions of different levels of e-skills.
- Purpose of the study: assessments of current supply and/or demand versus foresights, assessment of e-skills among other skills or topics.
- Measurement instrument: performance tests, analysis of existing labour market statistics (job profiles), self-report survey, qualitative assessments of skills matches.
- Indicators: performance levels, amount of training, ICT usage, work experience or job profiles.
- Sample: geographical reach, economic sector, target population, sample size.
- Methodological quality of the study: validity, feasibility, and reliability.
- Organisation of the study: national or international statistical offices, one organisation or consortia, private or public sector.
- Policy context: clients, targeted users.

To ease presentation we summarised the information in a table that addresses the following questions:

- Who/what is assessed?
- By whom?
- By which methods?
- Using what data?
- When?
- Other remarks about geographic reach and status of the report?

The overview of the survey of existing sources structured in this way can be found in Appendix I. It is used as an information source for Chapter 3, to analyse different approaches in Europe and the US.

[8] See http://eskills.cedefop.eu.int/em_june2005/

On the basis of an additional systematic literature review, we were able to identify a number of futures studies on e-skills that were described in relation to:

- Principles for foresight - developed for improving the science/policy relationship with the help of foresight (RAND Europe, 2005).
- Specific e-skills issues related to foresight assessments as identified in phase 1 of the study.

On the basis of reviews of futures studies, limitations were identified that relate to the way futures studies on demand and/or supply of e-skills are currently undertaken. This analysis was then used as an input to develop a framework for conducting futures research on the future of the ICT skill market (Chapter 5).

CHAPTER 3 Review of current e-skills studies

An analysis of the current situation related to the supply and demand of e-skills in Europe must consider the results of recent and ongoing activities. Not only do these studies inform the analysis of the current situation, they provide insight into the various perspectives that need to be considered. In addition, the various data collection and analysis methods used in the studies shed light on where future efforts can be strengthened and supported. This chapter reviews the studies, highlighting issues that will require further attention. In particular, this review is used to provide recommendations on definitions, indicators and approaches that could be used in order to provide more meaningful future analysis of the supply and demand of e-skills in Europe.

Our literature review yielded recent studies addressing e-skills stock, supply, demand, and shortages (see Appendix I). These studies can be analysed in a number of different ways. For example, the *focus or purpose* of the studies is an important factor, as it generally determines the methods used and the level of detail of the data collection. Another important factor is the framework in which e-skills are defined, and the ways in which e-skills are tracked and measured (these two elements are closely connected).

3.1 Focus or purpose of studies

A range of organisations have addressed the issue of e-skills: ministries, agencies, industrial consortia, practitioners' associations, social partners, and research organisations. These organisations focus on the topic for different reasons and, as would be expected, skills are addressed at a level of detail that is most relevant for the purposes of each study. Although attempts are being made to integrate different approaches to skills and skills definitions (e.g. Cedefop 2004), it is necessary to first describe the various foci that can be taken when addressing the issue.

Topical focus

Several studies go beyond an analysis of e-skills only. These studies try to capture the function of ICT in society and how it is not only affecting work, but life more generally, and government and business as well. The reports that specifically focus on e-skills in relation to training, education or employment can be roughly divided into two main categories: those studies that focus on assessing the specific e-skills profiles required for specific jobs (e-skills ***requirements***) and those that are aimed at estimating the presence of (specific) e-skills in occupations within the total labour force or segments thereof (e-skills ***estimates***).

E-skills *requirements* are of interest to ICT practitioner organisations and organisations concerned with vocational training and education, such as Cedefop and the EUCIP

1. People exercising jobs where they are likely to make intensive use of ICT in order to produce their output.
2. The job output can be traded/transmitted with the help of ICT (ICT-enabled trade in services).
3. The work has a high explicit information or "codified knowledge" content (and no or little tacit or implicit knowledge).
4. The work does not necessarily require face-to-face contact.

Although this list of criteria leads to the potentially worrying conclusion that some 20% of total employment in the EU15 could be affected by international outsourcing, Shapiro and Millard (2004) as well as OECD itself point out that jobs lost to offshoring are relatively small in comparison to general job turnover. With the exception of the UK, the question of offshoring on a national scale is less well researched and reported (O'Sullivan, 2004).

Finally, **migration** issues come into play when immigrants are recruited to fill job vacancies. Until recently, it was believed that the predicted shortages in the ICT labour market in Europe would create a brain drain in poorer countries. However, the recent slowdown in the ICT sector has changed this outlook to some extent (and the return of some ICT practitioners after periods of experience in higher wage economies has undoubtedly enriched the "home skills-base"). A number of countries, such as the UK, Denmark, US, Germany and France have added IT specialists to their lists of "favoured immigrants". The first three countries have already removed the special status for immigrants with ICT skills. Germany's much-acclaimed Green Card scheme never reached the required maximum, and the number of ICT-skilled permit holders in France fell sharply, both absolutely and as a percentage of all foreign workers (OECD 2004). The feasibility of such schemes in the future will depend on a number of political factors as well as the shortages experienced in the labour market.

National focus

About half of the surveyed studies focus on the national level.[9] The prime example here is the UK, where e-skills UK[10] has recently commissioned and finalised a series of reports on demand, supply and forecast of the e-skilled workforce in Great Britain. The year before, the UK's Learning and Skills Council issued a report on skill shortages – although broader than e-skills only.

In Spain, the ICT industry associations AETIC (formerly ANIEL) and COIT committed themselves to annually report on developments in ICT education and professions, which has resulted in a series of reports that are of varying quantitative and qualitative nature (PAFET 1, 2, 3).

The Information Technology Association of America (ITAA) has performed an annual survey over the last 7 years concerning IT practitioner employment and skills shortage in

[9] As will be shown in Chapter 4, more data is available, but not as reports

[10] E-skills UK is an organisation dedicated 'to ensure that the skills employers need are the skills employers get'

the US. Although this effort is based on a relatively small sample size (500 organisations), it provides a consistent, evolving overview of the situation in the US.

Other national efforts that we identified either cover a much broader range of ICT aspects, devoting relatively little direct attention to e-skills, or do not seem to have the consistent attention to e-skills as the examples provided above. Furthermore, definitions of e-skills may differ at the national level, making detailed EU comparisons difficult. The existing data on supply and demand of ICT and IT practitioner skills at the national levels is presented in the following chapter. A cross-country comparison of the outcomes cannot be conducted without caution.

3.2 Tracking and measuring ICT Practitioner skills

The fact that varying definitions and foci of e-skills exist inevitably influences what different studies report - and at what level of detail. This has serious adverse consequences for efforts to compare between studies and produce EU level estimates. The purpose of any study strongly influences the level of detail chosen. Looking at e-skills in order to streamline requirements or frameworks for national ICT education curricula needs different approaches and types of indicators than an analysis of general trends in the job market.

When considering the supply and demand of ICT practitioners, there are a number of ways in which e-skills can be measured. The following sections of this report examine and discuss three main approaches to tracking and measuring skills, using data relating to[11]:

- Occupational profiles;
- Skills profiles (which according to some includes the occupational approach);
- Formal education and additional training.

3.2.1 Occupational classifications

ISCO

General employment statistics based on occupational classifications or profiles provide a picture of the stock of ICT-skilled employees and the fluctuations in that stock over time. In the EU, Eurostat collects information, in cooperation with NSOs, on employment according to occupational profiles for its holdings of Member State *Labour Force Survey (LFS)* data using the so-called ISCO-codes (International Standard Classification of

[11] The amount of quantitative data available for all Member States in the EU that is both statistically valid and directly comparable between countries is very limited. The relevant data that does exist is of two main kinds: 1) data from specific ("one-off") surveys (both of employers – "enterprise surveys" and of individuals – "household surveys") that are carried out from time to time for specific purposes, and 2) Data from general surveys (both enterprise and household) that are carried out regularly by National Statistical Offices (NSOs). While data from specific (skills-related) surveys is often more precise and informative, meaningful comparison and assembling of meaningful EU-level estimates on a regular basis is only possible from general surveys. For a more detailed description of data availability and sources, see 4.2.

Occupations).[12] The OECD also uses these codes (which were developed and defined under the auspices of the ILO) in its analyses (OECD 2002; 2004).

However, these ICT occupational profiles are only an approximation of ICT skills, since they specify (what is agreed to be) what people in the occupation do (rather than what skills the individual working in that occupation possesses in order to be able to perform competently). A number of sources (OECD 2004, CEPIS 2002, WANE 2003, Cedefop 2004, STILE 2004) point out that there are some significant drawbacks in using ISCO88:

- The level of detail practically available is quite low: although ISCO-codes are defined at a reasonably detailed 4-digit level, gathering enough survey data for there to be meaningful results at that level would require very large data sets across European countries. The most important source for this data is the Eurostat LFS datasets for which Member State NSOs are only required to submit 3-digit level ISCO data.
- The classification system was designed prior to the ICT developments in the nineties and therefore does not include many modern ICT job categories.
- Furthermore, the STILE (2004) research point out that different countries apply the codes differently. As a result, using a range of ISCO88 codes to "track" ICT practitioners leads to wrong inclusions and/or wrong exclusions.

The most precise definitions of "IT practitioners" in ISCO are codes 213 (Computing professionals[13]) and 312 (Computer associate professionals[14]); these are the codes used in, for instance, CEPIS (2002) and by Eurostat in the Household Survey on ICT Usage to assess the skills applied in "ICT jobs". It is argued that the practitioners that fall under the two categories - predominantly software engineers and technicians, systems analysts and software development specialists - represent the core of IT technical staff. However, just focusing on these codes will ***exclude*** a number of occupations that require e-business skills, such as IT managers, computer operators, computer engineers, computer sales staff, IT workers in education, telecom practitioners and electronics engineers. Furthermore, they only represent **IT practitioners** and do not include professions in communications technology.

Others criticise the use of these professional and associate professional occupational categories because of their assumed primary focus on those with higher education with the consequent risk of exclusion of those who came via vocational routes (EUQuasit 2004).[15] Therefore, some broaden the definition by including codes 313 (optical and equipment

[12] The 1988 version is abbreviated as ISCO88

[13] Computing professionals conduct research, plan, develop and improve computer based information systems, software and related concepts, develop principles and operational methods as well as to maintain…systems…ensuring integrity and security of data.

[14] Computer associate professionals provide assistance to users…, control and operate computers and peripheral equipment and carry out limited programming tasks connected with the installation and maintenance of computer hardware and software.

[15] The term 'professional' would imply that the person in question has enjoyed higher education (there is an explicit link between ISCO code and educational level as defined in ISCED) and thus excludes practitioners with lower education level, but still high skill level.

operators) and 724 (electrical and electronic mechanics and fitters) (OECD 2002; 2004) and even 311 (physical and engineering science technicians) and 214 (architects, engineers and related professionals) (STAR 2001). The OECD (2004) study goes one step further by introducing a broad definition of ICT-skilled employment, which aims to include all those who can be considered "sector-specific ICT users" and "generic ICT users" (see Appendix A for OECD's definition). Although the assumption that most of these occupations involve the use of computers is plausible, it blurs the picture of ICT practitioners to 'those occupations that may be involved in computer use' as it ***includes*** practitioners that may or may not be knowledgeable about ICT practitioner skills and e-business skills.[16] The theoretical solution is to describe the professions at a more detailed level. Within the structure of ISCO, the 4-digit level descriptions generally allow a much more precise inclusion and exclusion of occupations. This approach is applied in EUQuasit (2004), which classifies ICT practitioners in 16 ICSO88 (4-digit) unit groups[17]. The authors argue that this classification is subject to interpretation of what occupations require ICT practitioner skills and in that sense may be considered imperfect. However, by covering communications, ICT management, marketing and sales practitioners, it provides a more comprehensive coverage of e-skilled occupations compared to the narrow view on IT- or Computer professionals often used. The important question when dealing with detailed definitions is:

1. to what extent data is available for these "finer grain" occupations;
2. what is the sample size of the survey used; and, so
3. whether using that data would lead to reliable results.

Also, as pointed out by the STILE project (2004a, 2004b) and EUQuasit (2004), the translation of national occupational classifications to ISCO-codes is problematic. There are efforts underway to revise ISCO88 that would make it more compatible with other ICT occupational frameworks and to incorporate new occupational profiles (related to types of ICT practitioner). However, this revision is not expected before 2008.[18]

Other occupational classifications

LFS data held internationally using ISCO88 has been translated from (official) national occupational classifications. Generally these classifications have more than two categories for ICT practitioners, and are therefore generally more useful than ISCO for assessing ICT practitioner employment. The UK's Labour Force Survey and the US Bureau of Labour

[16] For example, ISCO 313 harbours photographers and image & sound recording equipment operators, medical equipment operators; ISCO 724 e.g. harbours electrical cable installers, repairers and cable jointers.

[17] Sales and marketing managers (1233), Computing services manager (1236), Production and operation managers in communications (1226), Managers of small enterprises in transport, storage and communications (1316), Computer systems designers, analysts and programmers (2131), Computing professionals not elsewhere classified (2139), Electronic and telecommunications engineers (2144), Electronics and telecommunications engineering technicians (3114), Computer assistants (3121), Computer equipment operators (3122), Broadcasting and telecommunications equipment operators (3132), Data entry operators (4113), Calculating-machine operators (4114), Salespersons for ICT (5221), Electronics mechanics, fitters and services (7242) and Telegraph and telephone installers and services (7244).

[18] This timeline is based on conversations with Eurostat.

Statistics each use their own Standard Occupational Classification systems (SOC90, revised to SOC2000 and currently again in revision in the United Kingdom, and 2000 SOC in the United States); the Australian Bureau of Statistics uses ANSIC; and Canada uses its own New Occupational Classification. Although these classifications may be more useful for coding ICT occupations, the fact that they are all different means that they are not very useful for purposes of international comparison, nor do international statistical organisations support them. Therefore, we do not provide further detail for these classifications.

Sectoral data

Labour Force Survey datasets not only have data on the occupational profile of the respondent, but also on the "main business activity" of his/her employer. This requires a framework for classifying different sectors in which the employment takes place. The accepted European framework is the NACE (Nomenclature générale des Activités economiques dans la Communauté Européenne), which is based on the International Standard Industrial Classification. As with the occupational data, national variations exist and practices differ in the codification of sectors (STILE 2004a; 2004b). This can result, as for occupational data, in errors occurring in the *translating* of data from national frameworks to NACE.

The US, Canada and Australia/New Zealand have different and sometimes more specific sectoral codes, which are better equipped for measuring the ICT sector because they account for the development of new industries and technological innovations (WANE 2003). As is explained in EUQuaSIT (2004), the ICT sector covers a broad range of NACE codes and care must be taken when addressing different specific sub-sectors.[19] However, for comparison within the EU the NACE codes are useful. In the coming years the current NACE system will be revised and updated to include a specific section on the ICT sector.

3.2.2 Skill-based classifications

Standard occupational classification systems tend to be too static to capture the changing landscape of ICT and the ongoing creation of new ICT tasks. As such, they are generally felt to be inadequate for the task of charting ICT jobs. For example, the IT National Training Organisation in the UK has estimated that labour force survey estimates (based on SOC90) may underestimate IT Practitioner jobs by up to 40 percent, because a number of IT Practitioner occupations are excluded (WANE, 2003, and paragraph 3.2.1 above).

An alternative is to attempt to track skills directly rather than assume them to be present in certain occupations. A number of skill-based classification systems – such as the UK's Skills For the Information Age (SFIA), German Advanced IT Training System (APO), or the NWCET IT Skill Standards in the US – have been recently compared and analysed for

[19] It should be noted that errors occur when LFS respondents attempt to classify the "main business activity" of their employer. This results in a recognised limitation of the validity of sectoral distribution of LFS data, which should where possible be cross-checked against employment data from employer (enterprise) surveys. Such errors are generally restricted to some 10-20%.

development into an encompassing framework for ICT Practitioner skills in Europe. Cedefop (2004) reports that "there is really not a work and skill level system, classification or framework which has a national or European wide recognition and which is easy to use for the split of employment". Hence, the number of studies using these skill-based classification systems for quantifying supply and demand of skilled workers remains low. They are therefore of limited use in quantitative comparisons.

e-Business skills

Many reports refer to e-business skills: there seems to be wide agreement that ICT skills need to go beyond the pure technical matters. However, in the literature that we have reviewed there are few attempts to qualify let alone quantify this specific set of skills. It seems that e-business skills are by definition plural: they are a (unspecified) combination of business and ICT skills and as such very difficult to capture.

The Irish Expert Group on future skills needs (2000) defines e-business skills as a mix of business, creative and technical skills, that are partially learnt in disciplines such as: business studies, commerce, multimedia, information systems (combinations of business science and computing), design, communication studies, fine art, and also librarianship, journalism, film/TV/video studies, and photography. Although many of these disciplines nowadays involve computing, this broad and unspecified description would lead to wrong inclusions if an attempt at quantification were made.

IDC/EITO (2001) take the occupational approach in defining e-business skills as those skills needed by *internet business strategists* (e.g. online marketing professionals, CIOs, internet economy architects) and *internet-dependent professionals* (e.g. e-commerce project managers, editor-content managers, web banner designers, product information brokers). It is not completely clear what occupations fall under these headings, but it is clear that this approach has not been followed by other initiatives; it thus provides very little opportunity for international comparison or validation.

As it is acknowledged that e-business skills are an important element in the discussion about future skills needs, these skills are considered as falling within an integrated (albeit not clearly definable part of) general e-skills framework. Until e-business skills emerge or distil into clear occupations, the only way that internationally quantitative data will be available would be from (new) primary research (survey work).

3.2.3 Formal education and additional training

A third way to take stock of skills is to use indicators of formal educational qualifications or training episodes as a proxy measure of skill development and/or supply. However, the assumption that formal education in computing is directly related to a set of relevant e-skills (even just for ICT Practitioners) is not sustainable. Achievement at higher education levels or qualifications as defined by the ISCED97 (International Standard Classification of Education – 1997 version) categories does not automatically translate to higher ICT practitioner skills (although, of course, they do relate to an extent) and the knowledge delivered through higher education provision may be mismatched with employers' needs.[20]

[20] Indeed this is often reported, and many new graduates recruited for ICT Practitioner work have graduated in non-ICT subjects

This is a core issue for educators and trainers, but also employers and employees, especially with regard to the 'interchangeability' of qualifications in an international (European) context. Cedefop (2004) identifies the main problems:

- There is a lack of common definitions of ICT skills and skill levels relevant for ICT employment;
- There is a lack of qualification (learning output) definitions and qualification levels relevant for ICT education;
- There are few common approaches to skill and training standards and their assessment and certification across the European Union;
- There is no way to validate the training, independent of when, where or how it has been achieved.

Attempts to elaborate an overarching framework for qualifications in a European Higher Education Area are being made as well as for vocational education. The US-based joint Taskforce for Computing Curricula (2004) recently drafted a reference framework for future use, comparing different types of computer curricula: computer engineering, computer science, information systems, information technology and software engineering, and proposing the kind of content that should be in each. The approach is of a qualitative nature. Also Cedefop (2004) attempts to integrate different qualification and education frameworks with skills frameworks (see Appendix B). However, until an agreed meta-framework is implemented at the international level, it requires estimates to quantify and compare formal education and training activities.[21]

3.3 Measuring e-skills

Attempts to track the demand and supply of e-skills are being made through a broad variety of methods. Most studies on e-skills address stock, the demand or the supply side, while the studies that assess both sides of the labour market often address each side with a different method. This complicates any effort to assess and compare supply and demand.

3.3.1 Stock

The stock of employees, as measured by statistical offices through household survey data using occupational frameworks, provides information on the number of ICT Practitioners in employment accumulated over time by inflows (hiring) and/or depleted by outflows (retirement, replacement, job shift). This method gives information on the demand currently met and/or acceptable supply; however, it does not provide information on unmet demand or surplus supply.

The idea is that if the skills required for any "job" defined by its occupational title could be measured reliably and precisely, and if such data were available for all relevant occupations,

[21] Under the assumption that university education in Europe is reasonably comparable (which is a bold assumption), a limited measure of e-skills supply would be the number of informatics students (ISC/EF code 480). For (on-the-job) training such a measure that specifies training content does not exist.

then the skills of the employed part of the population could be assessed through a simple count of occupational employment, as obtained through censuses or labour force surveys. Unfortunately, neither of the two conditions in the previous statement proves to be satisfied. Often, experts' judgements of skills specified in terms of qualification requirements are simply made from the achievements of incumbents, which is not necessarily a good guide to the present and future requirements for new recruits to the occupation.

In addition, there can also be variation in the skills requirements even within fairly narrowly defined occupations: this derives from how individual jobs are configured. Ergo, even if a satisfactory (quantitative) measurement is conducted, a qualitative interpretation thereof is bound to be of limited value.

3.3.2 Supply

There are, in principle, a number of ways to measure the skills present in a population as a whole or within the labour market more specifically. The most precise method is conducted at the level of the individual possessing the skills. Based on the recent studies on e-skills, we have made a classification of the various methods.

Direct testing

There is a general presumption that the most valid way to assess the supply of (e-)skills is through direct testing, as this provides "objective" outcomes with regard to the quality of skills (against an agreed yardstick) – and thus also with regard to mismatches between employer needs and the capabilities of newly trained employees and/or skills gaps of the existing workforce. Examples of such tests are the UK Skills for Life Survey and use of the European Computer Drivers Licence (ECDL). However, these standards relate to user skills. When addressing ICT practitioner skills, the number of possible skills tests increases considerably, which makes it particularly difficult to establish an agreed set of generalised tests.

The Danish Technological Institute - DTI (2003) expects that testing beyond a narrow set of well-defined skills would either be too costly or would not successfully pass the tests of validity, reliability and transferability in a European context. Furthermore, as most computer environments and work processes are changing quite rapidly, it is unlikely that the same test could be applied in successive assessments separated across, for example, five years; measurement of progress is therefore difficult and gaps and mismatches would not be recognised. A further consideration is that any test of ICT skills would need a substantial amount of time (and corresponding scale of resources).

Self-assessment and self-report surveys

Skills are often assessed through indirect measures, such as self-assessment or "peer" or "supervisor" assessment (e.g., asking how skilled someone is). The advantage is that a broad range of skills can be addressed. The disadvantage is that respondents are either biased about their own capabilities (social-esteem bias), or that they may have unreliable knowledge of their own skills.

Self-reporting is not necessarily restricted to asking people directly about their skills, but could also require them to report on their job activities and ICT usage.[22] As an indication of the skills of individuals, this method gives us only approximate measures. Job-holders may have too many or too few skills for the job and they could be asked to indicate whether this is the case. Also, it should be recognised that any national-level measures of skills obtained in this way would be strictly measures of the skills utilised in workplaces of each nation. Additional items asking respondents about skills gaps between the individual jobholder and the job requirements could add to our knowledge of over- and under-utilisation of skills. Nevertheless, the reliability of such responses in an international context would need to be evaluated. A third disadvantage is that the job analysis method cannot be applied to the economically inactive population (who - by definition - do not have jobs), although other approaches (in particular employer surveys) would have the same limitation.

Educational qualifications

The (future) supply of skilled people can be estimated by measuring the number of (students enrolled and) graduates of each education/training institution that offers specific e-skills learning and qualifications. For schools and universities, national statistical offices collect this information. However, there is not a uniform framework for assessing the coverage and 'value' of specific educational profiles and thus the capacity of educational systems to generate the skills for work and life in general. If qualifications could be made internationally more comparable in a reliable and accepted manner, particularly for the fields that we are interested in, measurements of the number of qualified adults would be a useful indicator (DTI et al., 2003). In order to prevent the risk of mismatches, the curricula would have to be re-assessed regularly (e.g. every 3-4 years). In addition, it is important to recognise that many "new recruit" ICT Practitioners are graduates of non-Computing disciplines.

Training and certifications

There is a wide range of professional training available that is offered by private training organisations (sometimes supported by professional or sectoral associations), and software or hardware vendors. Research has found that employers say the skills they require are not directly related to formal education (as such, educational provision can represent a mismatch of skills to what employers need, see CompTIA, 2004a and 2004b) and thus additional training is required.

Theoretically, it would be possible to amass the numbers of certificates documenting each successful completion of commercial IT (practitioner) training issued in every (European) country. However, such an effort would lead to a long list of specific courses and certificates that would be difficult to compare. In their study on e-skills certification systems, Weiss et al. (2005) also indicate that the majority of stakeholders and experts in this field are of the opinion that fewer, but more relevant, e-skills certification schemes would be desirable, and that Europe is confronted with too many systems and schemes.

[22] It is clear that self-reporting could also be used in another context, such as in a household survey in which ICT usage is reported.

Furthermore, it seems that private training organisations do not make such data public, as it generally constitutes commercially confidential information. Nor are statistics on on-the-job training publicised by corporations. Therefore, interviews or surveys are the most often used method for gathering this information. CompTIA (2004a and 2004b) offers overviews and opinions (together with subjective market trends), but not numbers of certifications.

Number of unemployed

A final measure of (potential) supply would be the number of unemployed within a specific occupation (as related to a specific occupational code). The larger the pool of unemployed, the higher is the (apparent) "untapped" supply of workers. On the one hand, this number informs us about the tightness of the skills/jobs market; on the other hand, it gives little qualitative information as the issue of the skills possessed by such people (which may be the reason why these individuals are unemployed)[23].

3.3.3 Demand

Job vacancies

Demand is often estimated by an analysis of the number of job vacancies for relevant occupations in a specific period for a specific country (e.g., by systematically reviewing and counting newspaper articles or analysing web-based job databases). Job vacancies can provide a crude measure of new demand, but may not take into account labour market dynamics. A more informative measurement would be *unfilled* or *hard-to-fill vacancies* (over a period of time), as this reveals real labour market supply shortages. Thus, *unfilled vacancies* is an indicator of unmet demand. To the extent that real skill shortages are a significant factor in determining the need for policy response, *hard-to-fill vacancies* is a very important indicator.

Employer surveys

Often, the demand for skills is established through employer surveys or interviews, which ask for the number of people needed with a certain job profile or set of specified technical skills (for different economic sectors). This way of measuring is informative for finding shortages, as well as gaps and mismatches.

However, as discussed above, there is little uniformity in what set of skills are required for specific jobs. Also, it could be argued that these surveys are subject to bias as employers

[23] It must be recognised what the data on numbers of unemployed "whose occupation is ICT Practitioner" -- that is derived from Member State LFS responses – actually represents. Clearly, no unemployed person can be viewed as having a (current) occupation, but in the same way that a Lawyer moving between practices does not cease to be a lawyer, it is not unreasonable for ICT Practitioners not currently in employment to view themselves as ICT Practitioners. Of course, lawyers may (and sometimes do) decide to quit and start some other kind of work. Likewise, not all "unemployed ICT Practitioners" will necessarily be seeking further work in this occupation. It is also true that some of this group might have lost their jobs because they were felt by the previous employer not to be performing adequately, and the skills of others in this group may be in need of updating. The key point, in terms of this group of people's role as being one potential source of supply of ICT Practitioner skills (in addition to the others listed), is that they are a source of these skills precisely because they have direct experience in this work, and that (perhaps at the right price) they could (often very quickly) form part of the response to new demand.

have an interest in boosting estimations of demand for e-skills so that governments will invest in this section of the labour market. Employer surveys are even more suspect when carried out by the ICT sector itself.

Nevertheless, certain specific issues can only be directly addressed by employer surveys: outsourcing/offshoring of jobs to non-EU countries is most directly measured by asking the employers what their plans are and to what extent they are already using offshored services: this clearly influences the demand for skilled professionals within the EU. As long as e-business skills are not captured in a specific occupational code, educational qualification or training profile, employer questioning remains the only option to find out about these specific skills.

Replacement demand

Replacement demand is a specific qualification of the demand-side: although employment levels within an occupation may not grow over time, there will nevertheless be a net demand arising from the "attrition" of people leaving that occupation. The most obvious reasons for replacement demand are retirement of an older workforce, resignations, leave-of-absence, contract expiration and other categories such as deaths, dismissals and shifts to other functions. The replacement demand can either be estimated with an expected fraction of the stock that will need to be replaced (based on workforce characteristics such as age distribution or recent statistical evidence) or be estimated from employer survey questions.

3.4 Conclusions and recommendations

Based on this study's analysis of current reports and discussions with experts, it emerges that recent approaches in addressing supply and demand of e-skills provide a mosaic picture of their current status in Europe. To some extent, this can be attributed to the different foci that the different stakeholder organisations and their researchers have: either targeting skills requirements and detailed qualitative descriptions of professions and skills (including skills gaps and mismatches), or targeting estimates of numbers of skilled employees and shortages in a quantitative sense.

The different definitions of skills and skill levels are closely related to the focus of the study. A detailed study on skills requirements would use a skills framework but would also have to cope with the differences that exist between different frameworks applied. It would have to rely heavily on 'translation tables' until such time as a single agreed European framework is available. Studies focused on estimating numbers of people have to cope with the limitations of existing international occupational and educational classification schemes. As indicated before, occupational codes from ISCO88 can lead to wrong exclusions and inclusions - avoiding such pitfalls would require more in-depth research at national level. While there are examples of this, they do not help for an analysis covering the EU-25 area.

Educational achievement statistics lack detail and are difficult to compare internationally on highly aggregated levels. In addition, tertiary education statistics for computing courses are only a limited indicator of skills required. Industry certification schemes are plentiful

and such certifications are used for employment purposes. However, data on numbers of certifications is generally not publicly available, and in addition the certifications prove difficult to compare.

A common feature of most methodologies used for measuring supply and demand of ICT practitioner skills is the discrepancy between what is subject to measurement (the possible indicators) and what is actually measured. This is due to data availability constraints and limitations of classifications (such as ISCO) and curricula. While the methodologies are useful for providing indications, care should be taken that they are not used to represent correct and detailed estimates.

The use of labour market estimates for describing the stock of ICT practitioner skills is a good example. Measuring skills in terms of occupational employment levels is relatively easy when using internationally accepted occupational codes. Although occupational codes have methodological constraints, they provide a stable base for the measurement of the development over time of (a subset of) ICT practitioners even although the e-skills required for certain professions might change over time. As an indication of trends they are informative, but they need to be backed up with more detailed data if they are to provide meaningful information on future developments. The issue of transparent and clearly delimited definitions is essential in the absence of a methodology able to exhaustively capture and measure ICT practitioner skills.

3.4.1 Definition of e-skills

As already indicated in Chapter 2, a general definition of e-skills in terms of three "component" skill-sets is given by the European e-Skills Forum; this definition is useful as it broadly specifies and delimits the issues at stake. If a short-hand definition should be required to effectively communicate the topic of our research to a broader policy audience, e-skills beyond user skills could be formulated as follows:

Skills to design, develop, maintain and operate ICT systems and/or to exploit business opportunities and organisational improvements provided by ICT systems.

A general definition would be represented by an agreed framework against which data could be gathered to permit analysis of specific e-skills requirements and estimates, often expressed in terms of different classification systems (occupational, skill-based, sectoral, education or training). Depending on the need for qualitative and/or quantitative results, as well as the level of detail requested, different classification systems could be used for this. The main requirement for this is transparency of the underlying assumptions.

3.4.2 Data gathering implementation and indicators

In choosing between a requirements and estimates approach, the level of detail needed should be considered carefully, since combining breadth with depth requires significant (primary) research investment and may defeat the purpose of the study: it may take too long to deliver results on the basis of which policy decisions can be made. We therefore strongly recommend an approach that reflects the purpose(s) of measuring supply and demand for ICT practitioner skills. What (policy) question is the measurement supposed to address and what level of detail should the data supply? Depending on the answers to these questions, different methods of measurement are likely to be appropriate. For different purposes we propose one of the following measuring methods.

1. Trend analysis of employment in e-skilled occupations
2. A complementary indicator approach that distinguishes between supply and demand
3. Survey of employer perceptions
4. Qualitative skills profile identification and development of situation-specific indicators

1. If the objective is to provide a general estimate of the number of ICT practitioner needed in the EU, we propose a trend analysis of employment where ICT-skills are tracked by occupational codes. Given current available classification systems and data, we recommend that until the system is updated, ISCO codes 213, 312, 313 and 724 be used for the measurement of ICT practitioner skills. This definition is subject to over-inclusion and exclusion of skills in relation to the general definition, but provides the basis for an indicative general understanding.
2. If the objective is to come up with more precise estimates of the current general supply and demand for ICT practitioner skills, we propose to measure this using the following additional indicators:

    - Unemployment in e-skilled occupations (for now: ISCO 213, 312, 313, 724) - total and per occupation separately, split by gender and age - as an estimate of the supply of skilled workers and an indication of the tightness of the labour market, bearing in mind that the qualitative issue of skills gaps is not addressed;
    - Number of graduates in e-skilled educational fields, split by main fields (e.g. computer science, information science and telecommunications/electronics engineering; the most relevant ISCED97 codes are EF481 (computer science), EF482 (computer use) and EF523 (Electronics and automation)) as an estimate of the new supply of skilled workers, bearing in mind that the qualitative issue of mismatch is not addressed; furthermore it would be informative to know in what sector and what occupation these graduates will start working;
    - Number of issued training certificates for training of more than a minimum amount of days (e.g. one week) and of the appropriate level (practitioner/advanced, to be determined by an intermediary organisation), which would give an indication of increase in skills in general and when split into fields (such as network administrator, web professional, database administrator or security expert) would indicate rise or fall of demand for specific fields;
    - Current employment in e-skilled occupations (as defined through occupational codes), to understand the size and development over time of the labour force, but also split into male/female ratios, age, company size and nationality, to be able to support more qualitative assessments with regard to gender, age distribution, relevance of small, medium or large enterprises, migration;

- Unfilled or hard-to-fill job vacancies in e-skilled occupations (as defined through occupational codes), split by industrial sector and firm-size, as quantification of unmet demand with possibly an indication in which types of organisation this problem is largest;
- Replacement demand (due to retirement or other structural reasons) of current employees, per occupational code, which contributes to a more precise estimate of the *net* demand for skilled practitioners, not only based on the growth (or decline) of stock;
- Replacement of jobs by offshoring activities, as a quantification of the decline of demand due to offshoring, if possible by country to which the activities are offshored.

Thus, the first three indicators inform about the supply-side, the fourth indicator about the stock and the fifth, sixth and seventh about demand. This approach requires that assumptions be made considering how different specific definitions relate, since for example defining e-skills in terms of educational classifications does not directly translate to other classification systems such as occupational classification systems. Furthermore, the use of these indicators does not enable clear monitoring of e-business skills; for which new primary research (e.g. with the help of employer surveys) would be required.

3. If the objective is to find out in detail about supply and demand for specific skills and an assessment of skills gaps and mismatches, we recommend surveying employers and learning providers, either on predefined skills profiles or by asking them to define specific skills. (as remarked above, this may be the way to focus on e-business skills)
4. If the objective is to identify potential problem areas in terms of shortages, gaps or mismatches as well as to estimate the scope of the problem, we recommend stakeholder consultation to identify, for each policy question being considered, specific skills (required) and thereafter develop suitable quantitative indicators that can measure the supply and demand for these skills. No further recommendations on indicators can be given at this point before such a consultation has been undertaken.

CHAPTER 4

were selected based on the analysis of classifications of e-skills and ways to measure their supply and demand as presented in the previous chapter.

To retrieve information at the national level, we contacted e-skills networks and national statistical offices. Two e-skills networks were approached:

1. The European e-Skills Forum;
2. The Northern eDimension Action Plan (NeDAP) e-skills working group.

National representatives in each network were contacted in order to collect information about studies and data collection initiatives and sources within the domain of supply and demand of ICT practitioner skills in their countries. The national statistical offices of the EU member states were contacted via their IT/ICT departments or via general data provision departments. The priority has been to assess what data is readily available within the statistical domain about supply and demand of ICT practitioner skills, rather than to provide an exhaustive account of the current situation in each country, which is not feasible given the size of the project.

Useful EU Member State data was also collected from Eurostat, which has recent national Labour Force Survey statistics. Data of interest not covered by the EU Labour Force Survey database and not collected or used by an e-skills initiative is generally not collected by the national statistical offices but by other government agencies, such as Public Employment Services. Data available at the national statistical offices collected by these agencies are generally not comparable across EU Member States. Hence, the only way to present that level of data would be to look at each Member State separately for each indicator - an in-depth analysis that goes beyond the scope of this study. Therefore, we have not specifically focused our attention on collecting this type of data.

4.2 On data availability

EU level and the US

An assessment of the current situation of e-skills is obviously dependent on the ways that supply and demand of ICT practitioner skills are classified and measured. Given the discussion in the previous chapter, our analysis would require information about a number of key indicators. These indicators are listed in Table 1and elaborated on after the table.

Table 1. Supply and demand indicators.

Feature	Indicators
Demand	▪ Job vacancies or unfilled job vacancies for e-skilled occupations ▪ Replacement demand ▪ Offshoring activities ▪ Stock of e-skilled employment
Supply	▪ Training (on the job or external) ▪ Formal Education ▪ Stock of e-skilled employment ▪ E-skilled unemployment

Demand

The indicator "**unfilled vacancies**" provides valuable information on the imbalances of ICT practitioner skills in the labour market, since it captures – as closely as is possible - unmet demand. Unfortunately, our review of available data indicates that recent data on unfilled vacancies for e-skilled occupations is not available at the EU level. The only currently available source identified is a BISER report published in 2004. This report provides some, if limited, survey data on unfilled vacancies. From 2006 on, similar data will be collected regularly by the ICT Enterprise Survey carried out by Eurostat. The BISER report provides information on the fraction of companies having unfilled vacancies for computer specialists and the ICT Enterprise Survey will offer data on the fraction of companies experiencing problems hiring people with ICT practitioner skills. Neither survey directly collects data for the *number* of unfilled vacancies but for a related indicator, which captures the fraction of the business population having unmet demand. The ICT Enterprise Survey is currently looking at including more EU-benchmarking indicators for e-skills. The effort might consider developing an indicator that does measure the number of unfilled vacancies.

"**Job vacancies for e-skilled occupations**" is a second indicator that can give information about demand for e-skills. The indicator provides evidence on new demand, whether it is met or unmet in the end. Eurostat collects data on job vacancies but currently only by economic activity, not by occupation. Moreover, the data on job vacancies by economic activity are at a level of aggregation that makes it impossible to analyse job vacancies in the ICT sector and ICT practitioner skills intense sectors. The Eurostat Job Vacancies Survey is currently undergoing improvement. The improved survey might possibly produce better data for analysis of job vacancies for ICT practitioners.

Rather than try to recruit more ICT staff, companies may decide to outsource and/or offshore their work, leading to a reduction of local (/national) demand. We did not find clear (quantitative) data on "**offshoring activities**" at the EU-level, although it is considered an important issue. OECD (2004) presents mixed anecdotal evidence and OECD (2005) examines indirect sources, such as trade data on exports of business services and occupational data showing that close to 20% of *total European employment* is potentially affected. An enterprise survey could pose the question what number of workers are "employed" or "contracted abroad" to determine the local decline in demand. Total demand consists of unmet demand and the stock of e-skilled employment (demand currently met). However, information on "**replacement demand**" provides an important additional element with regard to the difference between supply and demand. In

combination with growth in employment, replacement demand constitutes *net demand*. This replacement demand has been estimated by CEPIS (2002) as 3% of stock, by EUQuasit (2004) as 2.5%, and by E-skills UK (2004) as 9% (of ICT professionals). The basis for these estimates is not fully transparent, but more valid estimates of demand would require a more precise measurement of this number, which could be investigated within an enterprise survey.

Data on the indicator "(stock of) **e-skilled employment**" can be retrieved from the EU Labour Force Survey database, which uses ISCO88 occupational codes. As discussed in section 3.2.1, the use of these codes results in limits of how well they represent ICT practitioner skills. We chose to look at two definitions that would measure the supply and demand of ICT practitioners. The first one includes occupations (ISCO 213, 312, 313 and 724) according to OECD's definition of "ICT specialists." The second one, used by among others CEPIS (2002), is more narrow and restricted to "IT practitioners" (ISCO codes 213 and 312). The lack of more general statistically significant and internationally comparable data prevents us from choosing a more detailed definition that would allow the measurement of supply and demand of ICT practitioners more precisely. The only source of employment data directly comparable at the EU level is the Eurostat Labour Force Survey database, which only contains data for 3-digit occupational codes. As discussed in the previous chapter more detailed analysis requires data at the 4-digit level. Additional research efforts would be needed at the national level as fewer than half of the Member States deliver ISCO data at 4-digit level to Eurostat. The current efforts result in statistically non-reliable data once an analysis at the 4-digit level is attempted because too few data points are available per occupational code. A pragmatic way to tackle the problem of wrong inclusions in ISCO 313 and 724 would be to examine employment levels in a small sample of member states at a higher level of detail in order to assess what percentage of those two occupational groups should not be considered e-skilled. If this percentage were relatively comparable across the "sub-set", then it could, in principle, be applied to the EU data as a whole.

Supply

Organisations such as IDC, that previously collected data on **training** for certain ICT practitioner skills, indicate that the most feasible way to get this kind of data is to directly contact product vendors which operate their own certifications and ask them how many people they train for different skills. CompTIA (2004b) surveyed IT training providers in Europe in 2004. The data collected through this survey was the respondents' (senior management) perception about the development of demand for IT-training in their country. This kind of data is a (secondary) indication oDRSt:N"PéRFéS :BR5é"PéNSI:R"BD"FJPNPS :BNNJ"NPR

not be valid for an overview of the current situation. However, a new survey will be conducted in 2006 and these results would be useful for future purposes.

The supply of ICT practitioner skills via **formal education** can be estimated to some extent. Data on number of students enrolled and graduated in certain educational fields is readily available from both Eurostat and OECD. In our analysis, we examined the number of enrolled and graduated tertiary students within the field of EF48(0) "Computing" as the indicators for new supply to estimate recent developments in the supply of e-skills. We have omitted the aggregate EF52(0) as this would have included too many graduates in addition to EF523 (Electronics and automation). In future, a more detailed split would be advisable.

The Eurostat ICT Household Survey collects data on supply of e-skills. Unfortunately, this survey currently focuses on basic user skills, and as such the results do not provide data on the type of e-skills examined in depth in this study. Inclusion of questions regarding ICT practitioner skills would be required for this source to be useful for the key area of ICT Practitioner skills. The feasibility of such an extension is, however, questionable as it would require a doubling of the sample size (communication with Eurostat, 2005).

The **stock of e-skilled employment** is, as previously mentioned, not only an indication of demand currently met, but also of accepted supply. Hence, the EU LFS data will also be used to indicate the current state of accepted supply of ICT practitioner skills. Moreover, LFS data is also useful for estimating unaccepted supply, measured as **unemployment in e-skilled occupations**. We have used the LFS data for this purpose to the extent that it is reliable.[26]

The in-depth review of available data sources carried out in this study for indicators measuring supply and demand of e-skills has shown that the desired data is mostly lacking. Because of the limited data availability the analysis in the next section of this chapter relies heavily on data from the EU LFS database. There are, as previously mentioned in chapter 3, a number of drawbacks to this considerable dependency on LFS data, relating to the quality of the data and its level of detail. The fact that the EU LFS data is based on self-reporting[27] and that occupational data has to be translated into an international classification system (ISCO) from national classification systems affects its reliability negatively. Moreover, the purpose for collecting the data is not to address e-skills, and therefore the data is limited and does not have all the necessary features for an in-depth analysis of the demand and supply of specific e-skills. The occupational classification systems used for Labour Force Surveys provide insufficient detail to single out detailed skills profiles. Also, the data essentially provides information on the stock of ICT Practitioner employment. We know that the stock of e-skilled employment does not, on its own, inform us about possible discrepancies between supply and demand in the marketplace. The only information LFS data provides on such discrepancies is unemployment figures. However, the unemployment data is limited and cannot inform a

[26] The samples of unemployment are inevitably smaller

[27] As this is a household survey

more qualitative analysis of the underlying reasons for observed divergences, such as shortages, mismatch and gaps.

Given the data availability the analysis in the next section will focus on development in the labour market for fairly highly aggregated IT and ICT practitioner occupations. The LFS data is complemented by limited data on additional indicators – in particular on unfilled vacancies from a BISER report (2004) as well as Eurostat data on formal education within the field of computing.

US data

To compare the situation of supply and demand of ICT practitioner skills between the EU and the US, we examined the availability of US data. The data for the US should ideally be directly comparable to the European data available.

There are two major data sources for US employment statistics, the Occupational Employment Statistics (OES) program at the Bureau of Labor Statistics and the Current Population Survey (CPS). Both the OES and the CPS currently use the 2000 Standard Occupation Classification (SOC) system. Comparability between this system and ISCO-88 is essential for comparability between EU Labour Force survey data and US employment data. Unfortunately, there is no official "mapping" scheme between these two systems, making a direct comparative analysis not possible.

OECD (2004) made an effort to match ICT-related occupations from the ISCO-88 system with CPS occupation classes, enabling an EU-US comparison of ICT-skilled employment trends. Unfortunately, it was not possible to use that definition of US e-skilled occupations, since it is based on 1990 Census occupation codes instead of 2000 SOC codes. However, correspondence schemes between 1999 Census codes, 2000 Census codes and 2000 SOC codes enable us to define e-skilled occupations for the US according to 2000 SOC codes.[28] It should be noticed that this method for selecting e-skilled occupations in the 2000 SOC system is imperfect, since it most certainly fails to identify all ICT-skilled occupations of the 2000 SOC system and includes occupations that are actually not "e-skills intense".

OES employment data is used for describing the current situation in the US, in order to maximise the length of the time series. The CPS has only used the 2000 SOC system since 2003 while the OES has data using this system since 1999. The OES datasets only include data for 25 of the 39 identified e-skilled occupations presented in Appendix E. This of course affects the validity of the analysis negatively, since the size of the e-skilled workforce will be underestimated.

The OES data has been complemented with data from the ITAA[29] 2004 Annual Workforce Survey and data on formal education within the field of computing. Eurostat collects comparable data on number of tertiary graduates in the filed of computing for the EU level and the US.

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[28] Appendix E gives an account for the translation from 1990 Census occupation codes into the 2000 SOC codes of the ICT-skilled occupations identified by the OECD (2004).

[29] Information Technology Association of America

National EU Member State level

The domain of ICT practitioner and e-business skills is broad in terms of actors involved within a nation, which makes it difficult to cover all perspectives and potential data sources. Ministries, statistical offices, business associations, professional associations, educational institutions, training providers, information society associations and research institutes and unions may all collect certain relevant data. The national EU Member State data made available to us depends on the national representatives' perspectives and knowledge about work in the domain, and their willingness to share their knowledge and provide us with information.

The assessment of the current situation with regard to supply and demand of ICT practitioner skills at the EU Member State level includes figures from the EU Labour Force Survey database (submitted by national statistical offices), complemented by the data made available to us via our contacts in each country. The Labour Force Survey data presented for each country will be less detailed compared to the data presented for the EU level since the size of the national samples in many cases is so small that disaggregated data is below the threshold level for which figures can be considered statistically reliable.

4.3 Current situation at the EU level and in the US

EU level

Stock of ICT practitioner employment

In the year 2004, an estimated 3.2 million people worked as "IT practitioners" (ISCO 213 and 312) and 5.9 million worked in "ICT practitioners" occupations (ISCO 213, 312, 313 and 724) in the EU. The numbers account respectively for 1.6 percent and 3.0 percent of estimated total employment in the EU in 2004. [30]

The **distribution of this e-skilled employment** in the economy can be examined by looking at the estimated number of "IT practitioners" and "ICT practitioners" by economic sector. Many studies on ICT distinguish between the ICT sector and ICT user sectors. Most studies base their definition of the ICT sector on the use of NACE 3- and 4-digit codes.[31] Unfortunately, the EU LFS database does not include data coded on these detailed levels, thus, making it impossible to apply available definitions to our dataset. The available dataset only permits analysis of e-skilled employment by "industry division" i.e. NACE 2-digit codes. In Europe, the industry division with the highest estimated stock of "IT practitioners" and "ICT practitioners" is the core IT services industry, classified as NACE code 72 ("Computer and related activities"). This economic sector employs the largest number (in absolute and relative terms) of "IT practitioners" and "ICT practitioners". Other economic sectors that employ large numbers of I(C)T practitioners are: "Other business activities" (NACE 74) and "Post and telecommunications" (NACE 64). Table 2 presents the broad economic sectors in Europe with the highest estimated

[30] The figures in this paragraph are based on data presented in Appendix F.

[31] See for example OECD (2004) and EUQuaSIT (2004)

stock of "IT practitioners" and "ICT practitioners" respectively, and shows for each sector estimated numbers of people employed in these occupations.

The seven economic sectors that are major employers of "IT practitioners" are estimated to account for about 68 percent of the total employment in those occupations. This indicates that the "IT practitioner" workforce is fairly concentrated in a limited number of industries. Comparing employment in the core IT services industry to that in all other industries shows that about 58 percent of the "IT practitioners" and 77 percent of the "ICT practitioners" workforce are estimated to be employed outside the core IT services industry (NACE 72).

Table 2. Industry divisions with highest stock (demand currently met) of ICT practitioner skills

IT practitioners (ISCO 213 and 312)		ICT practitioners (ISCO 213, 312, 313 and 724)	
Industry division	**Number of people employed**	**Industry division**	**Number of people employed**
72 Computer and related activities	1,303,139	72 Computer and related activities	1,360,834
74 Other business activities	189,584	45 Construction	385,639
75 Public administration, printing, and reproduction of recorded material	186,614	74 Other business activities	364,688
65 Financial intermediation, except insurance and pension funding	149,699	64 Post and telecommunications	341,979
64 Post and telecommunications	144,404	52 Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	273,659
80 Education	93,858	75 Public administration, printing, and reproduction of recorded material	251,368
51 Wholesale trade and commission trade, except of motor vehicles and motor cycles	92,982	40 Electricity, gas, steam and hot water supply	222,480

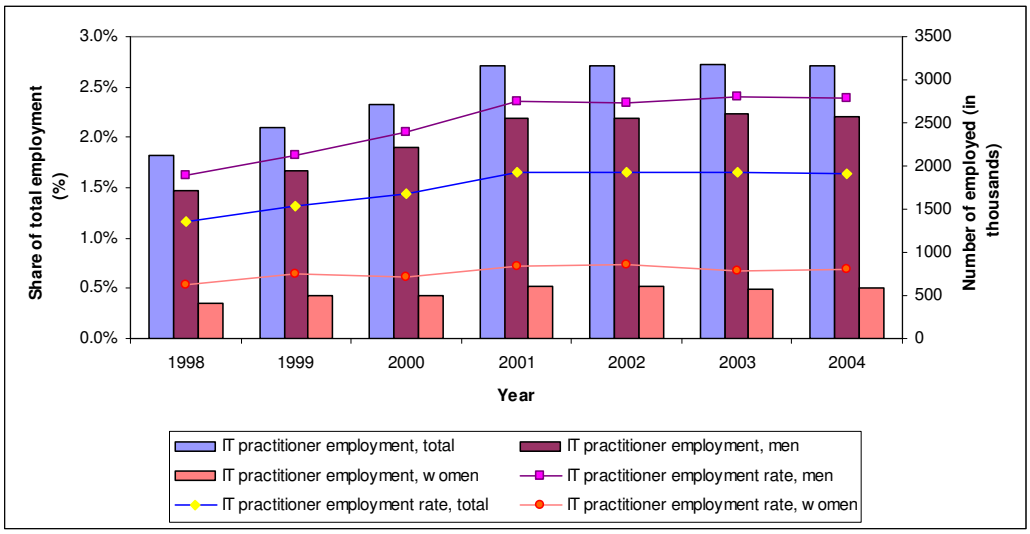
Source: Computations based on EU LFS 2004

Note: The figures are considered statistically reliable since they all exceed Eurostat's threshold level of 92,000 for EU25 in 2004, see appendix D. The figures for the Netherlands in the data set are provisional.

Figure 2 and Figure 3 illustrate **trends** for the stock of ICT practitioners from **1998 to 2004**. The figures show the fraction of I(C)T employment as part of total employment. Between 1998 and 2001 the estimated number of employed "ICT practitioners" increased by around 18.4 percent and thereafter, between 2001 and 2004, the number declined by about 3 percent. This development is not surprising and probably related to the overall development of the ICT industry where rapid growth was followed by a considerable downturn. The labour market for "IT practitioners" also experienced a strong positive trend until 2001, but instead of a slight negative trend in the most recent years the trend stabilised. During the whole period between 1998 and 2004, there has been an overall increase in estimated number of employed "ICT practitioners" of about 14.9 percent and of about 48.2 percent for "IT practitioners".

Figure 2 and Figure 3 also show that the **fraction of female IT and ICT practitioners as part of total female labour force** at the EU-level was low in 1998 and remains so today. This is most probably due to a supply shortage of women with the skills required or wanting to work in these occupations. Historical figures from Eurostat on number of female graduates from computing educations support this assumption. However, supply is slowly increasing.

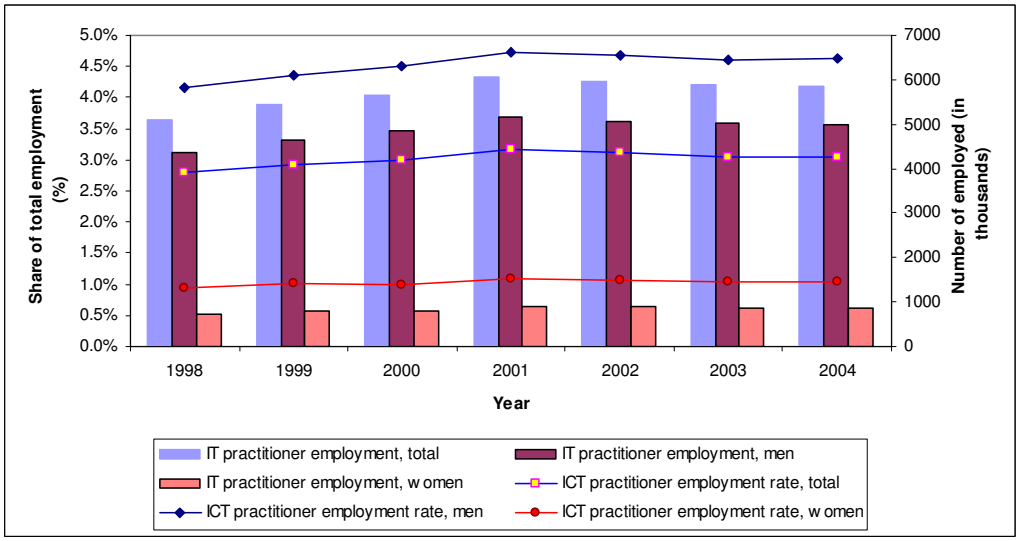
Figure 2. EU employment of "IT practitioners", 1998-2004



Source: EU LFS Q2 for 1998-2004

Note: Malta is not included in the data set as data is missing for 1998-2001. The figures for the Netherlands in 2004 are provisional. The aggregated EU24 figures are statistically reliable since they all exceed the Eurostat's limits applicable each year for EU25 figures, see Appendix D.

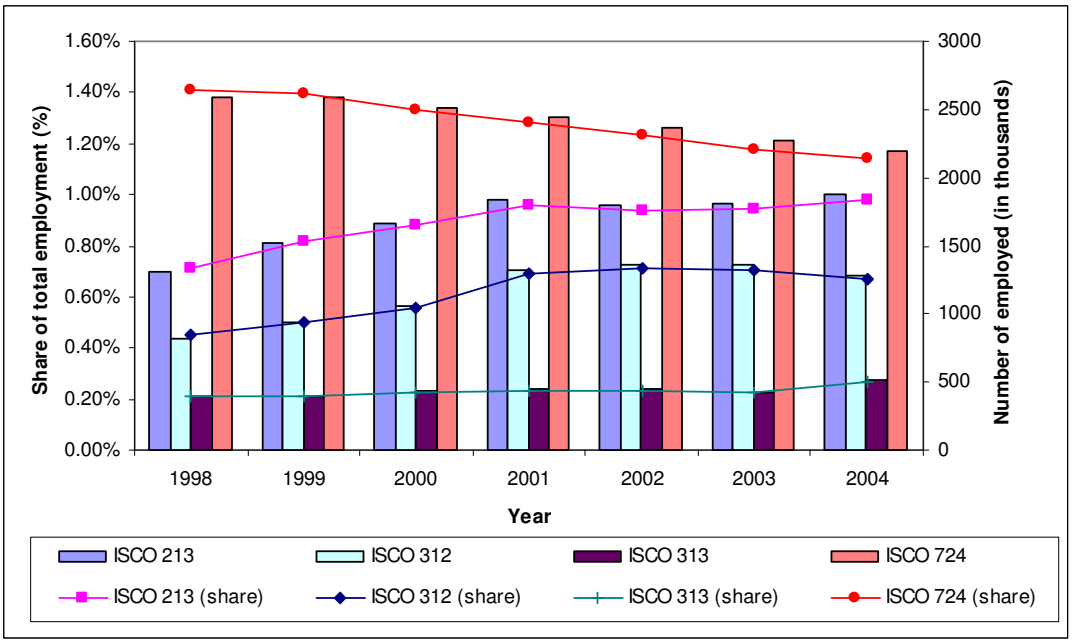
Figure 3. EU employment of "ICT practitioners", 1998-2004



Source: EU LFS Q2 for 1998-2004

Note: Malta is not included in the data set for any year since data is missing for 1998-2001. The figures for the Netherlands in 2004 are provisional. The aggregated EU24 figures are statistically reliable since they all exceed the Eurostat's limits applicable each year for EU25 figures, see Appendix D.

Figure 4. EU employment in four ISCO 3-digit level e-skilled occupations, 1998-2004



Source: EU LFS Q2 for1998-2004

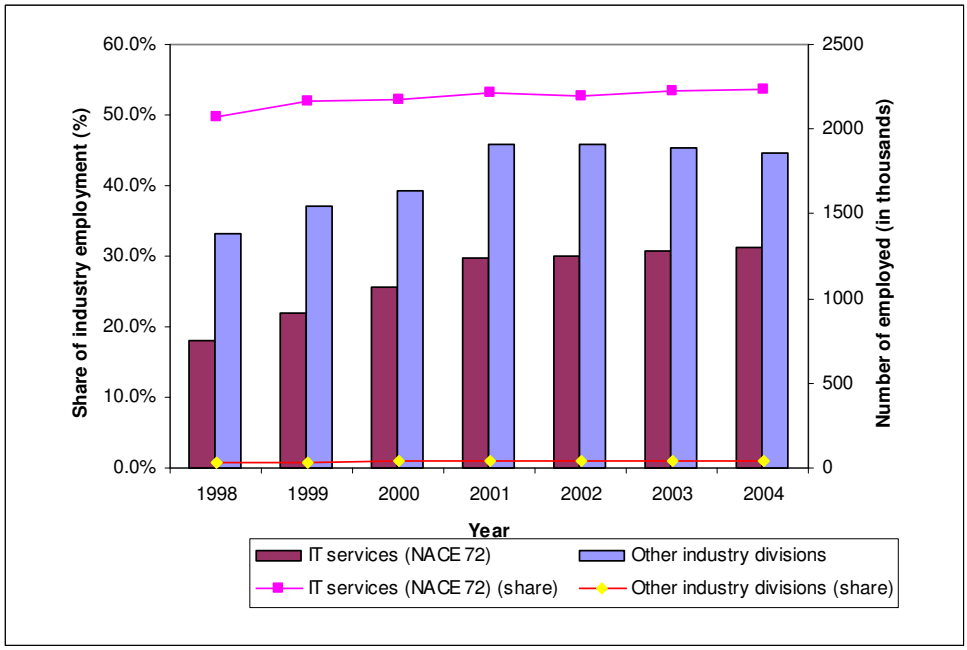
Note: Malta is not included in the data set for any year since data is missing for 1998-2001. The figures for the Netherlands in 2004 are provisional. The aggregated EU24 figures are statistically reliable since they all exceed the Eurostat's limits applicable each year for EU25 figures, see Appendix D.

Analysing the development of the ICT practitioner employment in **individual occupations** under study, Figure 4 shows that ISCO 724 (Electrical and electronic equipment mechanics and fitters), which requires the least advanced skills, does not follow the same pattern as the two core e-skilled occupations (ISCO 213 and 312). A possible explanation is that demand for electrical and electronic equipment mechanics and fitters is less affected by the development in the ICT sector than is demand for "IT practitioners". The explanation is reasonable given that electrical and electronic equipment mechanics and fitters only account for about 2.2 percent of total employment in the core IT services industry (NACE 72)[32]

The employment in "IT practitioners" and "ICT practitioners" occupations appears to have followed a fairly similar trend within the core IT services industry compared to other industries between 1998-2004, see Figure 5 and Figure 6. However, the overall positive trends during the period are relatively stronger in the core IT services industry as compared with other industries. Between 1998-2004, the employment of "IT practitioners" increased by about 74.3 percent in the core IT services industry compared to about 33.9 percent in the other industries.

[32] Figures from EU LFS Q2 2004.

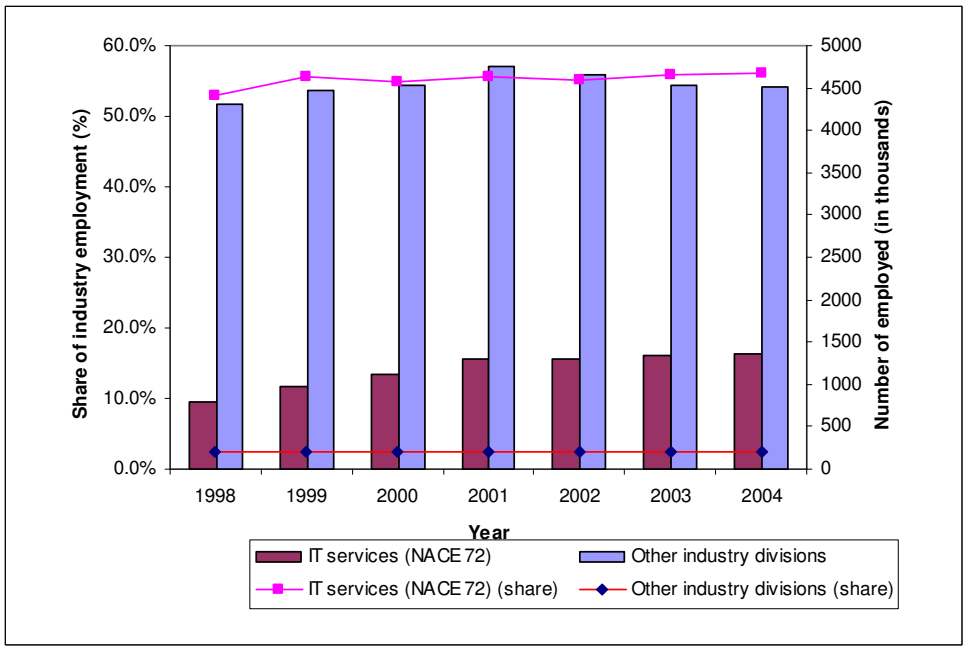
Figure 5. EU employment of "IT practitioners" by industry division, 1998-2004



Source: EU LFS Q2 for1998-2004

Note: Malta is not included in the data set for any year since data is missing for 1998-2001. The figures for the Netherlands in 2004 are provisional. The aggregated EU24 figures are statistically reliable since they all exceed the Eurostat's limits applicable each year for EU25 figures, see Appendix D.

Figure 6. EU employment of "ICT practitioners" by industry division, 1998-2004



Source: EU LFS Q2 for1998-2004

Note: Malta is not included in the data set for any year since data is missing for 1998-2001. The figures for the Netherlands in 2004 are provisional. The aggregated EU24 figures are statistically reliable since they all exceed the Eurostat's limits applicable each year for EU25 figures, see Appendix D

Demand, unfilled vacancies for computer specialists

The 2003 BISER survey on unfilled vacancies for computer specialists is the only currently available source with recent EU-level data relating to unfilled vacancies for ICT practitioners. The data is too limited to support any strong conclusion; nevertheless, it provides an indication of the average situation in the EU with regard to unfilled vacancies for computer specialists. The survey results show that only 2.7 percent of the 8,579 establishments that participated in the BISER (2004) survey reported that they had unfilled vacancies for computer specialists. The survey also found that demand is low: only 11.6 percent of the responding establishments had been searching for computer specialists. The results indicate no evidence of a large ICT practitioner skills shortage at the EU-level at that time.

Demand, replacement demand

As indicated, we have only found estimates of replacement demand in three different sources. When we apply these to the stock of practitioners, the following picture emerges:

Table . (EU LFS) Estimates of replacement demand in 2004 of "IT practitioners" and "ICT practitioners" according to three different estimates of attrition rate

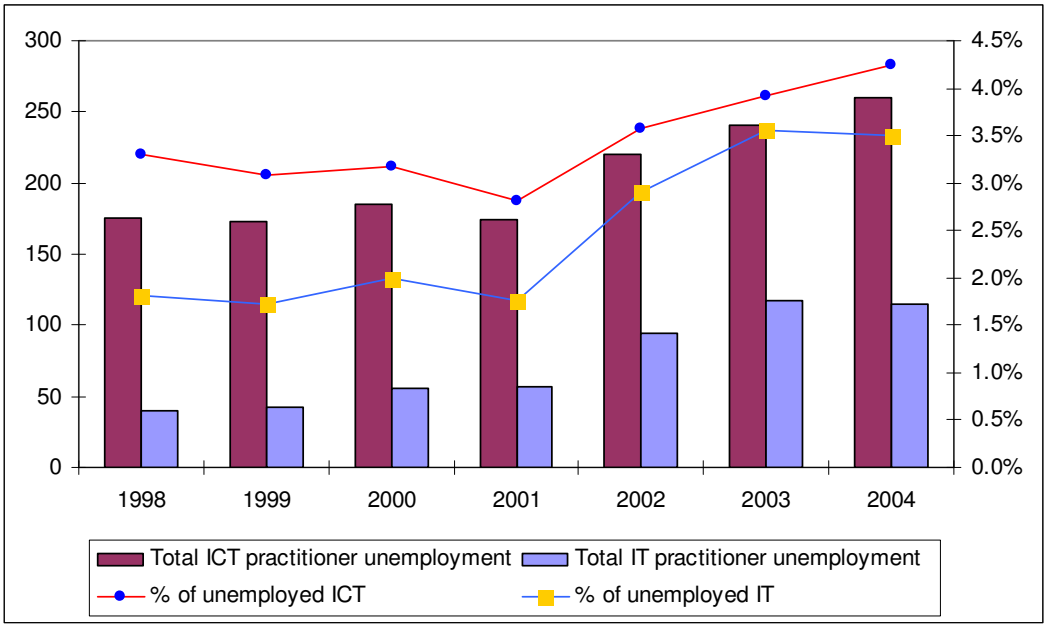
	CEPIS	EUQuaSIT	e-skills UK
IT practitioners	96,000	80,000	288,000
ICT practitioners	177,000	147,500	531,000

Table indicates that the range of replacement demand becomes quite large depending on what estimate of replacement rate is taken and that – should the value be closer to that shown in the e-skills UK study – shortages in the near future are still foreseeable.

Supply, ICT practitioner unemployment

Unemployment indicators by occupation are useful for tracing possible excess supply of skills that could either be due to skills mismatches or a general supply surplus. EU level unemployment figures for "ICT practitioners" occupations suggest that there are e-skills available in the EU for which there is no demand in the job market. **Error! Reference source not found.** illustrates the development over time of unemployment for "IT practitioners" and "ICT practitioners" in absolute numbers and relative to the total labour force. Even though the trend is negative in the sense that unemployment has increased of late, the level of unemployment is still not very high. In 2004, the estimated numbers of unemployed "ICT practitioners" and "IT practitioners" were 259,778 and 114,467 respectively, which account for 4.2 and 3.5 percent of the total labour force of each group of occupations.

Figure 7. Total EU unemployment of "IT practitioners" and "ICT practitioners (in 1,000s) and as share of total number of "IT practitioners" and "ICT practitioners, 1998-2004



Source: EU LFS Q2 for1998-2004

Note: Data is missing for France and the Netherlands for all years. Data is missing for Sweden in 1998-1999 and 2001-2002. The 1998 and 1999 datasets lacks data for Cyprus and Malta. The aggregated available EU figures are statistically reliable since they all exceed the Eurostat's limits applicable each year for EU25 figures, see Appendix D.

Supply, formal education

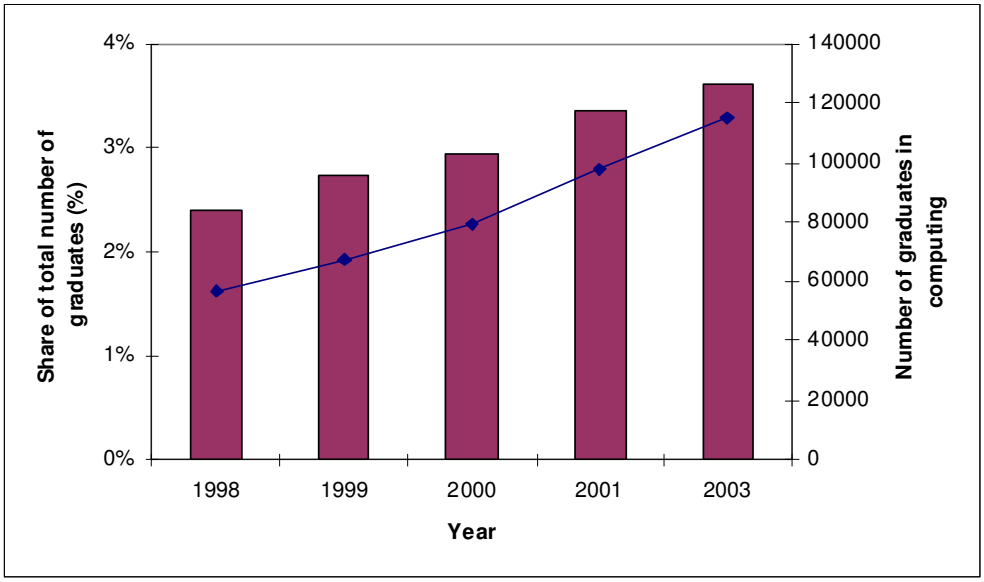
The levelling-out trend observed in the stock of ICT practitioners does not appear to be due to supply side conditions, as the supply from the tertiary education system has steadily increased between 1998 and 2003. Figure 8 shows that the increase in the number of tertiary graduates in the field of computing, EF480 during this period was about 102 percent. The positive trend for supply will probably continue for a few more years since the number of enrolled students also increased during most of the period, see Figure 9. But the fact that the number of students has remained flat between 2002 and 2003 is an indication that the trend might change in the future. In general, it can be stated that there is a strong connection between the overall state of the labour market and new entry, and subsequent enrolment and graduation. That is, increased labour market opportunities can provide a fairly immediate pull effect on enrolment figures.

It should be pointed out that the "formal education supply" figures capture only a small share of total supply. The proportions of "IT practitioners" and "ICT practitioners" that have acquired their skills through higher education within the field of computing are low.[33] In 2004, only 18 percent of the "IT practitioners" and 10.1 percent of the "ICT practitioners" workforce were estimated to have a higher-level degree in computing

[33] Note that this is not the same as the proportions of these workforces that have achieved higher education in any field. This discussion specifically addresses higher education in the field of computing (EF480).

(EF480).[34] Formal higher education completion data in the field of computing represents, as expected, only a small proportion of skills supply and would need to be complemented by training data to give a fuller picture of the supply side conditions.

Figure 8. Number of tertiary graduates in the field of computing, EF480, 1998-2003

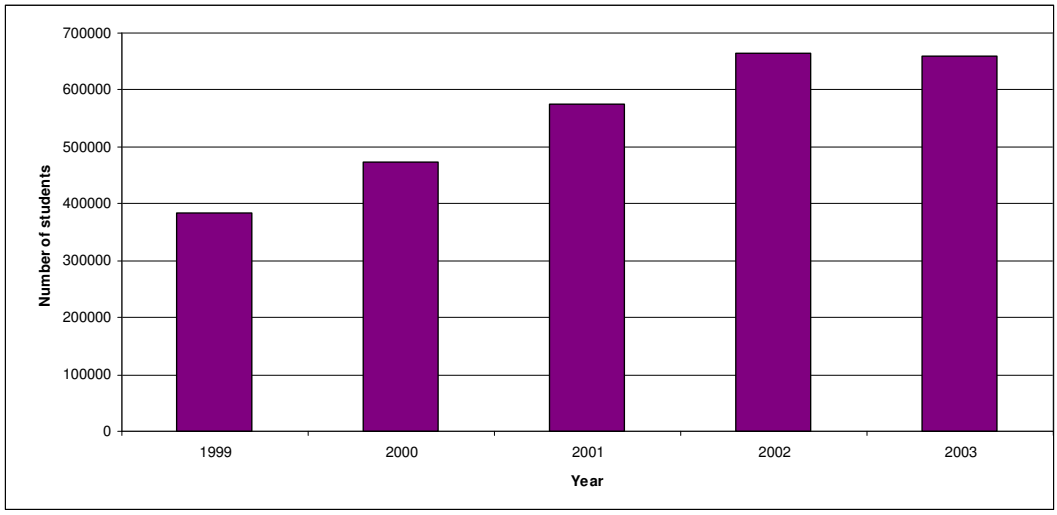


Source: Eurostat, Education and lifelong learning data (Population and Social Conditions)

Note: EU data is missing for 2002. For all other years the EU data excludes Greece due to missing data. Estimates based on historical data have been calculated for all other cases of missing data for individual countries.

[34] The LFS database includes data on the number of people employed in e-skilled occupations (ISCO 213,312 ("IT practitioner"), 313, and 724 "ICT practitioners") with a higher education degree in computing (EF480). The figures reported are calculated ratios between this data and LFS data on the total "IT practitioners" and "ICT practitioners" workforces. "IT practitioners": 570,026/3160,462 ≅ 0.18, "ICT practitioners": 592,317/5869,004 ≅ 0.101. The figures might be slightly underestimated since educational field is not reported for Czech Republic in 2004.

Figure 9. Number of tertiary education students in the field of computing, EF480, 1999-2003

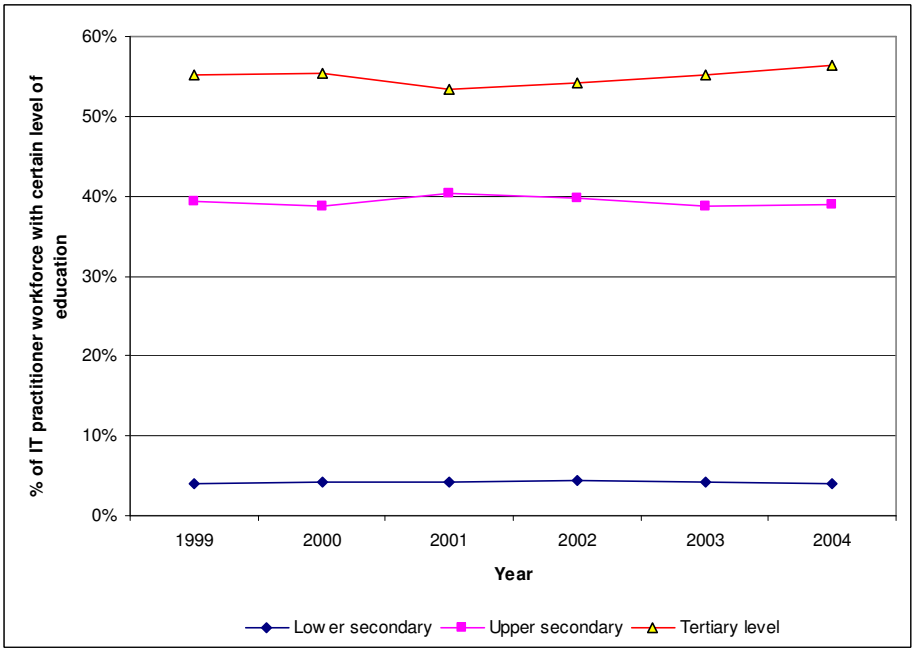


Source: Eurostat, Education and lifelong learning data (Population and Social Conditions)

Generally, it is assumed that work in "IT practitioner" occupations (ISCO 213 and 312) requires tertiary or secondary education since they belong to skill levels 2 and 3 within the ISCO88 system (ILO, 1990). Figure 10 shows the distribution between different levels of education achieved by the people in the "IT practitioner" workforce over time. The figure shows the estimated share of the workforce that has achieved Lower secondary, Upper secondary and Third level education respectively.[35] In recent years almost 60% of the "IT practitioners" workforce have third level education (ISCED 5-6) in any field. The corresponding figure for "ICT practitioners" is lower, only 38%. The reason for this is easily explainable given the skill level system according to which the ISCO88 system is structured. As mentioned "IT practitioners" by definition in the ISCO88 system only involve higher and medium skill levels, whereas "ICT practitioners" - including also ISCO 313 and 724 - involve a larger proportion of medium level skills and the lower skill level 2. This analysis shows that depending on which occupations that are included in an aggregated measure of ICT practitioner skills the levels of e-skills involved can differ substantially.

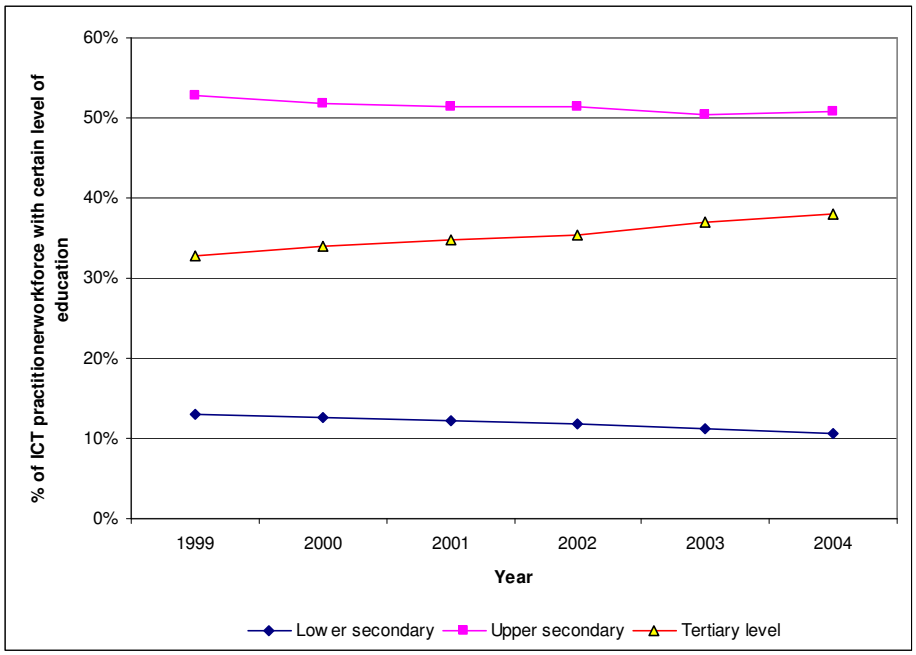
[35] Lower, Upper secondary and Third level correspond to ISCED 0-2,3-4 and 5-6 respectively.

Figure 10. Education level of "IT practitioners" workforce, 1999-2004



Source: EU LFS Q2 for 1998-2004
Note: Malta is not included in the data set for any year since data is missing for 1998-2001. The figures for the Netherlands in 2004 are provisional. The aggregated EU24 figures are statistically reliable since the absolute number that the shares are based on all exceed the Eurostat's limits applicable each year for EU25 figures, see Appendix D.

Figure 11. Education level of "ICT Specialists" workforce, 1999-2004



Source: EU LFS Q2 for 1998-2004
Note: Malta is not included in the data set for any year since data is missing for 1998-2001. The figures for the Netherlands in 2004 are provisional. The aggregated EU24 figures are statistically reliable since the absolute number that the shares are based on all exceed the Eurostat's limits applicable each year for EU25 figures, see Appendix D.

Summary EU level

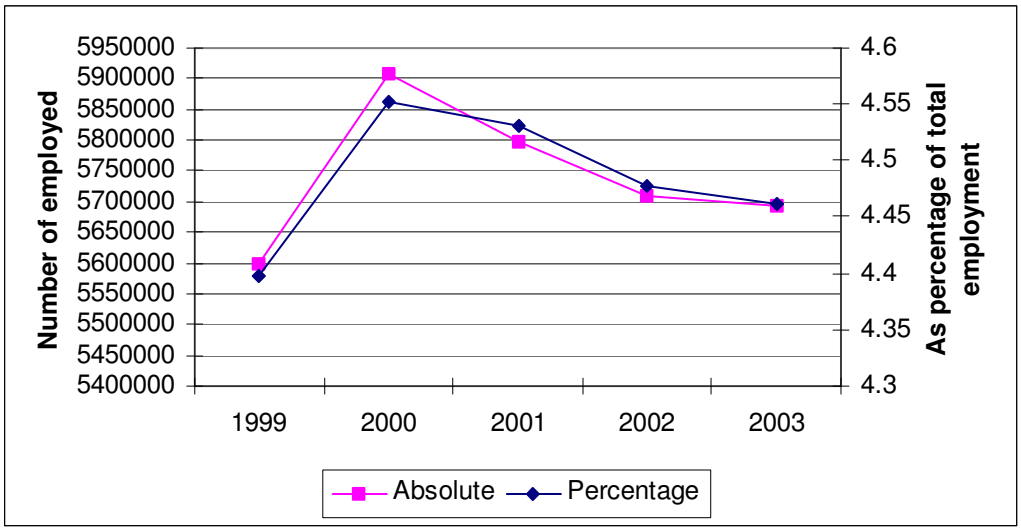
The analysis of the current situation of supply and demand of IT and ICT practitioner skills shows that growth in employment in the labour market has recently slowed down, and that there are no indications of a general practitioner skills shortage at the EU level. However, it should be stressed that due to inadequacies of available data the analysis is limited. The occupational codes used to capture ICT practitioner skills are at such an aggregated level that some occupations that are not e-skilled intense are captured while others that in fact are e-skills intense are not. It would be possible for there to be no skill shortage in the overall broad/aggregate set of ICT practitioner occupations but shortages in one or more specific occupations within this (the question would then arise as to the relevance of any policy response). Moreover, it is not possible to explore more detailed issues, such as skills mismatches and skills gaps, with the available data. In order to do this, other types of research approaches are required.

A reasonable explanation for the observed slowdown in the labour market for IT and (particularly) ICT practitioners is the downturn in the economic activity of the ICT industry. The underlying factors for that development are numerous and fall outside the scope of this report. Another possible explanation to the slowdown could be user maturation. ICT user organisations could be expected to involve more practitioners the first time they implement and use an ICT application compared the second time. If this is true, the slowdown is – as with the ICT industry slowdown - due to reduced demand, which in turn can be explained by decreasing need for practitioner involvement as users develop their own e-skills. Finally, there is the argument that offshoring ICT activities might result or might have resulted in a recovery of the ICT industry without an increase (or actually a decrease) in the ICT practitioner employment.

US situation

ICT practitioner employment has, as shown in Figure 12, followed a similar trend in the US compared to the EU, although the peak was reached already in 2000 compared to 2001 in the EU.

Figure 12. US employment (absolute and relative) of ICT practitioners, 1999-2003



Source: Bureau of Labour Statistics OES program

Note: The occupations associated with ICT practitioners in this figure refer to the occupations presented in . The selection is based on the OECD (2004) definition of US e-skilled occupations, but subject to a number of classification translations wherefore the levels presented in the figures should be interpreted with caution.

Table 3. ICT practitioner employment by occupation (2000 SOC) in the US

Occupation	Number of employed
11-3021 Computer and Information Systems Managers	257,860
11-9041 Engineering Managers	188,350
13-1111 Management Analysts	433,830
15-1011 Computer and Information Scientists, Research	23,770
15-1021 Computer Programmers	403,220
15-1041 Computer Support Specialists	480,520
15-1051 Computer Systems Analysts	485,720
15-1061 Database Administrators	97,540
15-1071 Network and Computer Systems Administrators	244,610
15-1081 Network Systems and Data Communication Analysts	156,270
15-2031 Operations Research Analysts	53,620
17-2061 Computer Hardware Engineers	70,110
43-1011 First-Line Supervisors/Managers of Office and Administrative Support Workers	1,402,290
43-9011 Computer Operators	150,030
43-9071 Office Machine Operators, Except Computer	92,880
47-2111 Electricians	575,980
49-2011 Computer, Automated Teller, and Office Machine Repairers	142,910
49-2091 Avionics Technicians	21,020
49-2095 Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	20,310
49-2096 Electronic Equipment Installers and Repairers, Motor Vehicles	15,070
49-2097 Electronic Home Entertainment Equipment Installers and Repairers	34,700
49-2098 Security and Fire Alarm Systems Installers	47,690
49-9051 Electrical Power-Line Installers and Repairers	99,290
49-9052 Telecommunications Line Installers and Repairers	146,410
51-2031 Engine and Other Machine Assemblers	47,520
Total	5,691,520

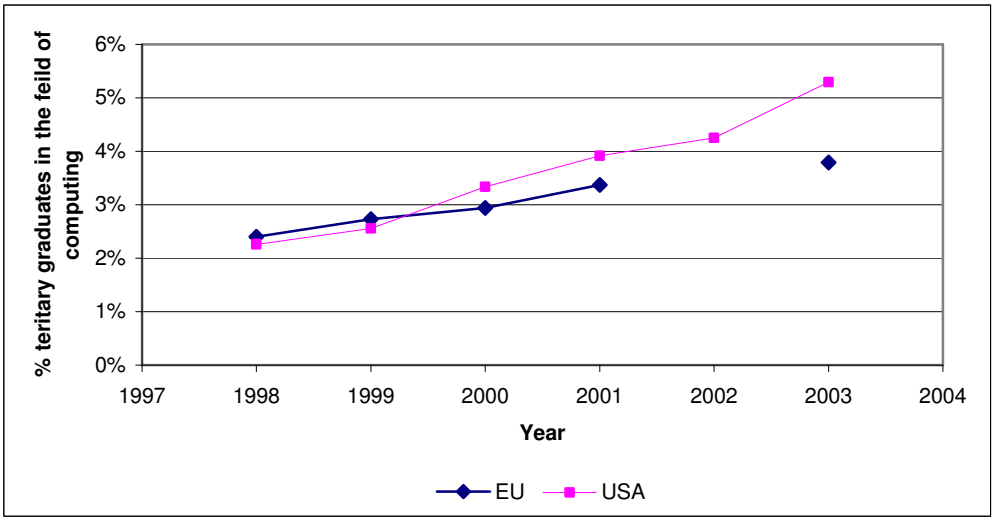
Source: Bureau of Labour Statistics OES program, 2003.

Table 3 shows the 25 e-skilled occupations in 2000 SOC, for which employment data is available in 2003. In total an estimated 5.7 million people worked in these e-skilled occupations in the US in 2003, which is 4.46% of the total workforce. The figure underestimates e-skilled employment in the US, since the 25 occupations do not cover the whole e-skilled practitioner workforce. According to the ITAA 2004 workforce survey the IT workforce was in 2004 made up of approximately 10.3 million workers.

OES data is not suitable for analysing which industries in the US are major employers of ICT practitioner skills. But the ITAA 2004 workforce survey indicates that non-IT companies represent 79 percent of employment for IT workers. Moreover, the ITAA workforce survey confirms that the demand for IT workers has dropped of late. In 2003 there were approximately 500,000 vacancies compared to an expected 230,000 in 2004.

The US has experienced similar positive trends to the EU in terms of the supply from the education system of ICT practitioner skills, measured as the number of graduates emerging from tertiary education in the field of computing. Figure 13 compares the development in number of graduates from tertiary education courses in the field of computing as a share of total number of tertiary graduates, both in the US and the EU. It shows that the relative number of graduates in the US is more than 25% higher than that of the EU.

Figure 13. Share of tertiary graduates in the field of computing, EF480, to total tertiary graduates EU and US, 1998-2003



Source: Eurostat, Eduation and lifelong learning data (Population and Social Conditions)

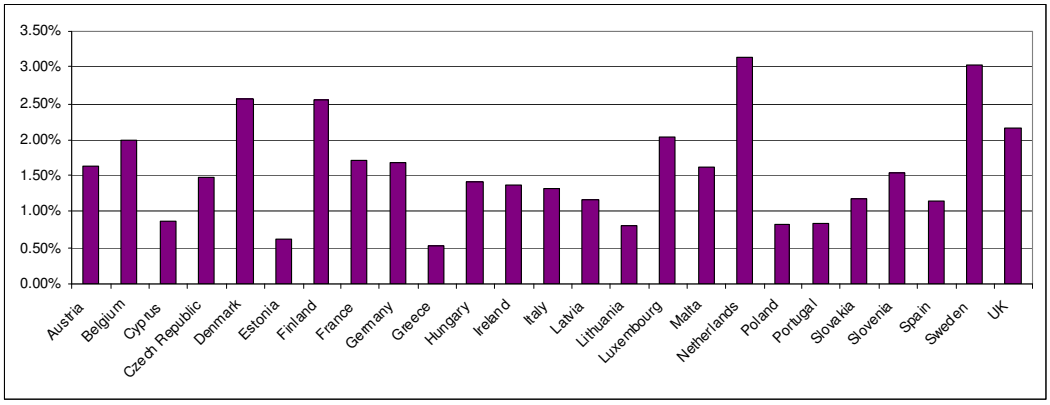
Note: EU data is missing for 2002. For all other years the EU data excludes Greece due to missing data. Estimates based on historical data have been calculated for all other cases of missing data for individual countries.

4.4 National situations

4.4.1 EU Labour Force Survey data

EU Labour Force Survey data shows that the Scandinavian countries together with the UK and the Netherlands have the highest proportion of "IT practitioners" in the EU as compared to their total employment, see Figure 14 (and as shows, these Member States have been 'in the lead' since 1998). Figure 15 shows, as compared to the previous figure, that there are larger differences between countries in terms of "IT practitioners" share of total employment than in terms of "ICT practitioners" share of total employment. This suggests that the employment distribution between the four occupational groups (ISCO 213, 312, 313 and 724) included in "ICT practitioners" vary substantially between countries.

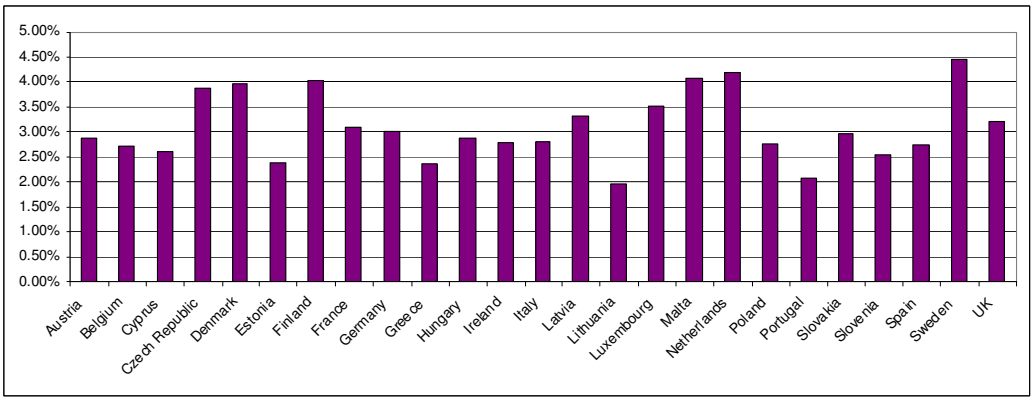
Figure 14. "IT practitioners" share of total employment, by EU country



Source: EU LFS Q2 for 2004

Note: The shares are statistically reliable since the absolute numbers that the shares are based on all exceed the Eurostat's limits applicable for each country, see Appendix D. The figures for the Netherlands are provisional.

Figure 15. "ICT practitioners" share of total employment, by EU country



Source: EU Q2 LFS 2004

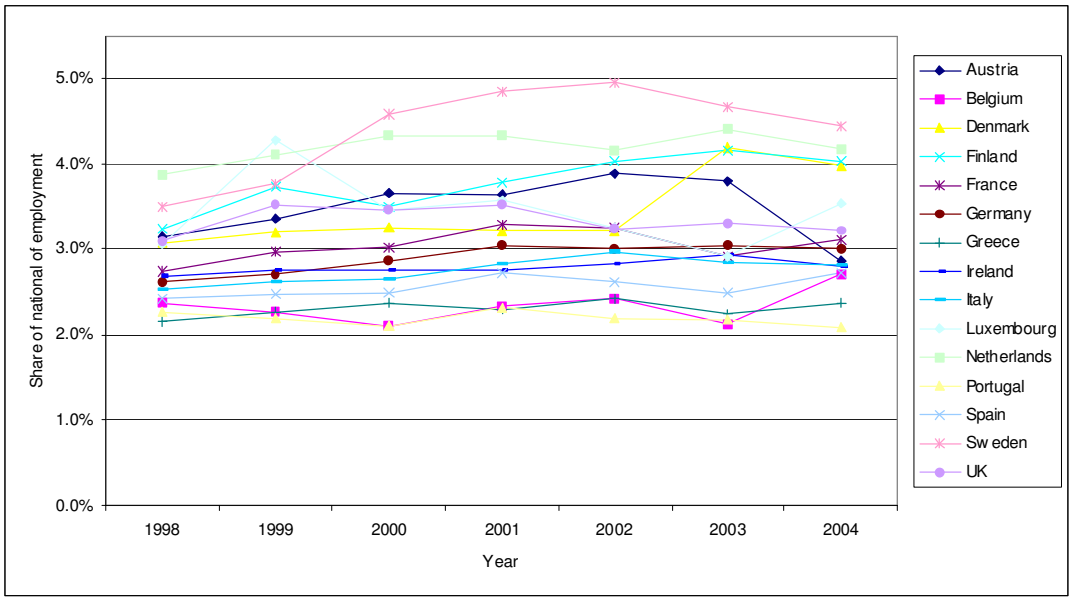
Note: The shares are statistically reliable since the absolute numbers that the shares are based on all exceed the Eurostat's limits applicable for each country, see Appendix D. The figures for the Netherlands are provisional.

Figure 16 to Figure 19 illustrate the variation in recent national trends for the e-skilled workforce as a share of the total workforce (Absolute numbers are shown in Appendix G).

Most countries do not seem to have experienced a decline, but rather a 'plateau', as a response to the recent economic downturn. A relative peak followed by a decline is only visible in Sweden (for both narrow and broad definition) and in the Czech Republic for the narrow definition. Austria apparently recently experienced a sharp decline in the number of "ICT practitioners" whereas Denmark experienced a jump in "ICT practitioners" from 2002-2003.

The countries joining the EU in 2004 seem to have overcome the downturn in demand experienced in the EU as a whole and appear to have outperformed the EU-15 in terms of "ICT practitioner" share of total employment.

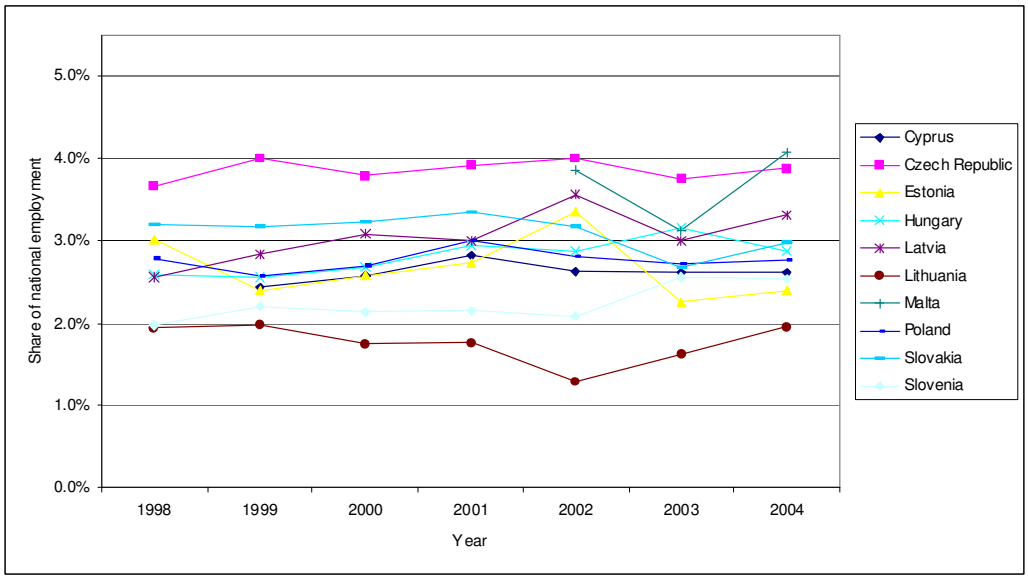
Figure 16. "ICT practitioners" share of national employment, EU15



Source: EU LFS Q2 for1998-2004

Note: The shares are statistically reliable since the absolute numbers that the shares are based on all exceed the Eurostat's limits applicable for each country, see Appendix D. The figures for the Netherlands in 2004 are provisional.

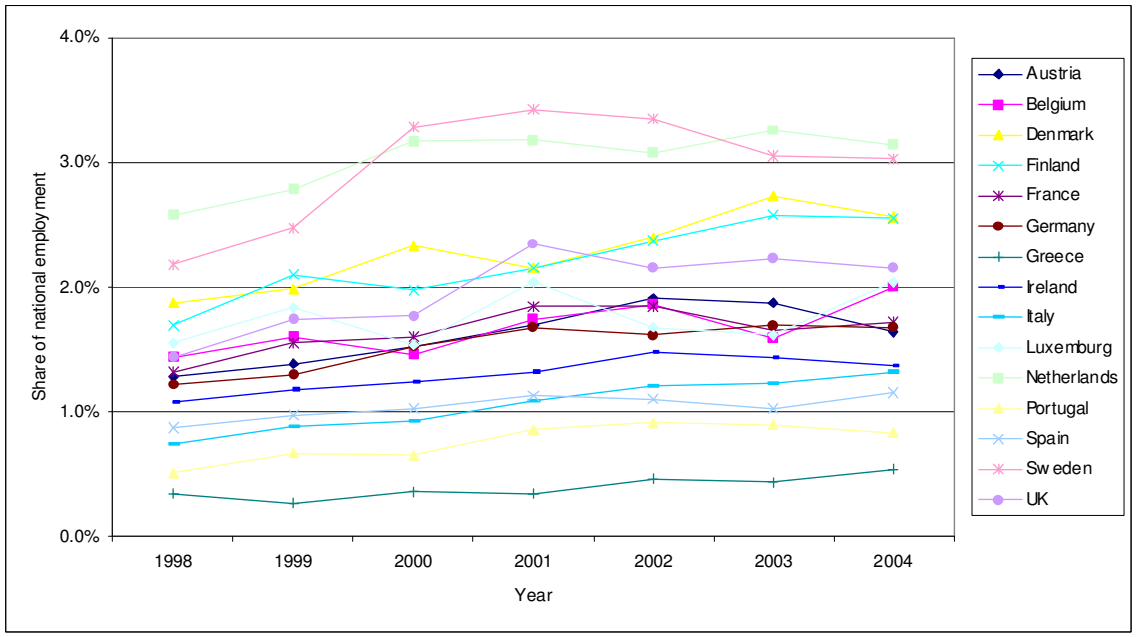
Figure 17. "ICT practitioners" share of national employment, Member States since 2004



Source: EU LFS Q2 for1998-2004

Note: The shares are statistically reliable since the absolute numbers that the shares are based on all exceed the Eurostat's limits applicable for each country, see Appendix D.

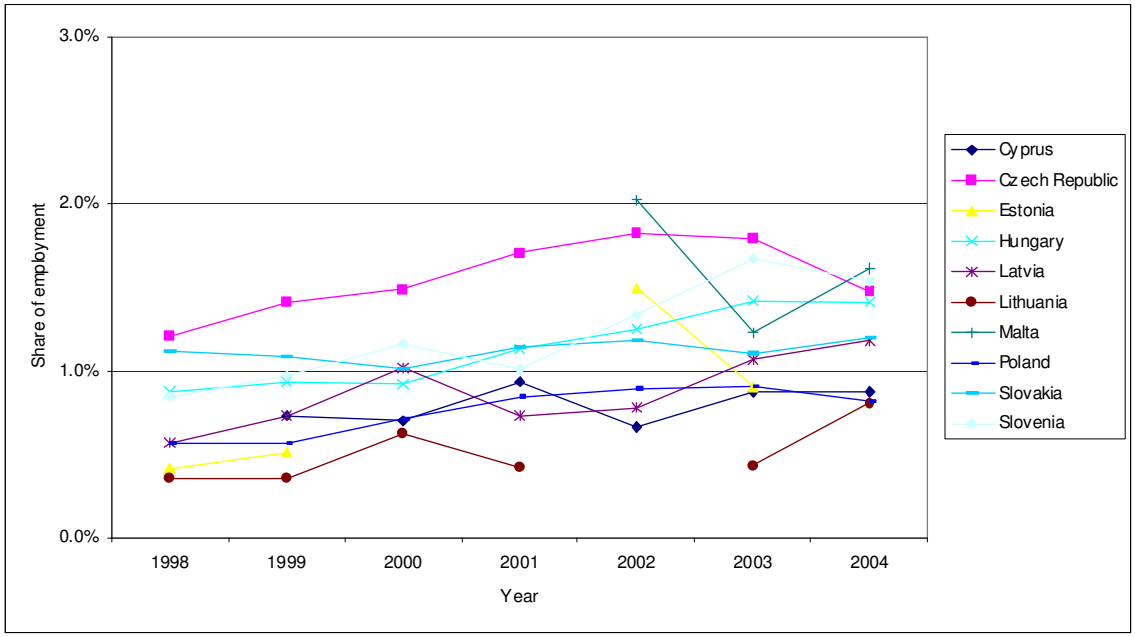
Figure 18. "IT practitioners" share of national employment, EU15



Source: EU LFS Q2 for1998-2004

Note: The shares are statistically reliable since the absolute numbers that the shares are based on all exceed the Eurostat's limits applicable for each country, see Appendix D. The figures for the Netherlands in 2004 are provisional.

Figure 19. "IT practitioners" share of national employment, Member States since 2004



Source: EU LFS Q2 for1998-2004

Note: Most shares are statistically reliable since the absolute numbers that the shares are based on all exceed the Eurostat's limits applicable for each country, see Appendix D. However, the figures for Estonia in 1998,1999, 2002 and 2003, Latvia in 1998, 1999 and 2001 and Slovenia in 1998-2001, should be interpreted with caution.

The path followed by each Member State is a function of many different factors and should be examined in closer detail if country-specific remarks are required, particularly in view of the problems of "translation" from national occupational frameworks to ISCO. Below we have shown additional data from country-specific sources, where available.

4.4.2 Country specific data sources

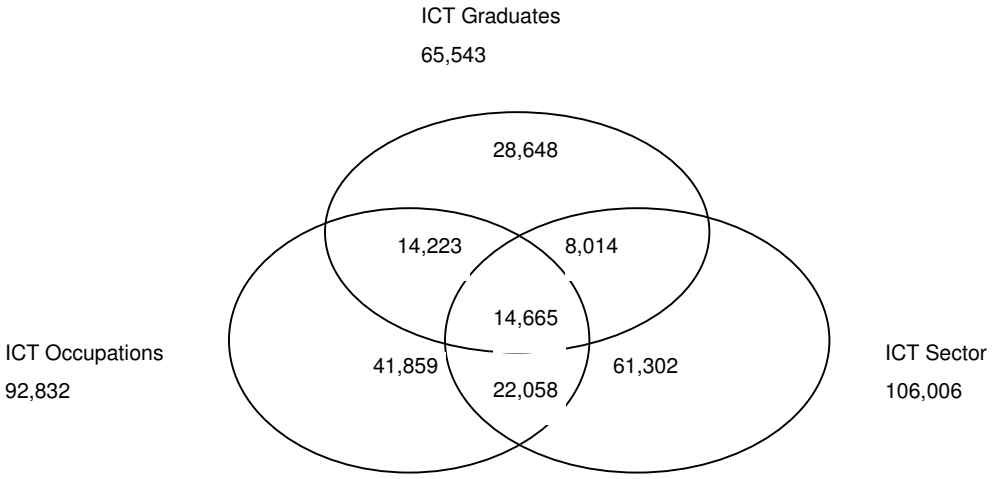
An analysis of the current situation in different Member States is presented in Appendix H[36]. The table summarises national initiatives and evaluates the usefulness of specific data for giving an overview of the current situation of supply and demand for ICT practitioner skills in individual Member States. The data provided is only considered useful for this study if it reflects the current situation. Data from before 2002 is considered too old and such estimates have not been used. The table in the appendix shows that eight countries provided useful data. These are Denmark, Estonia, Germany, Latvia, Luxembourg, the Netherlands and the UK. The following sections present information from these countries. Few of these sources use the same terminology and precise definitions for e-skills as applied in the rest of the report. We have not attempted to synchronize the outputs from the national sources. The general definition of ICT practitioner skills and e-business skills has guided the inclusion of material. We feel that all the various ways of naming and defining e-skills presented below fall within that definition.

[36] This analysis is based on information that is additional to the data provided through the EU Labour Force Survey.

Denmark

The Danish report "Information Society Denmark – Status 2004" presents survey data on the ICT labour market situation in 2003. **Error! Not a valid bookmark self-reference.** Figure 22 shows the relationship between ICT degrees, occupations and employment. Some 44 percent of ICT graduates had an ICT occupation and 35 percent of them were employed in the ICT sector. These figures indicate either there is a supply surplus, a skills mismatch or that ICT graduates for some reason prefer working in non-ICT occupations. Moreover, non-ICT sectors employ together more ICT practitioners than the ICT sector. About 40 percent of the people with ICT practitioner occupations work within the ICT sector.

Figure 20. Danish ICT practitioner skills labour market 2004.



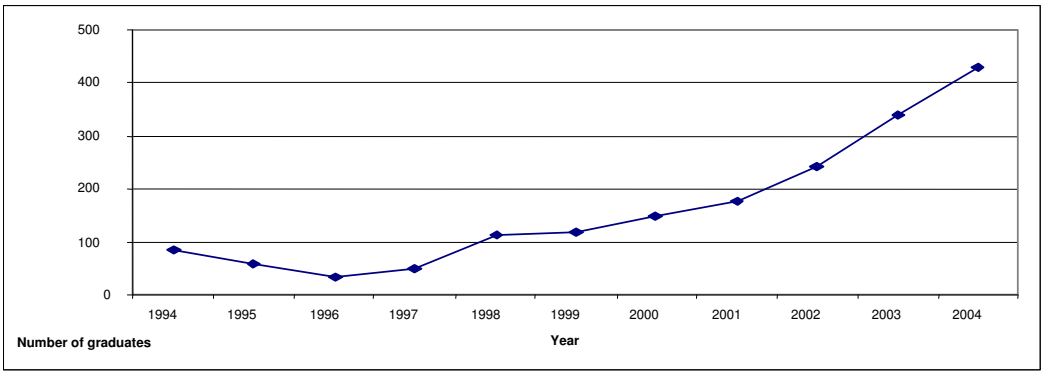
Source: Information Society Denmark – Status 2004

The Confederation of Danish Unions has commissioned a scenario exercise on future demands of ICT qualifications at upper-secondary level/ short cycle higher education for the year 2015. It is expected that demands for people with ICT profiles at upper secondary level will be limited as the supply of graduates at tertiary level has been gradually increasing. (Danish Technological Institute with the Confederation of Danish Unions, 2004)

Estonia

Figure 21 shows that the new supply of e-skills, measured as computing graduates in higher education per year, is increasing in Estonia. The Estonian Labour Force Survey data indicates that, except for last year, Estonia has experienced increased demand for e-skills in general since 2001.

Figure 21. Development of Estonian computing graduates in higher education 1994-2004

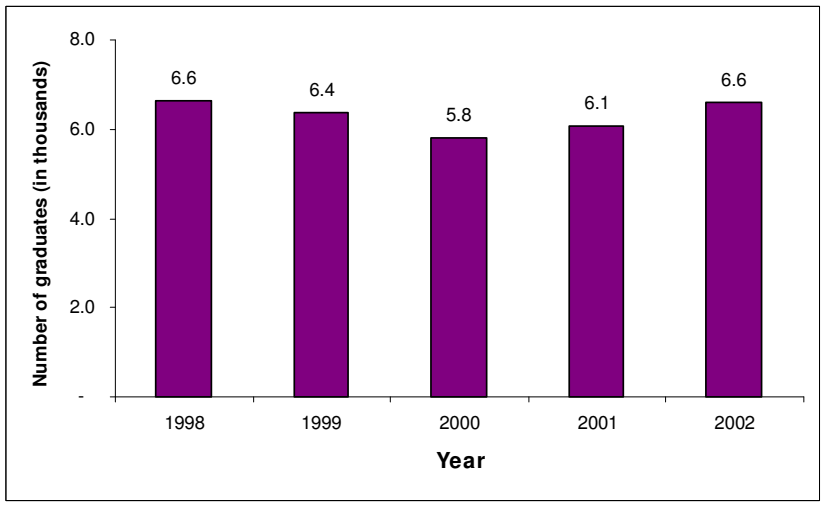


Source: Statistical Office of Estonia

Germany

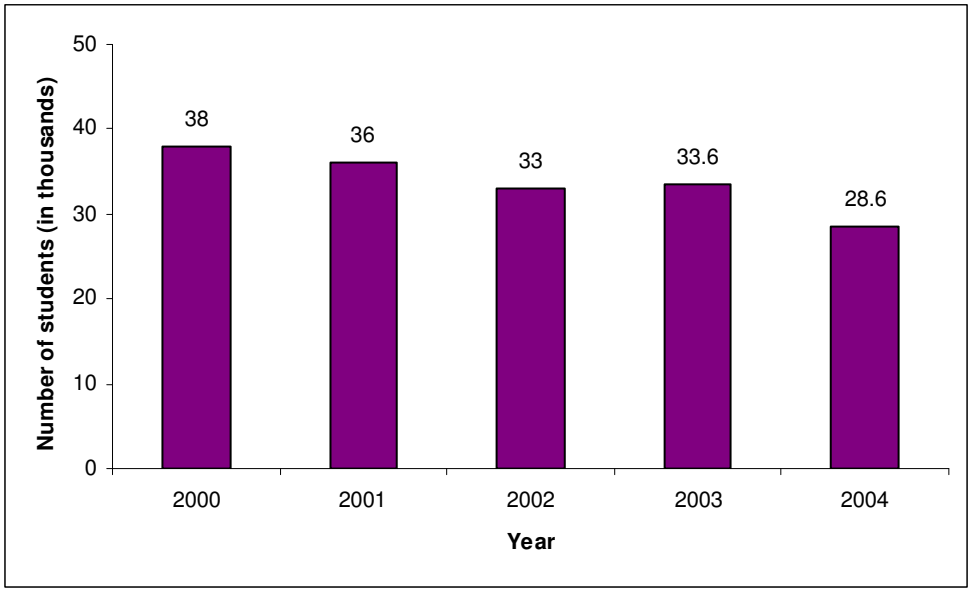
The available data for Germany focuses on the supply side and formal education. Supply of ICT practitioner skills, measured as number of graduates in informatics, increased in Germany a few years ago (see Figure 23). However, according to data in BITKOM (2005), this development might not continue in the future. Figure 23 shows that the number of students starting Informatics studies has been decreasing between 2000 and 2004.

Figure 22. Number of graduates in informatics in Germany, 1998-2002



Source: Federal Statistical Office Germany

Figure 23. Students starting Informatics studies in Germany, 2000-2004

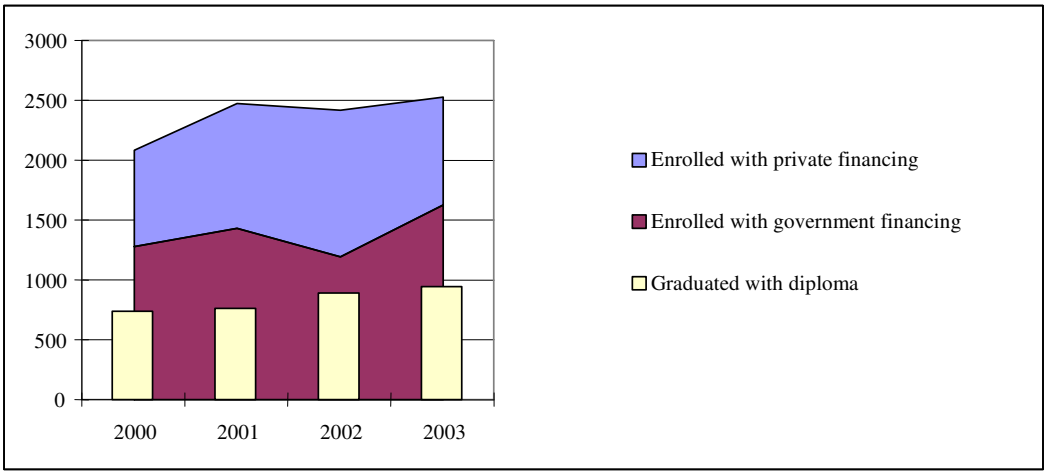


Source: BITKOM based on Federal Statistical Office Germany

Latvia

According to the reviewed reports, the Latvian Government has prioritised education in ICT since 2001. In 2005, the University of Latvia will open a Faculty of Computer Science that will offer study programmes in line with Career-Space skills classifications. The supply of e-skills is already increasing. During the last four years enrolment for ICT students has on average increased about 7 percent annually.

Figure 24. Increase of ICT students in Latvia, 2000-2003

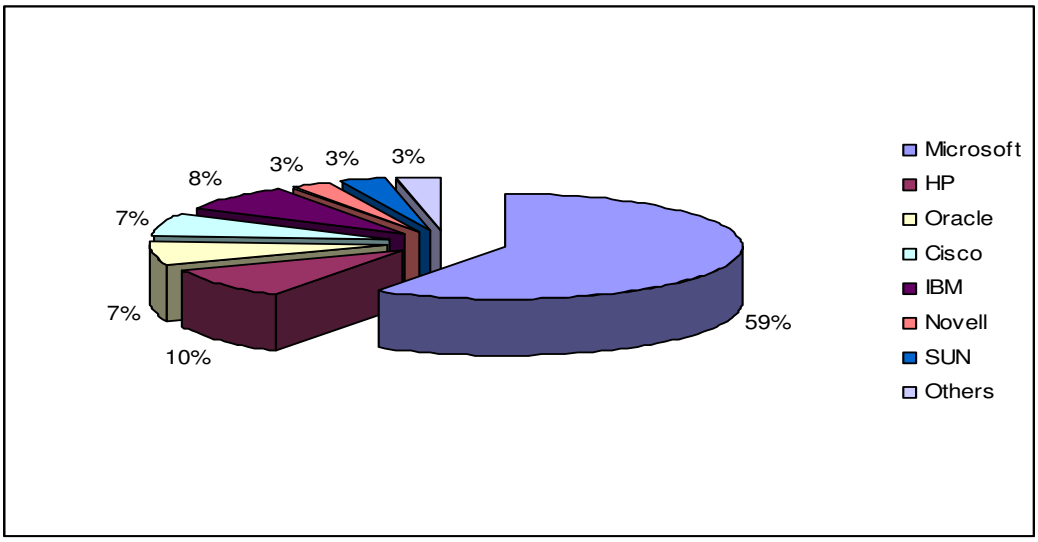


Source: LITTA, 2004

The reports also address the supply of skills developed through training. In 2003, IS companies reported spending €1,2M on training – an average of € 890 per employee. That is twice as much as was spent for this purpose among all IS companies in 2002. The Baltic

Computer Academy delivers an average of some 700 (industry) certification examinations per year to IT specialists who take tests in IT solutions.

Figure 25. Certification exams split by IT vendors, Latvia



Source: The Baltic Computer Academy, 2003

LITTA (2004) reports findings from a survey carried out by the Hay Group in 2004, which indicates e-skills shortages or mismatches in Latvia. According to the survey, 88 percent of Latvian ICT companies reported that they encounter scarcity on the market for certain types of jobs or degrees specific for the ICT sector. Table 4 shows that e-business skills are perceived as the scarcest skills. Latvian companies lack qualified IT consultants with management and communication skills and of business developers and sales representatives. These results suggests strong need for finding ways to increase the monitoring of the demand and supply for these e-business skills. The survey by the The Hay Group study is the only data source this study has found, either at the international or national level, that explicitly measures demand for e-business skills.

Table 4. Jobs for which there is a perceived scarcity in Latvia

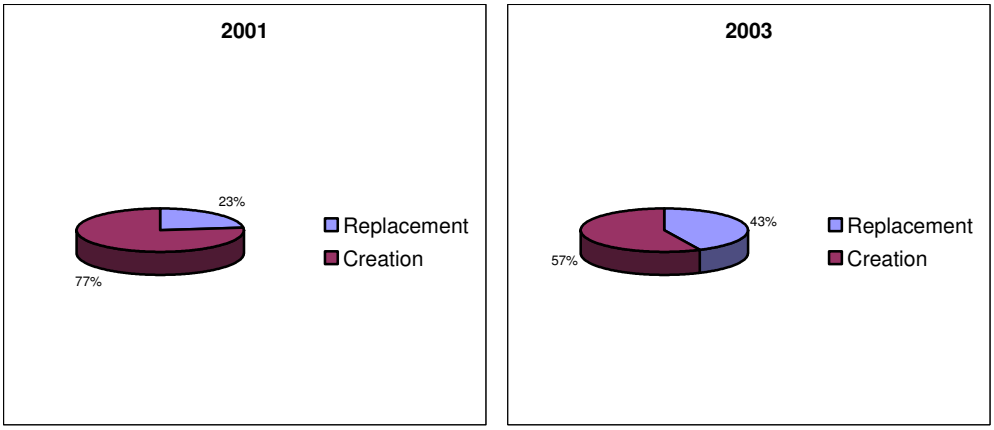
Jobs	% of companies that perceive scarcity
Qualified IT consultants with management and communication skills	88%
Business developer / sales representative	75%
IT architect	75%
Project manager	50%
Programmer	50%
ERP specialist	43%
SAP specialist	38%
Data communications specialists	25%
IS security specialist	25%
Voice service specialists	17%
Marketing specialist	12%
UNIX specialist	12%
Help desk operator	12%

Source: Hay Group, 2004

Luxembourg

A survey of 265 enterprises, representing a total of 41,023 staff, suggests that the demand for ICT practitioner skills has decreased during recent years. illustrates that replacement demand is becoming more important for employment in the ICT sector compared to creation of new positions. The data includes all occupations within the ICT sector, so it is not possible to identify the demand for ICT practitioner skills.

Figure 26. Creation versus replacement of positions in Luxembourg



Source: ABBL, clc, FEDIL 2004

The Netherlands

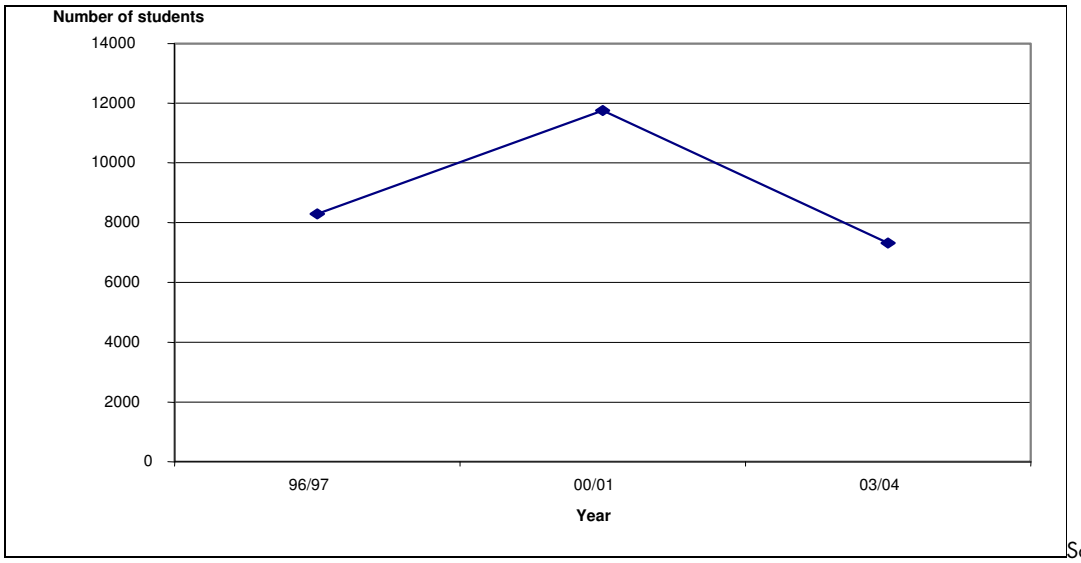
The "ICT Marktmonitor 2004-2005" estimates that the ICT practitioner skilled workforce in the Netherlands in 2004 was made up of 117000 professionals. Furthermore, the report argues that there has been an excess supply of e-skills in recent years but that this situation is changing. In 2003, there was a surplus of 4600 highly educated ICT practitioners in the labour market. In 2004 the surplus had decreased to around 1000 practitioners and projections for 2005 show expected shortage.

Sweden

According to the report "Arbetskraftsbarometer 2004", the share of Swedish companies recruiting ICT practitioners increased in 2004 for the first time since the year 2000. This indicates that less favourable market conditions for ICT practitioners in the Swedish labour market of previous years might be changing. However, the report suggests that there still is a surplus of e-skills in Sweden. The report looks at quite broadly defined groups of skills, and classifies them according to educational background. Given this classification it is not possible to determine if the increased demand is actually for ICT practitioner skills or for closely related skills.

On the supply side, the trend is reversed. Between 1996 and 2001 the number of students accepted for ICT educations increased, but has since sharply declined. This trend is illustrated in , which is likely to decrease the future new supply of ICT practitioner skills, probably due to the fact that students have become reluctant to follow ICT higher education due to the unattractive situation in the labour market in recent years. If the situation in the labour market is currently changing as suggested in the "Arbetskraftsbarometer 2004", this trend might well change again.

Figure 27. Number of students accepted for ICT educations in Sweden 1996/97 – 2003/04



Source: National Agency for Higher Education (2004)

United Kingdom

In 2004 a survey of 3240 British employers investigated the current situation in Britain with regard to ICT-skills gaps and demand for ICT practitioners. An estimated 9 percent of business units in Britain employing ICT practitioners reported skills gaps - i.e. some or all of their ICT practitioners were not considered to be fully proficient in their job. On average this amounts to about 3 percent of all ICT practitioners employed, thus is not a big problem for the British economy overall. The identified gaps were most often apparent in the development /implementation skills of IT staff and amongst larger establishments.

In Britain, the 2004 demand for ICT practitioners, measured as number of vacancies, is estimated to be 65,000 vacancies occurring in some 41,000 establishments across Great Britain. 15,000, around 34 percent, of these establishments with vacancies for ICT practitioners were finding these hard to fill, implying that around 1% of all UK business sites have difficulties recruiting IT staff. These levels would not be considered to represent any serious skills shortage.

4.5 Concluding remarks

In the year 2004, an estimated 3.2 million people worked as "IT practitioners" (ISCO 213 and 312) and 5.9 million worked in "ICT practitioner" occupations (ISCO 213, 312, 313 and 724) in the EU. The numbers account, respectively, for 1.6 percent and 3.0 percent of estimated total employment in the EU in 2004. The analysis of supply and demand of ICT practitioner skills indicates that Europe on average has been experiencing over the last few years a slowdown in the labour market for e-skilled occupations, which is believed to be driven by diminishing demand (notwithstanding significant needs from replacement demand) rather than shortage of supply. The limited information available on unfilled vacancies in combination with the slight rise in unemployment of IT practitioners seems to support this analysis. The trend seems to be stronger in the old Member States especially in

comparison to the new ones. There is some evidence that several new Member States currently experience certain ICT practitioner skills shortages.

The supply of "new" e-skills, measured in terms of graduates from tertiary education in the field of computing, is increasing at the EU level. However, both EU level data and data at the national level indicate that the trend might well change in a few years time. The number of tertiary students in the field of computing remained flat on average in the EU between 2002 and 2003, after growth in the years before. Moreover, data from Sweden and Germany shows that the number of students starting ICT/Informatics educations is decreasing, implying a future decrease in new supply from the formal education system in these countries. A further drop in the number of computing students would increase the gap between the US and EU in this respect.

Clear quantitative information on the supply of skills through training is lacking. However, the types of skills that are in demand in the commercial training market are given by some sources.

The currently available data is very limited regarding e-business skills. The review has only come across one source that explicitly estimated the demand for this kind of skill. The source was a survey among Latvian ICT companies conducted by the Hay Group. A review of national data collection showed that Member States collect data suggested by Eurostat, even when it is voluntary to do so. Almost all Member States collect ICT data through standardised household and enterprise surveys. These surveys could potentially be a useful vehicle for the collection of additional data on supply and demand for ICT practitioner skills.

Another poorly measured item is outsourcing and off-shoring of jobs. We were unable to find clear data on this aspect save a selection of articles cited in OECD (2004) and indirect calculations using trade data and occupational employment data (OECD 2005), and found nothing at all on the skills implications of outsourcing and off-shoring. Further development of indicators would be called for – a minimum being including questions regarding this topic in employer surveys, and there are likely to be significant problems with companies disclosing much of the relevant data. Furthermore, the occupations and the corresponding sectors that according to OECD are affected could be studied in greater depth.

4.6 Future improvements of existing statistical data collection

Table below provides an overview of the indicators that were proposed in chapter three, the current sources used for this report, and an indication of improvements to data collection activities. Unless an encompassing data collection effort is to be performed at the EU level over a range of years, employing the same frameworks and indicators, the options for improvement are severely limited.

In our discussions with Eurostat, we have identified some possibilities for improvement of current and expected data collection activities; the main possibilities are within the ICT enterprise survey, the ICT household survey, the job vacancies survey, and the CVTS survey. It would also be possible for Eurostat to work with National Statistical Offices to

improve the quality of national data submissions to Eurostat databases. In particular improvements could be made in the "translation" coding across LFS data from national occupational frameworks to ISCO. Should more detailed information be required beyond the range of Eurostat's regular activities, other data collection activities by, for instance, the OECD should be stimulated. This would include counting (online) job vacancies, interviewing/surveying training institutes and further statistical analysis of national level data.

Clear holes in available data are related to the offshoring field, training and certificates, and replacement demand. At this point, we do not have a clear recommendation for the offshoring data except for adding questions to employer surveys. The same surveys may also be helpful in acquiring a more precise estimate of replacement demand than the range that we have found in three reports. Data on training volumes and certificates awarded may, in principle, be obtained from training providers, probably with the help of appropriate intermediary organisations such as CompTIA/eSCC.

Table . Overview of indicators, existing data sources and potential improvements to data collection

Indicator	Sources	Potential improvement
Unfilled vacancies	BISER (2004) collected information on number of establishments that experience unfilled vacancies for selected European regions	ICT Enterprise Survey (or another employer-based survey) **should** include questions on unfilled practitioner vacancies – a quantification of number of vacancies would be appropriate
Job vacancies	At EU level no data was found.	1) Eurostat collects data on job vacancies but currently only by economic activity, not by occupation - Eurostat Job Vacancies Survey **should** include e-skilled practitioner occupations 2) Regularly counting (online) job vacancies in different media. This methodology has been used in Germany, by industry sources to track the supply and demand situation in the ICT practitioner field. An extension to the EU would be interesting but requires investment for set-up and piloting 3) Incorporate expertise of national employment offices

Indicator	Sources	Potential improvement
Replacement demand	Estimates of 2.5%, 3% and 9% of stock are used	ICT Enterprise Survey (or another employer-based survey) **may** include question on replacement demand Estimates could be improved from further analysis from LFS (in combination with other – demographic) data.
Offshoring activities	No data sources were found	ICT Enterprise Survey (or another employer-based survey) **may** include question on offshoring activities
Unemployment	EU LFS data provides information on unemployment in occupational profiles, but low sample size makes outcomes less reliable	Get Member States NSO's to agree to increase sample size of LFS
Number of graduates	2-digit ISCED EF numbers are readily available	1) In future, data on graduates should be collected and submitted to Eurostat at 3-digit level (EF481, EF482 and EF523) – changes to the classification are not foreseen 2) Following the example of Denmark and the UK, graduates' "First Destination" industry and occupation should be recorded
Training and certifications	ITAA and CompTIA provide information on what types of courses are taken, which indicates relative importance of topics Eurostat CVTS shows number of hours spent on computer courses (all levels)	1) Directly interview training providers to ask how many people they train for different practitioner skills 2) The 2006 CVTS survey **should** include questions on practitioner courses

Indicator	Sources	Potential improvement
Stock of ICT practitioner occupations	Eurostat LFS data is readily available for 3 digit ISCO codes and provides information on industry, gender, age distribution and nationality of labour force	1) The problem of wrong in- and exclusions of occupations can be addressed by going into the 4 digit level, for which research at the national level would be necessary and current sample sizes may not be sufficient. The updating of ISCO (due 2008) should help in addressing this issue Commission/Eurostat/OCED should press for new, more realistic categories for ICT Practitioners at the 4-digit level 2) A pragmatic way to tackle wrong inclusions in ISCO 313 and 724 would be to examine employment levels in a small sample of member states at a higher level of detail in order to assess what percentage of those two occupations should not be considered ICT-skilled occupations
Other skills measurements	ICT household survey focuses on basic user skills.	ICT Household Survey could include questions regarding practitioner skills, but would require (significant) increase of sample size

CHAPTER 5 Anticipating e-skills

The assessment and analysis of the current situation relating to the supply and demand of e-skills has been a challenging exercise given the variety of definitions, the rapidly changing environment within which e-skills are being applied, and the extensive data needs that a detailed review across countries, sectors, and skills levels requires. In addition to the focus on the current situation, this study considered existing forecasting and foresight activities that are aimed to anticipate the future developments related to e-skills. Obviously, given the additional uncertainty involved, anticipating the future situation of e-skills provides even further challenges.

In the second stage of our research, we identified, documented, and reviewed future oriented studies, which explicitly aimed to assess the future demand and supply of e-skills. This chapter provides an overview of the outcome of these studies, in particular how they deal with e-skills related issues and what can be learned from their assessments. Subsequently, we offer foresight as an alternative approach to forecasting the supply and demand of e-skills in the mid-term future, presenting what a foresight study should contain, and what the future-oriented studies that were reviewed contained. Finally, we present a detailed approach for setting up a European e-skills foresight mechanism and a foresight-oriented network of experts, indicating elements of a business plan.

5.1 Systematic review of conducted future studies on e-skills

5.1.1 Approach

Based on the method described in section 2.3.1, we analysed a further 15 future-oriented studies examining how these studies deal with specific e-skills issues related to foresight assessments as identified in phase 1 of the study[37]:

- What is (attempted to be) measured: I(C)T skills, e-business skills?
    - What levels of skills are addressed: practitioner, advanced, basic?
- In what terms are skills assessed: future occupational requirements, overall skill requirements, etc.?

[37] We also reviewed ten additional reports that contained predictions of the future situation of e-skills. However, in these cases, the predictions were solely based on expert judgement and were not substantiated by any transparent or verifiable method.

- Does the future-oriented assessment look at demand, supply, or both?
- What indicators have been used for the measurement/assessment of future e-skills (stock of employment, qualitative assessment of needs, job vacancies, etc.)?
- Are attempts made to assess mismatches, shortages, gaps in e-skills?
- Are attempts made to distinguish across sectors, countries? What is the basis for the various distinctions?
- Does the future-oriented assessment consider specific issues: gender distribution, offshoring, and the like?
- What data collection techniques have been used (large, small-scale surveys, interviews, etc)?

5.1.2 General observations from these studies

In Appendix J, we present the full descriptions of the future studies on e-skills. The table below gives an overview of the frequencies with which certain features appeared in the reviewed studies.

Table . Feature frequency table for future studies on e-skills

Feature	Number	% of reviewed studies
5-10 year time horizon	7	47%
2-5 year time horizon	6	40%
International	9	60%
Focus on demand and supply	6	40%
Focus on demand only	6	40%
Focus on e-business skills	1	7%
Employment indicators	8	53%
Trend analysis	3	20%
Scenario approach	5	33%
Survey approach	9	60%
Economic model	5	33%

We found that all studies have a 10-year time horizon or less; this is probably an attempt to strike a balance between aiming for predictability of technological developments and requirements (which would favour a shorter time horizon) and considering a horizon that could include societal, organisational and educational responses to skills requirements. Furthermore, only about half of the studies places skills in an international perspective. The focus on demand, supply and employment indicators is mixed – in other words: the studies focus on a limited set of issues at stake. About half of the studies had some form of stakeholder involvement through a survey, questionnaire or interview and only one study specifically mentioned e-business skills.

The studies reviewed have applied different methods for estimating or forecasting future supply and demand. We have distinguished two main categories: the first comprises those studies that are using economic growth models or analyses; the second group consists of studies that are based on scenario approaches. Some studies apply scenarios to an economic growth model and thus fall in a 'hybrid' category.

5.1.3 Economic growth approach

CEPIS (2002) suggests that the prevailing approach is to estimate skills demand levels from a productivity factor applied to business activity levels arising from assumed economic growth in a sector. The most well known example of a forecast approach is the IDC/EITO 2001 analysis, which predicted a sizeable increase in e-skill shortages. However, this approach suffers from a number of shortcomings: (1) the chosen skills categories are uniquely based on IDC's own classification and thus cannot be tested against other approaches using different skills frameworks; (2) all kinds of ICT users are included in their estimates although the IT-component of their job may be very small; and (3) the supply estimate relied heavily on formal education only.

The second example is the European Economic Research Consortium (ERECO) approach, which is based on employment growth rates derived from a European-wide econometric model (E3ME)[38]. According to the authors, the appeal of this approach is that it can be encompassed within a coherent forecast of growth and jobs (Career-Space 2001). However, European developments were predicted based on the sector employment levels within the UK (as UK SOC90 data was used and comparable data for Europe was not considered detailed enough), which does not take into consideration differences in sectors per country. Also, only IT employment was forecasted and no shortage figures were estimated.

5.1.4 Scenarios approach

The approaches discussed above present their outcome as a single number. However, as Career-Space (2001) points out, the rapid and at times discontinuous pace of innovation of ICT technologies can mean that point projections of skill-demands quickly become obsolete. In addition, presenting just one number could give a false impression of certainty (CEPIS 2002). The scenarios approach partly accounts for the uncertainty in forecasts by providing a range of potential future developments.

Based on current stock

CEPIS (2002) chose to base its scenario predictions on the relatively constant measure of the EU LFS data (of ISCO 213 and 312). An initial 'trough' in the demand (reflecting expectations about lay-offs in the high-tech sector) is superimposed over 4 scenarios of annual employment growth (2%, 5%, 10% and 15%). It is argued that employment development curves do not change significantly in the short run (several years) and that this approach is more robust than the IDC and Career-Space approaches due to the use of EU LFS data. However, the reservations about the data gathering of EU LFS data remain and the 'trough' in the data is based on the author's assumptions about the future. In essence, one could argue that the predictions are still based on a single scenario, but with four variants.

Based on expert opinion

As with the measurement of the current status of skills, future developments can also be based on the opinion of experts or stakeholders gathered through questionnaires or

[38] This is the Energy-Environment-Economy Model for Europe, developed by Cambridge Econometrics.

interviews. Biat (Cedefop/biat 2003, EUQuaSIT 2004) took this approach and concluded that close to 30% of companies in the ICT sector and ICT user sectors expect short-term growth in ICT employment. They also found that most European companies rate the supply of ICT practitioners as fair (40-50%) or even very good (30-40%). However, their conversion of this information to an annual European need of 230,000 ICT practitioners and supply of 220,000 is somewhat unclear.

Instead of coupling employment to GDP growth, they determine ICT employment growth in the next years at no more than 5% per annum;[39] they apply three variants ('scenarios'): 2 %, 3.5% and 5% linear growth between 2000 and 2010. When starting with an initial population of ICT practitioners of 3,7 million in 2000 the middle variant leads to a stock of approx. 5,1 million practitioners in 2010.

Based on economic indicators/hybrid

The Federation of Finnish Electrical and Electronics Industry commissioned a scenario study based on economic indicators (Åbo Akademi, 2001; this approach could also be considered based on economic growth). The model calculated the ICT employment (total and in manufacturing, telecommunications, and services) based on the relationship between ICT employment and 8 indicators: GDP growth, ICT expenditure growth, R&D in ICT growth, ICT export growth, Total employment growth, Value added in manufacturing growth, Value added in ICT services growth and an opinions multiplier. Although from a data-gathering point of view it is an impressive exercise, there are some drawbacks to this approach. The approach assumes the same economic structure in the 10 years after 2000 as in the six years before it (the multiplier factors are based on 1994-1999 data and kept constant afterwards, and the weight of each of the multipliers in the model is fixed (65% for GDP and 5% for the other seven factors)). In addition, Finland, The Netherlands, France and Spain are used as representative of the EU-15. It is also not clear how ICT employment is defined and whether this definition is similar in the four countries.

5.1.5 Lessons to be learned

The field of ICT and ICT-related skills is still very dynamic and many studies admit that capturing skills in a static framework is bound to display only a limited picture. Such a picture still yields valuable information, but it should at least be augmented by a more comprehensive discussion of issues at stake, including policy issues.

However, the question arises to what extent policy makers in the field of e-skills – notably the European Commission – would benefit from yet another prediction in a range of predictions that seem to address slightly different topics with slightly different definitions. Based on the current knowledge base on e-skills, and the studies and reports that we have identified in this project, we can conclude that the topic is still defined in a multitude of different ways and that as a consequence the debate remains blurred.

[39] Based on the data from company surveys as well as assumptions of the economic development, specifications on the demand of ICT practitioners and the overall development until 2010 are given.

There are a number of major uncertainties that have to be taken into account when addressing the future of e-skills:

1. ICT developments are rapid and uncertain: over the past decade, technology has developed at a tremendous speed and as a consequence ICT skills constantly need to be reviewed or refreshed (or even discarded) in most professions today; moreover, in what direction the developments are moving is unclear: the effects of convergence of technologies and the rise of alternative ones such as ambient technology cannot be clearly foreseen thus making it risky to prepare for a specific technology that might not catch on;
2. The education system takes time to change: knowledge needs to be synthesised, assimilated, and formalised before it can be incorporated into any more or less formal education system; we have seen that elements of computer literacy have taken a long time to percolate into primary level education and still many teachers are lacking the computer skills to educate their pupils;
3. A great variety of stakeholders are involved with different interests in the topic: from a policy perspective there are different elements to consider such as competition in a global market, upgrading the educational system, developing a strong R&D base, free flow of labour, IT-induced innovation, equal access to services, and equal opportunities for developing skills, to name but a few.

These conditions severely limit the strength and usability of the currently applied approaches. Instead of proposing a 'better approach' to predictions (disguised as scenarios), we would like to forward a process-oriented approach that incorporates some of the data gathering methods and outcomes described in the previous chapters, but also includes notions of discussion, networks, opinions and interests: a process known as foresight. However, this may entail accepting the fact that quantification of *skills* demand and supply (and therefore not focusing on occupations) beyond the near-term future (less than 5 years) is a wrong approach.

5.2 Background of future studies and foresight

Within the European Union, foresight is used as one of the major instruments to inform policymaking. The work programme "Strengthening the foundations of the European research area"[40] stated that the coherent development of research and innovation policies should be supported by "the development and dissemination of Science & Technology indicators, economic analyses, studies and the exploitation and synthesis of the results of **foresight activities** carried out at regional, national, European and international levels." The same approach can be used in streamlining the discussion on e-skills policies as well as coming up with policy recommendations.

Studies concerning the future generally come in two distinct flavours that are based on one of the following premises:

[40] ftp://ftp.cordis.lu/pub/fp6/docs/wp/sp1/p_wp_200201_en.pdf

1. Predicting the future (extrapolation, forecasting), which is based on the idea that the system under scrutiny can be described and understood in detail and that the system's future states can be known;
2. Creating a future to work towards or to avoid (visioning, backcasting), which is based on the thought that present-day action can change the future outcome of a system – however, that some aspects of the future state are not yet known.

Over the past decades, we have seen the emphasis change from the 'type 1' future studies to the 'type 2' studies. Also, future-oriented studies shifted from activities performed by a select group of experts who were barely involved in the actual field to an exercise in which stakeholders play a more pertinent role in describing and shaping their future. [41]

A process called 'foresight' was developed that encompasses a wide range of approaches also used in planning, management of group processes, and organisational learning. Foresight studies formulate and explore visions of the future, exploring developments in science, technology and society. While there are a variety of ways of conducting foresight exercises, they do share some common features, namely:

- Systematic thinking about the medium to long term future;
- Broad scope, including social and natural sciences;
- The formulation of actions and/or priorities; and
- The creation of new networks of actors.

In a foresight process, elements of systems analysis and 'prediction' are still present but play a limited role; an equal role is given to clarification of perceptions and values and identifying networks of power and influence. A foresight exercise that includes both forecasting and backcasting is useful for policymakers as it can provide them with a better understanding of the strategic context in which they have to make decisions and possible outcomes of activities planned. Thus, analysing the future can enable:[42]

- An improved understanding of trends, drivers, uncertainties, issues, influences and technologies;
- The identification of pertinent risks and also opportunities within these contexts;
- The formulation of relevant strategies, policies and plans, which are robust (which means that they work in different futures imaginable).

Given the current state of knowledge about e-skills, we believe policymakers (and other stakeholders) can benefit from a foresight exercise, because it could lead to the clarification of this topic that still contains uncertain technological and societal issues (which we will describe below).

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[41] Hjelt Mari, Paivi Luoma, Erik van de Linde, Andreas Ligtvoet, Janneke Vader, James Kahan: Kokemuksia kansallisista teknologia-ennakoinneista (Experiences with national technology foresight studies), Sitra report 4, Helsinki, 2001.

[42] Ibid.

5.3 Observation of foresight elements in conducted studies

On the basis of interviews with key informants and a scan of European foresight exercises (RAND Europe, 2005), the following defining qualities for connecting foresight to the policy process could be formulated:

- Stakeholder presence
    - Identify the right stakeholders of relevance to the topic
    - Give each stakeholder reason to participate
    - Involve different groups at different stages
    - Ensure that the topic is defined narrowly enough to allow a representative group of stakeholders to be selected given the available resources
    - Build political support
- Topic design/relevance
    - Identify the specific objectives of the foresight exercise
- Technical design/validity
    - Allocate responsibility and resources for conducting foresight to dedicated professionals
    - Select appropriate foresight techniques
    - Focus on disagreement as well as consensus
- Process design
    - Think in time
    - Communicate actionable recommendations tailored to their audiences
- Evaluation design/feedback
    - Evaluate

These qualities should also apply to a scenario-based foresight of e-skills. As a next step we analysed how the studies that we have reviewed deal with a set of foresight characteristics. As none of the studies under review were specifically set up as a foresight process, we did not expect them to score very well in terms of these 'principles', as indeed they did not. But, they do provide a starting point for identifying an appropriate direction for e-skills foresight.

5.3.1 Stakeholder presence

Involving the right stakeholders (multi-stakeholder participation)

One of the key points of a foresight process is that the involvement of all relevant stakeholders is necessary to ensure that the results of the exercise are comprehensive. Further, the involvement of all stakeholders lends the exercise the legitimacy it requires to contribute to policy development.

In the studies that we have reviewed, the main method of involving stakeholders was through interviews and surveys in the ICT industry, with area experts and foresight specialists. The fact that some studies were conducted by or on behalf of consortia of stakeholder groups (such as the Career Space Consortium) only partially satisfies the need to involve a broad range of viewpoints. Ideally, stakeholders would be involved in both the problem definition phase as well as a solution-seeking phase.

Building political support

There must be sufficient political support for the objectives set for the foresight exercise. In addition, there has to be sufficient political support for the foresight exercise itself. High-level political support is needed before the start of the project. This is necessary to ensure that sufficient resources are devoted to the foresight exercise, and to encourage other stakeholders to participate.

In the exercises reviewed, support from policymakers before and during the project is often not reported. Two reports mention some support: in the Forfás report (2003) an Expert Group is mentioned that work in commission from the Irish Minister for Enterprise, Trade and Employment and the Minister for Education and Science; the government is also mentioned in the report of e-skills UK (2004) - the government licenses the remit of e-skills UK as the Sector skills Council for IT, Telecoms and Contact Centres.

5.3.2 Topic design/relevance

Identifying specific objectives

The objectives of the selected studies focus mainly on highlighting a selection of recent developments and future directions in the field of e-skills and education. The overall aim is often to inform or influence policy decisions and only few studies aim to develop a coherent strategy to prevent future lack of ICT people (i.e. strengthen education and training of I(C)T practitioners). Two reports focus on measuring the needs required by industry (Career Space, 2001; Qualifications de demain, 2004).

Depending on the objective, the focus of the studies differs: demand only, supply only, both supply and demand, or employment. In some cases outsourcing (to low wage countries) and skill shortages were explicitly addressed. The type of skills that are mainly addressed are practitioner I(C)T skills and in only one publication (EMCC, 2003 - Shaping the future of financial services) we found an explicit focus on e-business skills. Often the future-oriented studies measure occupational requirements at the practitioner level.

As already indicated in previous chapters, the area of research is potentially vast. The formulation of the policy objectives to be addressed by foresight defines to a large extent the orientation of the subsequent foresight exercise – for example, whether it is primarily technology or society driven – and to some extent also the most appropriate methodology and techniques: e.g. a formulation of skills supply in terms of employment using ISCO codes will leave out a whole range of practitioners – notably those with e-business skills.

5.3.3 Technical design/validity

Selecting the appropriate techniques

The background data to the studies is mainly collected by means of surveys or interviews, secondary data analysis that mainly focus on LFS data, and literature review. These techniques are all appropriate for specific goals: surveys and interviews to gauge opinions and expectations, statistical data to provide the quantitative, historical context and literature review to provide a broad background of policies and studies.

However, on the basis of the review we can conclude that the different future-oriented studies focus on (quantitative) forecasting and very few studies use backcasting. Almost all studies use some form of trend analysis or economic growth approach, but do not take into consideration **structural changes** in the demand and supply of e-skills (as caused by technology breakthroughs, new innovations, paradigm shifts). Therefore, these analyses project a future market for ICT practitioners *under the assumption that everything remains the same for the years to come*. Some studies refer to the term 'scenario', but actually these scenarios constitute a sensitivity analysis based on the variation of one (or two) variable(s).

Allocating responsibility

It should be clear that a broad foresight exercise encompassing both quantitative and qualitative elements as well as backcasting and forecasting, should involve the right mix of professionals for the job.

Focusing on disagreement as well as on consensus

Whereas the studies that focus at providing an overview (such as OECD, 2004) do indicate divergence in outcomes of studies, the future-focused studies seem to provide little discussion regarding diverging opinions. As said above, some scenarios present different employment numbers based on the variation of a few variables. The basic premise of the forecast is however not challenged.

Although the presentation of disagreement complicates the discussion of outcomes, it would provide a broader picture of the issues under scrutiny.

5.3.4 Process design/credibility

Thinking in time

A study is most effective if it is delivered at the point at which a decision is taken. Furthermore, repetition and continuity ensure that the outcomes of an exercise can be compared to previous outcomes.

In most of the e-skills reports no specific connect

changing educational practices as a response to a foresight-study would require several years.

Communicating actionable recommendations

Many of the studies are mainly focused at providing information. This is a perfectly valid goal, but it does decouple the information provision process from the policy making process. As such, the main recommendations of the studies reviewed concern information provision. If a future study is aimed to help policy makers,

5.3.5 Evaluation design/feedback

Evaluating

This element is also underdeveloped in the studies – this is probably due to the fact that the studies are mainly focused at providing information (see above). A more action-focused project would include an evaluation section. This would periodically review whether the actual developments in the field match the foresighted developments. If this is not the case, the basic assumptions of the foresight may be wrong and policy recommendations should be reviewed. Once again this emphasises a process approach instead of a one-time study.

5.3.6 Conclusion

From this analysis we conclude that the conducted future-oriented studies on e-skills do not address the bigger picture of e-skills (i.e. ICT skills and e-business skills in the context of changes in technology, education and society) and that most studies are based on different assumptions, making comparisons difficult. Furthermore, stakeholder involvement could be improved and the outcomes of the studies have an unidentified effect on the policy making process. The challenge is to address these limitations in upcoming foresight studies.

5.4 Structure for a foresight study on e-skills

Based on our research, we find that most future-oriented studies that focused on e-skills supply and/or demand:

1. frame the issue of e-skills in different ways;
2. depend heavily on forecasting skills demand and supply by trend extrapolation or an economic-growth approach whereas structural changes are not accounted for (even although the term 'scenario' is sometimes used);
3. seem to be geared towards providing information, but not engaging in the policy process and disregarding political realities;
4. lack sufficient inclusion of the variety of stakeholders that is involved in the various topics related to e-skills.

In the paragraphs below we indicate how a new foresight exercise may be structured to provide the required input for the field of e-skills.

5.4.1 Framing the issue

One of the prime problems with recent studies of e-skills demand and supply is the incoherence between the definitions of what skills are included and what skills are excluded, at what level of education the practitioners should be considered 'practitioners', what skills correspond to what job title, and which type of skills a study should focus on. This issue is clearly visible for the e-business skills, for which a clear definition that can be operationalised is lacking.

The first task of the foresight exercise would be to reframe the issue, which may initially even broaden the question to: "what skills are needed under what circumstances as a result of the production and application of ICT in business processes?" In all studies concerning the topic, e-skills (however framed) were already the answer before the question was asked. In coordination with a steering group of stakeholders, an approach should be chosen that sufficiently captures the most important issues.

The first step is to *expand* as much as possible the evidence base that will be used for the foresight exercise (which has partially been done in this report). In this step, it is better to capture something that will later be abandoned than to miss something that would have been useful – in foresight terms: looking for weak signals. The next step is *structuring the evidence* according to the major analytic dimensions that will be needed, including substantive content, geographical and temporal scope, issues addressed, societal factors influenced, and the nature and quality of the evidence. Given the breadth of the topic, we expect this structured evidence to not require the highest degree of detail imaginable in terms of quantification. Additional research in the shape of surveys may still be required – not to find out what the status quo is, but what expectations are for the coming years.

5.4.2 Developing scenarios and structural changes

One of the reasons for going beyond forecasts is that they rarely encompass structural or systemic changes – i.e. planning as if things will remain the same in the future. Although this assumption may hold in some fields, the field of ICT has been notorious for its quick and unforeseen changes over the last decades, and the e-skills domain includes many facets of education, training, organisational needs and other job market developments.

A scenario approach is therefore more appropriate: this enables the combination of quantitative and qualitative elements as a basis for discussion in foresight panels. Scenarios thus form an analytic tool to illuminate the underlying uncertainties of a policy decision, and to enable decision makers to make more rational decisions taking fuller account of the unpredictability of the future. By discussing *possible futures*, discussions do not have to focus on whether a prediction is *true*, but on what actions have to be undertaken to promote such a future (if it is positive) or to mitigate it (if it is negative). There are various approaches to scenario development, but most focus around a core set of steps to be taken:

- Step 1: Identify the scope of the scenario and develop a system diagram
- Step 2: Identify drivers of change
- Step 3: Categorize drivers based on their level of impact and uncertainty
- Step 4: Develop scenarios

Finally, a scenario or a set of scenarios has to fulfil the criterion that it should be plausible, but it does not have to be probable. Indeed, given the uncertainty of the future, we explicitly state that a scenario is not a prediction, but only a possibility, as likely as many other possibilities.

5.4.3 Finding the right stakeholders

What flows from the logic of the sections above is that it is important to engage with the right type of stakeholders. The European e-Skills Forum already engages a number of different national experts and/or policy makers. Whereas this set-up may suffice as a discussion forum, the Forum does not cover all stakeholders from EU member states and thus is too limited a selection for a full-fledged foresight exercise. A broad European foresight exercise requires the identification of additional panellists (researchers, policy makers, business representatives). In the course of this project, we have identified a number of additional researchers and policy makers that are involved in e-skills as well as organisations that have worked on e-skills futures (these are all mentioned in Appendix C). Nevertheless, that list may be considered a starting point; when expanding the scope of the project, these types of stakeholders should be included in a foresight:

- Representatives of trade unions, as they would have a broad view of market developments and problems related to shortages of skilled workers;
- Representatives of enterprises (ICT users), as they depend on a skilled workforce and have a stake in ensuring that new personnel is properly trained and that the skills of existing personnel are updated to be more effective;
- Representatives of ICT industry, who depend on skilled workers like the other industries, but also are responsible for implementing new technologies and are better aware what type of skills are required;
- ICT researchers and developers, as the developers of new technologies have insight in what technology has to offer and can (partially) influence to what extent these technologies are skill-friendly and would require basic user skills or more advanced practitioner skills;
- E-skills researchers, who have researched both quantitative and qualitative aspects of the issue of e-skills, are aware of historical developments and methodological issues;
- Policymakers in the field of education, research, enterprise, innovation, information society, as they are the ones that can influence policies and initiate changes should they be convinced of their importance;
- Foresight specialists, who have a broad view on changes in society and the interaction between society and technology.

All the issues conceivable in the realm of e-skills cover a very broad spectrum and could significantly expand this list of stakeholders. What is important to note is that the social and political framework in each country is different and that therefore the type of stakeholder per country may differ too. An EU-encompassing exercise may require a too diverse group of stakeholders to interact, so that either a very narrow selection of topics is

required or a more regional focus – the task of a European project would then be to prepare a generic framework and scenarios for a discussion on e-skills topics that could be used at regional or national level.

5.4.4 Developing visions and formulating strategies

The final outcome of foresights goes beyond the development of scenarios. Based on various ways of interactive discussions, the function of a foresight is to identifying areas of consensus. Following from this is the crucial element of the elaboration of a guiding strategic vision, to which there can be a shared sense of commitment (achieved, in part, through the networking processes). The shared vision is not a utopia. There has to be explicit recognition and explication of the implications for present day decisions and actions.

At the same time, foresight can make an important contribution by increasing understanding of the differences between participants' views. Identifying such areas of disagreement can be an important policy contribution since it identifies areas where joint action is impossible. This is relevant for exercises at the European level since policy development requires a threshold of support from Member states.

In short, the output of foresights should provide insights into the consequences of alternative courses of action in the context different possible futures.

5.4.5 Engaging in policy making

The involvement of policy makers as well as other stakeholders in a foresight and scenario exercise will enable a more direct way of engaging all parties in policy making. This notion stems from the recent development of policy-making as a single-actor top-down (i.e. the policy maker) activity to policy-making as a multi-actor activity.[43]

Stakeholder involvement in the development phase has three important functions:

- *Integration and analysis from different points of view* and can lead to results that never could have been arrived at if the stakeholders had not been involved. The danger here is that the focus can become too broad and therefore a careful consideration of issues is necessary.
- *Learning*. It contributes to learning by participants. The foresight exercise is focused on future developments that are potentially very important to the stakeholders. They are exposed to developments, some of which they may not have considered before.
- *Mobilisation*. It draws people into an ongoing discussion in an active and creative way. It provides the venue for drawing participants into a vision development process. This can generate support for the process.

Identification and interaction with the stakeholders has an additional purpose: the information from the stakeholders regarding their interests, their points of view and the

[43] Cf. Riet, O.A.W.T. van de: *Policy analysis in multi-actor policy settings*, Eburon, Delft, 2003; It has now become customary to involve representatives of the major stakeholders in the policy preparation process, where a stakeholder is defined as an actor who is affected by the policy issue or can affect the direction of policy.

interactions thereof, will be included in the impact assessment of the developments. This is useful in the next step of foresight, which is to construct potential *levers for policy action* in order to try to steer the course of history towards desirable aspects of the future and away from undesirable aspects.

- A final important element is *dissemination*. Anything worth saying should be said well. To say it well requires multiple ways of presenting, including a scientifically acceptable report of the work performed. However, presenting only to other scientists is far from sufficient; in addition, dissemination must include presentations of a general nature acceptable to policy makers, and specialised documents and presentations that provide lessons learnt and potential action recommendations to specific audiences.

5.4.6 Process Issues

In designing a foresight exercise, there are process issues that need to be addressed concerning the ambition level, which translates into scale and sustainability. As we have repeated throughout this chapter, foresight is a process that encompasses 'continuous' engagement of stakeholders in shaping policy. Assuming a high ambition level, the involvement of as many stakeholders as necessary to achieve the required breadth of interests should be pursued. Given the different types of stakeholders mentioned above and the broad geographical scope of Europe, the required amount may well be above several hundred individuals. Before committing to such an exercise, it may be wise to start off with what could be called a 'pilot study': to see whether a foresight exercise would be feasible and interesting to the different stakeholders and whether the parties involved would remain interested.

5.5 Setting-up a foresight scenario mechanism at the European level

The previous section provided a number of general technical issues that should be addressed in order to conduct a foresight on e-skills. This section proposes a number of steps for the setting up and implementation of a foresight mechanism.

These steps are:

- Providing overall objectives and context
- Choosing the focus of the foresight
- Determining the scope of the foresight
- Setting a time horizon
- Developing the foresight
- Ensuring commitment of stakeholders

5.5.1 Providing overall objectives and context

While there have been a number of foresight exercises focused on future developments related to information society technologies, the specific focus on e-skills development has mostly been lacking or undervalued. The overall objective of this foresight exercise should

be to develop a vision or visions on the development of IST and the implications for future skills requirements for e-business and ICT practitioners in Europe. Therefore, it will address e-skills related issues that will be affected by broader developments in the domain of IST.

A foresight on e-skills in Europe would bring together stakeholders in order to develop insights in the future of e-skills requirements, in a systematic manner. It would provide a broad forum for identifying future visions for e-skills, compare national approaches and viewpoints, and make concrete suggestions to policymakers at both national and EU level.

The outcome of the foresight should be directed to:

- facilitating the planning and developing of skills required by business;
- providing priorities in the investment in education and training;
- improving the cooperation between public and private actors, at international, national, and regional levels, and across domains of employment, education, and business.

Emphasise the European dimension in this exercise

Slightly less than half of the studies that we identified had a focus that crossed national boundaries. Most often these studies had a much broader focus than just e-skills development. A European foresight exercise will have to demonstrate its value added to more nationally oriented foresights by stressing the European dimension of the skills issues and by focusing the exercise on how policy actions at the EU-level can be initiated (and perhaps adopted by national member states subsequently). A European foresight can also help to provide overviews of the relative strengths and weaknesses of individual countries in meeting demand or (benchmark progress in European e-skills development in a global context.

5.5.2 Choosing the focus of the foresight

Need for focus

One of the first steps in the process of setting up a foresight on e-skills is to determine what its focus should be. A foresight exercise on e-skills development will have to face the challenges created by the complexity of the types of stakeholders associated to it. The levels of governance involved (from local to international), the various domains to which the issues are related (e.g., business, education, employment), and the mix of public and private sector actors that have an interest, create this complexity. In the assessment of the current situation presented in the earlier sections of this report, a large set of issues was already addressed that affect the needs of the various stakeholders mentioned (e.g., differences between developments in various industry sectors, the potential of increasing the share of women with e-skills in the labour force, the effects of offshoring on the demand and supply of e-skills, etc.). To decrease the complexity, a specific focus should be provided for this initial foresight exercise.

Selection criteria

The criteria that should be applied for the selection of this focus are:

- There is a current lack of understanding of certain broader developments related to e-skills;
- There is a considerable level of uncertainty about what factors are affecting developments in the future;
- There is a value added to conduct the issues at a European level, for instance, by providing an opportunity to benchmark various strategic and policy directions and to create transnational learning potential for policymakers.

Offshoring or a broader development such as the internationalisation of ICT may be good examples of these issues. Also, the significance of e-business and the required skills to conduct e-business is a topic that seems to meet the selection criteria.

The definitions of e-skills and the occupations (e.g., ICT practitioners) that will be affected in the future are at the same time too narrow and too broad to become a topic of a foresight. They are too narrow in the sense that they may be such fundamental changes related to ICT that a focus on e-skills specifically may not capture these (e.g., internationalisation of ICT, or convergence of technology). At the same time, scenarios focused on ICT practitioners may miss important underlying issues of certain target groups (such as women, older professionals, certain skills groups).

Nature of the effort

Foresight efforts can be potentially expansive and expensive. In addition to the thoroughness of the analysis and the developments considered (most likely expressed in the duration of the foresight), the geographical scope and the potential recurrence of a foresight activity will strongly determine the nature of the effort. There are a number of directions that can be considered:

- A unique Pan European foresight study focused on potential policy interventions;
- Tailored approaches to regional and specific countries but with an overarching architecture that provides consistent definitions and methodologies enabling broader analysis;
- An approach stressing the overall European position in comparison to other major countries or regions.

Additionally, specific sectoral approaches can be applied to all these directions.

We would propose an initial pilot-oriented approach covering a limited number of countries. The foresight should start out as a moderate effort that could be upscaled and repeated once successful, e.g. a pilot foresight study in four countries (where the issue of e-skills is prominent). These countries do not necessarily have to be representative of the entire EU but should take account of differences in size, location and political system (involvement of stakeholders) to provide sufficient flavour of potential intervening factors. The benefit of a smaller scale effort is to create familiarity with the foresight mechanism for

the larger e-skills community and insight in the possibility to link outcomes to the policy process.

5.5.3 Determining the scope of a foresight

An outside-in approach

Despite the need for a focus on an e-skill related issue, a foresight exercise has to be broad in scope almost by definition. More importantly, the emphasis of the entire exercise would have to take a much broader perspective than solely anticipating what future (demand of) e-skills would be based on economic, social, or technological developments. Such an inside-out approach will undoubtedly fail to capture all the factors that affect the demand for e-skills in the future.

In principle, the main starting point should be: what e-skills should be available or will likely be demanded in the mid to long-term future. An outside-in approach like this would provide much more valuable insight by identifying all factors that are related to e-skills developments in that future.

A foresight study on e-skill developments is to expand on the knowledge that has been developed by other related studies and, subsequently, should apply this knowledge in the context of ICT & work and ICT & society. In the first instance, this may not be directly addressing (e-)skills development but broadens the issue so that this may lead to additional insights that may not be found when focusing narrowly on skills.

Factors/dimensions to be considered

As indicated, a number of broader scenario and foresight studies have already identified the driving elements of the developments of IST, albeit not often with the focus on how that will affect the future demand of skills. These driving elements can be classified in a number of groups:

- Science & technology factors: the convergence of technology, the rise of ambient technology, developments of hardware and middleware, infrastructure, improved human-machine interfaces, and new applications or work methods evolving from this;
- Economic factors: internationalisation of ICT and globalisation of the economy, emergence of countries such as India, Russia, Brazil, and China affecting the competitive position of Europe, overall economic growth, changing business models;
- Demographic factors: growth of world populations, decline and diversification of European working populations (e.g., flexibility of workforce, ageing of workforce, composition of workforce, female share of the workforce);
- Social factors: acceptance of the use of new technologies (privacy and security related), need for new products and services, increasing mobility of people, increasing importance of life-long learning (LLL);
- Political factors: governance, e-democracy/demands for transparency of public decision-making processes; public resources available, new possibilities of raising revenues on a consumption basis through the use of ICT.

Subsequently, these broad developments should be analysed to determine the following set of questions:

- What consequences do these developments have on jobs that depend on ICT?
- What are consequences for skill requirements?

5.5.4 Setting the time horizon

While foresight exercises could possibly consider developments in a 50-year time period, the heavy emphasis on ICT developments and the expectations of the continuous dynamics in that domain requires a relatively shorter time horizon, perhaps even between five and ten years. However, a longer-term vision facilitates the departure of thinking about e-skills in terms of current problems, technologies, and possible solutions. Taking these two possibilities in consideration, we propose a time horizon of ten years.

5.5.5 Developing the foresight study

The foresight study should make use of scenario development that builds on existing scenario exercises (such as ISTAG, foresights documented by FISTERA). In preparation of the scenario developments, insights in additional IST-related developments and potential effects on skills development would need to be further investigated. Thus, in developing the foresight study, there need to be two types of workshops: preparatory workshops and scenario workshops.

Preparatory workshops

Workshops should be held at different locations in Europe to identify drivers of change for ICT-skills and e-business skills (such as technological progress, economic growth linked to growth of the ICT industry, uptake of ICT in industry, skills lifecycles, industry requirements, education system, applications in the market), answering questions such as:

- What developments determine the direction of e-skills requirements?
- How certain are these developments?
- Which skills will become more important in the future?

The outcomes of the workshops can then be utilised for scenario building.

Scenario development & scenario workshops

Next is the development of scenarios that combine quantitative information (forecasts that may be based on a trend analysis or economic growth approach augmented with findings based on (stakeholders') survey) with qualitative information (possible changes in driving factors, selection of specific focal points based on the main topics).

Scenario workshops should be organised at different locations in Europe to engage with stakeholders and address the main topics of interest or issues of concern. Such scenario workshops allow targeting certain groups such as women or older professionals. The aim of the scenario workshops would be to articulate policy responses that could be implemented at both European and national level.

5.5.6 Ensuring commitment of stakeholders

A large and possibly continuous exercise would not only entail a significant amount of funding, but it would also be challenging in terms of keeping the required stakeholders involved in the process. Therefore, apart from a 'looking into the future' exercise, a community should be built and fed with incentives to stay involved.

Formulate the problems, objectives, scope of the exercise and the anticipated results (and timing thereof)

In general terms, this would consist of the following steps.

- Define problems in quantifiable terms
- What are current policy objectives that will be addressed by the foresight?
- Connect objectives to positions and expectation
- Formulate a single-sentence missions statement to guide the formulation of objectives to ensure what the importance of the foresight exercise is
- Formulate outcome objectives in relation to a specific (high-priority) policy area
- Ensure the added value of a **European** initiative

A possible mission statement could be formulated as follows:

> *To assist European policy makers and professionals to identify future needs with regard to changing professional skills and new job profiles (due to impact of broader social, technological, economic and political developments) by providing a roadmap that will help anticipate upon the required response in terms of changes to the education system, training practices and human resource strategies.*

The outcome objectives are very much dependent by the group of stakeholders that is involved. From an employment perspective, a foresight exercise should create understanding about issues in order to improve and plan for the development of career paths, employability, the mobility of labour, and in education and training. From a more specific business perspective, the exercise should shed light on future market requirements for e-business and ICT practitioners, the role of certifications, ways to facilitate the continuous improvement and adapting of (e-)skills of the workforce. Finally, the implications for the education system need to be laid out and should focus on the structural changes that would need to occur to adapt the system to changing skills and knowledge requirements and to provide appropriate ICT training.

Identify a core group of industry, policymakers, civil society, foresight planners

- Use national, regional, and sectoral brokers to cover geographical, functional differences
- Identify positions and expectations of these groups

Based on activities with comparable methods or aims (e.g., the UK Foresight, which is clearly much broader in scope, or a European activity that is more focused, such as the

TrendChart on Innovation) it is necessary to balance the different interests of ambition, scale and sustainability.

In order to establish this balance, one should differentiate between a 'core group' of experts and the broader interested stakeholders: the core group should consist of a highly dedicated group of strategic thinkers who set out the direction of the foresight in terms of content, it should also include the project team that does the actual work; the broader group would not necessarily be involved in all activities, but may attend periodic, regional meetings or scenario workshops, based on a special interest.

In addition, a basis should be provided for building a network, such as a who-is-who directory, a common repository of data and reports, regular news provision, periodic activities that focus around topics of interest (the workshops of the Trendchart on Innovation provide good examples of such topical workshops).

Finally, a knowledge base to support the network can be established by commissioning research activities that are targeted to specific topics such as ICT skills requirements in a specific sector or educational activities at a certain level of training.

Assess at what stage of the foresight stakeholders should be involved and how

There are various mechanisms to involve stakeholders and experts. The next section will focus on the establishment of a sizable and sustainable network of experts. There are additional ways of soliciting the input of these stakeholders, which could be brought together through workshops and focus groups, Delphi studies, interviews. These will be dependent on the operational design of the foresight exercise.

A foresight would be **sustainable** in the case that stakeholders are and remain involved in the activity. This can be achieved through regular information provision and holding events/workshops.

5.6 Establishment of a network of experts

The European e-Skills Forum 2004 conference declaration reached consensus that the European Commission should support the development of e-skills foresight scenarios in cooperation notably with industry, OECD and Cedefop, *as well as* the establishment of a European network of experts. This section of the report provides a concrete proposal for the establishment of such a network including the elements of a business plan indicating how such a network could be sustainable and scalable. This network of experts would serve as a knowledge base for the foresight activities as described above (which also involves a much larger set of stakeholders) and for e-skills related developments in general.

Purpose

The establishment of a more or less permanent network of experts attempts to systematically structure the activities in the field of e-skills and the continuous interaction about the results of these activities and to raise awareness of these findings in a broader environment. The purpose of a network of experts in the field of e-skills would be twofold.

1. The network would provide direct substantive support and guidance to the process of the foresight on e-skills and to provide expertise and credibility to the

activities to be conducted, and the resulting outcomes. In addition, it should reflect on the (substantive) progress of the foresight exercise.

2. The network would have to build capacity for the identification, evaluation and development of e-skills related research, studies and plans by exchanging information, sharing of analysis of ongoing research, and the facilitation of cooperation with other countries (e.g., the US) and other experts in related areas (such as e-business, e-learning). The exchange of information should be conducted among the members, with representatives of the European Commission, and the wider research and policy community. In addition, it should contribute to identifying main areas for research and training.

As such, it would have both a longer-term perspective as well as serve a direct feedback function for the ongoing foresight developments. The perspective on the latter function would be dependent on the feasibility of setting up a structural foresight mechanism.

Scope

The network of experts should focus on e-skills development and all related issues (varying from such issues as skills training and certification to gender to offshoring) as they affect competitiveness, employment, and education from a quantitative and qualitative point of view. In addition to the foresight activities, it should cover work in the private and public sector.

These experts should be very familiar with or represent different communities involved in the setting up and conduct of foresight on e-skills development in Europe. They should be able to recognise the importance of the issues addressed by the project, and keen to take the recommendations forward. At the same time, the network should be responsive to requests for support and effective in its contributions to further the development of the foresight activities. As such, it should be scalable and sustainable.

Size and composition

The network should consist of a maximum of 12-15 people. Such a size enables the most effective exchange of information while at the same time covering the variety of issues for which expertise may be required. Alternatively, a smaller group may be formed which would engage with additional experts based on the need for additional knowledge and expertise in a committee structure (under the leadership of one permanent network member). This configuration could enhance the dynamics and responsiveness of the network as a whole while at the same time being able to tap into sufficient knowledge bases. A disadvantage may be the lack of committed availability of the additional experts.

Researchers and academics specialising in the field of e-skills should constitute the large majority of the experts in the network. These researchers should have various disciplinary backgrounds (economics, sociology, science & engineering, statistics, public administration) and focus on the various dimensions related to e-skills (such as skills and work, skills and education, skills and innovation, skills and society). In addition, analysts with an experience base in relevant economic sectors as well as public administration should also be part of the network, albeit limited to less than one third to avoid potential overlap with the function of the European e-Skills Forum. Finally, the members should represent various geographic regions within the European Union.

In addition to these direct members of the networks, the nomination of various points of contacts in international governmental and non-governmental organisations and industry associations should be stimulated to liaise with this network.

Operations

The network of experts should formally meet in person approximately once every four months. Such a frequency will give enough opportunities to interact and will provide sufficient continuity to make the effort sustainable. Undoubtedly, there will be additional occasion where parts of the network come together, for instance related to the conduct of the foresight.

In addition to the physical meetings, there should be a digital platform for communication that could develop into a virtual community. This could be tied to similar initiatives, for instance, Cedefop's European Training Village. The web site should contain a discussion space for the members.

On an annual basis, the network should develop a plan of activity as well as a financial plan. This plan of activity should consist of priority fields to be examined, specific actions to be carried out to meet the objectives set, and should contain a dissemination plan. This dissemination plan should include the structure of the web site.

Support

The activities of the network of experts should be supported by a secretariat. The secretariat should have both a preparatory role (drafting of plans, agenda, website) as well as a pure organising role (convening meetings, organising conferences, collation of information

Costs

We foresee the following categories for which resources are required:

Remuneration of experts Based on a average membership of 15, involvement of 10 days per year @ 600	€ 90.000
Additional expenses of experts Travel Per diem	€ 45.000 €36.000 €9.000
Infrastructural and operational costs (web site, communication s, facilities)	€ 30.000
Organisation of events	€ 50.000
Costs of secretariat (2 x 0.2 FTE, including overhead)	€ 80.000

Evaluation

The network of experts should be evaluated at a regular basis on how it is meeting its objectives. In order to conduct a proper evaluation, the network in collaboration with its client and financier should develop indicators (e.g., identification of studies, progress in indicator development, number of interactions) along which it can be effectively and efficiently evaluated. For an adequate evaluation such a list should be developed at the start of the operations of the network). A first interim evaluation should take place after two years of operation.

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For references on national reports see Appendix H.

APPENDICES

Appendix A: OECD definitions of skilled employment

Narrow definition: IT specialists or practitioners group, using the occupations previously used in OECD publications (ISCO88 categories)

213: Computing professionals

312: Computer associate professionals

313: Optical and electronic equipment operators

724: Electrical and electronic equipment mechanics and fitters

Broad definition: attempt to capture those classified as IT specialists, as well as those who can be considered as sector specific users and generic users (ISCO88 categories)

121: Directors and chief executives

122: Production and operations managers

123: Other specialist managers

211: Physicists, chemists, and related professionals

212: Mathematicians, statisticians and related professionals

214: Architects, engineers, and related professionals

241: Business professionals

242: Legal professionals

243: Archivists, librarians, and related information professionals

341: Finance and sales associate professionals

342: Business services agents and trade brokers

343: Administrative associate professionals

411: Secretaries and keyboard-operating clerks

412: Numerical clerks

Appendix B: e-Skills reference framework

The framework suggested by Cedefop (2004) attempts to correspond the ISCO 88 skill levels and ISCED 97 education levels as well as the latest level definition of the 'Directive of the European Parliament and of the Council on the recognition of professional qualifications' (EC 2004, Article 11).

<table>
<tr><th colspan="5">Europe</th></tr>
<tr><th colspan="2">ICT skill level</th><th>Correspondence</th><th colspan="2">ICT qualification level</th></tr>
<tr><td rowspan="2">ISCO 88 level</td><td>Skill level 6 (work)</td><td rowspan="8">Skill level
corresponding to
qualification level

Overall orientation:
International
ISCO 1988 - ISCED 1997
Europe
ISCO (COM) 1990 - EC 2004</td><td>Qualification level 5M (MA/SCD)</td><td rowspan="2">EC 2004 level D</td></tr>
<tr><td rowspan="2">ISCO 88 level 4</td><td>Skill level 5 (work)</td><td>Qualification level 5B (BA/FCD)</td></tr>
<tr><td rowspan="2">ISCO 88 level 3</td><td>Skill level 4 (work)</td><td>Qualification level 4 (VET)</td><td rowspan="2">EC 2004 level C</td></tr>
<tr><td>Skill level 3 (work)</td><td>Qualification level 3 (VET)</td></tr>
<tr><td rowspan="2">ISCO 88 level 2</td><td>Skill level 2 (work)</td><td>Qualification level 2 (VET)</td><td rowspan="2">EC 2004 level B</td></tr>
</table>

Appendix C: Persons contacted

The following **persons** were helpful in providing statistics, reports, suggestions for contacts, or information concerning the lack of data:

Person	Institute	Country
Burkart Sellin	Cedefop	
Franz Gramlinger	Cedefop	
Katja Nestler	Cedefop	
Filip Van Bel	Cisco	
Ana Franco	Eurostat - Labour Force Survey	
Birgitta Andrén	Eurostat - Education and Culture	
Christophe Demunter	Eurostat - ICT Household Survey	
Hartmut Buchow	Eurostat - ICT Enterprise Survey	
Heidi Seybert	Eurostat - ICT Enterprise Survey	
Jonny Johansson	Eurostat - Labour Force Survey	
Spyridon Pilos	Eurostat - Education and Culture	
Paul Lefrere	Microsoft EMEA	
Desiree Van Welsum	OECD	
Graham Vickery	OECD	
Karsten Gareis	Empirica	
Andreas Schiefer	Statistics Austria	AT
Els Somers	Statbel	BE
Hugo Lueders	CompTIA	BE
Jitka Krcilova	Directorate of eGovernment Projects	CZ
Zdenka Strnadlova	Czech Statistical Office	CZ
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Susanne Schnorr-Baecker	Destatis	DE

Jens Storm	Ministry of Science, Technology and Innovation	DK
Aime Lauk	Statistical Office of Estonia	EE
Jaan Oruaas	NeDap	EE
Jimena Acedo Batalla	Ministry of Industry, Tourism and Commerce	ES
Jean-Claude Burgelman	IPTS	EU
Anneli Manninen	Technology Industries of Finland	FI
Jouni Kangasniemi	Finnish ministry of Education	FI
Parjo Lea	Statistics Finland	FI
Veli-pekka Niitamo	Nokia	FI
Roula Salappa	National Statistical Service of Greece	GR
Thomas Carroll	Central Statistics Office	IE
Franco Patini	Federcomin	IT
Valentina Samiene	Statistics Lithuania	LT
Linda Szelest	Centre de Recherche Public Henri Tudor	LU
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Jacek Tchorzewski/Artur Satora	GUS (Polish Statistical Office)	PL
Sandra Lameira	Institute for Quality in Training	PT
Max Kesselberg	Ministry of Education	SE
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Vladimir Cicmanec	Statistics Slovakia	SK
Jonathan Cook	Statistics UK	UK
Marianne Kolding	IDC	UK

Terry Watts	e-skills UK	UK
Bob Cohen	ITAA	US
Catherine Freeman	U.S. Department of Education	US
Craig Symons	Forrester Research	US
Diane Morello	Gartner	US
Kimberly Riley	Bureau of Labour Statistics	US
Janeka Sanders	Bureau of Labour Statistics	US

The following **organisations** have performed future-oriented studies:

Organisation	**Country**
Career-Space	
CEPIS	
EMCC European Monitoring Centre on Change	
IPTS – Fistera	
biat - Berufsbildungsinstitut Arbeit und Technik	DE
IAMSR/Åbo Akademi	FI
Forfás	IE
ABBL	LU
clc	LU
FEDIL	LU
Nederland-ICT	NL
e-skills UK	UK
ITAA	US

RAND EUROPE STUDY
ON 'DEMAND AND SUPPLY FOR E-SKILLS IN EUROPE'
PRESENTATION AND DISCUSSION OF THE INTERIM REPORT
5 April 2005

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e-SKILLS: FACTS, FIGURES AND FORESIGHT SCENARIOS
EXPERTS WORKSHOP / TESSALONIKI
23 - 24 June 2005

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Appendix D: Statistical Reliability Limits for EU LFS data EU 25 Aggregates (1) Year	A
1998	89500
1999	89500
2000	93000
2001	86500
2002	86500
2003	90000
2004	92000

(1) For 1998-2003 the EU 25 aggregates 'A' limits are computed as the sum of the country 'A' limits applicable each year.

Member States	A	B
Belgium	2500	4500
Czech Republic	1000	-
Denmark (5)	3500	7500
Germany	8000	-
Estonia (4)	5000	10000
Greece	2500	4500
Spain	2500	5000
France (6)	7000	21000
Ireland	2500	4500
Italy	3500	7500
Cyprus	500	1500
Latvia (4)	4500	7500
Lithuania	5000	-
Luxembourg	500	1500
Hungary	2500	4500
Malta	1500	3000
Netherlands (2)	4500	10000
Austria (8)	4000	8000
Poland	5000	20000
Portugal	7500	15000
Slovenia	1000	10500
Slovak Republic	2500	4500
Finland	2500	4500
Sweden (3)	2500	-
United Kingdom	10000	-

(2) Restrictions for wave specific variables: A:10000 & B:20000.

(3) The Limits applicable to 1995-2000 data are: for Sweden, A:9000 & B:- / for EU-15, A:63500 & B:-.

(4) The Limits applicable to 1997-1999 data for Estonia are: A:4000 & B:8000 (1997), A:1500 & B:3000 (1998-1999). The Limits applicable to data prior to 1998-2001 for Latvia are: A:2500 B:4500.

(5) The limits applicable to 1983-1993 data for Denmark are: A:2500 B:4500.

(6) The limits applicable to 1983-2002 data for France are: A:3500 B:8500.

(7) The limits applicable to 1996-2001 data for Switzerland are: A:3000 B:10000.

(8) The limits applicable to 1995-2003 data for Austria are: A:2000 (no B limit).

Figures less than those in column A above, should not be published; By convention, a dot or full stop is used instead. When applicable, figures less than those given in column B but greater than those in column A, should be printed only with a warning concerning their reliability.

Appendix E: Defining Professional E-skills by 2000 SOC

The table below illustrates how OECD's (2004) definition of professional e-skilled occupations by 1990 Census codes was translated into 2000 SOC codes.

1990 Census codes crosswalk to 2000 SOC codes, via 2000 Census codes

1990 Census codes	2000 Census codes	2000 SOC codes
55	030	11-9041
	102	15-1030
	111	15-1081
	140	17-2061
	141	17-2070
	153	17-2199
	290	27-4010
64	011	11-3021
	071	13-1111
	100	15-1011, 15-1051, 15-1099
	101	15-1021
	102	15-1030
	104	15-1041
	106	15-1061
	110	15-1071
	111	15-1081
	140	17-2061
65	070	13-1081
	100	15-1011, 15-1051, 15-1099
	122	15-2031
213	100	15-1011, 15-1051, 15-1099
	155	17-3020
	286	27-3090
	743	49-9060
229	101	15-1021
233	790	51-4010
304	500	43-1011
308	580	43-9011
309	580	43-9011
	590	43-9071
523	290	27-4010
	635	47-2111
	701	49-2011
	702	49-2020
	703	49-2091
	710	49-2094, 49-2095
	711	49-2096
	712	49-2097
	713	49-2098
	742	49-9052
525	701	49-2011
527	741	49-9051
	742	49-9052
529	702	49-2020
	742	49-9052
683	772	51-2020
	773	51-2031
	775	51-2090

Source: U.S. Census Bureau, http://www.census.gov/hhes/www/ioindex/crosswalks.html

The table below presents the definition used in this study for ICT practitioner skills by the 2000 Standard Occupation Classification system.

Professional e-skills by 2000 SOC

	Occupation
1	11-3021 Computer and Information Systems Managers
2	11-9041 Engineering Managers
3	13-1081 Logisticians
4	13-1111 Management Analysts
5	15-1011 Computer and Information Scientists, Research
6	15-1021 Computer Programmers
7	15-1030 Computer Software Engineers
8	15-1041 Computer Support Specialists
9	15-1051 Computer Systems Analysts
10	15-1061 Database Administrators
11	15-1071 Network and computer Systems Administrators
12	15-1081 Network Systems and Data Communication Analysts
13	15-1099 Computer Specialists, All Other
14	15-2031 Operations Research Analysts
15	17-2061 Computer Hardware Engineers
16	17-2070 Electrical and Electronics Engineers
17	17-2199 Engineers, All Other
18	17-3020 Engineering Technicians, Except Drafters
19	27-3090 Miscellaneous Media and Communication Workers
20	27-4010 Broadcast and Sound Engineering Technicians and Radio Operators
21	43-1011 First-Line Supervisors/Managers of Office and Administrative Support Workers
22	43-9011 Computer Operators
23	43-9071 Office Machine Operators, Except Computer
24	47-2111 Electricians
25	49-2011 Computer, Automated Teller, and Office Machine Repairers
26	49-2020 Radio and Telecommunications Equipment Installers and Repairers
27	49-2091 Avionics Technicians
28	49-2094 Electrical and Electronics Repairers, Commercial and Industrial Equipment
29	49-2095 Electrical and Electronics Repairers, Powerhouse, Substation, and Relay
30	49-2096 Electronic Equipment Installers and Repairers, Motor Vehicles
31	49-2097 Electronic Home Entertainment Equipment Installers and Repairers
32	49-2098 Security and Fire Alarm Systems Installers
33	49-9051 Electrical Power-Line Installers and Repairers
34	49-9052 Telecommunications Line Installers and Repairers
35	49-9060 Precision Instrument and Equipment Repairers
36	51-2020 Electrical, Electronics, and Electromechanical Assemblers
37	51-2031 Engine and Other Machine Assemblers
38	51-2090 Miscellaneous Assemblers and Fabricators
39	51-4010 Computer Control Programmers and Operators

Appendix F: E-skilled Employment Data on the EU-level in 2004

Employment of "IT practitioners" (CEPIS 2002) and "ICT practitioners" (OECD 2004) by industry

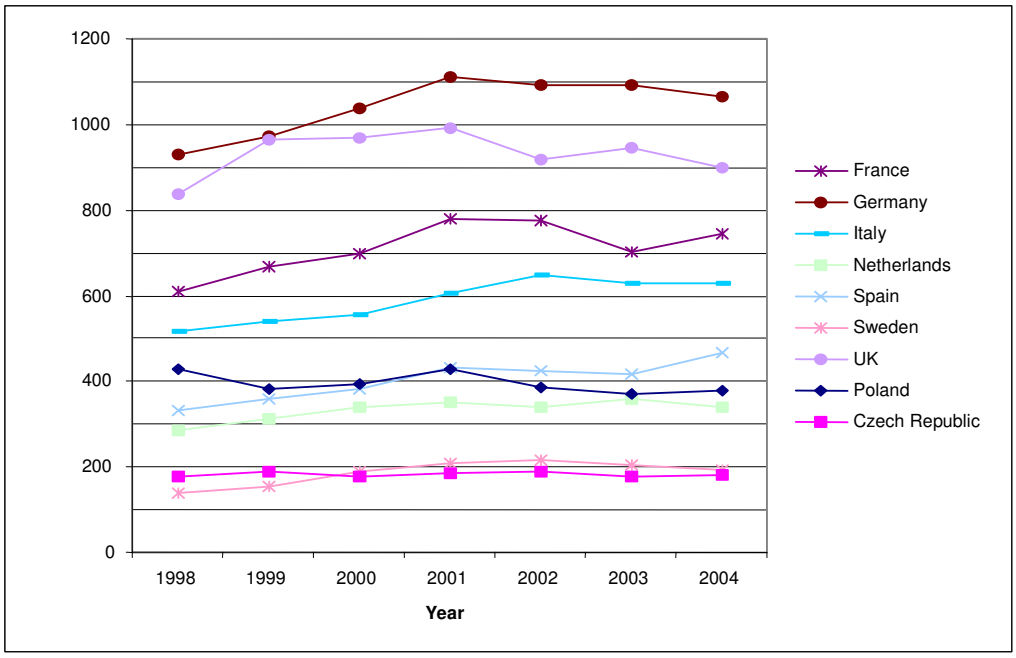
Sector / Occupation	NACE 72	NACE 74	NACE 75	NACE 65	NACE 64	NACE 80	NACE 51	Total major e-skills sectors	Other sectors	All Setors
ISCO 213	853.00804	118.29326	92.52767	99.47225	93.8187	38.92057	49.27911	1345.3196	537.74561	1883.06521
ISCO312	450.13086	71.29093	94.08615	50.22655	50.58561	54.93757	43.70306	814.96073	468.57201	1283.53274
Total e-skilled employment	1303.1389	189.58419	186.61382	149.6988	144.40431	93.85814	92.98217	2160.28033	1006.31762	3166.59795
Other employment	1122.32507	12322.044	13799.6855	2538.56978	3088.03433	11248.0483	5117.47476	49236.18173	125686.9854	189425.789
Total employment	2425.46397	12511.6281	13986.2993	2688.26858	3232.43864	11341.9065	5210.45693	51396.46206	126693.303	192592.387

Sector / Occupation	NACE 72	NACE 45	NACE 74	NACE 64	NACE 52	NACE 75	NACE 40	Total major e-skills sectors	Other sectors	All Sectors
ISCO 213	853.00804	19.46592	118.29326	93.8187	34.68078	92.52767	18.03324	1229.82761	653.2376	1883.06521
ISCO 312	450.13086	16.06664	71.29093	50.58561	43.15676	94.08615	16.48495	741.8019	541.73084	1283.53274
ISCO 313	4.81412	2.16178	132.59129	27.77271	15.20392	12.27408	0.1159	194.9338	314.66493	509.59873
ISCO 724	52.88097	347.9442	42.51267	169.80195	180.61791	52.48042	187.84628	1034.0844	1164.67596	2198.76036
Total e-skilled employment	1360.83399	385.63854	364.68815	341.97897	273.65937	251.36832	222.48037	3200.64771	2674.30933	5874.95704
Other employment	1064.62998	14506.8845	12146.94	2890.45967	17271.0591	13734.931	1083.53239	62698.43662	124018.9937	186717.43
Total employment	2425.46397	14892.523	12511.6281	3232.43864	17544.7185	13986.2993	1306.01276	65899.08433	126693.303	192592.387

Appendix G: National e-skilled employment

The figures in this appendix show the trends in e-skilled employment by country between 1998 and 2004. The Member States are divided into two groups defined by the number of people employed in "ICT-specialists" occupations. Countries with more than 150 000 people employed in "ICT practitioners" occupation belong to the first group and countries with less than that to the second group. The division is made due to layout purposes.

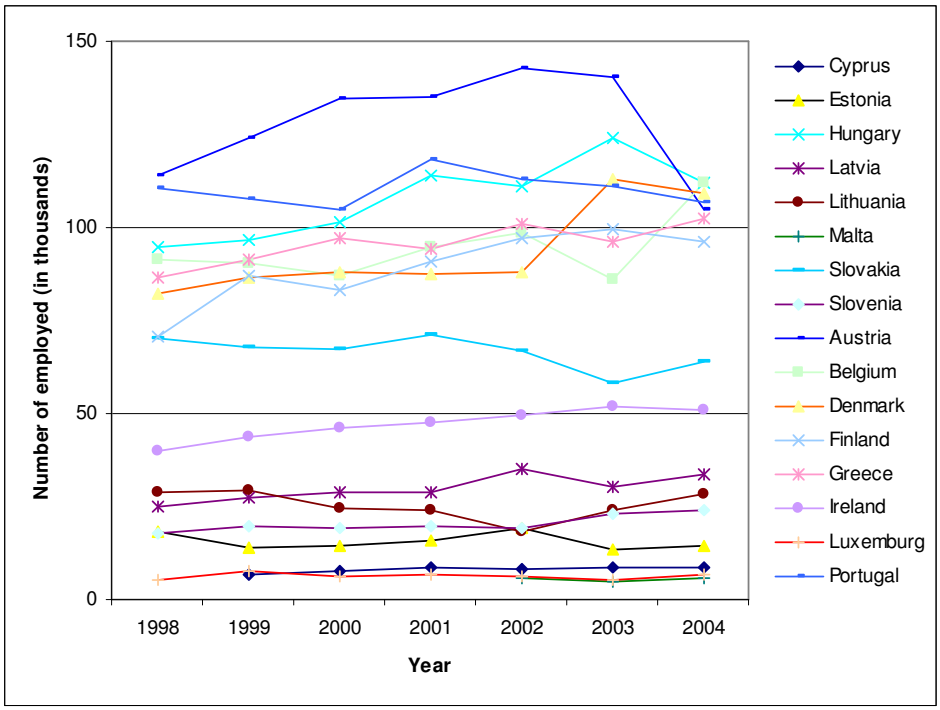
National employment of "ICT practitioners", Group 1



Source: EU LFS Q2 for1998-2004

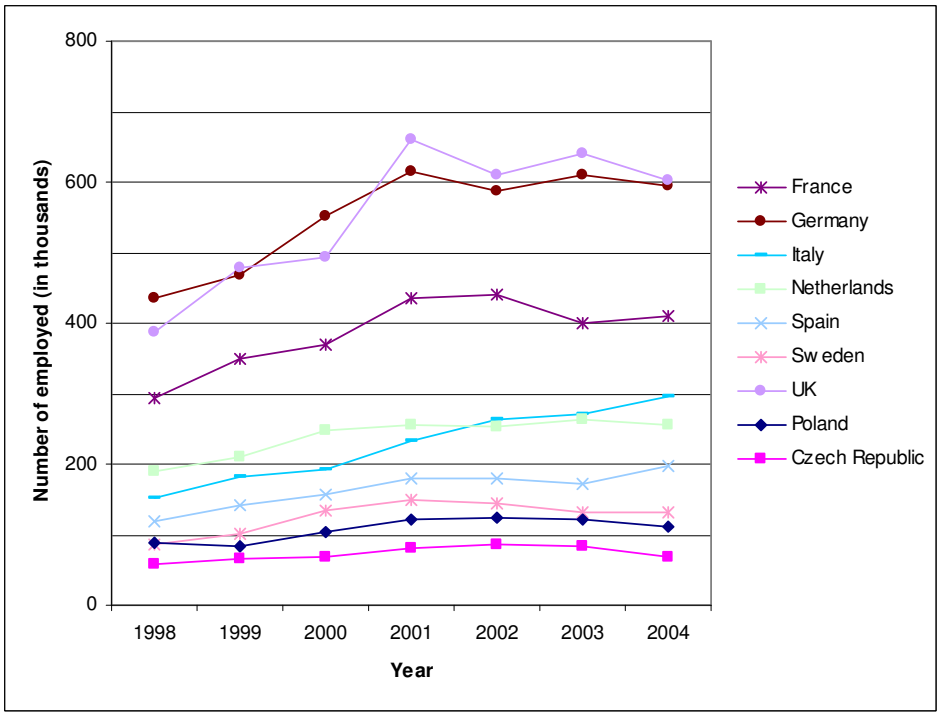
Note: The numbers are statistically reliable according to the Eurostat's limits applicable for each country, see Appendix D. The figures for the Netherlands in 2004 are provisional.

National employment of "ICT practitioners", Group 2



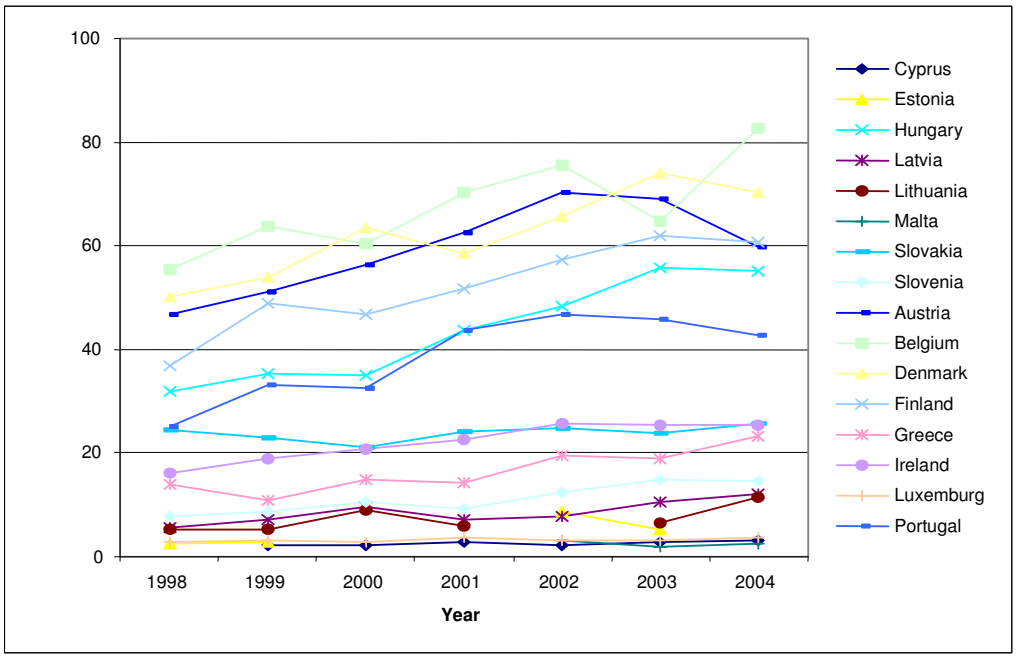
Source: EU LFS Q2 for1998-2004
Note: The numbers are statistically reliable according to the Eurostat's limits applicable for each country, see Appendix D.

National employment of "IT practitioners", Group 1



Source: EU LFS Q2 for1998-2004
Note: The numbers are statistically reliable according to the Eurostat's limits applicable for each country, see Appendix D. The figures for the Netherlands in 2004 are provisional.

National employment of "IT practitioners", Group 2



Source: EU LFS Q2 for1998-2004

Note: Most numbers are statistically reliable according to the Eurostat's limits applicable for each country, see Appendix D. The figures for Estonia in 1998,1999, 2002 and 2003, Latvia in 1998, 1999 and 2001 and Slovenia in 1998-2001, should be interpreted with caution.

Appendix H: Overview of country specific data sources

Data by Member State

Country	Data	Source	Year	Usefulness	Remarks
Austria	"IKT-Einsatz in Haushaluten"	Statistic Austria	2003	Does not contain relevant data, focuses on basic user skills	-
Belgium	"ICT-bevraging 2003-2004 "	Ministry of the Flemish Community Education Department – Information and communication technology in Education	2005	Does not contain relevant data, focuses on ICT-skills in schools.	The national statistical office has informed us that they have not done any work in the domain of ICT practitioner skills.
Cyprus	No information	-	-	-	-
Czech Republic	"Závěrečná zpráva o pokroku eEurope+2003 – únor 2004"	Czech Statistical Office	2004	Does not contain relevant data, focuses on usage and diffusion of ICT, not on skills.	The data used in this report has been sent to us in raw form from the statistical office.
	"Information Society Statistics"	Czech Statistical Office	2003	Does not contain any statistical data, gives an overview of what IS statistics is collected by the national statistical office.	Ministry of informatics is conducting research of e-skills in the Czech Republic. The new report, considering the research and development of e-skills in the last year, will be available in April.
Denmark	"Information Society Denmark – Status 2004"	Ministry of Science, Technology and Innovation together with Statistics Denmark	2004	Useful	-

cont. Data by Member State

Country	Data	Source	Year	Usefulness	Remarks
Estonia	"The survey on ICT in enterprises"	Statistical Office of Estonia	2003	Does not contain relevant data, focuses on usage and diffusion.	Sources indicate that not much have been done in the domain lately. A report from political research centre PRAXIS on IT high and vocational education situation will be published in April.
	Dataset - Computer science admittance in higher education	Statistical Office of Estonia	1994-2004	Useful	
	Dataset – Computing graduates in higher education	Statistical Office of Estonia	1994-2004	Useful	
Finland	"Tekniikan Alan Korkeakoulutuksen Kehitysnäkymät"	Ministry of Education	2002	Does not contain any statistical data, focuses on how to develop IT education system.	The national statistical office collects data on basic ICT skills and user-skills in enterprises in line with Eurostat model survey by the IS unit.
	"Teknillistieteellisen koulutuksen mahdollinen laajentaminen Keksi-Suomessa ja Pohjois-Savossa"	Ministry of Education	2004	Information only available in Finish.	
France	No info	-	-	-	-
Germany	"IKT in Deutschland, Informations- und Kommunikationstechnologien 1995- 2003"	Federal Statistical Office Germany	2004	Useful	The statistical office does only collect education data and no data on ICT professions due to lack of a generally accepted definition in terms of statistics for the latter.
	"Bestand sowie Bedarf und Angebot an IT-Fachkräften"	Biat and BIBB	2001	Does not reflect current status, data to old.	
	"Daten zur Informations-gesellschaft 2005"	BITKOM	2005	Useful	
Greece	No info	-	-	-	The National Statistical Service of Greece referred to Eurostat
Hungary	No info	-	-	-	-
Ireland	"Information Society Statisitcs – Ireland 2004"	Central Statistics Office	2004	Does not contain relevant information, focuses on usage and ICT industry contribution.	-
	"The 4th report of the Expert Group of Future Skills Needs"	Expert Group on Future Skills Needs, Forfás	2003	To the point in terms of domain, however, does not reflect current situation but presents forecast estimates.	

cont. Data by Member State

Country	Data	Source	Year	Usefulness	Remarks
Italy	"ICT un mondo di competenze "	An@sin and Federcomin	2003	Information only available in Italian	-
Latvia	"What kind of ICT Education do we need?"	Riga Information Technology Institute, published in Baltic IT&T review #34	2004	Useful	-
	"Information and communication technology – Country profile Latvia"	ITC	2003	Useful	
	"The Baltics as a Business Location for Information Technology and Electronics Industries"	VTT Technology Studies	2002	Does not reflect current situation, data too old.	
	"Competencies Potential in the ICT Sector of Latvia"	Latvian Information Technology and Telecommunication Association - LITTA	2004	Useful	
Lithuania	No info	-	-	-	-
Luxembourg	"Les qualifications de demain dans les domaine des technologies de l'information et de la communication"	clc, ABBL and Fedil	2004	Useful	-
Malta	No info	-	-	-	-
Netherlands	"ICT Marktmonitor 2002-2003"	Nederland-ICT	2003	Useful	-
Poland	No info	-	-	-	-
Portugal	Report on Portuguese ICT professional profiles	Instituto para a Qualidade na Formação		Information only available in Portuguese	-
Slovakia	Dataset – ICT in Enterprises	Statistical Office of Slovakia	2002-2003	Does not contain relevant data, focuses on usage and diffusion	-
	Dataset – ICT in Households	Statistical Office of Slovakia	2002-2003	Does not contain relevant data, focuses on usage and diffusion	
Slovenia	No info	-	-	-	-

cont. Data by Member State

Country	Data	Source	Year	Usefulness	Remarks
Spain	"Propuesta de Acciones para la Formacion de Profesionales de Electronica, Informatica y Telecomunicaciones para las empresas del Sector" PAFET 1		2001	Does not reflect current situation, data too old.	-
	"Evolución de los perfiles tic en la sociedad del conocimiento" PAFET 2		2002	Does not reflect current situation, data too old.	
	"Nuevos perfiles profesionales TIC en los sectors usuarios" PAFET 3		2004	Focuses on the content of the work of ICT professionals and not demand /supply aspects.	
Sweden	"Arbetskraftsbarometer 2004"	Statistics Sweden	2004	Useful	-
	"IKT Utbildning efter bubblan – tillgång, tillskott, efterfrågan och behov"	National Agency for Higher Education	2004	Useful	
UK	"National Employers Skills Survey 2003: Key Findings"	Learning and Skills Council	2003	Does not contain relevant data, has a too general approach	-
	"IT Insights: Employment Forecasts"	e-skills UK	2004	Does not reflect current situation, forecast oriented	
	"IT Insight: Employer Skills Needs"	e-skills UK	2004	Useful	
	"IT Insight: Trends an UK skills Implications"	e-skills UK	2004	Does not reflect current situation, forecast oriented	

Appendix I: Framework of reviewed studies

Reviewed studies

Initiative	By whom?	Who/what is assessed?	By which methods?	Using what data?	When?	Remarks
ICT en arbeid (2005) [ICT and work] as indicated by Jos de Haan	SCP (Dutch social and cultural planning office)	ICT workers and their chances on the national job market	Social data analysis	Analysis of existing data	June 2005 (expected)	NL - The research plan is available, but not all data sources are mentioned as this is part of the project.
"Research and development of e-skills in 2004" as indicated by Ms Krcilova	Czech Ministry of Informatics	Research and development; e-skills in 2004	?	The collection of data about ICT is based on official statistics gathered from different statistical sources of the CZSO such as general enterprise statistics, sector specific statistics and foreign trade statistics.	April 2005 (expected)	CZ
Offshoring in de Nederlandse ICT [Offshoring in the Dutch ICT]	Raad voor Werk en Inkomen – Regioplan Beleids-onderzoek	Effects of offshoring for the Dutch economy and job market	Literature study, interviews, analysis of statistics	Forrester, ICT marktmonitor, CBS, CPB	February 2005	NL

cont. Reviewed studies

Initiative	By whom?	Who/what is assessed?	By which methods?	Using what data?	When?	Remarks
Daten zur Informations-gesellschaft 2005	BITKOM	Range of IT indicators including number of first-year students and employees in ICT sector	Analysis of statistics	EITO, Eurostat and Statistisches Bundesamt (Destatis) as well as other sources	2005	
Samenvatting Marktmonitor 2004-2005 [Summary of the Marktmonitor]	ICT Office	Number of statistics concerning IT including number of ICT professionals	Survey	Survey	2005	NL
IT Insights: employment forecasts (2004)	E-skills UK / Experian	IT industry employment, ICT professional employment forecasts	Analysis of several UK sources and modelling/forecasting on the basis of this data	National employers skills survey 2003, UK labour force survey, Annual Business Inquiry	November 2004	UK - Extensive research activity in UK consisting of 4 reports; this one is most relevant for supply/demand, others for future focus.
IKT in Deutschland 1995-2003 [ICT in Germany] – chapter 3	Statistisches Bundesamt	Students in ICT subjects Foreign ICT workers ICT patents ICT expenditure for education	Analysis of Destatis data	Eurostat and German statistical data	September 2004	DE
International comparison of occupational profiles in the eEconomy	STILE – Bollen, Huys & Ramioul	Practices of coding occupation in several European countries - assessment	Coding exercise	n/a	July 2004	Methodological research
FISTERA - The human resource factor in the information society future (2004)	Systems Research/Sami Mahroum	IT skill shortage, Employer satisfaction with ICT skills, Origin of S&T immigrants, Offshore attractiveness	Literature review	IDC 2002, Booz Allen Hamilton, European report on S&T indicators 2003, AT Kearney offshore attractiveness index 2004, OEDC, Eurostat	April 2004	Generally a summary of existing data

cont. Reviewed studies

Initiative	By whom?	Who/what is assessed?	By which methods?	Using what data?	When?	Remarks
Nuevos perfiles profesionales TIC en los sectores usuarios (2004) [New professional ICT profiles in the industrial sectors] PAFET 3	AETIC	Identification of professional ICT qualifications needed in the industrial sector as well as training needs	Survey among 646 ICT professionals and companies, 8 interviews with ICT professionals and panel discussion.	Own data with several other sources	March 2004	ES - This report is mainly focused on the content of the work of ICT professionals and not demand /supply aspects
Profiling occupations in the eEconomy	STILE – Bollen & Ramioul (eds.)	Practices of coding occupation in several European countries – project description	Coding exercise	n/a	February 2004	Methodological research
OECD – ICT skills and employment (2004)	OECD	ICT-skilled employment, per sector (ICT professionals narrow definition ISCO 213, 312, 313 and 724). Measuring shortages: education (ICT equipment in schools), training, vocational training. Outsourcing and foreign workers. Recruitment via internet.	Analysis of Eurostat and other data.	Eurostat LFS 2003, ISCO-88 and NACE (and sources for non-EU OECD countries).	2004	Overview of data available on ICT-skilled employment, based primarily on Eurostat LFS data and other non-OECD sources.
Les qualifications de demain [The qualitifications of tomorrow]	FEDIL – ABBL - CLC	Growth of employment per sector Outsourcing Number of ICT professionals per company per sector Required staff by function, education	Interviews with 265 enterprises on their future expectations for 2-3 years	Chambre de Commerce data	2004	LU – needs projections are approx 1/3 of the numbers from 2001

cont. Reviewed studies

Initiative	By whom?	Who/what is assessed?	By which methods?	Using what data?	When?	Remarks
Measuring the pulse of the IT industry (2004)	CompTIA	IT training market	Senior management survey of 200 organisations in 46 countries	Survey	2004	Training providers predict steady market growth in 2004; most important topics are: security, project management and soft skills/business skills
Adding value…growing careers (2004)	ITAA	IT employment and skills gap in USA	Survey among 500 IT managers of companies representative for the USA economy based on size, location, IT/non-IT company	ITAA survey 2004	2004	USA - Although the representativeness of the 500 informants is questionable, this exercise is consistently held over 7 years. NWCET job categories.
Towards a comprehensive European e-skills reference framework: ICT and e-business skills and training in Europe (2004)	Cedefop / Flensburg and York universities	Industry's ICT skills needs, Computer professionals and Associates (ISCO 213 and 312), comprehensive European skills framework, European framework of ICT qualifications, ICT curriculum development, policy recommendations	Analysis of data and comparison of different skills frameworks (SFIA, ISCO-88, Career Space and GAHFA) With focus on three industries: automotive, banking and graphic arts	Biat 2001, EUQuaSIT 2002, CEPIS 2002	2004	Supply and demand are not main focus, but a reason for addressing the differences in skills frameworks.
What kind of ICT education do we need? (Baltic IT&T Review)	Riga Information Technology Institute – Juris Borzovs	Number of ICT students enrolled and graduated ICT professional standards	Analysis of existing data with national statistics?	National statistics?	2004	LT - NeDap

cont. Reviewed studies

Initiative	By whom?	Who/what is assessed?	By which methods?	Using what data?	When?	Remarks
National Employers Skills Survey 2003: Key Findings	Learning and Skills Council - Institute for Employment Research and IFF Research Ltd	Hard-to-fill vacancies and skill-shortage vacancies in the UK for all sectors	Survey	Own data	2003-2004	UK - Computing sector has significantly less HtFV and SSV than other sectors
ICT practitioner skills and training solutions at sub-degree vocational level in Europe	Cedefop/biat - A. Willi Petersen and Carsten Wehmeyer	Qualitative and quantitative approach to skills needs	Analysis of existing data with additional questionnaires	CEPIS, EUQuasIT, biat 2001	July 2003	EU – though based on Germany, Netherlands and Portugal
Education and training for the Information Technology Workforce (2003)	US Department of Commerce	Identification of employers' needs, the IT education and training landscape, and the role of IT employers and workers to meet the skills needs	Analysis of data	US Dept of Commerce, US Dept of Labor, Bureau of Labor Statistics	June 2003	USA
Information Technology (IT) Employment: What is it? (2003)	WANE (Workforce Ageing in the New Economy)	Analysis of different classification schemes, with focus on IT industry (NAIC 54151) and highly skilled IT workers	Comparison of classifications NACE, SIC, ISIC, NAICS (Appendix B8) ISCO, SOC90, SOC2000, ANSIC, NSOCS, NOC SFIA	n/a	2003	CA – National Occupation Code has two advantages: 1)focus on high-skilled ICT professionals 2) possible use for international benchmarks
Determining the future demand for ICT skills in Europe – workshop proceedings (2003)	CEPIS	Provides an overview of different eSkills issues, initiatives etc.	Analysis of data, literature review and overview of initiatives	CEPIS 2002 and other data	2003	Stucky: different initiatives for different skill levels Dixon: Longitudinal LFS is very useful combined with forecasting

cont. Reviewed studies

Initiative	By whom?	Who/what is assessed?	By which methods?	Using what data?	When?	Remarks
2003 Workforce Survey (2003)	ITAA	IT employment and skills gap in USA	Survey among 500 IT managers of companies representative for the USA economy based on size, location, IT/non-IT company	ITAA survey 2003	2003	USA - Although the representativeness of the 500 informants is questionable, this exercise is consistently held over 7 years. NWCET job categories.
Evolución de los perfiles tic en la sociedad del conocimiento (2002) [Evolution of ICT profiles in the knowledge society] PAFET 2	AETIC	Qualitative assessment of changes in ICT profiles and future requirements	Interviews?	?	2002	ES
Competenties van werknemers in de Informatiemaatschappij (2002) [Competencies of employees in the Information Society]	Amsterdam Institute for Advanced labour Studies	Qualitative assessments of employees of their ICT use and skills	Computer-mediated questionnaire of 2000 households in NL	Own data	June 2002	NL - Content knowledge and social skills are more important
ICT skills and employment (2002) STI working paper	OECD/Vladimir Lopez-Bassols	Employment growth in knowledge workers, Employment in IT-related occupations, IT-workers as percentage of total, IT-worker gap, tertiary education, IT degrees and gender, IT certifications, foreign workers, attracting IT workers	Analysis of different sources of ICT statistics and policy reports	US BLS, Occupational Employment Statistics, LFS, EITO 2001, ITAA 2001	July 2002	Analysis and overview of ICT skills related reports and statistics.
Digital Transformation – a framework for ICT literacy (2002)	Educational Testing Service	Framework for ICT literacy, digital divide, ICT literacy measurements	Theoretical approach to measuring ICT literacy and policy recommendations for doing so	n/a	May 2002	Conceptual piece, not specifically focused at professional skills.

cont. Reviewed studies

Initiative	By whom?	Who/what is assessed?	By which methods?	Using what data?	When?	Remarks
Information Technology Practitioner Skills in Europe (2002)	CEPIS/Dixon	IT Practitioners (ISCO-88 213 and 312). Other data dependent on national information: e.g. remuneration, immigrants, large companies, education level, migration.	Analysis of Eurostat and other data. Special focus on Germany, Ireland, Sweden and UK.	Eurostat LFS 2001 and a number of reports from the 4 countries mentioned.	May 2002	General overview of LFS data in EU-15 and specific summary of research in 4 countries said to be representative for EU-15.
Addressing the ICT skills shortage in Europe (2002)	Intel e-business group	IT workers skills gap	Review of literature	EITO 2002 and other references	November 2002	Summary of other work and position of Intel.

Appendix J: Future-oriented studies on demand and/or supply of e-skills

Author	Future Horizon	Focus[44]	Skills[45]	Indicators[46]	Identified stakeholders[47]	Objectives[48]	Political support[49]	Timing[50]	Professional involvement[51]	Techniques used[52]	Outputs[53]	Evaluation[54]
ABBL, clc, Fedil 2004	2004-2007?	Employment, recruitment, outsourcing IT tasks	Different types of ICT professionals + education level	Types of jobs created and replaced in 9 professions and sub-professions	Enterprises	Guide youngsters towards a study choice Clarify needs of enterprises toward government and professionals	Supported by ministry of Education and EU	-	Interviewees	Survey	Report of number of ICT jobs foreseen, dissemination probably through networks that commissione d the study	Small survey

[44] 1) Focus on demand, supply, both?; 2) Focus on specific issues e.g. gender distribution, offshoring, and the like?; 3) Assessed mismatches, shortages, gaps in e-skills?; 4) Made distinction across sectors, countries?

[45] 1) Which skills?: I(C)Tskills; e-business skills; 2) What was measured?: future occupational requirements; overall requirements; 3) What level was assessed?: advanced, professional, basic

[46] Which indicators were used?: stock of employment, qualitative assessment of needs job vacancies, etc.

[47] 1) What expertise have the stakeholders involved?; 2) What is the level of participation?; 3) What is the division of different stakeholders?; 4) Are stakeholders involved in implementing results?

[48] 1) What is the mission statement for the foresight team and the outside world?; 2) What is the connection of objectives with policy action?; 3) What are the measurable objectives?

[49] 1) What is the level of support from politicians/key civil servants before project started? 2) What is the level of support from politicians/key civil servants during the project

[50] Is a timetable used for decisions to be taken?; 2) Is there a regularly delivery of outputs?

[51] What range of skills involved? eg. project management; area experts; foresight specialists

[52] What kind of data collection was used: large, small-scale surveys, interviews

[53] 1) What are the outputs?; 2) What are the consequences (use and impact) of implementing the outputs?; 3) What is the dissemination strategy - targeted to different stakeholders?

[54] 1) What is the scientific quality of the foresight process?; 2) What are the effects on structures networks among stakeholders; 3) What is the quality and quantity of outputs

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Biat/Cedefop 2003	2010	Employment, supply & demand, training profiles, VET	Different skills classifications at various educational levels	# of IT practitioners at different levels, # of IT students at different levels	Not specifically – SMEs and employers of sub-degree IT specialists	Analysing industry's needs of ICT skills and practitioners at sub-degree levels in the ICT and user sectors	EU-funded – no specific political support	Study builds on previous work, but no continuity guaranteed	Social scientists?	Literature review, secondary analysis, questionnaires and case studies	Report	Very detailed study on the subject of sub-degree level IT specialists, but based on limited number of countries
Career-Space 2001	2000-2004	Demand Western Europe, occupations and industries ICT sub-industries vs. rest of economy	ICT skills Occupational requirements Professional (generic skills profiles mapped on SOC)	Stock of employment	-	Develop a methodology, which would lead to a better quantification of the resources required by the industry in Europe. If the future required resources can be better monitored then the possibility to implement adequate policy measures to hinder shortage of ICT skilled personnel	-	No timetable and no regularly delivery of outputs	Area and foresight experts	Secondary data collection from OECD 1997 on employment by sector. Employment growth rate projections from ERECOs E3ME model.	Employment in ICT skilled occupations in 2000 and annual growth rate of employment in ICT skilled occupations till 2004	Combining forecasts of employment by sector with an extrapolation of the trends towards increasing share of ICT skills within those employment totals.

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CEPIS 2002	2000-2005	Demand Discussion of skills shortage methods EU 15, Germany, Ireland, Sweden and UK	IT skills Occupational requirements Professional ISCO 213 and 312	Stock of employment	No stakeholder involvement	Improve validity of estimates and forecast in relations to previous studies. Provide factual basis on which plans can be developed to strengthen education and training of It professionals	Support from CEPIS which is a stakeholder group before and during the project	No timetable and no regularly delivery of outputs	Area expert	EU LFS data	Forecasted annual new demand and the growth trend of the stock of employment. Initially there is a decline in demand followed by steady growth.	Scenarios

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EMCC 2003	2002-2010	Supply: % of knowledge workers Outsourcing	ICT Far higher levels of education and skills needed to maintain employment in EU	Qualitative	-	To stimulate dialogue and debate about policy alternatives regarding ICT and their future impacts	-	-	-	Literature review	% of knowledge workers in the EU Digital literacy Mentioning that governments will have to take the lead in re-orienting education systems for the knowledge economy and employers must take greater responsibility for education and training in the future to ensure that employees have the necessary skills	Scenario's Location of economic activities will increasingly be determined by the availability of skills at low cost - expectation that companies' strategy will be directed; Europe will have to compete with newly industrialising countries for many jobs; could result in restructuring of enterprises in Europe (more mobile)

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EMCC 2003	2002-2013	Supply and demand Migration of jobs from EU to developing countries Other jobs that emerged to fill the gaps that were created in the European labour market - less skilled than the jobs lost	E-business skills - well qualified English speaking graduates; MBA's	Qualitative	-	Exploring the driving forces likely to shape development in the financial services sector	-	-	-	Literature review	Policymakers might be advised to monitor drivers (FSAP, USbased large scale mergers in the financial services sector, digital currencies and global eBanking), to consider ways in which they could be avoided and to prepare contingency plans in case they occur	Scenario's It is not possible to predict the path things will take with any certainty
e-skills UK 2004	2003-2014	Demand Distinctions made across industry, occupations and regions	IT Skills Occupational requirements IT industry employment (4-digit SIC), IT occupational employment (4-digit SOC) (professional) and IT user skills	Stock of employment And share of employed required to have specific skill	Regional and sector expertise Inspect and comment forecasts, scenario selection, survey.	The foresight is one of a suite of publications that underpins the development of a coherent strategy for IT-skills for the UK. The forecasts form part of evidence base for trends and UK skills implications	Government licenses the remit of e-skills UK as the Sector skills Council for IT, Telecoms and Contact Centres	No timetable and no regularly delivery of outputs	Foresight specialists from Experian Business Strategies, area experts, project managers	Secondary data collection from Annual Business Inquiry, LFS Northern Ireland, UK LFS and 2001 census data, National Employers skills Survey 2003.	Total gross jobs in IT industry and IT occupations and the growth trend for these stocks of employment (2003-2014) and share of employed required by employer to have a certain degree of IT user skills (2003-2006)	Relationships between key macroeconomic variables, SIC/SOC matrix and scenarios

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EUQuaSIT 2004	2010	Work and employment; education and training Vocational and higher education, continued training	IT and CT skills	Workforce based on an adaptation of ISCO-88, Students based on ISCED-97	Regional and sector expertise	Contributing to more transparency of ICT employment and qualifications in Europe, both quantitatively (statistical data) and qualitatively	No direct political support (EU-project)	3.5 year study not specifically targeted to policy timetable	Researchers from 5 investigated countries, ICT training professionals surveyed, companies surveyed	Survey, review of skills frameworks, analysis of national labour force data and LFS and OECD	Reports, database, suggested framework of skills	Broad quantitative and qualitative study
Fistera 2004	-	Demand, supply, shortages, life long learning, immigration, ageing workforce, outsourcing	ICT skills in general, nothing measured	AT Kearney offshore attractiveness, % foreigners in tertiary education, non-native S&T employees, BAH satisfaction with ICT skills, IDC IT skill shortage	Workshop stakeholders unknown	Provide overview – inform policy makers?	-	-	-	Report review	Report Workshop outcomes are unknown	Overview study, no analysis of scientific validity
Forfás 2003	2003-2010	Supply and demand Skill gaps (skills shortage) analysis Ireland and four different categories of graduates	ICT skills Occupational requirements Professional	Demand: Stock of employment Supply: Numbers of graduates	Interviews Industrial development agencies, companies and academia	Study the skills needs for the ICT sector up to 2010 The study shall inform policy decisions in the field of skills and education	The Expert Group work in commission from the Minister for Enterprise, Trade and Employment and the Minister for Education and Science	No timetable and no regularly delivery of outputs	McIver consulting and PA Consulting carried out the foresight exercise	-	Figures on demand and supply, as well as the balance between the two, (skills gap). Supply and demand relatively well balanced up to 2006, thereafter demand overtakes supply	Investigation of relationship between economic conditions and the ICT sector employment growth. Interviews, literature review and scenarios.

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ITAA 2004	2004-2007?	Employment size, IT workforce supply, background requirements, retention, growth areas, background for employment	7 different types of IT employees – technical and soft skills	Opinions of 500 HR managers in USA	Enterprise HR managers – stratified sample of small, medium, large enterprises	To monitor, assess and communicate market conditions for IT employers and employees	-	No policy linked Annual survey	Interviewees	Survey	Annual report	Limited set of surveys but regular (annual)measurement provides valuable trend evidence
Nederland - ICT 2003	2002-2003	supply and demand Outsourcing was measured Netherlands	ICT Education/detachment activity, consultancy professional – tertiary education	Stock of employment (1997-2003) Job vacancies (1997-2003) Job increase	FENIT members Survey	Insight in recent developments and future direction Prevent future lack of ICT people	-	Since 1997 a Marktmonitor is published	-	Survey EITO (2002) data CPB prognosis economic growth	Supply and demand of eskills Insight in developments and future direction of supply and demand of eskills in the Netherlands	Economic growth approach
TIDE 2002	2010?	Shortages, employment, demand – skills required in Finland in the future	Skills in general; Future occupational requirements for all levels	Number of employees; qualitative indicators	Businesses as interviewees	Anticipating knowledge and skills needs Define the ICT industry and concepts	Proposed and financed by ministry of Education + organisations in the sector	-	-	Survey, Delphi, scenarios	Reports – impact unknown	Limited set of respondents but may have brought different stakeholders together – in Finnish
Vries 2003	Not specified	Demand	ICT skills Overall requirements	Qualitative assessment of needs	-	Provide a future view from the industry on ICT skills requirements	-	There is a list of actions needed from the industry	Industry expert	Description of market and technology trends, data sources are not reported.	View on ICT skills needed to anticipate the future, such as a skill set combining creative, technical and commercial skills.	10 Base the qualitative forecasts on reference scenarios driven by technology waves and market growth

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Åbo 2001	2000-2010	Employment – 3 sectors ICT manufacture, services, telecoms – FI, NL, FR, ES as exemplars for European countries	No skills specified	Overall employment	No stakeholders	Explain ICT sector employment based on econometric model	-	-	Econometricians	National-level indicators for 4 countries which are extrapolated to rest of EU-15	2000-2010 employment predictions for 4 countries + EU not connected to policy dissemination unknown	Rigorous econometrics, no stakeholder involvement

Appendix K: Terms of reference

The Contractor shall study the supply and demand for e-skills in the 25 Member States of the European Union. Because of the nature of the tasks and of the domain which is related to new information and communication technologies, the working language for this operation will be English.

The tasks to be performed by the Contractor are the following:

- To collect the most recent information and statistical data available concerning ICT and e-business skills in the European Union and to interview the main stakeholders (ICT companies, associations and trade unions) and public policy makers, notably members of the European eSkills Forum;
- To analyse these materials in order to provide an overview of the situation in 2004 relating to the supply and demand of e-skills in the European Union.
- To deliver to the Commission an interim report presenting this overview no later than three months after the signature of the contract;
- To undertake an in-depth analysis and assessment of the situation in 2004 relating to the supply and demand of e-skills in the European Union;
- To identify and document existing forecasting activities and foresight scenarios actions in the Member States as well as existing network of experts in this domain at the international level;
- To propose a common definition and methodological framework for the measurement and the forecast of the demand and supply for e-skills in the European Union;
- To make proposals for the improvement of existing statistical data collection, including recommendations relating the future possible activities of EUROSTAT and the OECD and other international organisations in this field;
- To propose five main indicators for the monitoring of supply and demand of e-skills in the European Union;
- To make concrete proposals for the setting-up of foresights scenarios mechanisms at the European level, based on similar existing approaches in the Member States (notably in Finland for example), together with the establishment of a European network of experts;
- To deliver to the Commission a final report shall present a detailed analysis of the situation in 2004 relating to the supply and the demand of e-skills in Europe and present concrete proposals for the setting-up of foresights scenarios mechanisms at the European level and the establishment of a European network of experts. It is also requested to include a short business plan indicating how such a network could be both scalable and sustainable.