THINKING AHEAD ON *e*-SKILLS FOR THE ICT INDUSTRY IN EUROPE

Harnessing our Strengths and Diversity for the World Stage

Council of European Professional Informatics Societies

December, 2006

Preface

Attitudes to e-skills in Europe are maturing. The marked surge of interest in this area at the end of the 1990s was triggered by industry in response to severe shortages of ICT practitioners arising from a dramatic rise in demand for skilled staff. This rise was caused by concerns about the 'Y2K' problem, the introduction of the Euro and the excitement around opportunities for exploiting the huge commercial potential of the Internet.

With the collapse of the 'dot.com' bubble in 2000 a strong reaction set in which was primarily characterised by shake-outs within the ICT sector. More recently, the period from 1996 to 2000 has been recognised for what it was: an outbreak of ill-founded exuberance, which was then followed by a corresponding over-reaction and loss of confidence.

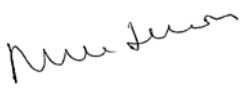
A new era has commenced in which caution prevails alongside recognition of the potential of ICT as an area with huge opportunities. The importance of the skills required for the emerging knowledge based economy has become part of the mainstream agendas within industry. This new understanding has resulted in an improved conceptualisation of the issues that are to be confronted and some serious but balanced approaches to thinking ahead.

The European Commission has worked carefully to connect the growing interest in the e-skills arena in Member States and has built up a community of interested stakeholders, policymakers and analysts. It has developed, through the European e-Skills Forum and the ICT Task Force, an agenda that aims to deliver sound strategic thinking and analysis at European level. This will provide important additional insights for Member States, and disseminate better understanding and good practice to stakeholders throughout the European Union. This report[1] presents work important to that agenda, contributing to the establishment of a framework for common long term thinking about e-skills.

There will be continued innovation and growth of ICT exploitation that adds real value. This development will bring its own growth in demand for e-skills. At the same time, the very globalisation of work that ICT itself has brought about has enabled the shifting of ICT and ICT enabled work to any suitable location. The resulting shifts lie within Europe and some outside Europe – potentially threatening the job prospects of some ICT practitioners.

This report represents our contribution to the Commission's efforts to build a community for assessing future supply and demand for e-skills in Europe and inform policy.





N G McMullen	Professor Jeremy Howells	Pierre Simon
President, CEPIS	Executive Director, PREST	President, Eurochambres

[1] The Commission issued a call for tender in September 2005 inviting proposals for a study on e-skills foresight scenarios for Europe. The consortium led by CEPIS was awarded the contract in March 2006. Mr. André Richier (DG Enterprise and Industry), provided liaison with the consortium.

Consortium Team

The Study consortium was led by CEPIS, with support from PREST (University of Manchester), and Eurochambres.

The consortium team was:

Matthew Dixon
Ian Miles
Lawrence Green
Vincent Tilman
Julian Seymour
Paul Skehan
Francois-Philippe Draguet

Con Gregg of Publica Consulting made a significant contribution in the design of the economic model.

Executive Summary

1 Introduction

Information and Communication Technology is a major force in the European economy. The ICT market is estimated at being worth over €500bn in the EU (2005), and the ICT sectors between them now employ over 6m people. The Software & IT Services sector alone employs over 2.8m people, and in 2003 added over €150bn of value to the European economy. Member States' Software & IT Services industries typically win exports of some €60bn a year, the third most exported service[*]. The capabilities of people to create, deploy and use ICT have become a major component of economic activity.

The prime movers in this world are *ICT practitioners* – those who research, develop, design, manage, produce, consult, market, sell, integrate, install, administer, maintain, support and service ICT systems, devices and services. Official statistics confirm that there are more than 4m[**] ICT practitioners of different kinds working within the European Union, throughout all sectors of the economy. Between 1995 and 2005 over 1.7m of these jobs have been created around the EU, and although employment growth rates have slowed significantly since 2001, ICT practitioners will continue to make a major contribution to the European economy.

The wealth and jobs created in the wider economy also arise from contributions from Europe's *ICT users* – those who deliver the capabilities required for effective application of ICT systems, devices and services by the individual. There are approximately 180m people using ICT in the EU, and their contribution to the effective use of ICT (whether in the public or private sectors) has brought about the widespread innovation achieved in business operations in all parts of the economy.

This innovation has helped EU public and private sector organisations modernise and compete with enterprises around the world in an increasingly global economy. This has been achieved through the leadership of those with *e-business skills* – those who have the capabilities to exploit opportunities provided by ICT, notably the Internet, to ensure more efficient and effective performance of different types of organisations. Those with such skills also explore new ways of conducting business and organisational processes, and establish new businesses.

2 The Study

How will the availability of these three types of 'e-skills' support the future global competitiveness of the ICT industry in the EU? This study looks ahead at how the e-skills position could develop over the coming years, focusing in particular on the IT practitioner needs of the industry.

Contact was made with relevant experts within major ICT Industry players at the EU level, and early analysis was presented to the ICT Industry bodies in most Member States. An extensive literature review was carried out, and particularly careful analysis was made of the approach and outcomes of previous e-skills future research, both qualitative and quantitative.

The report contains a wealth of information and quantitative data on recent trends in ICT Industry employment in all Member States for which there are statistically robust figures available. A

[*] Eurostat (2006a)

[**] Structure of employment EU-25 (Source: estimates mostly from EU Labour Force Survey (LFS: 2005Q2), rounded):

	ICT Industry	User Sectors	Total
ICT practitioners	2.0m	2.2m	4.2m
Other Occupations	4.2m	208m	212m
Total	6.2m	210m	216m

significant amount of additional information is provided that can help clarify the debate and foster constructive dialogue on e-skills at the European level.

The report examines the key trends that will play a role in influencing the supply and demand of each of the three types of e-skills, as well as the *off-shoring of ICT work* that is of growing political interest and could substantially affect future demand levels. It then examines, qualitatively and quantitatively, how things could develop. ***Ninety 'change drivers';*** covering social, technological, economic, environmental, political and values-related forces have been identified and examined.

The main impact of each *change driver* on demand for ICT practitioner skills is analysed, and three factors that are strong determinants of this demand, and that are impacted most significantly by the ninety drivers, were identified:

- **The rate of ICT innovation (technological change)**
- **Economic growth (both within the EU and beyond)**
- **The degree of off-shoring undertaken within the industry.**

2.1 Scenario Analysis

Future development of these *core-drivers* is uncertain, giving rise to the need for *scenario* analysis. In trying to assess possible future developments and sensible options for preparing for them, one of the most powerful approaches found so far, in both business and policy contexts, is to construct a number of possible futures ('scenarios') which can illustrate some of the range of situations that may confront us in the future and so open up group thinking by working through how each might look, and feel. Scenario exploration has proved very valuable for better understanding in a number of areas, and the project has developed, in response to the remit, six descriptive and quantitative scenarios that will help to inform thinking about the future of e-skills in Europe.

In highly complex areas like this, with a wide range of uncertainties present about future developments, the main benefits of the scenario approach are to help analysts and study users to:

- consider, in the light of possible developments, what sensible *contingencies* might be;
- reach their own views as to *what are the key factors* that need to be taken into account;
- think about '*early warnings*' of possible courses of development; and
- form a more accurate view of *how different parties might respond* to various developments.

Six scenarios using different combinations of the *core-drivers* are shown below: Summaries of the six scenarios is provided in 3.3 and each scenario is fully presented in the Report as a structured summary, with the situation described in relation to ten key contexts.

Scenario	Pace of Technological change	Economic Climate	Pace of Off-shoring
A :**Renaissance**	Rapid	Positive	Moderate
B: **Steady Climb**	Moderate	Positive	Moderate
C: **Global**	Rapid	Positive	High
D: **Fight back**	Rapid	Turbulence	Moderate
E: **Dark Days**	Moderate	Turbulence	Moderate
F: **Decline**	Moderate	Turbulence	High

Table i: The Six Scenarios

. The qualitative scenarios were presented and reviewed at a validation workshop, involving representatives from Member State ICT Industries, and feedback has also been received from major industry players at the EU level. Reactions from these informed observers indicated that Scenarios A, B and C were expected to be the most likely to take place.

Table ii shows the likely broad impact in the different scenarios of the prevailing conditions on Supply and Demand, assuming three levels of ICT practitioners low, medium and high, (where '-' indicates *decline or no increase*; '+' signifies *slow increase*, and '++' means *rapid increase*: all relative to the historical trend).

ICT practitioner Skill level	State of Skills within European Union (ICT Industry)	Renaissance	Steady Climb	Global	Fight back	Dark Days	Decline
Low	Supply of Skills within EU	+	+	+	-	-	- (+)
	Demand for Skills within EU ICT Industry	+	+	+	+	+	-
Medium	Supply of Skills within EU	+	+	+	+	- (+)	- (+)
	Demand for Skills within EU ICT Industry	++ (+)	+	++	+	+	+
High	Supply of Skills within EU	+	- (+)	+	- (+)	- (+)	-
	Demand for Skills within EU ICT Industry	++	+	+	++	+	+
Overall	Supply of Skills within EU	+	+	+	- (+)	- (+)	- (+)
	Demand for Skills within EU ICT Industry	++	+	++	+	+	+

Table ii: Summary of Broad ICT Practitioner Skills Impact of Conditions in Each Scenario

2.2 Mathematical Model

2.2.1 Modelling Approach and Scope

The Study also explored the broad *quantitative* implications of the six scenarios. However, while the *qualitative* scenarios showed additional possible developments arising from the impact of a number of other change drivers, the mathematical model was purely based on variations of the three *core-drivers* (+ an assumption about the development of real remuneration). Thus the numerical results of the six future trajectories estimated from the model are broadly coherent with, but not identical to, the conditions in the descriptive scenarios.

In considering the modelling approach, the consortium team studied the recent published forecasts of e-skills employment in some detail, as well as published approaches to modelling the impact of employment on some of the input values (in particular, off-shoring). An Annex to the report describes the modelling approach and model design from first principles. The over-riding priorities for model design were to maximise use of relevant sound data and to keep the model as simple as possible to increase chances of lay understanding.

The study developed a simple but powerful mathematical model, which can be used to explore a wide range of 'what-if?'s. The model's foundations lie in the power of software investment as an indicator with strong correlation to employment levels in the Software & IT services industry over an extended period. Software investment also forms part of Member States' *national accounts*, so that general economic outlook properties can be drawn upon. The model design was chosen for simplicity, communicability and for maximum exploitation of data availability, given the serious lack of desirable data for many variables[*].

[*] alternative model forms were considered, in particular in relation to handling areas with extreme lack of data (e.g. off-shoring), and an Annex explains the approach behind model form selection.

The model draws on data for software investment and employment from official sources for the EU-15, covering the *Software & IT Services Sector* (which employs over 85% of all the IT practitioners within the ICT Industry in Europe). In order to estimate the development over the coming years of total IT practitioner demand for the ICT Industry as a whole, these figures are grossed-up to cover the additional IT practitioners in the new Member States and within the *Broad (Electronics) Hardware Production*, and *Telecommunications* Sectors. The grossing-up is based on the fractions of IT practitioners employed by these ICT Industry sectors in the latest EU Labour Force Survey data. Table iii shows the distribution of IT practitioners between three main sectors of the ICT Supply Industry for the EU-15 and the EU-25 for 2005.

	Software & IT Services (NACE 72)	**Broad Hardware Production** (NACE 30+32)	**Telecomms** (NACE 64.2**)	**Total Hardware, Software, IT Services & Telecomms**
EU-15	1,300,000	110,000	118,000	1,528,000
EU-25	1,417,000	120,000	130,000	1,667,000

Core modelling scope (estimates from model projections)

Estimates grossed-up from core estimates in line with the most recent employment ratios

Table iii: Distribution of IT Practitioner Employment* Across ICT Industry Sub-sectors**
(Note: that these figures are a *sub-set* of the ICT practitioner totals)

While specific estimates of the future development of employment in the other two sectors within separate models would have been ideal, no evidence was found providing, for *Hardware Production* or *Telecommunications*, close correlation equivalent to that between *Software Investment* and *Software & IT Services* employment. As can be seen from the table, the Software & IT Services sector is so dominant, in relation to ICT Industry employment of IT practitioners, that the error introduced by possible changes over the coming years in the distribution shown in the table is unlikely to be significant.

2.2.2 Model Assumptions

- It was chosen to model rapid technology change in the EU-15 as a continuation of the historical *rapid* rate of increase in software's share of non-residential fixed capital formation. *Moderate* technology change was then modelled by increasing the variable at half the historical pace. This was based on the observation from US data that periods of rapid technology change are typically reflected in published national investment statistics. This data shows a ramp up in the share of all non-residential fixed investment accounted for by software, while periods of moderate change are typically reflected by slower growth in this variable.
- It was chosen to model a *strong* EU economy with 2.5% growth per annum, accompanied by an increase in the share of GDP going into business investment. A *turbulent* EU economy was modelled with a 1.5% annual rise in real GDP, accompanied by a fall in the share of GDP going into investment. Because a smooth transition from the OECD investment the turbulent economy view only turns negative after 2009. This was based on the evidence from both EU and US data that growth in investment in software is related closely to growth in non-residential investment. This is in turn related to both growth in GDP, and, by confidence in future growth prospects, this influences the share of GDP that is devoted to investment. For the period up to 2007, the consortium team adopted projections from the OECD's most recent *Economic Outlook* on GDP growth, and growth in investment relative to GDP.

** using adjusted UK data for disaggregation within NACE 64

*** levels for ISCO 213+312 occupations, source: EULFS (Eurostat holdings of Member State LFS – or equivalent – data) 2005Q2

- It was chosen to model off-shoring as the net percentage of EU-15 *Software & IT Services* sector (NACE 72) jobs lost to off-shoring each year, whether actually lost or not created. The data on current levels of outsourcing is too thin to provide a reliable estimate of the current value of this variable. A value of 0.5% per annum was chosen, which is consistent with the available information. This was held constant to represent *moderate* off-shoring, and ramped up towards 3.5% in 2015 to represent *rapid* off-shoring.

The *general logic* for the model is as follows:

- In the absence of off-shoring, changes in employment in NACE 72 will be a function of changes in investment in software and changes in the real cost of labour. For example, if software investment rises by 5% and real pay rises by 2%, then employment will rise by 3%.
- The main factors driving changes in investment in software are:
  - general changes in business investment; and
  - the rate of emergence or improvement of technologies relevant to business, that causes companies to decide to increase or reduce the share of their investment that goes into software.
- Off-shoring reduces the share of all EU-15 investment in software that is spent domestically, and therefore reduces the employment level supported by any particular level of investment.

In the model, a number of *variables are held constant,* explicitly or implicitly.

- The rate of increase in real pay is assumed to be constant at 1.5% per annum. This reflects the general economy-wide tendency of pay to increase beyond the rate of inflation. This is underpinned by whole economy increases in productivity, with an increment to reflect a shift in the skills mix required in NACE 72 in favour of higher level skills.
- It is assumed that there is no change in the share of ICT activity within the EU that is outsourced to NACE 72 businesses from businesses in other sectors.
- It is assumed that there is no change in the margins taken by NACE 72 companies.
- Aside from the influence of off-shoring, the share of software investment accounted for by imports remains constant. The share of NACE 72 output exported from EU-15 also remains constant.

3 Findings

3.1 Future Demand

This set of input assumptions to the model produces the trajectories for possible development of total employment (assuming adequate supply) in the Software and IT Services sector in the European Union* shown in Figure i below:

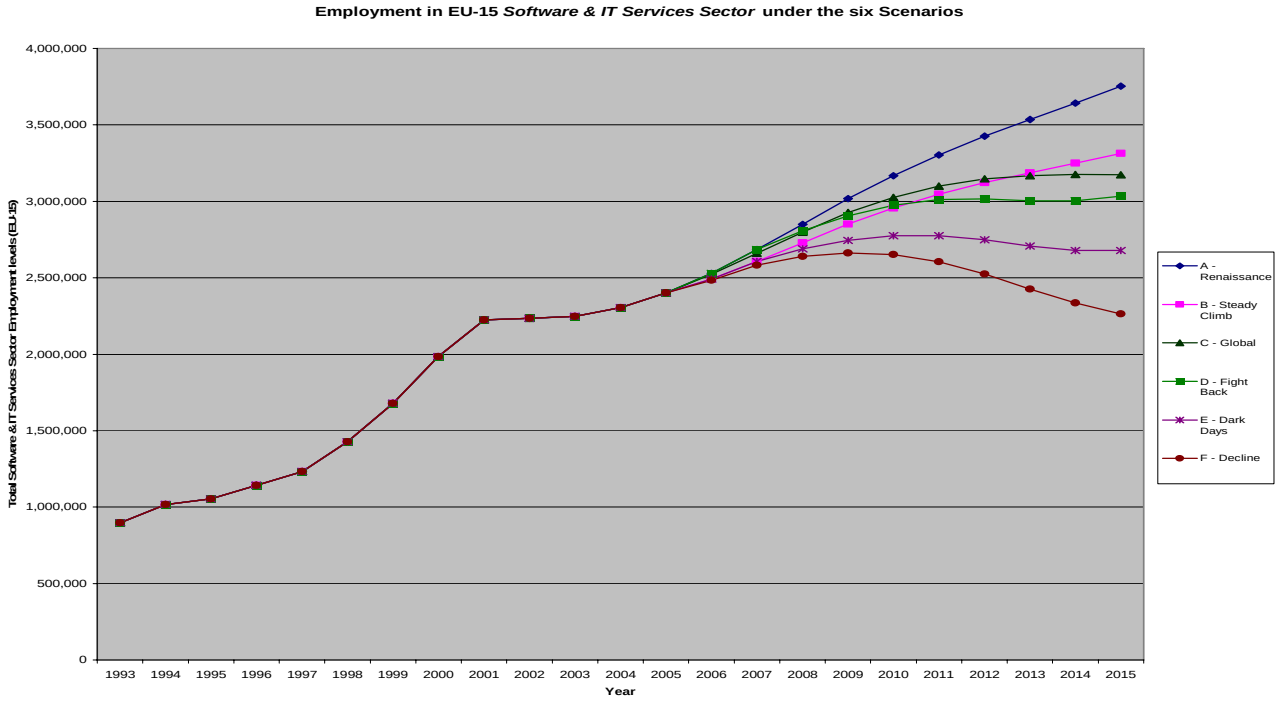


Figure i: Employment in the EU-15 Software & IT Services Sector

These trajectories are converted to estimates of annual net demand for IT practitioners for the whole ICT Industry in the EU-25 shown in Figure ii, based on assumptions about replacement demand and the fraction IT practitioner represent of industry employment, and grossing-up as shown:

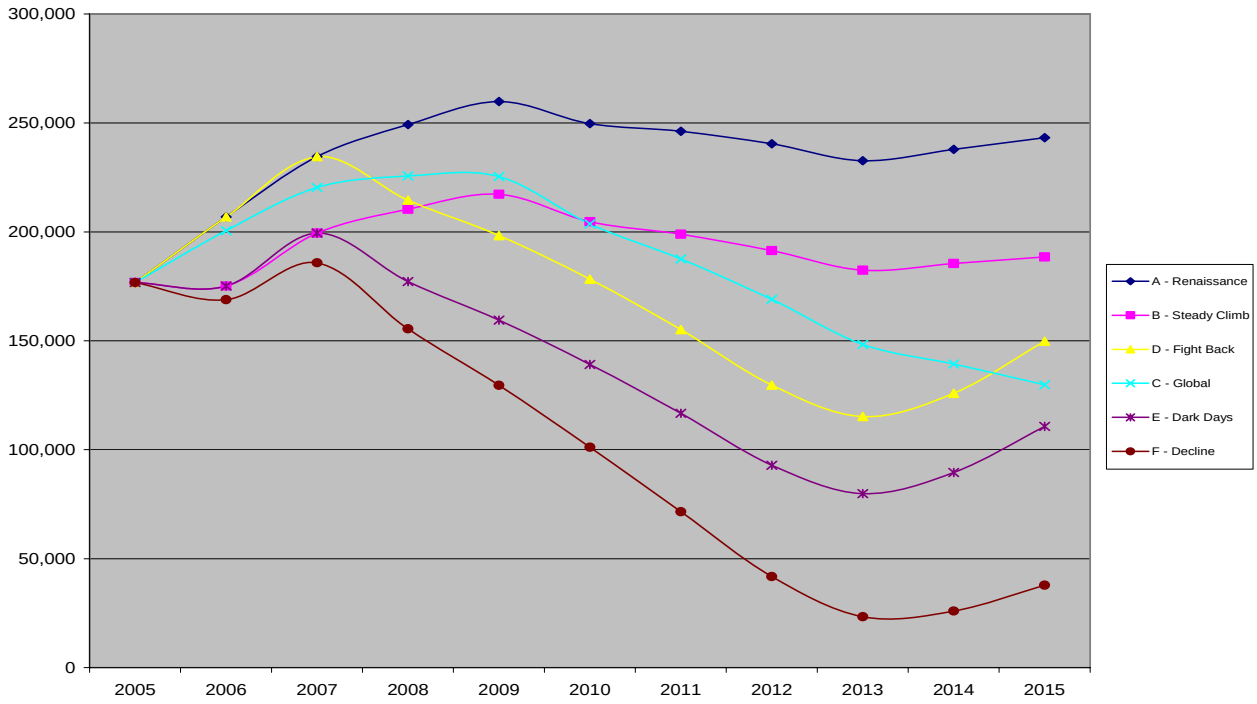


Figure ii: Estimates of 'New' IT Practitioners Needed Each Year in the EU-25 ICT Industry

* EU-15 data is used, as much greater historical evidence is available, as compared with EU-25

3.2 Future Supply

The levels of new demand shown in Figure ii assume that there will be supply adequate to fill the positions. The supply of new IT practitioners comes from a number of different sources, in particular:

- Graduates of Higher Education (HE) informatics/computing* courses, arriving onto the labour market, that can be recruited by companies in the Software and IT Services sector;
- Existing employees being 'trained up' by their employer to become IT practitioners (within the ICT Industry);
- 'Occupational migrants' entering IT practitioner work in the sector via some kind of conversion learning from other kinds of work;
- Graduates from non-informatics HE courses recruited by ICT Industry employers;
- New market entrants with IT knowledge from other parts of the formal education system (e.g. from secondary vocational-, or even general-, education courses);
- New IT practitioners entering ICT companies from *inward-migration* from outside the EU;
- IT practitioners re-entering the labour market (e.g. from unemployment or career-breaks);
- IT practitioners moving in from user sectors (in particular as a result of additional Outsourcing *within* the EU).

An *illustrative* supply projection was produced to complement each demand trajectory. Given the importance of the informatics graduate recruitment source of supply, and the fact that meaningful data is available for such graduations over recent years, this was separated out within the supply trajectories. To complement this 'core' supply, illustrative estimates were produced for the sum of supply from the six other sources. The supply and demand trajectories corresponding broadly to each qualitative scenario are shown in the Annex.

One compelling concern about supply is the reported decline in supply of good graduates from informatics courses. The most recent official Eurostat statistics for enrolments and graduations of Higher Education students on informatics courses suggest a growing supply of fresh graduates. However, there are clear declines in applications for mainstream ICT courses in some Member States and it is possible that classifications used for reporting national HE data to Eurostat include courses beyond mainstream informatics subject matter. Specifically, the ICT Industry reports serious concerns at least in Germany, the Netherlands, Sweden and the UK.

In this situation, it was decided, for the supply projections, to take the informatics graduate data to 2004 from Eurostat (latest available data), but assume, based on the growing reported concern from the industry, a fall-off in growth for 2005 and 2006 followed by a substantial decline in the years to 2015. While there is currently no statistical evidence for this, such an assumption is a conservative one. This approach is consistent with the *precautionary principle*, given the seriousness of the reports, and the importance of this source of supply for the future well-being, and particularly innovation capability, of the EU ICT Industry. As a result of expected demographic impacts, applications from EU residents would be expected in any case to fall by some 8% between 2005 and 2015, but the illustrative supply scenarios assume a significantly greater fall – a ca. 30% fall in graduations over the same period, assuming a continuation of the growing decline of interest in HE technology-oriented courses.

As well as taking into account the contribution to new IT practitioner supply of other sources, it is also necessary to recognise that not all informatics graduates who want to work as IT practitioners will be recruited by the ICT supply Industry. Significant numbers will continue to be recruited by the many large employers in the user sectors of the economy. The illustrative supply trajectories assume that, at the outset of the scenario period, the ICT Industry recruits some 75% of such graduates, and for higher demand scenarios, action by ICT Industry employers increases this share. However, strengthening recruitment, ever more actively, from other sources is the over-riding means of compensating for the continuing fall in availability of informatics graduates

* although Eurostat uses *computing* for the relevant HE subject category statistics, *informatics* is used in this study to refer to courses on informatics, computing, information systems, ICT, computer science, etc.

3.3 Scenario Projection Summaries

An overview of the quantitative aspects of each scenario is presented below and each presents how supply and demand might develop in each case:

3.3.1 Scenario A: Renaissance

In the ***Renaissance*** Scenario the:

- ***rate of ICT innovation*** is assumed to be ***Rapid***;
- ***economic climate*** is assumed to be ***Positive***; and
- ***pace of off-shoring*** is assumed to be ***Moderate***.

Figure iii illustrates how 'new' IT practitioner supply, and informatics graduate recruitment within that, might develop in response to the strong growth in new demand involved in Scenario A.

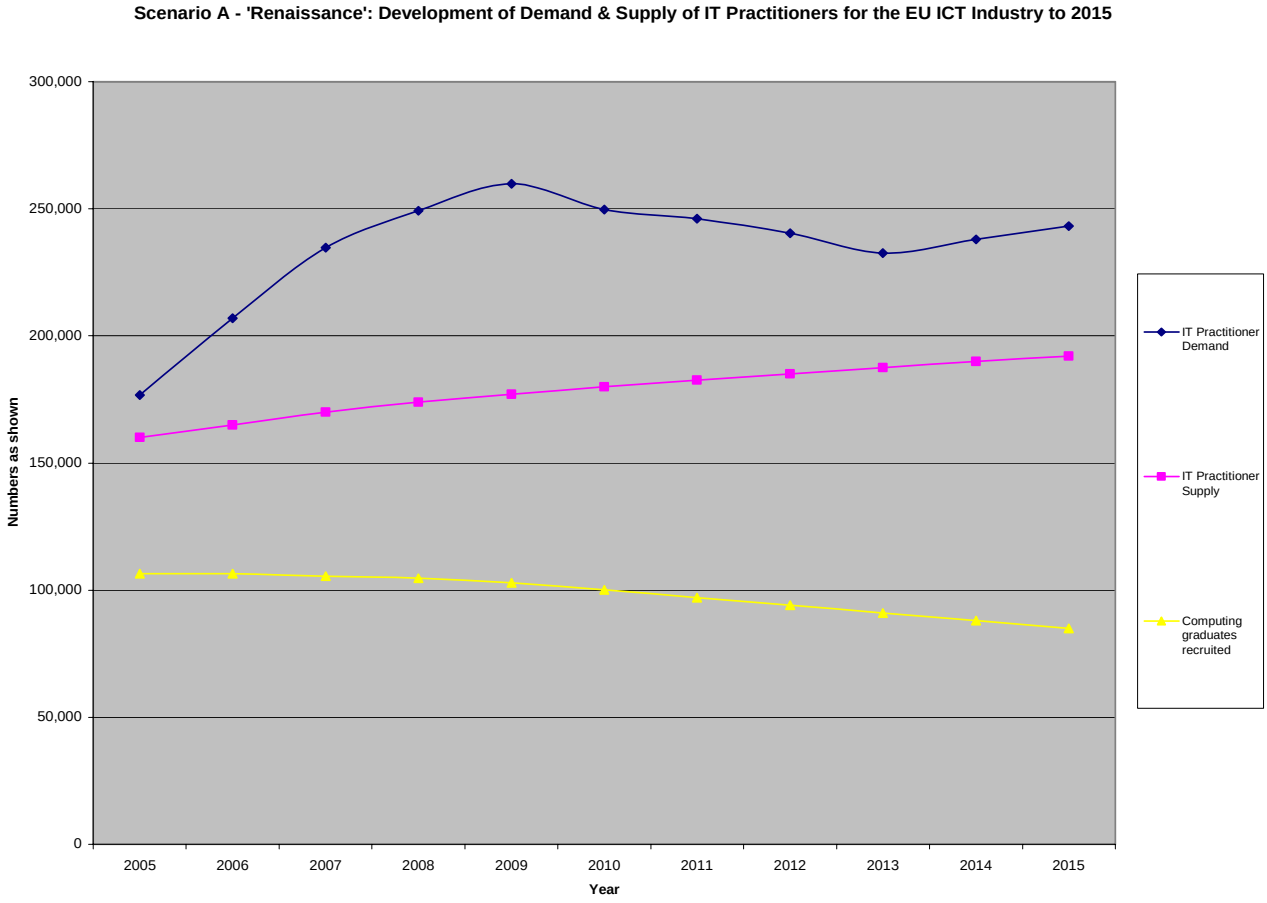


Figure iii: (Net, new) EU Supply and Demand Trajectories for A: *Renaissance*

This scenario sees the greatest rise, of all six scenarios, in new demand levels over the period to 2015. These will result in significant skill shortages, which will be further impacted by the growing fall in numbers of informatics graduates coming onto the labour market after 2007. The acute shortages quickly evident after 2006 result in action by employers to augment their ICT practitioner teams from other sources. The fall in flows of the technical graduates begins to take effect more strongly in 2009, but from then onward the illustrative projections involve stronger measures being taken by the ICT Industry, and sometimes substantial rising salary offers help the supply industry win an increasing share of the informatics graduates that are available. In some Member States the ICT Industry joins

with government to launch campaigns promoting work in the Industry, and overall, these measures result in steadily rising recruitment from sources other than IT graduates.

More detailed *Implications* of the scenario for the Industry and for various areas of policy are presented in Section 10 of the report.

3.3.2 Scenario B: Steady Climb

In the ***Steady Climb*** Scenario the:

- ***rate of ICT innovation*** is assumed to be ***Moderate***;
- ***economic climate*** is assumed to be ***Positive***; and
- ***pace of off-shoring*** is assumed to be ***Moderate***.

Figure iv illustrates how informatics graduate recruitment, and total IT practitioner supply, might develop, in response to developing demand as envisaged in Scenario B.

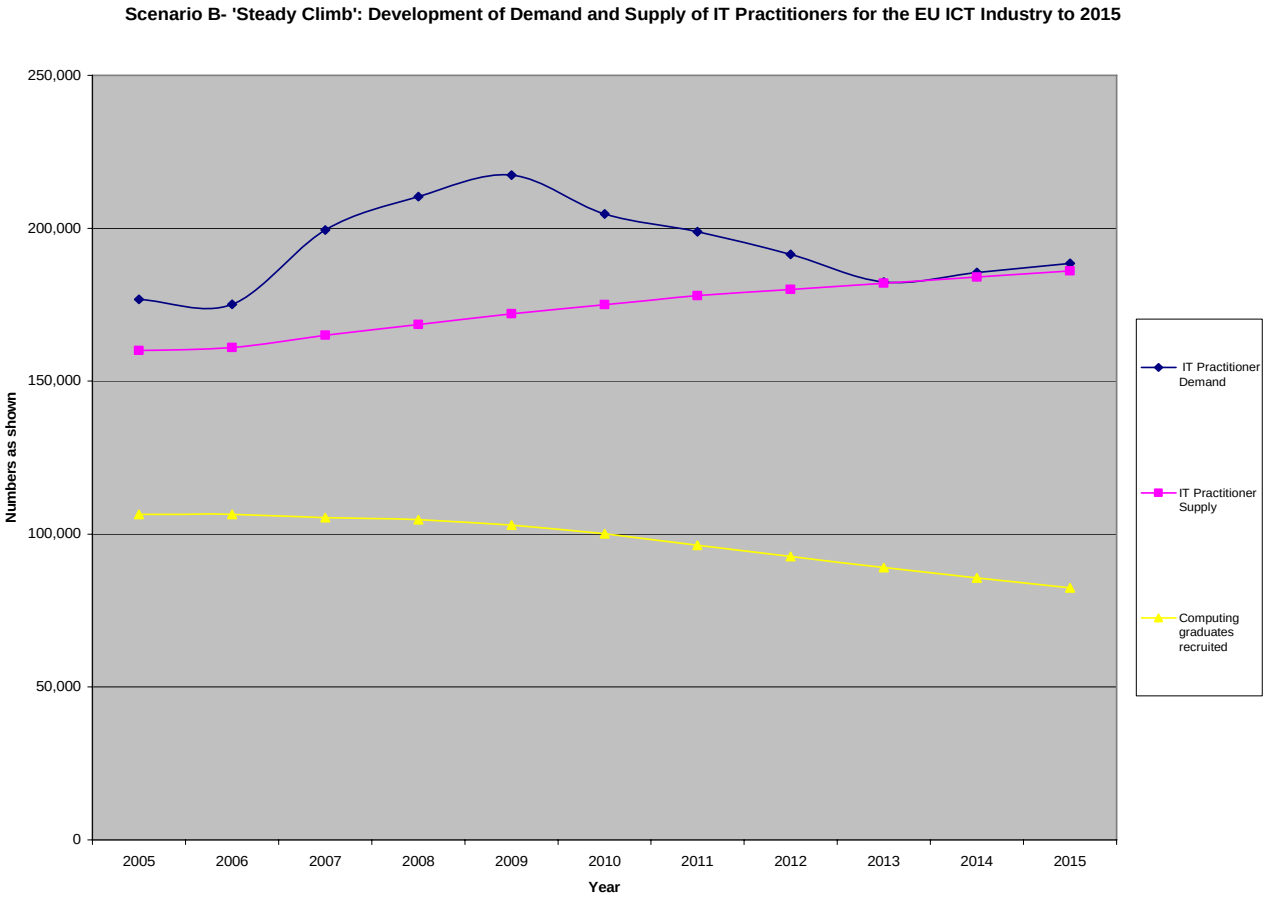


Figure iv: (Net, new) EU Supply and Demand Trajectories for B: *Steady Climb*

This scenario also involves initial growth in new demand for IT practitioners, but at lower levels than for 'Renaissance'. The fall-off in numbers of informatics graduates plays a role here, but the demand levels to which supply has to rise are not so great, as a result of which less dramatic recruitment action is required by the ICT Industry. Nevertheless supply can only be increased by accelerating growth from sources beyond informatics graduates, including increased training of existing staff and attracting in people from other supply sources, through increasing salary offers. As demand falls after 2009, efforts to strengthen supply result in the labour market being in balance by 2013. There are net skill shortages in 2010 and 2015, although notably lower than in Scenario A.

More detailed *Implications* of the scenario for the Industry and for various areas of policy are presented in Section 10 of the report.

3.3.3 Scenario C: Global

In the ***Global*** Scenario the:

- ***rate of ICT innovation*** is assumed to be ***Rapid***;
- ***economic climate*** is assumed to be ***Positive***; while
- ***pace of off-shoring*** is assumed to be ***High***.

Figure v illustrates how new practitioner supply and informatics graduate recruitment might develop, in response to the new demand conditions of Scenario C.

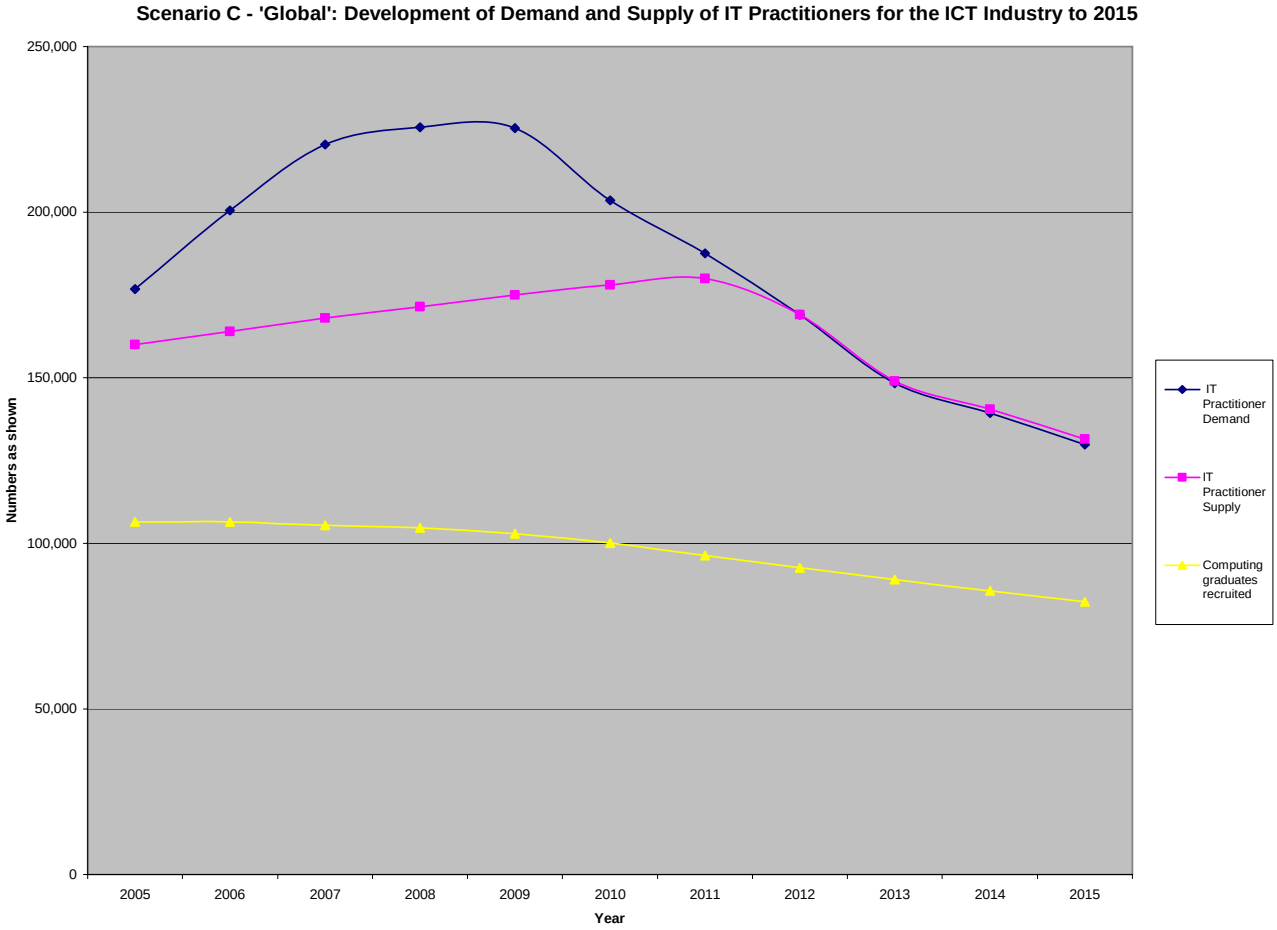


Figure v: (Net, new) EU Supply and Demand Trajectories for C: *Global*

Initial new demand is nearly as strong as in Scenario A, but this falls away strongly after 2009. Recruitment activity to augment IT practitioner teams from candidates beyond informatics graduates is thus strong up to 2011, after which net new demand falls steadily, and recruitment effort eases in response. A small residual surplus grows as candidates from non graduate sources fail to get recruited by the ICT Industry.

More detailed *Implications* of the scenario for the Industry and for various areas of policy are presented in Section 10 of the report.

3.3.4 Scenario D: Fight Back

Scenario D: Fight Back

In the ***Fight back*** Scenario the:

- ***rate of ICT innovation*** is assumed to be ***Rapid***;
- ***economic climate*** is assumed to be ***Turbulent***; while
- ***pace of off-shoring*** is assumed to be ***Moderate***.

Figure vi illustrates how informatics graduate recruitment and total new supply might develop, in response to the strong swings in new demand involved in Scenario D.

Figure vi: (Net, new) EU Supply and Demand Trajectories for D: *Fight Back*

Initial new demand grows strongly for the first two years of the scenario, but then falls away until 2013. Recruitment activity to augment IT practitioner teams starts strongly, and manages to meet demand in 2010. Thereafter, recruitment effort can ease as demand continues to fall, and a small but growing residual surplus emerges as candidates from non graduate sources fail to get recruited by the ICT Industry. 2013 sees a 'bottoming-out' of new demand, after which recruitment effort is strengthened, but cannot respond fast enough to prevent the re-appearance of shortages.

More detailed *Implications* of the scenario for the Industry and for various areas of policy are presented in Section 10 of the report.

3.3.5 Scenario E: Dark Days

Scenario E: Dark Days

In the ***Dark Days*** Scenario the:

- ***rate of ICT innovation*** is assumed to be ***Moderate***;
- ***economic Climate*** is assumed to be ***Turbulent***; while
- ***pace of off-shoring*** is assumed to be ***Moderate***.

Figure vii illustrates how informatics graduate recruitment, and total IT practitioner supply, might develop, in response to the less encouraging developments involved in Scenario E.

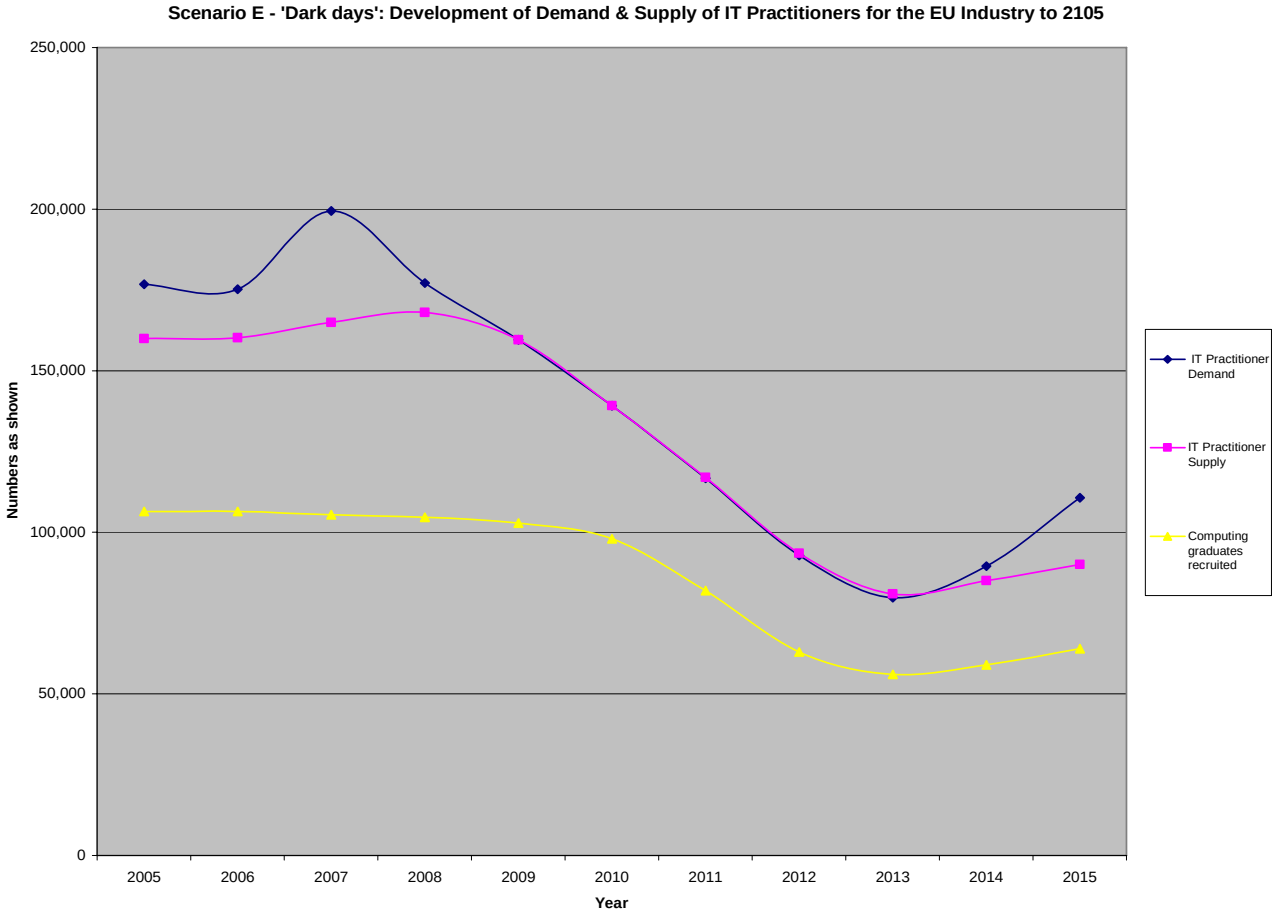


Figure vii: (Net, new) EU Supply and Demand Trajectories for E: *Dark Days*

In this scenario, net new demand really begins to feel the effect of the lower general economic confidence, and the slipping of ICT innovation rates. Growth is limited to 2006-2007, and 2008-2013 sees steady falls, to levels that begin to impact on the job prospects of informatics graduates. Recruiting ICT enterprises continue to seek experienced IT practitioners as part of their 'new recruits', so that the ICT Industry does not recruit as high a fraction of the emerging IT graduates as before as supply levels become very low. 2014 and 2015 see a pick up in demand, to which supply levels take time to respond.

More detailed *Implications* of the scenario for the Industry and for various areas of policy are presented in Section 10 of the report.

3.3.6 Scenario F: Decline

In the ***Decline*** Scenario the:

- ***rate of ICT innovation*** is assumed to be ***Moderate***;
- ***economic climate*** is assumed to be ***Turbulent***; and
- ***pace of off-shoring*** is assumed to be ***High***.

Figure viii illustrates how total IT practitioner supply and informatics graduate recruitment might develop, in response to the near-disappearance of new demand that emerges towards the end of the period under study in Scenario F.

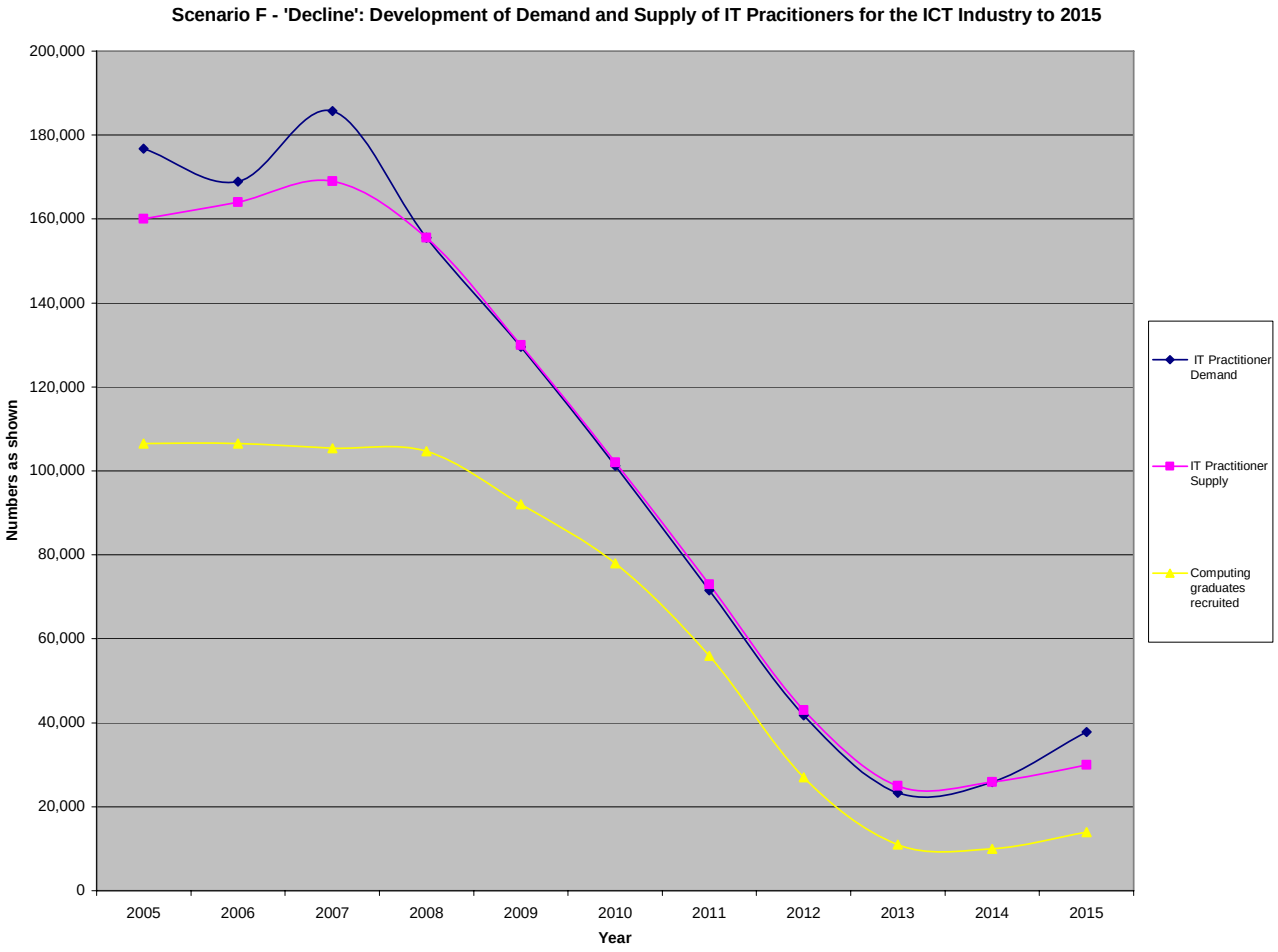


Figure viii: (Net, new) EU Supply and Demand Trajectories for F: *Decline*

All three *core drivers* are now in states that reduce net new demand for IT practitioners. Only 2007 has new demand above the 2005 level, and 2008-2013 sees strong falls, to levels that reduce significantly the fraction of emerging informatics graduates recruited by the ICT Industry. Recruiting ICT enterprises continue to seek experienced IT practitioners as part of their 'new recruits', and the numbers of technical graduates recruited falls to unusually low levels. 2014 and 2015 see a modest pick up in demand, to which supply levels take time to respond.

More detailed *Implications* of the scenario for the Industry and for various areas of policy are presented in Section 10 of the report.

3.4 Possible Net Labour Market Conditions

Based on the net new demand for IT practitioners within the EU ICT Industry (Figure ii), and the illustrative supply trajectories produced, the figures for 2010 and 2015 provide estimates of the *supply-demand imbalances* for those years, as follows:

2010 Labour Market Imbalance Estimates						
	Scenario A: ***Ren-aissance***	Scenario B: ***Steady Climb***	Scenario C: ***Global***	Scenario D: ***Fight back***	Scenario E: ***Dark Days***	Scenario F: ***Decline***
Demand:	250,000	205,000	204,000	178,000	139,000	101,000
Supply:	180,000	175,000	178,000	178,000	139,000	102,000
Surplus/ Shortage	**-70,000**	**-30,000**	**-26,000**	**0**	**0**	**1,000**

Table iv:
IT Practitioner Supply and Demand for the EU ICT Industry: 2010

2015 Labour Market Imbalance Estimates						
	Scenario A: ***Ren-aissance***	Scenario B: ***Steady Climb***	Scenario C: ***Global***	Scenario D: ***Fight back***	Scenario E: ***Dark Days***	Scenario F: ***Decline***
Demand:	243,000	188,500	129,800	150,000	111,000	38,000
Supply:	192,000	186,000	131,300	120,000	90,000	30,000
Surplus/ Shortage	**-51,000**	**-2,500**	**1,500**	**-30,000**	**-21,000**	**-8,000**

Table v:
IT Practitioner Supply and Demand for the EU ICT Industry: 2015

As can be seen, skill shortages are expected in the two years for most scenarios, although the scale of them varies considerably in the light of the projection variations.

3.5 Additional Findings

The report also summarises the main sources of supply and demand for *ICT User skills* and *e-Business skills*, and outlines the latest thinking in trends from the ICT Industry, in particular on the more detailed technical skills within ICT practitioner work. While there are different perspectives from different major players, the strongest common message coming through is that the *combination* of technical understanding of the capabilities of current and emerging ICTs, and expertise in certain market sectors or underlying sciences & other technologies that will be crucial in triggering the technological innovations on which future survival and success of European ICT Industry will depend. In this context the current decline in applications for European university courses in the broader *Science, Technology, Engineering and Mathematics* domain is also cause for concern.

5 Conclusions

The study has shown that:

1. a very large number of drivers are likely to influence the supply and demand of the different types of e-skills in Europe in the coming years, the study identifies ninety such drivers;

2. these ninety drivers impact on one or more of the of three *core-drivers identified* which are likely to have the greatest influence on future demand for ICT practitioner skills for the ICT Industry:
   - the *rate of ICT innovation*,
   - *economic climate*, and
   - *pace of off-shoring*,

3. it is possible to explore, and gain new insights on, developments of ICT activity and e-skills demand and supply in the coming years through consideration of qualitative scenarios built on different combinations and value of the *core drivers*, six such scenarios were identified;

4. broad implications of each scenario on the expected future supply and demand of three *levels* of ICT practitioner skills can be analysed;

5. a simple but effective mathematical model can be developed and calibrated to show expected ICT Industry employment levels corresponding in broad terms to different qualitative scenarios for the domain where certain meaningful quantitative evidence is available: the core and technical IT practitioner occupations;

6. estimates of annual net new demand for IT practitioners for this sector can be produced from these employment levels, making assumptions about the fraction of employment represented by IT practitioners and about levels of replacement demand, and grossing-up to the ICT Industry for the EU-25, based on the relevant ratios of IT practitioner employment[*];

7. drawing on these quantitative foundations for demand, illustrative projections can be produced for future supply of IT practitioner skills in the EU in the light of different market-, ICT Industry- and policy- responses, given a possible serious decline in numbers of good graduates from informatics courses;

8. based on these assumptions, estimates for supply and demand levels in 2010 and 2015 show a range of possible IT practitioner labour market conditions, including a number of scenario combinations for which non-trivial supply shortfalls exist;

9. under the scenarios explored, skill shortages of up to 70,000 could occur, where future high demand conditions coincide with supply limitations, while for scenarios where ICT activity within the EU falls off significantly, surplus conditions are also possible.

[*] Such demand estimates provide useful quantitative indications of the scale of possible future developments based on the best relevant data available. However, given the considerable limitations of (even this) data availability, such projections must always be *continuously* reviewed by, and tested against, the views and assessments of industry experts and evidence from specific market surveys.

5 Recommendations

The proposals in the study include initiatives that could improve the validity and value of quantitative data on e-skills within the EU, in addition to a range of suggestions, most resonating with ideas that emerged from the work of the 2006 EU ICT Task Force. Key recommendations include:

a) Further elaboration of the scenarios developed in this study in workshops and dissemination of the understanding generated, for both ICT Industry and ICT User organisations. This must include:
   - continuing review of developments to clarify actual employment levels going forward, in relation to how the model input variables develop, and
   - indicators, measures and criteria that can be agreed, which can then facilitate comparability of future studies of this kind.

b) Creation of a greater awareness, understanding, and acceptance, of the threats and opportunities arising from the growth of globalisation of ICT activity;

c) Promotion of improved understanding for both the Industry and public policy of the real, quantitative position of e-skills in Europe;

d) More serious collaboration between the ICT Industry and policy-makers on the impacts of the cyclical effects of the ICT market on e-skills supply and demand;

e) Work to improve existing EU-level data collection in relation to e-skills and meaningful benchmarking against the e-skills position in competitor economies;

f) Examining more closely the *quality* aspects of skill shortages, and recognising the need to track *skills excellence*, in addition to overall skills volumes, in relation to ICT innovation;

g) Exploration of innovative mechanisms for addressing possible university-industry mismatches, including:
   - collaborative work recognising the need for better links between informatics departments and *application* communities,
   - more serious exploration of the use of *competence frameworks* as targets for HE provision and mapping of informatics *bodies of knowledge* against them, and
   - creative ways of integrating elements of industry certification knowledge into HE informatics courses.

h) Joint action to counteract negative signals about ICT practitioner work, in particular:
   - ensure that *news of industry recruitment drives* gets through to the key audiences as well as news of redundancies, and
   - encourage choice of informatics courses to senior students in secondary education, (through better briefing material about opportunities at graduation time, to counteract any reports of *current job losses.* Informatics needs to be seen as an attractive career option for all students, especially the most talented.

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1 Introduction

Information and Communications Technology (ICT) has become all pervasive in the European Union of today. Most Europeans will interact with ICT during the course of their working day, and even during their personal time. Young people enjoy exploiting the many functions of their mobile phones, MP3 players, Internet chat rooms and 'blogs'. Many people in office jobs use a search engine to track down information they need from websites, and even those in more traditional sectors and activity rarely escape some impact of ICT on their worlds.

In terms of the greater European economy, ICT is a major force.

The European ICT Market is estimated[2] at being worth over €500 billion, and the ICT Industry employs over 6m people. The Software & IT Services sector alone employs some 2.8 million people, adding over €150 billion of value to the EU economy, and Member State Computer Services industries win exports of some €60 billion a year – the third most exported service[3]. Given the scale of this activity and the comparative complexity of the devices, it is natural that the capabilities of people to create, deploy and use ICT have become a major component of economic activity.

The skills required for developing and operating ICT systems, and for using the devices in support of a wide range of activities, are complex. Since they are largely derived from ICT systems and their capabilities, understanding e-skills requires an adequate understanding of ICT systems plus awareness of the many aspects of skills (inc. the core concepts of knowledge, skill and competence). As defined by the **European e-skills Forum** (2004), the term **e-skills** covers three categories:

- ICT Practitioner skills;
- ICT User skills;
- e-Business skills.

The wealth and jobs created by ICT all stem from the innovation, creativity and work of **ICT Practitioners** – those who: "research, develop, design, manage, produce, consult, market, sell, integrate, install, administrate, maintain, support and service ICT systems". Official statistics confirm that there are more than 4m ICT Practitioners of different kinds employed (or self-employed) within the EU, and their contribution occurs throughout all sectors of the economy. Between 1995 and 2005 over 1.7 million jobs have been created around the EU in this work, and – while employment growth rates have slowed since the 'dot.com bubble burst' - these professionals will continue to make a major contribution to the European economy. Through their inventiveness and creativity, they will have a significant impact on the technological innovation that will be so crucial to the global competitiveness of European enterprise.

In addition to the role of ICT Practitioners, the wealth and jobs created in the wider economy arise also from contributions from Europe's **ICT Users.** These are considered as those who deliver: "the capabilities required for effective application of ICT systems and devices by the individual". They apply systems as tools in support of their own work, which is, in most cases, not ICT. There are estimated to be at least 180 million ICT Users in Europe, and their contribution to the effective use of ICT in business operations whether in the public or private sectors has helped achieve the widespread innovation of business operations in all parts of the economy. This has raised levels of productivity and in the private sector competitiveness of European enterprise.

[2] EITO (2006)
[3] Eurostat (2006a)

This widespread innovation has helped European public and private sector organisations modernise and compete with enterprises around the world in an increasingly global economy, and has taken place primarily through the leadership of those with **e-Business Skills** – who have: "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".

The purpose of this study is to explore possibilities for the future development of the different kinds of e-skills in Europe, as a basis for more informed thinking about the situation, and to enable those involved in policy development, and organisational planning by employers, to **think ahead** when preparing their decisions. The futures analysed in this study are explored from both qualitative and (for ICT Practitioners, for the nearer term) quantitative points of view. There are many factors that will influence the future development of supply and demand of each of e-skills. As a result the exploration of what might happen needs a sound understanding of both the exact parameters around e-skills definitions and the dimensions of the ICT Industry. For this reason, this report presents, before the analysis of future developments, background clarification of what is involved in both e-skills and the ICT Industry in Europe.

The Strategic Importance for Europe

As with all technologies, adoption of ICT changes the way work is done, and ultimately has a positive impact on the productivity of operations. In the case of ICT, this impact is very much broader across the economy than is the case with more traditional engineering technologies, whose impact, albeit often significant, is generally restricted to certain sectors. It is the very all-pervasiveness of ICT that accounts for the huge scope of its impact. This also means that small differences in the (average) effectiveness of the use of ICT across an economy can have a marked effect on overall national productivity. Econometric evidence of the significant contribution of effective deployment of ICT to productivity continues to grow (see, for example, Clayton (2005))

In addition, the growth in ICT infrastructure has, together with the growth in all aspects of mobility (in particular air travel), accelerated the reduction of geographical barriers to economic activity. When this is coupled with work on trade liberalisation, this trend has contributed to the acceleration of the advent of the Global economy. The net effect of this is to increase competition in most sectors. Moreover, for countries with comparatively high pay levels/labour costs like most EU Member States, it has turned the challenge for increased productivity into a challenge for increased global competitiveness.

As a consequence, the cost-effective deployment of ICT across the economy becomes, for both productivity and competitiveness reasons, a matter of major strategic importance. This cost-effective deployment requires adequate levels of e-skills. The significance of e-skills for the economy and society as a whole has been recognised over recent years in all Member States, and most Member State governments have initiated a range of measures that address the need to raise e-skills levels both in the workforce and beyond. Many of these initiatives have involved consultation, and in some cases joint effort, with the ICT Industry within Member States. This is a very desirable approach where policy relates more effectively to what is happening in the marketplace.

The Report Context: EU-level Work on e-skills

Further to the industry-led Career Space initiative, the European Commission invited Member States to consider what approach should be taken at the EU level. The conclusions of the "ICT Skills Monitoring Group" and of a benchmarking study of national policies were discussed at the

2002 European e-skills Summit hosted in Copenhagen by the Danish Presidency. The Council adopted Conclusions on 5 December 2002, welcoming in particular the proposal of the Commission to establish a **European e-skills Forum** to foster an open dialogue between all relevant stakeholders. The Forum released a synthesis report "e-skills in Europe: Towards 2010 and Beyond", which was presented at a conference on 20-21 September 2004. A Declaration was adopted supporting the analysis and the recommendations of the Forum and recognising that the way forward is through multi-stakeholder dialogue and partnerships for actions.

The e-skills agenda since that time has largely come from the Forum's recommendations. Specific projects and studies have been commissioned, which have resulted in steady progress being made in a number of areas:

- A CEN Workshop Agreement (CWA) was published in February 2006 by CEN/ISSS covering a state-of-the-art review of progress in ICT practitioner skills frameworks. Within this agreement, the realities within which such frameworks are developed are explained and recommendations are made for next steps towards a European e-Competence Framework taking into account the proposal for a European Qualifications Framework.
- A module has been developed to include e-skills in the regular Eurostat Enterprise Survey in 2007 and a report from Rand Europe, delivered in September 2005 analysed the evidence, qualitative and quantitative, on the supply and demand of e-skills in Europe.
- The conference "e-Business: The Way Forward" organised on 5-6 December 2005 in Cambridge confirmed that stakeholders see the need for a long term EU e-skills agenda to ensure adequate e-skills for the future across both workforce and population.
- A series of projects is underway in 2006: e-learning benchmarking initiative, benchmarking of e-skills multi-stakeholder partnerships and a feasibility study for the development of a European ICT skills and career portal.

The "Thessaloniki Declaration" adopted at the **European e-skills 2006 Conference** which took place on **5 - 6 October 2006 in Thessaloniki** (www.e-skills-conference.org) confirmed the preparation of the long term strategy to ensure adequate e-skills for the future across both workforce and population (see Annex C).

This study is an integral part of the EU e-skills agenda. Specifically, it follows on from the report on the e-skills labour market delivered by Rand Europe in 2005. The summary of that study and its key findings are shown in Annex D. The intention of this study, within the broad context of the European Commission's Task Force on the Competitiveness of the European ICT Industry and ICT Take-up, is to explore key e-skills issues in Europe in the coming years, in relation to the ICT industry. Thus the analysis must prove of relevance and value to leaders and senior managers within ICT companies based in EU Member States. They must also prove useful to policy-makers – at both European level and within national Governments – who are considering possible policy measures that could benefit both the ICT Industry's competitiveness and the take up of ICT more generally within the economy.

This report is structured into three parts:

- **Part 1: e-skills and the ICT industry in Europe**
- **Part 2: Designing and assessing possible futures**
- **Part 3: Implications, conclusions and recommendations**

Part 1: e-skills and the ICT industry in Europe

2 What e-skills are

2.1 Introduction

The term 'e-skills' covers a wide range of activities and aspects of ICT work, and encompasses the activities of many people involved in different parts of the ICT world. This includes those working in ICT companies, in a wide range of ICT user organisations (e.g. manufacturing companies, banks, government offices, travel tourism enterprises). It also refers to home users, and those working within the educational sector the different perceptions evident from within the wide range of stakeholders involved in European level discussions confirmed the need for clarification to ensure meaningful thinking about future e-skills development.

The **European e-skills Forum** defined the term e-skills in its synthesis report "e-skills in Europe: Towards 2010 and Beyond" (2004). It broadly covers three categories:

- **ICT practitioner skills**: The capabilities required for researching, developing and designing, managing, producing, consulting, marketing, selling, integrating, installing and administrating, maintaining and supporting and service of ICT systems;

- **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 (sectors) other than the ICT industry;

- **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. e-Business skills are strategic and related to innovation-management, rather than technology-management, skills – which are part of ICT practitioner skills.

2.2 What lies behind the definitions?

Both ICT Practitioner and ICT User categories contain a wide range of skills, covering a number of operational functions and competence levels. This two-dimensional structure can be seen by reference to two of the detailed frameworks for these skills that have been developed within the EU.

The accompanying *Background Paper* shows such frameworks, and examples of the specifications of the skills involved are provided. The two frameworks used to illustrate the principles in this document are: the Skills Framework for the Information Age from the SFIA Foundation, and the IT User Framework from e-skills UK, and used in relation to the National Occupational Standards for IT Users and the 'e-skills Passport'. The fact that these two Frameworks were developed in the United Kingdom has no special significance (they were chosen to illustrate the principles). Such frameworks also exist in other EU Member States (e.g. the Advanced IT Training System (AITTS) framework in Germany and the CIGREF[4] Nomenclature framework in France, for ICT Practitioners; and the Digital Skills Framework being developed by the ECDL Foundation, in

[4] Club Informatique des Grandes Entreprises Françaises (ICT Club of large French companies)

relation to user skills). For more information about such frameworks, see the European Standards body's publication CEN Workshop Agreement 15515 (CEN/ISSS, 2006). The fundamental thing to recognise about such frameworks is that:

- They are statements of (competence) requirements that have been developed by (groups of) employers. Their importance lies in the fact that they represent an agreed 'target' at which both individuals seeking employment and learning providers can aim.
- They are in essence, 2-dimensional, in recognition that a number of different operational functions are specified, and that (each of) these may exist at a number of different levels.

It is also important to be clear about the use in this study of the word skill(s). There are two usage nuances of the word.

- The first, the broader meaning, relates to the role of the requirements and capabilities of individuals on both sides of the labour market. Thus skill is a shorthand for 'labour input' in the economic sense, and this is its normal use in the context of this study.
- The second, more narrow, more specific use of skills relates to one set of the specific human capabilities that make an individual of value to an employer. Skills in this context are generally viewed as the ability of the individual to apply the relevant knowledge that s/he has acquired, in the execution of a task, generally in a work context or workplace.

There has been very considerable debate over recent years around the EU, and particularly through the work of the European Centre for Vocational Training – CEDEFOP – about the concepts of knowledge, skills and competence. This has led, in the context of the development of a proposed European Qualifications Framework (EQF) (EU Commission, 2005), to the specification, at 8 levels, of (the 'narrow' meaning of) skills, along with the two other core concepts of human capability. The currently proposed EU-level definitions of Knowledge, Skills and Competence are:

- 'Knowledge' is the outcome of the collection and assimilation of information through learning. In the EQF, knowledge is described as theoretical and/or factual;

- 'Skills' are the ability to apply knowledge and use know-how to complete tasks and solve problems. In the EQF, skills are described as cognitive (use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments); and

- 'Competence' is the proven ability to use knowledge, skills and other abilities to perform a function against a given standard in work or study situations and in professional and/or personal development. In the EQF, 'Competence' is described in terms of responsibility and autonomy.

It is recognised that all three of these capabilities are required in order for the possessor to add value through their work, and one important conclusion from this is that knowledge – which can often be the main (or only) focus of analysis and debate on skills, must be complemented – generally through the acquisition of direct experience – by skills and competence.

3 The ICT Industry in Europe

3.1 Introduction

Many of the scientific and technological innovations associated with the development of ICT have come from European inventiveness and creativity. Examples are early computer prototypes, telecommunications development and mobile phones and the worldwide web etc. It is generally felt that the exploitation of these inventions into products and services that create wealth and jobs has not been as fast, effective and successful within EU Member States as it has in some other parts of the world, notably the US.

This is not an ideal situation from a strategic stand point but there is no doubt that the ICT industries within European Member States have considerable strengths, even though the number of European-owned ICT companies with a significant global market share is limited. Subsidiaries of overseas companies within EU Member States generally represent significant enterprises, creating wealth and jobs of great importance to the European economy. Many large US players (for example, Intel, IBM etc.) draw significantly from leading-edge work in R&D laboratories within Europe for some of their major innovations.

3.2 The scope and structure of the ICT industry

The complex and changing nature and relationships of the sectors (and sub-sectors) involved in ICT has resulted in a number of different perspectives on what should be covered within the industry's scope (see, e.g. OECD (2004, 2006b), Eurostat (2001, 2006a). There are also considerable challenges in trying to validly track and measure the 'Knowledge Economy' more generally (Dixon (2005), Intellect (2006b)).

The traditional way of specifying the scope of economic analysis on different industries is by reference to the generally agreed standard industry classifications used for statistical purposes. The classification used for European data is the Nomenclature of economic activities in the European Community[5] (NACE). The main NACE categories of relevance to this study are seen to be the three major 'classes':

- **NACE 30** **Manufacture of office machinery and computers** (strictly: DL.30.02 - Manufacture of computers and other information processing equipment)
- **NACE 64** Post and **telecommunications** (strictly I .64.20 – Telecommunications), and
- **NACE 72** **Computer and related activities** (strictly: K .72.00 - Computer and related activities)

  Class 72 breaks down into:

  - K .72.10 - Hardware consultancy
  - K .72.20 - Software consultancy and supply
  - K .72.21 - Publishing of software
  - K .72.22 - Other software consultancy and supply
  - K .72.30 - Data processing
  - K .72.40 - Database activities
  - K .72.50 - Maintenance and repair of office, accounting and computing machinery
  - K .72.60 - Other computer related activities

[5] The latest revision of NACE is Rev. 1.1: a new revision is scheduled for 2007

In addition, now that computers and other ICT devices have become consumer commodities, there are wholesale and retail 'channels' for distribution of ICT products:

- G .51.84 - Wholesale of computers, computer peripheral equipment and software
- G .52.45 - Retail sale of electrical household appliances (unit E1) and radio and television goods

Other relevant NACE categories are:

- DE.22.33 - Reproduction of computer media
- DL.32.30 - Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods (this includes the manufacture of – electronic - Telecommunications equipment)
- G .52.72 - Repair of electrical household goods
- K .71.33 - Renting of office machinery and equipment, including computers

Consideration of these categories confirms that the current classification system used for statistical and macro-economic analyses does not provide a particularly helpful structure or discrimination. Conversely, there is a wealth of publicly-available data based on these classifications. In this situation, the analyst is presented with two main options:

1. to use the existing classifications with their known limitations, or
2. to carry out the analysis in some other classification system, that would be 'more natural' from the perspective of those involved in the industry

Table 1 shows the strengths and weaknesses of each approach:

	Benefits	**Disadvantages**
Option A: Use 'traditional' official industry/sectoral classification systems that are used for all official statistics	Allows access to a wide range of data that is comparable between Member States	The structure of the classification (NACE) does not correspond so well to current market & industry realities
Option B: Use a 'new' classification created specifically for the analysis	Classification can be designed to correspond very much better to current (and emerging) industrial and product structures	Most official data will not be able to be used, and in its absence, there are questions about the validity of data from alternative sources. Conclusions resulting from such analysis will generally need to be 'mapped' across to the official classifications

Table 1: Strengths and Weaknesses of adopting different industry classifications

Perhaps the most relevant example of option B is provided in the annual reports of the European Information Technology Observatory (EITO). While the estimates and forecasts provided in the EITO reports are very interesting, they are largely based on industry data provided by IDC from undeclared, not-public-domain sources on a commercial-in-confidence basis, and reconciling them with official statistics is complex. The numerical analysis and forecasting of the kind presented in the EITO reports is of considerable interest to industry observers. As this study is set in the context

of policy analysis and development, there is no real alternative to the adoption of the official classification in order to base the analysis on data that provides the current trusted evidence for all policy work. This is the official national statistics relating to industrial sectoral activity, and the central holding of this data by the European Statistical Office (Eurostat).

These challenges are now widely recognised, and there are efforts to tackle them at the European/OECD level. It is the desire of the European Commission that studies of this kind should, wherever possible, attempt to draw on both public and private data sources. The fact that both have strengths and weaknesses supports the aspiration that an effective public-private partnership on this work could be very valuable.

The European Information, Communications and Consumer Electronics Technology Industry Associations (EICTA), the European representative body, distinguishes between the ICT and consumer electronics sectors. While the growing convergence of the underlying enabling technologies challenges many boundaries in ICT products and the associated markets, this study focuses primarily on the 'core' ICT technologies sectors. It does not pay explicit attention to the Consumer Electronics market. EITO classifies the European ICT market, excluding consumer electronics, into the following categories and sub-categories:

Computer Hardware:
Server Systems
PCs
Other computer Hardware and add-ons
End-User communications equipment:
Mobile Telephone sets
Other End-User communications equipment
Office Equipment:
Copiers
Other Office Equipment
Datacoms. and Network equipment:
PBX, key systems, circuit-switching eqt. and transmission
cellular mobile radio infrastructure
packet switching and routing equipment
other datacoms. and network equipment
Software Products:
System Software
Application Software
IT Services
Carrier Services:
Fixed voice telephone services
Fixed data services
Mobile telephone services
CaTV services

Table 2: European ICT market

The overall economic scale and setting of the ICT industry can be seen from Figure 1, using EITO 2006 data, showing estimates of recent, current and projected market size:

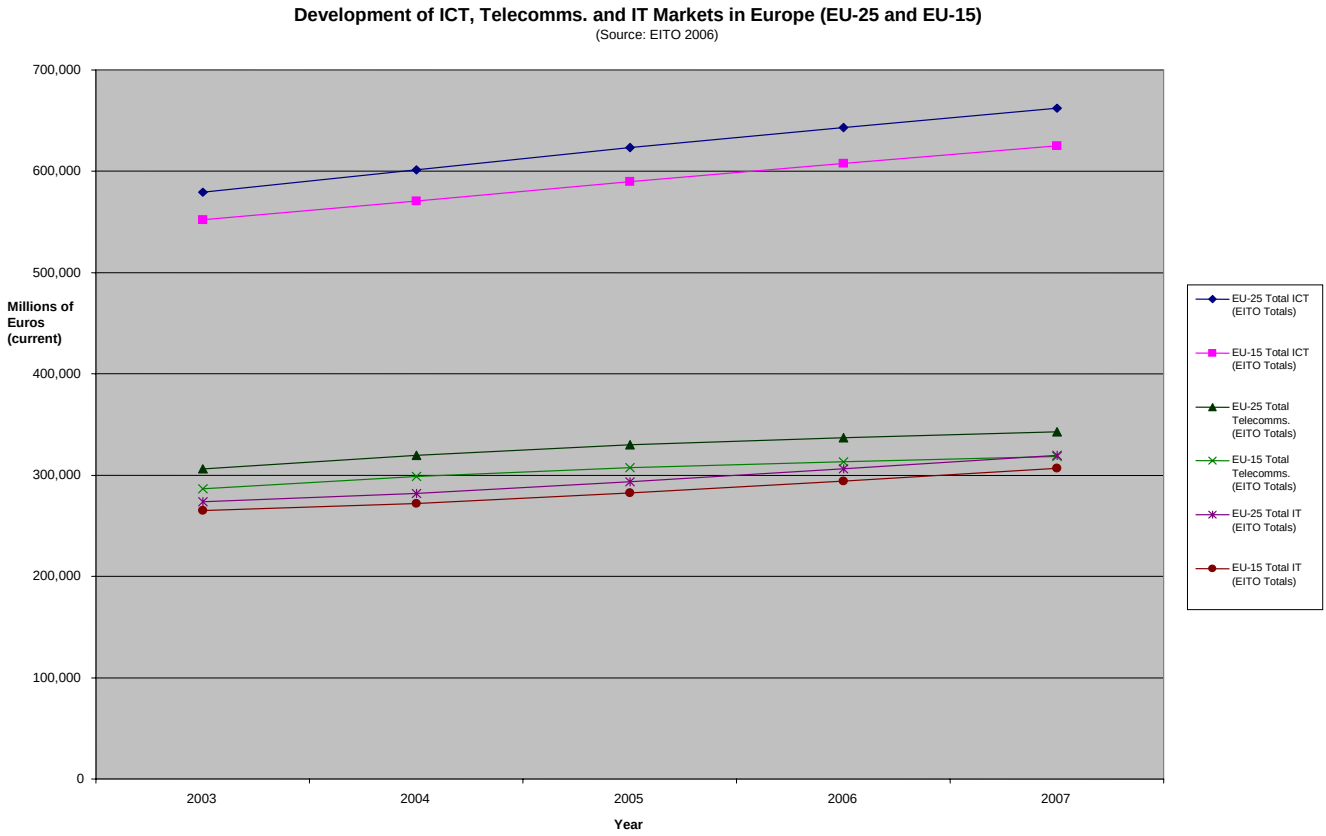


Figure 1: European ICT, Telecomms, and IT markets

Some clear features can be seen:

- That (following the significant upheavals in the ICT world between 2000 and 2003), the markets have been comparatively buoyant from 2003 (some 11% increase over the 3 years for the EU-25 ICT Market, with ~10% in telecoms and ~12% in the IT Market)
- The ICT Industry in the new Member States have, between them, contributed some 5½% to the total ICT market (~7% to the telecoms market and ~4% for the IT market)
- The telecoms and IT markets are very comparable in size, with the telecomms. market having been a little larger than the IT one, although IT spend is now beginning to catch-up and overtake it.

3.2.1 Convergence

More than most previous technologies, ICT is changing the nature of work and of markets. From the early days of IT, it was clear that bringing together Computers and Telecommunications would produce a combination of immense power and potential. The arrival of the Internet in the mid-1990s, and the subsequent technological refinements and advances, has begun to challenge a number of traditional market structures and infrastructures. Powerful examples are:

- The impact of broadband access by large numbers of end-users poses challenges to traditional telephone services and markets, leading to a central threat to traditional telephone prices and indeed business survival;
- The next generation of broadband will allow transmission of video images and real time video content, thus providing options for viewers that by-pass existing broadcast and film infrastructure;

- The ability of high-speed digital transmission at low cost has already begun to threaten existing markets and price structures for music consumption;

- Digital Television and Radio.

The opportunity for very low cost digital transmission (which can essentially convey any kind of information content) across comparatively high bandwidth links all the way to the business and domestic user, poses real threats to all traditional delivery of content, whether 'informational' or for entertainment purposes. In the resulting turmoil (still underway in 2006), people are seeking new business models that will exploit the opportunities offered by the new infrastructure without removing – or too adversely affecting – the revenue streams that allow the content provider to earn a living. Table 3 (based on EITO, 2005) shows the nature of the structure, in terms of content categories and access platforms, of the on-line content marketplace relating to the changes that are expected: a market is developing in every cell of the matrix: EITO estimates of market value for 2004 are shown (EITO, 2005).

Content categories:	Online Music	Online Games	Online Video	Online publishing	
Access ⇩Platforms⇩	Consumer				Business
Digital TV	€0 (no service in 2004)	€236m	€166m	€0 (no service in 2004)	(€0)
Broadband PC	€40m	€82m	€46m	€373m	€8,374
Mobile	€0.6m	€254m	€150m	€288m	€88m

Table 3: Structure of digital content

3.3 The scope of the study analysis

Overall, within ICT Industry and statistics bodies, most economists and analysts generally distinguish between three main sub-sectors within the ICT Industries: a) (electronics) hardware manufacture and maintenance; b) Software and IT Services, and c) Telecomms. services. In spite of a major level of convergence of the enabling technologies, IT Services and Telecommunications Services are sufficiently different in character to make an 'ICT Services' category of limited meaning.

The ICT Industry categories considered for this Study are:

1) Manufacturing of ICT products (computers, telecommunications equipment, and other devices): "**ICT Hardware**";

2) Provision of Telecommunications services ("**Telecommunications**"); and

3) Production of software and provision of IT services ("**Software and IT Services**");

3.4 Key skills concerns of the ICT industry

The ICT industry has long suffered from challenges to find enough skilled and talented people. A telling quote from a senior manager in a major European software house makes the point: "Issues like the availability of staff with the right skills for each development in our industry have plagued us ever since I joined the industry forty years ago."

The problem is not surprising if one considers the pace at which computing and communications have developed. With respect to ICT practitioners, until very recently, there were few (if any) years during which the 'traditional professional supply channels' ('vocational' tertiary education courses) provided cohorts that were as great as the net demand that the growth of the ICT industry required. In the absence of 'properly-trained' young professionals, the insatiable demand from employers arising from the remarkable growth levels attracted a wide range of people (generally university graduates) without a base of deeper technical understanding of the technologies.

While the ICT industry has its own needs for ICT User Skills and (in particular, e-Business skills), the main concern of the ICT Industry has been finding sufficient numbers of technically-capable practitioners to feed the rapid growth.

It is in the interests of ICT companies for ICT User skills to be widely available. If ICT products and services are widely understood and effectively used, they will add value to business processes, pay their way, gain respect and stimulate future consumption. As will be seen in the next sub-section, many large ICT companies make significant investments in relationships with educational institutions, and will benefit from public investment in ICT user skills. In addition, some ICT products can enable users to do more than be productive. Although the overall productivity contribution of ICT user skills is the area where most interest has been focused of late, the innovation-enabling features of powerful ICT systems must also be recognised. Inventive people who, as ICT users, become familiar with the capabilities of powerful pieces of software (whether spreadsheet, database tools or Computer-Aided Design (CAD) systems) can often create ideas for significant new applications or application areas.

3.5 Industry skills initiatives

Industry has responded to these skills supply limitations with a range of initiatives, combining contributions to the public good and making good the shortfalls in public provision. Outlines of some significant examples of current approaches, summarised from information published on the relevant websites, are shown below.

3.5.1 eSCC/Microsoft

> *The European Alliance on Skills for Employability is a partnership between the e-skills Certification Consortium (eSCC) (whose members are Cisco, CompTIA, EXIN, Microsoft and the European Computer Driving Licence (ECDL) Foundation), with Randstad and State Street Corporation. The Alliance aims to help train and provide access to technology for 20 million Europeans by 2010 by investing in and promoting the provision of skills training for employability to disadvantaged groups: young under- and un-employed workers, older at-risk workers, and people with disabilities.*
>
> *Working with government, industry and Non-Governmental Organisation (NGO) partners across Europe the Alliance will be investing in partnerships that aim to support and assist:*

- *today's untapped work force – unemployed youth who have dropped out of education and the over-50s who need new skills and confidence to find jobs later in life – to gain basic IT skills for work and life through local community IT training centres, IT academies and online training;*
- *tomorrow's European knowledge workers – by bringing IT skills into the mainstream of schools curricula with an emphasis on support and training for teachers, students and their communities; and thus supporting*
- *Europe's Small and Medium-sized Enterprises (SME)s by enabling them to widen their recruitment base of local people able to use IT as tools for business growth and innovation.*

3.5.2 Intel

Enhanced business skills around Europe would ensure a better transition from the technical innovation phase to the go-to-market phase, where initially most of the responsibilities and ownership is taken on by the technical entrepreneur. An example of the private sector addressing this challenge is the cooperation between Intel's Philanthropic Education Group with UC Berkeley's Haas Business School of Entrepreneurship in developing the worldwide programme and curricula for "Technology Entrepreneurship – Theory to Practice". Over 300 professors in Europe have already been trained on how to teach Technology Entrepreneurship at their universities. Intel actively seeks the partnership of governments and educational institutions who want to help drive the technical entrepreneur agenda forwards.

While the ICT training for teachers is a necessary step, a further requirement is to help teachers of various subjects to better understand how ICT technology can be embedded into their teaching and to change teaching methods by using the newly acquired ICT skills meaningfully in their classrooms. An industry-led initiative, the Intel Teach to the Future Program, has taken on this challenge and trained more than 3 million teachers worldwide, amongst them around 703,000 in EU countries. Currently, the Intel Teach Program is moving towards an online platform (already running in Germany and Austria) which will certainly drive these numbers further up.

3.5.3 CNAP

The Cisco Networking Academy Programme, started 10 years ago and running now in 160 countries, is probably the largest industry-led ICT training and certification program operating as public-private partnerships. It enables the right skills to get out to the market quickly and cost effectively. In the EU today, the Program has more than 3,000 networking academies and 7,000 teachers. It has impacted more than 1 million students in Europe.

In addition to the major up-skilling of network professionals and technicians through this worldwide provision, the Cisco Networking Academy Program also helps bridge the gap between those who can effectively use new technology and communication tools, such as the Internet, and those who cannot. Academies located in underserved communities and countries help local people learn the IT skills they need to join the global Internet Economy. This experience is disseminated through the CNAP Web presence, with the site showing best practices, successful strategies, and useful tools for those organizations and Academies that support underserved populations around the world.

In addition, certain populations have been left behind in the digital economy due to a lack of access to technology. The Program works to achieve digital equity in underserved areas to benefit low-income individuals, certain ethnic groups, people in disadvantaged communities and those with disabilities.

3.5.4 SAP university alliances programme

This program enables schools of business, IT and engineering to use SAP solutions in the academic environment. Through demonstrations, exercises and problems, case studies and research projects, students are able to put theory into practice, enhancing their educational experience. Initially launched in Germany in 1988, the program has some 500 participating universities in 36 countries and on all populated continents. More than 2,200 faculty members are now proficient in SAP technology and 130,000 students participate in courses supported by SAP software.

3.5.5 Sun Microsystems

Sun is committed to helping educators use and adapt new technologies through business partnerships with Primary and Secondary ('K-12') & Higher Education institutions. Sun has a range of relationships with tertiary education institutions: support is provided for teachers, researchers and students. For those responsible for managing or administrating networks of computers in their departments, Sun provides helpful resources, contacts, discount programs, and opportunities to connect with peers.

In addition Sun has programs for primary and secondary education ('K-12' in the United States). In particular, Sun is working to create the 'schools of the 21st century' by developing new models of instruction, where students are able to utilise the network to become active learners and teachers are empowered with network-based tools that promote student-centred instruction.

These initiatives show the kinds of commitments undertaken by some of the large ICT companies in the learning field. There are clearly philanthropic dimensions to the initiatives, and it is possible to detect three main types of objectives:

1) Straight investments for the public good – a natural part of a Corporate Social Responsibility agenda;
2) Investments in 'customer/potential customer education' that will improve the effectiveness of use of the company's products and grow the future customer base, and
3) Programmes that are initiated in response to a substantive need for skills that are not provided by the public education system.

Some of the investment made by companies involves activity around the *certification* of skills for their software products. These industry ('vendor') certifications are a significant development, and can lead to significant revenue streams[6]. As such they cannot be viewed as a purely philanthropic investment. Their development and market penetration alongside the formal education system has led to the co-existence of two 'parallel universes' (Adelman, 2000). Efforts continue to reconcile and better integrate these two worlds.

[6] CompTIA also provides Vendor-neutral certifications, with widespread take-up on the global scale.

3.6 Recent employment levels

The quantitative analysis of ICT Practitioner skills in this study explores the development of employment levels of *Computing Professionals* and *Computer Associate Professionals* (which can together be reasonably viewed as *IT Practitioners*[7]) drawing on data from the Labour Force Surveys carried out in all Member States and submitted, on a quarterly basis, to Eurostat.

The data presented usually relate to employment levels in ICT-related sectors and occupations. It is now recognised (Huws, 2003) that there are real quality issues with these aspects of LFS data arising from differences between Member State occupational classifications and the implementation of the 'mapping', and this must be recognised when interpreting the following charts. However, these datasets represent the only comprehensive source of broadly comparable data across the European Union. As with all less-than-perfect data sources, where the measurement process remains essentially unchanged, trend data contains important evidence, even if what the indicator is measuring is not what would be desirable. In particular, as explained above, this official data is constrained by the classification systems in use – in this case NACE for the sectoral breakdown and ISCO for the occupations. For estimating employment in specific sectors, the majority of the analysis in this study concentrates on:

- NACE 30 and NACE 32 (which can be assumed to contain within them the vast majority of 'Broad Hardware Production' - indeed the figures would normally be an over-estimate of employment levels in the manufacture of computing and telecommunications equipment), and
- NACE 72 (which can reasonably be viewed as validly covering the Software and IT Services sectors).

The main gap in coverage that remains relates to Telecommunications Services (NACE 64.2), which is not available from LFS data separately from employment in Postal Services (since data is only available for all Member States for the 2-digit NACE 64 category).

With regard to occupations, the data examines ISCO 213 (Computing Professionals) and ISCO 312 (Computer Associate Professionals). This leaves a gap in relation to the hardware engineering occupations, for which data is only available in two larger groups: ISCO 210 (Physical, mathematical and engineering science professionals) and 310 (Physical and engineering science associate professionals). While employment levels of electronics (and telecommunications) engineers are included within 210, and those of electronics technicians form part of 310, these also include the engineers and technicians from all the other engineering disciplines – including civil, mechanical, chemical, aeronautical, marine, and even electrical – as well as all branches of science and other occupations. It is normally assumed that (at the European level) it is not possible to discriminate down to the level of electronics engineers and technicians from this data.

The following charts show the recent development of employment levels for the EU-15 (data for the new Member States is generally only available for a small number of years), in relation to:

- **Computing Professionals and Computer Associate Professionals** (taken together, as *IT Practitioners* – ISCO 213+312), and other occupations, and
- the three sectoral components of the ICT Industry: **Broad (Electronics) Hardware Production sector** (NACE 30+32), **Telecommunications services** (NACE 64.2) **and the Software and IT Services sectors** (NACE 72).

[7] ISCO 213 ("Computing Professionals") and ISCO 312 (Computer Associate Professionals") must be recognised to be the ***core technical*** IT Practitioners, since the categories do not include IT managers, nor those concerned with sales and marketing aspects of IT work, nor those who teach IT within the formal education system (or provide IT training).

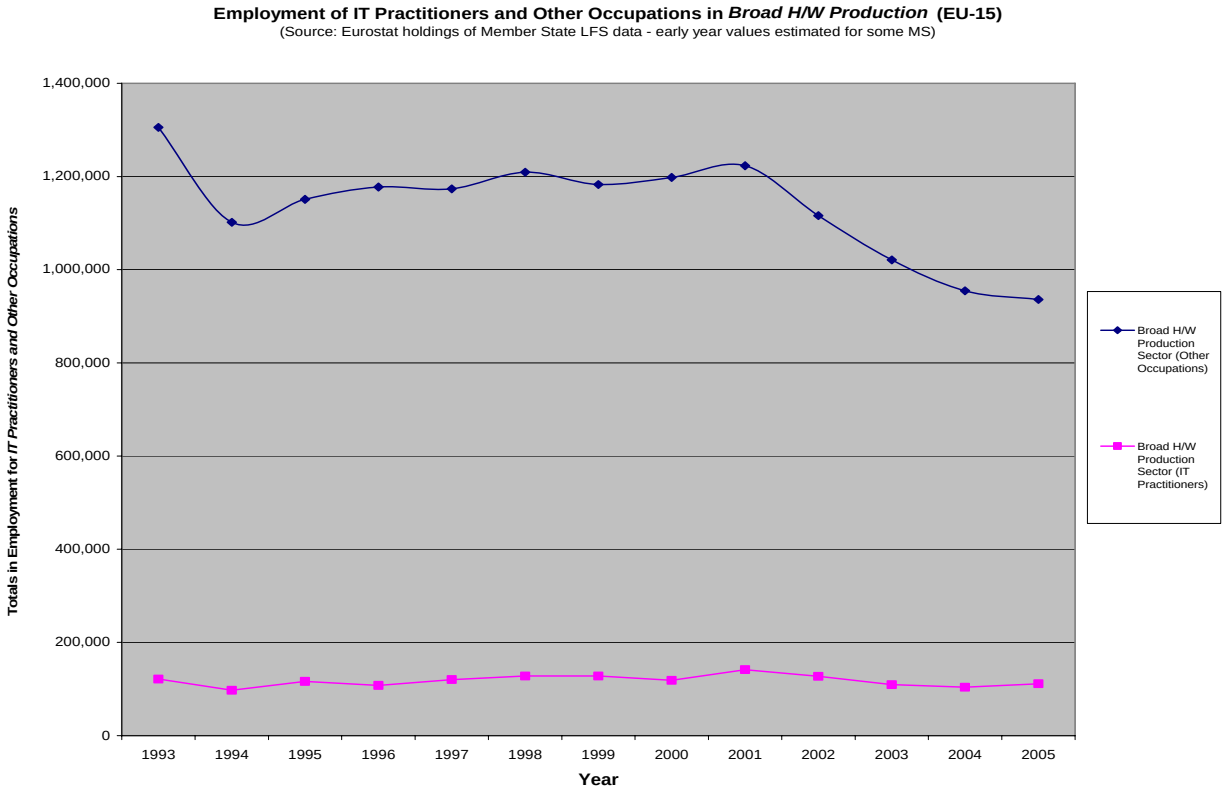


Figure 2: Employment in ICT Hardware production

Strong features of recent development are the significant drop-off of employment levels in European electronics manufacture – in particular in the non IT Practitioner occupations – over the last five years.

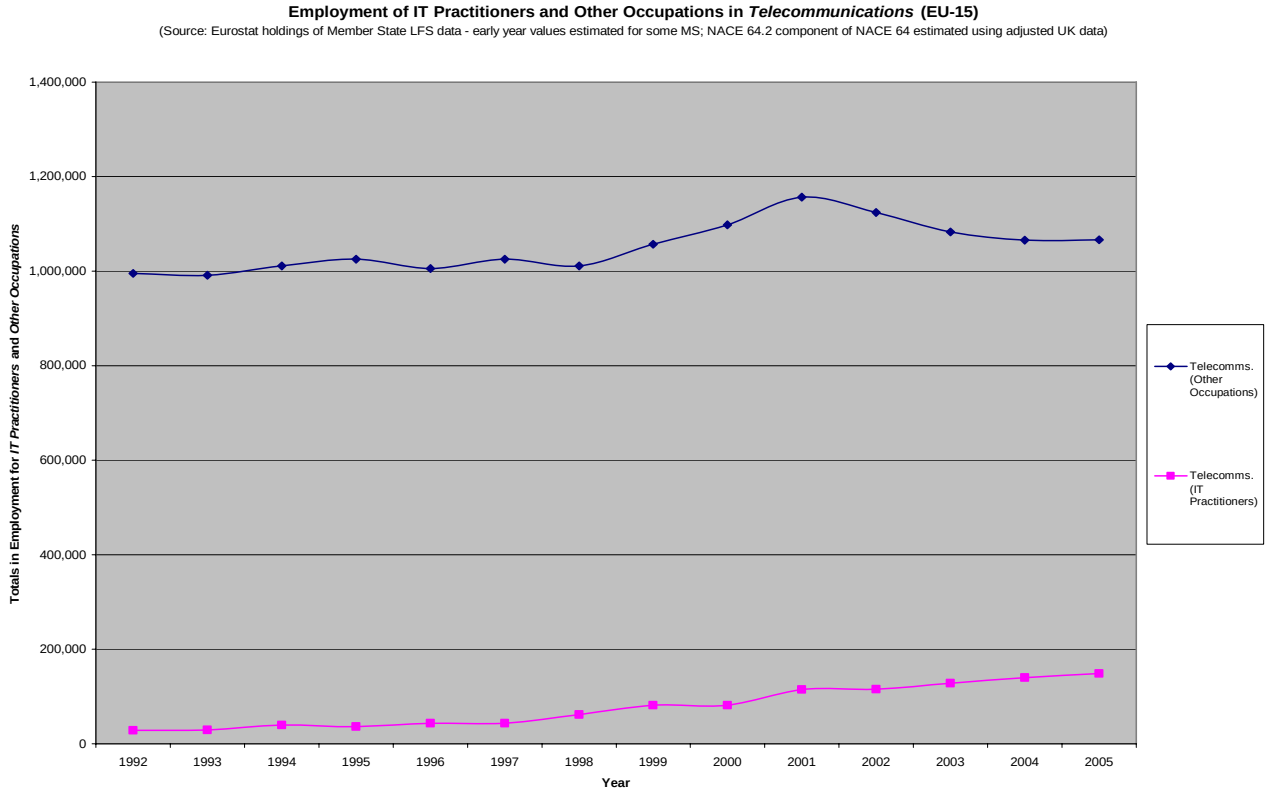


Figure 3: Employment in Telecommunications

By contrast, in European *Telecommunications* employment, there is steady growth of numbers in IT practitioner occupations from a comparatively low base, reflecting the growing role of software in Telecomms. systems and services. The peak associated with the dot.com activity is noticeable, but, although employment in other occupations eased, the 'bubble burst' did not slow the growth of IT practitioners significantly.

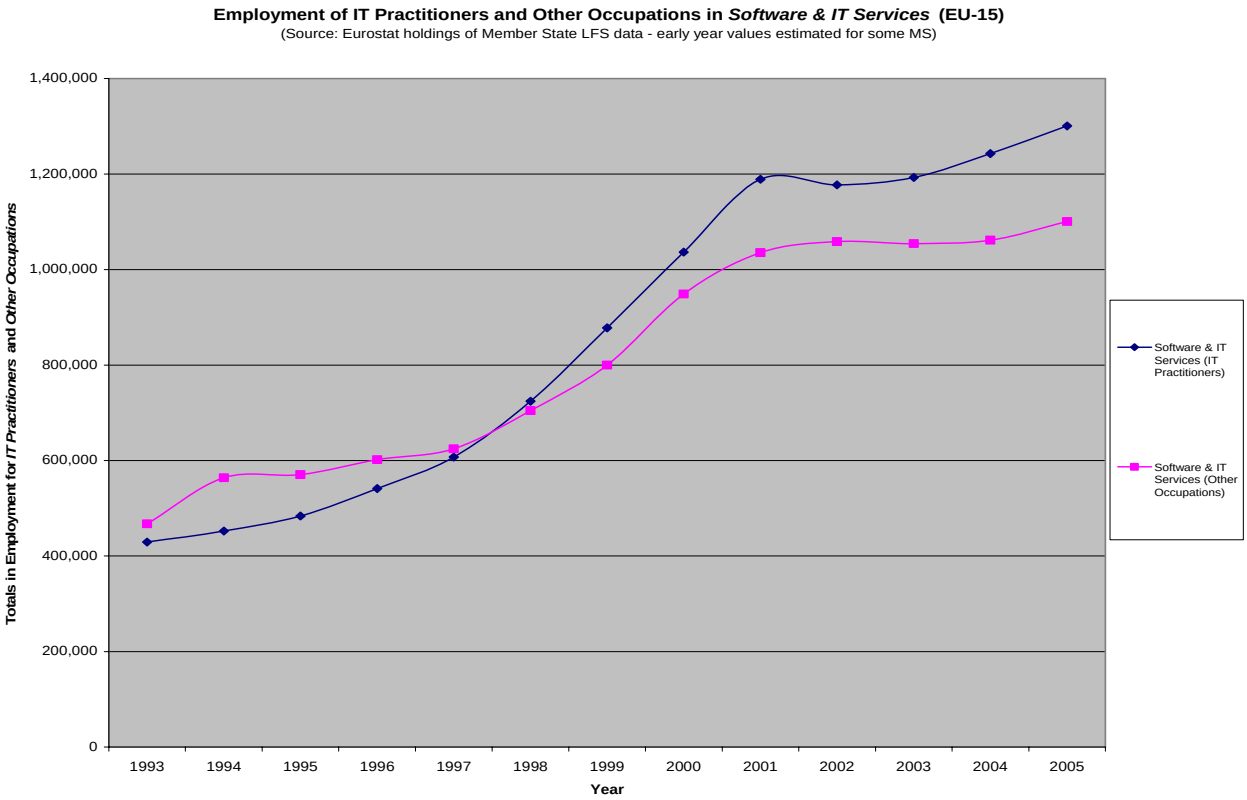


Figure 4: Employment in software and IT services

Even greater employment level rises occurred in the *Software and IT Services* sector over recent years, albeit checked notably in 2001-2002 in the wake of the 'dot.com bubble burst'. The other clear feature is the steady eroding of relative levels of 'non-technical' staff.

IT Practitioners are also employed in the 'ICT User Sectors' of the economy: Figure 5 shows how the fraction of IT Practitioners employed in the three 'supply' sectors has developed over recent years.

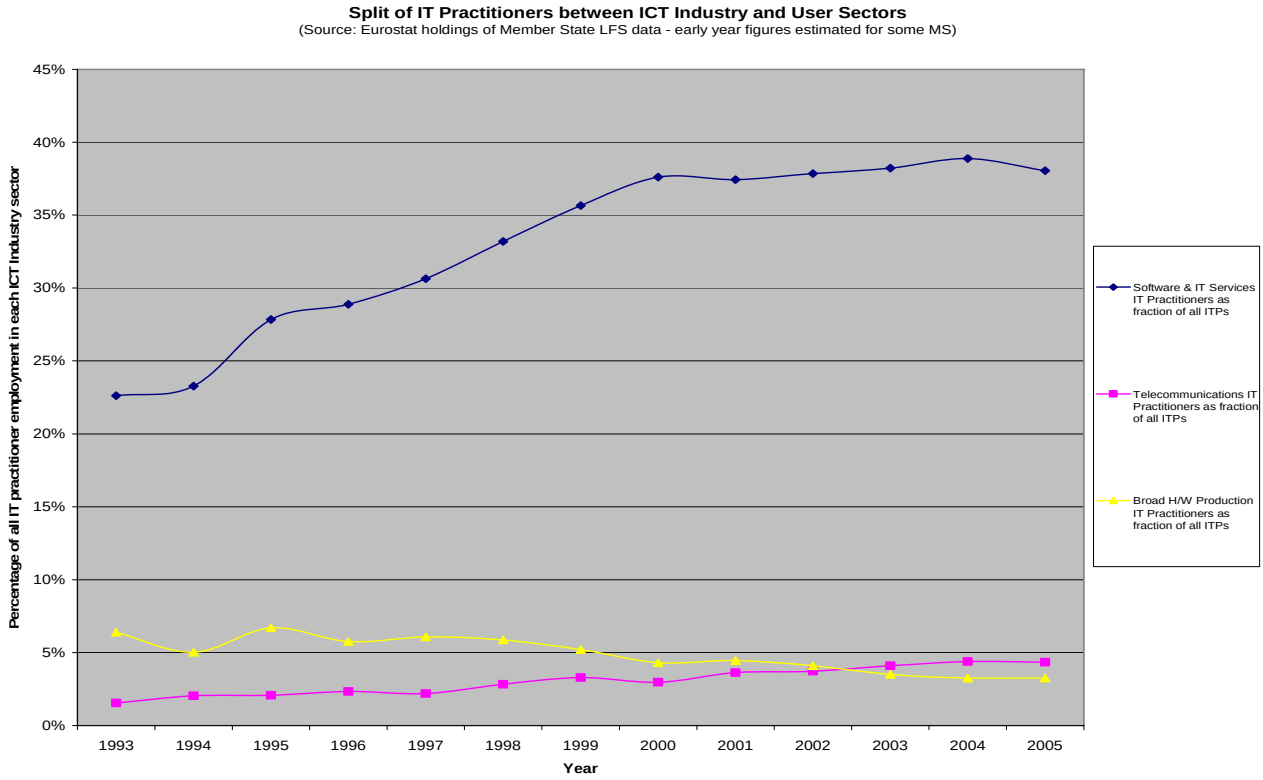


Figure 5: Contribution of IT Practitioners in ICT Industry to the total ITP workforce

The recent trends show:

- steady, but decreasing, growth in the contribution of IT Practitioners that are employed in the Software and IT Services sectors;
- steady growth in ITPs working in Telecomms.; and
- a slowing falling percentage of IT Practitioner employment present in the Broad Hardware Production sectors.
- a steady rise in the total 'supply side' contribution from some 30% in 1993 to around 46% in 2005.

For clarification, figures for the different sections of the workforce examined in these charts can be seen from Table 4:

		Software & IT Services	**Broad Hardware Production**	**Telecomm-unications** (80% of NACE 64)	**Total Hardware, Software, IT Services and Telecomms.**
EU-15	(Core, Technical) IT Practitioners (ISCO 213+312)	1,300,000	110,000	118,400	**1,528,400**
	ICT Practitioners beyond ISCO 213&312*	150,000	90,000	92,000	**332,000**
	Total ICT Practitioners	**1,450,000**	**200,000**	210,400	**1,860,400**
	Other Occupations	950,000	846,000	2,044,000	**3,840,000**
	Total	2,400,000	1,046,000	2,254,000	**5,700,000**
EU-25	(Core, Technical) IT Practitioners (ISCO 213+312)	1,417,000	119,900	129,000	**1,666,000**
	ICT Practitioners beyond ISCO 213&312*	164,000	98,000	100,000	**362,000**
	Total ICT Practitioners	**1,581,000**	**218,000**	229,000	**2,028,000**
	Other Occupations	1,035,500	922,000	2,228,000	**4,186,000**
	Total	2,616,000	1,140,000	2,457,000	**6,213,000**

Table 4: The structure of European ICT Industry employment (figures rounded)

It should be noted that, since ISCO 213 and 312 cover the 'core technical' occupations, the figures (and percentages) for ICT practitioners as a whole, including (e.g.) ICT Managers, Trainers and those involved in Sales & Marketing of ICT products and services, will be higher (probably by about 10-15%) than those shown. Details of the development over recent years of the equivalent *Software and IT Services* employment levels in individual Member States are shown in Annex E.

3.8 Strategies and approaches of leading ICT companies

How have ICT companies responded to the human resource (HR) recruitment and retention challenges arising from the swings? Probably the two main approaches in the turbulence of the labour market environment in which these companies have had to operate have been described as 'coping', and 'not quite coping'.

The 'coping' situation involved the recruitment of intelligent, highly educated, people without the tertiary education base in the field that would be the normal basis for a traditional profession, with adequately professional practice and professionalism of delivery. Graduates were recruited from non-ICT courses initially from 'allied' disciplines, e.g. mathematics, science and engineering, and thereafter from a broader set of disciplines. It was recognised that systems analysis and programming required a clear, disciplined and logical approach, rather than particular expertise in

mathematics or any of the physical sciences. It also required effective communication with the customer (ICT user organisation), which was increasingly recognised as crucial to successful specification and implementation.

The 'not quite coping' situation has over time given rise to problems with delivery of projects within the agreed deadline and to an adequate quality. While ICT application to some areas provided greater challenges than others in this respect, the existence of many examples of 'failed' ICT system development projects, in particular in the public sector, bears witness to the fact that ICT is far from achieving maturity in terms of delivery as expected. Perhaps the greatest impact of this has been that the true cost of developing systems that are delivered on time, perform well from the start, and cost what was agreed as the initial price is probably still not recognised or accepted.

Concerns about the quality issue in system development, delivery and performance have produced efforts to improve the professionalism of ICT work, and so the professionalism of ICT Practitioners. Although strong competitive pressures within the marketplace continue to limit the amount of time and resource available for such activity, there appears to be a growing recognition of the importance of raising levels of professionalism within the ICT Practitioner workforce, as exemplified in the British Computer Society's current ProfIT programme[8]

In addition to the general approach, most ICT Industry companies that depend on leading edge techniques and technologies have[9] attempted to develop partnerships with leading edge ICT teams, whether in university departments or high-tech Small and Medium-sized Enterprises (SMEs).

The final element of the ICT Industry's response strategy to the problems of supply has consisted of the establishment of educational programmes that have addressed, in one way or another, some of the limitations of public sector provision through the formal Education system.

3.9 Attractiveness of Europe to the ICT industry

One of the key strategic aspects of Europe's potential in relation to expected globalisation trends is its comparative attractiveness for inward investment, in-sourcing, and/or the establishment of certain high-value or leading-edge centres by global players. Europe has a wide range of attractions in a global context:

- good business climate;
- large, attractive markets;
- stable currencies;
- good legal structures, and;
- stable democracies and historical heritage;
- cosmopolitan cities with many attractions;
- attractive countryside; and
- a wide variety of cultural strengths.

However for inward investment factors like comparatively favourable tax regimes and availability of highly skilled workforces are particularly important. Perhaps the most challenging issue concerning the attractiveness of Europe to major global ICT companies relates to Europe's universities. On the one hand these represent an enormous wealth of intellectual resource across an extra-ordinarily wide range of academic disciplines, while on the other, experience suggests that

[8] see http://www.bcs.org/server.php?show=nav.8627
[9] unless they have, like the leading global players, been able to afford their own research laboratories

few European universities have managed, or chosen, to 'gear up' to an ability to provide ICT companies with some of the capabilities for major high-speed response to those companies' needs (Nokia's disappointment with what European universities could provide in response to its need for a high-speed skilling up of Symbian engineers is a good example). Comparative surveys of quality and performance of universities around the world have identified comparatively few in the top echelons of the rankings.

In fact European universities have been undergoing comparatively very radical change over recent years, arising from the Bologna Declaration of 1999, with longer courses generally be re-structured into two 'cycles' corresponding to the 'Anglo-Saxon' Bachelors and Masters arrangements. This change increasingly allows European universities to compete in the global tertiary education market, since 'entry' and 'exit' points allow mobile students to move between European and (e.g.) North American universities between 'cycles'. Significantly courses at European continental universities are beginning also to be given in English. In relation to language issues more generally, many global players – even ones from Sweden and Germany – increasingly use English as the *de facto* working language within their organisations. This means that basic and technical English is in practice a requirement on most who want to work in ICT.

This major upheaval is providing a new reaction to external pressures, and may provide a strategic opportunity for achieving other refinements in the EU Higher Education landscape, in particular in relation to universities' approach to responding to market and labour market needs.

3.10 The context of Skills and human resource management

As already indicated, the management of ICT Practitioner skills has not been an easy task over the years. In addition to the challenge of clarifying effective work organisation and skill needs, there are some indications that a 'constrained-quality market equilibrium'[10] may have emerged here. If bidding competitively for major ICT contracts involves having to trim margins to the bone, then this puts pressure on many types of cost, and in particular reduces the flexibility that might allow more training investment. There are also times when such competitive pressure can lead to situations that test the professional integrity of the ICT Practitioners involved.

The challenge of effective management of large teams of ICT Practitioners has led to efforts to structure the roles and skill requirements more formally than would be necessary in less complex occupational areas. This has led to investment in the development of processes and frameworks that have proved of value. While many major ICT Industry players have developed their own skills/competence frameworks, in some cases companies have come together, often with support from the public sector, to develop public domain frameworks.

3.11 European internal market and Europe as an 'ICT space'

Many EU-levels measures, in particular arising from establishment of the Single European Market, and in recent years from efforts to achieve by 2010 the ambitious Lisbon objectives, are strengthening the integration of national ICT markets. However, there are a number of hurdles still to be overcome.

The continuing element of heterogeneity among national ICT market conditions within Member States (as compared, for example, with those within North American economies), taken with the fact that the internet has enabled interactions (including those, commercial or otherwise, about ICT)

[10] where, as indicated above, the real cost of developing a system on a truly professional basis is not recognised in the market-place

to become truly global, will need to be taken into account in any process of policy development in this area. It will be important and challenging to strike the right balance between EU and national-level analyses and perspectives in relation to policy responses. The EU-level/Member State-level balance for policy response is considered more in Section 5.

4 Origins of demand and supply and the behaviour of the labour market

In order to inform thinking about future developments it is important to clarify the dynamic behaviour of the labour markets relating to the three types of e-skills. In doing so it is necessary to consider the sources of supply and demand. It is also important to examine the way in which market behaviour in both the primary and secondary markets for skills operates to generate supply in response to demand.

4.1 Sources of supply and demand

In order to validly assess the labour markets for the different types of e-Skills, both sides of those labour markets need to be examined (*supply* and *demand*). This sub-section attempts to review these. In essence, employers can choose to deploy Human Resources (HR) by one of three methods:

- get work done by the organisation's own staff (which requires that there are enough staff available with adequate skills to do the work);
- bring in self-employed contractors to do the work (often assumed to be used mostly for temporary assignments;
- sub-contract the work to a provider of the required service ('out-sourcing').

As the amount of work increases, additional resource can be acquired by:

- recruiting additional staff who have the required skills;
- up-skilling existing staff to perform the additional work (and making arrangements for carrying out what that staff member was previously occupied with);
- bringing in (more) contract staff (or perhaps using more of existing contractor's time); and/or
- out-sourcing the additional work.

The choices made by employers between these options within the ICT Industry in Europe vary between organisations and cultures and may also change over time.

As with all labour market issues, it is necessary to remember that the qualities required for adding value through employment are not limited to the *knowledge* the individual employee or jobseeker possesses. As recognised in the development of the European Qualifications Framework (EU Commission, 2005) it is a combination of *Knowledge*, *Skills* and *Competences* that provides the capability of an individual to add value through employment.

These capabilities increase over an individual's lifetime, with growing experience (of all kinds) as well as a certain amount of (generally) job-related training during the course of a career. More substantial learning can also be obtained through taking further or higher education courses as a mature student. While much of skills policy tends to focus on public provision through the formal education system (which generally occurs at the beginning of a career), it is important to remember both a) the many pressures on formal education curricula, and b) the fact that certain learning is acquired only from workplace experience.

While *work placements* are increasingly popular in tertiary education courses, it is rarely the case that young people emerging from a formal education system will have had much opportunity to acquire experience of the kind that different employers believe they need. Thus where employers

are hesitant to recruit people without experience, it is important to remember the 'catch 22' situation that can arise as a result: where can students acquire their initial experience?

When considering the sources of e-Skills supply for a labour market, it is essential to remember to think beyond formal education.

These sources of demand and supply – and the market responses to differences between them – operate differently for the three different types of e-skills. These sources and market responses are examined in some detail in the *Background Paper* to this report, but Table 5 summarises the key factors involved:

	Origins of Demand	**Sources of Supply**
ICT Practitioner skills	• Employer recruitment of Practitioners • Individual job seekers • Recruitment intermediaries • Reduction of demand with an economy where practitioner work is off-shored	• Higher education or VET courses in ICT • Conversion courses for those graduating from Non-ICT degrees • Commercial training courses on narrower technical areas
ICT User skills	• Employer recruitment (ICT user skills a subset of the employer requirements) • Individual job seekers (basic level of ICT User skills now mandatory for certain work – in particular office-work) • Reduction of demand where (low end?) jobs are off-shored • Reduction of demand where (low-end?) jobs using ICTs are automated	• Early (self-taught) learning, by exposure to ICT devices in the home, and informal work-based learning • User training within formal education (generally secondary and tertiary courses) • Commercial training courses, sometimes leading to a user qualification or certification (e.g. MOS or ECDL)
e-Business skills	• (Senior) management recognition of lack of expertise, where (more) effective exploitation of ICTs is realised to be competitive necessity – e.g. internet presence • This realisation is often felt to be too slow in some European businesses – part of policy challenge becomes to help raise demand for various aspects of e-skills – in particular e-Business skills	• Higher Education courses (generally at post-graduate level) • Commercial courses (generally on specific technical aspects) • Management briefings from external experts (e.g. consultants)

Table 5: Sources of supply and demand

4.2 Dynamic Effects of the ICT Practitioner Labour Market

The ICT Industry has, throughout its development, suffered from chronic shortages of supply of appropriately educated and trained people. This is largely because the growth of computing since the 1970s has been very much greater than the capacity of the traditional skills supply channels (in particular tertiary education courses) to provide for it, and the continuing changes underway in technologies and their application have posed continuing problems for responding. This huge growth, while overall quite remarkable, has not been steady. In particular, the recession of the early 1990s resulted in a loss of impetus and shedding of labour, and the dramatic swing of business confidence between the late 1990s and the early years of the new Millennium is only the latest and most dramatic of a series of swings. The growth in investment in Software within the EU (a good proxy for the growth of Software and IT Services activity) has undergone several significant swings since 1980. Even when considered as a fraction of other investment (which compensates for swings in overall economic development), several swings are evident. As a result, the experience over recent decades of ICT Industry employers has been one of both general insufficiency of graduate recruits and of alternating periods of severe shortage and retrenchment.

It is worth recognising that the continuing change of the ICT world poses a considerable challenge to attempts to validly track, assess and respond to e-skills needs. The seemingly relentless emergence of new tools, approaches and techniques prevent easy or valid identification and structuring of requirements. The 'waves of change' feed though to the derivative processes, in a way that needs to be understood in relation to skills/competence frameworks, and the specification of training needs that arise from it.

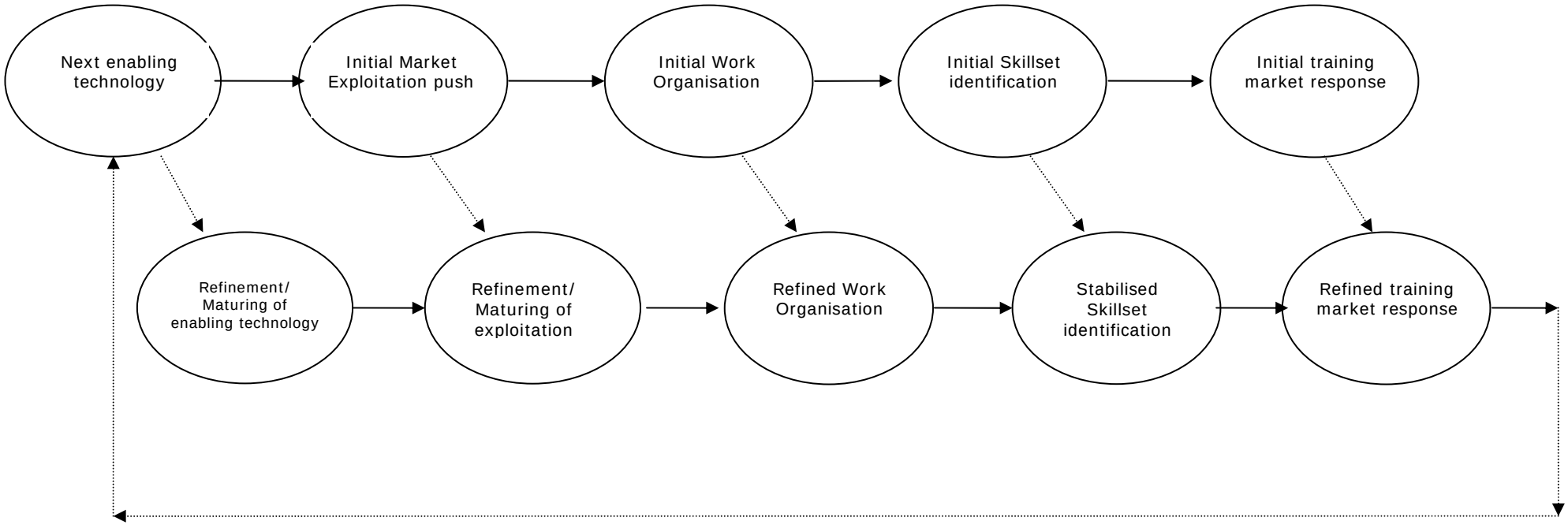
Successful exploitation of ICTs requires an organised structuring of a number of sequential steps for each new technology, including a) ICT exploitation (producing systems and applications from the new technology); b) Work organisation; c) Skill set identification; and d) Training market response. Figure 6 overleaf, from CEN/ISSS (2006), shows the process in more detail.

In terms of the dynamics of the market, two examples show the pitfalls inherent in the realities of supply and demand. The range of sources of labour supply for ICT Practitioners can be summarised as:

- graduates of Higher Education (HE) informatics/computing* courses, arriving ('fresh') onto the labour market, that can be recruited by companies in the S/W and IT Services sector;
- existing employees being 'trained up' from lower level work by their employer to become IT practitioners (within the ICT Industry);
- 'occupational migrants' entering IT practitioner work in the sector via some kind of conversion learning from other kinds of work;
- graduates from non-informatics HE courses recruited by ICT Industry employers;
- new market entrants with IT knowledge from other parts of the formal education system (e.g. from Secondary vocational-, or even general-, Education courses);
- new IT practitioners entering ICT companies from *inward-migration* from outside the EU;
- IT practitioners re-entering the labour market (e.g. from unemployment or career-breaks);
- IT practitioners moving in from User sectors (in particular as a result of additional Outsourcing *within* the EU).

* although Eurostat uses *computing* for the relevant HE subject category statistics, *informatics* is used in this study to refer to courses on informatics, computing, information systems, ICT, computer science, etc.

Figure 6: Evolution of Work Organisation for ICT exploitation*



This diagram attempts to clarify what ***drives*** the development of specifications of ICT skills/competence needs. It shows how the emergence of each new ICT enabling technology (delivering useful new functionality, whether hardware or software) produces a series of responses in the marketplace, both from ICT supply companies (who believe they can make money by helping deploy the new technology for their customers), and from ICT User Organisations (who believe that the new technology could help improve their business activity and performance, whether public or private). In each case, efforts to pick up the new technology lead to the need for each organisation involved to develop or refine the structure through which it deploys its Human Resources in this work, and from this to clarify the (at least, *technical*) skill requirements in the different jobs or roles. In the (general) absence of enough people with such capabilities, these in turn produce specific learning or training needs, to which the suppliers of ICT training provision respond through this "secondary" marketplace. Very often this chain of activity will be driven by assumptions about the new technology that do not (all) turn out to represent the essence of the contribution of the new approach. As a result, there can often be a "second phase" to the process, where each step is refined by being built more soundly on the realities of this technology's characteristics, now these are evident since it has matured. Since there is (as of late 2005) no real sign of the *waves of new technologies* abating, it will remain very important for all thinking about work organisation and skill/competence need specification for ICT to recognise the very dynamic nature of the context. As can therefore be inferred, consensus on structures of employer skill-set needs can often follow several years after emergence of each new wave of technical functionality.

* diagram reproduced from CEN/ISSS (2006) with kind permission of the *European Committee for Standardisation* © CEN

The 'supply dynamics' associated with these different 'supply channels' – i.e. the nature and speed of inflows - vary considerably. While each will involve an element of delay, these delays are different in nature. For example:

- IT Practitioners from User sectors, and those re-entering the work-force can move in to Software and IT Services companies relatively quickly – there is generally no element of (re-) training necessary, simply movement through the recruitment process;
- The conversion learning through which those migrating in from other occupations will pass will take, at least, months;
- The in-company up-skilling of workers from lower-level occupations will generally take weeks;
- The flows of inward-migrant ICT Practitioners will involve the delays associated with confirming to Visa/Work Permit processes;
- The flows of 'fresh graduates' (whether from informatics courses or not), generally takes place once a year – and a certain level of induction training will be necessary.

It is therefore inevitable that supply will lag demand in this labour market.

The details of supply lag will become more evident in the examination of the supply and demand associated with each of the Foresight Scenarios – Section 9.

It is worth noting that probably the main choice for ICT companies, as all employers, when faced with the need to increase and/or improve their skills base, is that of *buying-in* or *training-up*. There are costs and benefits associated with both approaches, but the effect of the two on the domestic labour market is importantly different. Only the second approach results in a positive change in the overall skill-base in the labour market, and so of total (national or EU) supply of such skills. The first approach has a second less-desirable impact on the labour market: that of increasing the (overall) mobility of the workforce in question. This mobility is generally viewed as 'churn' by labour economists and employers, but – not unreasonably – as career-development by the individuals involved.

Generally speaking, employers under competitive pressure often view buying-in as a more effective solution, in particular where there is strong time pressure. While it is not always evident, given delays in the recruitment process in the time required for induction training, that the buying-in approach finishes off quicker and cheaper, it is often viewed as preferable. It has the further appeal that the (skill augmentation) task can often be delegated to employment intermediaries with expertise in the field, and so (apparently) freeing up senior management time for operational tasks. This 'benefit' is generally sought at times of particular labour market 'tightness', as a result of which times of comparative supply shortage (for example in the ICT Practitioner market at the end of the 1990s) tend to involve growth in 'churn'/career development.

It is also necessary (in particular for ICT Practitioner work) to take into account the role of contract workers. Although sometimes rather 'expensive' at times of skill shortages, use of consultants and IT contractors allows additional flexibility in the management of HR costs, and in some Member States the ICT Practitioner labour market contains significant numbers of contractors. As with the buying-in of permanent staff, demand for these also tends to go up at times of supply shortage, resulting in increases of day-rates.

4.3 Demographic influences on future Supply

Since 'fresh graduates', specifically in informatics, are viewed as a major source of future supply of IT Practitioners, the effects of recent demographic changes in the EU need to be considered. Falling birth rates in Europe over recent years have been steadily reducing the size of youth cohorts. This will have a bearing on the sizes of cohorts passing through formal education, and in Higher Education, in the period under study.

It is well known that Europe's demography is changing, with most concern focused on falling birth rates and the growth of the dependent elderly population. These changes could have major implications for the structure of demand and attitudes to technology and innovation, but such implications are too complex to be able to model quantitatively at present. However, projections of the demographic structure of the population are undertaken on a regular basis by Eurostat. Therefore the nature of the population of school leavers for the next decade or so can be estimated with some degree of confidence.[11]

Eurostat (2006) presents current data which bears on this, for two future points. As can be seen, very similar trends are apparent in both EU-15 and EU-25 data.

Year	**2005**		**2010**		**2025**	
Age group:	*15-19*	*20-24*	*15-19*	*20-24*	*15-19*	*20-24*
EU-25 (000s)	28,171	29,998	26,822	28,648	24,343	25,100
EU-15 (000s)	22,705	24,079	22,051	23,207	20,891	21,609

Table 6: Demographic Trends for EU-15 & EU-25

This data confirms that a substantial long-term decline in the size of these cohorts is anticipated into the coming decades. A decline of around 1.3 million in the EU in each of the age groups from the 2005 figure to that for 2010 is forecast. Interpolating figures for 2015, the situation is more dramatic: the corresponding figure is 2.5 million. This represents around an 8% drop in the population normally expected to be undertaking University courses (an annual decline of more than 0.6%, in terms of CAGR).

There is no reason to suspect any significant qualitative change underway in the nature of the cohort: it is expected that the distribution of 'talents' will remain roughly equal from year to year, and the proportion of more or less gifted students to remain roughly constant. The implication is that the number of students capable of working as ICT practitioners would be expected to decline at approximately the same rate as for the whole population. Similarly, there is no reason to argue from the population projections alone that there would be likely to be any shift in student preferences for one sort of course or another. In consequence, we would anticipate a decline in the number of recruits available for informatics courses.

Efforts to offset this decline by more vigorous recruitment would entail a smaller pool of talented individuals to draw upon, and thus informatics courses would need to be rendered as more attractive options available to suitable recruits in order to maintain quality standards.[12]

[11] School leavers need not be the only University entrants, and there could well be scope for engaging more of the talented but educationally-excluded population in informatics courses. Thus there are possibilities of people from disadvantaged minorities, those who dropped out of education due to early parenthood, etc. taking such courses. While benefiting social cohesion and inclusion, such efforts are likely to require rather more resource input that following the classic recruitment models used by most Universities.

[12] Student capability might be increased, however, by remedial teaching – i.e. more effort to make up for lower quality intake by adding more value in the course of tertiary education - or by improvement in the quality of primary and secondary education, and indeed in the broader social circumstances that shape individual capacity.

4.4 Off-shoring

Recent years have seen a considerable growth in off-shoring activity and in studies about the phenomenon. Movement of operations to take advantage of lower labour costs is by no means new. However, the penetration of the approach into sectors and occupations previously untouched has raised concerns among new social communities for their future livelihoods, and in turn political interest, in many Western economies.

Accounting for the effects of the phenomenon in relation to trade and finance flows brings certain complexities. The overall effect of changes in geo-sourcing patterns needs to take into account movements of products, services and labour in both directions. Some EU Member States have already benefited considerably from in-shoring, and the positive economic impacts arising. Other positive impacts are those resulting from the increased global competitiveness of organisations within the EU that off-shoring can bring. These must be taken into account when concerns are raised about loss of jobs within Member States in the short term.

Publication of reports on research into off-shoring and its implications has grown significantly in recent years. Of particular relevance to the ICT Industry and ICT Practitioner work are publications by:

- Sato (2005), which helps clarify the different dimensions to the problem;
- OECD (2006c), which considers the characteristics of occupations likely to be affected by future off-shoring;
- Evalueserve/ NASSCOM (2004, and 2006) which estimate the impact of IT off-shoring on the US and the UK;
- Ovum (2006), which examines possible future impacts on the UK ICT industry and its national workforce in the coming years; and
- BCS (2004, and 2006), which examine how IT Professionals can assess and respond to developments.

In relation to this Foresight study, it is clear that (in spite of significant limitations to available data providing quantitative evidence, and the fact that the public debate in some countries does not seem justified by the current scale of activity) off-shoring is a trend that is likely to play a growing role in the global economy. It will also have a growing impact on future demand in certain occupations, not least in the European Union. The approach taken in this study explicitly examines the impact of off-shoring on future demand for IT Practitioners in the EU[13].

[13] Annex B examines recent research investigating the quantitative impact of 'off-shoring' on employment

4.5 Diversity issues in e-skills: Women and Older Workers

e-skills issues impact all sections of society, but there are certain differences in how the different aspects of e-skills have been picked up, in particular in relation to the composition of the ICT practitioner workforce.

4.5.1 Gender Issues

While women have undoubtedly picked-up, and thrived on, the opportunities open to them as users of ICT, significantly fewer have opted for work as ICT *practitioners* over recent years. Women have rarely exceeded an average of around 1/5th of the IT practitioner workforce, and a recent study of the position on *Information and Communications Technology and Electronics* skills internationally (Intellect, 2006c) reported no evidence of significant 'improvement' to that position,

The key relevant findings from the international component of the Intellect survey are:

- considering, *Computing Professionals*, *Computer Associate Professionals* and *Electrical and electronic equipment mechanics and fitters*, it appears that, at an average of 14%, the under-representation of women in the ICTE workforce is a common issue facing all European Member States to a varying degree;
- overall, when compared with the rest of the EU, Canada, Australia and the USA, the United Kingdom lies seventh in terms of the highest levels of female representation within ITCE occupations, though for electronics occupations the UK is second bottom;
- female representation appears more focused towards lower-level ICTE occupations in the UK than in other EU Members;
- the highest levels of female representation were observed within the USA, Canada, Ireland, Hungary and the Scandinavian countries (notably Sweden and Finland), with Hungary in particular notable for the high levels of female participation within electronics occupations;
- female representation in ICTE occupations appears to be in decline, with one or two exceptions (notably Germany over the 2000-2005 period).

On the one hand it can be said that a significant increase in the numbers of women wanting to work in ICT could have a major impact on the supply of ICT practitioners, while on the other it must be recognised that the choices made by women in the labour market arises from a perception of low attractiveness of the work, based on real experience, and that changing that widespread clearly-held perception is not something that is going to happen quickly. There are a range of initiatives within the EU intended to attract more females into the work, and many ICT Industry employers have worked hard to make the workplace more 'female-friendly'. The gender issue is likely to remain on the e-skills agenda for the foreseeable future.

Figures 7 and 8 show the fraction of the *Computing Professional* and *Computer Associate Professional* workforces[14] found in the Intellect report to be represented by women in 2005Q3.

[14] With appropriate selection and interpretation of the different national occupational classifications by e-skills UK

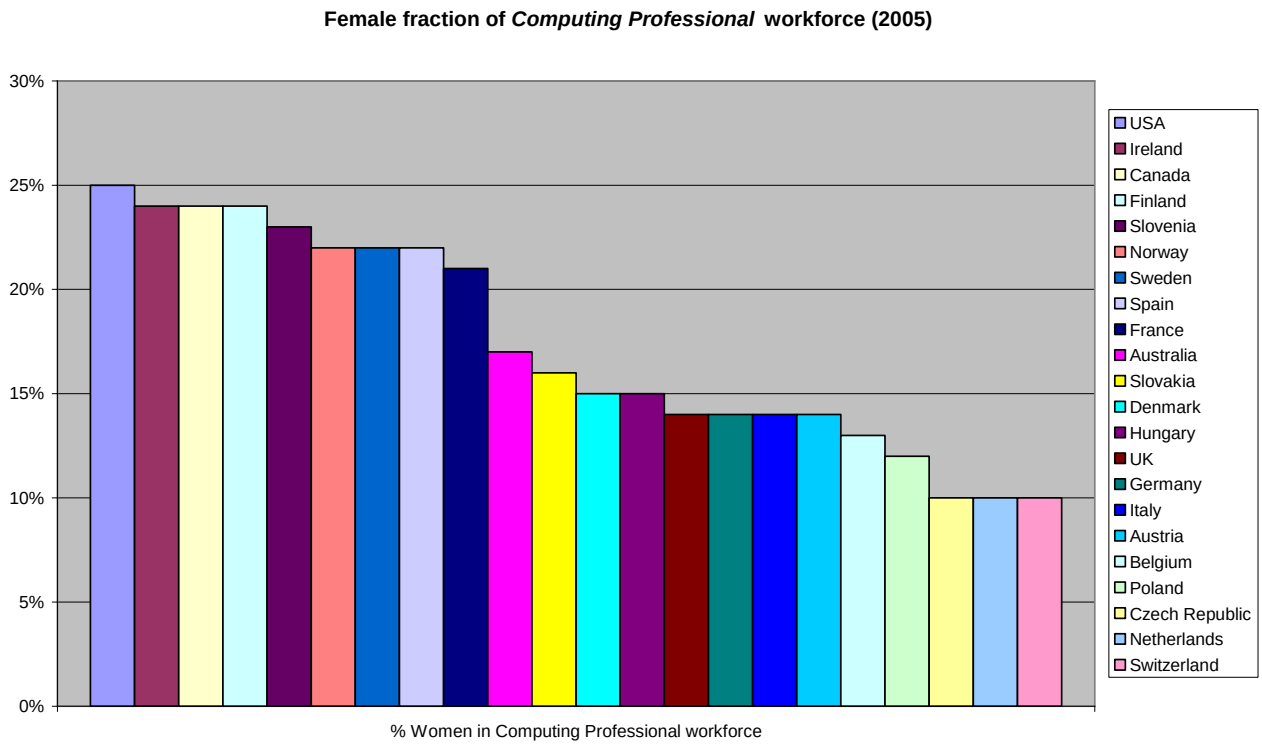


Figure 7: Female percentage of Computing Professional work in different countries

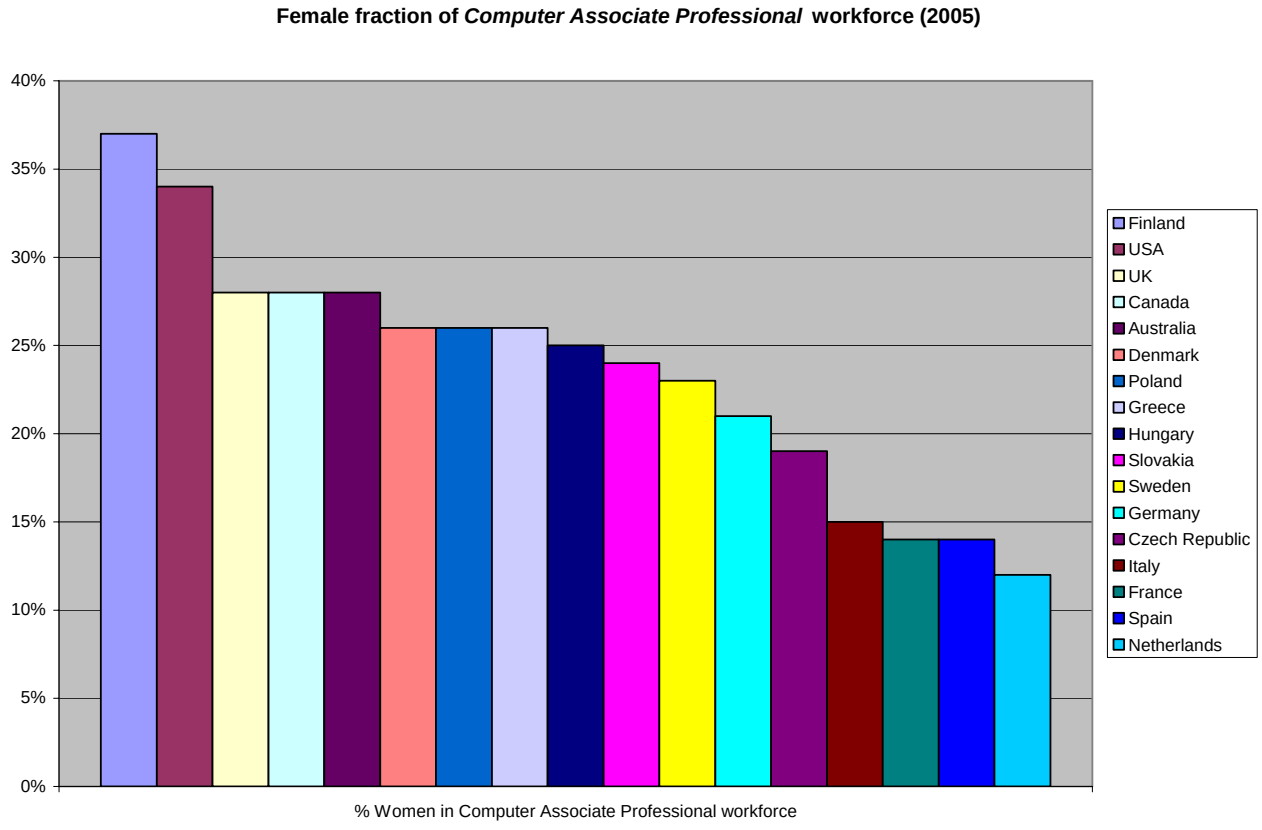


Figure 8: Female percentage of Computer Associate Professional work in different countries

4.5.2 Age Issues:

The Workforce Ageing in the New Economy (WANE) project has been investigating age-related issues in e-skills since 2001[15]. The European component of the Canadian-led project has examined the situation in Germany, the Netherlands, and the United Kingdom in some detail, in terms both of IT practitioner labour market statistics and a series of employer case-studies.

While the final project documentation is still awaited, key findings so far (Platman, K. and Taylor, P., 2004) include:

- the IT practitioner workforce in Europe is, compared with the workforce as a whole, a comparatively 'young' one;
- the overwhelming majority of IT practitioners are aged under 45 years;
- comparable figures for 2002 show that 82% of UK IT practitioners were aged 44 and under, cf. 77.5% in Germany and 79.5 in the Netherlands.

Figure 9 shows the broad age profile in the three Member States studied.

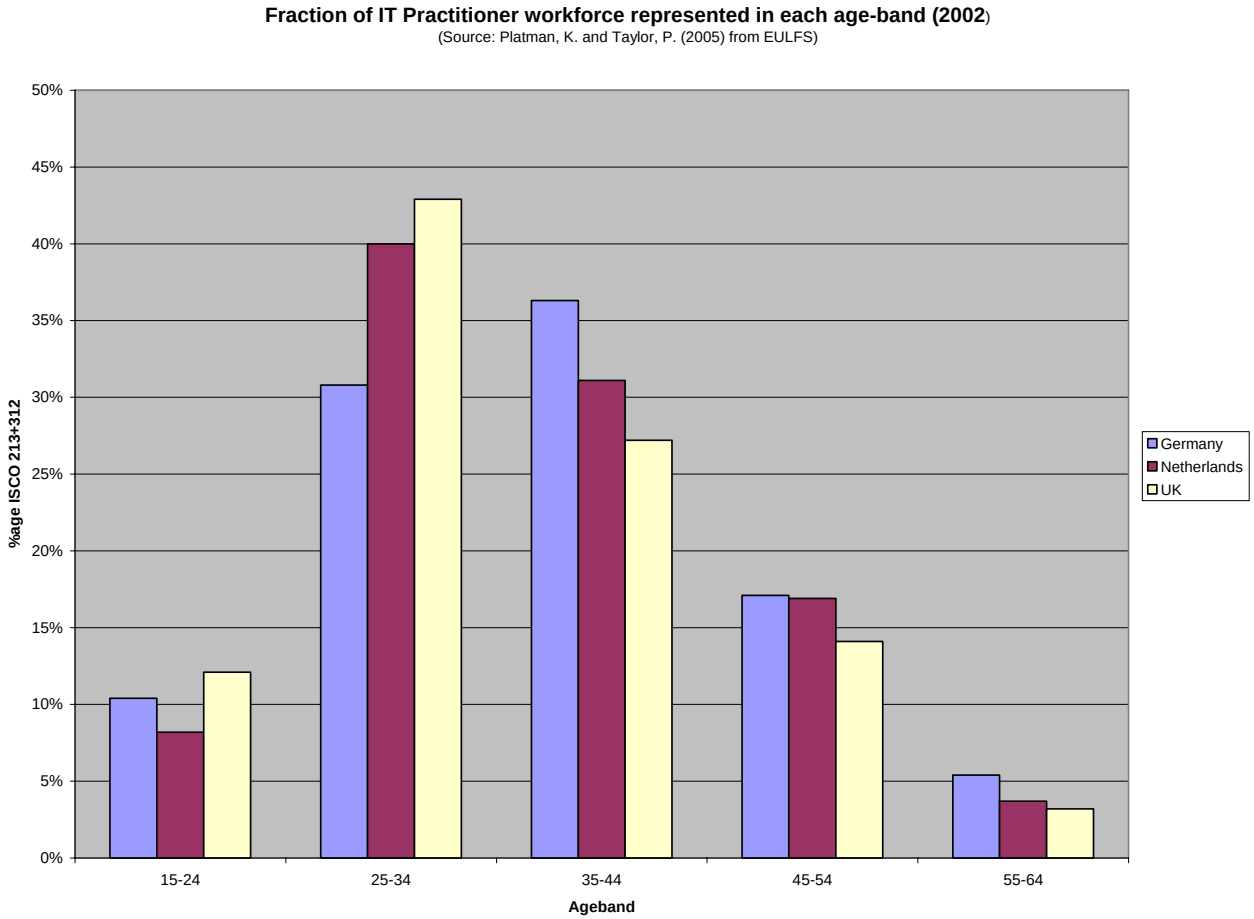


Figure 9: Age distribution of IT practitioner workforce in different Member States

The WANE study and other, national projects (e.g. *MaP>IT* – ITNTO/e-skills UK) confirm that, except in specific cases where legacy systems need to be handled (in particular in the Y2K-related work in the build up to the century change) job prospects for older IT practitioners are not so good.

As with women, in principle there is an untapped resource here, in the higher age-groups that could play a role in increasing supply, in response to labour market shortages.

[15] see http://www.wane.ca/

5 Policy responses and options

5.1 Introduction

This study relates to the use of the findings of explorations of possible futures in terms of possible actions that would help balance the market needs of supply and demand of e-skills. Such responses would need, in principle, to come from one or more of three places:

- Public Policy (whether at EU level or by Member State governments and their agencies)
- The ICT Industry as a whole, and/or
- Individual ICT companies.

Other stakeholders, for example Trades Unions, can and do make important contributions, but the role of employers forms a crucial part of how their problems can be addressed. While there are a number of steps that the ICT Industry leadership and individual companies can take in response to possible e-skills-related challenges, the central objective of this study is to clarify the measures that might be considered for policy responses, both at the EU-level and within Member States.

This section aims to set the scene for consideration of policy development in relation to e-skills.

When considering policy responses there can be differing perspectives in relation to where responsibility lies for different market imperfections in relation to skills. While evidence for market failure is one important possible basis for agreement for policy measures to respond to an economic 'problem', the demarcation of responsibility between industry and policy responsibility is also of relevance to the nature of evidence-, and so data-gathering. It is possible to illustrate the issue of where responsibility lies in this area by reference to two different (stylised) employer perspectives:

- that skill shortages and problems of losing good people are all 'someone else's responsibility'- that shortages of supply in the labour market arise from imperfections in the formal education system. Therefore, the problem arises from governments not providing enough resource in education budgets, and too many young people not choosing 'sensible' or Science, Technology Engineering and Mathematics-based subjects. Likewise, the loss of good people arises from other companies poaching, resulting in a waste of any training investment that has been made.

- that sourcing and retaining the best talent is just as much a competitive situation in a market-place as is competition for customers, and in other aspects of their business. The task of getting good people is therefore to establish a set of attitudes and arrangements that are attractive to the kind of people sought (including, for example, being known as an employer that invests in training), and from time to time, attracting them away from employers who are not taking this challenge seriously.

A significant challenge arises in relation to how employers, in particular within the ICT Industry, are represented in the dialogue between the private and public sectors in relation to skills and skills policy. Government understandably seeks a single interlocutor (or as small a number of stakeholders as possible) for discussions of common interest, for efficiency and effectiveness. On the Industry side, there are challenges when a group of enterprises in competition with each other come together to try to agree common perspectives and positions for the sector. As indicated above, there might be opportunities and a common desire for policy measures in the skills area where these relate to things beyond the direct activity and interests of individual companies (e.g. critiques of the education system). However, a greater challenge for common focus can exist in relation to measures

more directly affecting the individual business interests of powerful enterprises. There is also the paradox that is observed from time to time of the contrast between company leadership rhetoric ("people are our most valuable asset") and some aspects of actual behaviour in HR management, particularly in difficult circumstances. It is clear that in technology-based industries, highly-skilled staff really can provide a significant component of a company's competitive edge. Therefore, skills are sometimes seen as a very commercial area, and not always as an area where industry bodies should spend time or indeed where there is a significant role for the public sector. Finally, the relationship of the private sector (and so industry bodies) to government covers a number of important areas, and skills are often not very high on the priority list from the perspective of the private sector.

The split of responsibilities between individual employers, a sector as a whole, and policy-makers in respect of skills problems is as important for e-skills as elsewhere: but identifying, and implementing, effective joint ventures and 'public-private partnerships' is by no means easy. Skills policy issues at the European level are not immune from these challenges: indeed progress in this area continues to depend on the effectiveness of the crucial dialogue between the EU policy institutions - in particular the European Commission – and the private sector, as represented in this case by such bodies as EICTA, Career-Space, the eSCC and the European Software Association, on e-skills.

Skills policy generally refers to measures taken by governments to tackle problems of different kinds with the functioning of labour markets. The major concern to which governments have worked to respond in this respect is that of perceived skill shortages. When employers have difficulties recruiting skilled people, they often view the perceived lack of supply as something beyond their control, and therefore something for which government must take responsibility. Unfortunately, while it is possible to gather information on employers' reports of hard-to-fill vacancies, there remain questions about how skill shortages in any area can be assessed.

There is also a limit to what response options governments have at their disposal that would make a real difference to supply volumes in the labour market. For example, the most-discussed response to ICT practitioner skill shortages is undoubtedly the idea of adapting the curricula of tertiary education ICT courses, to 'improve the work-readiness and early contribution' value of ICT graduates. This forms a strong focus of debate, and the fact that over 135,000 informatics students graduated in the EU in 2004 (over 115,000 in the 'EU-15')[16] indicates that the formal education system, already makes a major investment in providing a core level of new ICT Practitioner skills supply within Europe. There are limitations on how strongly and quickly any new policy measure could make a real difference to the supply position through this 'channel'. Among the constraints are:

- the difficulty of getting clarity and agreement on what specific ICT Practitioner skills are needed in the marketplace (a number of different skills are mentioned by ICT industry leaders – it is not always clear what the top priorities are, and how long they last);

- limits to possible provision of specific skills felt to be in most demand within a tertiary education context (for example the greatest need might be for something rather specialised and narrow, something that would be difficult to justify sufficient time in a curriculum);

- the lack of expertise within the teaching resources that can often occur. This can occasionally arise from the inability of universities to attract the best people and sometimes

[16] Source: Eurostat Education database

from the fact that lecturers may not have enough opportunity to acquire and maintain, the latest technical knowledge required in the market-place;

- the difficulty for tertiary ICT courses to respond fully to employer need, given the range of other pressures on the curriculum, and growing independent quality assurance requirements;

- the delay with which graduates from such courses will emerge onto the labour market and begin to increase supply. Such courses generally last several years, so that, in such a fast-changing environment, the new supply may well emerge onto the market at a point when the labour market situation has changed.

The general and dynamic limitations involved in this 'linear' response to perceived skill shortages that tends to be assumed as the most 'natural' action can be taken to confirm that a more sophisticated approach is required in working to 'improve' the effectiveness of this supply channel. Required are also a broader range of policy responses, as can be seen from the examples of Member State e-skills related policies.

5.2 Variations of approach around the EU – some examples

Most EU Member States have had, over recent years, some element of active skills policy in place. Policy measures for e-skills take many forms, the most common are measures related to governments' overall ICT policy and are generally focused in particular on promotion of national ICT Infrastructure (in particular supporting increased penetration of broadband into business and the community) and ICT user skills, in order to enable access to ICT-delivered goods and services by as much of the population as possible, and to support full participation in the Information Society. In addition, public policy on ICTs also includes elements of:

- Standardisation issues (e.g. in Telecommunications)
- R&D support (involving national initiatives and participation in EU programmes;
- Innovation support;
- Regulatory dimensions of ICT (including provision in relation to Intellectual Property, protection of internet users, etc.)

The degree to which there are specific strategies or policies for the ICT Industry depends somewhat on the size of the country (in particular Ireland and Finland have followed, with different paths, major strategies for a leading ICT sector component in the national economy), and the starting strengths of the supply sector.

Two examples of the component of national ICT Policies relating to e-skills are shown overleaf, drawn from national responses to the OECD 2005 Survey on IT Policies in support of the preparation of the 2006 IT Outlook publication (OECD, 2006b), to illustrate the differences of approaches.

Finland

The Information Society Policy Programme of the Finnish Government, initiated in June 2003, aims at improving competitiveness and productivity, social and regional equality as well as the welfare and the quality of life of the citizens. The objective of the Programme is to keep Finland among leading countries as a producer and user of ICTs. The Programme also aims at enhancing trust of the citizens and enterprises on the services of the information society by improving information security and privacy. The Programme focuses on the following areas:

- telecommunication and digital television
- eSkills of citizens and increased use of information society
- education, working life, research and development
- eGovernment
- eHealth
- eBusiness, digital content, digital services
- development of the Government's own information systems
- the legislative environment of the information society

Fostering ICT Innovation

The Finnish Funding Agency for Technology and Innovation (Tekes) is the main government body responsible for setting up and funding national R&D programmes that foster the development and application of new information technologies.

The national technology programmes are a key instrument for implementing technology policies. The programmes aim at strengthening cooperation and networking between business enterprises and research units and promote technology transfer and internationalisation.

The duration of the technology programmes ranges from three to five years. Their volumes range from € 6 million to hundreds of millions of euros. Tekes usually finances about half of the costs of the technology programmes. The other half of the costs is covered by participating companies. The number of business participations in the technology programmes ranged from 1600 to 2400 in recent years, and research unit participations from 700 to 900. In 2005, Tekes financed a total of 2134 projects with a total of 429 million euros. The share of ICT projects was 143 million euros.

In TEKES' technology strategy, various focus areas are selected in the domains of technology, applications and cluster development. The selected technology focus areas address technologies and competences that will continue to develop and enable new technology leaps. In the ICT area, the technology strategy of TEKES states that the aim for Finland is to be a world leader in applying and developing technology. Strategic ICT application areas include: embedded intelligence and seamless communication, supporting business innovations through ICT; work in a knowledge-based society; and ICT in welfare society and knowledge society services.

ICT skills and employment

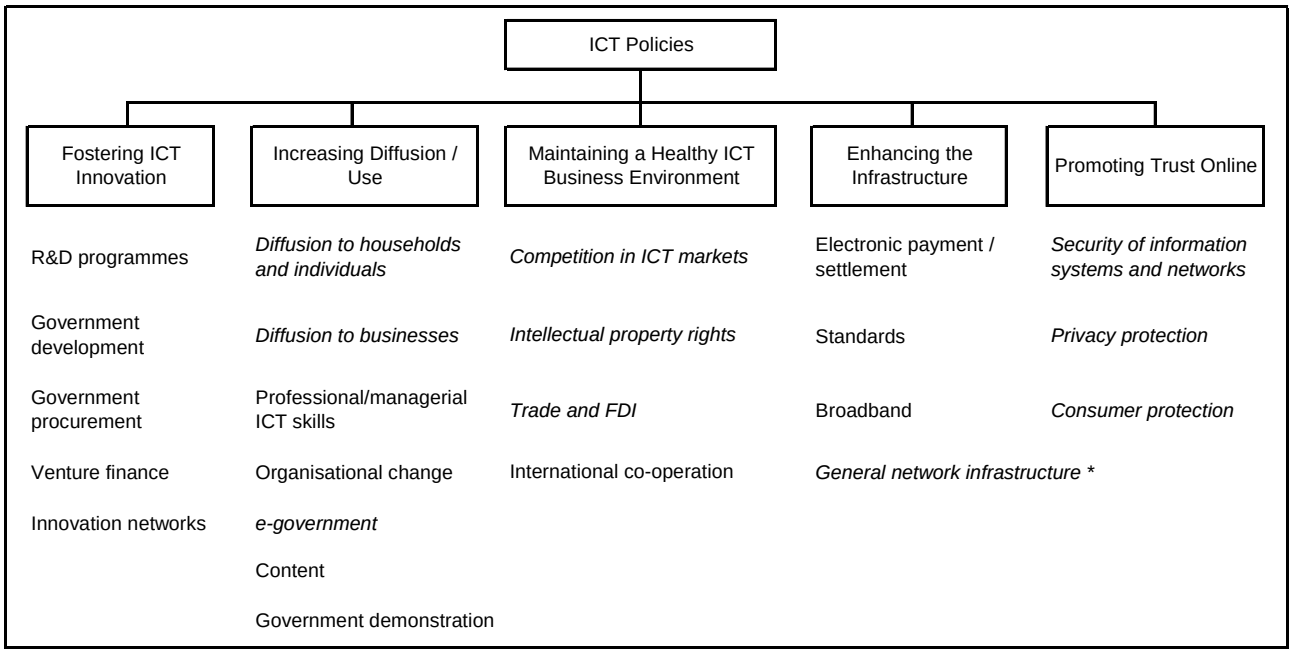
- Programmes aiming at expanding the IT workforce and updating the skills of IT workers including:
- promoting IT education, including better integrating industry concerns into education programmes;
- enhancing industry-based and on-the-job training;
- facilitating IT training and certification programmes;
- programmes to encourage inflows of foreign workers;
- encouraging international sourcing of skilled labour inputs, and/or policy reactions to international sourcing;
- improving labour market information, including the use of on-line job-search and job-matching.

The Ministry of Education implements the Information Society Programme for Education, Training and Research (2004-2006) and has launched measures to strengthen the media education in educational sectors.

Table 7: e-skills Policy summary within the overall Finnish IT Policy
(Source: Finnish response to 2005 OECD Survey on IT Policy)

United Kingdom

The UK e-skills strategy is set within the overall ICT policy of Her Majesty's Government, shown below:



Specific approaches include:

UK Professional / Managerial Skills

The Institute of Directors (IoD) and *UK Online for Business* are working closely to provide ICT awareness and skills as part of courses and support for company directors.

- http://www.sflqi.org.uk/ General user ICT skills are now defined as basic skills, as underlined in the UK's Skills Strategy launched in July 2003: 'Help adults gain ICT skills, as a third basic skills alongside literacy and numeracy in our *Skills for Life* programme'.
- *e-skills* http://www.e-skills.com/ was licenced in April 2003 as the Sector Skills Council for IT, Telecommunications and Contact Centres, under the aegis of the Department for Education and Skills (DfES) and the Department for Trade and Industry (DTI), to boost the supply, level and connection with business in the ICT skills arena.

Policies relating to building ICT skills

The Government is taking steps to ensure that ICT training is embedded in the education system. Priorities will include improving the ICT infrastructure in schools, further and higher education and GBP 230 m to improve ICT skill levels among educators as mentioned earlier, as well as the establishment of *City Learning Centres* (CLCs), which provide the chance to make the most of the Internet and new technologies to both school pupils and adults (http://www.standards.dfes.gov.uk/excellence/CLC_contents.html).

Professional IT skills

In the White Paper *Opportunity for All in a World of Change*, the Secretaries of State for Trade & Industry and for Education and Employment stated "*our ambition is to make the UK the number one country for the supply of advanced ICT and related skills*". The major themes of this agenda include:

- Expanding specialist ICT and other high-tech learning programmes in further and higher education. The UK trains tens of thousands of students a year on full time and updating courses;
- Introducing a programme that trains over 5,000 unemployed people for technician level jobs in ICT;
- Working with business to reverse the serious under-representation of women in ICT jobs; the aim is for the UK to match best international performance with regard to women's employment in ICT.
- The Learning and Skills Council has invested more than GBP 100 million to develop specialists, such as electronics, ICT and design & technology in further education colleges, for which they will be recognised as a

centre of excellence locally, regionally or nationally.

- Introduction of New Technology Institutes (NTIs) based on partnerships between universities, colleges and local business to provide specialist ICT and other high-tech learning programmes and ensure local companies have the know-how to apply advanced technology practices.
- Expanding provision of high quality work experience in ICT and related high-tech areas for students:
- Working with industry to create a more positive image of careers in high-tech sectors that helps attract a more diverse workforce: Introducing a new occupational skills framework for ICT: the framework provides a common standard for describing ICT jobs and represents a key business tool for assessing and improving ICT skills levels.

Basic IT skills

The Government is committed to helping raise standards of basic ICT literacy, amongst students in education, the workforce and society at large. Major initiatives to improve people's access to and competence in ICT include:

- to enable all school leavers to have a good understanding of ICT based firmly on the standards prescribed in the national curricula across the UK, with measures in place for assessing student competence;
- to ensure serving teachers generally feel confident and are competent to use ICT within the curriculum;
- to ensure all schools, colleges, universities and libraries and as many community centres as possible are connected to the National Grid for Learning;
- to make Britain a centre of excellence in the development of networked software content and a world leader in the export of learning services;
- to ensure that general administrative communications between educational bodies and the Government and its agencies cease to be paper-based;

In the Community

- Provision of thousands of UK online centres in disadvantaged and rural communities to ensure that all adults have access to ICT facilities and support;
- Large discounts on the cost of basic ICT courses for people opening Individual Learning Accounts.

In the workforce

- IT4All, an initiative to improve the ICT user skills of the UK workforce at large **http://www.e-skills.com/it4all/about.html**;
- increasing the number of unemployed people, those returning to the labour force and people facing redundancy who acquire a basic ICT qualification.

Advanced ICT Skills

- Over 10,000 students a year on full-time and updating courses in advanced ICT and related high-tech skills;
- Over 6,000 UK online centres in disadvantaged and rural communities to ensure all adults have access to ICT skills;
- proposed target for 2007 of 85% of 14-year olds to reach level 5 or above in Key Stage 3 tests in ICT;
- a broadband connection to the Internet in each school within the UK.

Table 8: e-skills Policy summary within the overall UK IT Policy
(Source: UK response to 2005 OECD Survey on IT Policy)

These examples give a feel for national approaches to e-skills policy in these Member States, in relation to the overall policy stance for ICT.

From the OECD surveys of national IT policies, it is evident that:

- for comparatively small economies, policy takes a stronger role in terms of commitment and investment in relation to a national strategy for the ICT Industry than it does in larger economies, where there is comparatively more focus on trying to set general economic conditions to be supportive of innovation and market growth;
- there have been clear strategies and major investments in Ireland and Finland, although of different kinds;
- the Irish industrial strategy of encouraging Foreign Direct Investment by major global ICT players (mostly North American based) involved, during the 1990s, significant support of ICT related investment in both Academic and Vocational educational provision;
- the major policy commitment in Finland to stimulating and growing a global presence in the mobile telecommunications market also included significant investment in upgrading educational provision;
- Germany's development of the Advanced IT Training System showed a concerted effort involving all major stakeholders to develop a more demand-led competence-based learning provision structure that marked a notable departure from the traditional (well-respected) VET dual system;
- the UK continued to develop a wide range of education and training innovations, all generally aimed at strengthening the influence of employer-needs in learning curricula and delivery;

5.3 EU level policy developments

As mentioned in the Introduction, there has been e-skills activity at the EU-level since 2001. The thrust of the approach can be seen from, in particular, the recommendations the European e-skills Forum (September, 2004), the ICT Task Force (2006) and the Thessaloniki Declaration (2006) from the e-skills 2006 Conference.

5.3.1 European e-skills Forum

The European e-skills Forum identified the following main priority actions:

(1) Developing a long-term strategic approach to the ICT sector

(2) Improving planning and data availability about the ICT labour market

(3) Promoting European e-skills multi-stakeholder partnerships

(4) Designing innovative e-skills training solutions

(5) Supporting the development of a European e-Skills meta-framework

(6) Fostering e-skills for the workforce and the population at large

Table 9: e-skills Forum priority actions

5.3.2 EU ICT Task Force

RECOMMENDATIONS TO DEVELOP SKILLS AND EMPLOYABILITY

1. Encourage the ICT industry to create an Industry Leadership Group to facilitate e-skills information and co-operation and pool resources and establish closer collaboration between all stakeholders to develop reliable statistics and forecasting scenarios regarding e-skills requirements at the EU level and the impact of global sourcing to provide a reliable basis for policy decisions and to help labour market participants to take informed career decisions.
2. Increase investment in the professional development of teachers and ongoing teacher support mechanisms. Member States and industry should work together to improve career advice in and around schools and provide better and more frequent training of career consultants. The content of consultations should be based on a more realistic understanding of future opportunities based on robust statistics and foresight scenarios and up-to-date job profiles and career paths. The transparency regarding different qualifications and ICT career paths should be increased by establishing and maintaining an e-skills and career portal to set out European job profiles, map industry-based ICT training and certifications to specific job roles, and integrate existing national ICT career portals.
3. Increase collaboration between industry, governments, employers, and education institutions via multi-stakeholder partnerships to address e-skills issues and with a view to reconciling the "parallel universes" between formal and non-formal education channels.
    - Consider how to develop enhanced e-skills curricula, including via the integration of industry ICT curricula and certifications into formal education. Initiate further research and evaluate good practice in order to promote the development of European quality criteria for e-skills training and certificates in close co-operation with relevant stakeholders.
    - CEN-ISSS should accelerate work towards the EU-wide eCompetence framework and maintain close cooperation with industry (user industries and certification providers) with a view to ensuring eventual compatibility of the framework with formal and nonformal ICT practitioner education and certifications, and to foster increased workforce mobility by facilitating Europe-wide recognition of qualifications.
    - Establish multi-stakeholder partnerships to train the workforce, especially disadvantaged groups (e.g. young underemployed and unemployed workers, older atrisk workers, and people with disabilities) and to help connect trainees to new jobs. These partnerships should also promote access for training participants to internships and work experience in local SMEs and larger businesses. Review how existing EU programmes might be used to fund and support actions related to skills & employability.
4. Continue the efforts already started in incorporating entrepreneurship in educational curricula at all levels. Document best practices on multi-stakeholder partnerships that deliver entrepreneurial skills to individuals and SMEs. Together, governments, industry, and universities must enable the creation of a new academic discipline on Services sciences, Management and Engineering to bring together ongoing work in computer science, operations research, industrial engineering, business strategy, management sciences, social and cognitive sciences, and legal sciences to develop the skills required in a services-led economy. Schools should also be involved in this process.
5. To reduce the e-skills gap between larger organisations and SMEs, notably the smaller SMEs and the less IT-oriented SMEs, and prepare them for increasing use of eLearning, provide the resources to educate and coach SMEs in partnership with IT-SMEs and local support centres, and reinforce European best practice exchange on this.

Table 10: Excerpt from EU ICT Task Force Recommendations

5.3.3 Thessaloniki Declaration

THE EUROPEAN E-SKILLS 2006 CONFERENCE:

Calls upon all relevant stakeholders to support the following actions and to include them in a long term e-skills agenda:

- IMPROVING THE AVAILABILITY OF E-SKILLS (10 detailed recommendations)
- EMPOWERING FUTURE GENERATIONS (5 detailed recommendations)
- BOOSTING THE EMPLOYABILITY OF THE WORKFORCE (5 detailed recommendations)
- MAKING A GREATER AND BETTER USE OF E-LEARNING FOR THE LIFE LONG ACQUISITION OF SKILLS (5 detailed recommendations)
- PROMOTING VISIBILITY AND MONITORING PROGRESS (5 detailed recommendations)

Table 11: Key themes from the Declaration following the 2006 European e-skills Conference

5.4 Relating European and national level policy development and responses on e-skills

This study focuses on the European level. EU-level thinking is crucial to understanding and responding strategically to the challenges faced by Europe in a world of accelerating globalisation.

However, jurisdictions for policy responses to problems like e-skills can be at the Member State level and at the European level. Recent work at the EU-level, as exemplified in the last sub-section, has showed the consensus on desirable actions agreed by stakeholders that can be achieved.

It seems likely that EU-level policy analysis and response concerning ICT practitioner skills will be most successful where it continues a number of tried and proven approaches, involving:

- bringing together stakeholders to review various aspects of the issue;
- commissioning studies to clarify the position in different e-skills areas (including good Member State experience);
- bringing together study evidence and stakeholder views into consolidated perspectives (e.g. e-Skills Forum Synthesis Report, Report of ICT Task Force Working Group);
- seeking to influence policy in Europe to enhance effective operation of the Community labour market in this area;
- exploring European Frameworks where relevant and felt helpful;
- disseminating this activity through both Member State and Stakeholder channels as well as directly where appropriate.

Given the needs of the ICT Industry in relation to e-skills, efforts to identify the right form of Multi Stakeholder Partnerships are understandable. In this context the partnerships between ICT industry

players and skills policy-makers are of particular importance, both at the Member State and EU levels. Following the fading contribution of the Career-Space consortium at the beginning of the decade, the representation of the European ICT Industry to the EU institutions in relation to skills is not at the same level or coherence as that operating in a number of Member States. The call in the ICT Task Force recommendations for an industry lead body to represent the Industry in relation to skills is understandable and to be supported. It would be important for such a body to link effectively to skills work in Member State ICT organisations.

Part 2: Designing and assessing possible futures

6 Forecasts, foresight and scenarios: *the future in words and numbers*

6.1 Introduction

Trying to fully understand 'how the future might pan out' is a difficult undertaking. One the one hand, if we use our ideas and conclusions about the future to determine what we do, there will always be a risk. If we go further and use our analysis and our forecasts to decide on significant *policy* measures (whether regulatory or investment), then the future well-being of taxpayers and other citizens could be seriously adversely impacted if our assessment based on our forecasts turns out to be wrong. Uncertainty and imperfect knowledge is always present. The continuing progress of science steadily improves our understanding, and continuing innovation and new technology developments strengthen our ability to control the different dimensions of our environment. However, many aspects of our world seem to present new complexities and uncertainties. Some relate to things beyond our current control (for example, certain environmental changes – whether caused by past human activity or not), but many others arise from constraints and unpredictable behavioural response of people to change.

Thus we do well, when exploring what the future might bring, to follow the precautionary principle[17], especially when contemplating taking policy action based on the outcomes of our efforts to assess how things will develop.

On the other hand, it is a natural part of our behaviour as responsible human beings to think ahead. We listen to weather forecasts in the mornings, and often choose different clothes to wear based on what we are told. We often take umbrellas with us when rain is forecast. Wise sailors decide on their plans in the light of what they are told about expected conditions at sea. Ferries, and even aircraft, sometimes stay in port when extreme conditions are forecast. On the 'money' front, we normally check before leaving home to see whether we have enough cash for the situations we expect to find ourselves in during the day (or we assess our ability to handle likely payments in other ways). We are generally aware of large payments we are likely to have to make in the coming days or weeks, and we try to prepare for them by managing the financial resources we have. Wise parents try to budget for the expected outgoings required for their children. Companies (and even more so, governments) generally try hard to choose directions and make contingency resource provisions to allow them to cope with unexpected events.

These examples illustrate some of the dimensions of uncertainty we are faced with, in our public and private lives, and some of the ways we handle them. Why should it be any different in principle when considering assessing the future in relation to policy matters in general and skills in particular?

What this report addresses are the efforts based on past experience and scientific analysis where possible to understand how the future will unfold, and to consider possible steps that will increase the chances of satisfactory outcomes, or – increasingly – reduce the negative effects of possible adverse events and trends. As indicated, there are real risks about whether our actions will turn out to improve things or the reverse. It must be recognised that there can be policy- as well as market-failures: the 'best laid plans' can come to grief - the 'law of unintended consequences' is indeed a powerful one.

[17] that, in the face of uncertainty and risk, it is wise to *act with caution* – to hold back from steps that could have negative consequences

6.2 Recent relevant foresight work

Foresight work in support of policy-making has seen unprecedented growth, in the European Union and beyond over recent years. The focus of Foresight work covers a considerable range, and the main areas of relevance are presented here. The approach taken in assessing the future development of e-skills for this project is that, for the most part, skills activity (demand and supply) is derived from the levels of ICT activity. Thus it is necessary to assess, as the major determinant of skills activity, the levels and types of ICT activity. To a degree, this equates to viewing skills activity as being demand-driven (at least for quantitative analysis), which is increasingly recognised as a sound approach. However, it is also important to consider possible contributions arising from supply considerations. This is done by the separate consideration of future development of skills – and e-skills – independently from the impact on skills demand from expected developments of ICT activity.

For this reason, the literature review has been structured into the three separate areas, covering:

- ICT Futures studies
- Skills Futures studies
- e-skills Futures studies

6.2.1 Recent analysis of ICT futures:

Research on futures of many kinds often has a significant element of ICT futures, normally in relation to particular application areas – for example in relation to ICT user in the home, or ICT use in Environmental matters. In addition, there are several recent studies exploring the likely impact of major ICT deployment on smaller Member States or regions within larger ones.

FISTERA (2002-2005): this was the work of a thematic network on Foresight on Information Society Technologies in the European Research Area**,** and represented the largest collaborative project in this area in recent years. While it is now completed, and the skills component was quite limited, it did result in a number of examinations of likely futures in several Member States.

Horizons2020 (2004): a very thorough 'thought-provoking look at the future" was commissioned by Siemens and published by TNS Infratest. It presented two extensively-worked Scenarios for life in Europe in 2020, each covering a wide range of aspects, including Lifestyles, Old Age, The Family, Home life, Work, Consumer behaviour, Travel, Leisure, Media and Communication, Health Care, Eating Habits, Education and Safety and Security. In addition, the book summarises Siemens' Technology Reports on Production and Automation Systems, Power Engineering, Healthcare, Information and Communication, & Biometrics, Materials and Nanotechnology, Transportation and Combining Biotech, Nanotech and IT.

Nordic ICT Foresight (2005-2007): the project 'aims to contribute to the strategic intelligence of the Nordic countries. It provides visions and scenarios concerning the societal applications of ICT's in four Nordic countries (Denmark, Finland, Norway and Sweden). The project creates scenarios illustrating the possible futures of ICT's along the axes of generic technologies, applications, and markets'.

The annual European Information Technology Observatory (EITO) Reports include both descriptions of current and prospective trends in particular areas of ICT (for example, recent editions have covered developments in such topics as the on-line content market and distribution, and peer-to-peer networks and markets). As indicated, the 2001 edition included a significant section on skills, including some IDC forecast data on future development.

Table 12 overleaf shows the key aspects of a number of recent ICT Foresight studies. Summaries of the approaches and conclusions of the most important are given in Annex F.

Title	Geographical coverage	Executor	Year of completion
The global course of the information revolution: Technological Trends	United States - International	Rand	2004
The Roadmap for the revitalisation of High-End Computing	United States	Computing Research Association	2003
The global course of the information revolution: recurring themes and regional variations	Europe - United States - America - Africa	Rand & National Defense Research	2003
Changing Communication Strategies	United States	Institute For The Future	2003
Visions of a wireless information society	Austria	AAS-ICE : Research Unit for Institutional Change	1999
Breakthrough to the Future with the Information Society in the Liege Region	Belgium	DGTRE : General Direction for Technologies, Research	1997
Future scenarios for the Information Society in the Catalan Region	Spain	Periscopi de Prospectiva i Estratègia	2000
Pervasive Computing Foresight	Denmark	PLS RAMBØLL Management A/S og Center for Pervasive Computing	2004
Estonian eVikings	Estonia	N/A	2002
eFORESEE Estonia	Estonia	N/A	2002
eFORESEE Malta - ICT & Education Pilot	Malta	Malta Council for Science & Technology, MCST	2001
EUFORIA - European Knowledge Society Foresight	Europe - Finland - Germany - Greece - Ireland - EU-25 - EU-15	PREST, ATLANTIS, EMPIRICA, FORFAS, FFRC	2003
UK National Foresight: Intelligent Infrastructure Systems	United Kingdom	Office of Science and Technology	2006
The Northern Ireland Foresight eBusiness Report	United Kingdom	Foresight Northern Ireland	2003
Online computer and video games	International	OECD	2005
Digital Delivery in Distribution and Logistics	International	Victoria University, Melbourne	2005
eHealth in the Context of a European Ageing Society: A Prospective Study	EU-25	VDI	2004
The Future Impact of ICT on Environmental Sustainability	EU-25	N/A	2004
Information and Communication Technologies	Spain	OPTI - MCYT - CDTI - ICT	2002
TICarm - ICT in the region of Murcia	Spain	Fundacion Seneca-OPTI	2004
Scenarios for Ambient Technology 2010	EU-15	ISTAG, IPTS & DG Information Society	2001
The Foresight eBusiness Report	Ireland	Northern Ireland Foresight Steering Committee	2002
Information Relationships Report	United Kingdom	Information, Communication and Media Panel	2001
Smart Internet 2010	Austria	Swinburne University of Technology	2005
eGovernment	Ireland	eGovernment Working Group	2003
FISTERA - Future Prospects in Poland: Scenarios for the Development of the Knowledge Society in Poland	Poland	Progress and Business Foundation (P&BF)	2005
FISTERA - Future Prospects in Romania: Scenarios for the Development of the Knowledge Society in Romania	Romania	Effective Decisions	
The Future of the Internet	United States	Princeton Survey Research Associates	2005
FISTERA - Delphi Information Society Technologies	EU-25 - EU-15 - International	PREST / WP 4 – IST FUTURES FO	2001
Nordic ICT Foresight	Nordic countries	N/A	2005
ICT at home: trends in ICT in the home environment at 2010	Netherlands	TU Delft (Faculteit Techniek, Bestuur en Management)	2000
The future of electronic communication	Netherlands	Ministerie van Economische Zaken Directoraat Telecommunication	2005
Industrial Wireless Technology for the 21st Century	United States	Energetics	2004

Table 12: Recent ICT Foresight work (United States and Europe)

6.2.2 Recent analysis of Skills futures:

Most EU Member State governments now devote resources to research examining in more detail the underlying context for skills policy. There is a range of different levels of investment and of approaches, but labour markets, their operations and the impact of supply limitations on national economies are now very much on the research agenda. As well as broader (macro-economic) analyses of broad characteristics of labour markets (e.g. the widespread debate about the relative flexibility in different Member States (see, notably, Coats 2006) for an intriguing insight on comparative flexibility). Some Member States have gone beyond into deeper explorations of future possibilities and their implications.

The European Centre for the Development of Vocational Training (CEDEFOP) has been active since 2001 in gathering experience from Member States in skills forecasting. This led to the convening, with the collaboration of the German Federal Ministry of Education and Research of two international conferences on the *Early Identification of skill needs in Europe*, in May 2002 (in Berlin) and May 2003 in Thessaloniki. The growing interest of those involved in such work led to the establishment in 2004 of Skillsnet, a Cedefop-supported international network on early identification of skill needs. Since that time the Skillsnet community has strengthened its commitment to the development of a European framework for skills forecasting, and met in October 2005 in Paphos, Cyprus and November 2006 at the University of Warwick, UK to progress this agenda. More substantial funding for this work is likely to be forthcoming.

Skillsnet's strategy involves two paths:

- In the short term to create a Pan-European forecasting model which would use data available for all Member States (for example Labour Force Survey data).
- In the longer term to involve all European countries in this exercise with a view to harmonising or matching sources used at national level, and with the possibility of creating a new core forecasting system for use by all European countries.

In preparation for the 2006 Workshop preliminary results for Pan-European Employment Projections were developed (Wilson, 2006) from a four-module analytical framework, involving:

1. a multi-sectoral macroeconomic model (E3ME[18]), based on Eurostat data;
2. an expansion demand model (EDMOD), using Eurostat LFS (EULFS) data;
3. a qualifications module (QUALMOD) focusing on the demand implications for different levels of formal qualifications, again based on EULFS data;
4. a replacement demand module (RDMOD), also based on EULFS data.

As can be seen, this approach provides future employment level estimates for both sectoral and occupations 'slices' through the economy. The quantitative model used for this study includes some of the principles of that approach. Since this study is not required to handle the whole-economy aspects of comprehensive national forecasting work, it is able to benefit from certain additional evidence relating to the ICT sector and ICT occupations.

In terms of national work of relevance, the UK has, as with skills issues generally, invested significantly into such analyses. Perhaps the most obvious example being the Working Futures project (Wilson et al., 2006a), in which detailed 10-year projections by occupation, sector and

[18] from Cambridge Econometrics: E3ME is intended to meet an expressed need by researchers and policy makers for a framework for analysing the implications of long-term Economic, Energy and Environment ('E3') policies, especially those concerning R&D and environmental taxation and regulation

region are presented as a baseline for more specific work of skills bodies with sectoral and geographical responsibilities.

However, a more strategic analysis by the UK Treasury is currently nearing completion: the Leitch Review of long term skills prospects in the UK (HM Treasury, 2005). The Government commissioned the Leitch Review to 'identify the UK's optimal skills mix in 2020 to maximise economic growth, productivity and social justice, and to consider the policy implications of achieving the level of change required.' This high-level initiative has drawn in a range of serious analysis, including, e.g. a set of alternative skills scenarios (Beavan et al., 2005).

In Ireland the Expert Group on Future Skills Needs has, since 1997, produced a steady flow of reports investigating a wide range of topics of relevance of Irish skills, including significant coverage on ICT areas and quantitative estimates for future demand (e.g. Forfas, 2003).

6.2.3 Recent analysis of e-skills futures

The 2005 report on Supply and Demand of e-skills in Europe (Rand Europe, 2005) examined recent work on e-skills Futures, and distinguished between three main types of analysis:

- Studies using an economic growth approach;
- Approaches using scenarios (based on either current stock or on expert opinion); and
- Analyses based on economic indicators/hybrid.

The papers believed to be of most relevance to this Study are summarised as follows:

IDC published a 'White Paper' – commissioned by Cisco Systems - on the future of Networking Skills in Europe (IDC, 2005). As with earlier IDC work, the report provided some useful insights into aspects of emerging demand and supply for this group of e-skills, but the absence of common occupational categories and of detail about the methodology prevents serious comparison of its findings with other work.

At the national level, the substantial body of work for the UK e-skills labour market represented by the IT Insights set of publications (e-skills UK, 2004) is worthy of particular note, and other recent future-oriented work in relation to e-skills has been carried out in Luxembourg (focused on certain practitioner profiles expected to show strong growth - Duran, 2004, 2006), and Australia (DCITA, 2006), where a comprehensive overview of the ICT Skills situation was produced.

In Spain the 'PAFET' series of studies (Proposals for Actions for the training of electronics and ICT professionals[19]) has included estimates of future needs in its analysis covering the needs of the:

- Software Sector
- User Sectors
- IT Services sector
- Digital Content sector.

The e-skills UK IT Insights series of reports include:

- IT Insights: Trends and UK Skills Implications
- IT Insights: Employer Skills Needs
- IT Insights: Employment Forecasts

[19] Propuesta de Acciones para la Formacion de Profesionales de Electronica, Informatica y Telecomunicaciones

- IT Insights: Drivers for Skills Demand
- IT Insights: Assessment of Current Provision
- IT Insights: Regional Skills Gap Analysis (one for each English region)
- IT Insights: Skills Gap Analysis – Scotland
- IT Insights: Skills Gap Analysis – Wales
- IT Insights: Skills Gap Analysis - Northern Ireland.

The 'synthesis report' (e-skills UK, 2004) identified nine priority skills themes for the UK:

1. over the coming decade, significant numbers of people are needed each year to enter the IT workforce, filling increasingly complex, high added value roles;
2. skills within the IT workforce are changing rapidly; the opportunities for greater strategic benefit from IT, the need to deliver greater return on IT investment, and the effects of geo-sourcing are leading to a stronger demand for broader and deeper skills than ever before;
3. innovative action is needed to address the gender imbalance that is endemic in the IT workforce;
4. IT underpins innovation, competitiveness and service in every sector. The UK has one of the best environments in the world for e-commerce but this has not been matched by the level of uptake by businesses, government and citizens;
5. business managers must be equipped to realise the potential of IT. This is a challenge for leaders of all enterprises and particularly for those in smaller organisations where there may be few, if any, professional IT staff;
6. the vast majority of employees will need to be equipped with IT skills at a growing level of sophistication;
7. there is a need to address issues of exclusion. Skills in the use of IT are becoming as fundamental as literacy and numeracy; those who lack them will find their personal and professional lives limited in the same way that illiteracy impacts on lives today;
8. ongoing skills development needs require new delivery methods that integrate work-based, vocational and academic learning, and take into account the impracticality of releasing employees from work, particularly for smaller companies; and
9. the private training industry alone will be unable to deliver the necessary IT skills development needed in the UK. Unprecedented, government-enabled collaboration is required, with educators and employers working together in new models of partnership.

In the US, industry analysts Gartner came up, in 2005, with a proposition for how the IT Profession would develop in the coming years. Gartner identifies four primary drivers for these predicted changes in IT practitioner work: Global sourcing; IT automation; The consumerisation of IT; Business restructuring. .

As a result of the impact of these drivers, by 2010, Gartner foresees the traditional IT field splintering into four distinct domains of expertise:

- **Technology infrastructure and services.** Opportunities in technology infrastructure and services, the foundation of the IT profession, will grow in service, hardware and software vendors. This will occur in many developing economies and may wane in user companies. Network design will remain strong everywhere.
- **Information design and management.** Business intelligence, online consumer services, work enhancement initiatives, search-and-retrieval practices and collaboration all will grow in user companies, systems integrators and consulting companies. Linguistics, language skills, business and cultural knowledge, and knowledge management will be fertile ground.

- **Process design and management.** IT professionals can look at process opportunities from three angles: competitive business processes, design of process automation and operational processes. The first will be the "sweet spot" for companies; the second, for software vendors; the third, for outsourcing vendors.
- **Relationship and sourcing management.** Far removed from the traditional skills that IT professionals pursue, relationship and sourcing management will gain ground. This will demand strengths in managing intangibles and managing geographically distributed parties with different work outcomes and cultures.

A recent Forrester Research report, IT Skills Shortages on the Horizon (Forrester, 2005a), identified eight IT skills that will be most in demand in 2005 and beyond:

- business analysis and relationship management;
- business intelligence and web-enabled analytics;
- enterprise architecture;
- security;
- Linux/open-source;
- agile programming;
- business process modelling; and
- web services (SOAP, XML, .NET and WebSphere).

A subsequent report (Forrester, 2005b) focussed more directly on the IT skills position within Europe. As well as summarising the kinds of shifts in demand indicated above, and acknowledging that employers are requiring fewer technicians and more business-oriented profiles as well as continuing to outsource routing activities, the study examines two aspects of *supply* causing concern in some detail:

- the impact of increasing retirement rates associated with the 'baby boom' generation, and
- the concerns raised about falling interest in university IT courses, and the challenges to Higher Education Institution (HEI) informatics departments ability to update provision in response to changing employer demand.

In particular, the report concludes that while '*in theory the educational system should be able to rapidly create new programmes to train IT/business analysts, architects, enterprise programme managers, and vendor managers – skills that firms expect to need in greater numbers in the future, in practice this will take too long to meet company demands. Other sources of talent, such as service providers, also need staff with technical skills – and the lack of IT graduates gives them cause for concern, too*'

In IBM's 2005 Skills and Growth White Paper (IBM, 2005a), Barnes summarised the company's perspective in relation to the expected development of ICT Practitioner skills in the United States and beyond. The U.S. IT Practitioner employment outlook was felt to be positive, but was showing a pronounced shift in demand to specialised "hot" skills that fuse industry-specific knowledge, IT competency and business process expertise. The view was that the market increasingly needs these skills to implement more integrated and customised technology and systems that create competitive advantage and enable innovation. Efficiencies created by global service delivery models were expected to drive intensified IT investment in the U.S. and growth in new job categories. The diffusion of IT into sectors, like health care, currently under-invested in IT was expected to drive job growth and productivity. The result was expected to be even stronger demand in the U.S. for IT-proficient workers and for better tools to continuously upgrade their skills. In parallel, the demand for some IT Practitioner skills was believed to be shifting more quickly from "hot" to "cold": the "shelf life" of many IT skills was growing shorter. Many technical specialties, once leading edge, were being standardised, automated, or sourced from low cost countries that had invested in their

workforce. Those trends, along with the consequences of an aging workforce would change the workplace and employment experience for many IT workers.

Examples of fading and growing skill areas were felt to be:

'cold' jobs/skill areas	'hot' jobs/skill areas
• Application Development • Application Maintenance • Packaged Application Tools • Transcription Services • Contact and Call-Centre work • Specialised BPO services	• Business Analysis • Security Analysis • Vendor Management • Service Management • System Integration • Data Mining • Business Intelligence • Database Administration • Network Engineering • Network Architecture • Internet/Web Architecture • Web Services

Table 13: Skills areas expected by IBM to decline and grow

IBM's own hiring in the U.S. showed a growing emphasis on "hot" skills and strategic growth areas; including business consulting, middleware architects and open standards specialists. The company expected more, higher-paid, consulting services and engineering jobs, and fewer, lower-paid production and administrative roles. IBM was increasingly applying supply chain management principles to its global workforce, to best match skills to client needs. In addition, IBM itself was continuing to invest heavily in learning programmes, and believed that employers and policy makers should work to support employees building new, innovation-focused skills to compete in the global economy.

Finally a very recent report by Ovum for the UK Department for Trade and Industry (Ovum, 2006) explores in some detail, based on interviews with the major players in the UK Software and IT Services sector, and with a quantitative model, the impact of global sourcing for these industries. It has a number of interesting findings. It outlines the estimates for the split of 'home' and 'off-shored' work in the coming years, and the implications for the UK national labour market for ICT Practitioners.

Specifically, the analysis concludes that the on-shore workforce will continue to shrink, with the fraction of employees supporting these sectors estimated to rise from 21 per cent in 2005 to 36 per cent at the end of 2006. This would result in a fall of the sectors' UK-based employee level by some 6 per cent. This would be somewhat offset by increases in the UK-based staff of supplier companies from overseas (in particular, India). In spite of certain 'backlashes', Ovum expect the off-shoring trend to continue steadily over the coming years. The majority of the likely job reductions in the UK are expected to be in such roles as programming, lower-level technical roles, call centre/help desk and corporate administration. The growth in ICT practitioner work is expected to come in the delivery of innovative applications in close cooperation with 'end-customers'. Suggested measures to support this direction include:

- greater commitment by companies to staff training and development;
- exploring incentives for re-training of those whose jobs are off-shored;
- working to improve the perceived attractiveness of the ICT profession;
- addressing the fall-off in interest in Computing and Mathematics HE courses, and strengthening the work-experience component of such courses.

The report also flags the fact that smaller businesses are more at risk to these trends than larger ones, and that, with growing volumes of off-shoring comes an increasing need for mutuality and 'level playing fields' in international trade.

6.2.4 Recent Analysis of relevant broader futures research

The 'Jobs of the future' reports an analysis by Accenture (for, and with, the Lisbon Council) of prospects for economic growth within the EU with a focus on the areas where new jobs are likely to be created over the coming years. The work arose from a concern by the Lisbon Council that 'urgent action is required if Europe is to reverse the recent trend of poor economic and employment growth'. The study highlights some key industrial sectors where employment can be increased in a sustainable way and shows that Europe has the potential to create some 10-14 m new jobs over the next five years, 'as long as it puts in place the right conditions for growth'. It concludes with sets of action points for both policy-makers and business.

Researchers at IBM have begun to focus increasingly on what they see as the emergence of Services Science, Management and Engineering (SSME). The view is that, while developed Western countries have seen major shifts in economic activity from Manufacturing to Services, there has been no resulting effort to develop a corresponding academic Body of Knowledge for Services. While there are many successful tertiary education courses around the world on different aspects of Manufacturing, there are few addressing the underlying principles of business operations for a Service economy. IBM has been in dialogue with leading Universities in the US about this. The overall proposition is put forward by Spohrer in IBM (2005b).

'Foresight 2020: Economic, Industry and Corporate Trends' has recently been published by the Economist Intelligence Unit (EIU) on a commission from Cisco Systems. This comprehensive analysis draws on an on-line survey of over 1500 senior executives from around the world at the end of 2005, and a series of in-depth interviews with executives, analysts and policy-makers globally, in addition to the EIU's own long-term economic forecasts for the world's major economies. The study looked in some detail at the Automotive, Consumer goods and retailing, Energy, Financial Services, Healthcare and Pharmaceuticals, Manufacturing, Public Sector and Telecoms sectors, and concluded by identifying 5 'mega-trends':

- Globalisation
- Demographics
- Atomisation
- Personalisation
- Knowledge Management

More generally in terms of Europe's strategic challenges, the 'Aho Report' (Independent Expert Group on R&D and Innovation, 2006) presented a strategy to create an Innovative Europe, concluding with three key recommendations, the need for:

- Europe to provide an innovation-friendly market for its businesses;
- measures to increase resources for excellent science, industrial R&D and the science industry nexus;
- Far greater mobility at three levels: Human Resources (across boundaries), financial mobility, and mobility in organisation and knowledge.

6.3 Quantitative future-gazing: forecasting

Forecasting of the development of economic variables is both quite common and fraught with risk, in terms of possible conclusions drawn. While the same sophisticated techniques that are used quite successfully in engineering dynamical systems can in principle be brought to bear on analysis of economic time series, confidence in the validity of the forecasts is considerably lower. This is because macro-economic variables relate to large, complex, ever-changing, systems whose behaviour is built on the combination of a large number of individuals – people, whose behaviour is less well understood or predictable than that of man-made engineering artefacts.

Nevertheless, it is possible to analyse and review behaviour of economic systems – 'markets' and, to an extent, labour markets, although it is crucial at every stage to be aware of, and take into account, the limitations of the validity of such forecasting models. In relation to skills forecasting, most models draw on the estimation of future employment levels, in particular of occupational data. This is because the skills supply and demand context – in fact each real labour market – is essentially occupational. Although people sometimes apply for jobs where they have limited experience or expertise (i.e. unskilled or semi-skilled work), if significant levels of expertise are required, employers offer a job or occupation, and the job-seeker offers a set of skills that relate to that occupation.

The main recent studies providing quantitative forecasts in relation to e-skills have been reviewed in some depth. In particular, the approach used in the following studies was considered in as much detail as was published:

Studies forecasting ICT Industry employment/skills levels for Europe:

- the 2001 Study for the Finnish Electrical by Abo Academy (SET/ÅA, 2001)

Studies forecasting ICT practitioner employment levels for Europe (showing scope):

- the 2001 IBM/Career Space forecast (Western Europe) (Career-Space, 2001);
- the 2002 IDC Study for CompTIA/VUE (Western Europe) (IDC, 2002);
- the 2003 BIAT/Cedefop study (EU-15) (Petersen, W. & Wehmeyer, C. (2003);
- the 2005 IDC White Paper on Networking skills for CISCO (EU-25) (IDC, 2005);

As with all previous forecasting studies, it is illuminating to review how things turned out, as compared to the forecasts. Of the above studies, the Abo Academy study and the IDC White Paper considered more than one possible future.

Considerable thought was given to the form of the mathematical model. The modelling approach and model design are described in more detail in Annex B. However, two things characterised the approach taken in this Study:

1) a remarkable correlation discovered, for the United States, between Software Investment and Software and IT services employment levels; and
2) the over-riding desire for the model to be simple and easy for lay people to understand and 'internalised'.

The model development is described in detail in Section 9.

7 Qualitative analysis: *designing and painting the pictures*

Many decisions require that we think carefully about the longer-term future, because today's actions and investments may not come to fruition for a decade or even more. Presenting scenarios can help us clarify our thoughts about the future. This section presents the Study's approach to the development of Scenarios for the future of e-skills in Europe, considering in particular the ICT Industry's needs for ICT Practitioner skills. Thinking about the long-term future is challenging. It is easy to overstate change, and equally easy to fall into the trap of assuming that a "business as usual" view will suffice. The "surprise-free scenario" is almost guaranteed not to happen – but just which surprises are likely to ensue, even if a comprehensive list of 'wild cards' were available, is very hard to establish. A number of alternative scenarios are therefore set out to illustrate some of the range of possibilities that may confront us in the future, and to stimulate reflection on the processes that are driving developments now and into the future.

The most effective way to set the scene for open-minded consideration of how the future may develop is generally recognised to be with the identification and consideration of a range of '**Drivers**'.

7.1 Introduction

Drivers relevant to this study are detectable significant trends that are likely to have an impact on some aspect of e-skills in the coming years. For example, they could increase demand for e-skills in general by affecting the overall level of ICT activity and use. They might influence which e-skills are required, they might affect whether firms seek to utilise in-house skills or acquire them from external sources. Such Drivers arise from a number of different dimensions of our world, in addition to the changes brought about by Information and Communication Technologies (ICT) themselves. For example some are economic, some relate to developments in society as a whole, while others result from changes in the values and thus the behaviour and preferences of individuals. In order to structure the rather large number of drivers, the project has adopted the S T E E P V grouping:

- **Social**
- **Technological**
- **Economic**
- **Environmental**
- **Political**
- **Values-related**

The set of STEEPV Drivers shown below are those identified by the Project Team and by experts consulted in this work. They are seen to be significant in terms of the influence/impact they are likely to have on the Supply of and Demand for e-skills within Europe in the coming 5 or 10 years. The drivers are largely expressed in terms of expected trends. They represent extrapolations of developments that are generally expected to continue. However, some drivers are more speculative – some are events which remain uncertain and/or contentious among the expert community (for instance, disruption of the Gulf Stream seems to be regarded as plausible in the nearer term by a significant minority of experts). Some are developments identified on the basis of "weak signals" which may or may not be being read accurately (this is probably especially the case when it comes to social and technological innovations and changes in direction).

While the grouping is helpful in developing an overview of such a large and complex conceptual space, the drivers themselves arise from many "original" causes. Some drivers may share such 'underlying determinants', others may be contradictory (i.e. if one factor is at work it may make one driver more likely, another less so). If drivers are traced back to their underlying determinants it can be possible to view many of them as belonging to another group. For example, P6 (raising of the retirement age) arises in part as a response to underlying demographic realities (which would be viewed as a social factor), although it is categorised under 'P', since it strictly arises from a political (policy/legislative) act.

Moreover there can be 'vicious circle' behaviour for individual Drivers, arising from interaction of supply and demand. For example, market responses to certain resource shortages can reduce demand for the resource and, as a result, reduce incentives for supply. This can subsequently reduce actual supply further. Off-shoring of work is a prime example of this. Decisions to off-shore can arise because of serious shortages of skill supply: the off-shoring step will then reduce demand for certain skills, thus reducing overall market supply shortages and so incentives for further supply.

7.2 The STEEPV Drivers identified

This list comprises the initial drivers identified by the project team augmented by the suggestions received for additional drivers from a wide range of commentators with understanding of ICT and e-skills.

SOCIAL Drivers

Social factors relate to organisational and institutional structures (inc. informal ones), relationships and practices, as well as social and cultural influences.

- S1: Improved Educational Levels
- S2: Expectations of higher wages and employment benefits within the EU
- S3: Population Ageing Trends (wealthier industrial societies have greater shares of older people)
- S4: Efforts to compromise systems (by hackers, fraudsters, cyber-terrorists, etc.) give rise to growing concerns about ICT Security
- S5: Adoption of ICT in ways that enable new working and learning practices grows (e.g. remote working and e-learning)
- S6: Adoption of ICT in ways that support development of new types of organisational structure (e.g. systems supporting structured – even highly disciplined – co-operative and mobile work)
- S7: Inward migration to richer EU countries
- S8: Shift of (in particular, *Female*) attitudes to work as ICT Practitioners
- S9: Fading significance of techno-sceptic attitudes as cohorts reared on ICT come to dominate
- S10: Increasing mobility generally (both within Europe and globally) – growing migration (in particular of the young elite) to other, generally more prosperous, regions
- S11: Demographic changes beyond age – e.g. in relation to gender and ethnic distributions (often described in terms of greater diversity in populations and workforces)
- S12: Increasing emphasis on safety and security-related measures (e.g. homeland security activity; increase in CCTV and other societal monitoring measures)
- S13: Improved health and well-being is sought after for ageing citizens (and is apparent in investment and expenditure decisions)
- S14: Growing importance of 'on-line socialisation' (with growth of virtual communities for work and leisure)
- S15: Growth of multi-culturalism (and of occasional backlashes)

TECHNOLOGICAL Drivers

Technological factors include knowledge of how to affect the material world, artefacts and software that can accomplish this, the functionalities that they offer.

- T1: Major new classes of technology, applications and styles of use of technology introduced and exploited
- T2: Improved user interfaces widely used
- T3: Greater adoption of software engineering (tools) and more disciplined approaches to system development
- T4: Enhanced telecommunications infrastructure and services (e.g. mobile broadband)
- T5: Maturing of (parts of?) ICT Infrastructure/Services
- T6: (Significant) improvement in (cost-) effectiveness of e-Learning
- T7: Growing impact of technology convergence on content-related products & services
- T8: New technologically-based threats to infrastructure and business are experienced on a significant scale (e.g. electronic warfare)
- T9: More use of *bio-mimetics* in design (growth of nature-inspired design)
- T10: Impact of more accurate geographical positioning systems (e.g. Galileo) in terms of more and better services, and new generation GIS generally
- T11: Growth of use of ubiquitous & utility computing – emergence of *Ambient Intelligence* as a social and business platform
- T12: Growth in development and availability of carbon-emission reducing technologies
- T13: Continuing growth in creative applications of ICTs in existing and new areas (e.g. e-health, spatial and movement tracking systems, e-democracy, leisure)
- T14: Development and deployment of Digital Rights Management (DRM) and related technologies
- T15: Shift towards of the use of Open-Source Software

ECONOMIC Drivers

(inc. Drivers of special interest for ICT – supply – Industry)

Economic factors concern prices, markets, supply and demand of commodities, general financial and business circumstances.

- E1: Levels of economic growth within the EU
- E2: Levels of global economic activity
- E3: Price trends of major classes of ICT equipment (continuing to decline?)
- E4: Prices of alternatives to ICT-delivered services (continuing to rise?)
- E5: Increased start-up rate for SMEs
- E6: Commoditisation of ICT goods & services is commonplace
- E7: (ICT Industry) increasing global competition
- E8: (ICT Industry) increasing customer demand for more cost-effective delivery
- E9: (ICT Industry) development of strong customer reaction to bad experience with outsourcing (and off-shoring)
- E10: (ICT Industry) emergence of new technologies and companies on a large scale
- E11: Increasing energy costs
- E12: Increasing globalisation generally (including global labour following global capital, and growth of globally-integrated businesses)
- E13: Increase in on-line services (both voice and data telephony delivered) – continuing automation of routine and lower-level work
- E14: Growth in 'management by measurement' – through increased use of performance and evidence indicators (in the private *and* public sectors)
- E15: Growing investment by large private companies in their own 'education'/training facilities (e.g. Motorola University; Cisco Networking Academy Programme)
- E16: Growing divergence between skill needs of large companies and SMEs – greater need for SME-related policies
- E17: Impact of the growing "pension crisis"
- E18: Impact of shifts in US HQ strategies on the European market
- E19: Growing business investment in skills and training
- E20: Development of supply of e-skilled labour in off-shoring and potential off-shoring economies

ENVIRONMENTAL Drivers

Environmental factors include developments in biological and natural environments and ecosystems, pre-eminently, but may also include those in the more immediate built and living environments of human beings and the local experiences of, for example, pollution and resource scarcity.

- N1: Acceleration of global warming and its impacts
- N2: Disruption of Gulf Stream
- N3: Pressure/effort to replace travel and transport with telecommunications
- N4: Emphasis on reduction of ICT and electronic waste
- N5: Environmental regulation & concerns lead to growth in business (ICT exploitation) opportunities
- N6: Increasing water shortages
- N7: Pressure for new energy sources and distribution architectures (e.g. local production)
- N8: Pressure for development of carbon sequestration technology
- N9: Significant economic impact of growing natural disasters
- N10: Growing pressure against planned obsolescence
- N11: Emergence of eco-terrorism
- N12: Pressure for accelerated development of natural resource-saving technologies

POLITICAL Drivers

Political factors include political regimes and the philosophies they apply, regulatory and legal; structures, the dominance of particular groups in decision making, etc.

- P1: Variation of skilled worker migration flow(s) into EU
- P2: Further reduction of barriers to migration of skilled workers within EU
- P3: Changes in taxes on labour
- P4: Pressure exerted on employers to reduce or limit off-shoring
- P5: Growing geopolitical instability
- P6: Raising of retirement age
- P7: Political/Governmental response(s) to ICT-related problems
- P8: (Changes to) Government commitment to ICT innovation and investment
- P9: (Changes to) employment legislation (labour market regulation) levels
- P10: Occasional major 'one-off' national ICT infrastructure transition events (e.g. analogue TV switch-off)
- P11: Widespread adoption of the Web as a political platform for both lobbying and direct action by grass-roots communities
- P12: Increasing polarisation of attitudes towards government at all geographical levels – possible erosion of national level politics as compared to local and international governance
- P13: Increasing importance of cultural differences in politics – especially Islam vs. secularism
- P14: Growth of e-Government and 'Transformational government' enabled by ICTs – and commitment to e-inclusion through awareness and entry-level user skill provision
- P15: Impact of EU Services Directive (in opening services markets)
- P16: Growth of effective lobbying of government by ICT Industry
- P17: Policy commitment to flexible markets and life-long learning

VALUES-related Drivers

Values factors cover lifestyles and aspirations, attitudes towards the use of time, resources, human beings and other entities, and the like.

- V1: Declining interest of young people in EU in undertaking technology related courses/qualifications
- V2: Demand of workforce for more satisfying jobs
- V3: Possible increase in "enlightened" management philosophies & practices
- V4: Resistance and growing hostility to surveillance/privacy invasion through ICT at work and in services
- V5: Growing concern about health hazards of ICT
- V6: Lifestyle changes through ICT use in leisure activity – growing use of ICTs of different kinds by young people
- V7: Decreasing attachment to specific jobs and employers – growing adoption of freelance practice
- V8: Increasing concern about personal security – increase in risk-aversion?
- V9: Growing use of ICTs for consumption
- V10: Emergence of anti-technology backlash (in response to environmental crisis and/or ethical issues thrown up by new ICT – e.g. surveillance, AI systems – and biotechnologies)
- V11: More interest in/emphasis on corporate ethics and CSR

7.3 Impact of the change drivers on the demand for ICT practitioner skills

A detailed analysis was carried out of the likely impact of each of the ninety drivers on supply and demand for each of the three types of e-skills, as well as on off-shoring. The results are presented in Annex G.

In order to distil the most important factors from the very long list of identified change drivers, it was decided to examine their impact on the most important of the influences. This Study has focused in most detail on the future development of the e-skills position for the ICT industry, and the central component of this is the possible future supply and demand of ICT Practitioner skills. This will be explored first and foremost through *assessment of the likely future development of demand*, followed by *consideration of how the supply channels might and could respond.*

Tables 14-19 therefore examine, drawing on the broader analysis reported in Annex G, the *likely impact of each driver on demand for ICT Practitioner skills.* It is important to remember that impact on demand occurs both directly and – through changes in supply, and so price – indirectly, and such effects are included in the Tables.

SOCIAL Drivers	
Driver	**Impact on Demand for ICT Practitioner skills** (including influence from supply change effects)
S1: Improved Educational Levels (reflecting greater funding and policy inputs to education and increased demand for higher and further education).	• Some higher expectations for greater professionalism from managers • More ICT Awareness in non-Technical graduates • More supply of ICT graduates where Computing courses hold their share of overall student numbers (this is evidently not happening in certain Member States) • Some increased demand from companies 'spun-off' from university research
S2: Expectations of higher wages / employment benefits? within the EU (c.f. outside EU).	• Higher benefits might increase demands for Practitioner work, but • Higher employer costs likely to result in increased off-shoring and so fall in demand • Increase demand of skills relevant to off-shoring operations
S3: Population ageing trends (wealthier industrial societies have greater shares of older people)	• Loss of Practitioners to retirement would reduce supply • Loss of expertise could reduce effectiveness/quality of delivery and so enterprise competitiveness (but loss mitigated by accelerating change, reducing seriousness of expertise loss for obsolescent systems/services)
S4: Efforts to compromise systems (by hackers, fraudsters, cyber-terrorists, etc.) give rise to growing concerns about ICT Security (e.g. criminal of politically-motivated attacks on systems or data).	• Increase demand for Practitioner skills in Security • Stimulate market for security-enhancing products/services • Security concerns might lead to loss of confidence and economic growth • Trend would stimulate technological innovations in response • Development might reduce off-shoring trend
S5: Adoption of ICT in ways that enable new working and learning practices grows (e.g. remote working and e-learning) (e.g. significant increase in remote/mobile work, e-Learning in the workplace, Life-long Learning).	• Increase in supply arising from reduction in access constraints? • Resulting economic growth stimulation should raise demand for practitioners
S6: Adoption of ICT in ways that support development of new types of organisational structure (e.g. systems supporting structured - even highly disciplined - co-operative and mobile work) (continuing of outsourcing trend, virtual enterprises,	• Increases in demand for certain types of ICT and approach • Increases in demand for systems to handle new organisational structure (but corresponding reduction in

network firms, multi-/inter-national organisations, new forms of collaboration).	demand for Practitioners to refine/maintain existing/traditional arrangements) • Resulting economic growth stimulation should raise demand for practitioners
S7: Inward migration to richer EU countries (from other Member States).	• Increased supply of ICT Practitioners in richer economies • Possible impact on salary levels • Increased economic growth should result in steady increase in demand for ICT Practitioners
S8: Shift of (in particular, Female) attitudes to work as ICT Practitioners.	• Increase of supply of ICT Practitioners • Possible impact on salary levels within the EU
S9: Fading significance of techno-sceptic attitudes as cohorts reared on ICT come to dominate.	• Increased ICT system and service consumption would increase demand for ICT Practitioners • Greater net demand for technologies would stimulate increased levels of innovation
S10: Increasing mobility generally (both within Europe and globally) - growing migration (in particular of the young elite) to other, generally more prosperous, regions.	• Continuing growth of ICT Practitioner demand from transport sector • Secondary growth in demand for telecoms sector including need for more practitioners
S11: Demographic changes beyond age – e.g. in relation to gender and ethnic distributions (often described in terms of greater diversity in populations and workforces).	• Demand for additional skill-sets for ICT Practitioners • Increases of ICT Practitioner supply from certain communities, resulting in growth of overall supply
S12: Increasing emphasis on safety and security-related measures (e.g. homeland security activity; increase in CCTV and other societal monitoring measures).	• Growth in all aspects of ICT Practitioner skills to do with security • Possible loss of certain strengths in Practitioners arising from growing risk aversion
S13: Improved health and well-being is sought after for ageing citizens (and is apparent in investment and expenditure decisions).	• Reduced loss of supply of experienced ICT Practitioners • Growth in demand for ICT devices, systems and services from mature consumers with substantial purchasing power, producing growth in demand for ICT Practitioners
S14: Growing importance of 'on-line socialisation' (with growth of virtual communities for work and leisure). The strong growth of Internet enabled communication between people will bring new experiences and approaches to remote interaction.	• Demand for next generation communication will stimulate growth in economic demand, and so additional recruitment of certain ICT Practitioners
S15: Growth of multi-culturalism (and of occasional backlashes)	• Demand for additional skill-sets for ICT Practitioners

Table 14: Impact of the *Social* Change Drivers on Demand for ICT Practitioner skills

TECHNOLOGICAL Drivers	
Driver	**Impact on Demand for ICT Practitioner skills** (including influence from supply change effects)
T1: Major new classes of technology, applications and styles of use of technology introduced and exploited.	• New demand for ICT Practitioner skills to handle the new systems and applications • Demand for ICT Practitioners in international roll-out • New demand arising from significant ICT innovation
T2: Improved user interfaces widely used. The impact of better user interfaces would be expected to include:	• Could make system development easier (more achievable with – only – User skills?) thus increasing productivity and reducing demand for ICT Practitioners? • Reduction might be compensated for by corresponding growth in innovation and overall demand for new systems • Could provide new work opportunities for Practitioners were better interfaces open up new applications/markets
T3: Greater adoption of software engineering (tools) and more disciplined approaches to system development (for increasing	• Possible increase in supply (lower level practitioners and some users could begin to carry out tasks previously

productivity of ICT Practitioners).	restricted to higher level practitioners • Possible increase in productivity resulting in decrease in demand to achieve the same result
T4: Enhanced Telecommunications Infrastructure and Services (enabling improved organisational and personal communications).	• Rise in demand for ICT Practitioner skills from growth in new ICT-based services
T5: Maturation of (parts of?) ICT Infrastructure/Services	• Reduced practitioner demand for innovative development – shift to operational and maintenance work • Increase in off-shoring of mature services?
T6: (Significant) Improvement in (cost-) effectiveness of e-Learning.	• Increased demand for ICT Practitioners with e-Learning development expertise
T7: Growing impact of technology convergence on content-related products & services.	• Growth in demand for Practitioners for Consumer electronics sector
T8: New technologically-based threats to infrastructure and business are experienced on a significant scale.	• Reduction in demand for all types of e-skills, resulting from loss of business confidence, economic growth and innovation • Growth in demand for security-related Practitioner skills
T9: More use of bio-mimetics in design (growth of nature-inspired design).	• Rise in demand for new types of Practitioner skills
T10: Impact of more accurate geographical positioning systems (e.g. Galileo) in terms of more and better services. All spatial-positioning and tracking systems will be affected, and the performance and precision improvements will provide opportunities for new types of product and service.	• Growth in demand for ICT Practitioner skills (in particular for GIS development)
T11: Growth of use of ubiquitous & utility computing - emergence of Ambient Intelligence as a social and business platform. The increasing availability of adequate amounts of computing power, wherever and whenever needed, at relatively low prices will effectively remove processing constraints. This will enable the development of a number of new systems and applications.	• The innovation and economic benefits involved will stimulate increased demand for ICT Practitioner skills
T12: Growth in development and availability of carbon-emission reducing technologies. Incentives for development of technologies to tackle carbon emissions are likely to accelerate. This will involve more efficient consumption of fossil fuels and growing substitution of non-fossil fuel energy sources. Such developments will have a significant innovation component, and ICTs will play their part.	• Growth in demand for ICT Practitioner skills, in particular with experience in energy-generation system applications
T13: Continuing growth in creative applications of ICT in existing and new areas (e.g. e-health, spatial and movement tracking systems, e-democracy, leisure). The scope for enhancements of existing systems and the development of others can be viewed as still very considerable.	• Growth in demand for ICT Practitioner skills, in particular with experience in the innovative sectors and applications
T14: Development and deployment of Digital Rights Management (DRM) and related technologies. Agreement on IPR principles for software and on-line content seems difficult to achieve: confrontations are significant, and the future path of this debate in different jurisdictions remains to be seen.	• Additional demand for specialised ICT Practitioner skills in DRM and related applications, as well as Practitioners with certain legal understanding
T15: Shift towards of the use of Open-Source Software. O-SS could bring e-skills benefits through additional resources being available for additional development work (both system- and human-). The Open-Source approach also provides a mechanism for the commoditisation of mature technologies, thus stimulating further innovation.	• Diversification of system design and development approaches, with growth in demand for ICT Practitioners in innovative contexts

Table 15: Impact of the *Technological* Change Drivers on Demand for ICT Practitioner skills

ECONOMIC Drivers	
Driver	**Impact on Demand for ICT Practitioner skills** (including influence from supply change effects)
E1: (Levels of) Economic Growth within the EU.	• Increase in ICT activity in other EU countries might reduce domestic supply of practitioner skills
E2: Levels of Global Economic activity.	• Probable positive spin-off for e-skills demand generally into domestic economy, plus, in principle, increased demand for export business • Increased demand for ICT HR beyond the EU might result in skill shortages in overseas ICT Industry and price rises for off-shored services.
E3: Price trends of major classes of ICT equipment (continuing to decline?).	• Demand for ICT Practitioner skills would generally hold up under continuing ICT investment and improved hardware power.
E4: Prices of alternatives to ICT-delivered services (continuing to rise?).	• Reduction in demand, arising from reduction in ICT activity
E5: Increased start-up rate for Small and Medium-sized Enterprises (SMEs).	• Increased demand for ICT Practitioners arising from growth in innovation
E6: Commoditisation of ICT goods & services is commonplace.	• Additional understanding/skills needed for ICT Practitioner skills
E7: (ICT Industry) Increasing Global Competition.	• Demand for greater Productivity by ICT Practitioners, followed by (step) fall of demand arising from off-shoring decisions
E8: (ICT Industry) Increasing customer demand for more cost-effective delivery. Expected impact on e-skills:	• Need for overall greater cost-performance by ICT Practitioners – including greater professionalism in ICT design, development and delivery. In absence of improved performance, threat to demand from off-shoring.
E9: (ICT Industry) development of strong customer reaction to bad experience with outsourcing (and off-shoring).	• Possible ICT Practitioner skill demand increase where off-shoring is 'brought back' to domestic market… Supplier Management skills are particularly needed
E10: (ICT Industry) emergence of new technologies and companies on a large scale.	• Increased demand for ICT Practitioner skills
E11: Increasing energy costs.	• Direct impact is on growth of demand for Practitioners to work in the sector, on system enhancements or systems that support new development of energy enterprises (e.g. in entering alternative energy supply markets)
E12: Increasing globalisation generally (including global labour following global capital, and growth of globally-integrated businesses).	• Potential reduction in demand for ICT Practitioner skills, mitigated by some additional need for skills in ICT infrastructure and supplier management
E13: Increase in on-line services (both voice and data telephony delivered) - continuing automation of routine and lower-level work.	• ICT Practitioner skills are demanded both for developing/maintaining on-line systems, and in particular for designing the automated services
E14: Growth in 'management by measurement' – through increased use of performance and evidence indicators (in the private and public sectors).	• Potential increase in ICT Practitioner skills
E15: Growing investment by large private companies in their own 'education'/training facilities (e.g. Motorola University; Cisco Networking Academy Programme).	• Provision of new supply of ICT Practitioner skills of relevance to the investing company (e.g. networking skills for CISCO)
E16: Growing divergence between skill needs of large companies and SMEs - greater need for SME-related policies.	• High demand for ICT Practitioners with wide range of practitioner skills
E17: Impact of the growing "pension crisis". The combination of greater numbers, better health and lower pension expectations is likely to mean more older people working than before.	• Increase in (reduction of loss of) supply of experienced ICT Practitioner skills • Increase in demand for new systems for older people, stimulating increased demand
E18: Impact of shifts in US HQ strategies on the European market. American ICT majors have had a very significant	• Potential loss of demand for ICT Practitioner skills (where operations are removed from European sites)

presence in Europe, and no major change to that is expected.	• Potential increase in supplier management ICT Practitioner skills, and skills where European workforce has leading-edge expertise
E19: Growing business investment in skills and training. Many forward-looking companies, not least in the ICT Industry, already commit significant investment into staff training.	• Raising of skills (supply) levels, in particular for ICT Practitioners
E20: Development of supply of e-skilled labour in off-shoring and potential off-shoring economies. A major (the primary?) cause of the off-shoring step is the greater availability of ICT skills in overseas economies at significantly lower price levels.	• Rise/fall in the comparative attractiveness of the off-shoring option, and so reduction/increase in demand for (in particular) ICT Practitioner skills within the EU. • Fall/rise (in principle, over time) in the price of labour within economies competing for EU off-shoring business, and so growth/contraction of demand for (in particular) ICT Practitioner skills in Europe.

Table 16: Impact of the *Economic* Change Drivers on Demand for ICT Practitioner skills

ENVIRONMENTAL Drivers	
Driver	**Impact on Demand for ICT Practitioner skills** (including influence from supply change effects)
N1: Acceleration of global warming and its impacts (disruptive of established economic patterns; migration from affected – developing – countries).	• Economic disruption would reduce ICT activity and demand for ICT Practitioner skills • Major impact on some off-shoring economies might result in off-shored work being re-located • Inward-migration might bring additional supply?
N2: Disruption of Gulf Stream (Europe's own major climate-change induced threat?). The consequent impact e-skills would be expected to include the following:	• Economic disruption would reduce ICT activity and demand for ICT Practitioner skills • Differential migration could affect Member States differently
N3: Pressure/effort to replace travel and transport with telecommunications (to reduce environmental impacts, escape congestion and effects of pollution).	• Increased Demand for practitioner skills (except in Transport sector!) • Probable increase in off-shore resourcing, since already remote-working.
N4: Emphasis on reduction of ICT and electronic waste (more re-use of equipment, etc).	• Likely reduction in ICT growth rates, reducing demand for ICT Practitioners • Some increased practitioner skills demand for re-configuring equipment and upgrading S/W?
N5: Environmental regulation & concerns lead to growth in business (ICT exploitation) opportunities (e.g. re-cycling business, water waste reduction, energy-saving/producing technologies, products).	• Increased demand for Practitioner skills in the sector
N6: Increasing water shortages. Rise of water prices and increasing need to reduce consumption (either voluntarily or not) could influence e-skills	• Increase of demand for Practitioner skills to support changed conditions and conservation activity
N7: Pressure for new energy sources and distribution architectures (e.g. local production). Such developments would involve significant engineering activity, within which ICT would play their role.	• Rise in demand for ICT Practitioner skills for development work on new systems
N8: Pressure for development of carbon sequestration technology. The need for accelerated progress in this field in response to the global warning threat will generate significant ancillary demand for ICT components.	• Additional demand for ICT Practitioner expertise (for example in R&D system design, development and test), followed by major plant monitoring and control systems)
N9: Significant economic impact of growing natural disasters. This threat is increasingly recognised, although (geographical) patterns of disruption may not be easy to predict.	• Loss of ICT activity in the worst affected areas, but likely response measures would involve demand for certain ICT Practitioner skills • Additional Practitioner skills demand for development of new monitoring and emergency response ICT infrastructure
N10: Growing pressure against planned obsolescence. Possible growing awareness of natural resource values could reduce rates of equipment replacement, on which some market growth relies.	• Reduction in amount of ICT updating and so growth, resulting in fall of demand for mainstream ICT Practitioners • Possible rise in demand for new skills that ensure maximum utility from ageing equipment?

N11: Emergence of eco-terrorism. Eco-terrorist attacks would presumably trigger increase in security measures both in relation to ICT and other economic activity. Occasional economic activity and infrastructure damage and growing emphasis on security.	• Demand for ICT infrastructure repair/replacement re-configuring (Practitioner) skills • Further growth in need for ICT security skills.
N12: Pressure for accelerated development of natural resource-saving technologies. Further engineering development would feed through to e-skills.	• Additional demand for Practitioners, in particular those with engineering application experience

Table 17: Impact of the *Environmental* Change Drivers on Demand for ICT Practitioner skills

POLITICAL Drivers	
Driver	**Impact on Demand for ICT Practitioner skills** (including influence from supply change effects)
P1: Variation of skilled worker migration flow(s) into EU (from beyond). Assume increase through loosening of Immigration/ labour market access policies.	• demand for all three kinds of e-skills from indigenous domestic labour force likely to fall, except if backlash resulted in tightening of admission policies • Some increase in overall ICT activity from immigrant workforce contribution to economic growth
P2: Further reduction of barriers to migration of skilled workers within EU.	• Differential impact between Member States (above impacts for economies with net inward-migration, some loss of growth in those losing workforce)
P3: Changes in taxes on labour (assume reduction).	• Increased demand for ICT Practitioners • Pace of off-shoring likely to reduce
P4: Pressure exerted on employers to reduce/limit off-shoring due to domestic unemployment and related concerns.	• Reduced loss of demand for ICT Practitioners through off-shoring
P5: Growing geopolitical instability (with emerging conflict between EU and emerging economies).	• Reduced practitioner demand through reduced economic growth • Reduction in pace of off-shoring
P6: Raising of Retirement Age (one-off policy/legislative change(s)).	• Small – 'one-off' increase in availability of (older, more experienced) ICT Practitioners
P7: Political/Governmental response(s) to ICT-related problems. (e.g. limits to Internet access; information Infrastructure Security-related measures, financial systems' auditability (SOX), etc.).	• Reduction in demand for ICT Practitioner skills arising from reduction in activity • some increase in demand for ICT security skills
P8: (Changes to) Government commitment to ICT innovation and investment (public investment of various kinds – may depend on relative political influence of ICT industry lobby).	• Increase in demand for ICT Practitioner skills arising from increase in investment/ICT activity
P9: (Changes to) employment legislation (labour market regulation) levels (inc. effects of differential employment protection between Member States).	• Changes of supply of ICT Practitioners arising from intra-EU movement
P10: Occasional major 'one-off' national ICT infrastructure transition events (e.g. analogue TV switch-off).	• Additional demand for ICT Practitioner skills, involving installing and upgrading – for both software and hardware – over a comparatively short period (12-18 months?).
P11: Widespread adoption of the Web as a political platform for both lobbying and direct action by grass-roots communities.	• Rise in security measures activity of both passive and active variety: resulting demand for ICT Practitioners with security expertise • Growth in demand for Practitioners to undertake system recovery/protection work
P12: Increasing polarisation of attitudes towards government at all geographical levels – possible erosion of national level politics as compared to local and international governance. While Internet removes geographical distance differences, the growing need for cost-effective implementation of ICT-enabled government services will impact the Practitioner skills position.	• Increased demand for ICT Practitioner skills for growing/changing e-Government work
P13: Increasing importance of cultural differences in politics – especially Islam vs. secularism. Cultural differences can influence perceptions about how institutional systems and political processes operate, and these can involve information systems.	• Specifications for public sector systems might involve additional adjustments, requiring additional expertise for some Practitioner skills

P14: Growth of e-Government and 'Transformational government' enabled by ICT – and commitment to e-inclusion through awareness and entry-level user skill provision. e-Government has already begun to make real differences to delivery of public administration, and much more is to be expected. ICT can both improve cost-effectiveness of delivery of government services and change the nature of the citizen's experience in this area	• Continuing strong demand for ICT Practitioner skills for growing/changing e-Government work, in particular for those with public sector experience
P15: Impact of EU Services Directive (in opening services markets). Greater openness of services markets around Europe would be expected to produce growth in cost-effectiveness of service delivery. The ability to deliver professional and other services across national boundaries will inevitably involve increased use of ICT.	• Rise in demand for systems, and Practitioner skills, that facilitate cross-boundary delivery of services • Increase in need for ICT Practitioners with some understanding of legal aspects and of differences of regulatory frameworks for service-delivery in different Member States
P16: Growth of effective lobbying of government by ICT Industry. While the ICT Industry has generally enjoyed considerable public investment related to its growing use over the years, support beyond general promotion poses problems for cash-strapped governments challenged to decide between many competing claims for public resources. Many in industry (including the ICT sector) would in any case prefer government's stance in the market-place to be 'light touch'.	• Some rise in demand for ICT Practitioner skills arising from growth of ICT activity • Increased government support for publicly-funded education and training could provide some improvement in supply of e-skills
P17: Policy commitment to flexible markets and life-long learning.	• Likely increase in economic growth, bringing more demand for ICT systems and services and so for ICT Practitioners • Greater investment in Life-Long Learning should increase supply of Practitioner skills

Table 18: Impact of the *Political* Change Drivers on Demand for ICT Practitioner skills

VALUES-related Drivers	
Driver	**Impact on Demand for ICT Practitioner skills** (including influence from supply change effects)
V1: Declining interest of young people in EU in undertaking technology related courses/qualifications.	• Reduction in flow of "new recruits" from University ICT courses would reduce supply of ICT Practitioner skills
V2: Demand of workforce for more satisfying jobs (covering both job interest and stress levels).	• The outcome, for ICT Practitioners, would depend on comparative (Labour Market) power of the "techies"
V3: Possible increase in "enlightened" management philosophies & practices (e.g. re demands on staff time/performance, outsourcing/ downsizing, de-skilling, etc.).	• Reduced demand for EU ICT Practitioner skills through off-shoring?
V4: Resistance and growing hostility to surveillance/privacy invasion through ICT at work and in services.	• Possible negative impact on supply of Practitioners and Users (people moving to other work due to falling image of ICT work) • Reduced off-shoring resulting from concerns about data protection?
V5: Growing concern about health hazards of ICT (this might follow from demonstration of serious negative health/safety/environmental impacts of new technology/RSI/radiation).	• Possible negative impact on supply of practitioner skills (people moving to other work due to falling image of ICT work and ICT exploitation) • Apart from possible significant demand for those with expertise in health hazards (research, innovation, management) reduced ICT growth/activity, and so demand for ICT Practitioner skills.
V6: Lifestyle changes through ICT use in leisure activity - growing use of ICT of different kinds by young people (music, richer visual experience-> immersive technologies? Armchair tourism???).	• Practitioner skills demand increase in support of (increasingly sophisticated) Consumer electronics
V7: Decreasing attachment to specific jobs and employers - growing adoption of freelance practice (e.g. attrition of loyalty/employed status duration; increase of employment mobility – occupational, geographical – increase of p-t &/or self-employed work/portfolio careers).	• Increase in apparent demand for Practitioner skills (labour market churn?) • Increase in need for certain (basic?) Practitioners skills when more people work on their own (and lose ICT

	support they had when employed!)
V8: Increasing concern about personal security - increase in risk-aversion? This could lead to a rise in interest in devices and systems that could support improved personal security.	• growing demand for ICT security practitioner skills for developing and maintaining such new systems
V9: Growing use of ICT for consumption. Although Internet-enabled sales have grown dramatically over recent years, the conviction of the advertising sector of its value as a future 'channel to market' confirms that there is considerably more commercial potential	• rise in demand for Internet-trading related e-skills, including practitioner work in web-design, content management and payment transaction systems
V10: Emergence of anti-technology backlash (in response to environmental crisis and/or ethical issues thrown up by new ICT – e.g. surveillance, AI systems - and biotechnologies).	• fall, possibly significant, in use of ICT, with the corresponding loss of demand for ICT Practitioners, and consequent job losses
V11: More interest in/emphasis on corporate ethics and CSR. Such a development could put pressure on profits and business confidence, although it might result in a new market equilibrium, with a more socially-responsible prevailing ethic. Unfortunately global market pressures might limit sustainability.	• new skills required to enhance some systems in response to new prevailing attitudes • Some new demand for ICT Practitioner skills

Table 19: Impact of the *Values*-related Change Driver on Demand for ICT Practitioner skills

7.4 Handling the complexity

It is clear from the length of the above list that a very large number of drivers are likely, in some way, to have an impact of some kind on the future supply and demand for e-skills in Europe. While it can be seen that one or two of the drivers bear similarity to others, and it may therefore be possible to reduce the list, there are undoubtedly other trends, not included that could also play a role. In addition, as seen from the summaries of possible impact, the ways in which these drivers will exercise this impact can vary considerably, with the likelihood of the trend indicated continuing and growing, and the strength of the influence, being unclear. In some cases even the net direction of the effect is not obvious, since there can be impacts in different directions (with respect to increasing or decreasing either supply or demand). And finally the timing of significant impact of the different drivers is in most cases difficult to predict.

This raises the fundamental question of how awareness of the impressive range of drivers can be used in the construction of the scenarios. The approach taken in this study is perhaps different to that used in the 'traditional' design of foresight scenarios. In principle, a foresight scenario design can be made by taking a list of agreed drivers, then 'whittling these down' to a small number of 'key drivers' which can be used as the basis of the design of the scenarios. However, two things quickly became clear in considering this approach for the development of Foresight Scenarios for e-skills in Europe:

- The starting list of drivers is too long. Serious understanding about their influence on the supply and demand for each of the three type of e-skills (and on off-shoring incentives) is too limited, for an 'expert consensus' process to be undertaken with any serious hope of consensus.
- The end-point of the process, a set of 5-10 scenarios that can be used to gain insights into the effect of the most significant influences on the future supply and demand of e-skills, poses rather strong constraints on the number of 'key drivers' that can be varied between scenarios.

As a result, it has been decided, in consultation with the client, to focus on a very small number of variables that are clearly of major influence, and from which the required number of scenarios can be generated.

Working from the desired number of scenarios, it can be seen that no more than five drivers can be chosen for detailed examination if variations in them are to be shown in different scenarios. In fact the number is less than this. It must be recognised that – in order to understand how the outcome (for example the numbers of new ICT Practitioners that will be needed each year to 2010 and 2015) varies under different conditions – it is necessary to have variation in a driver value. The minimum number of values possible for there to be variation is 2 (for example a Higher (H) and a Lower (L) value of a driver). Since the 'uncertainty space' for which insights are desired involves variations in more than one key driver, it is necessary to have at least two values for each key driver chosen to influence the scenarios. And since the number of possible 'states' of the uncertainty space depends on combinations of the two values for each driver chosen:

- the number of scenarios generated by sets of two values for each of five drivers is 32.
- for four drivers, each of which has two values, there are 16 scenarios generated.
- thus to produce between 5 and 10 scenarios with a small number of drivers, each of which has two values, the number of drivers necessary is three (producing 8 scenarios).

As can be seen from the tables in Section 7.3, the most prevalent influences in the impact of the ninety drivers on demand for ICT Practitioner skills that recur for the vast majority of drivers can be summarised under 3 headings;

- **Rate of ICT Innovation (Technological Change)**
- **Economic Growth, and**
- **Pace of Off-shoring**

It was therefore decided to adopt these as the '**core-drivers**' for the foresight scenarios, both qualitative and quantitative.

7.5 Impact of drivers – timing and input to core-drivers

The tables on the following pages show how the drivers that have been identified and analysed in some detail above impact on these three core-drivers, as well as indicating the likely timing of such impact, in relation to the two 'milestone' years specified (2010 and 2015).

SOCIAL Drivers

Driver	Impact by 2010?	Impact by 2015?		Impact on Rate of ICT Innovation	Impact on Economic growth	Impact on degree of Off-shoring
S1: Improved Educational Levels	+	++?		+	+?	
S2: Expectations of higher wages & employment benefits within the EU	+	++?			-?	+
S3: Population Ageing Trends (wealthier industrial societies have greater shares of older people)	+	++			-?	+
S4: Efforts to compromise systems (by hackers, fraudsters, cyber-terrorists, etc.) give rise to growing concerns about ICT Security	+	++?		+?	-?	-?
S5: Adoption of ICT in ways that enable new working and learning practices grows (e.g. remote working and e-learning)	+	++?		+?	+?	+
S6: Adoption of ICT in ways that support development of new types of organisational structure (e.g. systems supporting structured - even highly disciplined - co-operative and mobile work)	+	++		+?	+	+
S7: Inward migration to richer EU countries	+	++?		+?	+?	-?
S8: Shift of (in particular, Female) attitudes to work as ICT Practitioners	?	+?		+?	+	-?
S9: Fading significance of techno-sceptic attitudes as cohorts reared on ICT come to dominate	+	++		+?	+?	-?
S10: Increasing mobility generally (both within Europe and globally) - growing migration (in particular of the young elite) to other, generally more prosperous, regions	+	++		+?	+?	+?
S11: Demographic changes beyond age – e.g. in relation to gender and ethnic distributions (often described in terms of greater diversity in populations and workforces)	+	+?		?	?	+?
S12: Increasing emphasis on safety and security-related measures (e.g. homeland security activity; increase in CCTV and other societal monitoring measures)	+	++?		?	-	-?
S13: Improved health and well-being is sought after for ageing citizens (and is apparent in investment and expenditure decisions)	+	++		+	+	-?
S14: Growing importance of 'on-line socialisation' (with growth of virtual communities for work and leisure)	+	?		+	?	+?
S15: Growth of multi-culturalism (and of occasional backlashes)	+	++		+	+?	+?

Table 20: Impact of the *Social* Drivers in 2010 and 2015, and on the three Core-Drivers

TECHNOLOGICAL Drivers

Driver	Impact by 2010?	Impact by 2015?		Impact on Rate of ICT Innovation	Impact on Economic growth	Impact on degree of Off-shoring
T1: Major new classes of technology, applications and styles of use of technology introduced and exploited	+	++		++	+	+?
T2: Improved user interfaces widely used	?	+?		?	+?	?
T3: Greater adoption of software engineering (tools) and more disciplined approaches to system development	+	+?		+	+	+?
T4: Enhanced telecommunications infrastructure and services	+	++		+	+	+
T5: Maturation of (parts of?) ICT Infrastructure/Services	+	++		-	-?	+?
T6: (Significant) improvement in (cost-) effectiveness of e-Learning	?	+?		+	+	?
T7: Growing impact of technology convergence on content-related products & services	+	++		+	+	+?
T8: New technologically-based threats to infrastructure and business are experienced on a significant scale	?	+?		+?	-	-
T9: More use of bio-mimetics in design (growth of nature-inspired design)	+	++		+	+?	?
T10: Impact of more accurate geographical positioning systems (e.g. Galileo) in terms of more and better services	+	++		+	+	?
T11: Growth of use of ubiquitous & utility computing - emergence of Ambient Intelligence as a social and business platform	+	++		+	+	?
T12: Growth in development and availability of carbon-emission reducing technologies	?	+		+	?	?
T13: Continuing growth in creative applications of ICT in existing and new areas (e.g. e-health, spatial and movement tracking systems, e-democracy, leisure)	+	++		+	+	?
T14: Development and deployment of Digital Rights Management (DRM) and related technologies	?	+?		-?	?	?
T15: Shift towards of the use of Open-Source Software	+	++?		+	+	?

Table 21: Impact of the *Technological* Drivers in 2010 and 2015, and on the three Core-Drivers

ECONOMIC Drivers

Driver	Impact by 2010?	Impact by 2015?		Impact on Rate of ICT Innovation	Impact on (EU) Economic growth	Impact on degree of Off-shoring
E1: (Levels of) economic growth within EU	+	?		+	+!	?
E2: Levels of global economic activity	+	?		+	+?	?
E3: Price trends of major classes of ICT equipment (continuing to decline?)	+	++		+	+	?
E4: Prices of alternatives to ICT-delivered services (continuing to rise?)	?	+?		+	+?	?
E5: Increased start-up rate for SMEs	?	+?		+	+	-?
E6: Commoditisation of ICT goods & services is commonplace	+	++		?	+	+?
E7: (ICT Industry) increasing global competition	+	++?		+?	+	+
E8: (ICT Industry) increasing customer demand for more cost-effective delivery	+	++?		+	+?	+?
E9: (ICT Industry) development of strong customer reaction to bad experience with outsourcing (and off-shoring)	?	+?		+?	-?	-
E10: (ICT Industry) emergence of new technologies and companies on a large scale	+	++?		+	+	?
E11: Increasing energy costs	+	++?		+	-	?
E12: Increasing globalisation generally (including global labour following global capital, and growth of globally-integrated businesses)	+	++?		+?	+	+?
E13: Increase in on-line services (both voice and data telephony delivered) - continuing automation of routine and lower-level work	+	++		+	+	-?
E14: Growth in 'management by measurement' – through increased use of performance and evidence indicators (in the private and public sectors)	+	++?		+	+?	+?
E15: Growing investment by large private companies in their own 'education'/training facilities (e.g. Motorola University; Cisco Networking Academy Programme)	+	+?		+?	+	?
E16: Growing divergence between skill needs of large companies and SMEs - greater need for SME-related policies	+	++		-?	-?	+?
E17: Impact of the growing "pension crisis"	+	++		?	-	?
E18: Impact of shifts in US HQ strategies on the European market	?	+		+?	-?	+?
E19: Growing business investment in skills and training	?	+?		+?	+?	-?
E20: Development of supply of e-skilled labour in off-shoring and potential off-shoring economies	?	?		-?	?	-

Table 22: Impact of the *Economic* Drivers in 2010 and 2015, and on the three Core-Drivers

ENVIRONMENTAL Drivers

Driver	Impact by 2010?	Impact by 2015?		Impact on Rate of ICT Innovation	Impact on Economic growth	Impact on degree of Off-shoring
N1: Acceleration of global warming and its impacts	-	?		+?	--?	-?
N2: Disruption of Gulf Stream	=	?		+?	-?	?
N3: Pressure/effort to replace travel and transport with telecommunications	?	+?		+?	-?	+/-?
N4: Emphasis on reduction of ICT and electronic waste	?	+?		+/-?	-?	?
N5: Environmental regulation & concerns lead to growth in business (ICT exploitation) opportunities	+	++		+	+/-?	?
N6: Increasing water shortages	-	+?		+	-?	?
N7: Pressure for new energy sources and distribution architectures (e.g. local production)	+	++		+	?	?
N8: Pressure for development of carbon sequestration technology	+	++		+	?	?
N9: Significant economic impact of growing natural disasters	?	+?		+?	-	-?
N10: Growing pressure against planned obsolescence	-	?		-?	-?	?
N11: Emergence of eco-terrorism	-	?		+?	-	-?
N12: Pressure for accelerated development of natural resource-saving technologies	+	++		+	-?	?

Table 23: Impact of the *Environmental* Drivers in 2010 and 2015, and on the three Core-Drivers

POLITICAL Drivers

Driver	Impact by 2010?	Impact by 2015?		Impact on Rate of ICT Innovation	Impact on Economic growth	Impact on degree of Off-shoring
P1: Variation of skilled worker migration flow(s) into EU	+	?		+	+?	-?
P2: Further reduction of barriers to migration of skilled workers within EU	+	?		+	+	-?
P3: Changes in taxes on labour (reduction)	?	?		+?	+	-?
P4: Pressure exerted on employers to reduce or limit off-shoring	?	+?		?	-?	-?
P5: Growing geopolitical instability	?	+??		-?	-	-?
P6: Raising of retirement age	+	++?		?	+	?
P7: Political/Governmental response(s) to ICT-related problems	?	+?		-?	-?	-?
P8: (Changes to) Government commitment to ICT innovation and investment (assume increase)	+	+?		+?	+?	?
P9: (Changes to) employment legislation (labour market regulation) levels (assume decrease in regulation)	?	+?		+?	+?	-?
P10: Occasional major 'one-off' national ICT infrastructure transition events (e.g. analogue TV switch-off)	?	+?		+	+	?
P11: Widespread adoption of the Web as a political platform for both lobbying and direct action by grass-roots communities	+	++		+?	?	?
P12: Increasing polarisation of attitudes towards government at all geographical levels – erosion of national level politics as compared to local and international governance	?	+		+?	?	?
P13: Increasing importance of cultural differences in politics – especially Islam vs. secularism	+?	+?		?	?	?
P14: Growth of e-Government and 'Transformational government' enabled by ICT – and commitment to e-inclusion through awareness and entry-level user skill provision	+	++		+?	+?	?
P15: Impact of EU Services Directive (in opening services markets)	+	++		+	+	?
P16: Growth of effective lobbying of government by ICT Industry	+	+		?	?	?
P17: Policy commitment to flexible markets and life-long learning	+	++?		+	+	-?

Table 24: Impact of the *Political* Drivers in 2010 and 2015, and on the three Core-Drivers

VALUES-related Drivers

Driver	Impact by 2010?	Impact by 2015?		Impact on Rate of ICT Innovation	Impact on Economic growth	Impact on degree of Off-shoring
V1: Declining interest of young people in EU in undertaking technology related courses/qualifications	+	++?		-	-	+?
V2: Demand of workforce for more satisfying jobs	?	+?		?	-?	+?
V3: Possible increase in "enlightened" management philosophies & practices	?	+?		?	-?	+?
V4: Resistance and growing hostility to surveillance/privacy invasion through ICT at work and in services	+	++?		+/-?	-?	-?
V5: Growing concern about health hazards of ICT	?	+?		-?	-?	+?
V6: Lifestyle changes through ICT use in leisure activity - growing use of ICT of different kinds by young people	+	++		+	+?	?
V7: Decreasing attachment to specific jobs and employers - growing adoption of freelance practice	+	++?		+?	+?	-?
V8: Increasing concern about personal security - increase in risk-aversion?	+?	++?		-?	-?	?
V9: Growing use of ICT for consumption	+	++		+	+	+?
V10: Emergence of anti-technology backlash (in response to environmental crisis and/or ethical issues thrown up by new ICT – e.g. surveillance, AI systems - and biotechnologies)	?	+?		-	-?	+?
V11: More interest in/emphasis on corporate ethics and CSR	?	+?		-?	-?	+?

Table 25: Impact of the *Values-related* Drivers in 2010 and 2015, and on the three Core-Drivers

8. The Foresight Scenarios

8.1 The development from previous work

The Rand Europe report's finding for the state of Supply & Demand for e-skills in Europe in 2005 concluded (see Annex D) that:

- The best evidence available confirms that, in 2004, there were no widespread significant shortages of ICT Practitioner skills within the EU. The growth in demand for skills for certain ICT Practitioner occupations (e.g. both computing professionals and optical and equipment operators showed considerable increase in 2004) was greater than for others (e.g. the occupational group of electrical and electronic equipment mechanics and fitters has been in continuous decline since 1998). Employment growth 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).

The remit of this study has been to progress this analysis, in the light of the Rand Europe report's recommendations for approaching the development of Foresight Scenarios in this area, and of other work. The objective is to elaborate a more comprehensive analysis of how the future of e-skills supply and demand in Europe might develop. While covering the ground of e-skills in Europe overall, this Report focuses, in accordance, in particular for the quantitative modelling, with the contractual remit, on the likely future supply and demand of *I(C)T Practitioner* skills. This is specifically in relation to the development and the needs of the European ICT Industry, in particular those of the Software and IT Services sector.

8.2 The questions and issues

The most important challenge for this Study is to identify the key questions and issues on which representatives of the ICT Industry and policy analysts and developer need clarification. The analysis and consultations carried out for this study suggest that the most significant questions and issues that exist in relation to the e-skills debate at the European level include:

1. What is the nature and structure of e-skills?
2. What evidence is there of the current position and trends of each of e-skills?
3. What factors generally influence the supply and demand of e-skills within Europe?
4. What factors are likely to be significant in relation to the future development?
5. What aspects of possible 'improvement' to the functioning of the e-skills labour markets in Europe (and within Member States) are really most important?
6. What experience is there, both in EU Member States and beyond, of the success or otherwise of measures initiated to tackle problems in relation to e-skills? (specifically measures initiated by both the ICT Industry and governments).

Insights into most of these issues are given in this report, and the ideas in Part 3 attempt to synthesis proposals that relate to these questions.

8.3 Wild cards and critical change factors

The study's remit includes the need to identify critical change factors and 'wild-card' influences. Table 26 presents a number of wild-card factors that could in some way impact on the future development of supply and demand for e-skills.

Possible Wildcard developments (listed by STEEPV class)

Social

1. Rapid +/- change in the birth rate (a new 'baby boom' in some regions or decreasing sperm count in developed economies)
2. Impacts of disease and debilitating medical conditions (asthma, HIV/AIDS, Avian Flu – possible major impact on large parts of Africa and Asia, even global)
3. Greatly increased life-expectancy (via improvements in diet and health and care regimes) – impacts on the labour market and patterns of demand

Technology

1. Emergence of (unexpected) new and disruptive technologies (or combination of existing technologies to produce radically new functionalities)
2. Nanotechnology and Biotechnology opportunities divert attention away from ICT
3. Arrival of intelligent viruses
4. Surprise court ruling(s) in relation to software/content IPR
5. Technologies deployed for disruptive and destructive purposes
6. Scientific breakthrough re: cognition, mind/brain architecture, understanding of disease etc.
7. End of Moore's Law – previous expectations on increasing processing power/Euro no longer apply
8. Fusion energy technology becomes a reality

Economic

1. Crash of global financial markets
2. Failure of WTO and GATT negotiations – collapse of current trading arrangements and further marginalisation of developing economies
3. Emergence of China, India, Brazil and Russia as dominant economic powers – shifts in the global power balance
4. Compromise of the financial system - organised and opportunistic crime, hacking and attacks on banking, finance and security systems
5. Oil, gas and fuel crises (depletion of stocks, diversion and concentration of supply, major price hikes, withholding of resources etc.) – major but variegated impacts on 3rd world, developed and developing economies)

Environment

1. Rapid global warming in advance of earliest expectations, tidal changes, flooding and possible collapse of the gulf stream (a trigger for mass population shifts)
2. Environmental disaster (nuclear power and waste disposal, leakage of bio-agents)
3. Cumulative effects of pollution (increasing release and combination of new compounds)
4. Volcanic eruption
5. Earthquakes (and Tsunami)
6. Impact of Asteroids and proliferation of space debris
7. Vulnerability of water supplies (to malicious attack or accidental spillage)
8. Impacts of increased radiation on the Van Allen belt (via nuclear attack, leakage etc?) - wipe-out of satellite systems)

Political

1. Collapse of the US as a major economic, political and military power
2. increasing incidence of war and escalation in existing territorial and religious conflicts (->WWIII?)
3. Increasing (labour- and trade-related) protectionism at national and supra-national level
4. Increased prevalence and/or severity of terrorist attacks and guerrilla warfare
5. Increased national and international focus on security (reinforcement of physical borders, toughening of immigration policies, diversion of funding from other priorities – a threat and opportunity for ICT producers?)
6. Re-orientation of Europe towards the East (i.e., Eastern Europe and Asia)
7. Diminishing cohesion at regional, national and supra-national levels – assertion of perceived ethnic identity, fragmentation, 'Balkanisation', conflict and increased nationalism

Values-related

1. Rise of fundamentalist religions and cults (curtailment of 'public' role of women, opposition to use of some forms of technologies)
2. Rise of anti-science and technology movements (ideological opposition to 'dangerous' technologies, new-Luddism in the face of shifting employment patterns)
3. Take-up of ICT (in particular by young people) in quite unexpected ways
4. Rejection of and resistance towards corporate power (e.g. radical shift to open-source software)
5. Growth of anti-capitalist and poverty eradication movements

Table 26: Possible 'Wild Card' developments

In terms of Critical Change Factors, Sections 7 and 8 have shown how a very large number of the changes underway in the EU and beyond may have an impact on the way that supply and demand for the different types of e-skills develop in the coming years. The Drivers identified during the study and elaborated in the last section are all change factors of some kind: which, then, are the critical ones? This will depend on which types of e-skills are considered, and which imperfection of the labour market is to be addressed. In terms of the ICT Industry, the future supply and demand of ICT Practitioners, whose capabilities and creativity will have a major impact on how successful the sector within Europe will be in the face of growing global competition has been selected as the focus. This is felt to be the aspect of e-skills of highest priority, and in this area (changes in) a small number of key factors can be identified:

On the demand side:

- The levels of growth of ICT activity, influenced in particular by both rate of innovation and general economic confidence and growth;
- The Supplier Sector/User Sector split of activity (determined largely by the level of outsourcing chosen by ICT User Organisations);
- The structure of geo-sourcing of the ICT (supply) industry, as between 'home' labour markets, other countries within the EU, and off-shoring.

On the supply side:

- The flows (both quantitative and qualitative) of (generally young) people with an ICT-focused formal education onto the labour market (within the EU);
- The level of investment in relevant post-formal education learning by employers and individuals; and
- The effectiveness (and efficiency) of the (generally commercial) ICT Training market in providing the skills necessary for innovative ICT work.

The trade-off between "buying-in" and "training-up" in employers' skills acquisition strategies was introduced in Section 4. It is clear that the more employers invest in significant amounts of training for their ICT Practitioners, the greater the impact on the overall Practitioner skills base within Europe. A prevalence of 'buying-in' inescapably tends, rather, to increase the amount of 'churn' in the labour market.

8.4 The assumptions underlying the scenarios

The main assumptions underlying the development of the Scenarios can be summarised as:

1. The most significant e-skills factor for the future success of the European ICT Industry concerns the availability of ICT Practitioners.

2. The type of e-skills for which most meaningful, comparable quantitative data is available at the European level is IT Practitioner Skills (those officially designated as *Computing Professionals* and *Computer Associate Professionals*).

3. The part of the ICT Industry for which most meaningful, comparable data is available at the European level is the 'Software and IT Services' Sector. Employment levels of IT Practitioners are approaching an order of magnitude higher in this sector (NACE 72) than in the Broad Electronics Hardware sector (NACE 30+32), focusing on Software & IT Services constitutes the most significant element of the scope of the relevant skills base.

4. The three most significant Drivers determining the level of employment in the Software and IT Services Sector in Europe in the coming years are:
    a) The Rate of ICT Innovation (Technological Change)
    b) Economic Growth (both within the EU and beyond)
    c) The Degree of Off-shoring undertaking within the Industry.

5. Depending on possible variations of the degree of Outsourcing within the EU (and so the split of IT Practitioner occupations between the ICT Industry (supply) sectors and the rest of the economy. The numbers in employment of IT Practitioners can be estimated from the total employment levels within the Software and IT Services sector from past trends, as some 65% of the total;

6. The numbers of 'new' IT Practitioners required for each scenario can be estimated using a replacement demand assumption (of an average 5% attrition);

7. While this is not ideal, in the absence of adequate statistical data for the new Member States, the development over the coming years of quantitative estimates of employment levels for the EU-15 can be viewed as strongly indicative for the position in the European Union as a whole.

8.5 The six scenarios

The above considerations, in the light of the approach presented in Section 7, lead to the selection of the following Scenarios, outlined in Table 27.

Scenario	Pace of Techno-logical change	Economic Climate	Pace of Off-shoring	ICT Industry Employment level rank (by 2015 - see Section 9)
A: ***Renaissance***	Rapid	Positive	Moderate	1
B: ***Steady Climb***	Moderate	Positive	Moderate	2
C: ***Global***	Rapid	Positive	High	3
D: ***Fight back***	Rapid	Economic turbulence	Moderate	4
E: ***Dark Days***	Moderate	Economic turbulence	Moderate	5
F: ***Decline***	Moderate	Economic turbulence	High	6

Table 27: The six scenarios

The consultation, in particular with senior representatives of the ICT Industry in Europe, on the initial set of Scenarios developed, produced several valuable conclusions.

Perhaps the most important was that the scenario presentation needed to be shorter and more structured than the scenario descriptions initially developed. This is understandable, given the very limited time that industry representatives can realistically devote to this kind of work.

As a result, the style of scenario presentation has been shortened, and the presentation is structured in terms of how the situation would develop in each of 10 main respects:

- **Political Environment**
- **Economic Growth**
- **ICT investment cycle**
- **Technological Change**
- **New applications**
- **Demography**
- **Other Social, Environmental, and Values Drivers**
- **Outsourcing**
- **Off-shoring**
- **Relevant 'wild cards'**

The six scenarios selected are presented in the following pages in this summarised format. The descriptions that follow are an elaboration of those discussed in a scenario validation workshop in November 2006, with some of the text revised (a) to enhance clarity and (b) in response to comments made during the industry workshop.

Scenario A: *Renaissance* (Technological Change: *Rapid*; Economic Climate: *Positive*; Off-shoring: *Moderate*)	
Drivers	**Characteristics**
Political Environment	In this scenario the world would be characterised by low levels of geopolitical instability (P5); the expectations are that there would be little development of, for example, disruptive new ideologies, polarised regional blocs, major threats to world trade, etc. Of course there are bound to be problems, but these will mainly remain localised or containable.
Economic Growth	Sustained growth is reflected in strong general investment confidence (E1 E2). We would expect to see low levels of trade disputes, etc. in this scenario, and a move of emerging economies up the value chain.
ICT investment cycle	Strong innovation underpinning ICT Investment is expected. Sustained growth of European economies would be likely to lead to increased demand for e-skills, possibly with growth in new member states creating more domestic demand for the ICT Practitioners they produce. (Growth in emerging economies might similarly mean that their ICT Practitioners – especially the more capable ones – are increasingly required for local production and markets.) This would lead to relative price rises for off-shored services (E1).
Technological Change	Major new classes of technology, applications and styles of use of technology are likely to be developed, introduced and exploited. (T1) This will create demand for Practitioner skills (varying across sectors according to the applications that are developed, and varying across countries and regions in consequence of where the innovations are developed and applied). Implications for off-shoring also depend on the nature and source of the innovations, though it is plausible that many of the new skills have to be sourced within the EU.
New applications	See above - strong innovation driving the development of new applications and the uptake of new applications and roll-out of more established applications to wider markets, is anticipated (T1). What may also be expected is rapid rate of development of (a) automation of software and service production; (b) more user-friendly systems (T2, T3).
Demography	Increased Inward Migration to richer member states of EU (S7) would be expected; though it may be limited in part by domestic demand for ICT practitioners in new Member States. This migration would help counteract wage pressures associated with

	growing demand for these e-skills. Some element of ICT training is embedded into many courses. E-Learning is developed and rolled-out, helping to increase skills supply (T6).
Other Social, Environmental, and Values Drivers	Other developments relevant to this scenario are ongoing improvement in educational levels (S1); adoption of ICT to enable organisational innovation (S6). On the environmental front, we might well see more use of telecommunications to replace transport (N3); and a growth of environmental business opportunities using ICT (N5).
Outsourcing	Outsourcing becomes less attractive, probably due in part to increased automation of software and service production, and consequent ability to carry out design and development in-house.
Off-shoring	Though there are strong demands for ICT Practitioner skills, off-shoring remains at moderate levels, possibly in part due to political discouragement (P4), perhaps associated with new consensual trade regimes; but probably also conditioned by erosion of relative price differentials associated with the internal dynamics of the emerging economies.
Relevant Wild cards	A wide range of challenges could disrupt geopolitical stability, from the spill-over from regional conflicts to the effects of climate change. From political movements resisting the effects of globalisation to the evolution of new and powerful ideologies. A wild card whose likelihood may be increased by a period of sustained rapid growth is the emergence of new and disruptive technologies (or combination of existing technologies to produce radically new functionalities). These provide the basis for further growth and create major challenges for existing industries and (possibly) infrastructures.

Table 28: Scenario A

Scenario B: *Steady Climb* (Technological Change: *Moderate*; Economic Climate: *Positive*; Off-shoring: *Moderate*)	
Drivers	**Characteristics**
Political Environment	This scenario would be characterised by only moderate levels of geopolitical instability (P5); and the situation in the EU would be predominantly stable, despite some probable turbulence in certain of the emerging economies.
Economic Growth	Economic growth within the EU would be moderate or high and reasonably stable (E1); strong general investment confidence.
ICT investment cycle	Moderation in the rate of Innovation slows the rate of growth in ICT investment: falling growth in investment across ICT User sectors.
Technological Change	Moderation in the rate of Innovation leads to slower adoption of dramatically new technologies but with much innovation around established and what would be widely seen as maturing systems and infrastructures (T5). There would be continuing improvement of user interfaces and these would be widely adopted (T2); as would software engineering (tools) and more disciplined approaches to system development (T3). The development and use of automated software production and similar tools, might play some role in reducing demand for ICT services. Furthermore, training on the job as well as in the course of "normal" education would be enhanced by significant improvement in (cost-) effectiveness of e-Learning (T6).
New applications	Moderation in the rate of Innovation slows development of new applications: introduction of new approaches continues, but market development uneven. (Procurement may play a role in enhancing uptake of social and environmental innovations.)
Demography	Contrary to some recent fears, there would be increasing interest in ICT Practitioner occupations in the EU – in all likelihood, especially where these are combined with other technologies and/or application developments (this will require new skill mixes) (S8). "Techno-sceptic" attitudes will decline as cohorts reared on ICT come to dominate (S7). Associated with this there also may be more growth of positive interest on the part of women and girls to work as ICT Practitioners (S8). New member states are likely to supply many skilled professionals and significant inward migration to richer EU countries is anticipated (S9). The extension of the retirement age (P6) might also play a role here, which might be a response to the impact of the growing "pension crisis" (E17). A contribution from this community

	implies however that "ageist" attitudes are overcome and probably that ample retraining is available (cf contribution from e-learning (T6)).
Other Social, Environmental, and Values Drivers	Environmental regulation & concerns lead to growth in business opportunities such as in recycling, waste reduction, energy-saving technologies, green product design; some though not all of this would involve ICT-centred innovation (N5). Some factors that might moderate the rate of development of radically new ICT applications are concerns about privacy and surveillance (V4) which might, for instance, delay uptake of locational and identification systems, and fear of health hazards associated with ICT (e.g. concern about continuing proliferation of more powerful wireless transmissions) (V5). Both ICT use and continued development of off-shoring might be hindered by bad experience with outsourcing (E9) (and publicity about this).
Outsourcing	Moderate levels of outsourcing within the EU.
Off-shoring	Moderate levels of extra-EU off-shoring of ICT Practitioner work. Some application areas may require highly sophisticated skills that need to be sourced from within the EU. There may be other applications spearheaded in emerging economies, where these are major repositories of appropriate skills.
Relevant Wild cards	Rejection of- and resistance towards- corporate power, and possibly a significant shift to open-source systems, might be one development in this scenario that would lead to rather different patterns of growth (but mean relatively slower development of - some types of - technology and off-shoring). Another wild card would be the rise of fundamentalist religions and cults (e.g. curtailment of 'public' role of women; opposition to use of some forms of technologies) in some emergent economies.

Table 29: Scenario B

Scenario C: ***Global*** (Technological Change: *Rapid*; Economic *Climate*: Positive; Off-shoring: *High*)	
Drivers	**Characteristics**
Political Environment	As in the two preceding scenarios, this is seen as largely a future in which there is geopolitical stability to a large extent (P5), with, for instance, ongoing EU integration and consensual trade agreements in place for a large share of the global economy.
Economic Growth	High levels of growth, based in part on exploitation of new technological opportunities, and strong general investment confidence, are anticipated. (E1 E2). Some business cycles are anticipated, but not on a dramatic scale.
ICT investment cycle	As implied by the above, this scenario would feature strong ICT Investment across both ICT Supplier and User sectors, and this would stimulate ongoing innovation. New types of system would be the focus of much expenditure.
Technological Change	Rapid technological change, including much ongoing incremental evolution but also radical change – for example, associated with converging technologies (bio- and nano-) and a take-off of new content industries (see drivers T1, T2, T4, T7, T11, and T13 for more description of possibilities here).
New applications	Strong innovation driving the development of new applications: substantial development of applications of new types and in new markets. (For example: locational services; medical and other applications using genomics and monitoring systems) (T11, T13).
Demography	Supply of skills grows slowly, with other technology fields and creative and professional work round new services proving competitive for new graduates (cf T7, T11). E-Learning systems would be expected to be a focus of activity, partly as products of creative sector activity applied to training, partly as a response to skills requirements and need for lifelong learning (T6).
Other Social, Environmental, and Values Drivers	Wage pressures would be experienced in the EU (S2), rendering off-shoring a more attractive option. The outcome might be that many more services might be commoditised and standardised, and off-shored (E6).
Outsourcing	High levels of outsourcing are implied by the discussion above, to overcome User Industry difficulties in recruiting skills for major new technologies and applications. The ICT services industry would be expected to work on cost-effective solutions (E8: more automation and standardisation, flexible location of activity, use

	of off-shoring, etc) to meeting these needs.
Off-shoring	High levels of off-shoring beyond the EU, driven by domestic skill shortages and lower costs available overseas, and enabled by strong EU performance in stable and open world economy. The implication is that skill supply in emerging economies remains strong – partly because of the entry of new economies to the "emerging" category (e.g. Pakistan); partly because of heavy investment in education and training in these economies.
Relevant Wild cards	Re-orientation of Europe towards the East (i.e. Eastern Europe and beyond) might be more likely in this scenario. This might imply a seismic shift in cultural attitudes, away from fascination with US models of entrepreneurship, social welfare and lifestyles, to some new perspectives and aspirations.

Table 30: Scenario C

Scenario D: *Fight back* (Technological Change: *Rapid*; Economic Climate: *Turbulent*; Off-shoring: *Moderate*)	
Drivers	**Characteristics**
Political Environment	There is much geopolitical instability (P5), though internal arrangements within the EU remain largely unscathed. Social cohesion and economic development of some major emerging economies may be imperilled.
Economic Growth	In large part in response to this instability, general investment confidence would be weakened (say, from around 2008) (E1, E2). Moderate levels of growth would be achieved overall, though some fluctuations are likely. Growth would be fuelled in part by technology development, which helps offset problems in world trade, by creating new markets and greater efficiency. Business cycles are likely to be erratic and fairly dramatic – but with no sustained downturn.
ICT investment cycle	Despite a very mixed overall economic environment, ICT Investment would remain high – especially across ICT User sectors as new technologies are introduced to meet continuing challenges in markets and in global production chains.
Technological Change	Strong Innovation continues, driving rapid technological change: (T1, T2, T4, and T5) though this is likely to be more evolutionary with less radical change and more innovation around established systems and infrastructures, than in some of the earlier scenarios.
New applications	Strong innovation driving the development of new applications: but this would generally be a matter of roll-out of reasonably well established applications to a wider range of markets and platforms.
Demography	Increasing interest in ICT Practitioner occupations in EU, with new member states supplying many skilled professionals (P2). This is because these are seen as "safe" jobs in uncertain times, and the spread of more applications renders the functionalities and some of the principles of ICT more generally familiar.
Other Social, Environmental, and Values Drivers	Some of the new applications concern leisure use of ICT (V6) which helps keep ICT markets buoyant. It is possible that some of the instability in this scenario is associated with environmental problems. Thus global warming could be seriously impacting some emerging economies (N1) – and countries like China could be facing more localised problems associated with their rapid growth. Growth of such problems would have an "up-side" in the shape of environment-related ICT business opportunities (N5).
Outsourcing	High levels of outsourcing are likely within the EU. Much of this will be focused on the maintenance and incremental development

	of familiar applications.
Off-shoring	Extra EU off-shoring of ICT practitioner work is limited – especially where work is very strategic and/or requiring highly sophisticated skills. This follows from the issues of geopolitical instability – in part because of lack of business confidence, in part because of poor international relations and institutional governance of trade, etc.
Relevant Wild cards	One contributory factor in this scenario would be increasing (labour- and trade-related) protectionism at national and supra-national level. This could set off a vicious circle of further decline and conflict. A major failure of WTO and GATT negotiations would perhaps result in a collapse of current trading arrangements and further marginalisation of developing economies. (Some commentators argue that this would provide an opportunity for some countries and regions to development new trajectories of economic growth, it should be noted.)

Table 31: Scenario D

Scenario E: ***Dark Days*** (Technological Change: *Moderate*; Economic *Climate*: Turbulent; Off-shoring: *Moderate*)	
Drivers	**Characteristics**
Political Environment	The world political system is unstable and quite possibly highly disrupted, with major geopolitical strains and disruption to international trade (P5).
Economic Growth	Low levels of growth are anticipated, with a weakening of general investment confidence (again, we could notionally suggest that this becomes apparent from around 2008, though the precise timing is unpredictable) (E1 E2).
ICT investment cycle	The rate of growth in ICT investment is moderate or low across ICT User sectors. This is associated with a general lack of confidence in economic prospects and in the scope for new ICT applications to help meet the challenges of these difficult days. (The picture is likely to be mixed, with some areas of more rapidly expanding use –for instance, some governments might try to invest in large projects to stimulate renewed growth and support local jobs and industries.)
Technological Change	A decreased willingness to support new approaches and fundamental research reduces the rate of innovation and that of the adoption of new technologies. Though ICT remains an important underpinning to technology for much industrial change, development would be moderate with limited radical change in applications.
New applications	Relatively moderate rate of Innovation slows production and introduction of new applications: disruption of global supply chains means more emphasis on patching up and working with available – even if less reliable - systems.
Demography	Inflow of students into training courses related to ICT Practitioner occupations in the EU (i.e. V1 does not apply, while S8 does). Probably these are seen as offering more reliable opportunities for future employment in an uncertain world. Though growth in demand for these skills related to investment in ICT is moderate, there are still employment opportunities for those with appropriate ICT skills. Demographic trends related to population ageing (S3) cause a relative decrease in the appropriately-skilled employment pool; and reduction in the flow of younger new recruits with relevant skills.
Other Social, Environmental, and Values Drivers	There are two major societal problems being confronted (in addition to any that might be related to spill-overs of conflicts in other world regions). First are the results of population ageing, and a threatening pension's crisis (we might well see raising of

	retirement age P6). Second, are looming environmental problems: (N1, N2), with the EU taking account of problems elsewhere in the world (and probably facing pressures from refugees, food insecurity, and associated crises elsewhere).
Outsourcing	Outsourcing within the EU is a major way of meeting skill requirements. Bad experiences with outsourcing, especially in emerging economies, may limit developments, however (E9).
Off-shoring	Limited off-shoring due to volatile situation in many countries, and a measure of political reluctance to tolerate migration of jobs overseas (P4).
Relevant Wild cards	Increasing (labour- and trade-related) protectionism at national and supra-national level. Whether this would be associated with management-worker agreements about organisational change, or result in more rigid work organisations, is not clear. Failure of WTO and GATT negotiations – collapse of current trading arrangements and further marginalisation of developing economies. Crash of global financial markets; this could trigger a lengthy depression. Oil, gas and fuel crises (depletion of stocks, diversion and concentration of supply, major price hikes, withholding of resources etc.) – major but variegated impacts on 3rd world, developed and developing economies).

Table 32: Scenario E

Scenario F: *Decline* (Technological Change: *Moderate*; Economic Climate: *Turbulent*; Off-shoring: *High*)	
Drivers	**Characteristics**
Political Environment	This scenario envisages an unstable geopolitical environment, possibly with major strains being felt within Europe as well as in some other regions (P9).
Economic Growth	At best moderate, at worst very low and even negative economic growth levels would be experienced in the EU and in much of the world (E1 E2). General investment confidence would be weak (from around 2008), with only sporadic bursts of optimism.
ICT investment cycle	Relatively low rate of growth in ICT investment: declines in some countries and user industries are possible.
Technological Change	Relatively slow adoption of new technologies: Relatively limited ICT innovation. Some incremental innovation is expected, not least to maintain ICT systems that are under increased pressure and where established back-up is unreliable.
New applications	A relatively low rate of Innovation is associated with decreased generation and uptake of new applications, and even with a slow pace of roll-out of more established applications.
Demography	Lack of employment opportunities presses more young people to seek vocational, professional and technology courses, and this includes ICT training – but the interest here is limited by social attitudes that are pessimistic and dismissive of technological solutions to deep-rooted problems (V1).
Other Social, Environmental, and Values Drivers	Associated with the above, social attitudes might in general be wary of ICT use and investment, with environmental, health, and civil liberties concerns being articulated by influential figures (S4, V4).
Outsourcing	Overall, technology development is modest, with more incremental developments meaning that it is easier to outsource requirements (though in-house staff, if retained, could cope, and it is relatively easy to acquire such staff).
Off-shoring	Though overall demand for ICT professional skills and overall use of computer services outsourcing is relatively low, off-shoring expands considerably as a share of outsourcing and of ICT activity in general. This is a result of very competitive prices for overseas labour, and some emerging economies appearing to be

	no less unstable than the cheaper parts of the EU itself. (The labour prices would be driven down further by the world economic downturn.)
Relevant Wild cards	This is a scenario where many problems might be encountered – and where the global incidence of these players might be highly variable. For instance, off-shoring might be encouraged by major disaster(s) affecting European infrastructures and economy, while those of at least some major emerging economies remain fairly unscathed.

Table 33: Scenario F

8.6 The impact on skills supply and demand

It is clear from Section 2 and the supporting *Background Paper* to this Study, that there is considerable complexity involved in all the different aspects of e-skills. Simplistic designations of e-skills level are not very meaningful when considering specific employer needs or individual learning provision. It is helpful to distinguish between a small number of levels of ICT Practitioner skills when trying to assess overall market and labour market conditions for an industry, an economy or the European Union.

Thus from an overall strategic supply point of view, it is worth distinguishing between, say, three levels of skills for Practitioners, which might be described as follows:

1. The **lower** levels of ICT Practitioner work – support roles such as help desk and administrator functions, plus routine software development – these activities might broadly relate to Levels 1 & 2 of SFIA ("Follow", and "Assist");
2. The **intermediate** levels of Practitioner work: basic/routine operations management, the main set of software development and systems integration functions (these would correspond to the SFIA levels 3, 4 and 5 ("Apply", "Enable", and "Ensure"/"Advise");
3. The **senior/strategic/leadership** levels of ICT Professional activity, involving overall evaluation of applications and systems, 'architecture' and design, emerging technology assessment and ICT Strategy development, and innovation initiation and ICT exploitation. These are activities recognised by the top two levels of SFIA ("Set Strategy"/"Inspire"/"Mobilise", "Initiate", and "Influence")

The main benefits of this simplification are:

- To gain a better understanding of the 'qualitative' aspects of the overall labour market;
- To elicit information about the parts of the skill-base that will make a difference in relation to such macro indicators as innovation and productivity;
- To consider which element of overall learning provision might need special focus.

So, for example:

- some of the major 'swings' in past labour market activity relating to ICT Practitioners can be considered, in broad terms, to have related to the 'lower levels' of Practitioner skills. For example there is some evidence that significant numbers of people with very limited Practitioner skills were "sucked in" during the severe shortages of the late 1990s, and that many of these were the ones that lost their jobs in the subsequent fall in activity.
- In general it will be the 'leadership' levels of Practitioner skills that make the difference in relation to the innovation that will determine the growth elements in the ICT market in the coming years. In addition, it is at these levels that improvements in the crucial early stages of system design could occur – the area identified in many reviews where subsequent problems that can lead to project over-run (and even failure) take place.
- The 'intermediate' levels are where the vast majority of software development work is done, and where improvements in efficiency could make a difference to overall productivity.

It is essential not to forget, when considering of the supply of ICT practitioners, that this labour market is not restricted to the ICT sector. Although many of the brightest practitioners (in particular the younger practitioners) will want to join the supply sector, as shown in Figure 5 (section 3), many careers involve time in both supply and user sectors, and approximately the same number of Practitioners are employed in the IT User sectors as in the Software & Services sector. So when considering supply (for example, in terms of 'new' supply of ICT graduates) it is necessary to remember that the ICT Supply Industry cannot rely on 'winning' all of these in its recruitment.

Using the approach of three broad levels of ICT Practitioners, Table 34 shows the likely impact in the different scenarios of the prevailing conditions on Supply and Demand.

ICT Practitioner Skill level	State of Skills within European Union (ICT Sector)	**Scenario A**	**Scenario B**	**Scenario C**	**Scenario D**	**Scenario E**	**Scenario F**
Low	Supply of Skills within EU	+	+	+	-	-	- (+)
	Demand for Skills within EU Software and IT Services Industry	+	+	+	+	+	-
Medium	Supply of Skills within EU	+	+	+	+	- (+)	- (+)
	Demand for Skills within EU Software and IT Services Industry	++ (+)	+	++	+	+	+
High	Supply of Skills within EU	+	- (+)	+	- (+)	- (+)	-
	Demand for Skills within EU Software and IT Services Industry	++	+	++	++	+	+
Overall	Supply of Skills within EU	+	+	+	- (+)	- (+)	- (+)
	Demand for Skills within EU Software and IT Services Industry	++	+	++	+	+	+

Table 34: Summary of ICT Practitioner Skills impact, for Software & IT Services, in each Scenario

- = decline or no increase
+ = slow increase
++ = rapid increase (all relative to the historical trend)

9 Quantitative analysis: *scaling the pictures*

9.1 Introduction

There are many, not least within the ICT Industry, who argue that without quantitative evidence the real position in relation to an important issue (either current or expected) cannot be assessed: that, as argued by Peter Drucker, "what get measured gets done".

While there are certain indicators that relate to skills issues, there are often significant problems about how meaningful these are as proxies and/or how valid and/or comprehensive is the data available for them. Although there are some Member States for which quite a range of useful data exists, the EU situation was well summed up in the conclusions of the 2005 Rand Europe report: "The study has found that there is comparatively little consistent, reliable quantitative evidence in relation to clarifying the factual situation of the supply and demand of e-skills at the European level".

It is part of the purpose of this study to explore those limits of our quantitative knowledge, as well as to undertake as meaningful an investigation as possible in the circumstances into how those small number of indicators for which we have meaningful data are likely to develop into the future. Considering how certain indicators might develop in the future is very considerably easier if there is some evidence of how they have moved over recent years. Most quantitative forecasting is carried out in the light of what such time series of the recent past show. Perhaps the most important point to recognise in such an investigation relates to the fact that as already observed, most variables for which we do have data of some merit depend on an assumed constancy of structure, in particular in relation to occupations and sectors. In the case of 'disruptive technologies' like ICT, deployment impacts on a wide range of working practices throughout the economy. We are dealing with developments that cause widespread changes to business activities and work organisation which pose real threats to the very classifications of sector and occupations on whose stability we depend, in order to have meaningful time series. Time series become increasingly meaningless where the underlying structure against which they are measured is shifting. In practice, this problem is more of a challenge for sectoral classification systems (like NACE) than for time series using data relating to any particular NACE category.

In considering the type and size of mathematical model that would be most effective in the context of the Study, the consortium's approach has been that the greatest value in numerical projections of supply and demand for ICT Practitioner skills is likely to accrue where:

1. there is some level of coherence with the qualitative scenarios, and
2. the model is as simple as possible in order for it to be understandable to non-economists, and
3. the data – coefficients and indicator development assumptions are as transparent as possible.

Above all, caution is essential in interpreting results. The figures for the model results are restricted to 3 significant figures, and even these must be interpreted with genuine caution.

The overall design strategy is to:

- develop as good a forecasting model as possible, given data availability, for Scenario demand levels: numbers of new IT Practitioners needed, for each Scenario to enter employment in the sector each year till 2015;
- make the best assumptions possible given very limited data for the likely flows from the different supply channels to fulfil the above demand, estimating potential demand-supply imbalances for 2010 and 2015, while recognizing that responses – market, industry and possibly by public policy – will act to reduce any likely shortages.

9.2 Indicators and data

The main indicators of direct relevance to the estimation of possible future levels of ICT Practitioner employment are:

- ICT Activity levels: for example turnover, imports and exports in the relevant sectors (NACE 30 and 32, NACE 64.2, and NACE 72): these are available for some Member States but not all.
- ICT Sector Employment levels: in particular split into ICT occupations (ISCO 213 and 312), and other occupations: these are available for most Member States but not for all.
- Information about outsourcing and (particularly) off-shoring: meaningful data is relatively hard to obtain on these variables, although the split of ICT Practitioner employment between the Supply sectors and the rest of the economy gives some indication of the development of outsourcing of ICT Services.

The assumption is that ICT occupation employment levels are strongly related to ICT activity levels within a country. This is so that ICT Practitioner employment levels, both within the ICT industry and in the economy as a whole, can be estimated from assumptions about the likely development of ICT activity within a country, making assumptions about the development of off-shoring.

In the absence of adequate consistent data for ICT activity (sector turnover, imports and exports) it was decided to explore the development of Software Investment as an indicator that could be used in exploring employment levels.

The starting point is explorations by (Gregg 2006) of the relationship between Software Investment[20] and two key variables: Non-Residential Fixed investment, and Employment within the Software and IT Services sector.

As Software Investment has grown since the 1970s, its fraction of Gross Domestic Product (GDP) rose steadily, until the dot.com bubble burst, after which it fell away, for a couple of years. This is shown in Figure 10 for both the United States and the EU-15[21]:

[20] The precise scope of *Software Investment* varies somewhat between countries. In some cases this includes certain IT services, in some cases not. The key property is that it forms a good proxy for Software and IT Services activity as a whole, *inter alia* by-passing the problems of having to adjust sector turnover for imports and experts.

[21] Data on EU-15 Software Investment comes from the ***Groningen*** database of EU macro-economic data

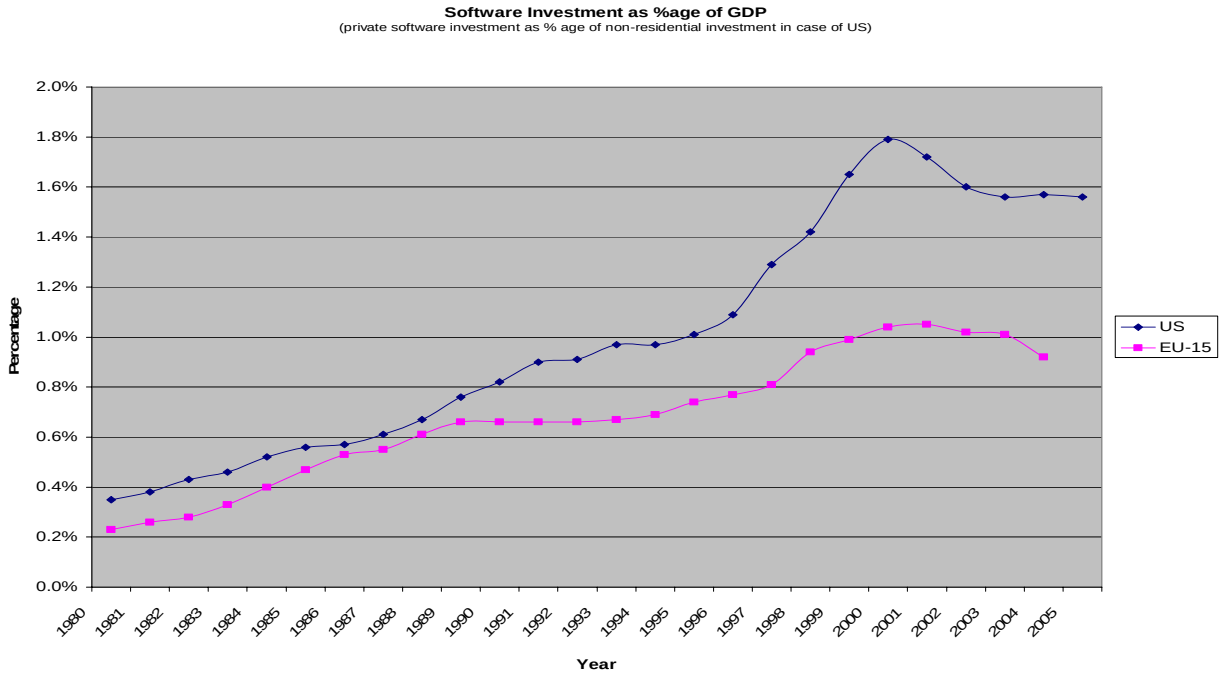


Figure 10: Software investment vs. GDP

However, a more interesting ratio, because it is more stable, is the percentage of overall national investment that is represented by Software Investment. In the light of the recognised idiosyncrasies of the residential property market, it is usual to separate that out. The resulting portion of non-residential Fixed Investment is shown below, again for the US and the EU-15.

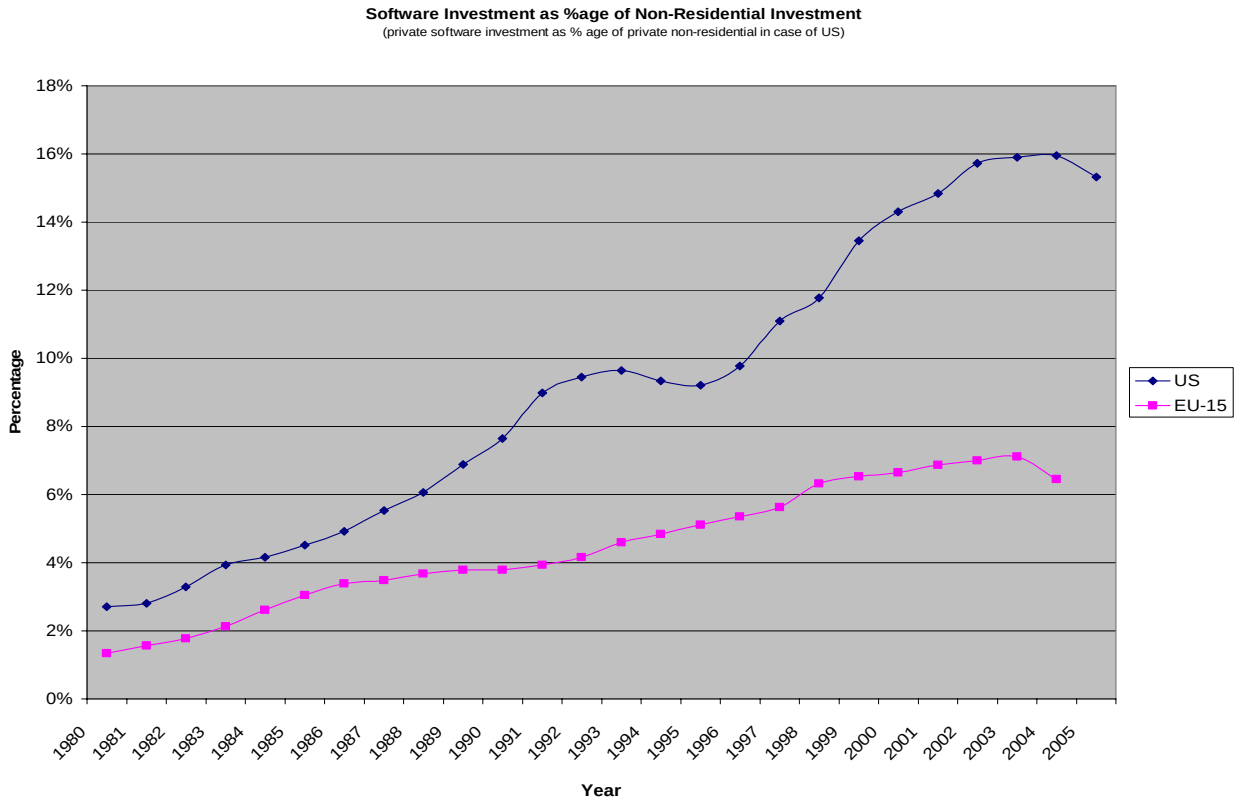


Figure 11: Software investment vs. non-residential investment

Again, steady growth is shown except at the end, and in the early 1990's, where the serious recession in the US is visible, which did not show up so strongly in the relationship with GDP.

The reason for exploring these Investment variables is twofold:

1) They track major aspects of an economy, and allow powerful macro-economic arguments to be brought into play;

2) There is better data available for these than for sectoral turnover and import/export figures, by virtue of their having an explicit position in National Accounts. This brings greater scrutiny generally, including having a presence within the macro economic forecasts that are collated and disseminated by finance ministries (and through the OECD).

The most important *macro*-argument in the model foundations relates to the fact that investment resources in any economy are limited, and that the fraction of total investment that goes into any particular technology represents, over time, a kind of market-penetration in relation to investment spend. Thus, while ICT investment (and Software and IT Services activity, for which Software Investment is a good proxy) has grown dramatically as a fraction of all investment, there will come a limit to this fraction, since people will continue to want to invest in tangible assets (as well as *intangible* assets like this. So for any particular technology (for example the succession of energy technologies – wood, coal, oil, nuclear), one would envisage a rise and then levelling off of the share of all investment, followed eventually by a fall. Technologies rise, then the market (in this case for investment spend) saturates, after which another technology that has subsequently emerged becomes dominant in its turn. What we are therefore considering here is the rise, likely eventual peaking, and possible fall-away of Software investment in terms of its share of all relevant investment.

As can be seen, the previous rise of the share of non-residential fixed investment represented by Software Investment only levelled off in the face of the 'dot-com bubble burst'. Data for 2005 shows a downturn, which could represent the start of a trend, or could merely be the prelude to renewed growth, as in the US in the mid-1990s. **The future of this share will be of great significance for overall levels of ICT activity**, and – as will be seen - this influence can be tracked.

The second relationship Gregg explored is between Software Investment and ICT Sector employment levels. The development of this relationship over time (normalised to 100 for both variables in 1980) is shown below for the United States:

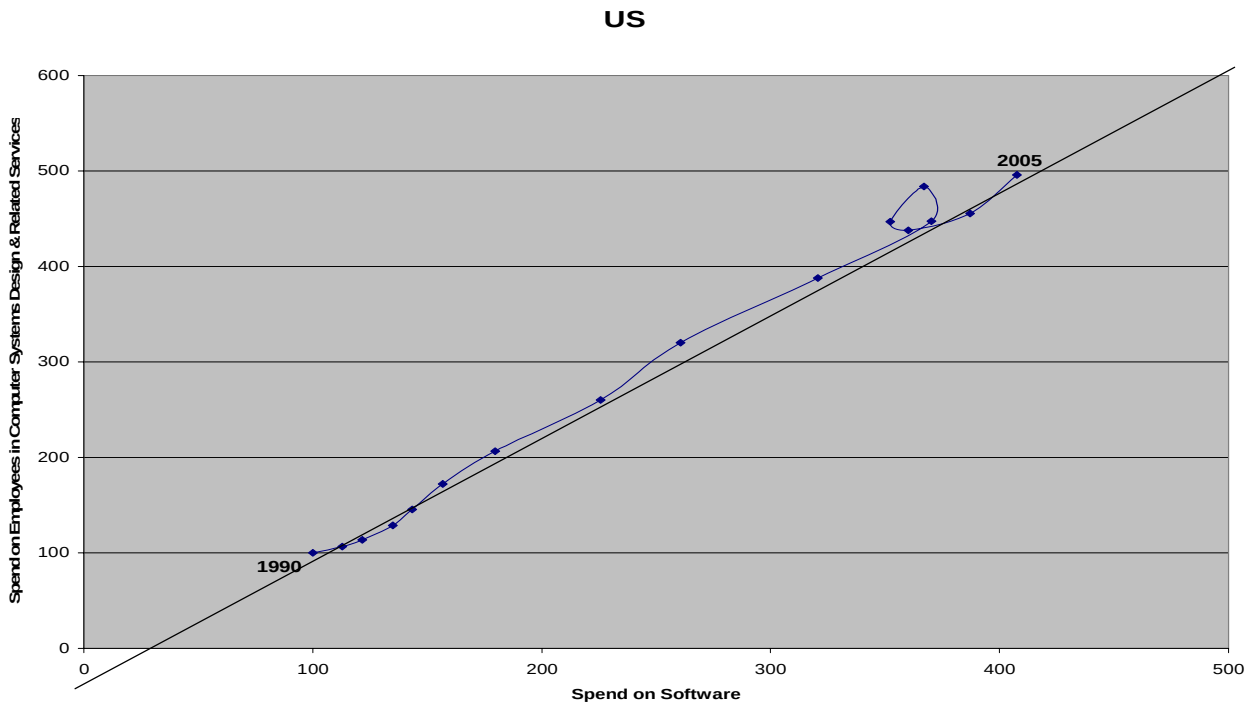


Figure 12: Relationship between ICT investment and employment in the United States (normalised to 100%)

As can be seen, the relationship is remarkably strong, and (perhaps most significantly) the trend appears to have recovered since the upheavals from 2000-2002. What this continuing straight line implies is that Sector employment, appears to be continuing to rise in line with software, irrespective of off-shoring activity (note that employment *spend* is shown in Figure 12, while employment *numbers* are shown in Figure 13 below).

While there are certain issues relating to accounting for pay[22] it is interesting that, while jobs were indeed lost following the 'dot.com bubble burst', the gradient thereafter continues at the same level (i.e. the fact that the trend line is shifted to below the initial line reflects increases in US labour costs, rather than providing any evidence of a major new off-shoring effect).

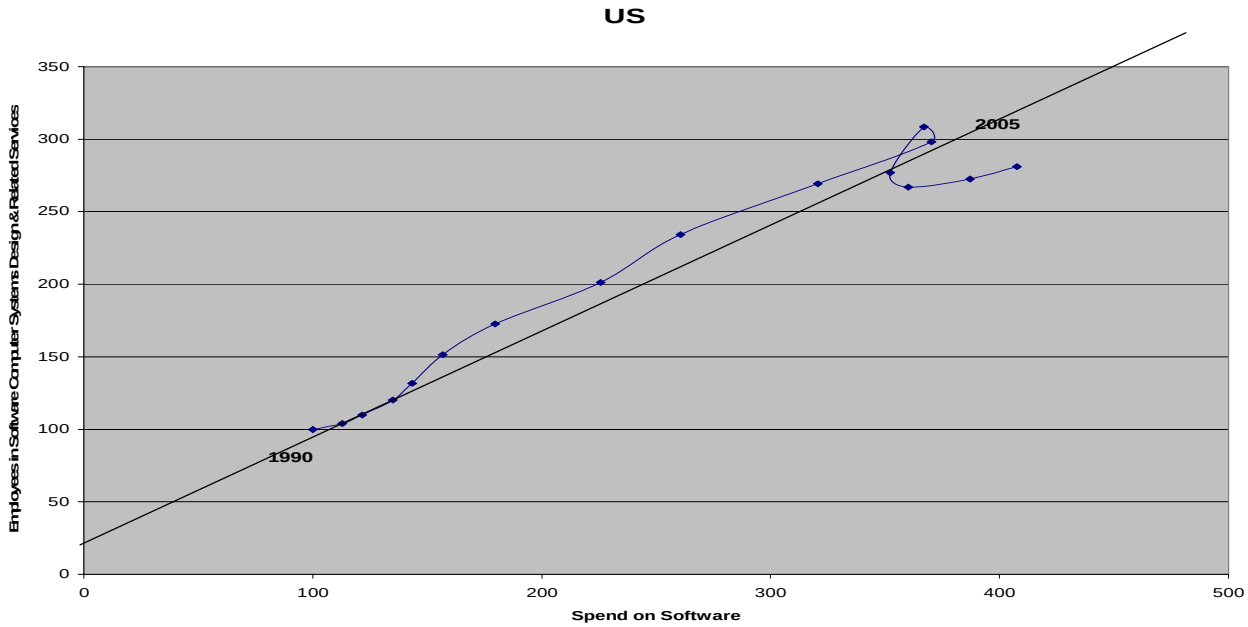


Figure 13: Software Spend vs. employee numbers in US software sector (normalised to 100%)

[22] since substitute deflators do not seem to work well

The project has explored the same relationships for Europe, although without the data on industry labour costs that allowed 'spend on employees' to be calculated for the US. The availability and quality of comparable national data from which to assemble the total is lower for Europe than for the United States. It was not possible to assemble this for more than the EU-15; however, in spite of this the result has much in common with the US situation.

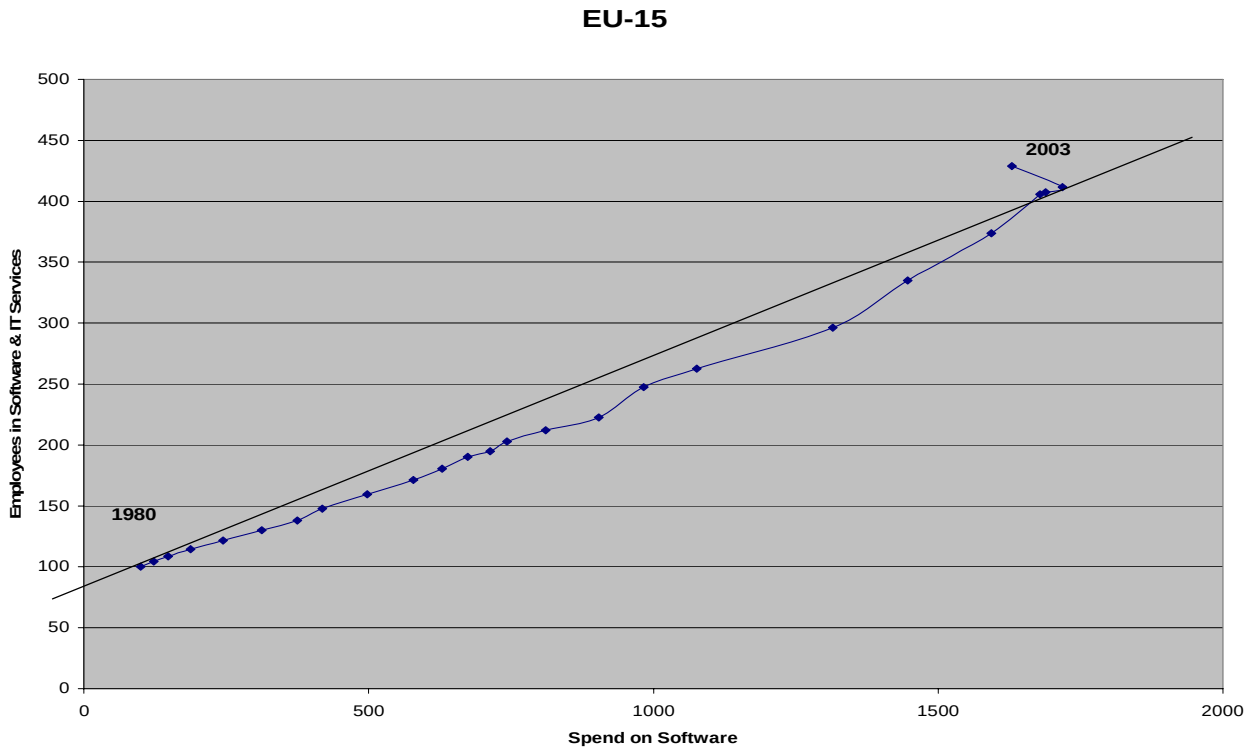


Figure 14: Spend and employment in EU software sector (normalised to 100%)

It must be noted that data on pay for the Software and IT Services sector in Europe (NACE 72) is incomplete, which only allowed use of employment *numbers* (for which alignment with the straight line was not so good for the US). It is noteworthy that employment continued rising when Software spend apparently stalled in 2004[23].

The key conclusion is that, based on the evidence of recent years, Software Investment and employment levels in the ICT Industry are closely correlated as variables.

9.3 The model

Based on this foundation, the model projects future employment in NACE 72 (Software & IT Services) for EU-15 under each of the scenarios set out in Section 8. The scenarios differ from each other primarily on three different descriptive variables:

- Rate of technology change – rapid or moderate
- State of the EU economy – strong or turbulent
- Off-shoring – rapid or moderate

In order to express these descriptive scenarios quantitatively, it was necessary to choose quantitative variables to act as proxies for the descriptive variables.

[23] In fact, as will be seen, the 2004 data on Software Investment is suspect, as a number of the Member State national figures on which it is based include significant estimates in the absence of final data. It is expected to be adjusted when all relevant data is received.

- It is clear from US data that periods of rapid technology change are typically reflected in published national statistics. This data shows a ramp up in the share of all non-residential fixed investment accounted for by software, while periods of moderate change are typically reflected by slower growth in this variable. Based on this observation, it was chosen to model rapid technology change in EU-15 as a continuation of the historical rapid rate of increase in software's share of non-residential fixed capital formation. Moderate technology change was then modelled by increasing the variable at half the historical pace.
- It is also evident from both EU and US data that growth in investment in software is related closely to growth in non-residential investment. This is in turn related to both growth in GDP, and by confidence in future growth prospects. This influences the share of GDP that is devoted to investment. For the period up to 2007, the team was guided by projections from the OECD's most recent Economic Outlook on GDP growth, and growth in investment relative to GDP. Beyond that, it was chosen to model a strong EU economy with 2.5% growth per annum, accompanied by an increase in the share of GDP going into business investment. A turbulent EU economy was modelled with a 1.5% annual rise in real GDP, accompanied by a fall in the share of GDP going into investment. Because a smooth transition from the OECD investment projections was chosen, the turbulent economy view only turns negative after 2009.
- It was chosen to model off-shoring as the net percentage of EU-15 NACE 72 jobs lost to off-shoring each year, whether actually lost or not created. The data on current levels of outsourcing is too thin to provide a very reliable estimate of the current value of this variable. A value of 0.5% per annum was chosen, which is consistent with the available information. This was held constant to represent moderate off-shoring, and ramped up towards 3.5% in 2015 to represent rapid off-shoring.

The general logic for the model is as follows:

- Discounting off-shoring, changes in employment in NACE 72 will be a function of changes in investment in software and changes in the real cost of labour. For example, if investment in software rises by 5% and real pay rises by 2%, then employment will rise by 3%.
- The main factors driving changes in investment in software are:
  - general changes in business investment; and
  - the rate of emergence or improvement of technologies relevant to business, that cause companies to decide to increase or reduce the share of their investment that goes into software.
- Off-shoring reduces the share of all EU-15 investment in software that is spent domestically, and therefore reduces the employment level supported by any particular level of investment.

In the model, a number of variables are held constant, explicitly or implicitly.

- The rate of increase in real pay is assumed to be constant at 1.5% per annum. This reflects the general economy-wide tendency of pay to increase beyond the rate of inflation. This is underpinned by whole economy increases in productivity, with an increment to reflect a shift in the skills mix required in NACE 72 in favour of higher level skills;
- It is assumed that there is no change in the share of ICT activity that is outsourced to NACE 72 businesses from businesses in other sectors;
- It is assumed that there is no change in the margins taken by NACE 72 companies;
- Aside from the influence of off-shoring, the share of software investment accounted for by imports remains constant. The share of NACE 72 output exported from EU-15 also remains constant.

A key factor underlying the design of the model is that, of the ICT Practitioners working in ICT producing sectors, most work in NACE 72, involved in activities that can reasonably be described as the production of software, or in ancillary activities. Only a minority are involved, for example, in outsourced IT operational roles.

The equation used in the model is as follows:

$$\text{Employment}_{y+1} = \text{Employment}_{y} *$$
$$((\text{software investment as \% of non-residential fixed capital formation})_{y+1} / (\text{software investment as \% of non-residential fixed capital formation})_{y}) *$$
$$(1 + \%\text{real GDP growth})_{y+1} *$$
$$(1 + \%\text{growth in real Gross Private Non-Residential Fixed Capital Formation after controlling for GDP growth})_{y+1} *$$
$$(1 - \%\text{ net loss of employment to off-shoring})_{y+1*}$$
$$(1 + \%\text{ increase in real compensation})_{y+1}$$

where y is the year for which an employment statistic or a projection of employment already exists, and y+1 is the net year, for which a projection is being calculated.

The coefficients presented to the equation are, as summarise above, based on:

a) known forecasts (for 2006 and 2007);
b) continuations or adjustments to recent trends; and
c) informed judgements, based in some cases on published work for part of the EU.

The values of the input factors assumed are shown in Table 35 below:

	Software Investment / Non-Residential Fixed Investment		Estimated % Change Real GDP		Estimated % Change in Real Gross Private Non-Residential Fixed Capital Formation - Controlling for GDP Growth		Annual % Loss of Employment Due to Off-shoring		Change in Real Compensation
	Rapid Tech Change	Moderate Tech Change	Positive Economic Developments	Economic Turbulence	Positive Economic Developments	Economic Turbulence	High	Moderate	
1992	4.16%	4.16%	1.13%	1.13%	-3.32%	-3.32%			
1993	4.59%	4.59%	-0.23%	-0.23%	-8.52%	-8.52%			
1994	4.84%	4.84%	2.81%	2.81%	-0.02%	-0.02%			
1995	5.11%	5.11%	2.53%	2.53%	3.65%	3.65%			
1996	5.36%	5.36%	1.64%	1.64%	1.80%	1.80%			
1997	5.63%	5.63%	2.71%	2.71%	2.90%	2.90%			
1998	6.33%	6.33%	2.82%	2.82%	6.48%	6.48%			
1999	6.53%	6.53%	2.91%	2.91%	3.32%	3.32%			
2000	6.64%	6.64%	3.97%	3.97%	2.90%	2.90%			
2001	6.87%	6.87%	1.93%	1.93%	-0.82%	-0.82%			
2002	7.00%	7.00%	1.15%	1.15%	-2.87%	-2.87%			
2003	7.12%	7.12%	1.06%	1.06%	-1.40%	-1.40%			1.50%
2004	7.52%	7.32%	2.07%	2.07%	0.18%	0.18%			1.50%
2005	7.77%	7.45%	1.56%	1.56%	1.14%	1.14%	-0.50%	-0.50%	1.50%
2006	8.03%	7.57%	2.26%	2.26%	1.77%	1.77%	-0.80%	-0.50%	1.50%
2007	8.28%	7.70%	2.31%	2.31%	2.59%	2.59%	-1.10%	-0.50%	1.50%
2008	8.53%	7.83%	2.50%	1.50%	2.50%	2.00%	-1.40%	-0.50%	1.50%
2009	8.79%	7.95%	2.50%	1.50%	2.40%	1.00%	-1.70%	-0.50%	1.50%
2010	9.04%	8.08%	2.50%	1.50%	1.50%	0.00%	-2.00%	-0.50%	1.50%
2011	9.29%	8.21%	2.50%	1.50%	1.00%	-1.00%	-2.30%	-0.50%	1.50%
2012	9.54%	8.33%	2.50%	1.50%	0.50%	-2.00%	-2.60%	-0.50%	1.50%
2013	9.80%	8.46%	2.50%	1.50%	0.00%	-2.50%	-2.90%	-0.50%	1.50%
2014	10.05%	8.58%	2.50%	1.50%	0.00%	-2.00%	-3.20%	-0.50%	1.50%
2015	10.30%	8.71%	2.50%	1.50%	0.00%	-1.00%	-3.50%	-0.50%	1.50%

Table 35: Model Input values to 2015

9.4 Employment and Demand trajectories

The employment trajectories resulting from the above input values are shown in Figure 15.

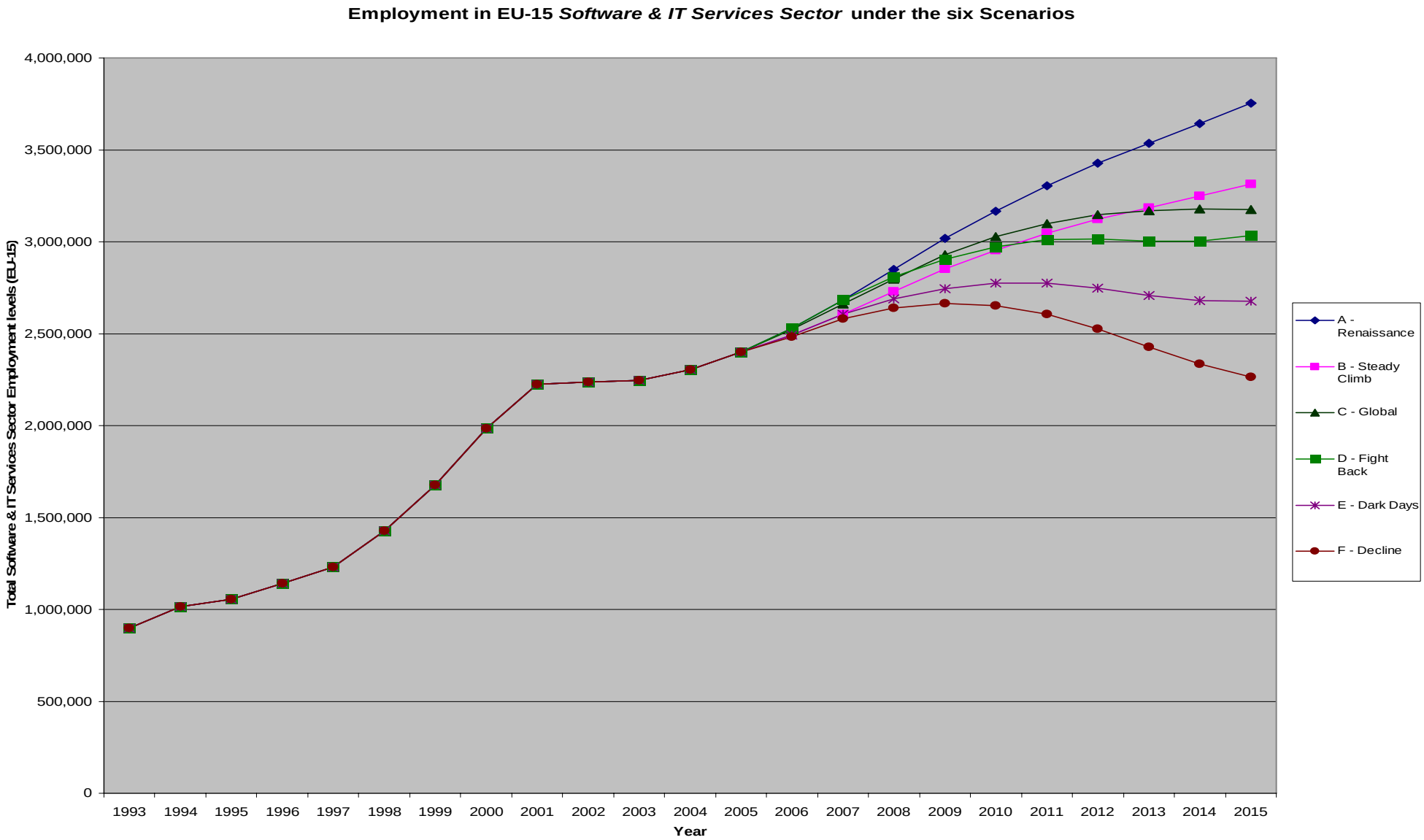


Figure 15: Software & IT Services Sector Employment under the six scenarios

The corresponding figures (rounded to 3 significant figures) are shown in Table 36.

	Scenario A	Scenario B	Scenario C	Scenario D	Scenario E	Scenario F	Scenario E
2005	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000
2006	2,530,000	2,490,000	2,520,000	2,530,000	2,490,000	2,480,000	2,490,000
2007	2,680,000	2,610,000	2,660,000	2,680,000	2,610,000	2,580,000	2,610,000
2008	2,850,000	2,730,000	2,800,000	2,810,000	2,690,000	2,640,000	2,690,000
2009	3,020,000	2,850,000	2,930,000	2,910,000	2,750,000	2,660,000	2,750,000
2010	3,170,000	2,960,000	3,030,000	2,970,000	2,780,000	2,650,000	2,780,000
2011	3,300,000	3,050,000	3,100,000	3,010,000	2,780,000	2,600,000	2,780,000
2012	3,430,000	3,120,000	3,150,000	3,020,000	2,750,000	2,520,000	2,750,000
2013	3,530,000	3,190,000	3,170,000	3,000,000	2,710,000	2,430,000	2,710,000
2014	3,640,000	3,250,000	3,180,000	3,000,000	2,680,000	2,340,000	2,680,000
2015	3,750,000	3,310,000	3,170,000	3,030,000	2,680,000	2,260,000	2,680,000

Table 36: Total Software and IT Services employment levels by Scenario

Based on these trajectories, it is possible then to estimate the number of people who would be entering employment in the Software & IT Services sector each year. This is calculated from the increase (or decrease) in employment levels between years, plus an estimate of the replacement demand necessary to fill the gaps in the sector workforce resulting from retirement, mortality, departure from the occupation to other work, etc. The estimate used for replacement demand is 5% - a figure consistent with assumptions made in national employment forecasting work for this sector (see, for example, Wilson, 2006) – a little higher than the average for the whole economy. The trajectories of 'net new demand' are shown in Figure 16.

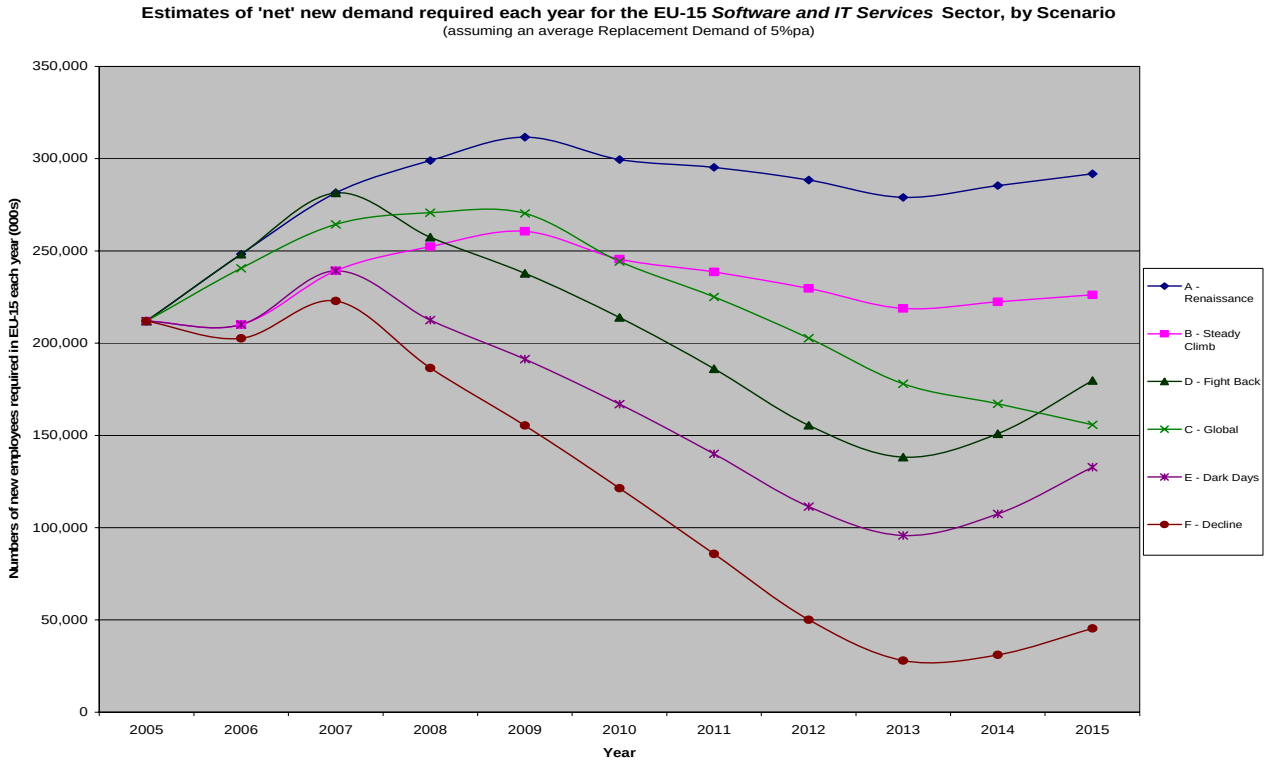


Figure 16: Annual new Employee demand in software and IT services sector

The corresponding figures are shown in Table 37 (rounded).

	Scenario A	Scenario B	Scenario C	Scenario D	Scenario E	Scenario F
2005	212,000	212,000	212,000	212,000	212,000	212,000
2006	248,000	210,000	241,000	248,000	210,000	203,000
2007	281,000	239,000	264,000	281,000	239,000	223,000
2008	299,000	252,000	271,000	257,000	213,000	187,000
2009	312,000	261,000	270,000	238,000	191,000	155,000
2010	299,000	246,000	244,000	214,000	167,000	121,000
2011	295,000	239,000	225,000	186,000	140,000	85,800
2012	288,000	230,000	203,000	155,000	111,000	50,100
2013	279,000	219,000	178,000	138,000	95,800	28,000
2014	285,000	222,000	167,000	151,000	107,000	31,100
2015	292,000	226,000	156,000	180,000	133,000	45,400

Table 37: Estimates of annual new Employee Demand by Scenario

These explorations focus on estimates of total employment (in all occupations) within the Software and IT Services sector (NACE 72) in Europe (EU-15). As seen from 3.7, the fraction of NACE 72 employment represented by IT Practitioners (ISCO 213+312) has grown over recent years, and as of 2005 amounted to some 54% of employment in all occupations. As explained, ISCO 213 + 312 represent the *core technical IT Practitioner occupations*, and if technically-experienced managerial and ancillary occupations (like sales and marketing) are included (as they are in IT Practitioner frameworks like SFIA), the percentage would be higher than 54%.

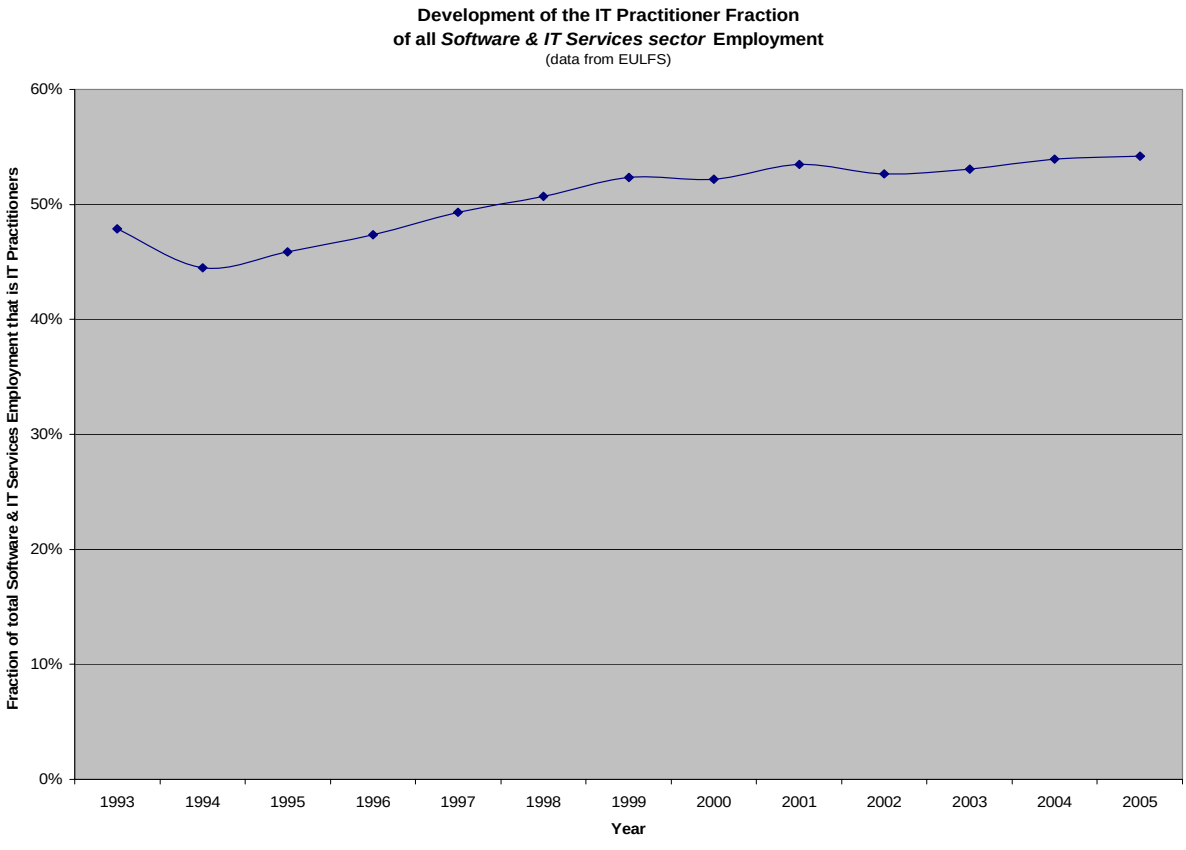


Figure 17: Development of IT practitioner fraction of all Software and IT Services employment

In the light of recent trends, and of expected pressure on increasing core, value-adding, human resource competences, it is not unreasonable to assume continuation of an upward trend. The assumption has been made that estimates of the numbers of IT Practitioners required by the Software and IT Services sector in the coming years can be inferred from adjusting the above figures by between 55% and 70% (65% has been assumed as a suitable figure).

These figures can then be adjusted to provide estimates for 'net new demand' of IT Practitioners in the whole of the European Union, using the fact that, for the latest LFS figures available, employment in NACE 72 in the New Member States was some 9.06% of the EU-15 figure. The adjustment produces the rounded estimates shown in Table 38, and the trajectories shown overleaf:

	A – Renaiss-ance	B - Steady Climb	D - Fight Back	C – Global	E - Dark Days	F – Decline
2005	150,000	150,000	150,000	150,000	150,000	150,000
2006	176,000	149,000	176,000	171,000	149,000	144,000
2007	199,000	170,000	199,000	187,000	170,000	158,000
2008	212,000	179,000	182,000	192,000	151,000	132,000
2009	221,000	185,000	169,000	192,000	136,000	110,000
2010	**212,000**	**174,000**	**152,000**	**173,000**	**118,000**	**86,100**
2011	209,000	169,000	132,000	160,000	99,300	60,800
2012	204,000	163,000	110,000	144,000	79,000	35,500
2013	198,000	155,000	98,000	126,000	67,900	19,800
2014	202,000	158,000	107,000	118,000	76,100	22,000
2015	**207,000**	**160,000**	**127,000**	**110,000**	**94,100**	**32,200**

Table 38: IT practitioner new demand in the whole European Union

And finally these estimates are 'grossed up' to take into account the additional IT practitioners needed for the *Broad Hardware Production* and *Telecommunications Services* sectors, using the ratios shown in Table 4.

	A – Renaiss-ance	B - Steady Climb	D - Fight Back	C – Global	E - Dark Days	F – Decline
2005	177,000	177,000	177,000	177,000	177,000	177,000
2006	207,000	175,000	207,000	201,000	175,000	167,000
2007	235,000	199,000	235,000	220,000	199,000	186,000
2008	249,000	210,000	215,000	226,000	177,000	156,000
2009	260,000	217,000	198,000	225,000	160,000	130,000
2010	**250,000**	**205,000**	**178,000**	**204,000**	**139,000**	**101,000**
2011	246,000	199,000	155,000	188,000	117,000	72,000
2012	240,000	191,000	130,000	169,000	93,000	42,000
2013	233,000	182,000	115,000	148,000	80,000	23,000
2014	238,000	185,000	126,000	139,000	90,000	26,000
2015	**243,000**	**189,000**	**150,000**	**130,000**	**111,000**	**38,000**

Table 39: IT practitioner new demand in the three ICT Industry sectors (figures rounded)

These estimates for annual new demand for IT Practitioners are then considered in relation to likely available supply in the next Section.

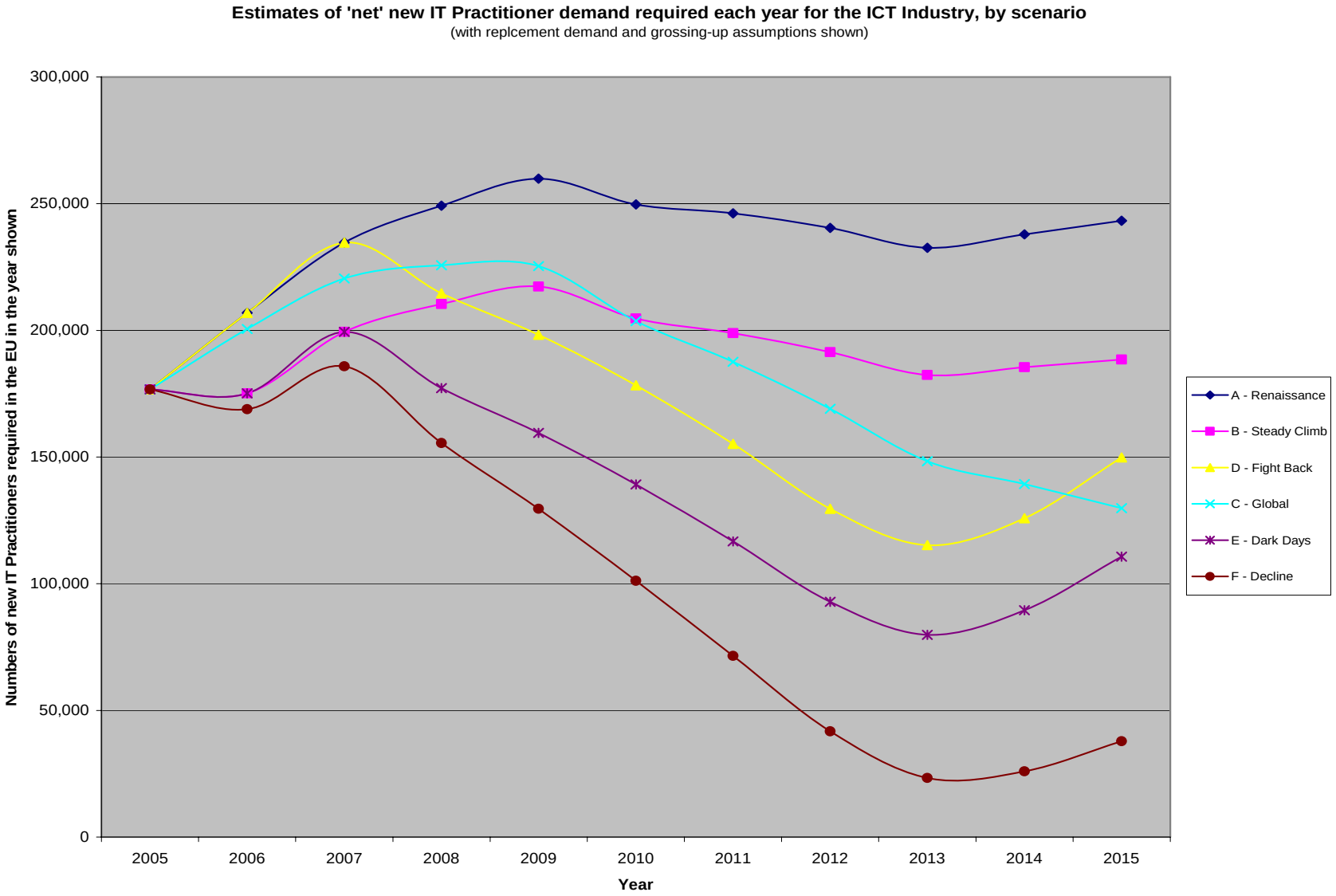


Figure 18: Estimates of Annual New EU IT practitioner demand in the ICT Industry to 2015

9.5 Supply Projections and shortage assessment

Section 9.4 developed, for each scenario, estimates of 'net new *demand*' for IT Practitioners for each year till 2015. This section examines the likely volumes of *supply* of 'new' IT Practitioners available to the ICT Industry to meet this demand. Although there is known to be considerable mobility of IT Practitioners between jobs[24], such movements make no (net) contribution to new supply. Since the scope of this analysis is the European Union as a whole, the effects of Intra-EU movement of IT Practitioners also cancel each other out. The replacement demand rate estimate adopted in 9.4 includes the effects of (outbound) migration of IT Practitioners to economies beyond the EU.

The levels of new demand shown in Figure 18 assume that there will be supply adequate to fill the positions. The supply of new IT practitioners comes from a number of different sources, in particular:

- graduates of Higher Education (HE) informatics/computing* courses, arriving ('fresh') onto the labour market, that can be recruited by companies in the S/W and IT Services sector;
- existing employees being 'trained up' from lower level work by their employer to become IT practitioners (within the ICT Industry);
- 'occupational migrants' entering IT practitioner work in the sector via some kind of conversion learning from other kinds of work;
- graduates from non-informatics HE courses recruited by ICT Industry employers;
- new market entrants with IT knowledge from other parts of the formal education system (e.g. from Secondary vocational-, or even general-, Education courses);
- new IT practitioners entering ICT companies from *inward-migration* from outside the EU;
- IT practitioners re-entering the labour market (e.g. from unemployment or career-breaks);
- IT practitioners moving in from User sectors (in particular as a result of additional Outsourcing *within* the EU).

An *illustrative* supply projection was produced to complement each demand trajectory. Given the importance of the informatics graduate recruitment source of supply, and the fact that meaningful data is available for such graduations over recent years, this was separated out within the supply trajectories. To complement this 'core' supply, illustrative estimates were produced for the sum of supply from the six other sources. The supply and demand trajectories corresponding broadly to each qualitative scenario are shown in the Annex.

One compelling concern about supply is the reported decline in supply of good graduates from informatics courses. The most recent official (Eurostat) statistics for enrolments and graduations of Higher Education students on informatics courses suggest a growing supply of 'fresh graduates'. However, there are clear declines in applications for mainstream ICT courses in some Member States and it is possible that classifications used for reporting national HE data to Eurostat include courses beyond mainstream informatics subject matter. Specifically, the ICT Industry reports serious concerns at least in Germany, the Netherlands, Sweden and the UK.

In this situation, it was decided, for the Supply projections, to take the informatics graduate data to 2004 from Eurostat (latest available data), but assume, based on the growing reported concern from the Industry, a fall-off in growth for 2005 and 2006 followed by a substantial decline in the years to 2015. While there is currently no statistical evidence for this, such an assumption is a conservative one. This approach is consistent with the *precautionary principle*, given the seriousness of the reports, and the importance of this source of supply for the future well-being, and particularly innovation capability, of the EU ICT Industry. As a result of expected demographic impacts,

[24] As mentioned, this is generally viewed by employers as 'labour market churn', and from the perspective of individual practitioners as 'career development'

* although Eurostat uses *computing* for the relevant HE subject category statistics, *informatics* is used in this study to refer to courses on informatics, computing, information systems, ICT, computer science, etc.

applications from EU residents would be expected in any case to fall by some 8% between 2005 and 2015, but the illustrative supply scenarios assume a significantly greater fall – a ca. 30% fall in graduations over the same period, assuming a continuation of the growing decline of interest in HE technology-oriented courses.

As well as taking into account the contribution to new IT practitioner supply of other sources, it is also necessary to recognise that not all informatics graduates who want to work as IT practitioners (and not all do) will be recruited by the ICT (supply) Industry. Significant numbers will continue to be recruited by the many large employers in the *User* sectors of the economy. The illustrative supply trajectories assume that, at the outset of the scenario period, the ICT Industry recruits some 75% of such graduates, and for higher demand scenarios, action by ICT Industry employers increases this share. However, strengthening recruitment, ever more actively, from *other* sources is the over-riding means of compensating for the continuing fall in availability of informatics graduates.

In reality, perceived and expected shortages are addressed as labour market conditions develop, partly by market response mechanisms, and partly by measures taken – initially by ICT Industry employers, and subsequently by Industry players in partnership with public policy. Such actions as:

- faster growth in the levels of flows from channels beyond the recruitment of informatics graduates (e.g. conversion from other occupations, inward migration, etc.) arising from market mechanisms – in particular increases in salary offers;
- stronger efforts by the ICT Industry to attract a greater fraction of the available informatics graduates;
- acceleration of training up within the company; and ultimately
- joint investment in promotional campaigns to increase the attractiveness of IT Practitioner work in the sector. These would be aimed in particular at those in secondary education considering what university course to apply for.

In addition in some Member States, public investment initiatives to support career change from other occupations into IT Practitioner work could be instigated.

In practice, therefore, response activity will depend on prevailing market (demand) conditions, and will therefore vary in the different scenarios explored. This has been estimated for each scenario, and the levels of supply and demand of IT Practitioners for the ICT Industry for the EU have been compared for 2010 and 2015. This produces the following labour market imbalances for each scenario:

2010						
	Scenario A: ***'Ren-aissance'***	Scenario B: ***'Steady Climb'***	Scenario C: ***'Global'***	Scenario D: ***'Fight back'***	Scenario E: ***'Dark Days'***	Scenario F: ***'Decline'***
Demand:	250,000	205,000	204,000	178,000	139,000	101,000
Supply:	180,000	175,000	178,000	178,000	139,000	102,000
Surplus/ Shortage	**-70,000**	**-30,000**	**-26,000**	**0**	**0**	**1,000**

Table 40:
IT practitioner supply and demand for the ICT Industry: 2010
Labour Market imbalance estimates for each scenario

2015						
	Scenario A: ***'Ren-aissance'***	Scenario B: ***'Steady Climb'***	Scenario C: ***'Global'***	Scenario D: ***'Fight back'***	Scenario E: ***'Dark Days'***	Scenario F: ***'Decline'***
Demand:	243,000	188,500	129,800	150,000	111,000	38,000
Supply:	192,000	186,000	131,300	120,000	90,000	30,000
Surplus/ Shortage	**-51,000**	**-2,500**	**1,500**	**-30,000**	**-21,000**	**-8,000**

Table 41:
IT practitioner supply and demand for *the ICT Industry*: 2015
Labour Market imbalance estimates for each scenario

9.6 Supply and Demand projections for the six Scenarios

The IT practitioner supply and demand trajectories for the ICT Industry are shown on the following pages, separately for each scenario, together with the numbers of informatics graduates recruited by the Industry.

9.6.1 Scenario A: Renaissance

In the ***Renaissance*** Scenario the:

- ***rate of ICT innovation*** is assumed to be ***Rapid***;
- ***economic climate*** is assumed to be ***Positive***; and
- ***pace of off-shoring*** is assumed to be ***Moderate***.

Figure 19 illustrates how 'new' IT practitioner supply, and informatics graduate recruitment within that, might develop in response to the strong growth in new demand involved in Scenario A.

Figure 19: (Net, new) EU Supply and Demand Trajectories for A: *Renaissance*

This scenario sees the greatest rise, of all six scenarios, in new demand levels over the period to 2015. These will result in significant skill shortages, which will be further impacted by the growing fall in numbers of informatics graduates coming onto the labour market after 2007. The acute shortages quickly evident after 2006 result in action by employers to augment their ICT practitioner teams from other sources. The fall in flows of the technical graduates begins to take effect in 2009, but from then onward the illustrative projections involve stronger measures being taken by the ICT Industry, and sometimes substantial rising salary offers help the supply industry win an increasing share of the informatics graduates that are available. In some Member States the ICT Industry joins with government to launch campaigns promoting work in the Industry, and overall, these measures result in steadily rising recruitment from sources other than IT graduates.

More detailed *Implications* of the scenario for the Industry and for various areas of policy are presented in Section 10.

9.6.2 Scenario B: Steady Climb

In the ***Steady Climb*** Scenario the:

- ***rate of ICT innovation*** is assumed to be ***Moderate***;
- ***economic climate*** is assumed to be ***Positive***; and
- ***pace of off-shoring*** is assumed to be ***Moderate***.

Figure 20 illustrates how informatics graduate recruitment, and total IT practitioner supply, might develop, in response to developing demand as envisaged in Scenario B.

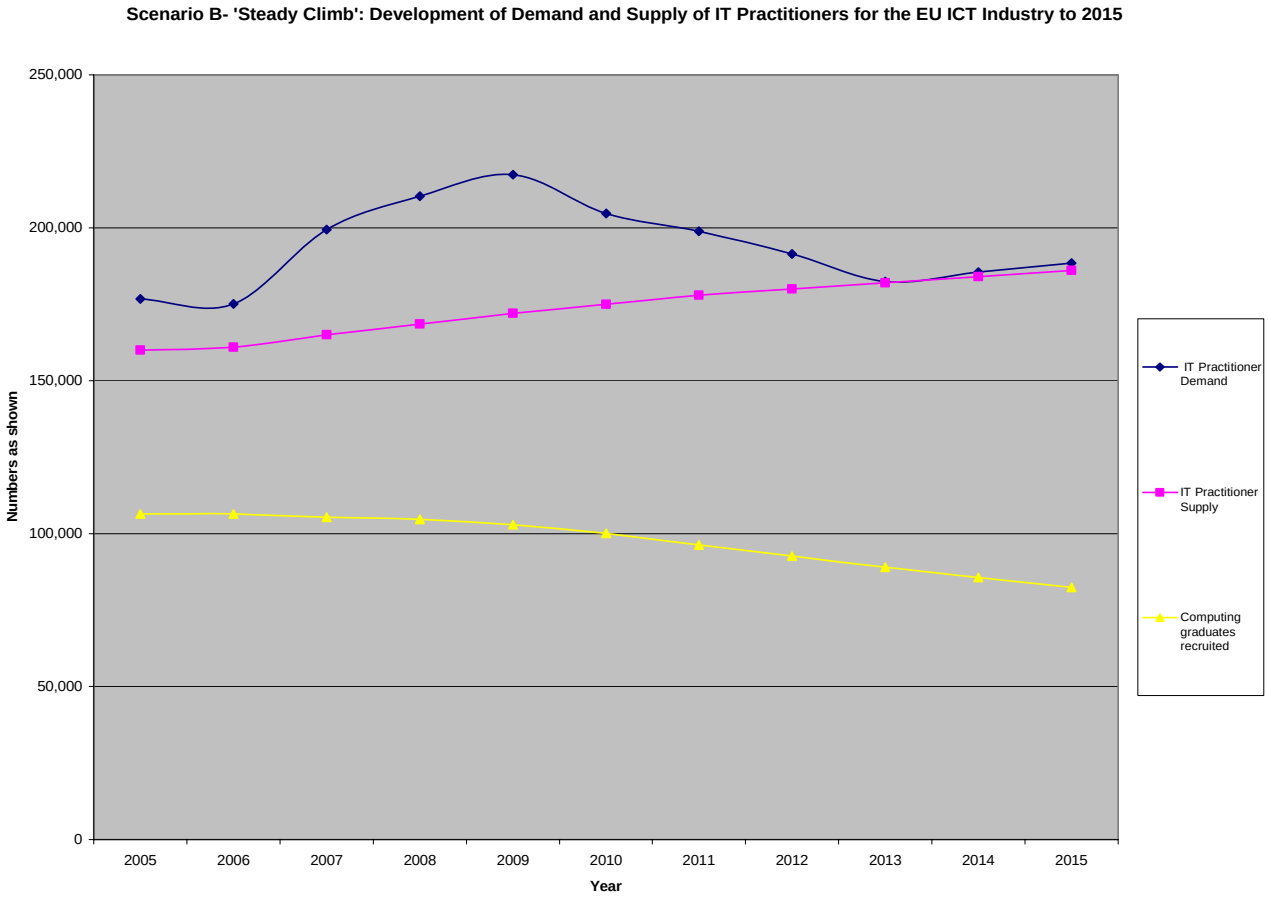


Figure 20: (Net, new) EU Supply and Demand Trajectories for B: *Steady Climb*

This scenario also involves initial growth in new demand for IT practitioners, but at lower levels than for 'Renaissance'. The fall-off in numbers of informatics graduates plays a role here, but the demand levels to which supply has to rise are not so great, as a result of which less dramatic recruitment action is required by the ICT Industry. Nevertheless supply can only be increased by accelerating growth from sources beyond informatics graduates, including increased training of existing staff and attracting in people from other supply sources, through increasing salary offers. As demand falls after 2009, efforts to strengthen supply result in the labour market being in balance by 2013. There are net skill shortages in 2010 and 2015, although notably lower than in Scenario A.

More detailed *Implications* of the scenario for the Industry and for various areas of policy are presented in Section 10.

9.6.3 Scenario C: Global

In the ***Global*** Scenario the:

- ***rate of ICT innovation*** is assumed to be ***Rapid***;
- ***economic climate*** is assumed to be ***Positive***; while
- ***pace of off-shoring*** is assumed to be ***High***.

Figure 21 illustrates how new practitioner supply and informatics graduate recruitment might develop, in response to the new demand conditions of Scenario C.

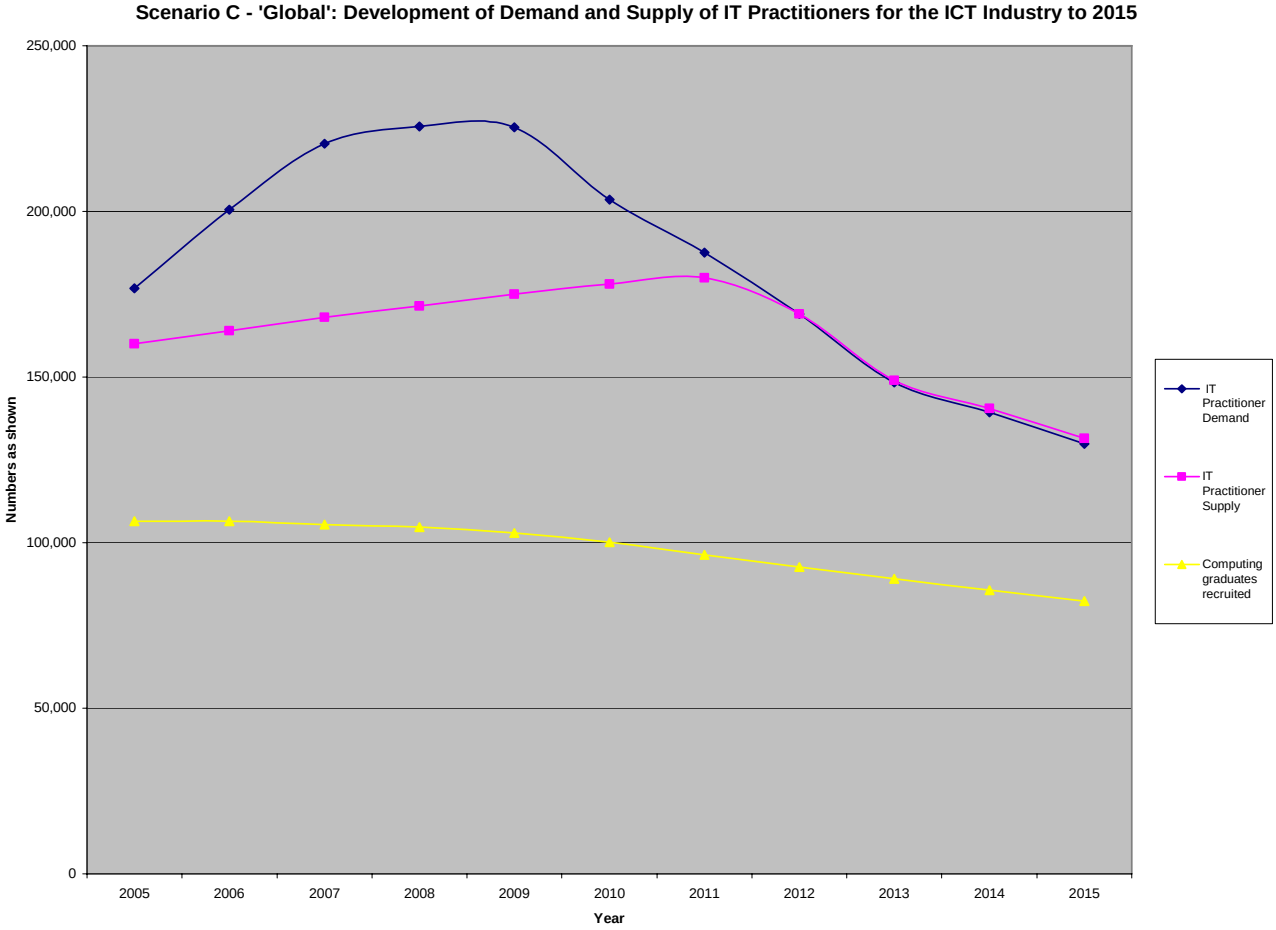


Figure 21: (Net, new) EU Supply and Demand Trajectories for C: *Global*

Initial new demand is nearly as strong as in Scenario A, but this falls away strongly after 2009. Recruitment activity to augment IT practitioner teams from candidates beyond informatics graduates is thus strong up to 2011, after which net new demand falls steadily, and recruitment effort eases in response. A small residual surplus grows as candidates from non graduate sources fail to get recruited by the ICT Industry.

More detailed *Implications* of the scenario for the Industry and for various areas of policy are presented in Section 10.

9.6.4 Scenario D: Fight Back

In the ***Fight back*** Scenario the:

- ***rate of ICT innovation*** is assumed to be ***Rapid***;
- ***economic climate*** is assumed to be ***Turbulent***; while
- ***pace of off-shoring*** is assumed to be ***Moderate***.

Figure 22 illustrates how informatics graduate recruitment and total new supply might develop, in response to the strong swings in new demand involved in Scenario D.

Figure 22: (Net, new) EU Supply and Demand Trajectories for D: *Fight Back*

Initial new demand grows strongly for the first two years of the scenario, but then falls away until 2013. Recruitment activity to augment IT practitioner teams starts strongly, and manages to meet demand in 2010. Thereafter, recruitment effort can ease as demand continues to fall, and a small but growing residual surplus emerges as candidates from non graduate sources fail to get recruited by the ICT Industry. 2013 sees a 'bottoming-out' of new demand, after which recruitment effort is strengthened, but cannot respond fast enough to prevent the re-appearance of shortages.

More detailed *Implications* of the scenario for the Industry and for various areas of policy are presented in Section 10.

9.6.5 Scenario E: Dark Days

In the ***Dark Days*** Scenario the:

- ***rate of ICT innovation*** is assumed to be ***Moderate***;
- ***economic Climate*** is assumed to be ***Turbulent***; while
- ***pace of off-shoring*** is assumed to be ***Moderate***.

Figure 23 illustrates how informatics graduate recruitment, and total IT practitioner supply, might develop, in response to the less encouraging developments involved in Scenario E.

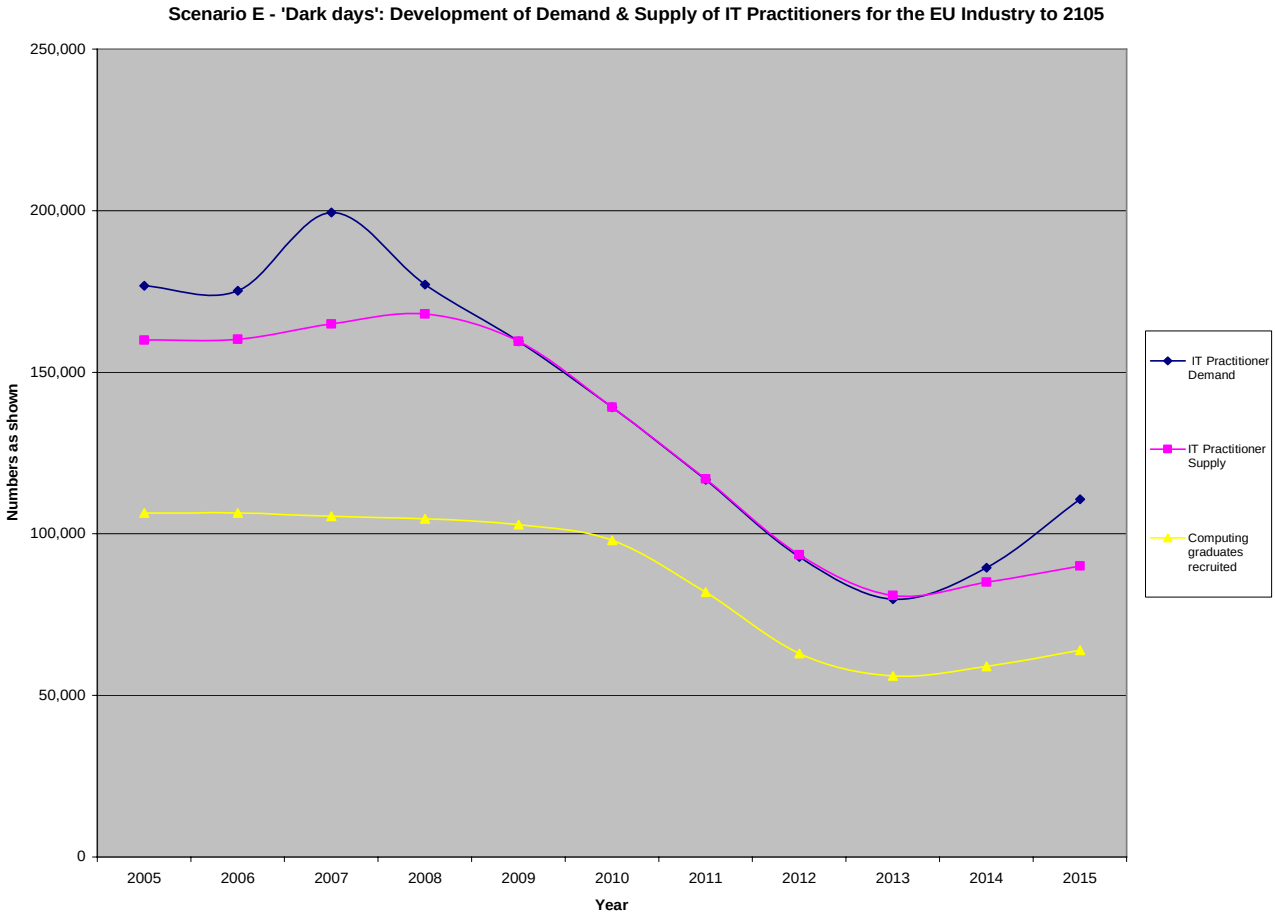


Figure 23: (Net, new) EU Supply and Demand Trajectories for E: *Dark Days*

In this scenario, net new demand really begins to feel the effect of the lower general economic confidence, and the slipping of ICT innovation rates. Growth is limited to 2006-2007, and 2008-2013 sees steady falls, to levels that begin to impact on the job prospects of informatics graduates. Recruiting ICT enterprises continue to seek experienced IT practitioners as part of their 'new recruits', so that the ICT Industry does not recruit as high a fraction of the emerging IT graduates as before as supply levels become very low. 2014 and 2015 see a pick up in demand, to which supply levels take time to respond.

More detailed *Implications* of the scenario for the Industry and for various areas of policy are presented in Section 10.

9.6.6 Scenario F: Decline

In the ***Decline*** Scenario the:

- ***rate of ICT innovation*** is assumed to be ***Moderate***;
- ***economic climate*** is assumed to be ***Turbulent***; and
- ***pace of off-shoring*** is assumed to be ***High***.

Figure 24 illustrates how total IT practitioner supply and informatics graduate recruitment might develop, in response to the near-disappearance of new demand that emerges towards the end of the period under study in Scenario F.

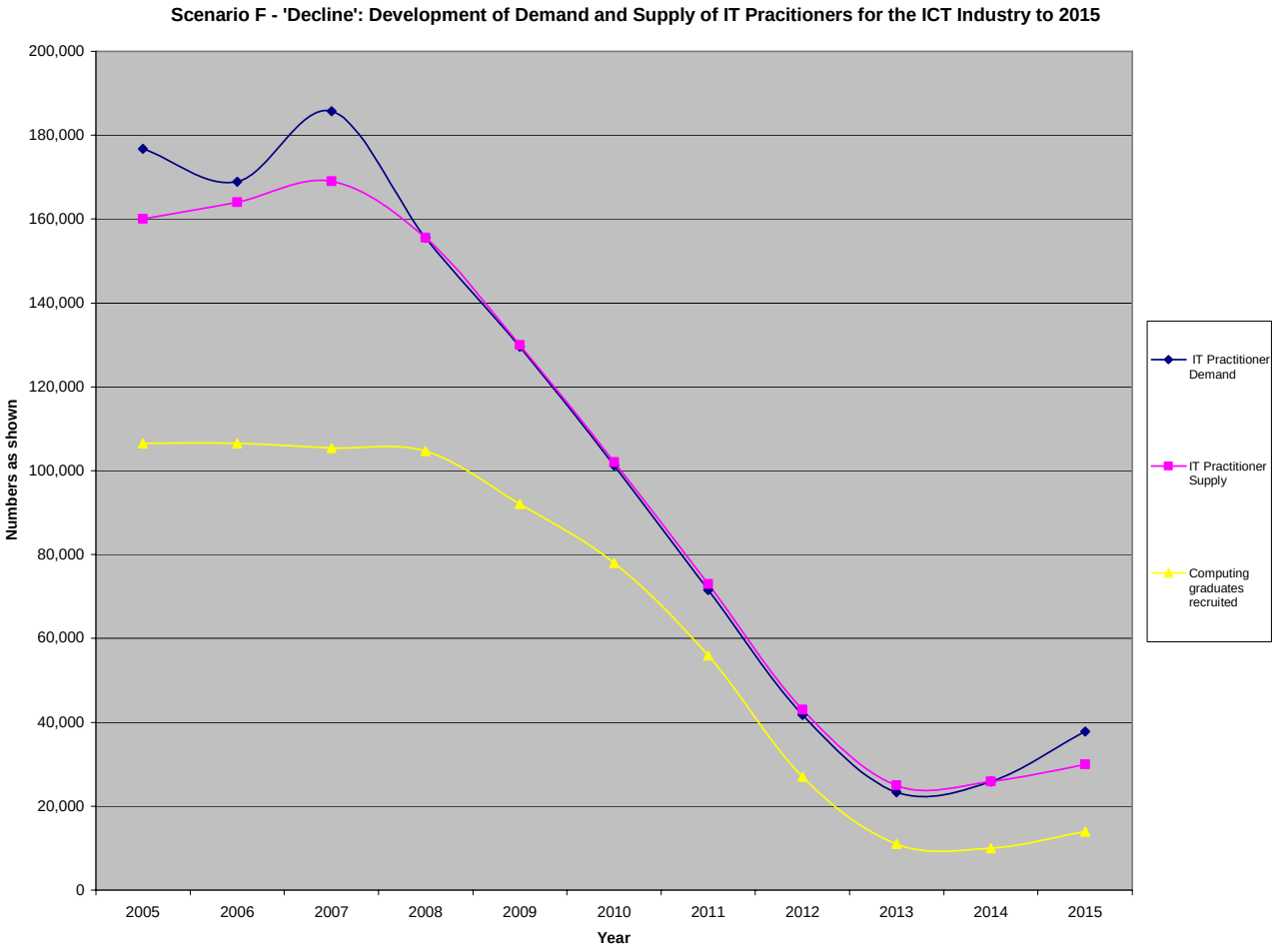


Figure 24: (Net, new) EU Supply and Demand Trajectories for F: *Decline*

All three *core drivers* are now in states that reduce net new demand for IT practitioners. Only 2007 has new demand above the 2005 level, and 2008-2013 sees strong falls, to levels that reduce significantly the fraction of emerging informatics graduates recruited by the ICT Industry. Recruiting ICT enterprises continue to seek experienced IT practitioners as part of their 'new recruits', and the numbers of technical graduates recruited falls to unusually low levels. 2014 and 2015 see a modest pick up in demand, to which supply levels take time to respond.

More detailed *Implications* of the scenario for the Industry and for various areas of policy are presented in Section 10.

9.7 Quality of Supply

While the overall supply and demand of the ICT Practitioner labour is an important starting position from a policy point of view, the total numbers have two important limitations:

- a focus on the overall numbers masks the question of the *quality* of skills supply;
- restricting discussions to the overall numbers ignore the importance of the *excellence* (of a comparatively *very small number* of key people – technical or business leaders) in influencing the generation of innovation, wealth and future competitiveness.

It is important to recognise that *level of skills* and *quality of skills* supply are not identical. It is possible to have a certain scale of demand for people at the intermediate level while the corresponding skills supply levels are not as great. In particular there is growing recognition that, in relation to the supply of 'new' graduates from Higher Education informatics courses, there is an issue about the academic achievement levels of entrants to such courses. This concern arises in two ways:

3) the achievement levels in the secondary education completion assessment (e.g. Baccalaureat/Matura/'A' level examinations);
4) the comparative competition for admission to informatics courses.

Thus, for example:

- in Sweden the ratio between applicants and acceptances on HE informatics courses is reported to have fallen by nearly an order of magnitude in less than 10 years;
- the 'A' Level 'scores' of those applying for HE informatics courses in the UK are among the lowest for all subject areas.

Moreover, reports from the industry (as reflected, for example, in the current push for greater professionalism in the UK led by the British Computer Society) generally confirm a growing attention to the need for greater quality of ICT practitioners. This arises at least from:

- The relentless need for increased productivity as global competition bites more strongly, and
- The higher expectations that greater opportunities for sourcing skills and labour from other economies bring.

In effect, this is increased competition arising from globalisation, both for the products and services of the ICT Industry, and for the human resources needed to deliver them

Part 3: Implications, conclusions and recommendations

10 Implications of the Scenarios

The future is very unlikely to look precisely like what is described in any one of the six scenarios developed for the Study, and review by the validation workshop with expert participants suggested that none of them can be ruled out as being inherently implausible (although their 'desirability' to those in the ICT Industry obviously varies remarkably!). The prevalent feeling at the workshop was that the future is most likely to resemble the more "optimistic" of the 'middle range' of scenarios, implying comparatively higher levels of demand for ICT Practitioner skills.

In fact the validation workshop, with participants including representatives from some Member State ICT Industry bodies, ranked the Scenarios in the following order, in terms of "how much their features are likely to characterise the actual future that we will confront":

- Scenario C ('Global')
- Scenario B ('Steady Climb')
- Scenario D ('Fight back')
- Scenario A ('Renaissance')
- Scenario E ('Dark Days'), and
- Scenario F ('Decline').

A subsequent meeting involving senior figures from the ICT Industry reached a consensus that the future was most likely to be reflected by Scenario A ('Renaissance') or Scenario B ('Steady Climb').

It will be important to monitor events as they unfold, to track what sort of trajectory is developing. Flexibility and capacity to deal with different contingencies will remain important, since a given policy measure or other response is likely to lead to different results in different scenarios, and strategies will need to be evolved as one or other scenario trajectory becomes apparent. The major implications for each of the six different scenarios are summarised in this section, although there are inevitably some similar points made between scenarios whose outcomes in terms of e-skills have responses in common.

10.1 Implications of Scenario A: 'Renaissance'

If the future seems to be evolving along the lines indicated in this scenario, with more substantial skill shortages forecast for 2010 and 2015, the ***implications*** that might arise for different sets of stakeholder and policy would include:

- ***for skills policies:***

Education Ministries: increased effort to make Higher Education informatics courses more attractive than other destinations for talented school leavers. This might include extra grants, relief from military service, and other similar measures. Primary and secondary level ICT education should be supported and elaborated to help improve the quality of intake for ICT courses in higher education.

Universities: increased effort to enhance the quantity and quality of informatics course provision, to extend it to wider parts of the population, to utilise e-learning facilities, etc.

Other stakeholders: private sector training activities will make their contribution to meeting demand – for ICT skills in general, and for new ICT skill specialisms; multi-stakeholder or public-private partnerships could be fostered as a way of providing creative solutions to shortages.

- ***for innovation policies:***

Need for innovation in particular in:

- e-learning;
- rendering ICT systems more user-friendly and maintainable by those with lower skills;
- automation of programming and software engineering; and
- making more use of standardised components and configurations.

- ***for other policy areas:***

Immigration: allowing more flexible recruitment from overseas, establishing frameworks for guest workers that facilitate social cohesion and good working conditions.

- ***for the ICT Industry:***

Both larger and smaller firms will need to strengthen or contract-out more training for their staff. They may also play important roles in improving the coherence of signals to Universities on the needs of industry for ICT Practitioner skills. Some 'Golden Hello's for new recruits, and offers of continuing structured training.

- ***for IT Professional Associations and Trade Unions:***

Recruitment of the swelling numbers of ICT practitioners, and ensuring that members can be kept abreast of changing technologies and practices, will be a priority. The Associations can play major roles in keeping Universities briefed on current trends in practice and labour markets. Associate Membership schemes to facilitate closer engagement with undergraduate and postgraduate students.

10.2 Implications of Scenario B: 'Steady Climb'

If the future seems to be evolving along the lines indicated in this scenario, many of the implications that might arise for different sets of stakeholders and policy-makers would follow those summarised for scenario A. The skill shortages are less acute here, however, so it would be harder to persuade policymakers and other stakeholders of the need for urgent action to address shortages. (In part the closer match between supply and demand than in Scenario A is expected to derive from such policy action and market adaptation to the shortages. But shortages are also less acute because of the lower pace of technological change that is assumed in this Scenario). The ***implications*** would include:

- ***for skills policies:***

Education Ministries: this scenario implies no great shortage of entrants to ICT courses; the goal must be to ensure that the best recruits are taken on, and that courses are delivered to high standards.

Universities: graduates will enter a more competitive world since demand is less strong than in scenario A. Many jobs will be available, but the best jobs will be hard to get. Candidates need to be equipped with practitioner skills (including business and interpersonal skills) and capabilities to market themselves.

Other stakeholders: continuing demand for private sector training, though less focus on new technologies and applications than in Scenario A. (To some extent standard tools will already be used in University courses, but there will always be a need for accreditation and more specific training than Higher Education Institutions are able/likely to provide.)

- ***for innovation policies:***

Given relatively slow pace of innovation in ICT, attention needs to be given to possible obstacles here (such as concerns over security, etc.)

- ***for other policy areas:***

Trade: the assumption is that increased world trade and openness continues, but with some internal difficulties in parts of the world rendering these less attractive for the off-shoring that industry would otherwise want to undertake.

Immigration: there will be pressure to allow greater entry to those with ICT skills.

- ***for the ICT Industry:***

Investment in in-house training, perhaps with government support and agreements or regulations limiting "poaching" of trained staff.

- ***for IT Professional Associations and Trade Unions:***

Codes of conduct or contracts concerning ICT system security and quality, possibly also dealing with mobility (e.g. "paying back" employers who have provided training).

10.3 Implications of Scenario C: 'Global'

If the future seems to be evolving along the lines indicated in this scenario, the implications that might arise for different sets of stakeholders and policy in many ways follow those sketched in for Scenarios A and B above. But in this Scenario, while the skill shortages in 2010 resemble those of Scenario B, the picture is that these become much less acute by 2015. (In part this is again expected to derive from market adaptation and certain policy action in response to the shortages. This does not reduce the need for effort to persuade policymakers and other stakeholders of the importance of addressing strategic needs and shortages. But in part it derives from higher levels of off-shoring.) The ***implications*** would include:

- ***for skills policies:***

Education Ministries: as in the previous scenarios, energetic promotion of University informatics courses is anticipated. ICT training through earlier (primary and secondary) stages of education remains important, preparing young people for more advanced study and upgrading e-skills more generally.

Universities: will need to focus on comparative advantages as compared to emerging economies where cheap skills are available and work is being off-shored. Given a high rate of technological progress, this would include more emphasis on new and sophisticated ICT practitioner skills, on specialisms reflecting new technologies and application areas, and on ensuring high quality student output, etc.

Other stakeholders: likely to be high demand for short courses giving accreditation in new ICT practitioner skill specialisms.

- ***for innovation policies:***

Rapid innovation is underway, implying support for creation and diffusion of new technologies. Attention to skill mismatches and support for technology development that might reduce these – e.g. enabling e-learning and remote working, avoiding proliferation of standards and languages, etc. – would be important.

- ***for other policy areas:***

Trade: Continuing support for liberalisation of markets and procurement rules in areas where ICT investment is likely to be substantial.

Immigration: Flexible policies to enable recruitment of scarce skills from overseas.

- ***for the ICT Industry:***

Both bigger and smaller firms are likely to respond to skill shortages by outsourcing and off-shoring ICT Practitioner work. This will require development of appropriate management skills and "absorption capacity" for the work that is done, to ensure quality and coordination of effort. Appropriate risk management and security systems will need to be in place.

- ***for IT Professional Associations and Trade Unions:***

Play a proactive role in identifying areas of shortages and mismatch, and especially in establishing where there are most opportunities for EU informatics graduates and other ICT practitioners to provide the economy with offerings that are more cost-effective than those derived from other parts of the world.

10.4 Implications of Scenario D: 'Fight back'

If the future seems to be evolving along the lines indicated in this scenario, skill shortages will be evident in 2010 and 2015, though to a lesser extent than in Scenario B. Rapid technological change is underway, but the world economy is problematic. Again, effort is required to stimulate action to address the shortages. Off-shoring is only moderately adopted as a response, in part because of global problems. The ***implications*** that might arise for different sets of stakeholders and policy here would include:

- ***for skills policies:***

Education Ministries: as in other Scenarios with rapid technological change, a need for support of ICT training in primary and secondary education, preparing young people for more advanced study (as well as upgrading e-skills in society at large).

Universities: important for courses to address leading edge skills, as new technologies and applications are being developed, as well as increasing the volume of training to address skill shortages.

Other stakeholders: As Scenario A, need for contributions from private sector training and scope for public-private partnerships.

- ***for innovation policies:***

Innovation is being adopted as a way out of economic difficulties both by private firms and public services, and is supported both by managers in these sectors and through public policy, as a tool for enhancing efficiency and improving the quality of goods and services. Policies to support innovation via the public science and engineering infrastructure and funding for ICT innovation are therefore important.

- ***for other policy areas:***

Trade: maintaining open trading regimes will be a major, but highly challenging, task.

Immigration: there will probably be significant migration pressures from people at all skill levels, but recruitment of ICT practitioners from overseas will be required by the ICT Industry, and suitable policies should support this.

Regional inequalities may need to be addressed, not least with possible clustering of ICT supply companies (and outsourcing to these: regional policymakers will need to work hard to attract these industries).

- ***for the ICT Industry:***

Commitment to innovation as a source of competitiveness and instrument for supporting dynamic market development in difficult times, requires sophisticated management strategies, and exchange of information about good practice in R&D management, design, systems integration, etc. Given a high level of intra-EU outsourcing, attention to the management of outsourced operations is critical.

- ***for IT Professional Associations and Trade Unions:***

Important role in identifying promising application areas, new skill needs - perhaps in validating new credentials.

10.5 Implications of Scenario E: 'Dark Days'

If the future seems to be evolving along the lines indicated in this scenario, the picture for the ICT supply side is rather challenging. Initial skill shortages in 2010 are replaced by a surplus of trained practitioners by 2015. (The professions remain attractive to potential students, however, because these look to be areas where there might be more job opportunities in hard economic times.) The pace of technological change and the amount of off-shoring, are only moderate, at best. Many ***implications*** of this scenario resemble those of Scenario D; they would include:

- ***for skills policies:***

Education Ministries: need to monitor the evolving situation of skill mismatches so as to be able to respond effectively to volatile developments.

Universities: face little shortage of applicants for HE informatics courses, but increasingly students may fail to find work immediately, so Universities have a responsibility to adapt course provision flexibly so as to provide graduates with appropriate mixes of technical and business skill.

Other stakeholders: also need to respond flexibly to shift in skill mismatch context.

- ***for innovation policies:***

Innovation remains important for wealth creation and quality of life, though budget pressures are likely to lead to reduced government support for large-scale research programmes. It will be important for tight budgets to be used wisely, with effective prioritisation, coordination of resources (across departments and different Member States), etc.

- ***for other policy areas:***

Trade: maintenance of trade links with reliable partners, and efforts to encourage and support stable regimes at a global level.

Immigration: sensitive policies needed to cope with changing EU circumstances in a volatile world.

- ***for the ICT Industry:***

Firms will need to cope with the changing availability of skills, and the likely difficulties created by variable access to imported technologies (especially hardware); likely to be more emphasis on maintaining and renovating legacy systems (and the associated skills). As in several other scenarios, need for skills to manage intra-EU outsourcing (driven by efficiency/cost-saving imperatives).

- ***for IT Professional Associations and Trade Unions:***

Major role in alerting members and potential members to the changing economic situation for demand for skills, and helping to promote solutions for adaptation.

10.6 Implications of Scenario F: 'Decline'

This scenario is even more 'gloomy' than Scenario E, and supposes a surplus of trained ICT practitioners in 2010, and even more so in 2015 – together with a (relatively) high degree of off-shoring of such work. If the future seems to be evolving along the lines indicated in this scenario, the strategic and policy responses resemble those for Scenario E, but would need to be undertaken even more strongly. These ***implications*** for different sets of stakeholders and policy-makers would include:

- ***for skills policies:***

Education Ministries: consider whether a shift in focus in education policy is appropriate to the difficult economic circumstances – if education is not simply to be a way of keeping young people from the unemployment register. More engagement of students with placements and similar work experience might be an appropriate strategy, aligned perhaps with "public works" as noted below.

Universities: given the reduced demand for conventional ICT practitioners, more focus on developing hybrid skills, and especially on cultivating entrepreneurial and self-reliant attitudes, might be appropriate. The key strategy will to be providing better labour-market-relevant education and training to that available to future ICT Practitioners in the emerging economies that are supplying cheaper skills.

- ***for innovation policies:***

Given the depressed state of much industry, public support for innovation would need to be strengthened.

- ***for other policy areas:***

"Public works" to help stimulate economic activity and support industries and regions could include a strong ICT element, for instance in upgrading transport and other infrastructures, maintaining environmental quality, etc. Strategies to promote industrial use of EU ICT skills, rather than off-shoring its requirements would need to be creatively developed. For instance, some relief from common burdens to do with employment law, taxes, or regulations might be in order; support for industrial training schemes, flexible working, etc.

Trade: efforts to maintain openness to critical imports of ICT components and systems would be vital. There will be pressures to limit off-shoring, though industry voices will speak out loudly in its favour. The arguments on both sides would warrant serious attention, and policies should be avoided that might trigger retaliation and threaten already precarious international trade relationships.

Immigration: policy here will be a major source of controversy, since pressures from economic and environmental would-be migrants will be strong. With little scarcity of ICT Practitioner skills, selective support for migrants with entrepreneurial and similar business skills might be most appropriate.

- ***for the ICT Industry:***

The temptation to downsize ICT practitioner staff will be a strong one, and it is important to recognise that what opportunities do exist are likely to depend upon creative and innovative use of ICT. Paradoxically, this may mean upgrading the quality of in-house ICT practitioners.

- ***For IT Professional Associations and Trade Unions:***

The pressure from both unemployed and/or under employed members will be strong, and is likely to be translated into demands for government support for these workers (especially by stimulating relevant industries through procurement and other means). But the Associations and Trade Unions could also be active in promoting retraining in more adaptive skill sets; in mobilising underemployed practitioners in *pro-bono-publico* and innovative work, and other such approaches.

11 Generic Implications: Strengths, Weaknesses, Opportunities and Threats

The purpose of this section is to analyse the generic implications of the preceding, quantitative and qualitative analysis. These two perspectives on the development of the ICT Market in Europe in the coming years and their implications on e-skills laid out in Part 2 highlight a number of areas of importance for Industry leaders, social partners other stakeholders and policymakers. Following this analysis of the generic implications and possible responses, a brief SWOT analysis is presented summarising Europe's current status in the e-Skills domain.

The first is the need for European enterprises and workforces to recognise and actively respond to the realities of globalisation and its implications. The debate on off-shoring, initially in the US and more recently gaining ground in certain EU Member States has produced an understandable climate of concern, fear and hostility within parts of national workforces.

It is noteworthy that Trades Union bodies (for example UNI[25]) with members in both European and Asian countries, appear to be responding with a range of realistic, constructive initiatives and perspectives (in particular in the context of contributions to the European Economic and Social Committee: Consultative Commission on Industrial Change (CCMI)). While they seek to ensure that employers do not unreasonably exploit the upheavals around moves towards global sourcing, many are working at the national level to contribute to e-skills policy. They also seek to gather sound data on what is going on in order to clarify trends to ensure a valid basis for policy analysis.

Most larger European companies in ICT Sector, are already responding actively to the globalisation challenge. Many of the larger European players are actively engaged both across the EU and in a range of economies across the world. Employers of many kinds have taken up the opportunities offered by the growing wideband telecommunications infrastructure. They have done this by exploring possibilities for engaging human resource from countries with significantly lower cost bases, whether within or beyond the boundaries of the European Union. However, the situation is not as positive for SMEs within the European ICT Industry. Ovum (2006) in particular outline the greater challenges that exist – as in certain other areas of policy – to smaller businesses in handling the challenge. Table 42 overleaf shows some options open to enterprises in responding to growing global competition, and illustrates the main skills-related aspects of the different options.

[25] Union Network International

Examples of ways for enterprises to respond to the rise of competition through globalisation:

Business Response to competition	**Possible Operational Means or Measure**	**Possible Skills Implication/ (increase) Need**
Improve the quality of product or service	Improve QA processes	Business Process change management skills; Improve HR commitment and motivation
	Improve Product/Service spec.	Development/Engineering resource (+ infrastructure) required
Reduce the price of product or service	Reduce cost base through greater efficiency	Improve employee contribution through leadership and training
	Reduce margin	(senior management skills)
	Reduce HR cost base through out-sourcing or off-shoring certain business processes	Assessment and negotiation skills; HR Management skills for transition; Supplier Management Skills
	Reduce HR cost base through pressure on remuneration levels	Negotiation/Motivation skills
	Reduce HR cost base through use of migrant workers (from other Member States and beyond EU	Recruitment expertise; general HR management (of employees from different cultures)
	Reduce HR cost base through automating certain business processes	ICT Practitioner (and some other) skills required to produce automated systems
	Reduce cost base through increased use or more efficient development processes (e.g. Software Engineering) and/or use of Open Systems software	Increase of ICT Practitioner skill-base in these areas
Accelerate Speed to Market of new products/services	Improve processes for product/service development	Leadership skills;
Increase Market Share	Major Marketing Campaign/ Innovation	Sales/Marketing skills and commitment
	Acquisition of competing Enterprise(s)	Financial Expertise M&A Management
Enter new geographical markets	Direct entry	Sales/Marketing and language/ cultural expertise skills
	Indirect entry	Marketing, Negotiating, liaison skills
Develop/Refine Market Niche position	Identify/develop existing market niche	Monitoring possible new competition within the niche
Innovating to create new products and services that provide better solutions for current or emerging client needs	Improve (or establish) arrangements that stimulate innovation	Incentives for innovating ideas; seek imaginative new recruits
	Increase investment provision for Research/Development	Investment alliances Research/Development leadership
	Make new innovation alliances – both to research centres and to innovating clients	Relationship- handling skills

Table 42: Responding to growing global competition: the skills implications

While the above list is not intended to be exhaustive, and the ideas are not new (indeed such responses are options for responses to any type of competition- not just global competition). Many of the best responses to the growing competitive threat arising from globalisation will need to come

from these areas, and the skills implications are often the most challenging in the implementation of business change.

The second major issue thrown up by the analysis is the balance between the role of the industry and that of policy in relation to skills.

The issue is strongly highlighted in the apparent paradox presented by two reports about e-skills published at more or less the same time in 2005:

- The Rand Europe report on the supply and demand of e-skills in Europe.
- The IDC report, commissioned by Cisco, on Networking Skills in Europe.

While Rand Europe analysed what had happened in the past (1998-2004) based on official statistical data available; the IDC survey looked at the future (2008) for the needs of specific skills. However, serious work on futures needs to be based from current realities and recent trends.

There is a dichotomy between analyses carried out by ICT industry players drawing on industry surveys and methodologies and that drawing on official data. In the first place, there are the fundamental differences between the two data sources used:

	+	-
Private Sector data	Generally more up to date, and reflecting industry perspectives, priorities and ways of viewing the analysis, in particular industry oriented skills/ occupational classifications – generally covering a finer level of detail	Generally not using classifications that can allow comparison with official data, and not open to peer review. Estimates often viewed as higher than might be expected, and forecasts have generally turned out to be unrealistically high
Public domain data (official statistics)	Occupational (EULFS) employment data available on a broadly comparable basis for all Member States based on generally adequate (if not ample) sample sizes and available quarterly. Labour Force Survey dataset are rather rich, allowing analysis (without additional effort) of cross-tabulations of things like age, gender, employer business (sector), employer size, working status (p/t, f/t, etc.)	Generally not available till (at EU level) some 12 -15 months behind the survey period, and generally at a rather coarse level of detail. Quality issues with occupational data arising from different national occupational classifications. Employment data is not hard-to-fill vacancy data, and therefore provides no direct measure of shortage, only employment levels (and rate of change)

Table 43: Relative merits of data sources

In addition, some observers are sceptical about private sector forecasts because they perceive that it is in the interests of the private sector (whether research company or its customer) for the skill shortage estimates to be high (This would provide an argument for the industry to press government for more investment in ICT education/training).

There has long been an interest at EU level in seeing whether a Public-Private Partnership could be developed in this area in the spirit of drawing on the strengths of both research worlds. While a concerted effort is one of the recommendations of this report, it is necessary to reflect on the context of the two kinds of studies.

The SWOT analysis overleaf summarises how European ICT Industry is positioned in relation to these key factors for e-skills.

11.1 Strengths

- Europe has a rich heritage of cultural value that could be exploited.
- Parts of Europe have specific ICT comparative advantage.
- Europe has a particularly strong knowledge-based economy (perhaps less skill-based than some other economies).
- Europe's universities are going through a period of considerable change, that could be built on to strengthen their market responsiveness.

11.2 Weaknesses

- Europe's universities have a weaker tradition of active collaboration with Industry than universities in some 'competitor nations'.
- Europe's Small and Medium Enterprises (SMEs) are generally not considering the threats presented by globalisation.
- Some parts of Europe have comparatively poor ICT productivity and innovation.
- ICT User skills are sometimes not as developed as those in (e.g.) United States.
- E-Business skills are probably not as highly developed as in other economies.

11.3 Opportunities

- Continued mobilising the single European labour market to support ICT development in existing centres of excellence.
- Continuing to mobilise the out-sourcing contribution of new Member States.
- Working with Social Partners to find effective ways of managing off-shoring while keeping strategic skill-bases within the EU.
- Pioneering effective Public-Private Partnerships.

11.4 Threats

- Slow responses to international competition.
- Excessive remuneration expectation.
- Serious political backlash to growing off-shoring.
- Social backlash against liberalising labour markets.

A range of perspectives on the strategic position of e-skills in Europe has emerged from consultation with ICT Industry representatives, including the following:

- Globalisation and change are inevitable. Europe needs to focus on the next wave of technology – healthcare, bio, nano, rather than try to stop basic economic trends.
- Trend will be towards the centralisation of complexity, with an improvement in ease of use.
- Moving rapidly to a 'network of things' whereby cars, houses, domestic appliances etc. will be connected to the network. This will significantly increase the demand for future IT hardware & software.
- ICT devices will become easier to use, and ICT User skills will not require significant training. These devices will be able to focus on the effective and creative application of ICT: users can create the next generation of applications and products.
- By contrast Practitioner skills will grow in demand: Infrastructure development (systems programming) and system admin skills.
- Need to convince young people of the economic benefits of ICT education/training.
- The importance of physical location will continue to decline.
- The ICT industry has had to cope with rapid changes over its lifetime. Given that different skill-sets will be needed in the future, it will need to continue to do so. In principle, the growing realisation of young people that there is no career for life will help support fast responses.
- The expected strong growth in ICT-enabled services needs a corresponding new academic body of knowledge.
- The management and maintenance of the ICT infrastructure will be concentrated in a way that will require major concentrations of highly specialised ICT Practitioner skills, instead of skills being available in a distributed and fragmented way.
- E-skills implications of the developments in internet technology referred to as Web 2.0: the full exploitation of these emerging technologies, good practice sharing, supporting the creation of user communities, and communicating success stories.

12 Policy implications

What implications does this analysis raise for Policy in relation to the ICT Industry in Europe?

12.1 Responding to globalisation

In terms of responses to globalisation, it is the essence of private enterprise that the company leadership has the freedom to respond to its market environment in the way it chooses. This includes the choice to ignore competitive threats and perhaps even ultimately go out of business. There a real question about what role there is for policy, either at an EU or at a Member State national level. Most Member State governments already provide basic information and analytical services concerning globalisation trends, and support is often available for fact-finding missions and market intelligence gathering.

12.2 SME policy

As with most areas of economic policy, Small and Medium-sized Enterprises, while generally more nimble, are less able to make strategic responses due to their limited capacity to make major changes beyond their core business mission. This confirms that policy-makers should focus initially on *their* needs, in this case in relation to responding to globalisation and acquiring adequate e-skills. While there are many aspects of skills management that pose problems for SMEs across the economy, the greatest need is to identify, and where appropriate respond to market failures relating to ICT SMEs.

12.3 Evaluating industry programmes

As indicated above, the dichotomy between the industry and public policy perspective of ICT Practitioner skills challenges needs to be addressed. One important way to do that might be for policy to review the experience that major ICT companies have had with their educational and training programmes, to identify what lessons can be learned for policy. Since such companies argue that these programmes have been initiated to fill gaps in existing (public) provision, then it is likely that experience with the programmes can provide insights into possible future policy opportunities.

12.4 Implications for educational curricula

In spite of the many limitations, it is worth continuing to review the processes for refining/developing new Tertiary ICT courses. It may be that growing interest in university course accreditation (for example in Engineering through initiatives like EUR-ACE[26]) could provide an opportunity for innovative ways to tackle university industry mis-alignment.

[26] see 4.3.4

12.5 Hybrid Skills

It is clear that the area of 'hybrid' skills or at the very least greater business awareness and understanding for ICT Practitioners is one of the major signals emerging from this analysis. The innovation that will be critical for generating new business and creating new value is evidently going to depend on explorations between traditional disciplines. New ICT-enabled services are likely to draw on co-production: creative collaboration between ICT supplier and User organisations. These needs are clearly very much in the e-Business skills area, and this suggests that sources of e-Business skills – not least business schools – have an important role to play.

13 Implications for the ICT industry in Europe

This report has attempted to present a holistic perspective of the e-skills situation for the ICT industry. It is hoped that ICT companies in Europe, and the organisations that represent them, will gain certain insights from the work.

The following implications for the ICT industry seem evident.

13.1 Over-riding need to initiate and sustain innovation

Various approaches could be considered, including:

- fostering an innovative environment in the company to support, encourage and reward those who come up with ideas for new or enhanced ICT applications;
- exploring contact with a relevant university research team, and investigate possible mechanisms for strengthening knowledge transfer from the laboratory (e.g. secondment of researchers);
- working closely with selected User organisation customers, to identify areas of opportunity for new applications/products/services;
- exploring possible strategic alliances with leading-edge technology companies.

13.2 Work to better understand the ICT practitioner labour market

This could be achieved through such measures as:

- Encourage debate with each national ICT industry (and at European level where possible) around the nature of the ICT Practitioner labour market – openly recognising that there are competitive, as well as common need aspects to the skills supply situation.
- Contribute to discussions with policy-makers about improving common understanding of skills issues.
- Improve communication with technical employees, so there is better mutual understanding about the needs of both sides leading to greater retention and better early warning of possible threats to the employer.

13.3 Learn from the growing experience of off-shoring, to increase the cost-effectiveness of Human Resourcing

- Securing world-class human resourcing will be increasingly necessary for success in the global market-place. Documenting and disseminating experience with this option could significantly reduce risk, in particular for Smaller Businesses.
- National ICT bodies and social partners have an important role to play in this dissemination.

13.4 Work to establish more coherent and committed representation to focus on e-skills at the European level

- Stakeholder partnerships must get beyond the rhetoric that sometimes prevails in EU-level discussions: 'Public Private Partnerships' for e-skills must both explicitly recognise the different interests of each stakeholder and involve real commitment to adjusting approaches and practice where necessary in order to achieve improvements.
- Work towards a single, authoritative body to represent the ICT Industry in relation to skills, in order to reconcile the areas where individual companies proceed in a competitive relationship and those where there is sufficient common interest to ensure real commitment to active collaboration with the EU Institutions.

14 Findings and Proposals on assessing future e-skills developments

The study has explored and clarified the very considerable complexity involved in trying to understand the forces likely to be at work in influencing the future development of e-skills for the ICT Industry in Europe, and so assess how they may develop.

The question then becomes, given what has been learned in the project, what conclusions can be drawn about future efforts in this direction? There are four main aspects of this.

14.1 The nature of the two scenario perspectives and their value in bringing new insights.

By making the qualitative and quantitative perspectives on the future of e-skills for the ICT Industry in Europe broadly coherent, it has been possible to support the visualisation of future developments. It must be noted that the two perspectives presented (in sections 8 and 9) are not, and probably could never be, 100% mutually consistent. This is because the mathematical model is – and for understanding, should remain - comparatively simple, involving a relatively small number of factors. By contrast the purpose of a set of scenarios includes the need to allow the analyst to become aware of all kinds of factors – including 'wild cards' – that could play a role in the world of the future.

Having used this approach, it has been recognised that there is a trade-off when presenting both quantitative and qualitative perspectives of the future. The balance is between having the descriptive scenarios with a relatively wide range of drivers varying between them, and the 'core-model' of scenario variations, where it is possible to get a feel, in an qualitative way, for how a very small number of 'core-drivers' influence what is happening. In summary, what scenario-set would be most effective for future-gazing on e-skills? Is it mainly an exercise in unstructured, free-thinking, mind-opening descriptions, or should it (also) pick up the impact realities of a very small number of the most important factors? The conclusion from this study is that there is value in considering a combination of the two.

14.2 Improving quantitative understanding of the e-skills position

It is clear from the Rand Europe report, and from related observations within this Study, that there is a real scarcity of meaningful, reliable data on which to base quantitative forecasts for the wide scope that is covered by e-skills. In 2003, the consultancy Empirica reported to Eurostat on a rather thorough analysis of e-skills and e-security statistics (Empirica, 2003). The report considered a wide range of possible statistical indicators that would, in principle, be valuable for improving the ability of policy-makers to assess, and track developments in the labour markets associated with e-skills. The problem with the report's conclusions was simple (and in no way reflects on the quality of the work): there is no realistic possibility that data would be likely to be gathered for the vast majority of the 29 'new or adapted' indicators proposed for e-skills.

While it would be possible for a survey to be initiated involving the gathering of certain (even the majority) of the indicators put forward by the Empirica study, it is not clear from where the resources for such a survey, with an adequate sample for the EU as a whole, would originate. More significantly, if we are to be able to track, developments over time of e-skills indicators (fundamental for forecasting work), then any such survey would need to be carried out regularly – in principle, at least once a year, requiring significant investment on a frequent basis.

More recently, the Rand Europe report (see Annex D) recommended combined use of seven 'complementary indicators' for "the best understanding of supply and demand within the constraints - of there being very little consistent, reliable, evidence in relation to clarifying the factual situation of the supply and demand of e-skills at the European level".

Table 44 shows the current position of data availability for these indicators, and suggests steps that could be taken in relation to each.

Proposed *complementary indicators*	**Clarification**	**Data availability position**
1) Unemployment in e-skilled occupations	From Labour Force Surveys, where (household survey) respondent indicates currently unemployed; normal occupation ISCO 213/312.	EULFS has certain data, although there are two limitations: a) the data provides no information about the skill-sets possessed the unemployed – some at least will be unemployed through failure to contribute, and b) data reliability issues are generally more serious than for employed numbers, given comparatively small sample sises
2) Number of graduates in educational fields of relevance to e-skills	Recent historical data from Eurostat (Higher) education database.	In principle available, subject to the need to clarify apparent differences between this data and reports from stakeholders (in particular, ICT Industry representatives) in Member States
3) Number of issued training certificates, for training of more than a minimum amount of days	This is taken to include certificates from a) Vocational Education and Training course completions and b) award of private sector (Industry) certifications.	Data is generally available for a), although there is very little availability of b). In both cases, there are questions about the nature and level of the certificates in question.
4) current employment in e-skilled occupations	Occupational data from Member State 'Labour Force Surveys'.	Available from EULFS (and used as key indicator in this study).
5) Unfilled or hard-to-fill vacancies in e-skilled occupations	Unfilled or hard-to-fill vacancies, especially if they are skill shortage vacancies rather than all unfilled vacancies are the 'holy grail' for skills policy work, as they are viewed as the closest proxy for skills shortage.	Datasets available from time to time from employer ('enterprise') surveys for individual Member States, but generally not using the same occupational classifications. A pan-EU employer survey of adequate sample-sise including this question would be the greatest single contribution to improved understanding of the ICT Practitioner labour market, were resources to be found to undertake it.
6) Replacement demand	This must generally be estimated from insufficient data (particularly at the European level).	Empirical evidence not generally available – more robust estimates could be gathered by exploration on LFS datasets in some Member States.
7) Replacement of jobs by off-shoring activities	There is generally only anecdotal data, mostly from gathering newspaper reports on individual off-shoring decisions, where made public. In principle, off-shoring steps could be tracked from a) (step) reductions in ICT Practitioner employment levels in the off-shoring economy and b) (step) increases in import levels of ICT services. However, generally not easy (possible) to separate such movement from other movement of the two indicators.	Some (secondary) research for off-shoring supply economies – in particular by Evalueserve for NASSCOM using unpublished sources and data (Evalueserve, 2004, 2006), and occasional consultancy reports (e.g. Ovum (2006)).

Table 44: Data availability for indicators proposed by Rand Europe

In progressing the agenda to improve our confidence in knowing how the e-skills position is developing at the EU level, it is necessary to understand what options are realistically open to (market and) policy analysis, and where resources for gathering more robust evidence might potentially be drawn from.

Although an EU-wide employer survey assessing levels of skill shortages would provide the first really valuable benchmark for assessing the possibility of market failure, it would be a one-off

(snap-shot) set of evidence whose validity, and so usefulness, would quickly fade. The chances of securing funding for regular surveys of this kind seem minimal. The consortium therefore believes that the greatest benefit in terms of return on investment to support valid policy analysis for assessing future e-skills development would come through improving e-skills related data gathering as part of *existing general purpose surveys* with EU-level consistency.

In particular, the most effective improvements could be made by:

- Working with Eurostat and Member State national statistical offices to review the quality and processes involved with the classification of IT Practitioner occupational Labour Force Survey data to ISCO for Eurostat, and recommending necessary steps for improvement/clarification;
- Working with Eurostat and Member State Education ministries to review the quality and processes involved with the gathering and submission of Higher Education data for subject areas, and recommending necessary steps for improvement/clarification;
- Working with IDC, with the support of the major ICT Industry players, to try to agree a common position in relating results derived from public and private survey and analysis on e-skills;
- Exploring the feasibility of including question(s) associated with occupational skill shortages in general (Eurostat-led) enterprise surveys (in the light of experience with the 2007 enterprise survey);
- Exploring possible interest among stakeholders in securing resources for a regular, significant employer survey for all Member States, focusing on the elicitation of skill shortage vacancies for ICT Practitioners.

14.3 Barometers and Scanning Variables

Barometers and Scanning Variables for an analysis are taken to be indicators of a) the activities under study and b) environmental factors likely to influence the development of the activities under study. Thus in relation to future development of e-skills, and in particular ICT Practitioner skills:

- Relevant *Barometers* would be the indicators of supply and demand examined in 14.2, and monitoring the development of these (where available) would enable the state of the IT Practitioner labour market on a regular basis;
- Relevant *Scanning Variables* would relate to the most significant of the identified Drivers, so that monitoring the development of these would help anticipate forthcoming change in the Supply and Demand position. Good proxies for two of the three *core-drivers* can be monitored on a regular basis, but effort will be needed to improve tracking of the *pace of Off-shoring*.

Barometers are also viewed in the context of the *Eurobarometer* survey activities that track cross-national and cross-temporal comparative social research.

Thus the most relevant/useful Barometer indicators for e-skills Foresight Scenarios work would be:

- Employment levels of IT Practitioners – split between the ICT (supply) industry and the rest of the economy (from quarterly EU LFS data). These could be disaggregated into Computing Professionals and Computer Associate Professionals (although only limited historical time-series data is available for these).
- Numbers of graduates from informatics courses (annual data, when reconciled with data from national ICT Industry bodies) (It may be possible to gather this data directly from a

significant number of Member States before each year's statistics are released from Eurostat.)

- Any available 'Graduate First Employment' data, where possible disaggregated into:
  - informatics and non-informatics courses,
  - ICT Practitioner and Non-ICT Practitioner work, and (within ICT Practitioner work),
  - ICT Industry and Non-ICT Industry employment

  (this would be annual data)
- Research is needed on improving the validity of Replacement Demand estimates – this could be done by reference to data from certain Member State Labour Force Surveys.

Data (current and recent trend) on volumes of Industry Certifications awarded in each Member State (or, if not possible, at the EU level), should be sought from the ICT Industry, ideally through the eSCC. This data could then be compared with the flows of informatics graduates, and any patterns elicited.

The Scanning Variables of greatest value to monitor would be:

- Software Investment
- GDP growth, and
- Such evidence that is available about the development of intra-EU out-sourcing

In addition, it is suggested that the Commission approach the ICT Industry bodies from the major ICT off-shoring providers – initially NASSCOM – to discuss possible joint studies to improve estimates of Off-shoring moves for ICT Practitioner work from the EU.

14.4 Proposals for periodically updating sustainable and useful e-skills foresight mechanisms

Based on experience gained in this Study, there are two main elements to how the Commission might consider next steps:

1) the most valid and effective *timing for review* of the Foresight analysis, and
2) ways to *strengthen the participation* in such work of the ICT Industry in Europe.

As can be seen from 14.3, the main barometer and scanning variable update period is annual. While the quarterly updating of LFS data on occupational employment is valuable, particularly in a fast moving field like this, the majority of the indicators are only updated annually, and an *annual review* of developments therefore makes most sense.

In order to minimise the delays inherent in the gathering of data from all Member States, it would make sense to schedule updates (and review meetings associated with them) just after the point (month) in each year when the annual updates are available – for example in the Spring months for the Eurostat Higher Education annual update.

In terms of strengthening involvement from the ICT Industry, the Consortium has made useful progress in bringing in to the project representatives from a number of Member State ICT Industry bodies. While their perspective is inevitably not directly an EU one, the additional input from those within such bodies involved in both market development assessment and skills/education work will provide precisely the grounding to national perspectives that will build greater credibility and support for EU-level work. In this context it would also be beneficial for EICTA and the European Software Association to be invited to participate.

The lessons that have been learned on the project about achieving this input are perhaps not too surprising:

- communications within industry representatives need to be brief, efficient and effective;
- people with either a 'technology or market future-gazing' or a skills/education remit can make valuable contributions (and can learn from each other);
- drafts on which feedback is desired need to be short;
- the feedback process needs to be simple, efficient and well structured;
- meetings need to be efficient and give ample opportunity to industry representatives to express their points of view, and
- there needs to be some element of the exercise that will provide them with *direct benefit for their own work*, to justify the time they can devote to this within their pressured working schedule.

15 Conclusions and Recommendations

The Report has investigated a range of aspects of the e-skills situation in Europe over the coming years. The complexity of the labour markets for e-skills has been explored, and the position of ICT Practitioner Skills in relation to the needs of the ICT Industry has been examined in some depth.

In particular, the study has shown that:

- a very large number of drivers are likely to influence the supply and demand of the different types of e-skills in Europe in the coming years;
- the vast majority of these impact one or other of three *core-drivers*: the *rate of ICT innovation*, *economic climate* and *pace of off-shoring*, which are likely to have the greatest impact on future demand for ICT practitioner skills for the ICT Industry;
- it is possible to explore, and gain new insights on, developments of ICT activity and e-skills demand and supply in the coming years through consideration of qualitative scenarios;
- for the domain where certain meaningful quantitative evidence is available, a simple but robust mathematical model can be developed and calibrated to show expected software and IT services sector employment levels corresponding to the six qualitative scenarios;
- estimates of annual net new demand for IT practitioners for this sector can be produced from these employment levels, making assumptions about the fraction of employment represented by IT practitioners and levels of replacement demand;
- drawing on these quantitative foundations, scenarios for future supply of IT practitioner skills supply in the EU show illustrative effects of ICT Industry and Policy responses to possible serious decline in numbers of good graduates from informatics courses;
- based on these assumptions, estimates for supply and demand levels in 2010 and 2015 show a wide range of possible IT Practitioner labour market conditions, including a significant number of scenario combinations for which supply shortfalls exist;
- under these scenario combinations, skill shortages of up to 60-70,000 could occur, where future high demand conditions coincide with supply limitations, but for scenarios where ICT activity within the EU falls off significantly, surplus conditions are possible.

Conclusions

The study has shown that:

10. a very large number of drivers are likely to influence the supply and demand of the different types of e-skills in Europe in the coming years;

11. the vast majority of these impact one or other of three *core-drivers*:
    the *rate of ICT innovation*,
    economic climate, and
    pace of off-shoring,
    which are likely to have the greatest impact on future demand for ICT practitioner skills for the ICT Industry;

12. it is possible to explore, and gain new insights on, developments of ICT activity and e-skills demand and supply in the coming years through consideration of qualitative scenarios built on different combinations and value of the core-drivers;

13. broad implications of each scenario on the expected future supply and demand of three *levels* of ICT practitioner skills can be analysed;

14. for the domain where certain meaningful quantitative evidence is available (the core, technical IT practitioner occupations), a simple but effective mathematical model can be developed and calibrated to show expected ICT Industry employment levels corresponding in broad terms to different qualitative scenarios;

15. estimates of annual net new demand for IT practitioners for this sector can be produced from these employment levels, making assumptions about the fraction of employment represented by IT practitioners and about levels of replacement demand, and grossing up to the ICT Industry for the EU-25, based on the relevant ratios of IT practitioner employment[*];

16. drawing on these quantitative foundations for demand, illustrative projections can be produced for future supply of IT practitioner skills in the EU in the light of different market-, ICT Industry- and policy- responses, given a possible serious decline in numbers of good graduates from informatics courses;

17. based on these assumptions, estimates for supply and demand levels in 2010 and 2015 show a range of possible IT practitioner labour market conditions, including a number of scenario combinations for which non-trivial supply shortfalls exist;

18. under the scenarios explored, skill shortages of up to 70,000 could occur, where future high demand conditions coincide with supply limitations, while for scenarios where ICT activity within the EU falls off significantly, surplus conditions are also possible.

Recommendations

In the light of these conclusions a number of **recommendations** have been distilled. These are summarised below.

a. Further elaboration of the scenarios developed in this Study in workshops and dissemination of the understanding generates, for both ICT Industry and ICT User organisations. This must include:
   - continuing review of developments to clarify actual employment levels going forward, in relation to how the model input variables developed, and
   - indicators, measures and criteria that can be agreed, which can then facilitate comparability of future studies of this kind.

The Scenario Validation workshop held at the end of the project, where the different trade-offs necessary in handling the complexity involved in trying to assess the future development of e-skills at the European level were discussed, proved the value of the approach in terms of the new insights gained by those participating. There is considerable scope for extending the exercise, initially as part of disseminating the results within the ICT industry in Europe, and then perhaps more valuably, to provide a sounding board for perspective within significant players in the ICT User sectors. As indicated, the approach should be carried forward as things develop.

[*] Such demand estimates provide useful quantitative indications of the scale of possible future developments based on the best relevant data available. However, given the considerable limitations of (even this) data availability, such projections must always be reviewed by, and tested against, the views and assessments of industry experts and evidence from specific market surveys.

b. Creation of a greater awareness, understanding and acceptance of the threats and opportunities arising from the growth of globalisation of ICT activity

Most Member State governments are already engaged in awareness activity of different kinds. Building on this, the Commission could work with social partners (stakeholders from the ICT Industry and from European Trades Unions like UNI- Europa) to draw on the latest information and execute a co-ordinated plan for dissemination of good practice in this area from within Member States.

c. Promotion of improved understanding for both the Industry and public policy of the real, quantitative position of e-skills in Europe

A more concerted effort than before should be made to establish sufficient common interest for a pilot public-private initiative to be undertaken to develop common understanding of likely estimates of e-skills needs at the European level. This would be likely to require both a) adequate investment by both private (ICT Industry) and public (European Commission) players, and b) a will by the Industry partners to commit to sharing certain aspects of the methodological approach used for estimating future levels of demand. Such an approach, if successful, could provide an important contribution to confidence-building between public policy and the ICT Industry.

d. More serious collaboration between the ICT Industry and policy-makers on the impacts of the cyclical effects of the ICT market on e-skills supply and demand

Attitudes towards skills and training aspects of ICT work follow the business cycle. When demand is strong, it is 'all hands to the pumps' – there are strong competitive pressures to deliver, and little time to devote to training. At the other extreme of the cycle, when business prospects are poor, staff generally have more time on their hands, but resources to invest in training are under great pressure. There may be ways of achieving stakeholder partnerships that over-come this "Catch 22" situation.

e. Work to improve existing EU-level data collection in relation to e-skills and meaningful benchmarking against the e-skills position in competitor economies

In addition to the serious effort to tackle the disconnect between public and private analyses and forecasts, an assessment should be made of what incremental improvements could be made to improve the quality of European official statistics of relevance to assessing e-skills. The main limitations are described by Rand Europe (2005) and have been mentioned in this report. The main task of particular importance is that of improving the quality of cross-coding of national LFS data for submission to Eurostat. Timely progress on this would 'dovetail' well with the introduction of ISCO-08. In addition, the growth of outsourcing raises more strongly than before the question of the e-skills strengths in competitor economies. There are already reports that skills shortages are appearing in India. Strategic thinking on e-skills in Europe in a global market therefore increasingly needs to be informed by growing understanding of the position elsewhere. While there are many barriers to an ability to make meaningful comparisons with some economies, this work should be progressed.

f. Examining more closely the *quality* aspects of skill shortages, and recognising the need to track *skills excellence*, in addition to overall skills volumes, in relation to ICT innovation

The focus on quantitative estimates in this Study has brought out a growing recognition of the limitations of 'lumping' all aspects supply and demand of IT Practitioners into one category. While it is clearly not possible at the European level to dis-aggregate into the kind of detail specified in ICT Practitioner skill frameworks, and the data problems will have to be addressed, it is becoming clear that the problem is both one of quantity and quality. In addition, even with more dis-

aggregation, it will not be possible to focus on the very small 'skills elites' that are most likely to make major impact on innovation. There may be ways to address this task in its own right.

g. Exploration of innovative mechanisms for addressing university-industry mismatches, including:
   - collaborative work recognising the need for better links between informatics departments and *application* communities,
   - more serious exploration of the use of *competence frameworks* as 'targets' for HE provision and mapping of informatics *bodies of knowledge* against them), and
   - creative ways of integrating elements of industry certification knowledge into HE informatics courses.

Debate on the shortcomings of Tertiary Education ICT course provision in relation to e-skills as perceived by the ICT industry tends to focus on the perceived mis-alignment between university courses and employer need. However, the range of expectations and emphases from different parts of the industry on the and the many constraints on university ICT departments, point to a need to explore alternatives to attempts to agree on what should go in a 'perfect' ICT course curriculum. On the one hand individual leading companies establish specific programmes that fit with their needs and on the other, governments, who ultimately fund the public provision, would like to support responsiveness of curricula to the fast-moving trends in the market-place. The three areas shown are strong candidates to be explored, and possible new mechanisms might include, for example:

- joint funding of elective courses that are adapted and made more generic in order to conform with university requirements for appropriate student 'credits';
- appropriate joint funding for scaling-up mutually-beneficial work-placement arrangements.

h. Joint action to counteract negative signals about ICT Practitioner work, in particular:
   - ensure that *news of Industry recruitment drives* gets through to the key audiences as well as news of redundancies, and
   - encourage choice of informatics courses by the more able senior pupils in secondary education (through better briefing material about *opportunities at graduation time*, to counteract any reports of *current job losses*)

Regular, comprehensive reports of significant new hirings and job creation would provide a counter to the news of lay-offs which inevitably gain profile in the media. Although the mechanism (presumably a web portal) would be largely funded by the ICT industry itself, the validity of the messages and labour market information would be such that it would be possible for the European Commission to associate itself with it, through appropriate branding. In addition, it is necessary to tackle the timing problem of 'labour market signalling', since negative conclusions drawn by those considering which HE course to take should be informed by the (likely) real conditions prevailing after graduation, and not those at the time of course selection.

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It is hoped that the work and conclusions presented in this Report will be found of value by interested parties, and CEPIS looks forward to engaging with the European Commission and stakeholders to further advance the understanding of e-skills in Europe, and to support measures that will help improve the position of e-skills throughout the EU.